PIPER
Customer Services

PA-31P **PRESSURIZED NAVAJO**

Service Manual

CARD 1 OF 4

PIPER AIRCRAFT CORPORATION

753 770

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material:

Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material or complete page additions are not identified by revision lines.

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INTERIM REVISION

Revisions appear in Sections III and IV of card 1, and Section XIV of card 4. Please dispose of your current cards 1 and 4 and replace them with the revised cards. DO NOT DISPOSE OF CARDS 2 and 3.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

TABLE OF CONTENTS

1A4

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1A5

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LIST OF ILLUSTRATIONS

Revised: 11/10/82

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

NOTE

Electrical schematics for Section XI, see Grid No. 3E17.

Revised: 11/10/82

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

1A13

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LIST OF TABLES

LIST OF TABLES (cont.)

GLOSSARY OF TERMS

A

Absolute Pressure - Pressure measured from absolute zero instead of normal atmospheric pressure.

Absolute Temperature - Temperature measured on the Rankine thermometer calibrated from absolute zero. The freezing point of water on the Rankine Scale is 492 ° R.

Absolute Zero - The complete absence of heat, believed to be -459.679°F. This is shown as 0° on the Rankine and Kelvin Scales.

Air Conditioner - A device used in the control of temperature, humidity, cleanness, and movement of air.

Air Conditioning - The control of the temperature, humidity, cleanness, and movement of air.

Ambient Air - Air surrounding an object.

Ambient Temperature - Temperature of surrounding air. In air conditioning work it refers to outside air temperature.

Atmospheric Pressure - Air pressure at a given altitude. At sea level, atmospheric pressure is 14.696 psi.

Atom - The smallest possible particle of matter.

B

Back Seat - (Service Valve) Turning the valve stem to the left all the way back-seats the valve. The valve outlet to the system is open and the service port is closed.

Boiling Point - The temperature at which a liquid changes to a vapor.

Brazing - A high temperature metal joining process satisfactory for units with relatively high internal pressures.

British Thermal Unit (BTU) - The amount of heat necessary to raise one pound of water one degree Fahrenheit.

C

Calorie - The smallest measure of heat energy. One calorie is the amount of heat energy required to raise one gram of water one degree Centigrade.

Can Tap - A device used to pierce, dispense, and seal small cans of refrigerant.

Capillary - A small tube with calibrated length and inside diameter used as a metering device.

GLOSSARY OF TERMS (cont.)

Capillary attraction - The power possessed by tubular bodies of drawing up a fluid.

Capillary Tube - A tube with calibrated inside diameter and length used to control the flow of refrigerant. In aircraft air conditioning the tube connecting the remote bulb to the expansion valve or to the thermostat is called the capillary tube.

Capacity - Refrigeration produced, measured in tons or BTUs per hour.

Centigrade - A thermometer scale using the freezing point of water as zero. The boiling point of water is 100°C.

Change of State - Rearrangement of the molecular structure of matter as it changes between any two of the three physical states; solid, liquid, or gas.

Charge - A specific amount of refrigerant or oil by volume or weight.

Charging - The act of placing a charge of refrigerant or oil into the air conditioning system.

Charging Cylinder - A container with a visual indicator for use where a critical, or exact, amount of refrigerant must be measured.

Charging Station - A unit containing a manifold gauge set, charging cylinder, vacuum pump, and leak detector, for servicing air conditioners.

Charging Hose - A small diameter hose constructed to withstand high pressures between the unit and manifold set.

Chemical Instability - An undesirable condition caused by the presence of contaminants in the refrigeration system.

Circuit Breaker - A bimetallic device used instead of a fuse to protect a circuit.

Clutch - A coupling device which transfers torque from a driving to a driven number when desired.

Clutch Armature - That part of the clutch that is pulled in when engaged.

Clutch Coil - See "Clutch Field".

Clutch Field - Consists of many windings of wire and is found fastened to the front of the compressor. Current applied sets up a magnetic field that pulls the armature in to engage the clutch.

Clutch Rotor - That portion of the clutch that the belt rides in and is free-wheeling until engaged.

Cold - The absence of heat.

Compound Gauge - A gauge that will register both pressure and vacuum, used on the low side of the systems.

GLOSSARY OF TERMS (cont.)

Compressor - A component of the refrigeration system that pumps refrigerant and increases the pressure of refrigerant vapor.

Compressor Shaft Seal - An assembly consisting of springs, snap rings, O-rings, shaft seal, seal seat, and gaskets, mounted on the compressor crankshaft permitting the shaft to be turned without loss of refrigerant or oil.

Condensate - Water taken from the air which forms on the exterior surface of the evaporator.

Condensation - The act of changing a vapor to a liquid.

Condenser - The component of a refrigeration system in which refrigerant vapor is changed to a liquid by the removal of heat.

Condenser Comb - A comb-like device used to straighten fins on the evaporator or condenser.

Condenser Temperature - The temperature at which compressed gas in the condenser changes from a gas to a liquid.

Condensing Pressure - Head pressure as read from the gauge at the high side service valve; pressure from the discharge side of the compressor into the condenser.

Conduction - Transmission of heat through a solid.

Conduction of Heat - The ability of a substance to conduct heat.

Contaminants - Anything other than refrigerant and refrigeration oil in the system.

Convection - The transfer of heat by the circulation of a vapor or liquid.

Cycling Clutch System - Referring to a system which uses a clutch, thermostatically controlled, as a means of temperature control.

Cylinder - A circular drum used to store refrigerant.

D

Density - Weight or mass of a gas, liquid, or solid.

Desiccant - A drying agent used in refrigeration systems to remove excess moisture.

Design Working Pressure - The maximum allowable working pressure for which a specific system component is designed to work safely.

Deoxidized - Referring to a tubing or metal surface that is free of oxide formations, which may have been caused by action of air or other chemicals.

GLOSSARY OF TERMS (cont.)

Diagnosis - The procedure followed to locate the cause of a malfunction.

Diaphragm - A rubber-like piston or bellows assembly dividing the inner and outer chambers of back pressure-regulated air conditioning control devices.

Dichlorodifluoromethane - See "Refrigerant - 12".

Discharge - To bleed some or all of the refrigerant from a system by opening a valve or connection and permitting the refrigerant to escape slowly.

Discharge Air - Conditioned air as it passes through the outlets and enters the passenger compartment.

Discharge Line - Connects the compressor outlet to the condenser inlet.

Discharge Pressure - Pressure of the refrigerant being discharged from the compressor. High side pressure.

Discharge Side - That portion of the refrigeration system under high pressure, extending from the compressor outlet to the thermostatic expansion valve inlet.

Discharge Valve - See "High Side Service Valve".

Distributor - A device used to divide the flow of liquid refrigerant between parallel paths in an evaporator.

Double Flare - A flare on the end of a piece of copper tubing or other soft metal that has been folded over to form a double face.

Drier - A device containing desiccant placed in the liquid line to absorb moisture in the system.

Drive Pulley - A vee pulley attached to the crankshaft of an aircraft used to drive the compressor clutch pulley by use of a belt.

Drip Pan - A shallow pan located under the evaporator core used to catch condensation. A drain hose is fastened to the drip pan and extended to the outside to carry off the condensate.

Drying Agent - See "Desiccant".

E

Equalizer Line - A line or connection used specifically for obtaining required operation from certain control valves. Very little, if any, refrigerant flows through this line.

Evacuate - To create a vacuum within a system to remove all trace of air and moisture.

Evaporation - Changing from a liquid to a vapor.

Evaporator - The compartment of an air conditioning system that conditions the air.

GLOSSARY OF TERMS (cont.)

Evaporator Pressure Regulator - A back pressure regulated temperature control device.

Expansion Valve - See "Thermostatic Expansion Valve".

External Equalizer - See "Equalizer Line".

F

Fahrenheit - A thermometer scale using 32° as the freezing point of water.

Fan - A device having two or more blades attached to the shaft of a motor, mounted in the evaporator, to cause air to pass over the evaporator. A device having four or more blades, mounted on the water pump, to cause air to pass through the radiator and condenser.

Field - A coil with many turns of wire located behind the clutch rotor. Current passing through this coil sets up a magnetic field and causes the clutch to engage.

Filter - A device used with the drier or as a separate unit to remove foreign material from the refrigerant.

Fitz-All - A can tap designed to be used on screw top and flat top refrigerant cans.

Flare - A flange or cone shaped end applied to a piece of tubing to provide a means of fastening to a fitting.

Flash Gas - Gas resulting from the instantaneous evaporation of refrigerant in a pressure-reducing device such as an expansion valve.

Flooding - A condition caused by too much liquid refrigerant being metered into the evaporator.

Fluid - A liquid, gas, or vapor.

Flush - To remove solid particles such as metal flakes or dirt. Refrigerant passages are purged with refrigerant.

Flux - A substance used in the joining of metals when heat is used to promote fusion of metals.

Foaming - The formation of a froth of oil and refrigerant due to rapid boiling out of the refrigerant dissolved in the oil when the pressure is suddenly reduced.

Foot Pound - Unit of energy required to raise one pound one foot.

Freeze Protection - Controlling evaporator temperature so moisture on its surface will not freeze and block the air flow.

Freeze up - Failure of a unit to operate properly due to the formation of ice at the expansion valve.

GLOSSARY OF TERMS (cont.)

Freezing Point - The temperature at which a given liquid will solidify. Water will freeze at 32°F this is its freezing point.

Freon - Refrigerant. Registered trade mark of E.I. Dupont.

Freon 12 - See "Refrigerant 12".

Front Seat - Closing of the compressor service valves by turning them all the way in, clockwise.

Front Seating - Closing off the line leaving the compressor open to the service port fitting. This allows service to the compressor without purging the entire system. Never operate the system with the valve front seated.

Frosting Back - The appearance of frost on the tail pipe and suction line extending back as far as the compressor.

Fuse - An electrical device used to protect a circuit against accidental overload or unit malfunction.

Fusion - The act of melting.

G

Gas - A vapor having no particles or droplets of liquid.

Gauge Manifold - See "Manifold".

Gauge Set - Two or more instruments attached to a manifold and used for measuring or testing pressure.

Genetron - 12 - Refrigerant - 12 by ALLIED Chemicals Company. A registered trade mark.

H

Head Pressure - Pressure of the refrigerant from the discharge reed valve through lines and condenser to the expansion valve orifice.

Heat Exchanger - An apparatus in which heat is transferred from one fluid to another, on the principle that heat will move to an object with less heat.

Heat Intensity - The measurement of heat concentration with a thermometer.

Heat of Respiration - The heat given off by ripening vegetables or fruits in the conversion of starches and sugars.

Heat Radiation - The transmission of heat from one substance to another while passing through, but not heating, intervening substances.

Heat Transmission - Any flow of heat.

GLOSSARY OF TERMS (cont.)

Heliarc - The act of joining two pieces of aluminum or stainless steel using a high frequency electric weld and inert gas, such as helium. This weld is made electrically while the inert gas if fed around the weld. This gas prevents oxidation by keeping the surrounding air away.

Hg. - Chemical symbol for Mercury.

High Head - A term used when the head, or high side, pressures of the system is excessive.

High Load Condition - Refers to times when the air conditioner must operate continuously at maximum capacity to provide the cool air required.

High Pressure Lines - The lines from the compressor outlet to the expansion valve inlet that carry high pressure liquid and gas.

High Side - See "Discharge Side".

High Side Service Valve - A device located on the discharge side of the compressor to allow the serviceman to check high side pressures and perform other necessary operations.

High Suction - Low side pressure higher than normal due to a malfunction of the system.

High Vacuum - A vacuum below 500 microns of 1/2mm Hg.

High Vacuum Pump - A two stage vacuum pump that has the capability of pulling below 500 microns. Many vacuum pumps will pull to 25 microns, or 29.999 of Mercury.

Hot Gas - The condition of the refrigerant as it leaves the compressor until it gives up its heat and condenses.

Humidity - See "Moisture".

Hydrolizing Action - The corrosive action within the air conditioning system induced by a weak solution of hydrochloric acid formed by excessive moisture reacting with the refrigerant chemically.

I

Ice Melting Capacity - Refrigerant equal to the latent heat of fusion of a stated weight of ice at 144 BTU per pound.

Ideal Humidity - A relative humidity of 50%.

Ideal Temperature - Temperature from 68° to 72°.

Inches of Mercury - A unit of measure when referring to a vacuum.

Inch Pound - Unit of energy required to raise one pound one inch.

Insulate - To isolate or seal off with a nonconductor.

GLOSSARY OF TERMS (cont.)

Insulation Tape - Tape, rubber or cork, use; to wrap refrigeration hoses and lines to prevent condensate drip.

Isotron - 12 - Refrigerant - 12 by Penn Salt Company. A trade mark.

K

Kelvin - A thermometer scale using 273°K as the freezing point of water. Absolute zero on this thermometer is the start: 459.67°F or 0°K.

L

Latent Heat - The amount of heat required to cause a change of state of a substance without changing its temperature.

Latent Heat of Condensation - The quantity of heat given off while changing a substance from vapor to a liquid.

Latent Heat of Evaporation - The quantity of heat required to change a liquid into a vapor without raising the temperature of the vapor above that of the original liquid.

Latent Heat of Fusion - The amount of heat that must be removed from a liquid to cause it to change to a solid without causing a change of temperature.

Latent Heat of Vaporization - See "Latent Heat of Evaporation".

Liquid Line - Line connecting the drier outlet with the expansion valve inlet. The line from the condenser outlet to the drier inlet is sometimes referred to as a liquid line also.

Load - The required rate of heat removal in a given time.

Low Head Pressure - High side pressure lower than normal due to a malfunction of the system.

Low Side - See "Suction Side".

Low Side Service Valve - A device located on the suction side of the compressor to allow the serviceman to check low side pressures or perform other necessary service operations.

Low Suction Pressure - Pressure lower than normal in the suction side of the system due to a malfunction of the unit.

Lubricant - See "Refrigeration Oil".

M

Magnetic Clutch - A coupling device used to turn the compressor on and off electrically.

Manifold - A device equipped with a hand shutoff valve that gauges may be connected to for use in system testing and servicing.

GLOSSARY OF TERMS (cont.)

Manifold Gauge - A calibrated instrument used for measuring pressures of the system.

Manifold Gauge Set - A manifold complete with gauges and charging hoses.

Mean Altitude - 900 feet is used as the mean, or average, altitude by engineers.

Melting Point - The temperature above which a solid cannot exist at a given pressure.

Mercury - See "hg".

Micron - A unit of measure .1,000 microns equal 1 millimeter, or .03937 inches.

Millimeter - A unit of measure .1 millimeter is 1/1000 of a meter.

Molecular Sieve - A drying agent. See "Desiccant".

Monochlorodifluoromethane - See "Refrigerant- 22".

Mount and Drive - Pulleys, mounting plates, belts, and fittings necessary to mount a compressor and clutch assembly onto an engine.

O

Operational Test - See "Performance Test".

Overcharge - Indicating too much refrigerant or refrigeration oil in the system.

Oxidize - The formation of crust on certain metals due to the action of heat and oxygen.

P

Performance Test - The taking of temperature and pressure readings under controlled conditions to determine if an air conditioning system is operating at full efficiency.

Pressure - Force per unit of area. The pressure of refrigerant is measured in pounds per square inch.

Pressure Drop - The difference in pressure between any two points that may be caused by a restriction or fiction.

Pressure Sensing Line - See "Remote Bulb".

Prestone - 12 - Refrigerant - 12 by Union Carbon and Carbide Chemical Company. A trade mark.

Primary Seal - A seal between the compressor shaft seal and shaft to prevent refrigerant and oil from escaping.

P.S.I. - Abbreviation for pounds per square inch.

P.S.I.G. - Abbreviation for pounds per square inch gauge.

GLOSSARY OF TERMS (cont.)

Psychrometer - See "Sling Psychrometer".

Pulley - A flat wheel with a vee groove machined around its outer edge, attached to the drive and driven number, provides a means of driving the compressor.

Pump - The compressor. Also refers to the vacuum pump.

Pump Down- See "Evacuate".

Purge - To remove moisture and air from a system or a component by flushings with a dry gas refrigerant.

R

Ranco Control - A trade name used when referring to a thermostat. See "Thermostat".

Rankine - A thermometer using a scale for the freezing point of water as 492°R. Absolute zero is the start of this thermometer.

Ram Air - Air that is forced through the condenser coils by the movement of the vehicle or action of the fan.

Receiver - A container for the storage of liquid refrigerant.

Receiver Dehydrator - A combination container for the storage of liquid refrigerant and a desiccant.

Reciprocating Compressor - A positive displacement compressor with pistons that travel back and forth in a cylinder.

Reed Valves - Thin leaves of screen located in the valve plate of aircraft compressors to act as suction and discharge valves. The suction valve is located on the bottom of the valve plate and the discharge on top.

Refrigerant - The chemical compound used in a refrigeration system to produce the desired cooling.

Refrigerant - 12 - The refrigerant used in air conditioners. Proper name; Dichlorodifluormethane. Chemical symbol; $C\,Cl_2F_2$.

Refrigerant - 22 - A refrigerant used in some early aircraft applications. Not used today because of him pressures. Proper name: Monochlorodifluoromethane. Chemical symbol; $C\,H\,CL\,F_2$.

Refrigeration Cycle - The complete cycle of the refrigerant back to the starting point, evidenced by temperature and pressure changes.

Refrigeration Oil - Highly refined oil free from all contaminants, such as sulfur, moisture, and tars.

GLOSSARY OF TERMS (cont.)

Relative Humidity - The actual moisture content of the air in relation to the total moisture that the air can hold at a given temperature.

Remote Bulb - A sensing device connected to the expansion valve by a capillary tube to sense tail pipe temperature and transmit pressure to the expansion valve for its proper operation.

Rotor - The rotating or free wheeling portion of a clutch on which the belt rides.

S

Saturated Vapor - Saturation indicates that the space holds just as much vapor as it possibly can. No further vaporization is possible at this particular temperature.

Saturated Temperature - The boiling point of a refrigerant at a particular pressure.

Schrader Valve - A spring-loaded valve similar to a tire valve located inside the service valve fitting and used on some control devices to hold refrigerant in the system. Special adapters must be used with the gauge hose to allow access to the system.

Screen - A metal mesh located in the receiver, expansion valve and compressor inlet to prevent particles of dirt from being circulated through the system.

Sensible Heat - Heat that causes a change in temperature of a substance but not a change of state.

Service Port - A quarter-inch fitting on the service valves and some control devices to allow manifold set charging hoses to be connected.

Service Valve - See "High Side (or Low Side) Service Valve".

Shaft Seal- See "Compressor Shaft Seal".

Short Cycling - May be caused by poor air circulation of a thermostat out of adjustment and cause the unit to run for very short periods.

Sight Glass - A window in the liquid line or in top of the drier used to observe the liquid refrigerant flow.

Silica Gel - A drying agent found in many air conditioners because of its great ability to absorb large quantities of water.

Silver Solder - An alloy of silver containing from 35% to 45% silver. Silver solder melts at 1120°F and flows at 1145°F.

Sling Psychrometer - A device using mercury-filled thermometers to obtain the relative humidity reading.

Slugging - The return of liquid refrigerant or oil to the compressor.

Solder - A metallic alloy for uniting metals.

GLOSSARY OF TERMS (cont.)

Solenoid Valve - An electromagnetic valve controlled remotely by energizing and deenergizing a coil.

Specifications - Information provided by the manufacturer that describes an air conditioning system function.

Specific Heat - The quantity of heat required to change one pound of substance one degree Fahrenheit.

Squirrel Cage - A blower case designed for use with the Squirrel Cage Blower.

Squirrel Cage Blower - A blower wheel designed for providing a large volume of air with a minimum of noise. The blower is more compact that the fan and air may be directed more efficiently.

Standard Ton - The amount of heat released while changing one ton of 32°F water to 32°F ice in a period of 24 hours.

Strainer- See "Screen".

Subcooler - A section of liquid line used to insure all liquid refrigerant to the expansion valve. This line may be a part of the condenser or lay in the drip pan of the evaporator.

Suction Line - The line connecting the evaporator outlet to the compressor inlet.

Suction Service Valve - See "Low Side Service Valve".

Suction Side - That portion of the refrigeration system under low pressure extending from the expansion valve to the compressor inlet.

Suction Pressure - Compressor inlet pressure. Reflects the pressure of the system on the low side.

Superheat - Adding heat intensity to a gas after complete evaporation of a liquid.

Superheated Vapor - Vapor at a temperature higher than its boiling point for a given pressure.

Swagging - A means of shaping soft tubing so that two pieces of the same size can be joined without the use of a fitting. The inside diameter of one tube is increased to accept the outside diameter of the other.

System - All the components and lines together make up an air conditioning system.

T

Tail Pipe - The outlet pipe from the evaporator to the compressor. See "Suction Line".

Taps All Valve - See "Fits All Valve".

Temperature - Heat intensity measured on a thermometer.

GLOSSARY OF TERMS (cont.)

Thermostat - A device used to cycle the clutch to control the rate of refrigerant flow as a means of temperature control. The driver has control over temperature desired.

Thermostatic Expansion Valve - A component of a refrigeration system that regulates the rate of flow of refrigerant into the evaporator as governed by action of the remote bulb sensing tail pipe temperatures.

Ton of Refrigeration - The effect of melting one ton of ice in 24 hours. One ton equals cooling at 12.000 BTUs per hour.

Total Heat Load - The human heat load, plus heat entering through the floor, glass, roof and sides.

Torque - A turning force such as that required to seal a connection measured in foot-pounds or inch-pounds.

U

Ucon - Refrigerant - 12. A trade mark.

V

Vacuum - Referring to less than atmospheric pressure, expressed in inches of mercury.

Vacuum Pump - A mechanical device used to evacuate the refrigeration system to rid it of excess moisture and air.

SECTION I

INTRODUCTION

SECTION I

INTRODUCTION

1-1. GENERAL. This manual contains service and maintenance instructions for the Piper PA-31 Pressurized Navajo, designed and manufactured as a versatile aircraft in the personal and business aviation field, by the Piper Aircraft Corporation, Lock Haven, Pennsylvania.

1-2. SCOPE OF MANUAL. Sections II and III comprise the service part of this manual, whereas Sections IV through XIV comprise the maintenance instructions. The service instructions include ground handling, servicing and inspection. The maintenance instructions for each system include troubleshooting, removal and installation of components, and corrective maintenance and testing; each major system of the airplane is covered in a separate section, and ample illustrations to supplement the text are located as closely as possible to the related instructions. Only qualified personnel should perform the operations described in this manual.

1-3. DESCRIPTION. The Piper PA-31 Pressurized Navajo is a six to eight place pressurized, twin-engine, low-wing monoplane of all-metal construction. The following paragraphs provide descriptions of the major components and systems.

1-4. FUSELAGE. The fuselage is a semi-monocoque structure that consists of three basic units: The nose section, the pressurized cabin section and the tail cone section.

1-5. WING. The laminar flow-wing is of all-metal stressed skin, full cantilever design, consisting of two wing panels bolted together at the center of the fuselage. The wing tips are removable. The ailerons are cable and push rod controlled and are statically and dynamically balanced. The trailing edge wing flaps are electrically operated.

1-6. EMPENNAGE. The empennage consists of the vertical stabilizer (fin), rudder with a servo trim tab, horizontal stabilizer, and elevator with anti-servo trim tabs. The control surfaces are cable controlled, and are dynamically and statically balanced.

1-7. FLIGHT CONTROLS. The flight controls are conventional, consisting of dual control wheels that operate the ailerons, and elevator, and dual foot pedals that operate the rudder. The trim tabs for each control are operated by wheels or knobs located in the control pedestal along with the position indicators for each tab.

1-8. HYDRAULIC SYSTEM. Two separate hydraulic systems are incorporated in the airplane. The main system is the hydraulic powerpak that operates the landing gear and inboard main gear door actuating cylinders. The second system operates the airplane's brake system.

1-9. LANDING GEAR. The tricycle landing gear system is hydraulically operated and fully retractable with doors that completely cover the gear when retracted. The gear struts are air-oil type units.

1-10. ENGINES. This airplane is powered by two Avco-Lycoming TIGO-541-E1A turbocharged engines, which are rated at 425 H.P. at 2133 propeller RPM. The engines are six cylinder, horizontally opposed, wet sump, fuel injected, single scroll turbocharged with pressurization air bleed, and use 100/130 minimum octane aviation gasoline.

1-11. PROPELLERS. The propellers used are Hartzell three blade, constant speed units controlled by a Woodward governor mounted on each engine. The blade diameter is 93 inches.

1-12. FUEL SYSTEM. The fuel system consists of four bladder type cells located in the wings with a total fuel capacity of 192 U.S. gallons and two bladder type fuel cells located in the nacelles with a total capacity of 50 U.S. gallons. The total fuel supply is 242 gallons. Incorporated in the system are fuel filters, submerged electric fuel pumps in the four wing cells, electric auxiliary fuel pumps, engine-driven pumps and a crossfeed system.

1-13. ENVIRONMENTAL CONTROL SYSTEM. The heating, airconditioning, ventilating, defrosting and dehumidification of the airplane's cabin are all controlled from the cabin comfort control panel located on the lower right instrument panel. The pressurization controls are mounted on the lower left instrument panel and grouped together for ease of operation.

1-14. INSTRUMENTS. Provisions for the instrument installation includes panels for engine instruments and advance flight instruments, as well as space for an optional second set of flight instruments for the co-pilot. Flight instruments are shock mounted to minimize vibration transmitted to the panel.

1-15. ELECTRONIC EQUIPMENT. Provisions for electronic equipment include various combinations of radio installations. AutoPilot and radar.

1-16. PRESSURIZATION SYSTEM. This system is capable of maintaining cabin altitudes over a range of 500 feet below sea level. to 10,000 feet above sea level. This is accomplished by the use of various valves and controls, along with bleed air from both engine compressors and pneumatic air pumps.

SECTION II

HANDLING AND SERVICING

SECTION II

HANDLING AND SERVICING

2-1. INTRODUCTION. This section contains routine handling and servicing procedures that are most frequently encountered. Frequent reference to this section will aid the individual by providing information such as the location of various components, ground handling procedures, routine service procedures and lubrication. When any system or component requires service other than the routine procedures as outlined in this section, refer to the appropriate section for that component.

2-2. DIMENSIONS. The principal airplane dimensions are shown in Figure 2-1 and are listed in Table II-I.

2-3. SERIAL NUMBER PLATES. The serial number plate for the airplane is located near the tail skid. The MAA plate is located under the lower front corner of the entrance door. The engine number plates are located on the upper rear portion of the injectors.

2-4. WEIGHT AND BALANCE DATA. When figuring various weight and balance computations the weight and empty weight center of gravity of the airplane may be found in the Weight and Balance Form of the Airplane Flight Manual.

2-5. STATION REFERENCE LINES. In order to facilitate the location of various components of the airplane which require maintenance and servicing, a method utilizing fuselage station, wing station or buttock line (BL), and water line (WL) designations is frequently employed in this manual. (Refer to Figure 2-2.) Fuselage stations, buttock lines, and water lines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 16.50 aft of the nose. Station 0 (BL) of the wing, horizontal stabilizer and elevator is the center line of the airplane; and station 0 (WL) of the vertical stabilizer and rudder is 15.82 in. above the cabin floor with the airplane level. The reference datum line is located at the main spar, fuselage station 137.

2-6. ACCESS AND INSPECTION PROVISIONS. The access and inspection provisions for the airplane are shown in Figures 2-3 thru 2-5. The component to be serviced or inspected through each opening is assigned an index number to identify it in the illustration. All access plates and panels are secured by either metal fasteners or screws.

NOTE

Before removing any access plates or panels in the pressurized portion of the fuselage, refer to Section IV to determine the sealing requirement.

The floor panels may be removed by first removing the desired seats, then removing the carpet, thus exposing the floor panel attachment screws. Carefully remove the floor panels so as not to damage the seals. To enter the aft section of the fuselage, remove the access panels on either side of the fuselage aft of station 274.

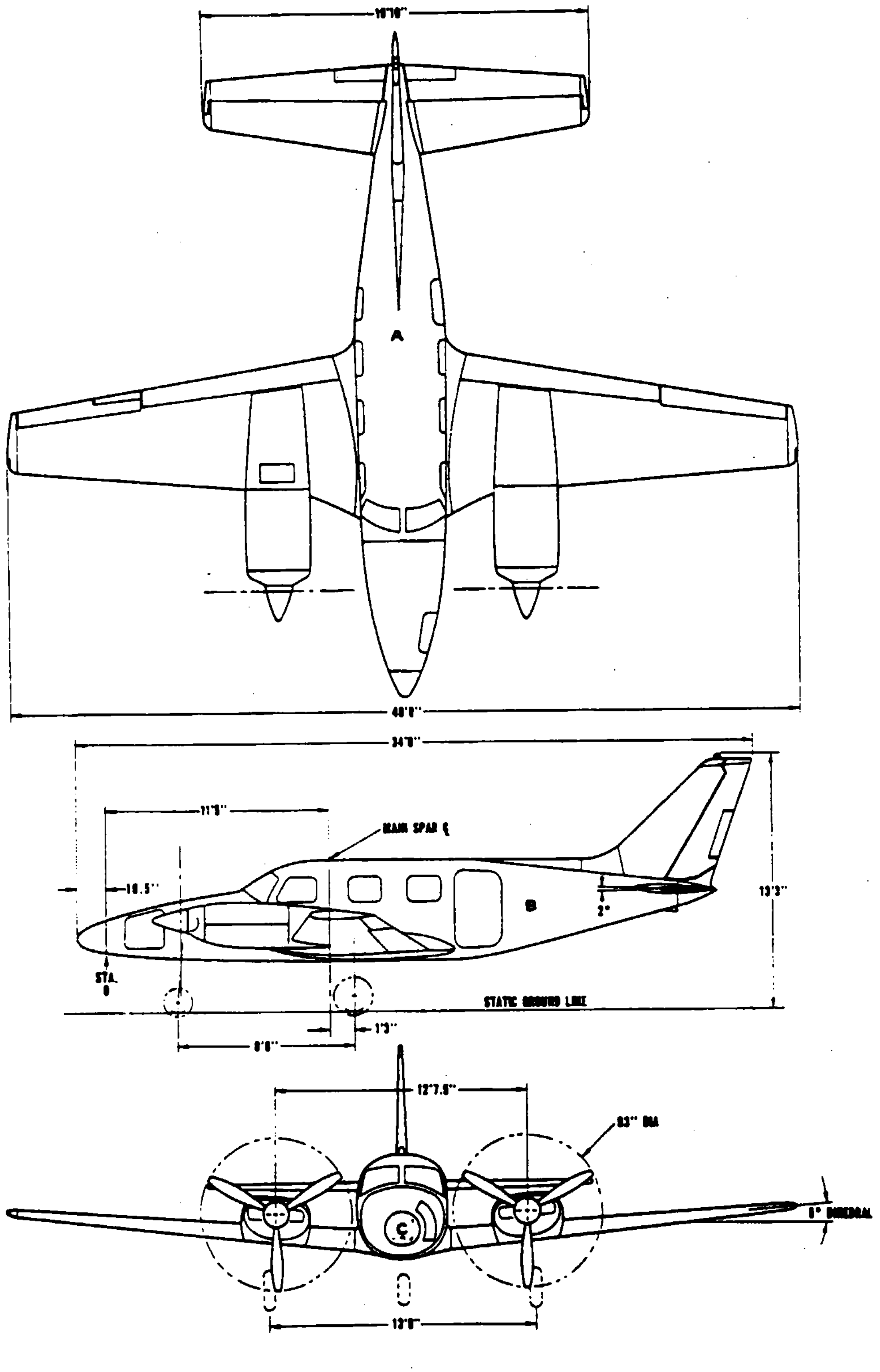


Figure 2-1. Three View PA-31P Pressurized Navajo

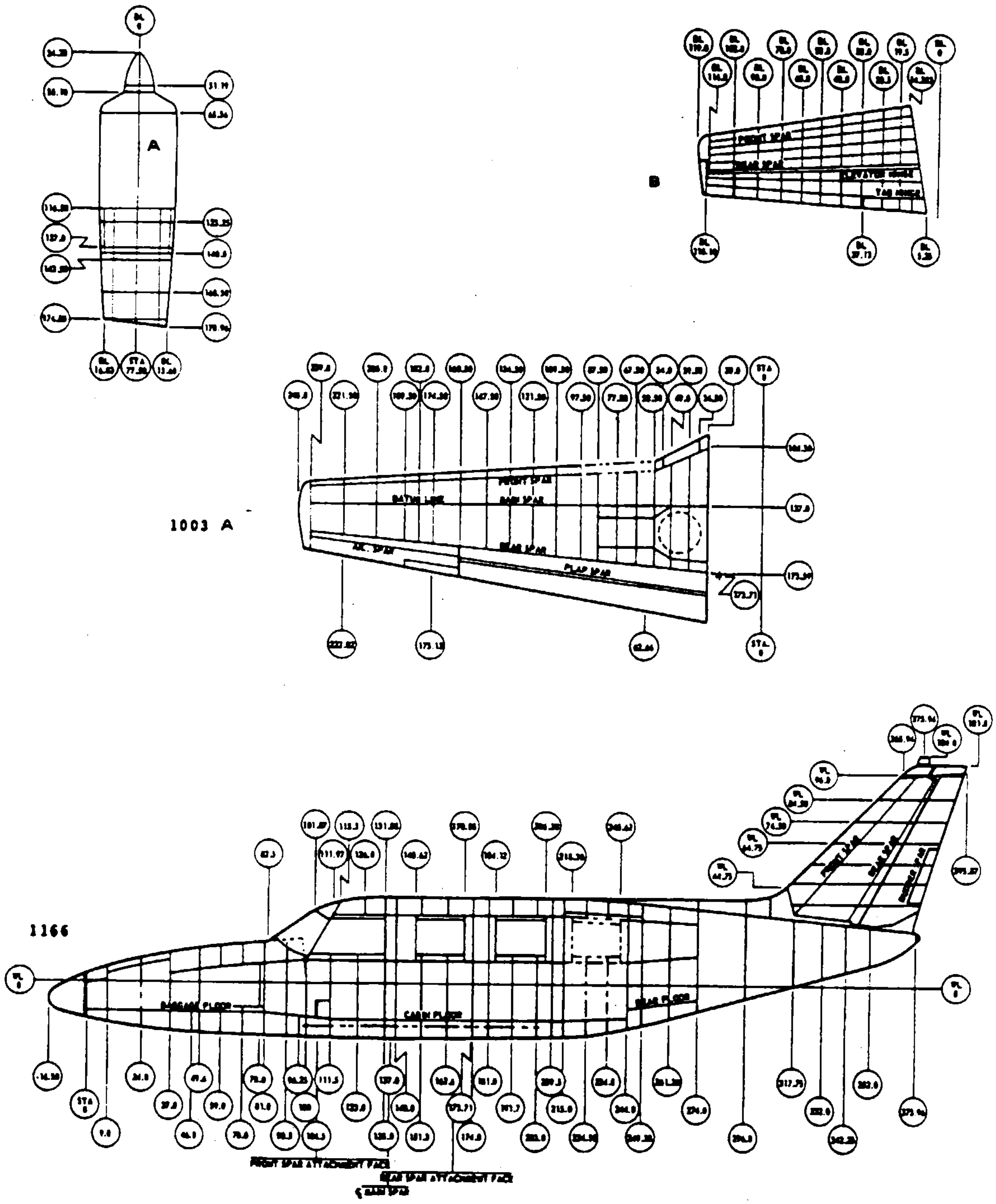
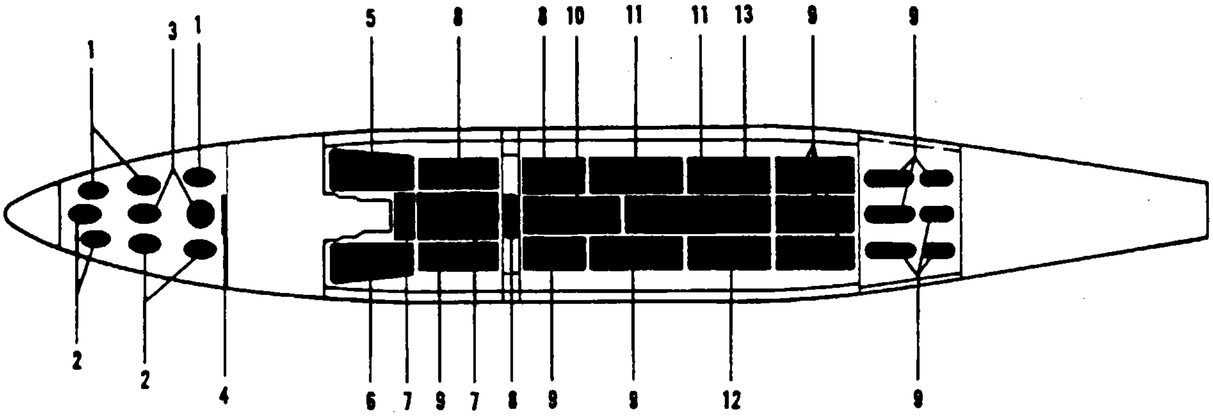


Figure 2-2. Station Reference Lines



1. ALTERNATOR SUPPLY CABLE, RIGHT
2. ALTERNATOR SUPPLY CABLE LEFT - BATTERY CABLE
3. ELECTRICAL LEADS
4. NOSE WHEEL STEERING
5. ENGINE INSTRUMENT LINES
6. ENGINE INSTRUMENT LINES AND CONTROL CABLES
7. TRIM CABLES
8. CABIN PRESSURE LINES ,ELECTRONIC GEAR
9. CONTROL CABLES
10. AUTOPILOT ROLL SERVO, VOLTAGE DIVIDER AND GYRO AMPLIFIER ,ELECTRONIC GEAR
11. CONTROL CABLE - AUTOPILOT PITCH TRIM SERVO
12. CABIN DOOR SEAL ACCUMULATOR AUTOPILOT
13. STROBE LIGHT POWER SUPPLY

Figure 2-3. Access Plates and Panels, Fuselage Interior

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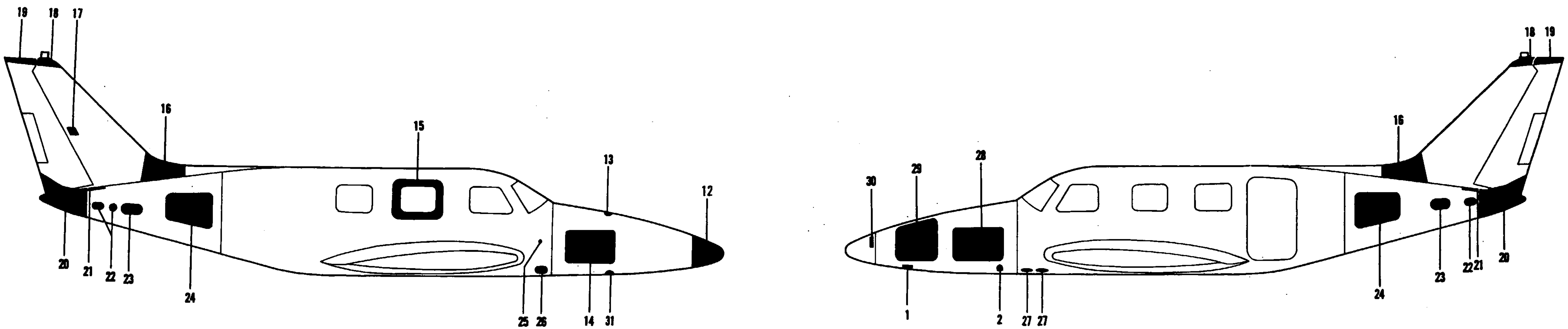

1. AUXILIARY POWER RECEPTACLE
2. OXYGEN CYLINDER RECHARGE
3. HYDRAULIC LINES AND ELECTRICAL LEADS
4. ELECTRIC FUEL PUMP - FUEL FILTER - SELECTOR VALVE - EMERGENCY SHUT OFF VALVE
5. ELECTRICAL LEAD, FUEL CONTROL PANEL
6. WING BUTT CONNECTION FITTING
7. SPAR SPLICE
8. HYDRAULIC FITTING
9. AILERON CONTROL CABLE - FLAP CABLE - ELECTRICAL LEADS
10. QUADRANT - CONTROL CABLES
11. GEAR DOORS
12. BATTERY ACCESS, RADAR
13. HYDRAULIC RESERVOIR
14. ENVIRONMENTAL CONTROL UNITS
15. EMERGENCY EXIT WINDOW
16. VERTICAL FIN DEICER BOOT CONNECTION, ELT TRANSMITTER
17. RUDDER TRIM DRUM
18. ANTI-COLLISION LIGHT
19. RUDDER BALANCE WEIGHT
20. ELEVATOR TRIM DRUM
21. RUDDER CONTROL HORN
22. TRIM CABLES
23. TRIM CABLES AND ELEVATOR BELLCRANK, ELECTRONIC GEAR
24. DEICER AND INSTRUMENT STATIC AIR LINES - CONTROL CABLES - PRESSURIZATION CONTROL VALVES, ELECTRONIC GEAR
25. RUDDER PEDAL TORQUE TUBE REMOVE ACCESS
26. ELECTRICAL LEAD - LINES TO ENGINE INSTRUMENTS
27. ELECTRICAL LEAD - LINES
28. RADIOS - ELECTRICAL SHELF
29. NOSE BAGGAGE DOOR
30. NOSE CONE LATCH RELEASE ACCESS, 31P-2 TO 31P-7530022 INCL.
31. AIR CONDITINER EVAPORATOR COVER DRAIN
32. PULLEY AND CABLE INSPECTION

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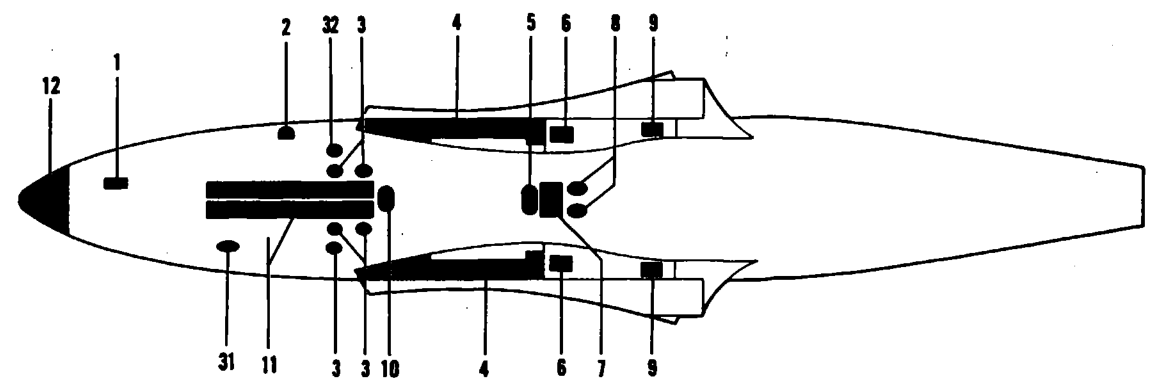
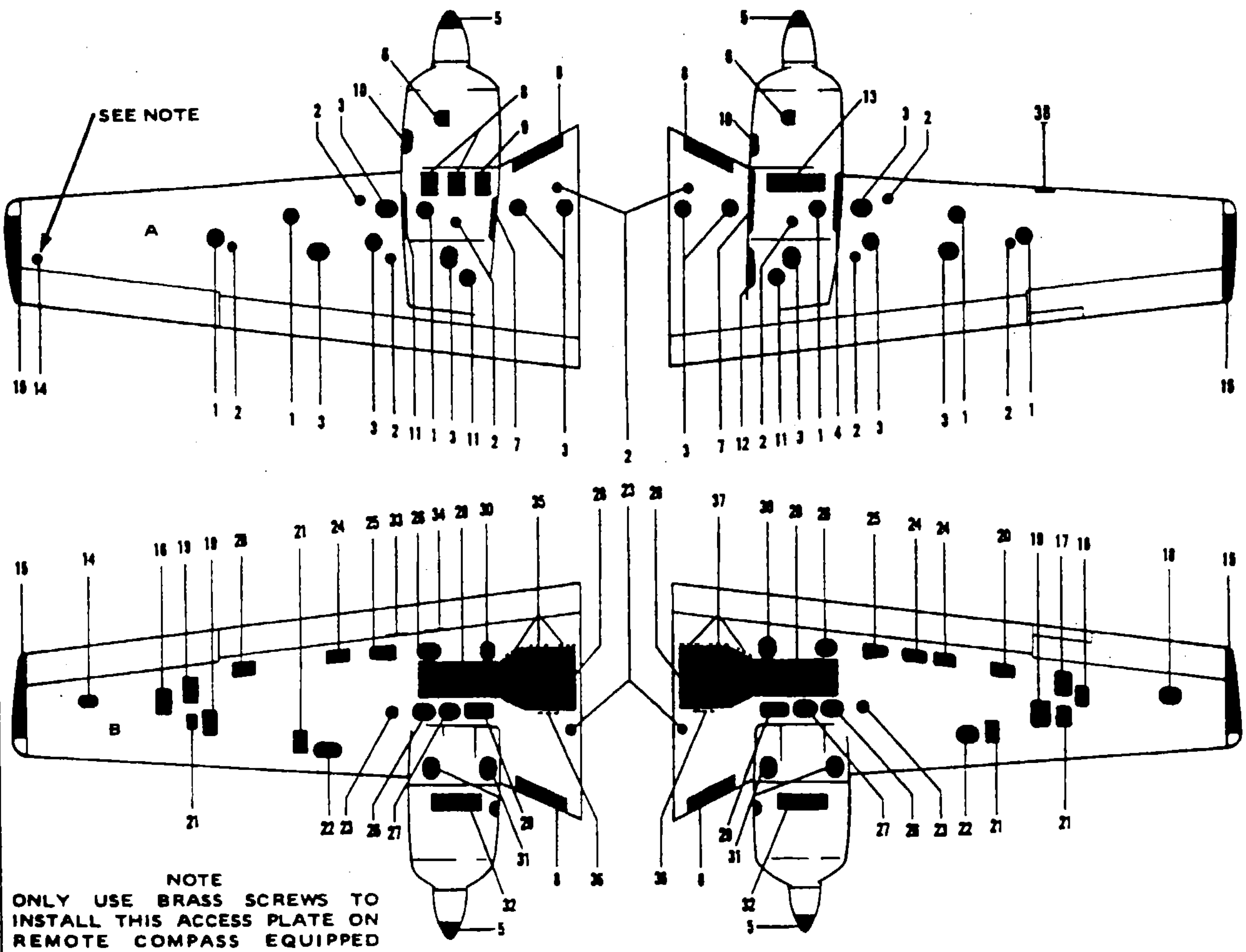


Figure 2-4. Access Plates and Panels, Fuselage and Empennage



NOTE
ONLY USE BRASS SCREWS TO INSTALL THIS ACCESS PLATE ON REMOTE COMPASS EQUIPPED AIRPLANES. STEEL SCREWS CAUSE ERRATIC COMPASS READINGS.

1. FUEL FILLER
2. FUEL SENDING UNIT
3. FUEL CELL
4. FREON CONDENSER AIR SCOOP MOTOR
5. PROPELLER RECHARGE VALVE
6. OIL FILLER
7. PNEUMATIC FILTER AND AIR PRESSURE CONTROL VALVE
8. LINE - WIRES - CABLES
9. ALTERNATE AIR DOOR
10. ENGINE OIL DIPSTICK
11. FUEL LINES
12. FREON LINES
13. FREON CONDENSER AIR SCOOP
14. ELECTRONIC GEAR
15. AILERON BALANCE WEIGHTS
16. AILERON BELLCRANK
17. AILERON TRIM DRUM
18. WING BAY ACCESS
19. ELECTRIC FUEL PUMP
20. AILERON CABLE AND FUEL LINE
21. FUEL CELL VENT
22. FUEL CELL VENT LINE
23. FUEL QUICK DRAIN
24. AILERON CONTROL CABLE
25. FLAP TRANSMISSION
26. LANDING GEAR ATTACHMENT BOLT
27. WIRES AND LINES
28. LANDING GEAR DOOR
29. FUEL LINES AND CABIN PRESSURE LINES
30. CABLES AND WIRES
31. ENGINE MOUNT ATTACHMENT BOLTS
32. ENGINE COWL FLAP
33. FLAP TIME DELAY SWITCH
34. FLAP LIMIT SWITCHES
35. FLAP CABLE- AILERON CONTROL CABLE - ELECTRICAL LEADS
36. PNEUMATIC LINES
37. FLAP CABLE - AILERON CONTROL CABLE - FREON LINES
38. LIFT INDICATOR

Figure 2-5. Access Plates and Panels - Wings

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-31 Pressurized
ENGINE	
Manufacturer	Avco Lycoming
Model	TIGO-541-E1A
FAA Type Certificate	
Rated Horsepower, RPM, Altitude:	425 @ 2133 RPM. 15,000
Performance Cruise (75% Rated)	2750 (1833)
Economy Cruise (60% Rated)	2000 to 2600 (1333 to 1733)
Fuel Consumption, Cruise:	
75% Rated Power	54.0 (gph)
65% Rated Power	42.0 (gph)
55% Rated Power	34.0 (gph)
Propeller Driven Ratio	2:3
Propeller Shaft Rotation	Counterclockwise
Bore	5.125
Stroke	4.375
Displacement	541.5
Compression Ratio	7.30:1
Weight (Without Installation Parts)	567 lbs. (565)
Dimensions:	
Height	22.65
Width	34.86
Length	57.57
Oil, SAE Number	See Lubrication Chart
Oil Sump Capacity	18 qts.
Oil Consumption	.010 LB/BHP
Turbocharger, AiResearch	T-18A21
Fuel, Aviation Grade, Minimum Octane	100/130
Fuel Injector, Bendix	RAS-10DB1
Magnetos, Bendix	
Left	S6LN-1208
Right	S6RN-1209
Magneto Drive, Ratio to Crankshaft	1.500:1
Magneto Drive, Rotation	
Left magneto	Counterclockwise
Right magneto	Clockwise
Magneto Timing (Spark Advance)	20° BTC
Magneto Point Clearance	
Main	.016 ± .003
Retard	.016 ± .006
Retard Angle	30°

TABLE II-1. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-31 Pressurized
ENGINE (cont.)	
Spark Plugs (Shielded):	Refer to Lycoming Service Instructions No. 1042H
Spark Plug Gap Setting	.017 - .021.
Firing Order	1-4-5-2-3-6
Tachometer Drive, Ratio to Crankshaft	0.500:1
Tachometer Drive, Rotation	Counterclockwise
Starter, Prestolite, 24-Volt	MHB4005
Alternator, Prestolite, 24-Volt, 100 Amp	ALV-9401
Voltage Regulator, Lamar	B-00274-1
Over Voltage Relay, Prestolite	X17620
Pressure Pump Drive, Ratio to Crankshaft	1.00:1
Pressure Pump Drive, Rotation	Clockwise
Hydraulic Pump Drive, Ratio to Crankshaft	1.00:1
Hydraulic Pump Drive, Rotation	Counterclockwise
Propeller Governor Drive, Ratio to Crankshaft	.800:1
Propeller Governor Drive, Rotation	Counterclockwise
Fuel Pump: Lear Siegler	RG9080-J4
Titan	4101-B-65
Propeller Drive Ratio to Crankshaft	2:3
PROPELLER	
Manufacturer	Hartzell
Type	Constant Speed - Full feather
Hub	HC-C3YN-2L or HC-C3YN-2LF or HC-C3YN-2LUF
Blade	JC 9684-3R or FJC 9684-3R
Diameter	93 in. max.; 93 in. min.
Blade Angle, Low Pitch (at 30 in. Station)	17.2°
Blade Angle, High Pitch (Feathered)	85.7° ± 1°
Governor Model (Woodward)	210463

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-31 Pressurized
FUEL CELL CAPACITIES	
Inboard (Main) Fuel Cells	Two
Capacity (each)	56 U.S. Gal.
Unusable Fuel (each)	3 U.S. Gal.
Outboard (Auxiliary) Fuel Cells	Two
Capacity (each)	40 U.S. Gal.
Nacelle (Auxiliary) Fuel Cells	Two
Capacity (each)	25 U.S. Gal.
LANDING GEAR	
Type	Hydraulically Retractable
Shock Strut Type	Combination Air and Oil
Fluid Required (Struts & Brakes)	MIL-H-5606
Strut Extension (Static Load)	3.25 in.
Tread (Width from each tire center)	13.75
Wheel Base	8.67
Nose Wheel Travel	40° Left and 40° Right ±1°
Main Wheel Toe-In	.5 degrees
Turning Radius (Min.) (Nose Wheel)	13 ft. 4 in.
Turning Radius (Min.) (Wing Tip)	30 ft. 6 in.
Wheel, Nose	6.00 x 6
Wheel, Main	6.50 x 10
Brake Type	Tri-Metallic
Tire, Nose	6.00 x 6 8 ply or 17.5 x 6.25-6 10 ply
Tire, Main	6.50 x 10 8 ply
Tire Pressure, Nose	45 psi
Tire Pressure, Main	70 psi
OVERALL	
Gross Weight	7800 lbs.
Empty Weight (standard) (six-place)	4842 lbs.
Gross Weight, zero fuel	7200 lbs.
Width (Span)	40 ft. 8 in.
Length	34 ft. 6 in.
Height (Static Ground Line)	13 ft. 3 in.
Height, Propeller Hub, Thrust Line Level	5 ft.
Clearance, Propeller Tips, Thrust Line Level	13.5 in.

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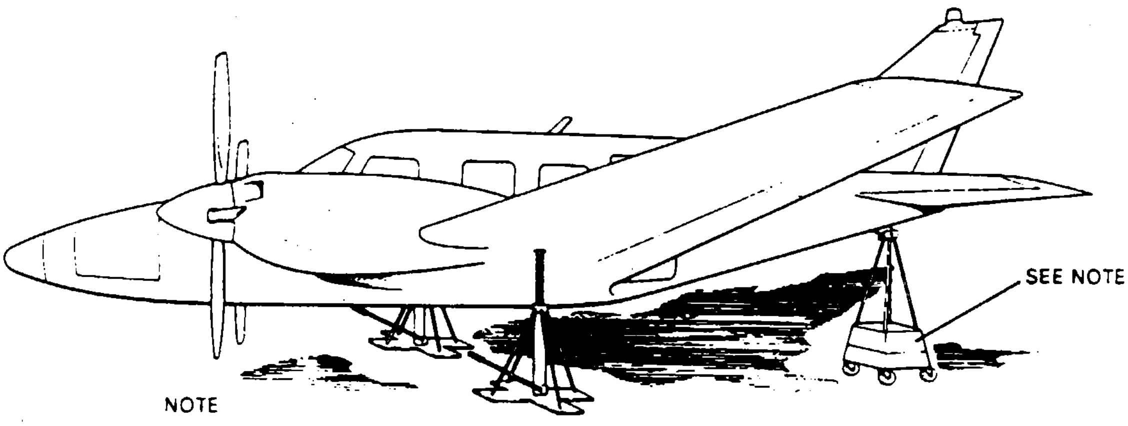


Figure 2-6. Jacking Arrangements

2-7. TOOLS AND TEST EQUIPMENT. Because of the simplicity and easy accessibility of components, few special tools outside normal shop tools will be required. Tools that are required may be fabricated from dimensions given in the back of the section that pertains to a particular component.

2-8. TORQUE REQUIREMENTS. The torque values given in Table II-II are derived from oil free cadmium-plated threads and are recommended for all airframe installation procedures where torqueing is required, unless otherwise noted in sections where other values are stipulated. Engine torque values are found in the latest revision of Avco Lycoming Service Bulletin No. 268, and propeller torque values are found in Section VIII of this manual. Table II-III list the torque values for flared fittings of various sizes and material.

NOTE

When flared fittings are being installed, ascertain that the male threads are properly lubricated. Torque the fittings in accordance with Table II-III.

CAUTION

Do not over torque fittings.

TABLE II-II. RECOMMENDED NUT TORQUES (Inch-Pounds)

TORQUES: The importance of correct application can not be overemphasized. Under torque can result in unnecessary wear of nuts and bolts as well as the parts they are holding together. When insufficient pressures are applied, uneven loads will be transmitted throughout the assembly which may result in excessive wear or premature failure due to fatigue. Overtorque can be equally damaging because of failure of a bolt or nut from overstressing the threaded areas. There are a few simple, but very important procedures that should be followed to assure that the correct torque is applied.

1. Calibrate the torque wrench periodically to assure accuracy; and recheck frequently.
2. Ascertain that the bolt and nut threads are clean and dry (unless otherwise specified by the manufacturer).
3. Run nut down to near contact with the washer or bearing surface and check "friction drag torque" required to turn the nut.
4. Add the friction drag torque to the desired torque recommended by the manufacturer, or obtain desired torque as shown in Table II-IV. This is referred to as final torque which should register on the indicator or the setting for a snapover type wrench.

- NOTE 1 -

For more details on torquing, refer to FAA Manual AC 43 13-1A.

For thread sizes 10 through 7/16, the friction drag torque for self-locking fasteners shall be assumed to be as specified in Table II-IIA, and for nonself-locking fasteners shall be assumed to be zero. The friction drag torque for other bolt sizes shall be determined as follows. The nut shall be turned to near contact (but not in contact) with the bearing surface. While still not contacting the bearing surface, the "friction drag torque" shall be determined.

The friction drag torque (if any) shall be added to the desired torque specified by Table II-II. This is referred to as final torque, which should register on the indicator or be the setting for a snap-over torque limiting device.

- NOTE 2 -

When the bolt is stationary and the nut is torqued, use the lower side of the torque range. When the nut is stationary and the bolt is torqued, use the higher side of the torque range.

When installing a castle nut, start alignment with the cotter pin hole at minimum recommended torque plus friction drag torque, and do not exceed maximum plus friction drag. If the hole in the bolt shank and the nut castellation do not align within this range, change washers and try again. Do not exceed the maximum recommended torque plus friction drag torque as determined above.

- NOTE 3 -

Nut and bolt sizes 8 through 7/16 include friction drag torque values.

COARSE THREAD SERIES				
	BOLTS Steel Tension			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039			
	NUTS			
	Steel Tension		Steel Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs	
SEE NOTE 3	Min.	Max.	Min.	Max.
8 -32	27	30	22	24
10 -24	38	43	30	33
1/4-20	70	80	55	60
5/16-18	140	150	108	115
3/8-16	240	265	175	190
7/16-14	330	335	240	255
1/2-13	400	480	240	290
9/16-12	500	700	300	420
5/8-11	700	900	420	540
3/4-10	1,150	1,600	700	950
7/8- 9	2,200	3,000	1,300	1,800
1 -8	3,700	5,000	2,200	3,000
1-1/8-8	5,500	6,500	3,300	4,000
1-1/4-8	6,500	8,000	4,000	5,000

TABLE II-II. RECOMMENDED NUT TORQUES (Inch-Pounds) (cont.)

FINE THREAD SERIES												
	BOLTS Steel Tension				BOLTS Steel Tension				BOLTS Aluminum			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039				MS 20004 thru MS 20024 NAS 144 thru NAS 158 NAS 333 thru NAS 340 NAS 583 thru NAS 590 NAS 624 thru NAS 644 NAS 1303 thru NAS 1320 NAS 172 NAS 174 NAS 517		Steel shear bolt NAS 464		AN 3DD thru AN 20DD AN 173DD thru AN 186DD AN 509DD AN 525D MS 27039D MS 24694DD			
	NUTS				NUTS				NUTS			
	Steel Tension		Steel Shear		Steel Tension		Steel Shear		Alum. Tension		Alum. Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 310 AN 315 AN 363 AN 365 MS 17825 MS 20365 MS 21045 NAS 1021 NAS 679 NAS 1291		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 365D AN 310D NAS 1021D		AN 320D AN 364D NAS 1022D	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
8 -36	12	15	7	9					5	10	3	6
10 -32	20	25	12	15	25	30	15	20	10	15	5	10
1/4-28	50	70	30	40	80	100	50	60	30	45	15	30
5/16-24	100	140	60	85	120	145	70	90	40	65	25	40
3/8-24	160	190	95	110	200	250	120	150	75	110	45	70
7/16-20	450	500	270	300	520	630	300	400	180	280	110	170
1/2-20	480	690	290	410	770	950	450	550	280	410	160	260
9/16-18	800	1,000	480	600	1,100	1,300	650	800	380	580	230	360
5/8-18	1,100	1,300	660	780	1,250	1,550	750	950	550	670	270	420
3/4-16	2,300	2,500	1,300	1,500	2,650	3,200	1,600	1,900	950	1,250	560	880
7/8-14	2,500	3,000	1,500	1,800	3,550	4,350	2,100	2,690	1,250	1,900	750	1,200
1 -14	3,700	4,500	2,200	3,300	4,500	5,500	2,700	3,300	1,600	2,400	950	1,500
1-1/8-12	5,000	7,000	3,000	4,200	6,000	7,300	3,600	4,400	2,100	3,200	1,250	2,000
1-1/4-12	9,000	11,000	5,400	6,600	11,000	13,400	6,600	8,000	3,900	5,600	2,300	3,650

TABLE II-III. FLARE FITTING TORQUE CHART

TORQUE - INCH POUND									
TUBING OD INCHES	ALUMINUM - ALLOY TUBING FLARE-AND 10061 OR AND 10078		STEEL TUBING FLARE AND 10061		HOSE END FITTING AND HOSE ASSEMBLIES				
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM			
1/8	—	—	—	—	—	—	—	—	
3/16	—	—	90	100	70	100	—	—	
1/4	40	65	135	150	70	120	—	—	
5/16	60	80	180	200	85	180	—	—	
3/8	75	125	270	300	100	250	—	—	
1/2	150	250	450	500	210	420	—	—	
5/8	200	350	650	700	300	480	—	—	
3/4	300	500	900	1000	500	850	—	—	
1	500	700	1200	1400	700	1150	—	—	
1-1/4	600	900	—	—	—	—	—	—	
1-1/2	600	900	—	—	—	—	—	—	
1-3/4	—	—	—	—	—	—	—	—	
2	—	—	—	—	—	—	—	—	

2-9. GROUND HANDLING.

2-10. INTRODUCTION TO GROUND HANDLING. Ground handling covers all essential information governing the handling of the airplane while on the ground. This includes jacking, weighing, leveling, mooring, parking, towing and taxiing. When the airplane is handled in the manner described in the following paragraphs, damage to the airplane and its equipment will be prevented.

2-11. JACKING. The airplane is provided with a jacking pad on each main spar just outboard of the engine nacelle and a support position by making use of the tail skid. (Refer to Figure 2-6.) To jack the airplane, proceed as follows:

a. Place the jacks under the jack pads.
b. Attach the tail support to the tail skid. Place approximately 500 pounds of ballast on the support to hold the tail down.

CAUTION

Be sure to apply sufficient tail support ballast; otherwise, the airplane will tip forward and fall on the fuselage nose section. Do not allow side loads to be applied to the tail skid.

c. Raise the jacks evenly until all three wheels clear the floor.

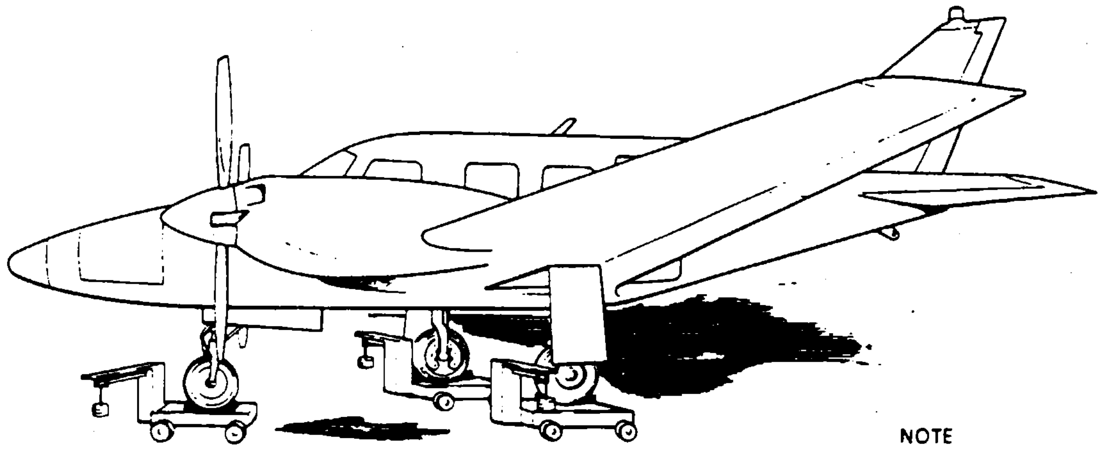


Figure 2-7. Weighing the Airplane

2-12. WEIGHING. (Refer to Figure 2-7.) The airplane may be weighed by the following procedure:

a. Position a scale and ramp in front of each of the three wheels.
b. Secure the scales from rolling forward and tow the airplane up onto the scales. (Refer to Towing, Paragraph 2-16.)
c. Remove the ramp so as not to interfere with the scales.
d. If the airplane is to be weighed for weight and balance computations, level the airplane per instructions given in paragraph 2- 13.

2-13. LEVELING. All configurations of the airplane are provided with a means for longitudinal and lateral leveling. The airplane may be leveled while on jacks during the weighing procedure, while the wheels are on scales, or while the wheels are on the ground. To level the airplane for purposes of weighing or rigging, the following procedures may be used:

a. To longitudinally level the airplane, partially withdraw the two leveling screws located on the right side of the fuselage nose section at station 48.35 and 80.25. (Refer to Figure 2-8.) Place a spirit level on these screw heads and deflate the nose wheel tire or adjust the jacks until the bubble of the level is centered.
b. To laterally level the airplane, place a spirit level across the two center seat rails of the cabin (Refer to Figure 2-8) and deflate the tire on the high side of the airplane or adjust either jack until the bubble of the level is centered.

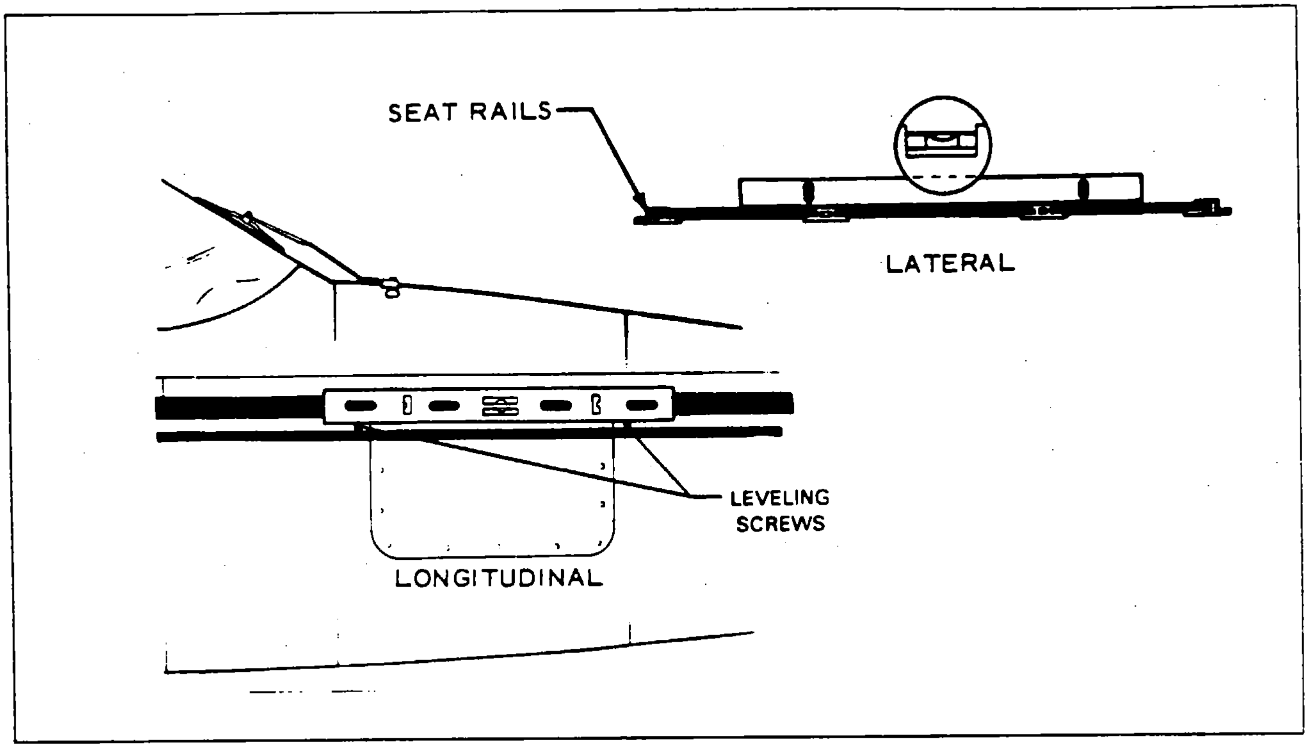


Figure 2-8. Leveling Longitudinally and Laterally

2-14. MOORING. The airplane is moored to insure its immovability, protection and security under various weather conditions. The following procedure gives the instructions for proper mooring of the airplane.

a. Head the airplane into the wind, if possible, and close engine cowl flaps.
b. Block the wheels.
c. Insert the internal control lock and/or control surface locks.
d. Secure tie-down ropes to the wing tie-down rings and the tail skid at approximately 45 degree angles to the ground. When using rope constructed of nonsynthetic material, leave sufficient slack to avoid damage to the airplane when the ropes contract due to moisture.

CAUTION

Use square or bowline knots. Do not use slip knots.

NOTE

Additional preparations for high winds include using tie-down ropes from the landing gear forks, and securing the rudder.

e. Install pitot tube cover(s) if available.

12-15. PARKING. When parking the airplane, insure that it is sufficiently protected against adverse weather conditions and presents no danger to other aircraft. When parking the airplane for any length of time or overnight, it is recommended that it be moored as in paragraph 2-14.

a. To park the airplane, head it into the wind, if possible.
b. Set the parking brake by applying toe pressure against the top of the rudder pedals and at the same time pull out on the brake handle. To release the parking brake, apply toe pressure on the pedals and push in on the parking brake handle.

NOTE

Care should be taken when setting brakes that are very hot or during cold weather when accumulated moisture may freeze the brakes. Prior to setting the brakes, if either of the above conditions exist, it is recommended that chocks be used to block the wheels rather than setting brakes.

c. Insert the internal control lock.

2-16. TOWING. The airplane may be moved by using the nose wheel steering bar that is stowed on the aft wall of the nose baggage compartment or power equipment that will not damage or cause excess strain to the nose gear steering assembly. Towing lugs are incorporated as part of the nose gear fork.

To pull the airplane on a hard level surface, it will require approximately 100 pounds pull to start its roll and approximately 60 pounds to maintain roll.

CAUTION

When towing, do not turn the nose gear in either direction beyond its 40 degree arc from center as this will result in damage to the nose gear and steering mechanism. A placard is installed on the nose gear strut to indicate turn limits. (Refer to Figure 2-9.)

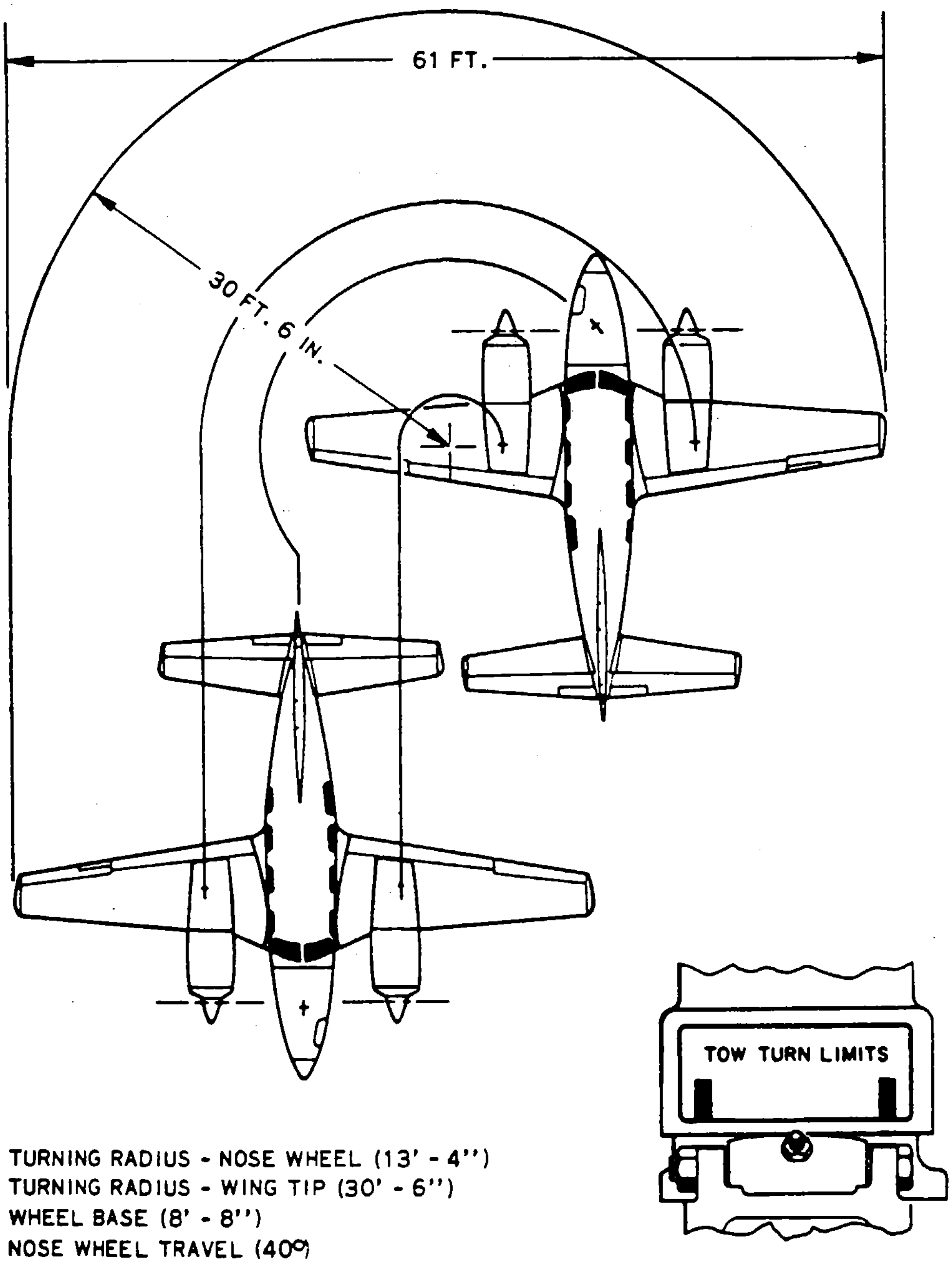
CAUTION

Do not tow airplane with control locks installed.

In the event towing lines are necessary, lines (rope) will be attached to both main gear struts just below the side brace link attachments. Ascertain that cowl flap doors are closed. Lines should be long enough to clear the nose and/or tail by not less than 15 feet, and a qualified person to ride in the pilot's seat to maintain control by use of the brakes and nose wheel steering.

2-17. TAXIING. Before attempting to taxi the airplane, ground personnel should be checked out by a qualified pilot or other responsible person on the engine starting and shut-down procedures and any other system functions which may be required to properly and safely move this airplane. When it is ascertained that the propeller backblast and taxi areas are clear, apply power to start the taxi roll and perform the following checks:

a. Taxi forward a few feet and apply brakes to determine their effectiveness.
b. Taxi with propellers set in low pitch, high RPM setting.
c. While taxiing, make slight turns to ascertain the effectiveness of the steering.
d. Observe wing clearance when taxiing near buildings or other stationary objects. If possible, station guides at each wing tip to observe.
e. When taxiing on uneven ground avoid any holes and ruts.
f. Do not operate the engines at high RPM when running up or taxiing over ground containing loose stones, gravel or any loose material that may cause damage to the propeller blades.



TURNING RADIUS - NOSE WHEEL (13' - 4")
TURNING RADIUS - WING TIP (30' - 6")
WHEEL BASE (8' - 8")
NOSE WHEEL TRAVEL (40°)

Figure 2-9. Tow Turn Limits and Radius

2-18. EXTERNAL POWER RECEPTACLE.

2-19. OPERATION OF EXTERNAL POWER RECEPTACLE. The external power receptacle is located on the underside of the nose section below the forward side of the baggage compartment door. To avoid any damage to the airplanes electrical system follow the instructions on the access door of the power receptacle.

NOTE

When using a 24-volt battery for external power starting and the airplanes battery is nearly depleted the instructions given in Section XI must be followed.

2-20. SERVICING.

2-21. GENERAL. Servicing the airplane includes the replenishment of fuel, oil, hydraulic fluid, tire pressures, oxygen, lubrication requirements and other items required to completely service the airplane.

2-22. FUEL SYSTEM.

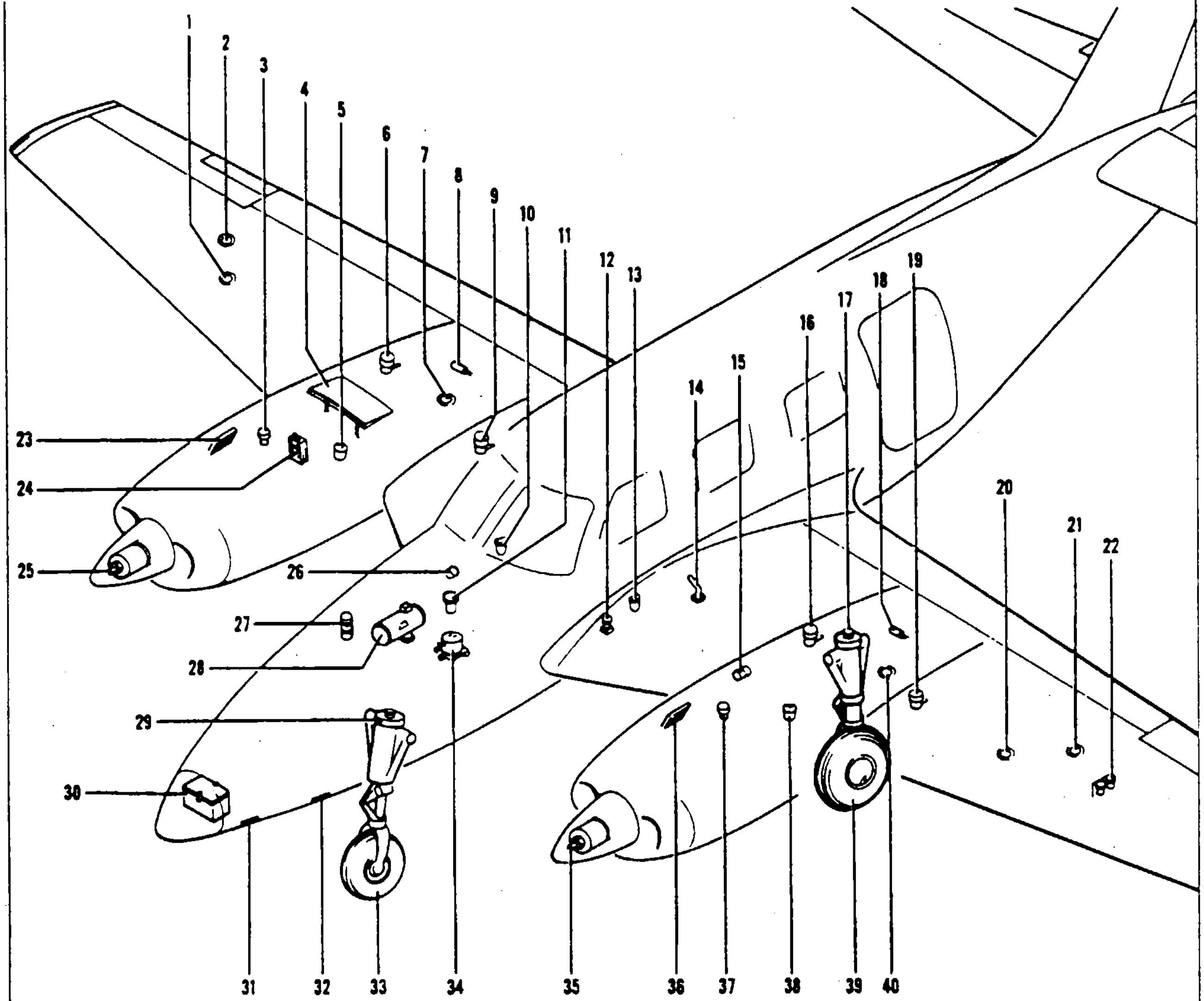
2-23. SERVICING FUEL SYSTEM. At internals of 50 hours or 90 days, whichever comes first, clean the screens and bowl in each fuel filter unit located between each wing and the fuselage. Remove and clean the filters in accordance with the instructions outlined in Section IX. Additional service information may also be found in Section IX. Inspection intervals of the various fuel system components may be found in Section III.

2-24. FILLING FUEL CELLS. The fuel cells of each wing are filled through filler necks located on the forward slope of the wings, outboard of the engine nacelles. Both nacelle fuel cells have the filler necks on the top of the nacelles.

2-25. DRAINING MOISTURE FROM FUEL SYSTEM. To facilitate draining the fuel system filter bowls, lines and fuel cells of moisture and foreign matter, drains are incorporated in the bottom of each filter bowl, in the system crossfeed line and the inboard end of each fuel cell.

a. To flush either filter bowl, open the access door located on the panel between the underside of the wing and fuselage. Push up on the arms of the drain valve for a few seconds with the fuel selector valve on one cell; then change the selector valve to the other cell and repeat the process. Allow enough fuel to flow each time to clear the fuel line as well as the fuel filter bowl. The same procedure will apply to the cells of the opposite side.
b. To flush the crossfeed line, open the crossfeed valve and push up on the arms of the drain valve for a few seconds. The drain valve is located on the left panel of the filter bowl access door.
c. To flush the fuel cells, push up on the arms of each cell drain and allow to flow for a few seconds.

2-26. DRAINING FUEL SYSTEM. The bunk of the fuel may be drained from the system by opening the valve at the inboard end of each fuel cell. Push up on the arm of the drain valve and turn counterclockwise to hold the drain in the open position. The remaining fuel in the system may be drained through each filter bowl. Any individual cell or compartment may be drained by closing the selector and crossfeed valves and then draining the desired component.



1. FILLER, INBOARD FUEL CELL, RIGHT
2. FILLER, OUTBOARD FUEL CELL, RIGHT
3. OIL FILLER, RIGHT ENGINE
4. CONDENSER AIR SCOOP
5. FILTER, HYDRAULIC, RIGHT
6. FUEL DRAIN, RIGHT OUTBOARD
7. FILLER, NACELLE FUEL CELL RIGHT
8. FILTER, PRESSURE LINE, RIGHT
9. FUEL DRAIN, RIGHT INBOARD
10. FUEL FILTER, RIGHT
11. HYDRAULIC RESERVOIR
12. ELECTRIC FUEL PUMP, R AND L
13. FUEL FILTER, LEFT
14. CROSSFEED DRAIN
15. PNEUMATIC AIR FILTER
16. FUEL DRAIN, LEFT INBOARD
17. FILLER, OLEO SHOCK STRUT, L AND R
18. FILTER, PRESSURE LINE, LEFT
19. FUEL DRAIN, LEFT OUTBOARD
20. FILLER, INBOARD FUEL CELL, LEFT
21. FILLER, OUTBOARD FUEL CELL, LEFT
22. ELECTRIC TRANSFER PUMPS, L AND R
23. FILTER, INDUCTION AIR, RIGHT ENGINE
24. COMPRESSOR, AIR CONDITIONER
25. AIR VALVE, RIGHT PROPELLER
26. GUAGE, OXYGEN PRESSURE
27. AIRCONDITIONER, RECEIVER DRYER
28. HEATER
29. FILLER, OLEO SHOCK STRUT, NOSE
30. BATTERY
31. EXTERNAL POWER SUPPLY
32. FILLER, OXYGEN
33. TIRE, NOSE
34. POWER PACK
35. AIR VALVE, LEFT PROPELLER
36. FILTER, INDUCTION AIR, LEFT ENGIN
37. OIL FILLER, LEFT ENGINE
38. FILTER, HYDRAULIC, LEFT
39. TIRE, MAIN, L AND R
40. FILLER, NACELLE FUEL CELL, LEFT

Figure 2- 10. Service Points

2-27. BRAKE SYSTEM.

2-28. SERVICING BRAKE SYSTEM. The brake system incorporates a hydraulic fluid reservoir through which the brake system is periodically serviced. Fluid is drawn from the reservoir by the brake master cylinders to maintain the volume of fluid required for maximum braking efficiency. Spongy brake pedal action is often an indication that the brake fluid reservoir is running low on fluid or air is in the system. Instructions for filling the reservoir are given in paragraph 2-29. When its found necessary to accomplish repairs to any of the brake system components or bleed the system, refer to the instructions given in Section VII.

2-29. FILLING BRAKE CYLINDER RESERVOIR. The brake cylinder reservoir should be filled to the level marked on the dipstick with the fluid specified in Table II-I. The reservoir, located in the upper nose section above the power pack shown in Figure 2-10, should be checked at every 50-hour inspection and replenished as necessary. No adjustment of the brakes are necessary, though they should be checked periodically per instructions given in Section VII.

2-30. DRAINING BRAKE SYSTEM. To drain the brake system, connect a hose to the bleeder fitting on the bottom of the cylinder and place the other end of the line in a suitable container. Open the bleeder and slowly pump the desired brake pedal until fluid ceases to flow. To clean the brake system, flush with denatured alcohol.

2-31. OLEO STRUTS.

2-32. SERVICING OLEO STRUTS. Air-oil shock struts are incorporated in each landing gear oleo assembly to absorb the shock resulting from the impact of the wheels on the runway during landing. To obtain proper oleo action, the nose and main gear oleo struts must have approximately 3.25 inches of piston tube exposed, with the airplane setting on a level surface, under normal static loads. (Refer to Figure 2-11.)

NOTE

Normal static load is the empty weight of the airplane plus full fuel and oil.

If a strut has less than the required inches exposed, determine whether it needs air or oil by rocking the airplane. If the airplane settles to its normal position within one cycle after the rocking force is removed, the oleo strut requires inflating (air). (Refer to Paragraph 2-35.) If the airplane continues to oscillate after the rocking force is removed, the oleo strut requires filling (oil). (Refer to Paragraph 2-34.) For repairs to the gear oleos, refer to Section VII of this manual.

WARNING

Do not release air by removing the strut valve core or filler plug. Depress the valve core pin until strut pressure has diminished.

NOTE

Struts may be serviced and adjusted per placard on strut.

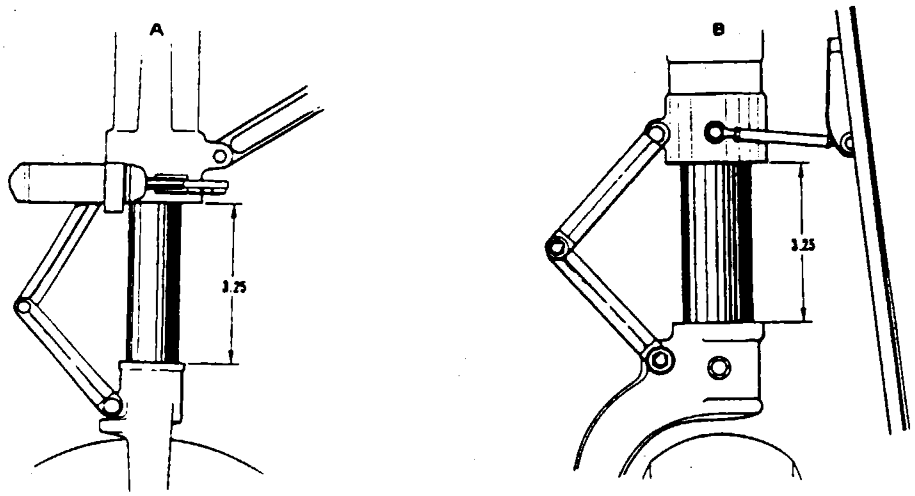


Figure 2-11. Servicing Landing Gear Shock Struts

2-33. ADDING FLUID TO STRUTS. To add fluid to an oleo strut which is partly full, proceed as follows:

a. Place the airplane on jacks. (Refer to paragraph 2-11.)
b. Place a pan under the gear to catch spillage.
c. Release the air in the oleo strut by pressing in on the air valve core pin.
d. Remove the air valve (filler plug). Allow valve core to remain in valve.
e. Extend the strut to two inches from the fully compressed position.
f. At the two-inch extended position, fill the strut through the filler opening with fluid as specified.
g. Slowly compress the strut to the fully compressed position allowing fluid to overflow.
h. With oleo strut in the compressed position, reinstall air valve and safety.
i. Inflate the oleo struts with air to the required extension per instructions in paragraph 2-35.

2-34. FILLING OLEO STRUTS. To fill an oleo strut which has been completely emptied because of repair, leakage, etc., proceed as follows:

a. Place the airplane on jacks. (Refer to paragraph 2-11.)
b. Place a pan under the gear to catch spillage.
c. Remove valve core from air valve.
d. Attach a clear plastic tube to the valve stem and place the other end of the tube in a container of hydraulic fluid as specified.

NOTE

An air-tight connection is necessary between the plastic tube and valve stem. Without such a connection, a small amount of air will be sucked into the oleo strut during each sequence, resulting in an inordinate amount of air bubbles and a prolonged filling operation.

e. Extend the oleo strut by pulling down on the wheel. Fluid will be sucked into the oleo strut. Compress and extend the oleo strut until it is full of fluid, and air bubbles cease to appear in the plastic tube.
f. Compress the oleo strut to within 1/4 inch of full compression, allowing the excess fluid to overflow.
g. With the oleo strut in the near compressed position, reinstall the valve core.
h. Remove the airplane from the jacks.
i. Inflate the oleo struts per instructions given in paragraph 2-35.

2-35. INFLATING OLEO STRUTS. After making certain that an oleo strut has sufficient fluid, as described in paragraph 2-33, attach a strut pump to the air valve and pump up the oleo strut. The oleo struts should be inflated until 3.25 inches of piston is exposed with normal static weight (Normal static weight is the empty weight of the airplane plus full fuel and oil.) on the gears. Before capping the valve, check for valve core leakage.

2-36. LANDING GEAR.

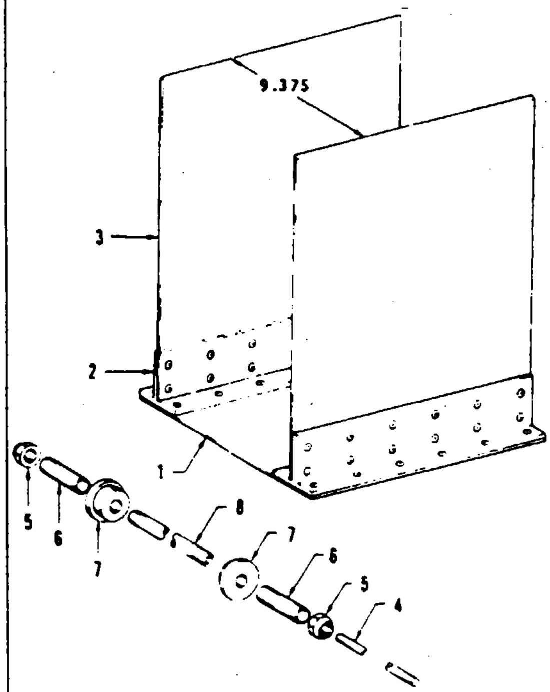
2-37. SERVICING LANDING GEAR. The operation of the landing gear oleo's is standard for the air-oil type. The piston tube has a total travel of 8.50 inches, and 3.25 inches of tube exposed under normal static load. (Normal static load is the empty weight of the airplane plus full fuel and oil.) All major attachments and actuating bearings are equipped with grease fittings for lubrication. Refer to Lubrication Chart.

2-38. TIRES.

2-38a. TIRE BALANCING.

Proper balancing is critical for the life of the aircraft tires. If a new tire is balanced upon installation it will usually remain balanced for the life of the tire without having any shimmy or flat spots, and an inexpensive balancer can be made that will balance almost any tire for light aircraft. (Refer to Paragraph 2-38b for fabrication instructions.) Balance the tire as follows:

a. Mount the tire and tube (if one is used) on the wheel, but do not install the securing bolts. Install the wheel bearings in the wheel; then, using the -7 bushings, -6 spacers, and -5 nuts, install the wheel-tire assembly on the -8 pipe. Secure the -5 nuts finger-tight so that the wheel halves touch each other. Be sure the bolt holes are aligned! Insert the -4 axle through the -8 pipe and place the wheel in the center of the balanced. Make sure the axle is only on the chamfered edges of the balancer and that it is at 90° to the sides of the balancer.
b. Release the tire. If it is out of balance it will rotate, coming to rest with the heaviest point on the bottom. Tape a 1/2 ounce patch across top center of the tire. Rotate the tire 45° and release it again. If the tire returns to the same position, add a 1 ounce patch and again rotate the tire and release it. Continue this procedure until the tire is balanced.
c. When balance is attained, put a chalk mark on the sidewall directly below the patch. Use one mark for each half ounce of weight needed. Mark the valve stem location on the tire and the opposite wheel half to assure reassembly in the same position. Remove the wheel from the balance stand, break it down, and clean the tire with toluol. Apply a coat of patch cement to both the patch and the inside center of the tire in line with the chalk marks. When the cement has dried, install the patches making certain they are on the center line of the tire and aligned with the chalk marks on the sidewall. Burnish the patches to remove trapped air, etc.



The following list of materials were used in making the balancer:

-1	1 ea.	Base	12 x 11	0.190 2024 T3 clad aluminum alloy
-2	2 ea.	Tee	2.5 x 2 x 11	0.190 2024 T4 extruded aluminum alloy
-3	2 ea.	Sides	14 x 11	0.128 2024 T3 clad aluminum alloy
-4	1 ea.	Axle	0.125 x 10.25	4130 steel, normalized
-5	2 ea.	Nuts	AN 365-624	
-6	2 ea.	Spacer	0.50 x 2.25	5052-0 aluminum tubing
	2 ea.	Spacer	0.50 x 1.25	5052-0 aluminum tubing
-7	2 ea.	Bushing	1.480 x 1.625 x 1.00	Richlight, phenolic or aluminum
	2 ea.	Bushing	2.240 x 1.37 x 1.00	Richlight, pheonolic or aluminum
-8	1 ea.	Pipe	1/8 x 9.3	black steel pipe
*	2 ea.	Bearings	Save two of each size worn wheel bearings from previous inspections.	

Figure 2-11a. Tire Balancer

d. When reassembling the wheel, powder the inside of the tire. Mount the tire on the valve side of the wheel in the same position it was in when it was balanced. Install the other wheel half, aligning the chalk marks. Install the bolts and tighten to required torque, then air the tire and recheck the balance. The wheel should not be more than 1/2 ounce out of balance.

2-38b. CONSTRUCTION OF TIRE BALANCER. (Refer to Figure 2-11a.)

a. The following instructions will help in building the balancer: chamfer top edges of -3 sides, leaving 1/16 inch flat on top inboard edge. Rivet -2 tee's to -3 sides using AN470-AD5 rivets 2" spacing. Use AN426-AD5 rivets 2" center to center to secure -2 tee's to -1 base. If tee extrusion is unavailable, heavy angle extrusion could be used. -3 sides must be paralleled and vertical.
b. The -4 axle must slide through the -8 pipe. The -5 nuts were made by reaming the existing threads in the AN365-624 nuts with an R drill, then tapping with a 1/8-27 pipe tap.
c. The -6 spacers were made from 1/2 inch aluminum tubing. The two lengths of spacers are suitable for balancing most any aircraft wheel.
d. The -7 bushing may be benchmade from one inch phenolic or aluminum using a 1 1/2 inch hole saw to cut out the smaller bushing and a 1 3/4 hole saw to cut out the larger. By inserting a 1/4 inch long threaded bolt through the pilot hole and securing with a washer and nut, a drill press and file may be used to make the off-set on the bushing. The turned-down part should just slide inside the bearing race. Ream the pilot hole to slide over the -8 pipe threads.
e. The -8 pipe was made from a piece of 1/8 inch black pipe and threaded with a 1/8-27 pipe die. Thread 3 inches in from each end of the pipe.

2-39. SERVICING TIRES. The tires should be maintained at the pressure specified in Table II-1. When checking tire pressure, examine the tires for wear, cuts, bruises and slippage.

2-40. HYDRAULIC SYSTEM.

2-41. SERVICING HYDRAULIC BRAKE SYSTEM. The fluid level in the hydraulic reservoir should be checked every 50 hours. Access to the reservoir is through the access door on the upper right portion of the nose section. If the fluid level is low, it should be filled with filtered hydraulic fluid MIL-H-5606.

2-42. SERVICING HYDRAULIC RESERVOIR. (Serial Nos. 1 to 47 inclusive.) The hydraulic reservoir fluid level should be checked every 50 hours and filled as necessary whenever the fluid level in the reservoir is low. The reservoir is reached by opening the access door located on the upper left nose section of the airplane. Repairs and check procedures for the power pack may be found in Section VI of this manual.

NOTE

The reservoir should be checked regularly as it also serves as the reservoir for the airplane's brake system.

2-42a. SERVICING HYDRAULIC RESERVOIR. (Serial Nos. 48 and up.) On airplanes with Serial Numbers 48 and up, a special filling and draining service hookup has been installed just inside the right fuselage access panel of the nose section. A pressure pot or hydraulic test unit can be connected to this installation by removing the access panel and the protective cap on the suction, fill and drain fitting. Connect the fluid supply line from the supply source to the fitting. Then raise the lever to open the valve and proceed to fill the reservoir. To gravity fill the reservoir, support the supply container of hydraulic fluid higher than the fluid level in the power pack reservoir. Be sure to close the suction, fill and drain valve by placing the lever in the down position before disconnecting the supply line from the fitting. Reinstall to Protective cap on the fitting and install the access panel.

2-43. PROPELLER.

2-44. SERVICING PROPELLER. The blades should be checked periodically for damage. Minor nicks in the leading edge of blades should be filed out and all edges rounded. Daily inspection should include examination of blades and spinner for visible damage and grease leakage. For further information on propeller servicing, refer to Section VIII. or FAA AC 43.13-1A Section 3 on propeller repairing.

2-45. ELECTRICAL SYSTEM.

2-46. SERVICING ELECTRICAL SYSTEM. There is little service required for the electrical system, other than making visual and operational checks of the various equipment. For more detailed information on servicing and repair of the various components refer to Section XI.

2-47. OIL SYSTEM. (ENGINE)

2-48. SERVICING OIL SYSTEM. The engine oil level should be checked before each flight and changed after each 50 hours of engine operation. During oil change, the oil screen(s) should be removed and cleaned, and the oil filter cartridge replaced. Intervals between oil changes can be increased as much as 100% provided the element is replaced each 50 hours of operation. The engine manufacturer does not recommend oils by brand names. Use a quality brand Aviation Grade Oil of the proper season viscosity. For more information on recommended oils refer to the latest revision of Lycoming Service Instruction Letter No. 1014 and the latest revision of Lycoming Service Bulletin No. 318.

CAUTION

Do not introduce any trade additive to the basic lubricant unless recommended by the engine manufacturer.

ENGINE OIL SPECIFICATION
USE ONLY ASHLESS DISPERSANT
TYPE OIL PER MIL-L-22851
OIL CAPACITY 18 QTS.

2-49. FILLING OIL SUMP. The oil sump should normally be filled with oil to the 18 U.S. quart mark on the engine dipstick. The specified grade of oil may be found in Table II-IV, the lubrication chart or on each engine oil filler access door. To service the engine with oil, open the quick release access door on top of the cowl and remove the oil filler cap.

NOTE

Oil dipsticks are marked for right and left engines. Use the correct side of stick when checking oil level.

2-50. DRAINING OIL SUMP. To drain the oil sump provide a suitable container with a minimum capacity of 18 quarts. Remove the engine cowl and open the oil drain valve located on the underside of the engine by pushing the arms of the drain up and turn counterclockwise. This will hold the drain in the open position. It is recommended the engine be warmed to operating temperature to insure complete draining of the old oil.

2-51. CHANGING OIL FILTER. (FULL FLOW).

a. The oil filter element should be replaced after each 50 hours of engine operation; this is accomplished by removing the lockwire from the bolt head at the end of the filter housing, loosening the bolt, and removing the filter assembly from the adapter.
b. Before discarding the filter element, remove the outer perforated paper cover, and using a sharp knife, cut through the folds of the element at both ends, close to the metal caps. Then, carefully unfold the pleated element and examine the material trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particles of metallic shavings might be found; these are generally of no consequence and should not-be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

NOTE

Refer to Section VIII of this manual and/or the latest revision of Lycoming Service Bulletin No. 337 for information concerning installation of new oil filter element.

c. After the element has been replaced, tighten the attaching bolt within 25 to 30 foot pounds torque. Lockwire the thermostatic bypass valve to the oil filter housing drain plug and the drain plug to the filter housing attaching bolt.

2-52. RECOMMENDATIONS FOR CHANGING OIL. (Refer to the latest revision of Lycoming Service Instruction No. 1014 and the latest revision of Lycoming Service Bulletin No. 318.

a. The only lubricants that are recommended for the TIGO-541 series engines are multi-viscosity ashless dispersant oils that essentially conform with MIL-L-22851 specifications.
b. Whenever the oil is changed, remove and check the oil suction screen for metal particles. Clean and reinstall in accordance with paragraph 2-53.

2-53. OIL SCREENS. (SUCTION) The oil suction screen, is located on the bottom aft end of the engine sump, installed horizontally. To remove, cut the safety wire and remove the hex head plug. The screen should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. After cleaning and inspection, place the screen inside the recess in the hex head plug, to eliminate possible damage to the screen. Insert the screen into the housing and when certain that the screen is properly seated, tighten and safety the plug with MS-20995-C41 safety wire.

2-54. LUBRICATION.

2-55. LUBRICATION INSTRUCTIONS. Proper lubrication procedures are of immeasurable value both as a means of prolonging the service life of the airplane and as a means of reducing the frequency of extensive and expensive repairs. The periodic application of recommended lubricants to their relevant bearing surfaces, as detailed in the following paragraphs, together with the observance of cleanliness, will insure the maximum efficiency and utmost service of all moving parts. Lubrication instruction regarding the locations, time intervals, and type of lubricants used may be found in Figure 2-12 to 2-12e. To insure the best possible results from the application of lubricants, the following precautions Would be observed:

a. Use recommended lubricants. Where general purpose lubricating oil is specified, but unavailable, clean engine oil may be used as a satisfactory substitute.
b. Check the components to be lubricated for evidence of excessive wear and replace them as necessary.
c. Remove all excess lubricants from components in order to prevent the collection of dirt and sand in abrasive quantities capable of causing excessive wear or damage to bearing surfaces.

2-56. APPLICATION OF GREASE. Care must be taken when lubricating bearings and bearing surfaces with a grease gun, to insure that gun is filled with new, clean grease of the grade specified for the particular application before applying lubricant to the grease fittings.

a. Where a reservoir is not provided around a bearing, apply the lubricant sparingly and wipe off any excess.
b. Remove wheel bearings from the wheel hub and clean thoroughly with a suitable solvent. When repacking with grease, be sure the lubricant enters the space between the rollers in the retainer ring. Do not pack the grease into the wheel hub.
c. Use extra care when greasing the Hartzell propeller hub to avoid blowing the clamp gaskets. Remove one grease fitting while applying grease to the other fitting.

2-57. APPLICATION OF OIL. Whenever specific instructions for lubrication of mechanisms requiring lubrication are not available, observe the following precautions:

a. Apply oil sparingly, never more than enough to coat the bearing surfaces.
b. Since the cables are sufficiently coated by the manufacturer, additional protection for the prevention of corrosion is unnecessary.
c. Squeeze the magneto cam follower felts at regular inspection periods. If oil appears on fingers, do not add oil. If the felt is dry, moisten with light oil.

CAUTION

Be careful not to add too much oil, because the excess will be thrown off during operation and will cause pitting and burning of the magneto points.

TYPE OF LUBRICANTS

SPECIFICATION NUMBER	LUBRICANT AND SUPPLIER
MIL-L-7870	LUBRICATING OIL, GENERAL PURPOSE, LOW TEMPERATURE
MIL-L-22851	ENGINE OIL SPECIFICATION USE ONLY ASHLESS DISPERSANT SAE 50 OR 60 ABOVE 60°F AIR TEMP. SAE 40 30°F TO 90°F AIR TEMP. SAE 40 OR 20W-30 0°F TO 70°F AIR TEMP. SAE 20W-30 BELOW 10°F AIR TEMP.
MIL-H-5606	HYDRAULIC FLUID, PETROLEUM BASE
MIL-G-23827	GREASE, AIRCRAFT AND INSTRUMENT, GEAR AND ACTUATOR SCREW
MIL-G-81322	GREASE, AIRCRAFT, WIDE TEMPERATURE RANGE
MIL-G-3545	GREASE, AIRCRAFT, HIGH TEMPERATURE
	ALL PURPOSE SLIP SPRAY DUPONT NO. 6611
BRB NO. 2 OR SRI NO. 2	CHEVRON BEARING GREASE
AEROSHELL NO. 5	SHELL BEARING GREASE
MOBILGREASE 77 OR MOBILUX EP2	MOBIL BEARING GREASE
MIL-G-4343	O-RING LUBRICATION, FUEL SYSTEM DOW CORNING DC-55

SPECIAL INSTRUCTIONS

1. AIR FILTER - TO CLEAN FILTER, BLOW OUT WITH COMPRESSED AIR FROM GASKET SIDE OR WASH IN WARM WATER AND MILD DETERGENT AND DRY. DO NOT USE OIL.
2. BEARINGS AND BUSHINGS - CLEAN EXTERIOR WITH A QUICK DRYING TYPE SOLVENT BEFORE RELUBRICATING.
3. COWL AND FLAP TRANSMISSION AND SCREWS, TRIM SCREWS AND WHEEL BEARINGS - DISASSEMBLE AND CLEAN WITH A QUICK DRYING TYPE SOLVENT. WHEN REASSEMBLING THE DUKES TRANSMISSIONS, PACK 3/4 MINIMUM FULL WITH DUKES FORMULA NO. 2 P/N 2196-74-1 LUBRICANT. (PIPER AIRCRAFT P/N 923 120). REASSEMBLY OF THE DURA TRANSMISSIONS REQUIRES A 1/2 FULL PACKING OF MIL-G-7118 GREASE. A THIN COAT OF MIL-G-7118 GREASE (FOR DURA) OR MIL-G-23827 GREASE (FOR DUKES) SHOULD BE APPLIED ON TRANSMISSION SCREWS. WHEEL BEARINGS REQUIRE CLEANING AND REPACKING AFTER EXPOSURE TO AN ABNORMALLY LARGE QUANTITY OF WATER. PACK CLEVELAND WHEEL BEARINGS WITH MOBILE GREASE 77 OR MOBILUX EP2. PACK GOODYEAR WHEEL BEARINGS WITH A GREASE CONFORMING TO MIL-G-81322.
4. OLEO STRUTS, POWER PACK RESERVOIR AND BRAKE RESERVOIR-FILL PER INSTRUCTIONS ON UNIT OR CONTAINER, OR REFER TO SERVICE MANUAL, SECTION II. DO NOT USE HYDRAULIC FLUID WITH A CASTOR OIL BASE.
5. PROPELLER - REMOVE ONE OF THE GREASE FITTINGS FOR EACH BLADE. APPLY GREASE THROUGH FITTING UNTIL FRESH GREASE APPEARS AT HOLE OF REMOVED FITTING.
6. LUBRICATION POINTS - WIPE ALL LUBRICATION POINTS CLEAN OF OLD GREASE, OIL, DIRT, ETC., BEFORE RELUBRICATING.
7. LUBRICATING OIL - INTERVALS BETWEEN OIL CHANGES CAN BE INCREASED AS MUCH AS 100% ON ENGINES EQUIPPED WITH FULL FLOW (CARTRIDGE TYPE) OIL FILTERS, PROVIDED THE ELEMENT IS REPLACED EACH 50 HOURS OF OPERATION.
8. LUBRICATE THE PIVOT POINTS, CABLE ATTACHMENT POINTS, AND TRIM WHEELS SPARINGLY.
9. REMOVE ALTERNATOR END COVER AND CHECK BEARING GREASE.
10. LOOSEN BOOT FROM GEAR LOCK ROD ASSEMBLY AND GREASE TUBE. TUBE MUST SLIDE FREE TO SLOT LIMITS. REFER TO THE LATEST REVISION OF PIPER SERVICE LETTER NO. 755.

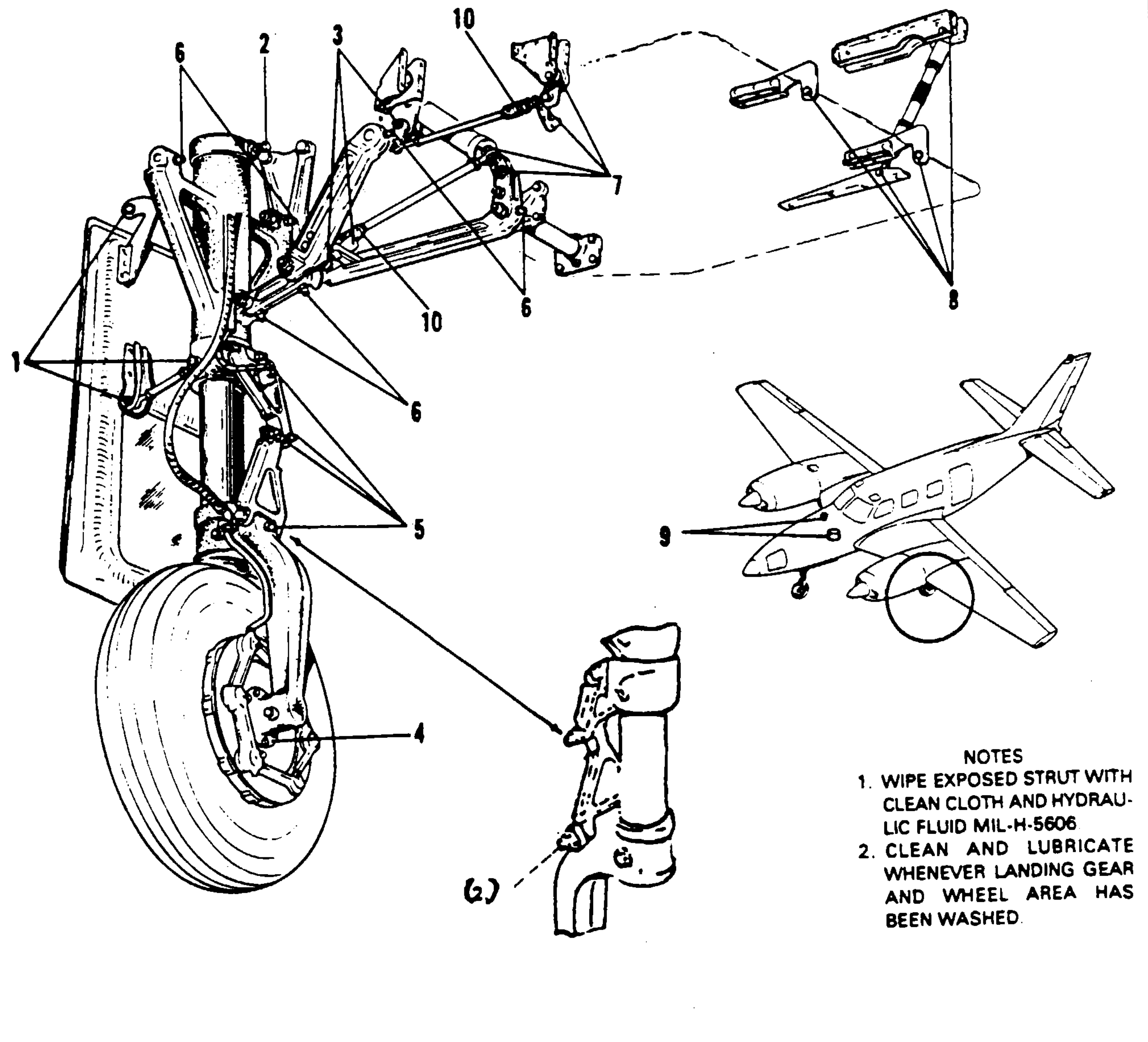
NOTES

1. PILOT AND PASSENGER SEATS - LUBRICATE TRACK ROLLERS AND STOP PINS AS REQUIRED.
2. CONTROL AND TRIM CABLES ARE TO BE WIPED CLEAN AT REGULAR INTERVALS, AND ARE NOT TO BE LUBRICATED.
3. SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTIONS NO. 1014 FOR USE OF DETERGENT OIL.

CAUTIONS

1. DO NOT USE STRAIGHT MINERAL OIL IN THESE ENGINES.
2. DO NOT USE HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.
3. DO NOT OVER-LUBRICATE COCKPIT CONTROLS.
4. DO NOT APPLY LUBRICANT TO RUBBER PARTS.

COMPONENT	LUBRICANT	FREQUENCY
1. GEAR DOOR, OUTBOARD, HINGES AND CONTROL RODS, RIGHT AND LEFT	MIL-L-7870	100 HRS
2. GEAR OLEO STRUT FILLER, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 4 AND CAUTION 2)	MIL-H-5606	AS REQUIRED
3. GEAR DOWNLOCK HOOK, CONTROL ROD ENDS AND BELLCRANK, RIGHT AND LEFT	MIL-L-7870	100 HRS
4. WHEEL BEARINGS, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3 AND NOTE 2)	MIL-G-81322	100 HRS
5. GEAR TORQUE LINK FITTINGS, RIGHT AND LEFT	MIL-G-23827	100 HRS
6. GEAR SIDE BRACE LINK BUSHING AND HOUSING BUSHING, RIGHT AND LEFT	MIL-G-23827	100 HRS
7. GEAR UPLOCK HOOK, CONTROL ROD ENDS, CYLINDER ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
8. GEAR DOOR, INBOARD, HINGES AND CYLINDER ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
9. BRAKE AND POWER PACK RESERVOIR (SEE SPECIAL INSTRUCTION 4 AND CAUTION 2)	MIL-H-5606	AS REQUIRED
10. GEAR LOCK ROD ASSEMBLY AND DOWN LOCK HOOK ASSEMBLY (SEE SPECIAL INSTRUCTION 10) SEE NOTE 2	MIL-G-3545	100 HRS



NOTES
1. WIPE EXPOSED STRUT WITH CLEAN CLOTH AND HYDRAULIC FLUID MIL-H-5606
2. CLEAN AND LUBRICATE WHENEVER LANDING GEAR AND WHEEL AREA HAS BEEN WASHED

Chart 2-12. Lubrication Chart Landing Gear, Main)

COMPONENT	LUBRICANT	FREQUENCY
1. NOSE GEAR OLEO STRUT FILLER (SEE SPECIAL INSTRUCTION 4 AND CAUTION 2)	MIL-H-5606	AS REQUIRED
2. STEERING ARM ROLLERS, BELLCRANK RETRACTION ROD ENDS, AND STEERING ROD ENDS	MIL-L-7870	100 HRS
3. NOSE GEAR DOOR ACTUATOR, RETRACTION ROD END AND CYLINDER ROD END	MIL-L-7870	100 HRS
4. UPLOCK HOOK AND UPLOCK ROD	MIL-L-7870	100 HRS
5. DOOR HINGES	MIL-L-7870	100 HRS
6. DRAG LINK ASSEMBLY AND IDLER LINK	MIL-G-23827	100 HRS
7. WHEEL BEARINGS (SEE SPECIAL INSTRUCTION 3 AND NOTE 2)	MOBILGREASE 77 OR MOBILUX EP2	100 HRS
8. UPPER AND LOWER TORQUE LINK	MIL-G-23827	100 HRS
9. UPPER AND LOWER TORQUE LINK CONNECTING BOLT AND SHIMMY DAMPENER	MIL-G-23827	100 HRS
10. GEAR HOUSING BUSHINGS	MIL-G-23827	100 HRS
11. NOSE GEAR UPLOCK ROD ASSEMBLY (SEE SPECIAL INSTRUCTION 10) SEE NOTE 2	MIL-G-3545	100 HRS

NOTES
1. WIPE EXPOSED STRUT WITH CLEAN CLOTH AND HYDRAULIC FLUID MIL-H-5606.
2. CLEAN AND LUBRICATE WHENEVER LANDING GEAR AND WHEEL AREA HAS BEEN WASHED.

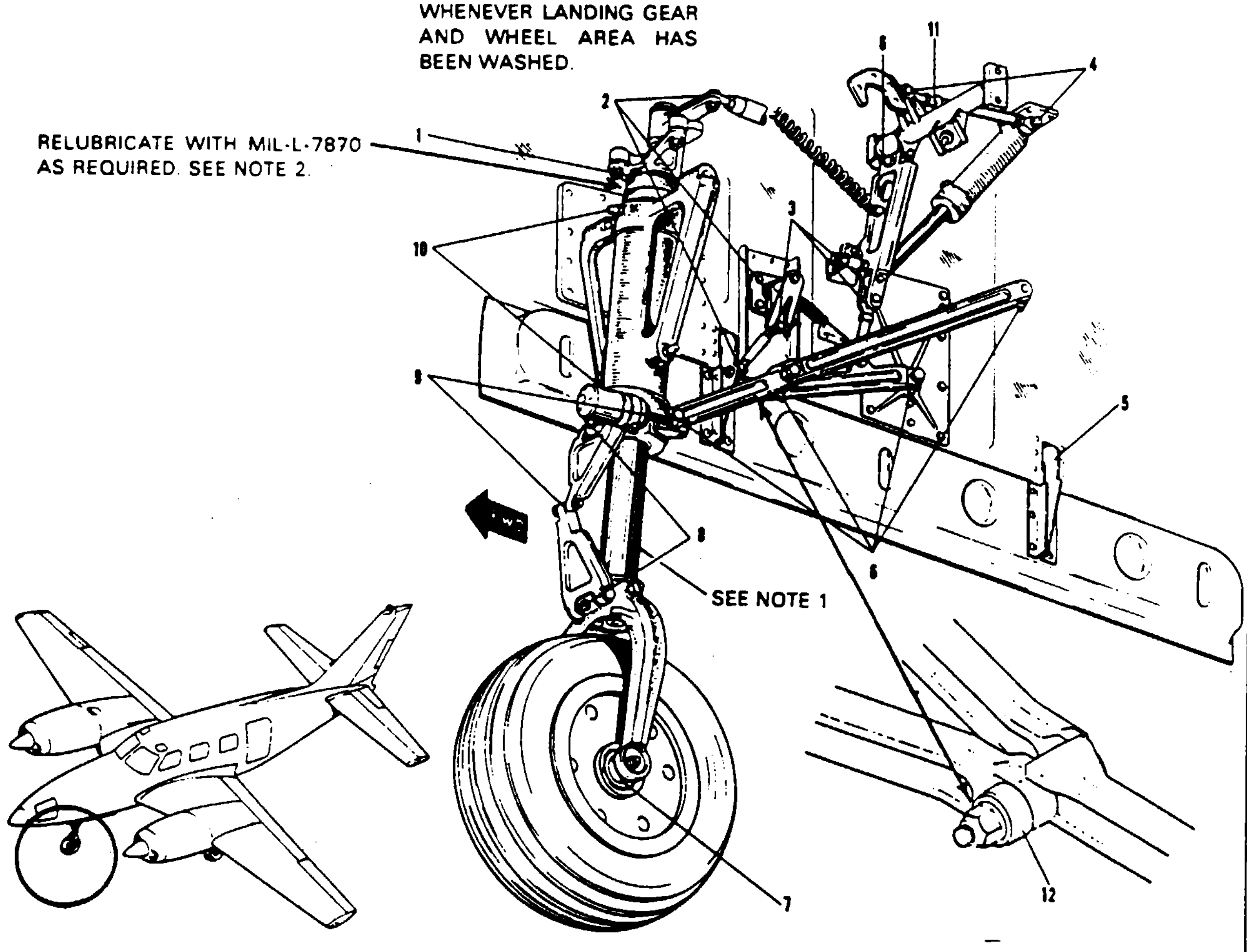


Chart 2-12a. Lubrication Chart (Landing Gear, Nose)

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON TRIM SCREW	MIL-G-23827	500 HRS
2. AILERON TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
3. RUDDER TRIM SCREW	MIL-G-23827	500 HRS
4. RUDDER AND RUDDER TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
5. ELEVATOR AND ELEVATOR TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
6. AILERON HINGES, RIGHT AND LEFT	MIL-L-7870	100 HRS
7. FLAP TRANSMISSION PIVOT BOLTS AND SENDER ARM	MIL-L-7870	100 HRS
8. FLAP TRANSMISSION AND SCREW, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3)		500 HRS
9. FLAP TRACK, RIGHT AND LEFT	ALL PURPOSE SLIP SPRAY (DUPONT NO. 6611)	50 HRS
10. FLAP TRACK ROLLERS, RIGHT AND LEFT	MIL-L-7870	100 HRS
11. AILERON BELLCRANK CABLE ENDS, PIVOT BEARING AND CONTROL ROD ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
12. TRIM SCREWS	MIL-G-23827	500 HRS

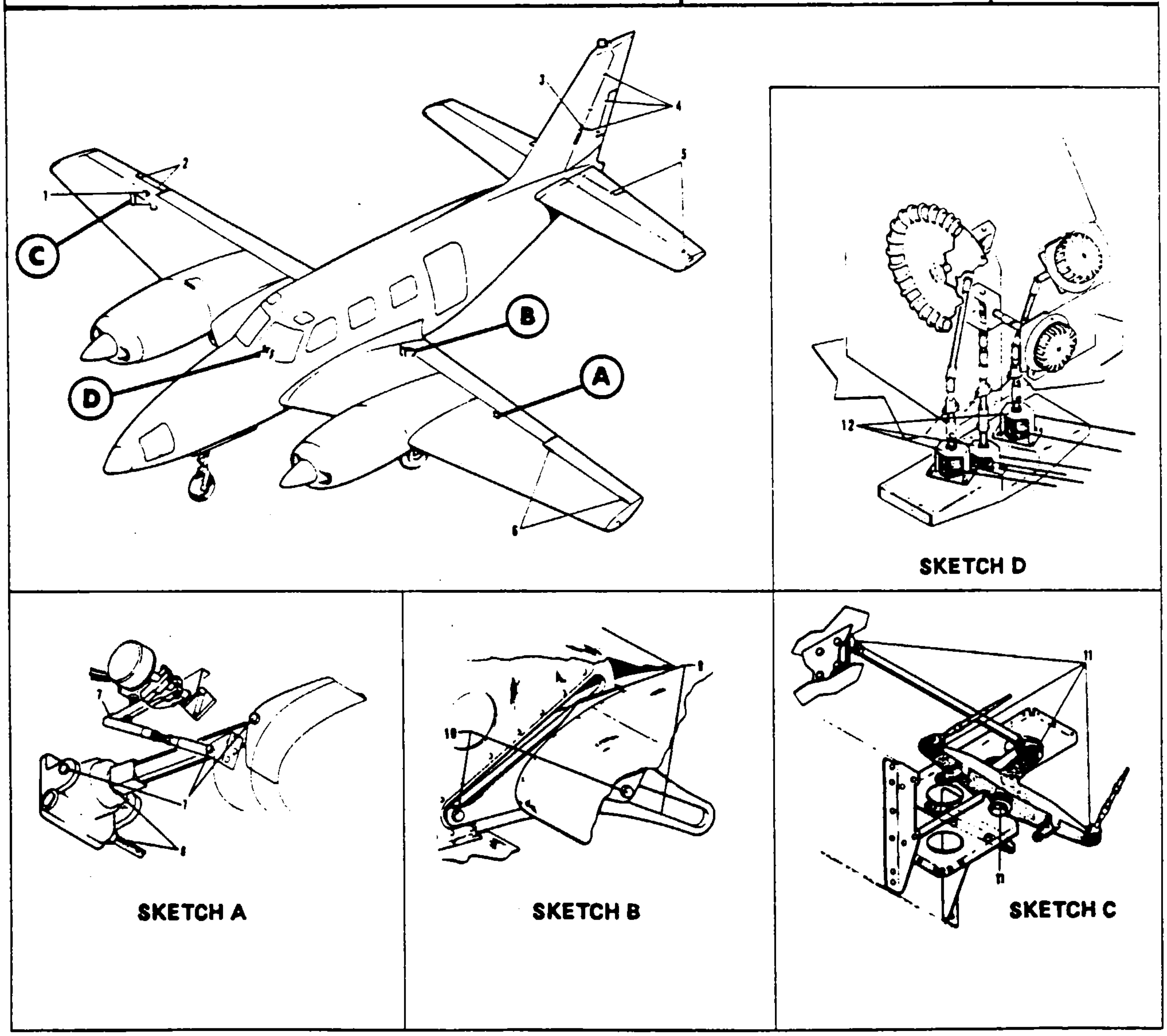
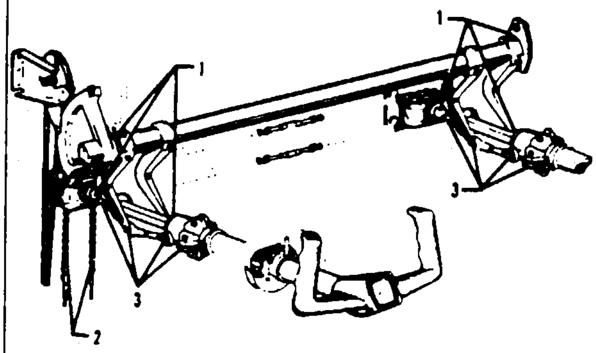
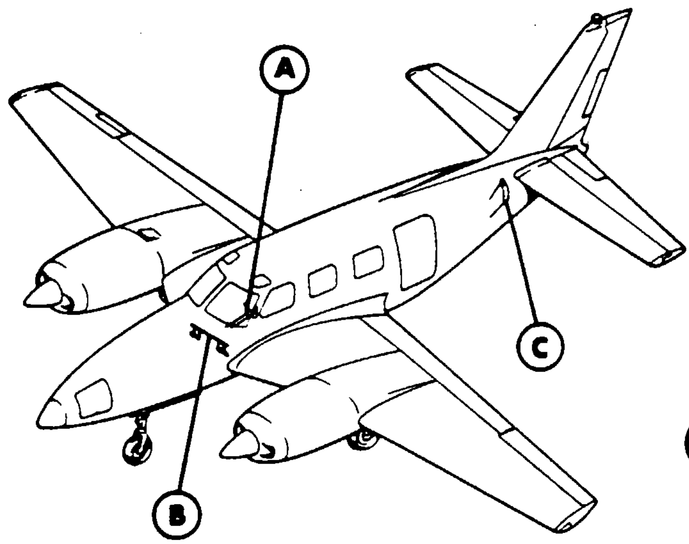


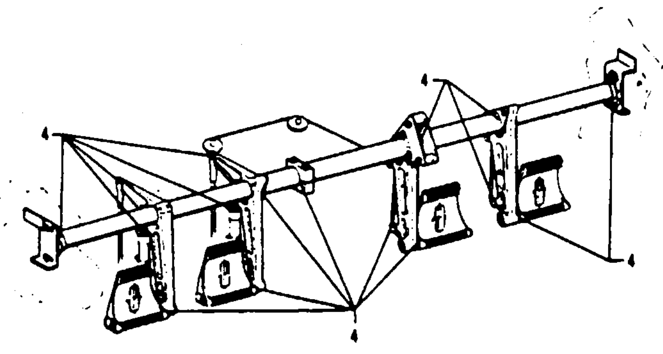
Chart 2-12b. Lubrication Chart (Control System)

COMPONENT	LUBRICANT	FREQUENCY
1. CONTROL WHEEL, TORQUE TUBE BEARINGS, SPROCKET BUSHINGS AND ROLLER BEARINGS	MIL-L-7870	500 HRS
2. CONTROL WHEEL CHAIN, VERTICAL AND HORIZONTAL	MIL-L-7870	500 HRS
3. CONTROL WHEEL, ROLLERS, LINK AND FLEXIBLE JOINT	MIL-L-7870	100 HRS
4. RUDDER PEDALS, TORQUE TUBE BEARINGS AND BLOCK, CONTROL CABLE ENDS, BRAKE CYLINDER ENDS, AND PULLEYS	MIL-L-7870	100 HRS
5. ELEVATOR BELLCRANK, PIVOT BOLTS AND CABLE ENDS	MIL-L-7870	100 HRS
6. RUDDER HORN CABLE ENDS	MIL-L-7870	100 HRS
7. ELEVATOR TRIM SCREW	MIL-G-23827	500 HRS
8. ELEVATOR TRIM TAB CONTROL ROD ENDS	MIL-L-7870	100 HRS
9. ELEVATOR CONTROL ROD	MIL-L-7870	100 HRS

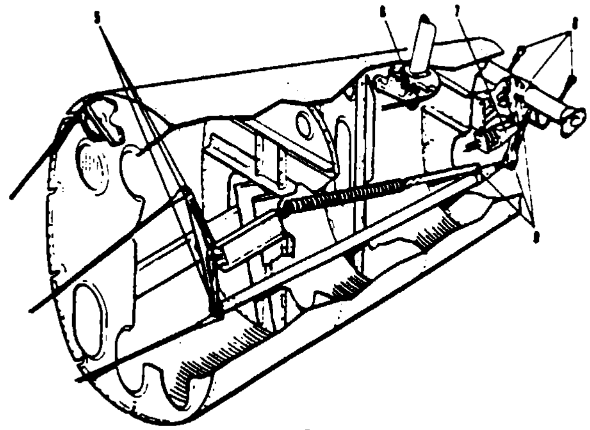


SKETCH A





SKETCH B



SKETCH C

Chart 2-12c. Lubrication Chart (Control System) (cont.)

COMPONENT	LUBRICANT	FREQUENCY
1. ZERK FITTINGS, BLADE HUB, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 5)	MIL-G-23827	100 HRS
2. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
3. AIR FILTER, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 1)		50 HRS
4. ALTERNATE AIR MECHANISM, RIGHT AND LEFT	MIL-L-7870	100 HRS
5. OIL FILTER CARTRIDGE, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 7)		50 HRS
6. ENGINE OIL SUMP, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 7, NOTE 3 AND CAUTION 1)	MIL-L-22851	50 HRS
7. CONTROL LEVERS AND TRIM INDICATORS (SEE CAUTION 3)	MIL-L-7870	500 HRS
8. CONDENSER AIR SCOOP AND ALTERNATE AIR DOOR HINGE	MIL-L-7870	100 HRS
9. COWL FLAP TRANSMISSION AND SCREW, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3)		500 HRS
10. COWL FLAP CONTROL ROD ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
11. COWL FLAP HINGE, RIGHT AND LEFT	MIL-L-7870	100 HRS
12. ALTERNATOR SLIP RING BEARING, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 9)	BRB 2 OR SRI 2 AEROSHELL 5	100 HRS

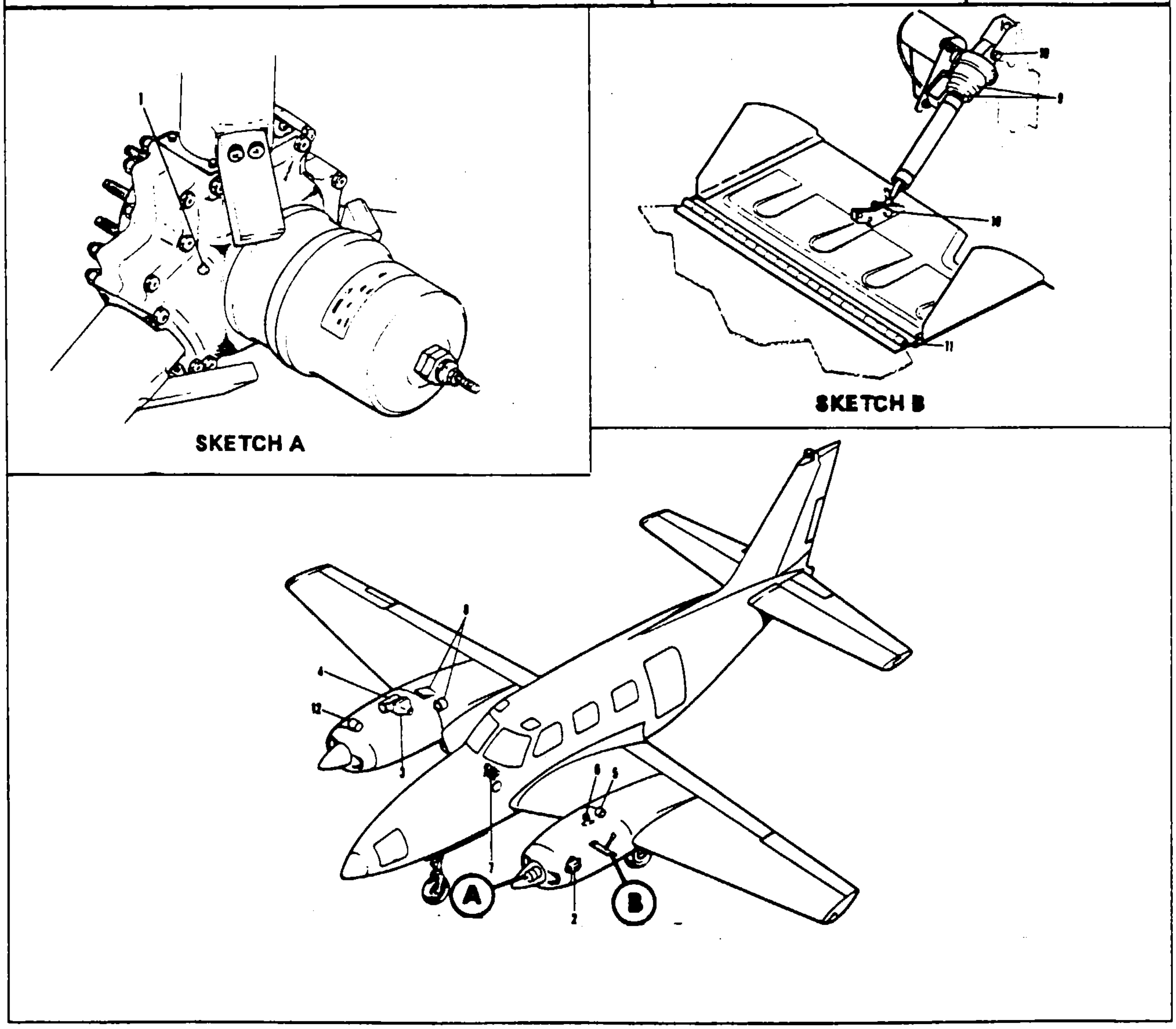


Chart 2-12d. Lubrication Chart (Power Plant, Propeller and Cowl Flap)

COMPONENT	LUBRICANT	FREQUENCY
1. CABIN DOOR LATCH, HINGES AND STEP MECHANISM	MIL-L-7870	100 HRS
2. NOSE CONE AND FORWARD BAGGAGE DOOR HINGES AND LATCHES	MIL-L-7870	100 HRS
3. SEAT TRACKS ALL (SEE NOTE 1)	MIL-L-7870	100 HRS

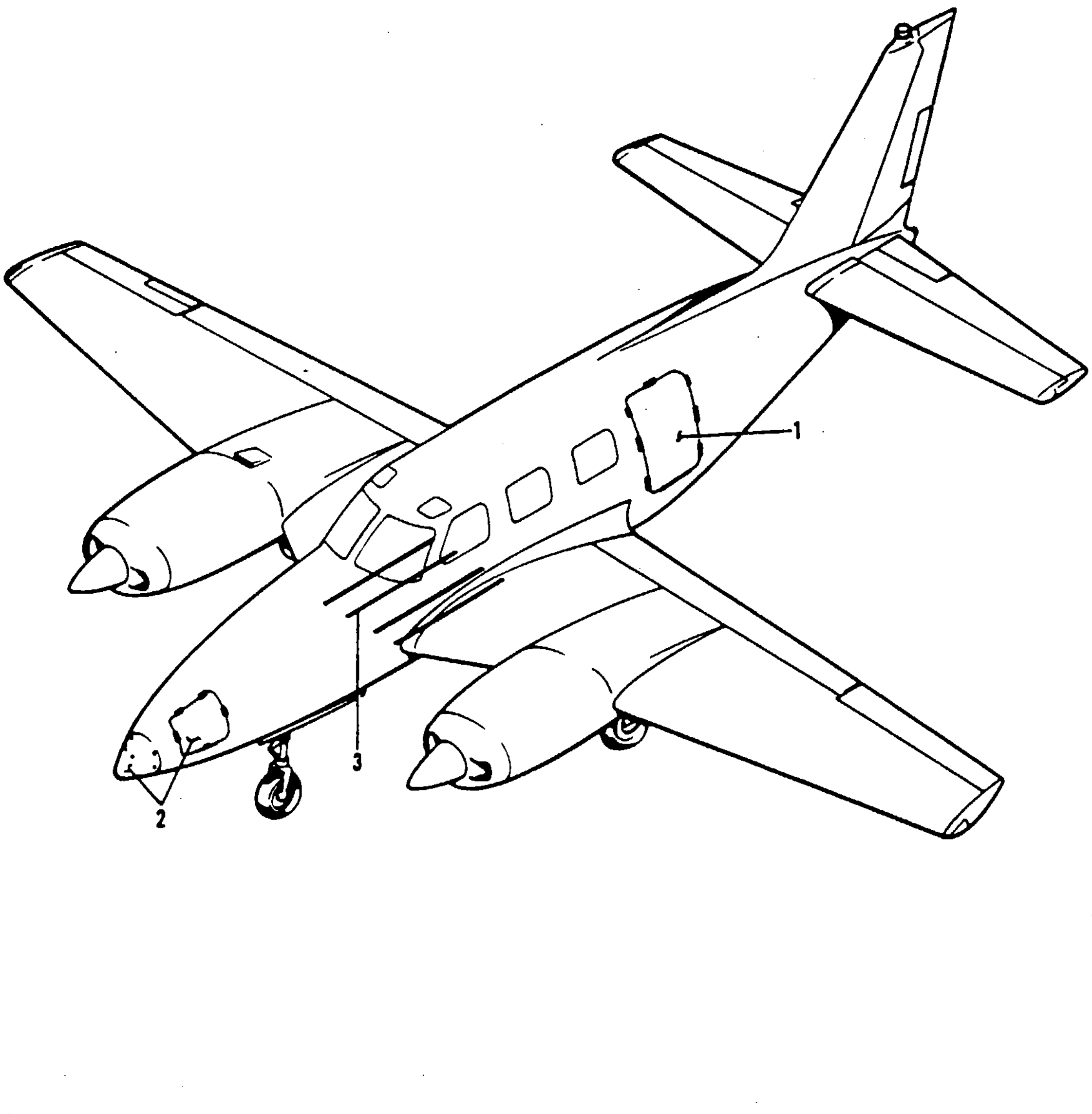


Chart 2-12e. Lubrication Chart (Cabin Door, Baggage Door and Seats)

TABLE II-IV. LIST OF CONSUMABLE MATERIALS

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Grease Aircraft and Instrument	MIL-G-23827 QPL-23827-10	Low Temp Grease EP	Texaco, Inc., 2000 Westchester Ave. White Plains, N.Y. 10650 914-253-4000
Flap Gear/Actuator Screw- DUKES	MIL-G-23827 QPL-23827-10	5114 EP Grease, AV 55	Standard Oil of California 225 Bush St. San Francisco, CA 94104 415-894-7700
Flap Gear/Actuator Screw - DURA	MIL-G-7118	Aeroshell Grease 7, Braycote 627S	Shell Oil Co., One Shell Plaza Houston, TX 77002 713-241-6161
		Mobil Grease 27	Mobil Oil Corporation 150 E. 42nd St. New York, N Y 10017 212-883-4242
		Royco 27A	Royal Lubricants Co., Inc. River Road, East Hanover, NJ 07936 201-887-3100
		Castrolease Al	Castrol Oils Inc., Newark, NJ
		Supermil Grease No. A72832	American Oil Company 239 Wilson Ave. Newark, NJ 07105 201-589-0250
		BP Aero Grease 31B	BP Trading Limited Moore Lane, Britannic House, London E.C. 2 England
Grease, Aircraft, General Purpose Wide Temperature Range	MIL-81322 QPL-81322-3	Aeroshell Grease 22	Shell Oil Co., One Shell Plaza Houston, TX 77002 713-241-6161
		Mobil Grease 28	Mobil Oil Corporation 150 E. 42nd St. New York, NY 10017 212-883-4242

TABLE II-IV. LIST OF CONSUMABLE MATERIALS (cont.)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
		Royco 22	Royal Lubricants Co., Inc. River Road, East Hanover, NJ 07936 201-887-3100
Grease, Aircraft and Instruments, High and Low Temperature	MIL-G-3278 QPL-3278-24	Unitemp EP	Texaco, Inc., 2000 Westchester Ave., White Plains, NY 10650 914-253-4000
		RPM Avn. Grease 5, Supermil Grease No. 8723	Standard Oil of California 225 Bush St. San Francisco, CA 94104 415-894-7700
		Aeroshell Grease 7A	Shell Oil Co., One Shell Plaza Houston, TX 77002 713-241-6161
		Mobil Grease 22	Mobil Oil Corporation 150 E. 42nd St. New York, NY 10017 212-883-4242
		Royco 78	Royal Lubricants Co., Inc. River Road, East Hanover, NJ 07936 201-887-3100
		L- 1212	Sinclair Refining Co., 600 Fifth Avenue New York, NY 10020
		1916 Uni-Temp Grease	California Texas Oil Corp. 380 Madison Ave. New York, N Y 10017
Lubricating Grease Molybdenum Disulfide	MIL-G-21164 QPL-21164-15	Aeroshell Grease 17	Shell Oil Co., One Shell Plaza Houston, TX 77002 713-241-6161
		Royco 64C	Royal Lubricants Co., Inc. River Road, East Hanover, NJ 07936 201-887-3100

TABLE II-IV. LIST OF CONSUMABLE MATERIALS (cont.)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
		Castrolease MSA (C)	Castrol Oil Inc., 254-266 Doremus Avenue, Newark, NJ 07105
Grease, Ball and Roller Bearing	MIL-G-18709 QPL-18709-55	Regal ASB-2 Formula TG-10293	Texaco, Inc., 2000 Westchester Ave., White Plains, NY 10650 914-253-4000
		Andok B	Exxon Company, U.S.A., Box 2180, Rm. 491 Houston, TX 77001 713-656-3636
		Code 1-20481, Darina Grease 1 XSG-6213 Code 71-501, Darina Grease 2 XSG-6152 Code 71-502, Alvania Grease 2 XSG-6151 Code 71-012, Cyprina Grease 3 XSG-6280 Code 71-003	Shell Oil Co., One Shell Plaza Houston, TX 77002 713-241-6161
Lubricating Grease, Plug Valve, Gasoline and Oil Resistant	MIL-G-6032 QPL-6032-10	Royco 32	Royal Engineering Co., Whippany, New Jersey
		Castrolease PV	Castrol Oils Inc., Newark, New Jersey
		Parker Fuel Lube 44	Parker Seal Co. 17325 Euclid Ave. Cleveland, OH 44112 216-531-3000
		BP Aero Grease 32	BP Trading Limited Moore Lane, Britannic House London E.C. 2 England
Anti-Seize Compound Graphite Petroleum	MIL-T-5544 TT-S-1732 (TT-A-580)	Royco 44	Royal Lubricants Co., Inc. River Road, East Hanover, NJ 07936 201-887-3100

TABLE II-IV. LIST OF CONSUMABLE MATERIALS (cont.)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Silicone Compound	MIL-S-8660 (MIL-C-21567) QPL-8660-7	DC-4, DC-6 Compound	Dow Corning Corp. Dept. A0021 P.O. Box 1767 Midland, Mich. 48640 (Mich.) 800-292-2323 (All others) 800-248-2345
		G-624	General Electric Co., Silicone Products Div. Section TR75 Waterford, NY 12188 518-237-3330
		Y 2900	Union Carbide 270 Park Ave. New York, NY 10017 212-551 -3763
Dry Lubricant, Flourocarbon Release Agent	MIL-L-60326	MS-122, 607S	
Waterproof Grease, High and Low Temperature		Aero Lubriplate	Fiske Brothers Refining Company, 129 Lockwood St. Newark, NJ 07105 201-589-9150
Rain Repellent		Repcon FSCM 50159	UNELKO Corporation 727 E. 110th. Street Chicago, IL 60628
Lubricant & Decoke Agent for Turbocharger		Mouse Milk	Worldwide Filter P.O. Box 1758 1677 Abram Court San Leandro, CA 94577 415-483-5122

2-58. LUBRICATION OF THREADS. All fittings on external lines, including their points of attachment at the engine and other components, should be lubricated with the proper lubricant as specified in Table II-IV.

The following steps should be followed when applying thread lubricants:

a. Thoroughly clean threads before applying lubricant.
b. Use selected thread lubricant sparingly.
c. Apply thread lubricant to male threads only.
d. Lubricate the first three threads on straight fittings.
e. Do not lubricate the first two threads on tapered fittings. Apply the lubricant to the next three threads only.
f. Ascertain that lubricant does not enter fittings or flared areas.
g. Any fittings going to the engine should be lubricated with the type of fluid going through the lines.

2-59. LUBRICATION OF GASKETS AND SEALS. Gaskets and "O" ring seals which require lubrication should be lubricated with the same type of fluid they are sealing.

2-60. LUBRICATION CHART. Each part of the airplane to be lubricated, as depicted on the lubrication chart, is indicated by a frequency symbol which shows the time internals between lubrications. Application symbols with the frequency symbols show how the lubrication is applied. A parts nomenclature key, referred to by a number adjacent to the frequency symbol, identifies the part to be lubricated. Within the frequency symbol is a code letter which identifies the type of lubricant to be used and a special instructions number which gives instruction for lubricating a particular component.

2-61. OXYGEN SYSTEM.

2-62. SERVICING OXYGEN SYSTEM. The oxygen for the system is furnished from a stationary DOT 3AA1800 cylinder located in the left side of the nose section, directly behind the baggage compartment. The cylinder, when serviced at 1800 psi at 70° F. has a capacity of 48 cubic feet. Service and maintenance instructions for the oxygen system may be found in Section XIV.

2-63. OXYGEN SYSTEM SAFETY PRECAUTIONS. The utmost care must be exercised in servicing, handling, and inspection of the oxygen system. Comply with the following precautions:

a. Keep the oxygen regulator, cylinder, gauge, valve, fittings, masks, and all other components of the oxygen system free of oil, grease, gasoline, and all other readily combustible substances.
b. Do not allow foreign matter to enter the oxygen lines.

WARNING

The presence of foreign matter in the high pressure lines can cause an explosion. When coming in contact with oxygen equipment, keep hands, tools, and clothing clean - hospital clean.

c. Never attempt to repair or repaint oxygen equipment.
d. Keep fire and heat away from oxygen equipment. Do not smoke while working with or near oxygen equipment, and take care not to generate sparks with carelessly handled tools when working on the oxygen system.
e. Never allow electrical equipment to come in contact with the oxygen cylinder.
f. Only a thread compound approved under MIL-T-5542 can be used safely on oxygen systems. Apply only in direction of thread spiral of the male pipe thread beginning with the second thread.

2-64. FILLING OXYGEN CYLINDER. The filler valve for the oxygen system is accessible through a door located on the lower left side of the nose section below the access panel.

a. To fill the oxygen cylinder, open the access door, unscrew the cap from the filler valve far enough to allow the vent hole in the cap to check the operation of the check valve. Remove the cap, ascertain that all fittings are free from combustible substances and foreign matter, and attach the filler hose from the recharge unit to the filler valve.

NOTE

If the airplane's oxygen cylinder pressure is below 50 psi, the system should be purged as described in Section XIV.

b. When using a recharge unit consisting of one supply cylinder, slowly open the valve of the supply unit and allow the oxygen to transfer.
c. When using a recharge unit consisting of two or more supply cylinders (cascade storage system), it is recommended that the following procedure be used:
   1. Before opening any valves, check the pressure remaining in the airplane's oxygen cylinder. If it is still partly charged, note the pressure indicated on the cylinder gauge. Then open and close each valve on the cascade storage system and determine which cylinder has the lowest pressure. When found, if this cylinder has a pressure lower than the oxygen cylinder in the airplane, do not attempt using it for filling. Use the storage cylinder that has a pressure higher than the airplane's cylinder but lower than the others.
   2. Open the valve on only the one storage cylinder with the lowest pressure. When the pressure indicated on the airplane's oxygen gauge and charging gauge has become equal, close the valve of the storage cylinder, then go to the storage cylinder with the next higher pressure and repeat the procedure.
   3. If, after using the last storage cylinder, the airplane's oxygen system is still not fully charged, a full storage cylinder should be put in place of a cylinder with the lowest pressure and used in the same manner.
   4. A good deal of oxygen will remain in the large cylinders used in the cascade system after filling only one of the cylinders, but such remaining oxygen will be at a pressure something less than the 1800 pounds, which is not sufficient pressure to completely refill another aircraft cylinder, although it will refill several smaller cylinders.
   5. It is not economical, even on a three or four cylinder cascade system to begin recharging with oxygen at less than 300 psi pressure in the 300 cubic foot bank of cylinders. So, use 300 cubic foot cylinders down to approximately 300 psi, then return for refilling. In two cylinder systems, use to approximately 600 psi, then return for filling.

TABLE II-V. INDICATED OXYGEN CYLINDER PRESSURES
VS. AMBIENT TEMPERATURE

Ambient Temperature - ° F	Indicated Cylinder Pressure - Psig
110	1980
100	1935
90	1890
80	1845
70	1800
60	1755
50	1710
40	1665

NOTE

These pressures are not exact, but sufficiently accurate for practical purposes for working pressures between 1800 and 2400 psig cylinders.

d. When the pressure gauge on the recharge unit or in the airplane reaches 1800 psi at 70° F. close the pressure regulator valve on the recharge unit. Refer to Table II-V for the appropriate psi values for temperatures other than 70° F. Disconnect the filler hose from the filler valve, check for any evidence of a leak, and replace the protective cap. Allow the cylinder temperature to stabilize and recheck the pressure to assure that it is in accordance with the marked service pressure. Make the necessary correction, replace protective cap, and close the access door.

2-65. PRESSURIZATION SYSTEM. This system requires very little maintenance other than periodic cleaning, checks for leakage around the cabin area, and the operation of the controls necessary to maintain proper cabin pressurization. A cabin pressurization check should be performed in accordance with Section XIII.

2-66. AIR CONDITIONING SYSTEM. Servicing this system consists of periodically checking the freon refrigerant level by operating the system and observing the sight gauge window in the upper end of the receiver-dryer. This is done through the nose baggage compartment rear access panel. Check for signs of foam or bubbles in the sight gauge. If these conditions are observed, refer to Section XIII for further instructions on the air conditioner. If the system must be recharged, it is advisable to check the oil in the compressor at this time before recharging the system, and replace the receiver-dryer and "O" rings in connections which were opened.

2-67. CLEANING.

2-68. CLEANING ENGINE COMPARTMENT. Before cleaning the engine compartment, place a plastic cover or similar material around the pressure pump inlet filter and a strip of tape on the magneto vents to prevent any solvent from entering these units.

a. Place a large pan under the engine to catch waste.
b. With the engine cowling removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. It may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.

CAUTION

Do not spray solvent into the alternator, starter, air intake, and alternate air inlets.

c. Allow the solvent to remain on the engine from five to 10 minutes, then rinse the engine clean with additional solvent and allow to dry.

CAUTION

Do not operate engine until excess solvent has evaporated or otherwise been removed.

d. Remove the protective covers from the filter and magnetos.
e. Lubricate controls, bearing surfaces, etc., per Lubrication Chart.

2-69. CLEANING LANDING GEAR. Before cleaning the landing gear, place a plastic cover or similar material over the wheel and brake assembly.

a. Place a pan under the gear to catch waste.
b. Spray or brush the gear area with solvent or a mixture of solvent and degreaser, as desired. It may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.

NOTE

If desired, the inboard gear doors may be lowered by actuating the emergency hand pump handle, with the master switch off.

c. Allow the solvent to remain on the gear from 5 to 10 minutes, then rinse the gear with additional solvent and allow to dry.
d. Remove the cover from the wheel and remove the catch pan.
e. Lubricate the gear per Lubrication Chart.

2-70. CLEANING EXTERIOR SURFACES. The airplane should be washed with a mild soap and water. Harsh abrasive or alkaline soaps or detergents used on painted or plastic surfaces could make scratches or cause corrosion of metal surfaces. Cover areas where cleaning solution could cause damage. To wash the airplane, the following procedure may be used:

a. Flush away loose dirt with water.
b. Apply cleaning solution with a rag, sponge or soft bristle brush.
c. To remove stubborn oil and grease, use a cloth dampened with naphtha.

d. Where exhaust stains exist, allow solution to remain on the surface longer. A cleaning compound may be used on the stainless steel exhaust shield.
e. Any good automotive wax may be used to presence the painted surfaces. Soft cleaning cloths or a chamois should be used to prevent scratches when cleaning or polishing. A heavier coating of wax on the leading surfaces will reduce the abrasion problems in these areas.

2-71. CLEANING WINDSHIELD AND WINDOWS.
a. Remove dirt, mud, etc., from exterior surface with clean water.
b. Wash with mild soap and warm water or an aircraft plastic cleaner. (Do not use plastic cleaners on glass windshields.) Use a soft cloth or sponge using a straight rubbing motion. Do not rub harshly on any surfaces.
c. Remove oil and grease with a cloth moistened with kerosene.

NOTE

Do not use gasoline, alcohol, benzene, carbon tetrachloride, thinner, acetone, or window cleaning sprays.

d. After cleaning plastic surfaces, apply a thin coat of hard polishing wax. Rub lightly with a soft cloth. Do not use a circular motion.
e. A severe scratch or mar in plastic can be removed by using jeweler's rouge to rub out the scratch. Smooth both sides and apply wax.

2-72. CLEANING HEADLINER, SIDE PANELS AND SEATS.
a. Clean headliner with a good quality rug and upholstery shampoo, such as the type manufactured by Bond Sanitary Products of York, Penna. Follow the manufacturer's instructions carefully. Avoid soaking or harsh rubbing.

CAUTION

Solvent cleaners require adequate ventilation.

b. Clean side panels and seats with a stiff bristle brush and vacuum where necessary.
c. Leather material should be cleaned with saddle soap or a mild soap and water.

2-73. CLEANING WOOD SURFACES. Wood surfaces may be cleaned with any good household liquid or spray cleaner and polish manufactured for this purpose.

2-74. CLEANING CARPETS. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a noninflammable dry-cleaning fluid. Floor carpets may be removed and cleaned like any household carpet.

2-75. CLEANING TOILET.
a. To dispose of the sanitary bag, pull the top of the bag from the pail and close with a wire tie. Remove it from the airplane in the covered pail and dispose of according to field facilities. Do not attempt to flush the bag in a toilet.
b. To clean and deodorize the airplane's toilet, mix a solution of disinfectant type cleaner. Using a soft bristled brush, rag and solution, wash the toilet pail and seat. The toilet may be removed for cleaning by disconnecting the two fasteners at the inside forward end of the unit. Slide it back and lift from the floor.

c. When offensive odor remains, use a stronger solution and reclean.
d. Rinse with fresh water and dry.
e. To install a new sanitary bag, place it over the top edge of the pail and push it into the bottom of the pail.

2-76. AIRPLANE FINISH CARE. The complete airplane is carefully finished inside and outside to assure maximum service life. Both sides of all parts are alodine treated and sprayed with zinc chromate primer. The external surfaces are coated with durable acrylic lacquer or optional polyurethane enamel.

When washing the airplane it is advisable to use a mild soap and water solution. Loose dirt should be flushed away with clean water. Harsh abrasive or alkaline soaps or detergents could cause corrosion or make scratches in the finish.

Use naphtha and a soft cloth to remove stubborn oil and grease. Any good automotive wax can be used to presence the painted surfaces. Soft cleaning cloth or chamois should be used to prevent scratches when cleaning or polishing. Apply a heavier coating of wax on the leading edges of the wings and tail surfaces and on the nose cone section and propeller spinners to reduce the abrasion problems in these areas.

When repainting the airplane, never use aluminum foil as a paint spray mask on Aircon Nesa coated windshields. Nesa film is used on the exterior for static electricity protection and is basically tin oxide. Most metal brightners, whether alkaline or acidic, can react with the aluminum foil and release hydrogen, which may come in contact with the tin oxide. When the hydrogen and the tin oxide combine, the tin oxide film is reduced to pure tin and when wiped away will have a permanent dark stain. If metal brightners are to be used, insure adequate protection for the windshield by using paper and pasteboard prior to painting.

2-77. ELECTRIC WINDSHIELD WIPERS. Windshield wipers are standard equipment on the left and optional on the right windshield. To operate the windshield wipers, turn the switch located on the upper right side of the instrument panel to either the HIGH or LOW position. When turning OFF the wipers, turn the switch to either the OFF or PARK position. The OFF position stops the blades in place while the PARK position returns the blades to the center post position.

WARNING

Never operate the windshield wiper on a dry windshield. This could scratch the glass and shorten the life of the wiper blades.

The windshield wiper motor is located forward of the bulkhead at Station No. 81.00 at the upper left portion of the fuselage skin. If the right side windshield wipers are installed, a flexible shaft is run from the electric motor and transmission to a converter on the right side of the same bulkhead and the wiper runs off this converter. Refer to Section IV for adjustment of wiper blade and arm.

TABLE II-VI. DECIMAL CONVERSION CHART

4ths	8ths	16ths	32nds	64ths	TO 3 PLACES	TO 2 PLACES	M.M. EQUIV
				1/64	.016	.02	.397
			1/32		.031	.03	.794
				3/64	.047	.05	1.191
		1/16			.062	.06	1.587
				5/64	.078	.08	1.984
			3/32		.094	.09	2.381
				7/64	.109	.11	2.778
	1/8				.125	.12	3.175
				9/64	.141	.14	3.572
			5/32		.156	.16	3.969
				11/64	.172	.17	4.366
		3/16			.188	.19	4.762
				13/64	.203	.20	5.159
			7/32		.219	.22	5.556
				15/64	.234	.23	5.593
1/4					.250	.25	6.350
				17/64	.266	.27	6.747
			9/32		.281	.28	7.144
				19/64	.297	.30	7.540
		5/16			.312	.31	7.937
				21/64	.328	.33	8.334
			11/32		.344	.34	8.731
				23/64	.359	.36	9.128
	3/8				.375	.38	9.525
				25/64	.391	.39	9.922
			13/32		.406	.41	10.319
				27/64	.422	.42	10.716
		7/16			.438	.44	11.112
				29/64	.453	.45	11.509
			15/32		.469	.47	11.906
				31/64	.484	.48	12.303
					.500	.50	12.700

4ths	8ths	16ths	32nds	64ths	TO 3 PLACES	TO 2 PLACES	M.M. EQUIV
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.656	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/64	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

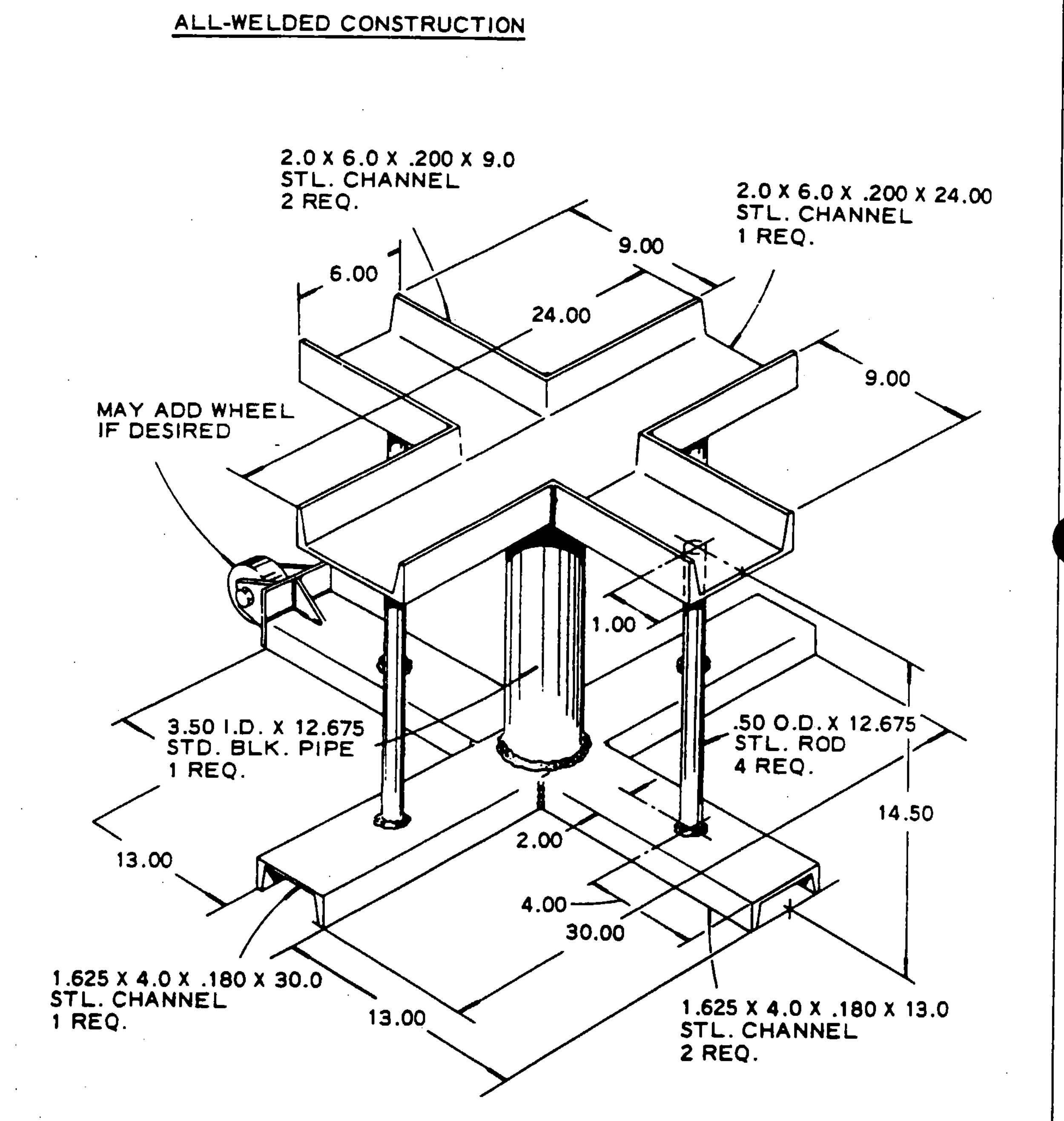


Figure 2-13. Fabricated Jack Stand for Piper Jack, Part No. 18338-00

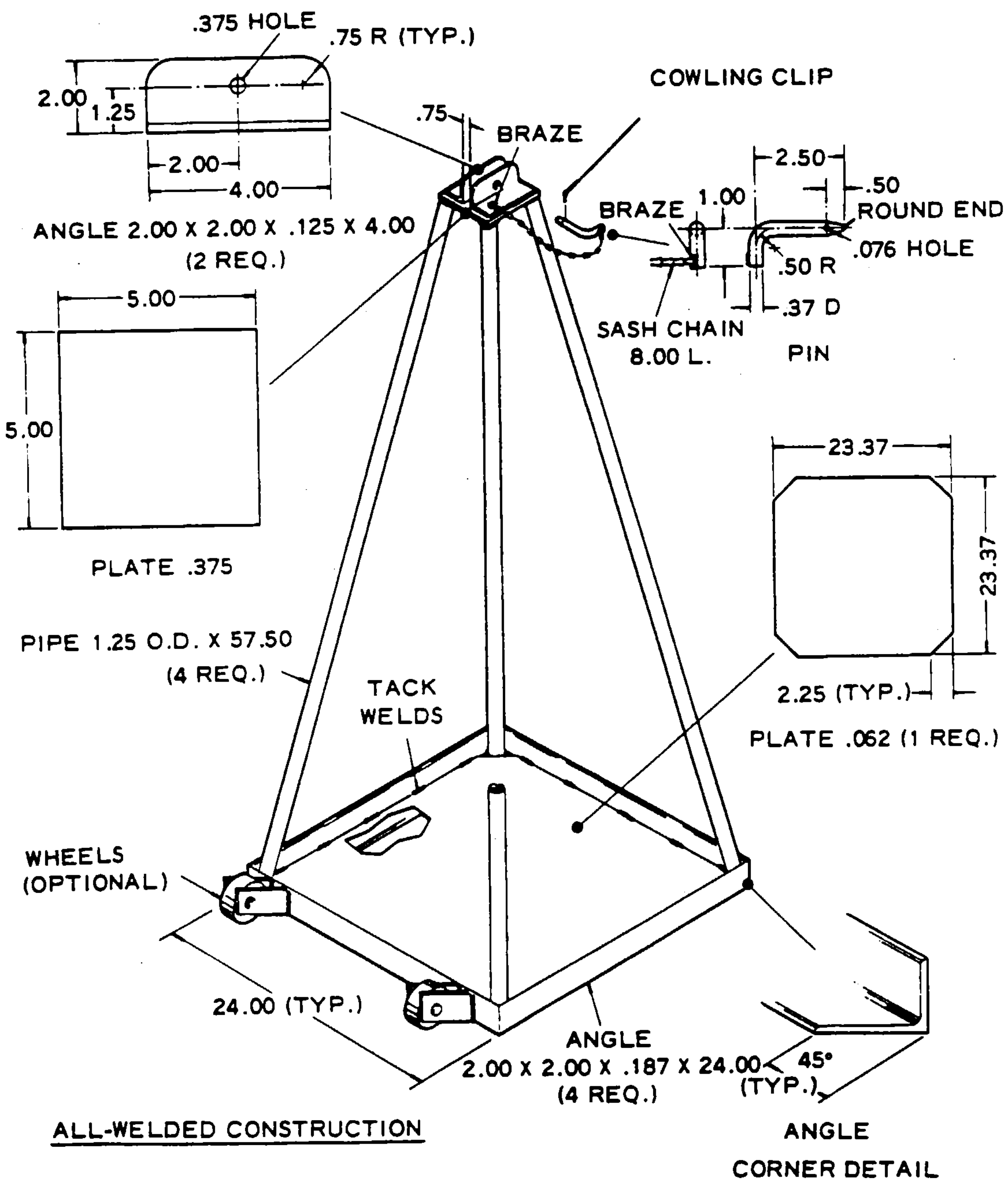


Figure 2-14. Fabricated Tail Stand

SECTION III

INSPECTION

SECTION III

INSPECTION

3-1. INTRODUCTION. This section provides instructions for conducting inspections. These inspections are described in paragraphs 3-4 and 3-5. Repair or replacement instructions for those components found to be unserviceable at inspection may be found in the section covering the applicable aircraft system.

CAUTION

When working on engines, ground the magneto primary circuit before performing any operation.

3-2. RECOMMENDED LUBRICANTS. Refer to Recommended Lubricants, Section II, for lubrication servicing instructions.

3-3. INSPECTION PERIODS.

3-4. INSPECTION REQUIREMENTS. The required inspection procedures are listed in Table III-I. The inspection procedure is broken down into major groups which are Propeller, Engine, Turbocharger, Cabin, Fuselage and Empennage, Wing, Landing Gear, Operational and General. The first column in each group lists the inspection or procedure to be performed. The second column is divided into four columns indicating the required inspection intervals of 50 hours, 100 hours, 500 hours, and 1000 hours. Each inspection or operation is required at each of the inspection intervals as indicated by a circle (O). If an item is not entirely accessible or must be removed, refer to the applicable section of this manual for instructions on how to gain access or remove the item. When performing inspection use forms furnished by the Piper Factory Service Department, available through Piper Dealers or Distributors.

NOTE

In addition to inspection intervals required in Table III-Ia preflight check must be performed as described in Paragraph 3-5.

3-5. PREFLIGHT CHECK. The airplane must be given a thorough preflight and walk-around check. The pilot and/or mechanic must include the preflight check as a normal procedure necessary for the safe operation of the aircraft. Refer to the Pilot's Operating Manual for a listing of items that must be checked.

3-6. OVERLIMITS INSPECTION. If the airplane has been operated so that any of its components have exceeded their maximum operational limits, check with the appropriate manufacturer.

3-7. PROGRESSIVE INSPECTION. The progressive inspection was designed to permit better utilization of the aircraft through the use of a planned inspection program. Programmed maintenance schedules are available from Service Sales under Part Number 761 485.

3-8. OPERATIONAL CHECK OF AIR CONTROL VALVES. (Refer to Section XIII, paragraph 13-110.) Operational checks of the outside air control valve and pressurized air control valve are required at every 50 hour inspection or when a malfunction of either valve is suspected. The following procedure should be performed to insure proper functioning of either valve. It should be noted that both valves are operated by the pressurization control lever on the instrument panel.

a. To check for proper operation of outside air control box turn on aircraft master switch and cabin comfort control master switch on lower right side of instrument panel. Place the pressurization control lever in the outside air position and check for suction at the outside air inlet underneath the nose. (See Figure 13-3 page 13-4, callout 11). If the pressurization control lever is placed in either the recirculated or pressurized air positions there should not be any suction felt at the inlet.

NOTE

The recirculating fan should be run as briefly as possible due to excessive drain on battery. No other electrical unit should be on at the time of the test.

b. To test the pressurized air control valve it is necessary to run both engines at 32 inches of manifold pressure and check for descent on the cabin rate of change instrument with the pressurization control lever in both outside or recirculated air position when the test switch is actuated. If no reading is noted, this part of the test is satisfactory. Now place the control lever in the pressurized air position and activate the test switch. If a dive is noted on the rate of change instrument, then a climb when the test switch is released and a return to zero, this valve is functioning properly and the test is complete. (Refer to Figure 13-34 page 13-80.)

NOTE

If either of these tests prove unsatisfactory the problem is either a broken actuator cable from the control lever or a valve not functioning.

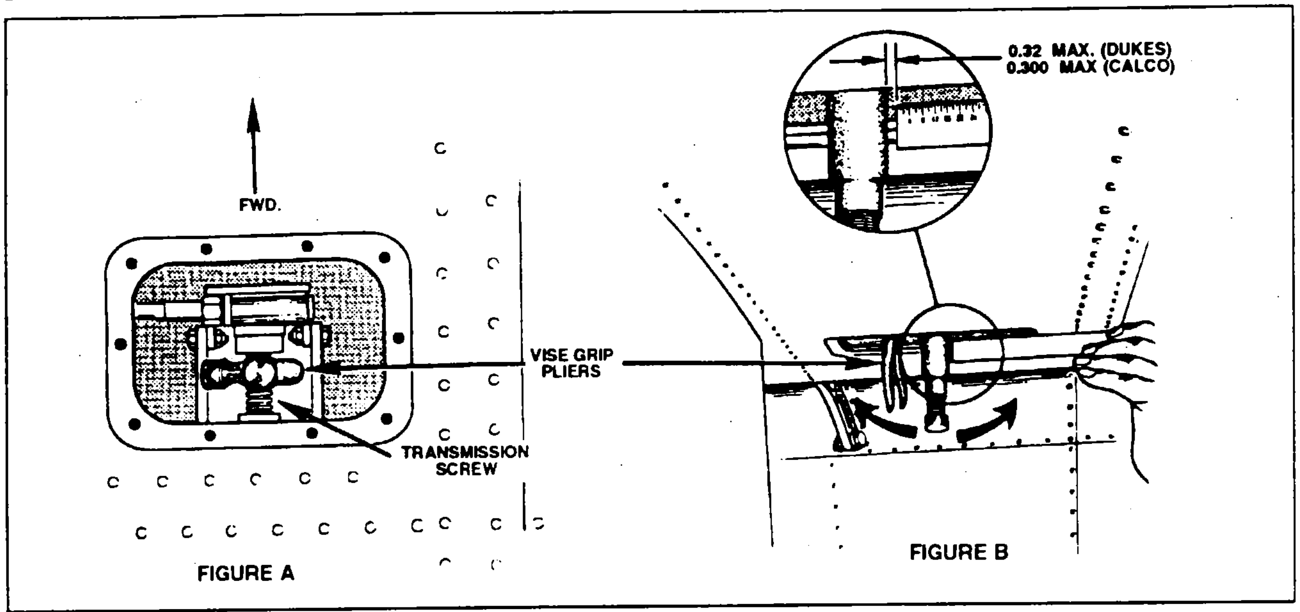


Figure 3-1. Wing Flap Transmission Inspection

3-9. INSPECTION OF Dukes WING FLAP TRANSMISSION. (Refer to Figure 3-1.) The flap transmissions are inspected at every 100 hour inspection cycle of the aircraft. This is accomplished without removal of the transmissions, by the following procedures:

a. Position the flaps in the extended position (Down).
b. Remove the access covers on the lower wing surface to gain access to the flap transmissions.
c. With the use of vise grip pliers and exerting light pressure, grasp the exposed portion of the screw close to the transmission as shown. (Refer to Views A and B.)
d. With the pliers secured to the screw, a light pressure will move the pliers and screw as free play in the transmission gear set is taken up in either direction. Do not force the pliers.
e. Place a six inch ruler along the skin surface as shown in View B, and measure the overall distance the pliers move.
f. Should this dimension exceed .32 (5/16) of an inch (8.128 mm), replace the transmission assembly or purchase Gear Transmission Overhaul Kit 755 051. (Refer to Section V, Paragraphs 5-60 and 5-61 for transmission removal and installation.)
g. Reinstall the access panels and make appropriate logbook entry.
h. Continue inspection at 100 hour intervals.

3-9a. INSPECTION OF *Calco* WING FLAP TRANSMISSION. (Refer to Figure 3-1.) The flap transmissions are inspected at the first 500 hour inspection cycle of the aircraft, and at each 100 hours time-in-service thereafter. This is accomplished without removal of the transmissions, by the following procedures:

a. Position the flaps in the extended position (Down).
b. Remove the access covers on the lower wing surface to gain access to the flap transmissions.
c. With the use of vise grip pliers and exerting light pressure, grasp the exposed portion of the screw close to the transmission as shown. (Refer to Views A and B.)
d. With the pliers secured to the screw, a light pressure will move the pliers and screw as free play in the transmission gear set is taken up in either direction. Do not force the pliers.
e. Place a six inch ruler along the skin surface as shown in View B, and measure the overall distance the pliers move.
f. If the dimension exceeds 0.300 (19/64) of an inch (7.620 mm), replace the transmission assembly.
g. Reinstall the access panels and make appropriate logbook entry.
h. Continue inspection at 100 hour intervals.

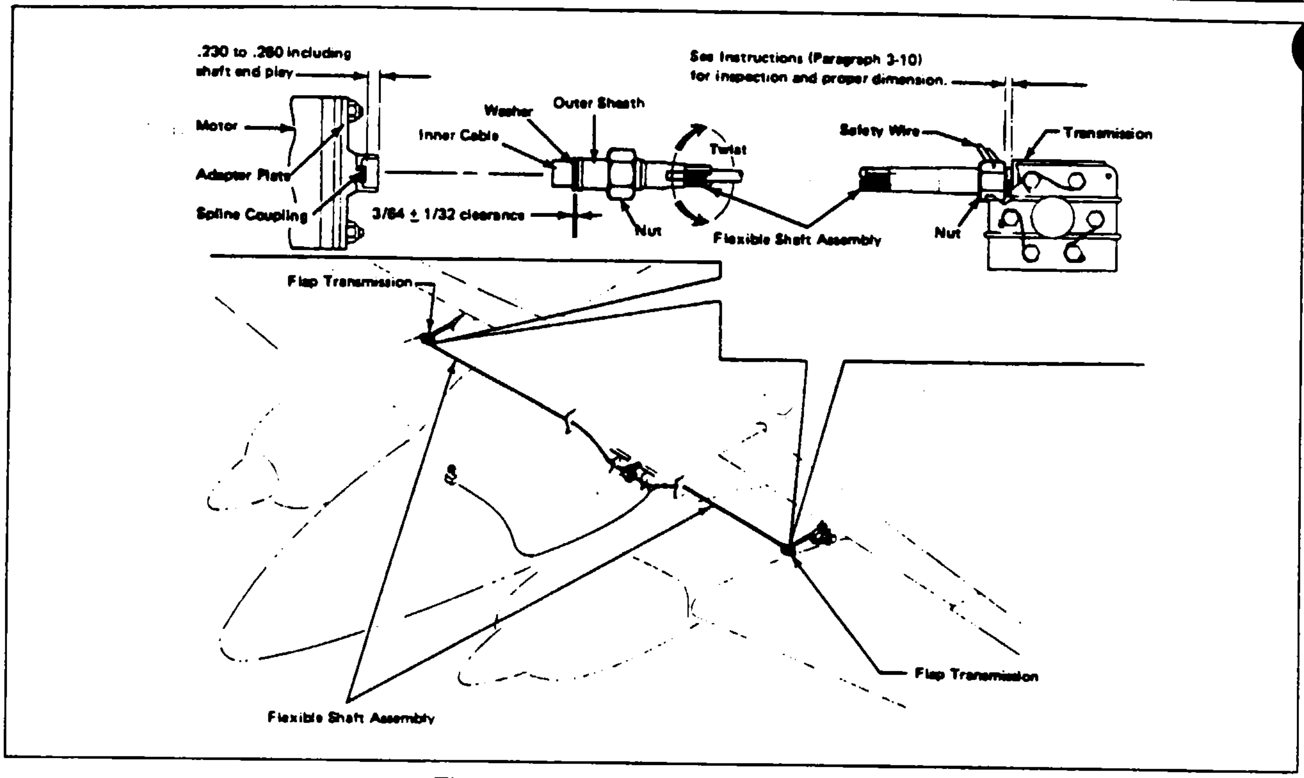


Figure 3-2. Wing Flap Actuator Cable

3-10. INSPECTION OF WING FLAP TRANSMISSION ACTUATOR CABLE. (Refer to Figure 3-2.)

a. Remove access plate from underside of left and right wing trailing edge, to gain access to flap transmissions.
b. Check the distance between the flexible shaft assembly nut and the transmission to determine if shaft assembly is properly installed.
c. When properly installed, the nut on flexible shaft will bottom or be within 3/16 of an inch of bottoming against transmission.
d. If inspection reveals that either of the shaft assemblies are not properly installed, it will be necessary to correct as follows:
    1. Cut safety wire from nut and disconnect shaft assembly from transmission.
    2. Align and insert tang on shaft assembly into slot in transmission. Tighten nut finger tight and wrench not over 1/16 turn from finger tight. When installed by this method the dimension between the nut and transmission will be as noted in Step c, thus ensuring that the end of shaft housing is firmly seated against transmission. Safety nut with .040 wire.
e. If flexible shaft assembly is disconnected from transmission or from flap motor, it will be necessary to check the flexible shaft rigging as follows:
    1. As the last step after the flap system has been rigged and the flex shaft nut has been tightened and safetied, the flex shaft is to be disconnected at the flap motor. Inspect swedged end of inner cable for wear or looseness.

NOTE

If replacement of transmission gears is required, perform transmission "run-in" as described in Piper S.B. 494B.

2. Observe the clearance between the outer sheath and inner cable.
3. Twist outer sheath in proper direction bringing clearance to 3/64 ± 1/32 of an inch. It may be necessary to loosen clamp on fuselage bulkhead in order to twist outer sheath.
4. Holding outer sheath in this position, insert spline into flap motor, tighten nut finger tight and wrench not over 1/16 turn from finger tight. Safety nut with .040 brass wire.
5. Proceed with Steps 1 through 4 for other flex shaft if it has been disconnected.
6. Tighten fuselage bulkhead clamp if loosened, reinstall access plates and make appropriate logbook entry.

3-10a. 500 HOUR INSPECTION OF WING FLAP TRANSMISSION ACTUATOR CABLE. (Refer to Figure 3-2.)

a. Gain access to the flap motor and flexible shaft assemblies by removing the center floor panel of the main cabin and the right and left seats and the floor panel aft of the main spar.
b. Remove the aft access plate on the fairing located on the underside between the fuselage and wing.
c. Remove the access plate at the aft side of the wheel well at wing stations: 34.5,44.50, and 54.00, and on the underside of wing trailing edge at wing stations: 65.00, 82.75, and 92.50.
d. Remove all Ty-Raps and support clamps along the entire length of both flexible shaft assemblies, and inspect the outer housing. If the housing is damaged, replace the flexible shaft assembly.
e. Disconnect flexible shafts and remove the flap motor. Using caution not to damage the flexible shaft housing, route the flexible shafts outboard through the longitudinal beams (Ref. Fig. 3-2a, Sketch 1).

NOTE

Do not disconnect flexible shaft from transmission at this time.

f. Visually inspect the flexible shaft splined drive coupling and retaining pin for evidence of looseness on the cable swage fitting. (Ref. Fig. 3-2a, Sketch 1, View A.) If any looseness is apparent, replace the flexible shaft assembly.
g. Inspect the swaged fittings at both ends of the flexible shaft as follows:
   1. Expose the swaged portion of the inner cable at the motor end by twisting the outer housing two (2) turns clockwise. The swaged portion of the cable should have eight (8) flats clearly visible and free from deep scratches or wear marks.
   2. Using a micrometer, or dial caliper, measure the diameter of the swage for each of the flats at the middle of the swedged portion of the cable. A total of four (4) measurements should be taken. If any of the measurements exceed .235 inches, replace the drive shaft.
   3. Disconnect drive shaft from the flap transmission. Using caution not to damage the shaft housing, route inboard through the Sta. 87.50 bulkhead. (Fig. 3-2a, Sketch 2) Inspect the swaged portion of the drive blade fitting end as described in steps "1" and "2" above.
   4. Inspect the drive blade dimension as shown in (Fig. 3-2a, View B).
h. Inspect the internal splines of the drive coupling for evidence of wear. If splines are distorted or significantly worn, replace the drive shaft. Use the following method to determine if the amount of spline wear is acceptable.
   1. Twist a piece of .032 safety wire around the swaged fitting at the motor end of the drive shaft to form a pointer (Fig. 3-2a, Sketch 3). With one end of the flap motor armature shaft secured engage the opposite end into the flexible shaft spline.
   2. Hold the spline end of the flexible shaft securely with one hand, and gently turn the flap motor to remove rotational play in the splines. Place a reference mark on the motor housing adjacent to the wire pointer. Turn the flap motor gently in the opposite direction to remove rotational play and place another reference mark on the motor housing. If any distance between these two marks exceed 5/32 of an inch (4 mm) replace the flexible shaft assembly.

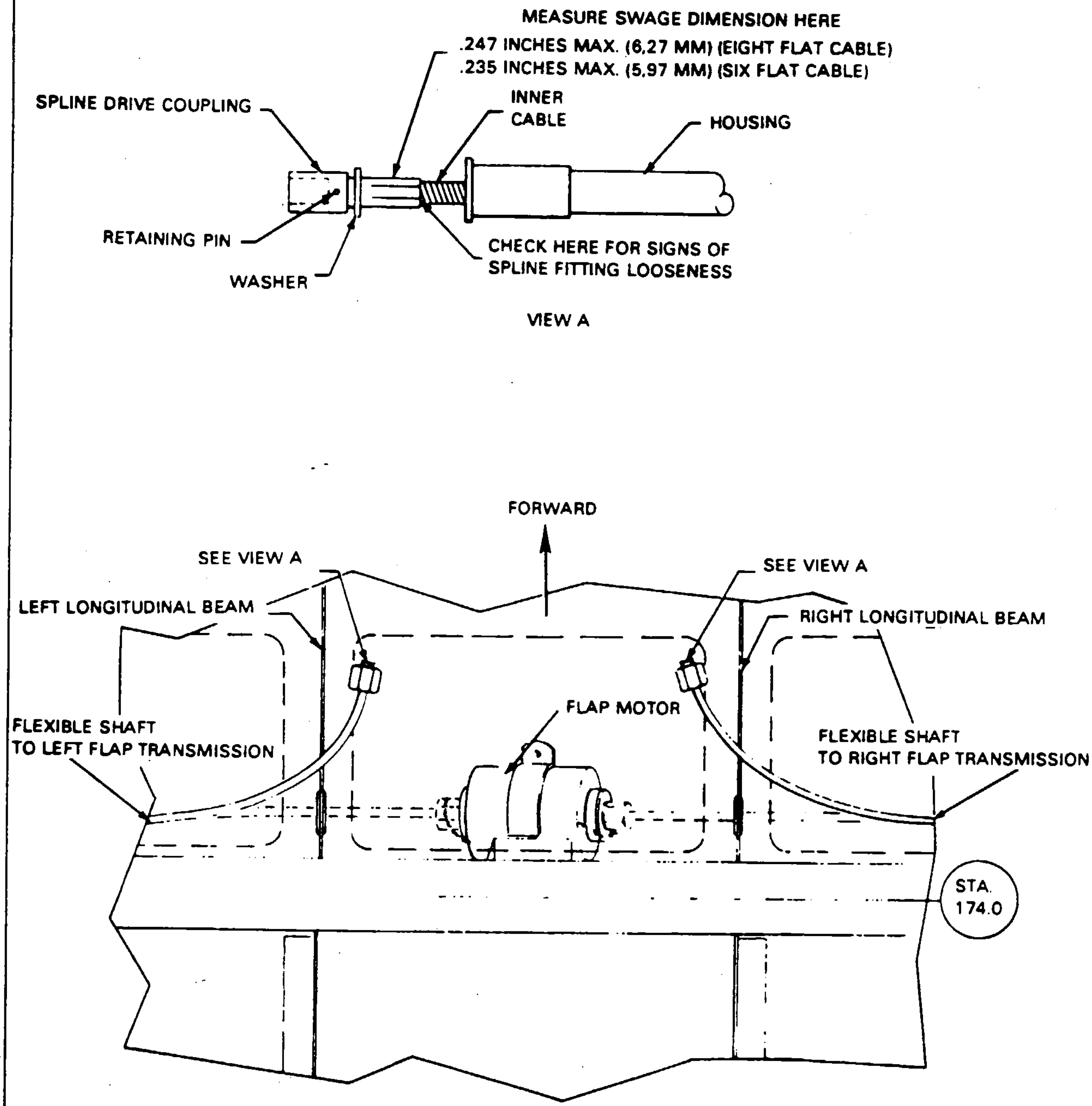


Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection

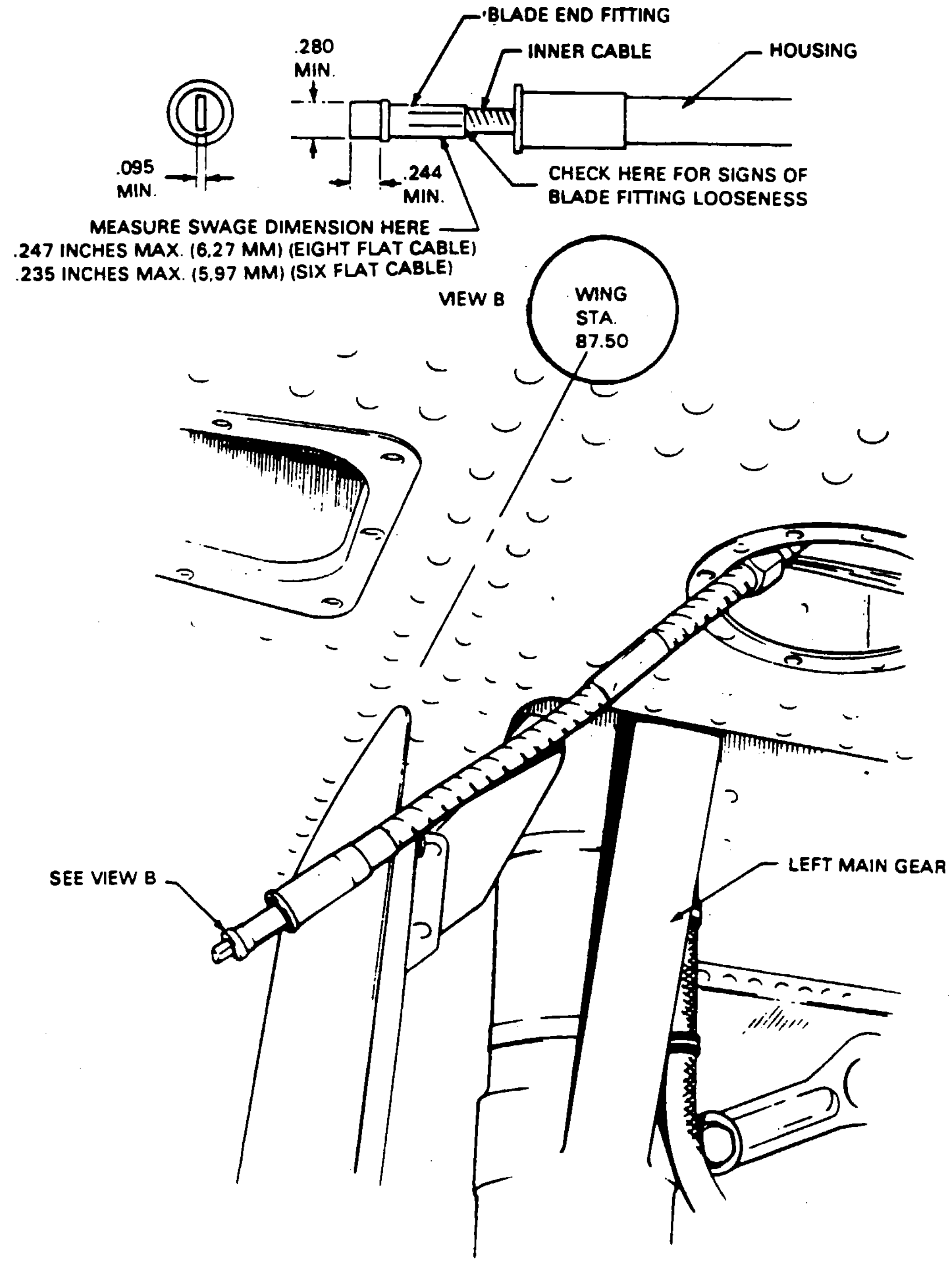
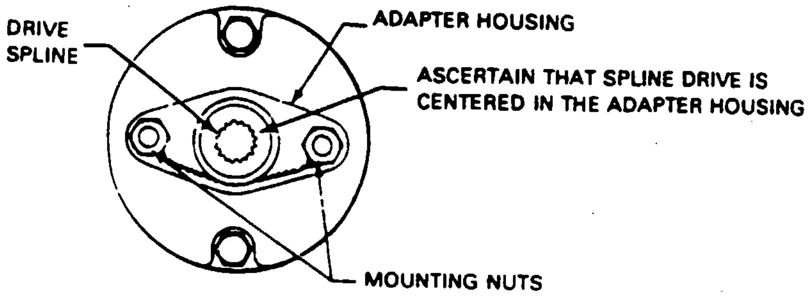
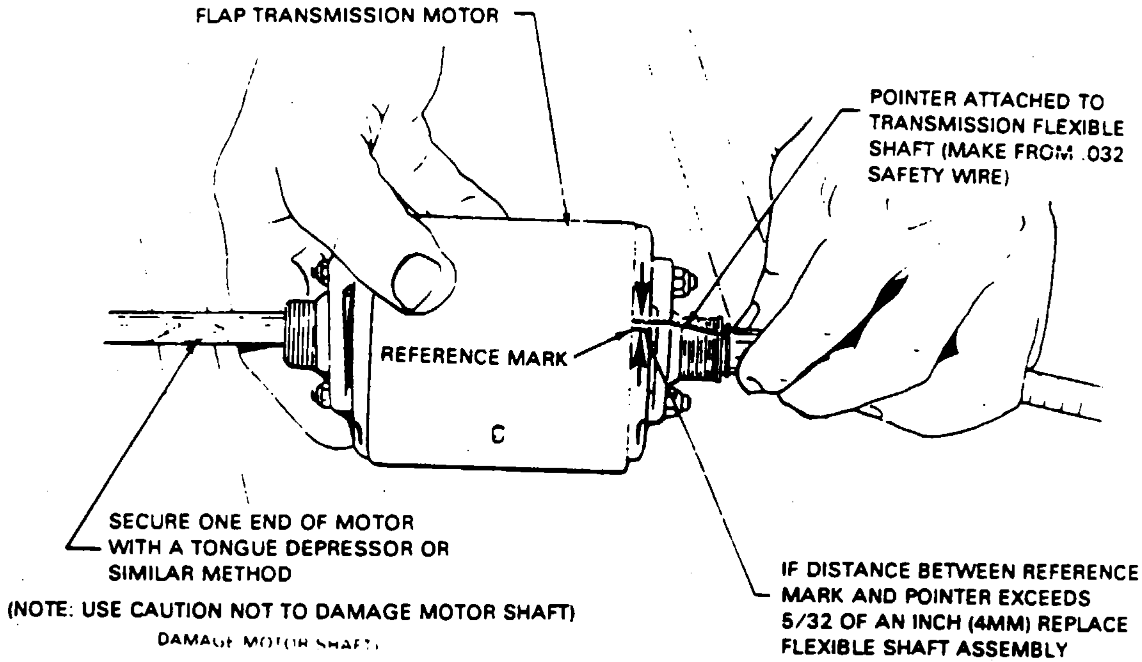


Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection (cont.)



VIEW C



SKETCH 3

Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection (cont.)

i. While holding the transmission end of the drive shaft stationary, twist the motor end one (1) turn clockwise and release. Inspect for evidence of movement between the inner cable and the swaged fittings at both ends. Turn cable one (1) turn counter-clockwise and repeat inspection. If movement or separation between the inner cable and the swage fitting is apparent, replace the flexible shaft assembly.

NOTE

If pliers or similar tool is used to twist cable, wrap cable ends with tape or a cloth to prevent damage.

j. Determine that the inner cable moves freely within the housing, and may be turned easily by hand. If there is any snagging or binding the cable must be replaced.
k. Reassembly of the flap system:
   1. Ascertain that the flap motor shaft is centered within the motor adapter housing (Ref. Fig. 32a, View C).
   2. Lubricate both ends of the flexible shafts with MIL-G-23827 grease.
   3. Reassemble and verify flap system rigging as outlined in the Surface Controls (Chapter 5).
l. Reinstall floorboards and access panels.

3-11. REDUCTION OF FRICTION IN WING FLAP SYSTEM. (Refer to Figure 3-3.) To insure proper flap system operation and reduce friction on the flap motor, the following inspection and repairs are only required should operational problems exist in the flap system.

a. Remove both right and left flap assemblies from the aircraft. (Refer to Section IV.)
b. Clean all paint and dirt from the top and bottom of the flap tracks.
c. Inspect the flap tracks for any burrs along the track edges. If any are found, remove them with a fine file. Insure that no noticeable depressions are evident at the ends of the track areas. (Refer to Figure 3-3 for specific locations.)
d. Using fine sandpaper, polish the inside surfaces of the flap tracks and lubricate the tracks with light oil, MIL-L-7870 or Dupont Slip Spray No. 6611.
e. Clean all dirt and paint from the flap rollers.
f. On each flap roller, remove 1/64 or .016 of an inch from one side of each roller. (Refer to Figure 3-3, View A-A.)
g. Polish all flap rollers and lubricate with light oil, MIL-L-7870.
h. Ensure that the washers used on both sides of the rollers are flat. (Refer to Figure 3-3, View A-A.)
i. Install both flap assemblies on the aircraft. (Refer to Section IV.) Do not connect the flap transmission screws to the flaps at this time.
j. Ascertain that the flap rollers turn freely and that the flaps will move freely in the flap tracks under their own weight through the entire length of the flap tracks.
k. Insure that the flap transmission screw fits into the horn assembly on the flap without any binding throughout flap travel.

NOTE

It may be necessary to move the horn assembly to obtain this no binding fit. The mounting holes on the horn assembly may be slotted to gain some adjustment if needed. (Refer to Figure 3-3, View B-B for dimensions of slots.)

CAUTION

Do not attempt to force the screw barrel into the horn. If misalignment cannot be corrected by slotting, contact the factory product support specialist.

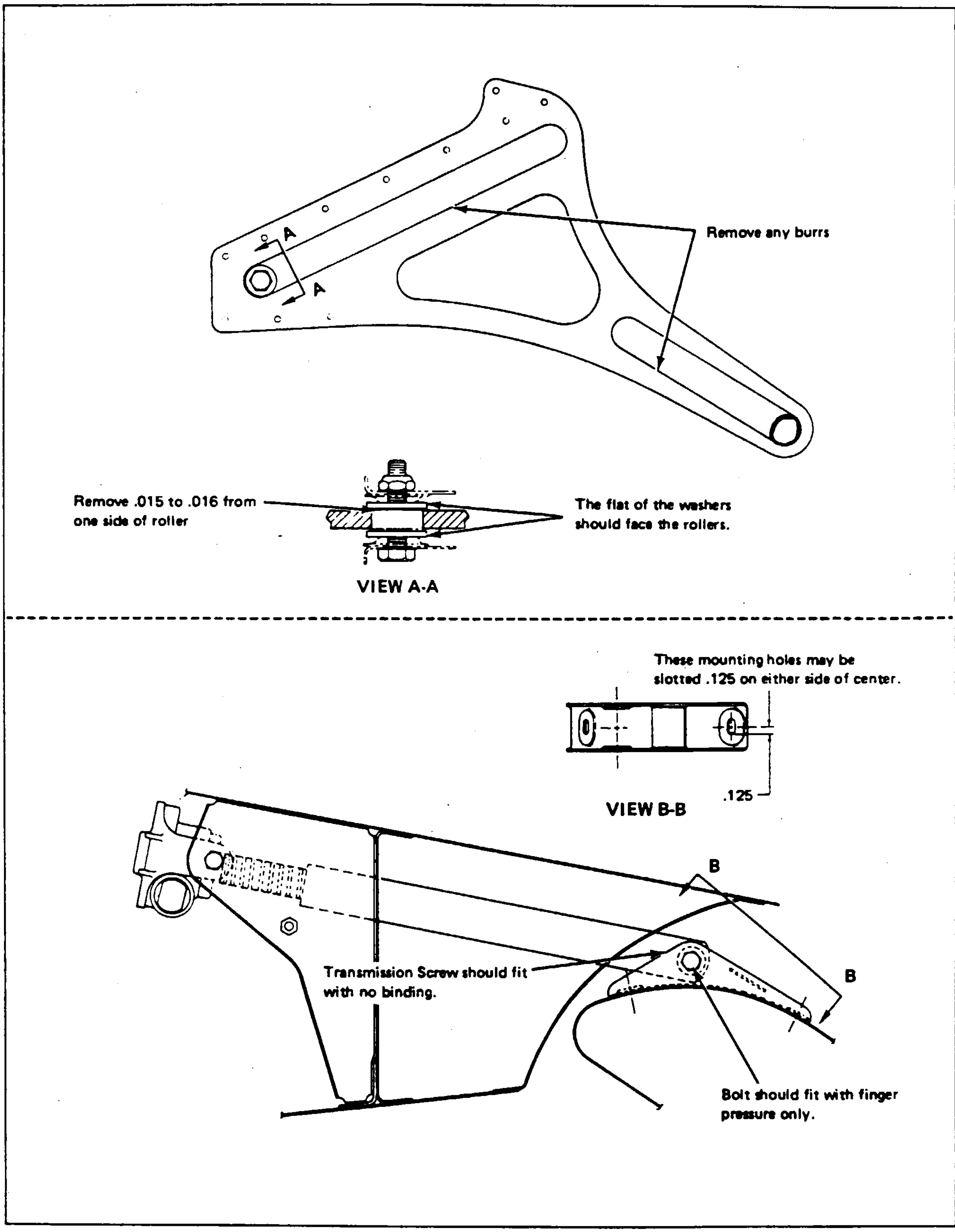


Figure 3-3. Friction Reduction in Wing Flap System

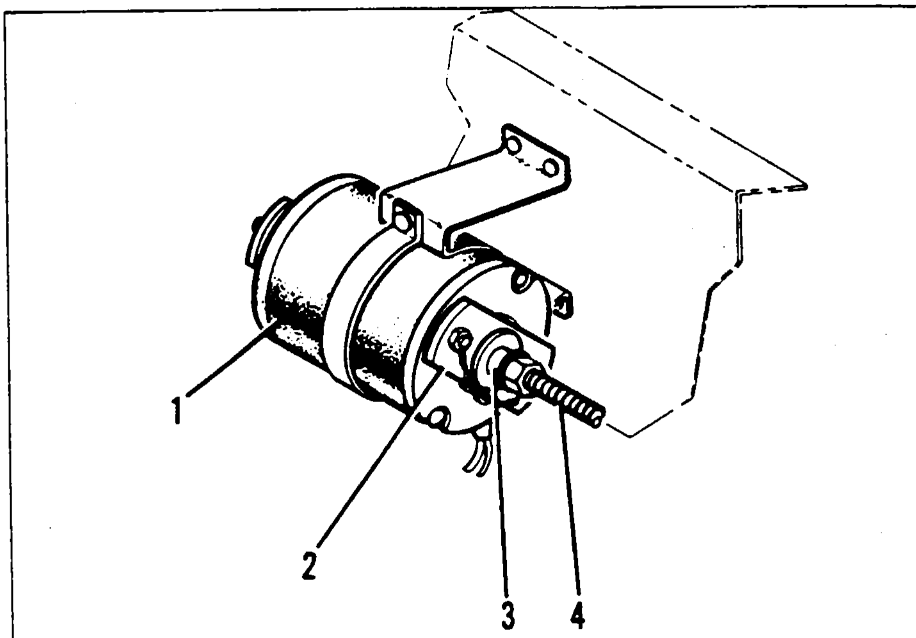


Figure 3-4. Wing Flap Motor

l. Ascertain that the transmission bolt at the flap end fits into the screw end and horn assembly with finger pressure only. (Refer to Figure 3-3.)
m. Install the transmission bolt AN4-15, washer AN960-416, and nut AN310-4 only finger tight and install a cotter pin MS24665-134.
n. If not previously accomplished at the regular 100 hour inspection, the flap transmission should be checked in accordance with Paragraph 3-9.
o. Ascertain that the flap transmission cables are installed properly. (Refer to Paragraph 3-10.)
p. Inspect the travel of the flaps in the flap tracks per instructions given in Section V.
q. Ascertain that all wires on the flap relay in the radio compartment are tight.
r. Ascertain that all wires on the flap selector switch are tight.

3-12. WING FLAP MOTOR NO LOAD RPM CHECK. (Refer to Figure 3-4.) S/L 764-A This check for demagnetization of the flap actuating motor should be accomplished along with friction reduction per Paragraph 3-11 if flap motor circuit breaker popping has been or remains a problem.

a. With the wing flap motor (1) installed in the aircraft, disconnect both of the flexible drive shafts (4) and remove one of the flex drive adapters (2) from the motor.
b. On the exposed motor splines, paint a white strip on one of the spline teeth.
c. Energize the flap motor with the flap selector switch.
d. With the aid of a Simpson 410 Photo Tachometer or equivalent, hold the probe within one half of an inch of the painted rotating spline shaft and observe the RPM reading on the meter. RPM in excess of 11,000 will indicate a demagnetized motor which should be replaced.
e. In the event that the above meter cannot be obtained, another method can be used to make the check. This would require the removal of the motor from the aircraft and using a hued hew tachometer and 24 volt D.C. power source. (Refer to Section V, Paragraphs 5-56 and 5-57 for removal and installation of flap actuator motor.) If this cannot be accomplished, remove the motor and take it to a local electric motor overhaul facility for the RPM check.
f. Reassemble and insure proper spline shaft engagement per Paragraph 3-10.

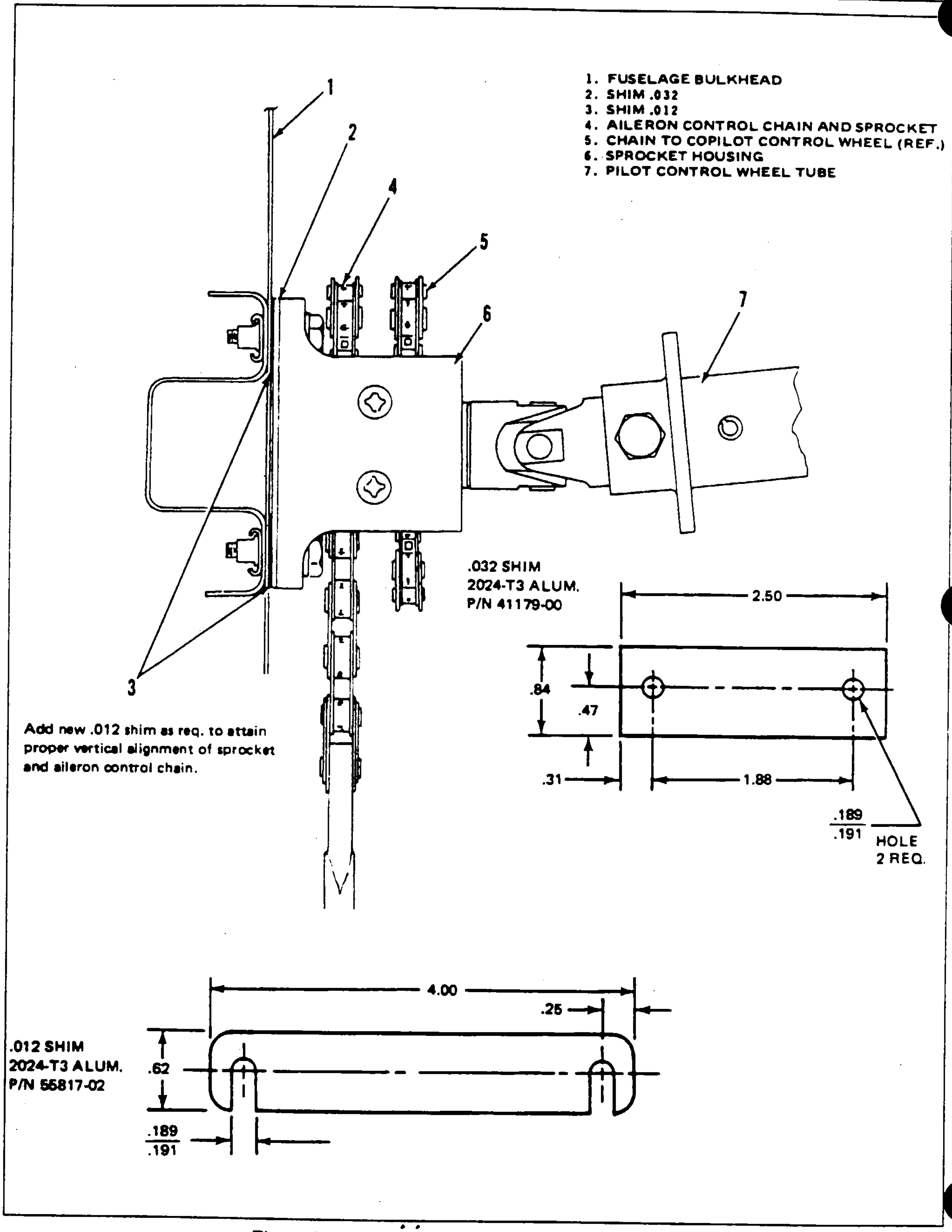


Figure 3-5. Inspection of Aileron Sprocket and Chain

NOTE

Do not perform no load RPM check unless a problem of circuit breaker popping exists or has existed with the flap motor that is still in the system.

3-13. INSPECTION OF AILERON SPROCKET AND CHAIN. (Refer to Figure 3-5.)

a. To determine if corrective action is required because of misalignment of the pilot's control wheel sprocket and mating aileron control chain, it will be necessary to perform the following checks at each 100 hour inspection of the airplane.

NOTE

To adequately perform the following checks, the aircraft should be located in an area relatively free of excessive noise and vibration.

1. Gently grasp the pilot's control wheel with both hands. Slowly rotate the wheel while carefully listening for sounds of roughness or the feel of uneven action when the aileron chain links pass over each tooth of the sprocket.
2. With one mechanic slowly rotating the pilot's control wheel, and another mechanic (with flashlight and mirror) observing the movement of the aileron chain over the sprocket, observe for smooth flow of the chain links over the sprocket throughout the total travel of the control wheel.

b. If roughness or uneven action is not felt, heard or seen, no further action is required.

c. If roughness or uneven action is detected, it could be due to lack of lubrication on the chain (if so, clean and lubricate), bent teeth on the sprocket (if so, sprocket must be replaced) or sprocket/control chain misalignment that must be corrected as follows:

1. Inspect at outboard end of sprocket housing to determine if the .032 shim is installed between the offset in the housing and the bulkhead. Install shim if it is not present. This shim will ensure proper horizontal alignment.
2. To attain proper vertical alignment, install new .012 shims between the top or bottom of the sprocket housing and the bulkhead, as required, to ensure a smooth flow of the chain links over the sprocket.

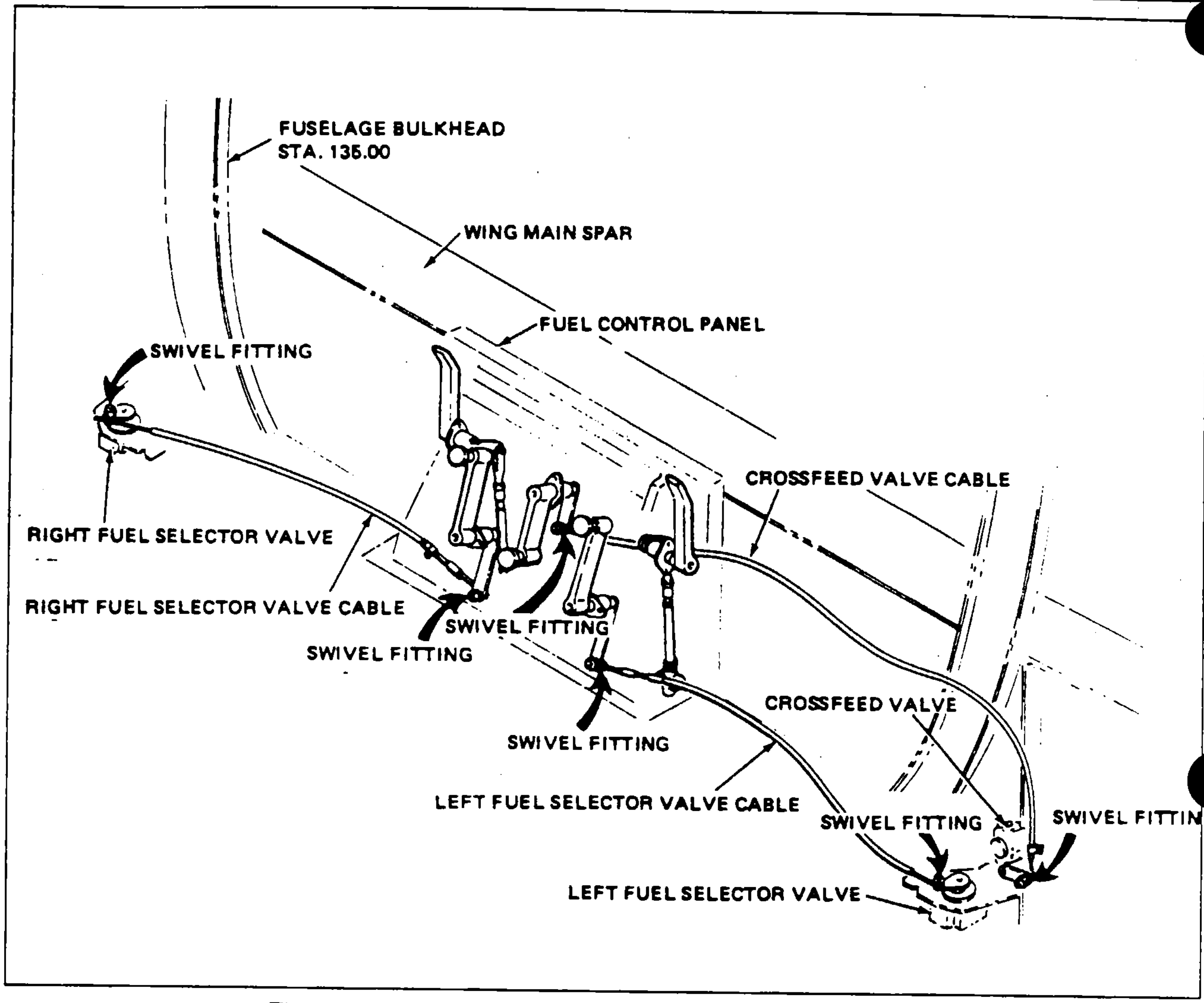


Figure 3-6. Fuel Selector and Crossfeed Valve Control Cables.

3-14. INSPECTION OF FUEL SELECTOR AND CROSSFEED VALVE CONTROL CABLES. (Refer to Figure 3-5.) At each 100-hour inspection of the airplane, inspect the fuel selector and crossfeed valve cable wires. Conduct the inspection as follows:

a. Remove the access cover located on the underside of the fuselage, below the fuel selector panel just ahead of the main spar and the access panels between the fuselage and the underside of the wing.
b. Visually check control cable wires at swivel fittings for indications of binding, nicks or bends; have someone in the cockpit operate fuel controls while mechanic inspects wires at swivel fittings.
c. Replace cable(s) exhibiting any of the above conditions.
d. Check adjustments of selector valve per Section IX.
e. Replace access panels and covers.

TABLE III-I. INSPECTION REPORT

— NOTES —

Refer to Notes 1, 2, 3, 4, and 33 before performing inspections.

Perform all inspections or operations at each inspection interval as indicated by a circle (O).

Nature of Inspection	Inspection Time (Hours)					
	L	R	50	100	500	1000
A. PROPELLER GROUP						
1. Inspect spinner and back plate for cracks	O	O	O	O	O	O
2. Inspect blades for nicks and cracks	O	O	O	O	O	O
3. Inspect for grease and oil leaks	O	O	O	O	O	O
4. Lubricate per lubrication chart	O	O		O	O	O
5. Inspect spinner mounting brackets for cracks	O	O		O	O	O
6. Inspect propeller mounting bolts and safety (check torque if safety is broken)	O	O		O	O	O
7. Inspect hub parts for cracks and corrosion	O	O		O	O	O
8. Rotate blades and check for tightness in hub pilot tube	O	O		O	O	O
9. Inspect propeller air pressure (check at least once a month)	O	O		O	O	O
10. Check condition of propeller deicer system (if installed)	O	O	O	O	O	O
11. Remove propellers: remove sludge from propeller and prop shaft	O	O		O	O	O
12. Overhaul propeller (per Hartzell Service Letter 61)	O	O		O	O	O
13. Inspect charge in unfeathering accumulator (See Note 15)	O	O		O	O	O
14. Inspect condition of synchronizer (if installed)	O	O		O	O	O
B. ENGINE GROUP						
— *WARNING* — *GROUND MAGNETO PRIMARY CIRCUIT BEFORE WORKING ON ENGINE.*						
— NOTE — Read Notes 11, 17 and 27 prior to completing this group.						
1. Remove engine cowl	O	O	O	O	O	O
2. Clean and inspect cowling for cracks, distortion, and loose or missing fasteners	O	O	O	O	O	O
3. Drain oil sump (See Textron Lycoming Service Bulletin 480)	O	O	O	O	O	O
4. Clean suction oil screen at oil change (Inspect screen for foreign particles)	O	O	O	O	O	O
5. Change full flow (cartridge type) oil filter element. (Inspect element for foreign particles)	O	O	O	O	O	O
6. Inspect condition of external valve guide oiler hoses for security and leaks	O	O		O	O	O
7. Inspect oil temperature sender unit for leaks and security	O	O		O	O	O
8. Inspect cylinder head temperature probe and wires for security	O	O		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (Hours)					
	L	R	50	100	500	1000
B. ENGINE GROUP (continued)						
9. Inspect oil lines and fittings for leaks, security, chafing, dents and cracks (See Note 17)	O	O		O	O	O
10. Clean and inspect oil radiator cooling fins	O	O			O	O
11. Remove and flush oil radiator	O	O	O	O	O	O
12. Fill engine with Ashless Dispersant type oil as per service manual	O	O		O	O	O
13. Clean engine	O	O		O	O	O
14. Inspect condition of spark plugs (Clean and adjust gap as required; adjust per latest revision of Lycoming Service Instruction No. 1042)	O	O		O	O	O
— NOTE — If fouling of spark plugs has been apparent, rotate bottom plugs to upper plugs.						
15. Inspect spark plug cable leads and ceramics for corrosion and deposits	O	O	O	O	O	O
16. Check cylinder compression (Ref. AC 43.13-A)	O	O	O	O	O	O
17. Inspect cylinders for cracked or broken fins (See Note 12)	O	O		O	O	O
18. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds (See Note 13)	O	O	O	O	O	O
— NOTE — Lycoming requires a Valve Inspection be made after every 400 hours of operation. (See Note 13.)						
19. Inspect wiring to engine and accessories. Replace damaged wires and clamps. Inspect terminals for security and cleanliness	O	O		O	O	O
20. Inspect ignition harnesses and insulators (high tension leakage and continuity)	O	O		O	O	O
21. Check magneto main points for clearance (Set clearance at .016 +/- .003)	O	O		O	O	O
22. Check magneto retard points for proper retard angle (30 degree) (Maintain clearance at .016 +/- .006)	O	O		O	O	O
23. Inspect magnetos for oil leakage	O	O		O	O	O
24. Inspect breaker felts for proper lubrication	O	O		O	O	O
25. Inspect distributor block for cracks, burned areas or corrosion, and height of contact springs	O	O		O	O	O
26. Remove intake pipes and check security of injector nozzles (See Note 14)						
27. Check magnetos to engine timing (20 degress BTC)	O	O		O	O	O
28. Overhaul or replace magnetos (See Note 5)						
29. Remove air cleaner filter and clean	O	O	O	O	O	O
30. Inspect intake seals for leaks and flanges for tightness	O	O		O	O	O
31. Inspect condition of alternate air door and box	O	O		O	O	O
32. Remove and clean fuel injector inlet line screen and fuel inlet strainers (Clean with acetone only)	O	O	O	O	O	O
33. Inspect condition of flexible fuel lines	O	O		O	O	O
34. Replace flexible fuel lines (See Note 17)	O	O				O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (Hours)					
	L	R	50	100	500	1000
B. ENGINE GROUP (continued)						
35. Inspect fuel system for leaks	O	O		O	O	O
36. Inspect fuel pumps for operation and pressures (See Note 8)	O	O		O	O	O
37. Overhaul or replace fuel pumps (engine driven and electric) (See Note 5)	O	O		O	O	O
38. Replace hydraulic filter element (Inspect filter element contamination)	O	O		O	O	O
39. Inspect hydraulic pump and gasket for leaks	O	O		O	O	O
40. Overhaul or replace hydraulic pump (See Note 5)	O	O		O	O	O
41. Inspect condition of flexible hydraulic lines. Replace as necessary. (See Note 17).	O	O		O	O	O
42. Inspect condition of pressure pumps and security of lines	O	O		O	O	O
43. Overhaul or replace pressure pumps (See Note 10)	O	O		O	O	O
44. Inspect throttle, alternate air, injector, mixture, and propeller governor controls for travel and operating condition	O	O		O	O	O
45. Inspect exhaust stacks and gaskets (Replace gaskets as required)	O	O	O	O	O	O
46. Inspect breather tube for obstructions and security	O	O		O	O	O
47. Inspect crankcase for cracks, leaks and security of seam bolts	O	O			O	O
48. Inspect engine mounts for cracks and loose mounting	O	O			O	O
49. Inspect all engine baffles for cracks	O	O			O	O
50. Inspect rubber engine mount bushing for deterioration (See Note 9)	O	O			O	O
51. Inspect fire walls for cracks	O	O		O	O	O
52. Inspect condition of fire wall sealing	O	O		O	O	O
53. Inspect condition of alternator and starter. Remove outboard end cover from alternator and check for bearing grease.	O	O		O	O	O
54. Inspect condition of flexible pneumatic lines. Replace as necessary. (See Note 17)	O	O		O	O	O
55. Replace pneumatic in-line filters	O	O			O	O
56. Lubricate all controls (DO NOT lubricate teflon liners of control cables)	O	O		O	O	O
57. Inspect security of compressor mounting	O	O	O	O	O	O
58. Check air conditioning compressor oil level (See Note 6)						
59. Inspect compressor drive belt condition and tension (6.5 to 7.5 lb.)	O	O	O	O	O	O
60. Inspect compressor clutch security and wiring (See Note 7)	O	O		O	O	O
61. Inspect tachometer generator security and wiring	O	O	O	O	O	O
62. Replace or overhaul tachometer generator	O	O				O
63. Overhaul or replace propeller governor (See latest Hartzell Service Letter 61)						
64. Complete overhaul of engine (See Note 5)						

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (Hours)					
	L	R	50	100	500	1000
C. TURBOCHARGER GROUP						
1. Visually inspect system for oil leaks, exhaust system leaks and general condition	O	O	O	O	O	O
2. Inspect the compressor wheel for nicks, cracks or broken blades	O	O		O	O	O
3. Inspect for excess bearing drag or wheel rubbing against housing	O	O		O	O	O
4. Inspect turbine wheel for broken blades or signs of rubbing	O	O		O	O	O
5. Inspect operation of alternate air control	O	O		O	O	O
6. Inspect oil inlet and outlet ports in center housing for leaks	O	O		O	O	O
7. Inspect turbine heat blanket for condition and security.	O	O		O	O	O
8. Inspect linkage between bypass valve and actuator	O	O		O	O	O
9. Inspect vent line from bypass valve for oil leaks	O	O	O	O	O	O
10. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks (See Note 21)	O	O	O	O	O	O
11. Check fluid power lines for leaks and security	O	O		O	O	O
12. Inspect for oil leakage from controller	O	O		O	O	O
13. Inspect condition of cowl fastener locked indicator stripes. Touch-up or restore as necessary. Refer to Section VIII, paragraph 8-7 of this manual	O	O	O	O	O	O
14. Install engine cowl	O	O	O	O	O	O
D. CABIN GROUP						
1. Remove inspection panels.				O	O	O
2. Inspect cabin entrance door for damage and operation of pressure seal, and seven switches in lock pin guides.				O	O	O
3. Inspect emergency exit latching mechanism (See Note 24)				O	O	O
4. Inspect upholstery for tears				O	O	O
5. Inspect seats, seat belts, security brackets and bolts (See latest revision of Piper Service Bulletin 525)				O	O	O
6. Inspect trim operation				O	O	O
7. Inspect operation of rudder pedals				O	O	O
8. Inspect operation of parking brake				O	O	O
9. Inspect condition of control wheels, column, pulleys and cables				O	O	O
10. Inspect aileron sprocket and chain per Section III, Paragraph 3-13				O	O	O
11. Check operation of landing, navigation, cabin and instrument lights				O	O	O
12. Inspect condition of instruments, lines and attachments				O	O	O
13. Inspect pneumatic gyro instruments and electric gyro instruments (Overhaul or replace as required)				O	O	O
14. Clean pressure control valve				O	O	O
15. Inspect pitot tube(s), lines and static vents for condition, security and stoppage				O	O	O
16. Inspect altimeter (Calibrate altimeter system in accordance with FAR 91.170, if appropriate)				O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (Hours) 50	100	500	1000
D. CABIN GROUP (continued)				
17. Change manifold pressure gauge filters			O	O
18. Drain crossfeed line		O	O	O
19. Inspect operation - fuel selector valve (see latest revision of Piper Service Bulletin 648)		O	O	O
20. Replace Scott fuel selector valve o-rings (see latest revision of Piper Service Bulletin 648)		O	O	O
21. Inspect operation - crossfeed valve		O	O	O
22. Inspect operation - emergency shutoff valve		O	O	O
23. Inspect fuel selector and crossfeed valve cables per Section III, Paragraph 3-14 of this manual		O	O	O
24. Inspect operation - heater fuel valve		O	O	O
25. Inspect switches to indicators registering fuel tank quantity		O	O	O
26. Inspect condition of environmental system ducts		O	O	O
27. Inspect oxygen system components per Service Manual		O	O	O
28. Inspect cabin pressurization system operation		O	O	O
29. Install inspection panels		O	O	O
E. FUSELAGE AND EMPENNAGE GROUP				
1. Remove inspection plates and panels	O	O	O	O
2. Inspect baggage door latch and hinges for condition, operation and security		O	O	O
3. Check fluid in hydraulic reservoir (Fill as required)	O	O	O	O
4. Inspect battery, box and cables (Inspect at least every 30 days. Flush box as required and fill per instructions on box)	O	O	O	O
5. Inspect heater for fuel or fume leaks and pressurized air leaks	O	O	O	O
6. Check freon level in sight gauge of receiver-dehydrator (Refer to Section XIII)	O	O	O	O
7. Inspect air conditioning system for freon leaks		O	O	O
8. Inspect recommended time for overhaul of heater per Section XIII		O	O	O
9. Inspect electronic installations for security and operation		O	O	O
10. Inspect bulkheads and stringers for damage		O	O	O
11. Inspect antenna mounts and electric wiring for damage of insulation and security		O	O	O
12. Inspect power pack and lines for damage and leaks	O	O	O	O
13. Inspect fuel lines, valves and gauges for damage and operation (See Note 28)		O	O	O
14. Inspect security of all lines (See Note 28)		O	O	O
15. Inspect vertical fin and rudder surface for damage		O	O	O
16. Inspect rudder and tab hinges, horns and attachments for damage and operation		O	O	O
17. Inspect security of vertical fin attachments		O	O	O
18. Inspect rudder and tab hinge bolts for excess wear		O	O	O
19. Inspect rudder trim mechanism installation		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (Hours)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP (continued)				
20. Inspect horizontal stabilizer and elevator surfaces for damage		O	O	O
21. Inspect elevator and tab hinges, horns and attachments for operation (See Note 19)		O	O	O
22. Inspect horizontal stabilizer attachments		O	O	O
23. Inspect elevator and tab hinge bolts and bearings for excess wear (See latest revision of Piper Service Bulletin 897)		O	O	O
24. Inspect elevator control tube		O	O	O
25. Inspect elevator trim mechanism installation		O	O	O
26. Inspect elevator down spring for broken or damaged springs and links, and proper tension (See Note 31)		O	O	O
27. Inspect aileron, rudder, elevator cables, trim cables, turnbuckles, guides and pulleys		O	O	O
for safeties, damage and operation (See Note 34)		O	O	O
28. Install all rod end bearings for freedom of ball movement. Use a 10X magnifying glass to check thread end of bearing for cracks and damage. Replace bearing if ball is frozen or hard to move		O	O	O
29. Clean and lubricate elevator and rudder trim drum screw		O	O	O
30. Inspect anti-collision lights for security and operation		O	O	O
31. Lubricate per lubrication chart in Service Manual		O	O	O
32. Inspect condition of pneumatic deicers if installed		O	O	O
33. Inspect security of Autopilot servo bridal cable clamps and bridle cable condition		O	O	O
34. Inspect emergency locator transmitter battery for replacement date or time per Service Manual (See latest revision of Piper Service Letter 820)		O	O	O
35. Install inspection plates and panels	O	O	O	O
F. WING GROUP				
— CAUTION — *The access panel on the upper outboard surface of the wing which covers the Flux Detector is secured with brass screws and must be **installed with brass screws only.***				
1. Remove inspection plates and panels		O	O	O
2. Inspect surfaces, skins and tips for damage and loose rivets		O	O	O
3. Inspect security of ailerons and tab hinges and attachments (See Note 32)		O	O	O
4. Inspect aileron and trim cables, pulleys and bellcranks for damage and operation		O	O	O
5. Inspect aileron balance weight and arm for security and condition		O	O	O
6. Inspect flaps and attachments for damage and operation per Section III of this manual (See Note 23)		O	O	O
7. Inspect condition of bolts used with flap and aileron hinges (Replace as required)		O	O	O
8. Inspect condition of all exterior bearings		O	O	O
9. Lubricate per lubrication chart		O	O	O
10. Inspect security of wing attachment bolts and brackets		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (Hours)			
	50	100	500	1000
F. WING GROUP (continued)				
11. Inspect security of engine mount attaching structure		O	O	O
12. Drain, remove and clean fuel filter bowl and screen (Drain and clean at least every 90 days)	O	O	O	O
13. Inspect fuel cells and lines for leaks and water (see Notes 20 and 28)	O	O	O	O
14. Inspect security of all lines (See Note 28)		O	O	O
15. Inspect condition and operation of submerged fuel (boost) pump		O	O	O
16. Drain both main fuel cells			O	O
17. Check tension and knots of nylon support cords			O	O
18. Inspect security of baffles, free operation of flapper valves and condition of fuel cell material (see Notes 18 and 20)	O	O	O	O
19. Fuel tanks marked for capacity		O	O	O
20. Fuel tanks marked for minimum octane rating		O	O	O
21. Inspect fuel cell vents		O	O	O
22. Inspect condition of pneumatic deicer (if installed)		O	O	O
23. Inspect air conditioning condenser air scoop rigging and operation	O	O	O	O
24. Change pneumatic in-line air filters and air cleaners			O	O
25. Install inspection plates and panels (see Note 16)	O	O	O	O
G. LANDING GEAR GROUP (Refer to Notes 25 and 26)				
1. Place airplane on jacks		O	O	O
2. Inspect oleo struts for proper extension (check for proper fluid level as required)	O	O	O	O
3. Inspect nose gear steering control and travel		O	O	O
4. Inspect nose gear steering control cable (see latest revision of Piper Service Bulletin 446)		O	O	O
5. Inspect wheels for alignment		O	O	O
6. Inspect tires for cuts, uneven or excessive wear and slippage		O	O	O
7. Remove wheels, clean, and repack bearings per lubrication chart in service manual		O	O	O
8. Inspect wheels for cracks, corrosion and broken bolts		O	O	O
9. Check tire pressure (N45-M70)	O	O	O	O
10. Inspect brake discs (stationary and rotating)		O	O	O
11. Inspect security of brake and hydraulic lines		O	O	O
12. Inspect shimmy damper operation		O	O	O
13. Inspect gear fork for damage		O	O	O
14. Inspect oleo struts for fluid leaks and scoring		O	O	O
15. Inspect gear struts, attachments, torque links, retraction links, and bolts for condition and security		O	O	O
16. Inspect downlock for operation and adjustment		O	O	O
17. Inspect main and nose gear lock rod and cable assemblies for corrosion, freedom of movement and spring tension (See Note 30)		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (Hours)			
	50	100	500	1000
G. LANDING GEAR GROUP (continued)				
18. Inspect torque link bolts and bushings (Rebush as required)		O	O	O
19. Inspect drag and side brace link bolts. (Replace as required)		O	O	O
20. Inspect gear doors and attachments		O	O	O
21. Inspect warning horn and light for operation		O	O	O
22. Retract gear - check operation		O	O	O
23. Retract gear - inspect doors for clearance and operation		O	O	O
24. Inspect anti-retraction system		O	O	O
25. Inspect condition of main landing gear actuator reinforcement brackets (See Note 29)		O	O	O
26. Inspect actuating cylinders for leaking and security		O	O	O
27. Inspect position indicating switches and electrical leads for security		O	O	O
28. Lubricate per lubrication chart in service manual		O	O	O
29. Remove airplane from jacks		O	O	O
H. OPERATIONAL INSPECTION				
1. Check fuel pumps, fuel cell selector and crossfeed operation	O	O	O	O
2. Check fuel selector valve operation (See latest revision of Piper Service Bulletin 648)	O	O	O	O
3. Check operation of fuel quantity and pressure or flow gauges	O	O	O	O
4. Check operation of all warning lights	O	O	O	O
5. Check oil pressure and temperature indications	O	O	O	O
6. Check alternator output	O	O	O	O
7. Check manifold pressure indication	O	O	O	O
8. Check alternate air operation	O	O	O	O
9. Check parking brake operation	O	O	O	O
10. Check gyro and pneumatic pressure gauges	O	O	O	O
11. Check gyros for noise and roughness	O	O	O	O
12. Check magneto switch operation	O	O	O	O
13. Check magneto RPM variation	O	O	O	O
14. Check throttle and mixture operation	O	O	O	O
15. Check propeller smoothness	O	O	O	O
16. Check propeller governor action	O	O	O	O
17. Check electronic equipment operation	O	O	O	O
18. Check cabin environmental system operation	O	O	O	O
19. Check pressurization operation and cabin door seal	O	O	O	O
20. Check air conditioner compressor clutch operation	O	O	O	O
21. Check air conditioner condenser scoop operation	O	O	O	O
22. Check flap operation (See latest revision of Piper Service Bulletins 560 and 739)	O	O	O	O
23. Check operation of Autopilot, including automatic pitch trim, and manual electric trim (See Note 22)	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (Hours)			
	50	100	500	1000
I. GENERAL				
1. Aircraft conforms to FAA specification	O	O	O	O
2. All FAA Airworthiness Directives complied with	O	O	O	O
3. All Manufacturers' Service Bulletins complied with	O	O	O	O
4. Check for proper flight manual	O	O	O	O
5. Aircraft papers in proper order	O	O	O	O

NOTES:

1. Refer to Piper's Customer Service Information Catalog No. 1753-755, for latest revision dates to Piper Inspection Reports and this manual. References to Chapter are to the appropriate Chapter in this manual.
2. All inspections or operations are required at each of the inspection intervals as indicated by a (O). Both the annual and 100 hour inspections are complete inspections of the airplane, identical in scope, while both the 500 and 1000 hour inspections are extensions of the annual or 100 hour inspection, which require a more detailed examination of the airplane, and overhaul or replacement of some major components. Inspections must be accomplished by persons authorized by the FAA.
3. Piper Service Bulletins are of special importance and Piper considers compliance mandatory.
4. Piper Service Letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Replace or overhaul as required at engine overhaul. Refer to Lycoming Service Letter L201.
6. Check compressor oil whenever the system is charged.
7. Clean any traces of oil from the clutch surface.
8. To check the various fuel pump pressures, refer to section IX of the PA-31P Service Manual.
9. It is recommended that all engine mount rubber bushings be replaced every 500 hours.
10. Overhaul or replace at 700 hours.
11. Inspections given for powerplant are based on the engine manufacturer's operator's manual (Lycoming Part No. SSP-1570). Any changes issued to the engine manufacturer's operator's manual supercede or supplement the instructions outlined in this report. Occasionally, service bulletins or service instructions are issued by Textron Lycoming Division that require inspection procedures that are not listed in this manual. Such publications usually are limited to specific models and become obsolete after corrective steps have been accomplished. All such publications are available from Textron Lycoming distributors, or from the factory by subscription. Consult the latest Textron Lycoming Service Letter L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.
12. Check cylinders for evidence of excessive heat indicated by burned paint on cylinders. This condition is indicative of internal damage to cylinder and its cause must be determined and corrected before aircraft is returned to service.

    Heavy discoloration and appearance of seepage at cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of barrel at factory or by slight gas leakage which stops after cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it is proven that leakage exceeds these conditions, cylinder should be replaced.

TABLE III-I. INSPECTION REPORT

NOTES (cont):

13. At every 400 hours of engine operation, remove the rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tops, valve keeper, springs and spring seat. If any indications are found, the cylinder and all of its components must be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision for Textron Lycoming Special Service Publication SSP-1776.
14. Remove intake pipes and check security of injector nozzles at every 400 hours of engine operation per Lycoming's operator's manual (Lycoming Part No. SSP-1570).
15. Refer to latest revision of Piper Service Letter 688 or latest revision of Woodward Service Bulletin 33551 for periodic accumulator maintenance.
16. Only use brass screws to install access plate that covers flux detector on top outboard section of the left wing on airplanes equipped with remote compass systems. Steel screws cause erratic compass readings.
17. Replace flexible fuel, oil, hydraulic, and pneumatic lines as required but not to exceed 1000 hours or 8 years, whichever comes first. In addition, replace lines at engine overhaul. ***(Flexible hose replacement times are in-service times. In-service must be determined by (1) the date the aircraft was licensed, if new or (2) the date entered in the logbook for the replacement hose placed in service. Do not use the date stamped on the hose, as time may be included for shelf life, and not in-service use.)***
18. Inspect fuel cells every 2 years or after 500 hours in service, whichever comes first. (Refer to Service Manual, Section IX.)
19. Refer to the latest revision of Piper Service Letter 789 for inspection of elevator bell crank and control rod.
20. Refer to the latest revision of Piper Service Bulletin 591 for inspection of Goodyear BTC-39 fuel cells to comply with FAA Airworthiness Directive 78-05-06.
21. Replace any V-band coupling attaching exhaust tailpipe to turbocharger at 1000 hour interval or sooner if inspection indicates wear, buckling, etc. (See latest revision of Piper Service Bulletin 884.)
22. Refer to flight manual supplement for preflight and flight check for intended function in all modes.
23. Refer to wing flap inspection procedures per latest revision of Piper Service Bulletins 560 and 739.
24. The emergency exit window should be removed completely from fuselage to ensure correct operation. (Refer to Chapter 4, Paragraph 4-52.)
25. Refer to latest revision of Piper Service Bulletin 822.
26. Refer to latest revision of Piper Service Bulletin 845.
27. Refer to VSP 69.
28. Pressure check all fluid hoses in fuselage and wing areas after 10 years time-in-service to system pressure. Visually check for leaks. Hoses that pass inspection may remain in service and checked thereafter each five years time-in-service.
29. When performing inspection, check for cracks developing in the main landing gear actuator reinforcement brackets. (See latest revision of Piper Service Bulletin 923.)
30. When performing inspection, check that cable attach clevis bolt on main landing gear downlock cable has not rotated from its original position. (See latest revision of Piper Service Bulletin 860.)
31. Elevator down spring and link must be replaced at each 1000 hours time-in-service. (See latest revision of Piper Service Bulletin 1002 and Service Manual, Section V.)
32. Remove aileron and inspect area beneath inboard hinge on aileron spar for cracks. (See latest revision of Piper Service Bulletin 967.)
33. Inspect all V-Band Couplings, used in the exhaust, bleed air and cabin heat systems, for security and integrity of T-bolts and lock wire. (See latest revision of Piper Service Bulletin 884.)
34. Check cable tensions per the Service Manual, Section V.

SECTION IV

STRUCTURES

Paragraph			Aerofiche Grid No.

Paragraph			Aerofiche Grid No.

SECTION IV

STRUCTURES

4-1. INTRODUCTION. This section contains information explaining the removal and installation procedures for the structural surfaces of the airplane. It also includes structural repairs and control surface balancing along with fuselage sealing.

NOTE

When torquing structural assemblies, standard-torque values are to be found in Section II or the FAA Advisory Circular 43.13-1A unless otherwise stated in the section.

4-2. DESCRIPTION. The fuselage is an all metal semi-monocoque structure which consists of bulkheads, stringers, stiffeners and longitudinal beams, all of which the outer skin is riveted to. The fuselage is pressurized between bulkhead 81.00 and 274.00. Windows include a two piece windshield and four windows along the right side of the fuselage and three windows along the left side. A 25.75 by 19.75 inch emergency exit is an integral part of the second right window and is removable when the release, which is located above the window is pulled. This window is sealed when it is installed in the fuselage and must be carefully reinstalled whenever removed to maintain the pressure seal. The cabin entrance door is located on the left side of the fuselage just aft of the wing. It is a one piece door which swings down to open and provides cabin entrance steps. A snubber may be installed to prevent the door from dropping too fast when it is opened. All wiring, plumbing and control cables passing through the pressurized portion of the fuselage are sealed to minimize air leakage.

WARNING

No holes should be added on any of the reinforcement channels and the forward pressure bulkhead. Any repair, modification or removal of floorboard cover plates for inspection which creates a break in the pressure seal is considered the responsibility of the owner or facility performing the work.

Each wing panel is an all metal, full cantilever, semi-monocoque type construction with a removable fiberglass tip. Installed in each wing are two bladder type fuel cells. Bladder type fuel cells are also installed in the upper portion of the engine nacelles aft of the firewall. The main landing gear is enclosed in wheel wells built into the lower surface of each wing and is enclosed by doors when retracted. Attached to each wing is the power plant, aileron and flap. The right aileron incorporates a trim tab which is adjustable through a control in the cockpit. The full length I beam type main spars extend into the fuselage and are joined with high strength butt fittings in the center of the fuselage making, in effect, a continuous main spar. The main spar is also attached to the side of the fuselage as are the front and rear spars.

The all metal empennage group is a full cantilever design consisting of a vertical stabilizer (fin), rudder, right and left horizontal stabilizer and elevator, all with removable fiberglass tips. The rudder and both halves of the elevator have a trim tab attached that are controllable from the cockpit. Both the vertical and horizontal stabilizers incorporate two channel main spars that run the full length of the stabilizers and attach to the aft bulkhead assembly of the fuselage.

All aluminum components of the pressure envelope and exterior surfaces are alodine treated and then zinc chromate primed to resist corrosion.

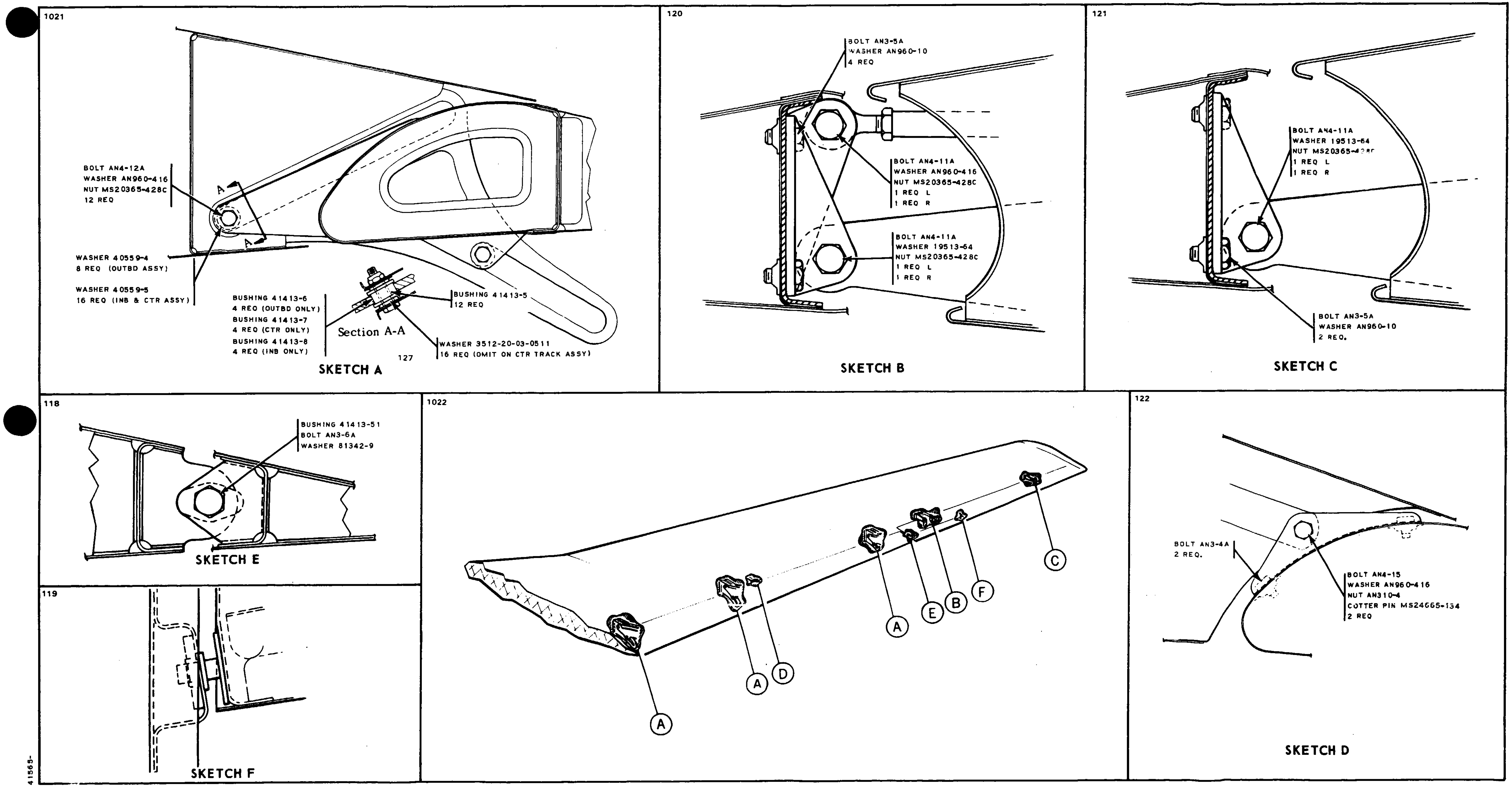


Figure 4-1. Aileron and Flap Installation

4-3. WING GROUP.

4-4. WING TIP.

4-5. REMOVAL OF WING TIP.

a. Remove the screws attaching the wing tip to the wing.
b. Pull the wing tip outward slightly and disconnect the navigation light positive wire at the quick-disconnect fitting and remove the screw securing the ground wire to the wing structure. Disconnect the wing tip strobe light plug if installed.
c. Remove the wing tip.

4-6. REPAIR OF WING TIP. The wing tip may be repaired in accordance with fiberglass repair procedures in the structural repairs portion of this section.

4-7. INSTALLATION OF WING TIP.

a. Attach the ground wire terminal to the wing structure and connect the positive electrical leads together.
b. Position the wing tip on the wing and start all screws with washers.
c. With all screws in place, tighten.

4-8. AILERON.

4-9. REMOVAL OF AILERON. (Refer to Figure 41.)

a. Remove the wing tip in accordance with paragraph 4-5.
b. Remove the wing tip aft attachment rib.
c. Disconnect the aileron control rod.
d. At the right aileron, disconnect the trim tab control rod.
e. Remove the hinge bolts and remove the aileron.

4-10. INSTALLATION OF AILERON. (Refer to Figure 41.)

a. Place the aileron in position, install hinge bolts and torque.
b. If the right aileron was removed, connect the trim tab control rod.
c. Connect the aileron control rod.
d. Attach the wing tip attachment rib.
e. Install the wing tip in accordance with paragraph 4-7.

4-11. AILERON TRIM TAB.

4-12. REMOVAL OF AILERON TRIM TAB. (Refer to Figure 4-1.)

a. Disconnect the control rod at the tab.
b. Remove the inboard hinge bolt.
c. Pull the tab back and inboard enough to remove the outboard hinge pin from its bushing. Remove the tab.

4-13. INSTALLATION OF AILERON TRIM TAB. (Refer to Figure 41.)

a. Insert the tab control rod through the aileron and insert the outboard hinge pin into its bushing.
b. Position the inboard hinge brackets, install hinge bolt and torque to 25±2 inch pounds.
c. Connect the tab control rod.

4-14. FLAP.

4-15. REMOVAL OF FLAP. (Refer to Figure 41.)

a. Lower flap to within a few degrees of full extension.
b. At the left flap, disconnect the position sender rod by removing the cotter pin from the forward end of the rod.
c. Disconnect the flap control tube at the flap. Do not rotate the control tube unless it is intended to adjust the flap.
d. Remove the upper roller assemblies from the flap brackets.
e. Remove the lower roller assemblies and remove flap.

4-16. INSTALLATION OF FLAP. (Refer to Figure 4-1.)

a. Put the flap in position and install the lower roller assemblies on the flap brackets and torque bolts.
b. Install the upper roller assemblies and torque bolts.
c. Connect the control tube.
d. If the left flap was removed, connect the position sender rod.
e. Check flap for proper operation. Rigging and adjustment procedure may be found in Section V.

4-17. WING.

4-18. REMOVAL OF WING. (Refer to Figure 4-4.)

a. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining the Fuel System, Section II.)
b. Remove the engine from the wing to be removed. (Refer to Removal of Engine, Section VIII.)
c. Remove the fairing and access panel from around the leading edge of the wing, located between the fuselage and engine nacelle.
d. At the fillet fairing on top of the wing, between the fuselage and wing, remove the rivets that attach the fairing to the wing.
e. Remove the access plates from the fairing located between the underside of the wing butt rib and fuselage and the access plate to the spar splice located on the underside of the fuselage.
f. Within the fuselage, remove the fuel selector cover and spar cover.
g. Remove the fore and aft floor panels adjacent to the main spar and, if removing the left wing, remove the left forward floor panel between the fuselage side trim panel and control pedestal.

NOTE

To help facilitate reinstallation of control cables and fuel or hydraulic lines, before removing mark cable and line ends in some identifying manner and attach a line where applicable to cables before drawing them through the fuselage or wing.

CAUTION

To prevent damage or contamination of fuel, hydraulic and miscellaneous lines, place a protective cover over the line fittings and ends.

h. If the left wing is being removed, the following items pertain to the removal of the left wing only:

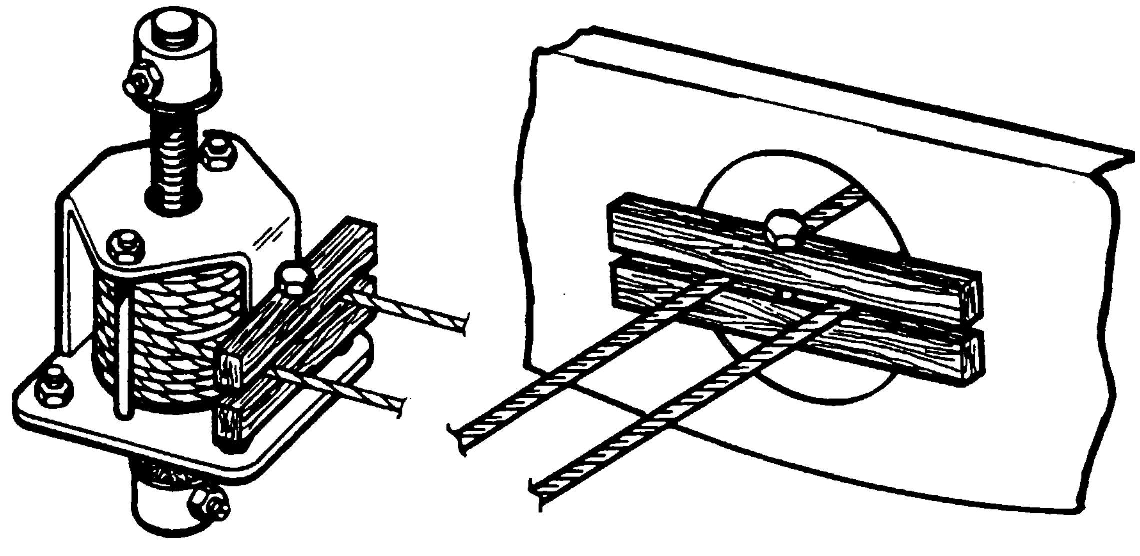


Figure 4-2. Methods of Blocking Trim Cables

1. Disconnect the primary control cables at the turnbuckles located at stations 100 and 110, between the left forward side trim panel and control pedestal. Draw the cables back through the spar. Remove the elevator cable guard pin at station 123 to allow the cable ends to pass through.
2. Remove the left aileron cable guard pin at station 164.
3. The balance cable to the left wing may be disconnected at the aileron bellcrank, drawn through the wing and taped out of the way at the side of the fuselage. The cable guard pin at the left wing near the bellcrank and wing butt rib will have to be removed to allow the cable end to pass through.

i. If the right wing is being removed, the following items pertain to the removal of the right wing only:

1. Disconnect the aileron control cable at the aileron bellcrank and draw it out through the wing. The cable guard in the wing near the bellcrank and wing butt will have to be removed to allow the cable end to pass through.
2. Disconnect the aileron balance cable at station 172 and draw the cable from the fuselage. Remove the cable pulley to allow cable to be removed.
3. Remove the access panels at the aft section of the fuselage. Block the elevator and rudder trim cables ahead of the main spar and in the aft section of the fuselage to prevent the cables from unwrapping at the trim drums. Refer to Figure 4-2. Disconnect the elevator and rudder trim cables at station 308 and draw the cables forward through the main spar. To allow the cables to be drawn through the fuselage, remove the cable guard at station 243 and rub blocks at stations 162, 174 and 215.
4. Block the aileron trim cable at the side fuselage and within the wing to prevent the trim drum from unwrapping. Disconnect the trim cable turnbuckles at wing station 90 and draw the cables inboard through the wing. Remove cable guard at butt end of wing and tape cables out of the way at the fuselage.
5. Disconnect the hydraulic lines that run through the spar at stations 112 and 144 and draw the lines back through the wing spar.

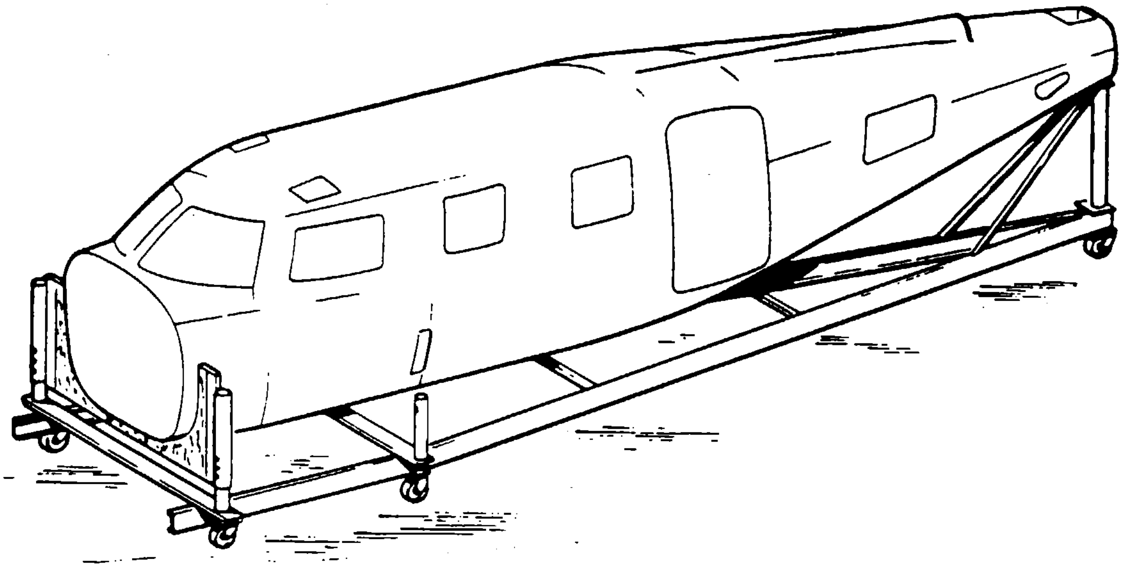


Figure 4-3. Fuselage Cradle

6. Disconnect the pressurized air duct, Freon lines and antenna cables that lead through the spar.

j. At station 174 disconnect the flap actuating cable from the actuating motor and bulkhead and draw the cable out through the fuselage.
k. Through the wing fairing access openings at the underside of the wing, disconnect the fuel line that is routed through the main spar and pull it back through the spar. Disconnect the hydraulic and fuel lines at the exposed fittings and control cables from fuel valves.
l. Through the access openings at the wing leading edge and butt, disconnect the engine instruments, vacuum, fuel and hydraulic lines. Remove support blocks and clamps.
m. Disconnect electrical wire connectors.
n. Draw engine control cables back through the firewall, engine nacelle and wing.
o. Arrange a suitable fuselage cradle and supports for both wings.
p. Remove the brace assembly that the fuel selector attaches to and lay forward. Unbolt and remove the angle support(s) that extend through the spar.
q. To the side of the fuselage, at the top of the main spar, remove the fore and aft lower support fittings. The upper fitting may remain in place.
r. Also to the side of the fuselage, at the bottom of the main spar, remove the support bolt assembly and spacer bushing.
s. Unbolt and remove the vertical spar splice channels.
t. Unbolt and remove the upper and lower horizontal spar cap splice plates.
u. Remove the bolt assembly that attaches the front spar and fuselage fitting.
v. Remove the bolt assembly that attaches the rear spar and fuselage fitting.
w. Pull the wing directly and slowly away from the fuselage, allowing lines, cables, etc., to follow.

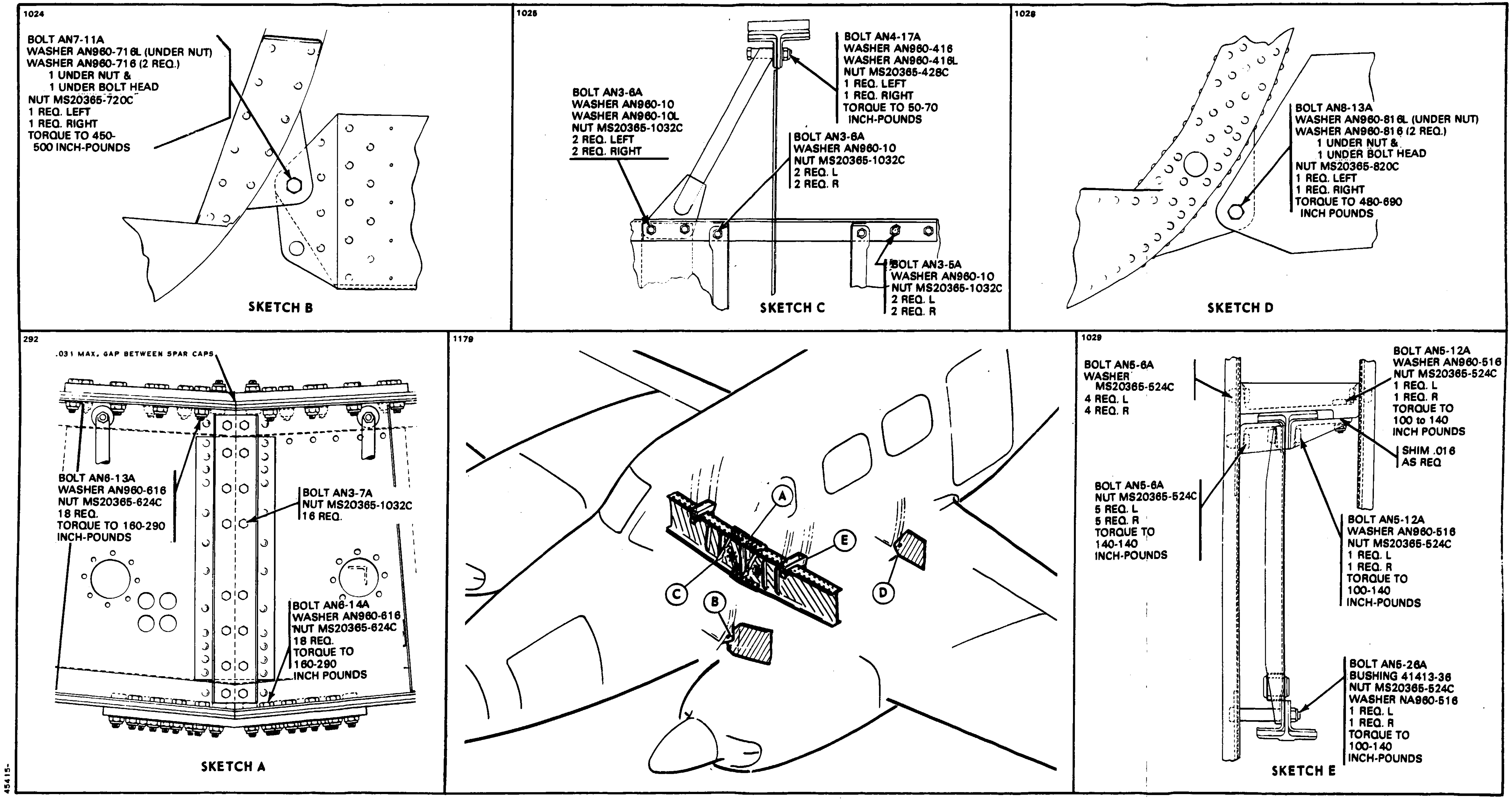


Figure 4-4. Wing Installation

4-19. INSTALLATION OF WING. (Refer to Figure 4-4.) (Left or Right.)

a. Ascertain that the fuselage is positioned solidly on a support cradle.
b. Place the wing in position for installation, with the spar end a few inches from the side of the fuselage and set on trestles. Turn out the three adjusting screws that draw the bottom fairing against the wing butt.
c. Prepare the various lines, control cables, pressurization ducts, etc., for inserting into the wing or fuselage when the wing is slid into place.
d. Slide the wing into the fuselage (it may be necessary to insert a metal strip between the fillet fairing and wing butt so as to funnel the wing between the upper and lower fairings) and butt the spar ends. (Maximum distance of .031 of an inch is permissible between spar caps.)
e. Install the bolt that attaches the rear spar and fuselage fittings.
f. Install the bolt that attaches the front spar and fuselage fittings.
g. Install and bolt the fore and aft vertical spar splice channels.
h. Install and bolt the upper and lower horizontal spar cap splice plates.
i. To the side of the fuselage, at the top of the main spar, bolt the fore and aft lower support fitting to the upper support fitting and spar.
j. At the lower side of the main spar, install support bolt assembly and bushing.
k. Install the angle support that extends through the fuselage and the brace assembly at the forward side of the spar.
l. Tighten bolts of all attachment fittings, plates, etc., to the torques specified in Fig. 4-4, all other bolts use standard torque values. (Refer to Figure 4-4 to obtain torques.)
m. Draw the engine control cables into place.
n. At the wing leading edge and butt, connect the engine instruments, vacuum, fuel and hydraulic lines. Secure the lines and cables in position with support blocks and clamps.
o. Connect electrical wire connectors.
p. Through the wing fairing access openings at the underside of the fuselage, connect the fuel and hydraulic lines and fuel valves control cables.
q. Draw the flexible drive shaft from the flap transmission into the fuselage and rig in accordance with Rigging and Adjustment of Flap Controls, Section V.
r. The following items pertain to the installation of the right wing only, along with the previous instructions:
    1. Connect the pressurization air duct to the tube assembly on the main spar.
    2. Route the Freon Lines through the fuselage at station 153. Refer to Section XIII for proper connection procedure.
    3. Route the control cables and antenna cables through the spar and connect.
    4. Route the hydraulic lines through the main spar and connect to their respective fittings at stations 122 and 144.
    5. Draw the aileron trim cables into the wing, connect turnbuckles at station 90 and unblock cables. Install cable guard pin at butt end of wing. Check rigging and adjustment of cable tension (Refer to Rigging and Adjustment of Aileron Trim, Section V) and safety turnbuckles.
    6. Draw the elevator and rudder trim cable back through the fuselage, connect turnbuckles in the aft section of the fuselage and unblock cables. Check rigging and adjustment (Refer to Rigging and Adjustment of Elevator and Rudder Trim, Section V), cable tension and safety turnbuckles.
    7. Draw aileron balance cable into the fuselage and connect to the left balance cable at station 171. Install cable pulley and secure.
    8. Draw the aileron control cable into the wing and connect at the aileron bellcrank. Install cable guard pin at the pulley near the bellcrank and at the wing butt. Check rigging and adjustment (Refer to Rigging and Adjustment of Aileron, Section V), cable tension and safety turnbuckles.
s. If the left wing is being installed, the following items pertain to the installation of the left wing only, along with the instructions given in steps a to q.

1. Connect the pressurization air duct to the tube assembly on the main spar.
2. Draw the left balance cable into the wing and connect at the aileron bellcrank. Install the cable guard pin at the cable pulley near the bellcrank and at the wing butt.
3. Draw the primary control cables through the main spar and connect turnbuckles at station 100. Install the cable guard pins for the left aileron cable at station 164 and the elevator cables at station 123. Check rigging and adjustment (Refer to Rigging and Adjustment of Aileron, Elevator and Rudder, Section V), cable tension and safety turnbuckles.

t. Install engine. (Refer to Installation of Engine, Section VIII.)
u. Check hydraulic fluid level (Refer to Section II or VI) and with the airplane setting on jacks, operate the gear through several retraction and extension cycles to ascertain that there are no hydraulic fluid leaks.
v. Check brake fluid level, bleed brakes (Refer to Bleeding Brakes, Section VII) and ascertain that there are no fluid leaks.
w. Check fuel system for leaks and flow.
x. At the top of the wing, rivet the fillet fairing to the wing and fuselage. Apply a bead of Minnesota Mining and Manufacturing Sealant EC750, or equivalent, along the edge of the wing root fillet at the fuselage and wing skins, starting at the leading edge and extending aft over the top of the trailing edge.
y. At the fairing between the underside of the fuselage and wing, turn the three adjusting screws that draw the fairing against the underside of the wing butt and ascertain that there is a rub strip between the wing and fairing.
z. Reinstall access plates and panel at the underside of the fuselage and wing and leading edge of wing.
aa. Install floor panels, spar cover and fuel selector panel.

4-20. EMPENNAGE GROUP.

4-21. ELEVATOR.

NOTE

Anytime service is accomplished on the elevator control system, a friction check must be made to insure friction is within limits. (Refer to paragraph 4-83a.)

4-22. REMOVAL OF ELEVATOR. (Refer to Figure 4-5.)

a. Remove the screws that attach the fuselage tail cone, pull the cone back far enough to disconnect the navigation light wires and then remove the tail cone.
b. At the right and left elevator, disconnect the trim tab control rods.
c. Remove the bolts that attach the elevator torque tube bracket to the elevator.
d. Remove hinge bolts and remove elevator.
e. To remove the elevator torque tube assembly after the elevators have been removed, disconnect the elevator push-pull rod at the control arm.
f. Remove the hinge bolt and separate the torque tube assembly from its mating hinge bracket.

4-23. INSTALLATION OF ELEVATOR. (Refer to Figure 4-5.)

a. Place the elevator torque tube assembly in position with its mating hinge bracket.
b. Install hinge bolt assembly, torque and safety.
c. The elevator push-pull rod may be connected to the arm of the torque tube assembly.
d. Place the elevator in position, install hinge bolt assemblies and torque.

e. Install proper length bolts attaching the torque tube bracket and elevator. Ascertain that the elevator halves align and tighten bolts.
f. Connect the elevator trim tab control rods to the right and left elevators and secure in position. Torque bolts.
g. Check elevator for proper operation and friction limits.
h. Connect the navigation light wires and place the tail cone assembly in position. Start all screws with washers and then tighten.

4-24. ELEVATOR TRIM TAB.

4-25. REMOVAL OF ELEVATOR TRIM TAB. (Refer to Figure 4-5.)
a. Disconnect the control rods at the tabs.
b. Remove the hinge bolts securing the tabs.

4-26. INSTALLATION OF ELEVATOR TRIM TAB. (Refer to Figure 4-5.)
a. Place the trim tabs in position and install bolts.
b. Position the tab control rods, install the attaching bolts and torque.

4-27. HORIZONTAL STABILIZER.

4-28. REMOVAL OF HORIZONTAL STABILIZER. (Refer to Figure 4-5.)
a. Remove the left and/or right elevator in accordance with paragraph 4-22.
b. Remove the access plates located on each side of the fuselage under the horizontal stabilizers and the panel located on top of the fuselage aft of the vertical fin.
c. To remove the right stabilizer, locate the elevator trim cable turnbuckles in the aft section of the fuselage, mark the ends of one turnbuckle to facilitate reinstallation, and block the cables at one of the fuselage bulkheads and in the stabilizer to prevent the trim cables from unwinding. (Refer to Figure 4-2.)
d. Disconnect the trim cables at the turnbuckles.
e. Through the access hole, remove the two elevator trim cable pulleys, spacer and bolt. Draw the cables through the fuselage to this point.
f. Disconnect the elevator trim tab control tubes and de-icer lines, if installed.
g. Remove the mounting bolts that attach the front spar to the fuselage bulkhead.
h. Remove the mounting bolts that attach the elevator torque tube hinge bracket and rear spar.
i. Pull the stabilizer directly away from the fuselage.

4-29. INSTALLATION OF HORIZONTAL STABILIZER. (Refer to Figure 4-5.)
a. Trial fit to ascertain gap between stabilizer and fuselage skin surface is 0.19 inch. Trim to obtain this gap.
b. Ascertain that the sealer extrusion is attached to the inboard side of the elevator.
c. Put the stabilizer in position and align the front and rear spar mounting holes. If installing a right elevator, guide the elevator trim cables into the fuselage.
d. Position the elevator torque tube hinge bracket and install the rear spar mounting bolts.
e. Install the front spar mounting bolts.
f. Tighten all mounting bolts.
g. If the right stabilizer was removed, enter through the top access hole and route the trim tab control cables forward and install cable pulleys.
h. Connect the trim cable ends and set cable tension. (Refer to Section V.)
i. Install the elevator(s) in accordance with paragraph 4-23.
j. Check elevator trim and elevator operation. (See Section V for the rigging and adjustment of elevator and elevator trim controls.)
k. Install all access plates and panels.

4-30. RUDDER.

4-31. REMOVAL OF RUDDER. (Refer to Figure 4-5.)

a. Relieve cable tension from the control system by removing the floor panel to the left of the control pedestal and loosen one of the rudder cable turnbuckles.
b. Remove the access panel located on top of the fuselage, aft of the vertical fin.
c. With the control cable tension relieved, disconnect the control cable from the rudder sector.
d. Disconnect the rudder trim control rod.
e. Swing the rudder and remove the hinge bolts.
f. Pull the rudder back and up removing the unit.

4-32. INSTALLATION OF RUDDER. (Refer to Figure 4-5.)

a. Put the rudder in position, install and torque the hinge bolts.
b. Position the rudder trim control rod, install bolt and torque.
c. Connect the rudder control cables to the rudder sector.
d. Adjust the control cable turnbuckle previously loosened to obtain proper cable tension as given in Section V, with the rudder and control wheels centered.
e. Check rudder for proper operation.
f. Install fuselage and cabin access panels.

4-33. RUDDER TRIM TAB.

4-34. REMOVAL OF RUDDER TRIM TAB. (Refer to Figure 4-5.)

a. Disconnect the control rod at the tab.
b. Remove the hinge bolts securing the tab.

4-35. INSTALLATION OF RUDDER TRIM TAB. (Refer to Figure 4-5.)

a. Place the trim tab in position and secure with bolts and bushings.
b. Connect rim tab control rod.

4-36. VERTICAL STABILIZER (FIN).

4-37. REMOVAL OF VERTICAL STABILIZER (FIN). (Refer to Figure 4-5.)

a. Remove the fairing around the front of the fin which is a portion of the dorsal fin.
b. Disconnect the rotating beacon wire or strobe light cable, radio antenna cable and de-icer line, if installed.
c. Disconnect the antenna wire from the top of the stabilizer if high frequency radio is installed.
d. Remove the access plates located on each side of the fuselage, under the horizontal stabilizer and the panel located on top of the fuselage, aft of the vertical fin. The tail cone may be removed, if desired.
e. Remove the rudder in accordance with paragraph 4-31.
f. Locate the rudder trim cable turnbuckles in the aft section of the fuselage, mark the ends of one turnbuckle to facilitate reinstallation and block the cables in the aft section of the fuselage and in the rudder to prevent the cable from unwinding. (Refer to Figure 4-2.)
g. Disconnect the trim cables.
h. Through the right fuselage access holes, remove the two sets of trim cable pulleys, spacers and bolts.
i. Remove the mounting bolts that attach the front spar to the fuselage bulkhead.
j. Remove the mounting bolts that attach the rear spar to the fuselage bulkhead.
k. Pull the stabilizer directly up from the fuselage.

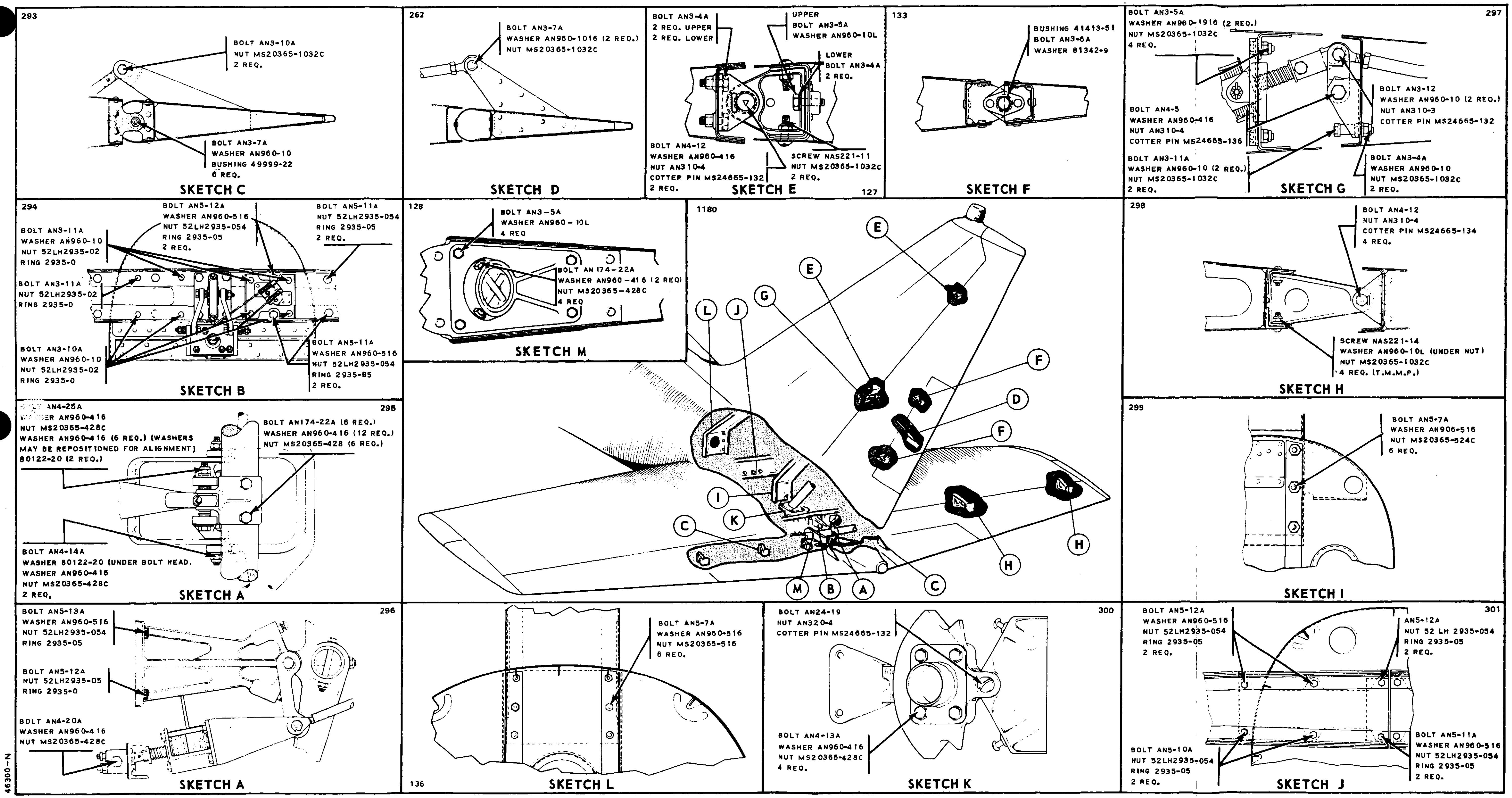


Figure 4-5. Empennage Installation

4-38. INSTALLATION OF VERTICAL STABILIZER (FIN). (Refer to Figure 4-5.)

a. Trial fit to ascertain gap between stabilizer and fuselage skin is 0.19 inch. Trim to obtain this gap.
b. Ascertain that the sealer extrusion is attached to the lower side of the vertical stabilizer.
c. Put the stabilizer in position and align the front and rear spar mounting holes.
d. Position the lower rudder hinge bracket and install the rear spar mounting bolts.
e. Install the front spar mounting bolts.
f. Torque all mounting bolts.
g. Route the rudder trim cable forward and install the two sets of cable pulleys.
h. Connect the trim cable ends, remove cable blocks and set cable tension. (Refer to Section V.)
i. Install the rudder in accordance with paragraph 4-32.
j. Check rudder trim and rudder operation. (See Section V for the Rigging and Adjustment of Rudder and Rudder Trim Controls.)
k. Install all access plates and panels.

4-39. WINDSHIELD.

4-39a. WINDSHIELD INSPECTION. See Appendix, Window Inspection and Repair - Standard Practices, located in Section XIV, Accessories and Utilities.

4-40. REMOVAL OF WINDSHIELD. (Refer to Figure 4-6.)

a. Remove the windshield wiper blade and arm from the airplane by removing the safety wire from the bolt holding the arm to the wiper motor and the cotter pin from the pivot bolt. (Refer to Paragraph 4-46.)
b. Remove the magnetic compass from the inside center post of the windshield.
c. Remove the cover panel on top of the instrument panel.
d. Remove the inside windshield molding and disconnect electrical leads on heated windshield.
e. Remove the existing sealant from around the locknuts on the windshield.
f. Remove the machine screws from around the collar moldings. This will require the assistance of another person.

NOTE

The machine screws which hold the windshield in position are installed in a particular order of sizes, and when removed, a note of their location should be made to insure the proper installation of the various sizes.

g. Remove the collar molding and the windshield.
h. With the windshield removed, the eyebrow bulkhead should be cleaned to remove all traces of old sealant before reinstalling the windshield.

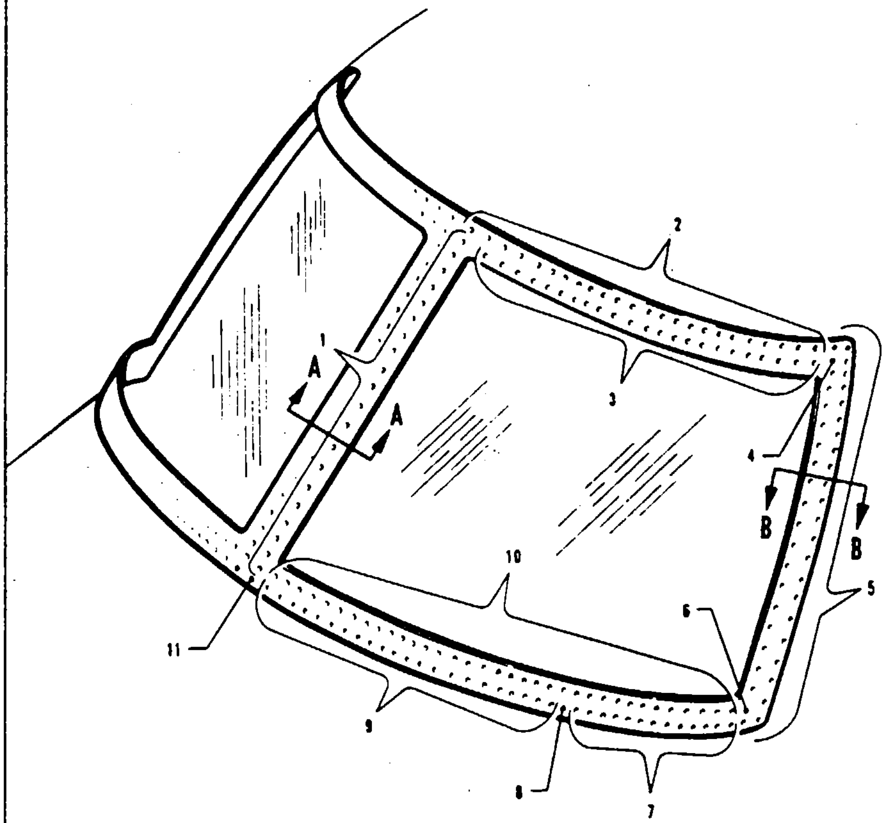
4-41. INSTALLATION OF WINDSHIELD. (Refer to Figure 4-6.)

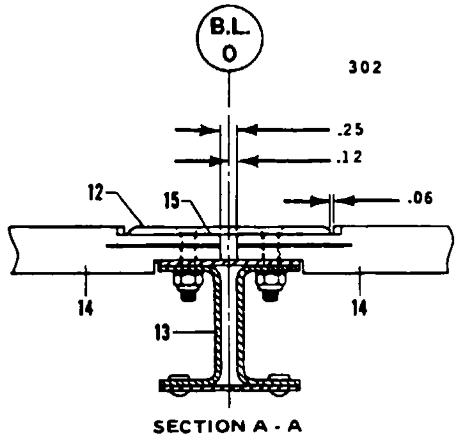
a. Perform the surface preparation in accordance with instructions given in Paragraph 4-89.

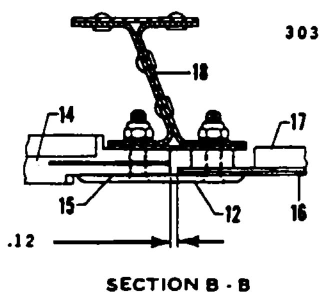
NOTE

Mask the windshield optical surface and fuselage skins around the windshield collar area to minimize cleanup.

b. Apply one inch wide, 1/16 inch thick vinyl foam tape (Norton Co., Tape No. V542, Piper No. 924 441) to the outer surface of the windshield, even with the edge and covering the holes.







1. MS24694-S13 (20 REQ.) LEFT
   (20 REQ.) RIGHT
2. MS24694-S5 (24 REQ.) LEFT
   (24 REQ.) RIGHT
3. MS24694-S11 (23 REQ.) LEFT
   (23 REQ.) RIGHT
4. MS24694-S13 (1 REQ.) LEFT
   (1 REQ.) RIGHT
5. MS24694-S12 (41 REQ.) LEFT
   (41 REQ.) RIGHT
6. MS24694-S13 (1 REQ.) LEFT
   (1 REQ.) RIGHT
7. MS24694-S5 (13 REQ.) LEFT
   (13 REQ.) RIGHT
8. MS24694-S6 (1 REQ.) LEFT
   (1 REQ.) RIGHT
9. MS24694-S5 (22 REQ.) LEFT
   (22 REQ.) RIGHT
10. MS24694-S11 (35 REQ.) LEFT
    (35 REQ.) RIGHT
11. MS24694-S6 (1 REQ.) LEFT
    (1 REQ.) RIGHT
12. WINDSHIELD COLLAR
13. WINDSHIELD CHANNEL
14. WINDSHIELD
15. VINYL FOAM TAPE
16. SKIN
17. WINDOW
18. BULKHEAD

Figure 4-6. Windshield Installation

c. Position the windshield into the eyebrow bulkhead from the outside.
d. Apply a bead of sealant to the frame on each side of the outer collar attachment holes.
e. Seal between the left and right windshields.
f. Position the collar over the windshield and install the machine screws, being certain to install the screws in the same location that they were removed from. Refer to Figure 4-6 for proper screw type and location.
g. Install the washers and locknuts on the machine screws and torque to 15-20 inch-pounds.
h. Apply a bead of sealant around the inner collar champer and windshield. Remove excess sealant with appropriate sealant removal tool noted in Figure 4-24.
i. Connect the electrical leads from the heated windshield.
j. Install the inside windshield molding and the top cover over the instrument panel.
k. Install the magnetic compass to the windshield center post.
l. Install the windshield wiper arm assembly and secure with the bolt previously removed and safety the bolt. Also install the cotter pin in the pivot bolt.

NOTE

The cabin should not be pressurized for at least 48 hours, to insure adequate time for the sealant to cure around the windshield.

4-42. HEATED WINDSHIELD CHECK. The following steps will help in determining if the windshield heating element and timer are functioning properly.

a. Connect a 24-volt test light to the positive and negative terminals of the windshield.
b. Set the switch marked "Windshield Heat" to the ON position. The test light should light indicating voltage is being delivered to the windshield.
c. Place your hand against the windshield to determine that the windshield heating element is operating and current is flowing.
d. The test light should go out before the windshield becomes too hot to hold your hand against it. This indicates that the temperature sensing element is operating properly and has passed through its thermostatic ON-OFF cycle.

CAUTION

Exercise caution during ground operation to prevent overheat and possible damage to the windshield.

e. When check is completed, set the "Windshield Heat" to the OFF position and remove the test light.

4-43. WINDSHIELD WIPER MECHANISM.

4-44. REMOVAL OF WIPER MECHANISM. (Refer to Figure 4-7.)

a. Remove the access panel on the left side of the nose section. If the co-pilots wiper is installed, remove the access panel on the right side of the nose section also.
b. Cut the lockwire (5) at the bolt which secures the arm (3) to the serrated converter shaft and remove the bolt.
c. Loosen the adjustment nut (4) and lift the wiper arm (3) off the converter shaft. Refer to paragraphs 4-47 and 4-48 for wiper blade replacement and adjustment.
d. Remove two screws from seal cover around converter shaft and remove cover and old sealant from shaft.
e. Disconnect the electrical connection to the wiper motor (8) and disconnect the flexible drive shaft to the co-pilots converter, if installed.

f. Remove the remaining screws holding the motor and converter to the airplane, and remove the complete assembly.
g. If necessary, the converter (7) and motor (8) can be separated by unscrewing the motor from the converter.

CAUTION

When separating the motor from the converter, do not lose the coupling (11) between the motor shaft (9) and converter drive shaft (12).

4-45. INSTALLATION OF WIPER MECHANISM. (Refer to Figure 4-7.)

a. The wiper motor and the converter must be timed before connecting the two units together and installing them in the airplane. The timing can be accomplished as follows:
   1. Rotate the drive shaft (12) in the converter (7) until the end of travel, corresponding to the park position, is obtained at the serrated converter shaft.
   2. Temporarily connect the electrical connector to the wiper motor (8) and operate the motor, ending with the switch in the PARK position. Disconnect the electrical connector.
b. Assemble the wiper motor and converter by screwing the two units together.

NOTE

Ascertain that the coupling (11) is installed when connecting the motor and converter.

c. Assemble the units slowly until the coupler engages the converter drive shaft (12). The alignment should be automatic, but if severe binding occurs, back off and reassemble.
d. Screw units together until the nipple (10) bottoms in the converter and then back off for alignment of mounting brackets (13 and 14).
e. Install the assembled units into the airplane and secure with four screws. Do not install the seal cover at this time.
f. Apply a bead of sealer around the converter shaft where it extends through the fuselage and position and secure the seal cover in place with two remaining screws.

NOTE

If a windshield wiper is installed on the copilots side, the converter must be timed as stated in Step "a" with the blade parked at the centerpost and the flexible drive shaft and coupling installed and safetied between both converters. Also, seal the converter shaft.

g. Connect the electrical connector to the wiper motor and replace the access panels removed.
h. Refer to Paragraphs 4-47 and 4-48 for wiper blade and arm installation and adjustment.

4-46. WIPER BLADE AND ARM REMOVAL.

a. Cut the lockwire at the bolt which secures the arm to the serrated converter shaft and remove the bolt.
b. Loosen the adjustment nut to relieve the arm tension and remove the wiper arm from the converter shaft.
c. Pull the lock on the wiper blade out to remove the blade from the arm assembly.

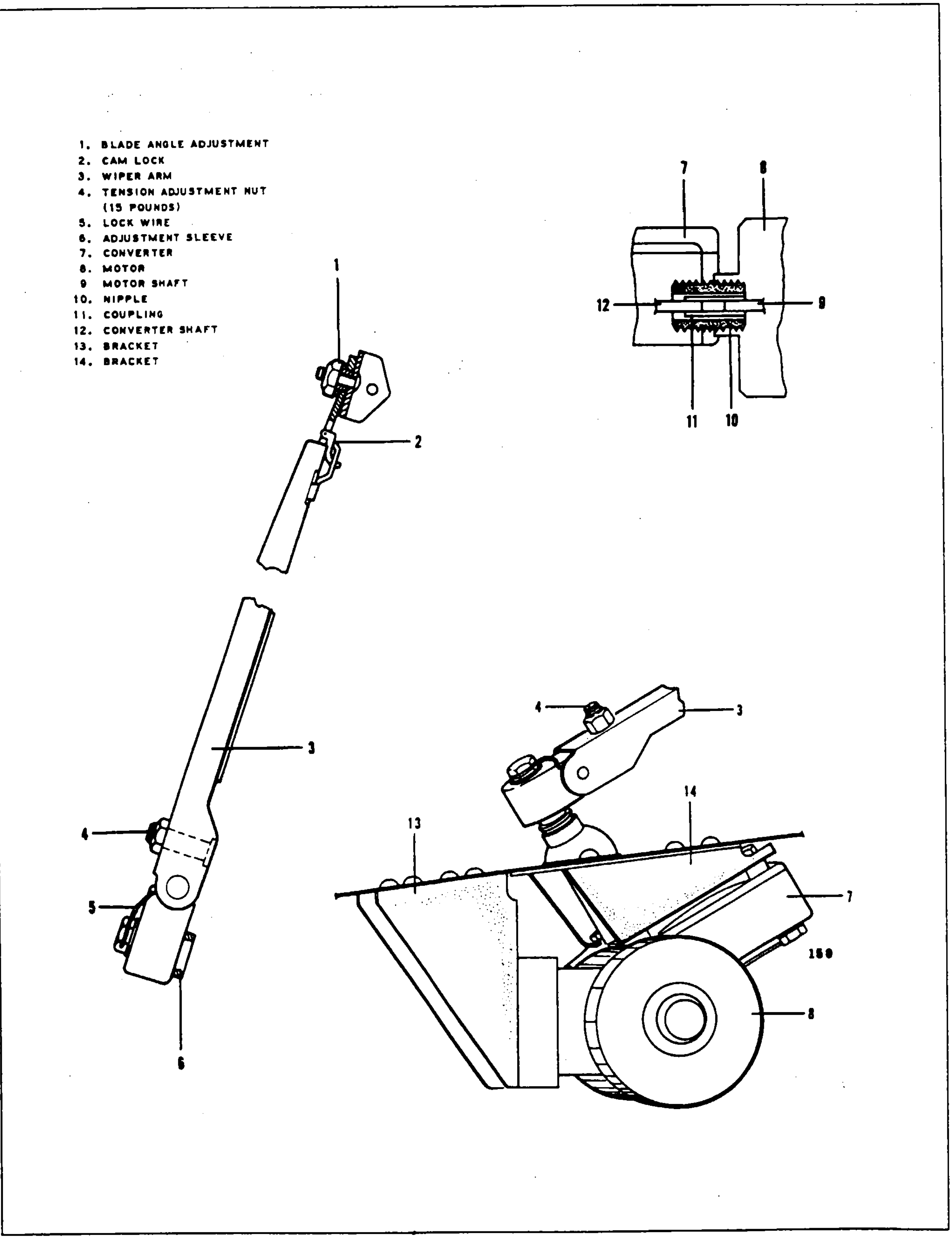


Figure 4-7a. Eyebrow Window

4-47. WIPER BLADE AND ARM INSTALLATION. (Refer to Figure 4-7.)

a. Install the wiper blade to the arm assembly and ascertain that the blade is locked to the arm.
b. Turn the wiper switch on momentarily to the PARK position, then position the arm assembly (3) and adjustment sleeve (6) on the serrated converter shaft so the wiper blade is clearing the windshield center post by approximately 2.00 to 2.75 inches during operation.
c. If the arm is not in the proper position, remove the arm and sleeve and rotate it in the direction required to get the proper setting.

NOTE

The outside teeth on the adjustment sleeve will not locate the arm in the desired position.

d. Install the bolt through the wiper arm into the converter shaft. Tighten and safety with MS20995-C41 lockwire (5).

4-48. WIPER BLADE AND ARM ADJUSTMENT. (Refer to Figure 4-7.)

a. Adjust the wiper blade height on the windshield by unlocking the blade height adjustment cam (2).
b. Adjust the blade height on the windshield so the bottom of the blade clears the windshield collar by three inches. Lock the adjustment cam.
c. To adjust the wiper blade angle, loosen the nut (1) on the wiper blade attachment stud and rotate the blade until it is parallel with the windshield center post, then tighten the nut on the stud.
d. Adjust the wiper arm tension to obtain five pounds tension at the blade pivot point by adjustment of the nut (4) on the wiper arm adjustment stud.

NOTE

Ascertain that the base of the adjustment stud (4) is in the recess provided in the wiper arm (3).

4-49. SIDE WINDOWS.

4-49a. WINDOW INSPECTION / REPAIR / REWORK PROCEDURE.

See Appendix, Window Inspection and Repair - Standard Practices, located in Section XIV, Accessories and Utilities.

4-50. REMOVAL OF SIDE WINDOWS.

a. Remove the trim molding from around the inside of the window.
b. Remove the sealant from around the locknuts securing the window to the fuselage.
c. Remove the locknuts and washers from the screws and remove the screws.
d. Remove the window by pushing it in toward the center of the fuselage.
e. Clean all traces of old sealant from around window frame.

4-51. INSTALLATION OF SIDE WINDOWS.

a. Apply a bead of sealant around the inside of the window frame.
b. Install the window from inside the cabin.
c. Install the machine screws and secure them with washers and locknuts. Torque to 15 to 20 inch-pounds.
d. Install the trim molding around the inside of the window.

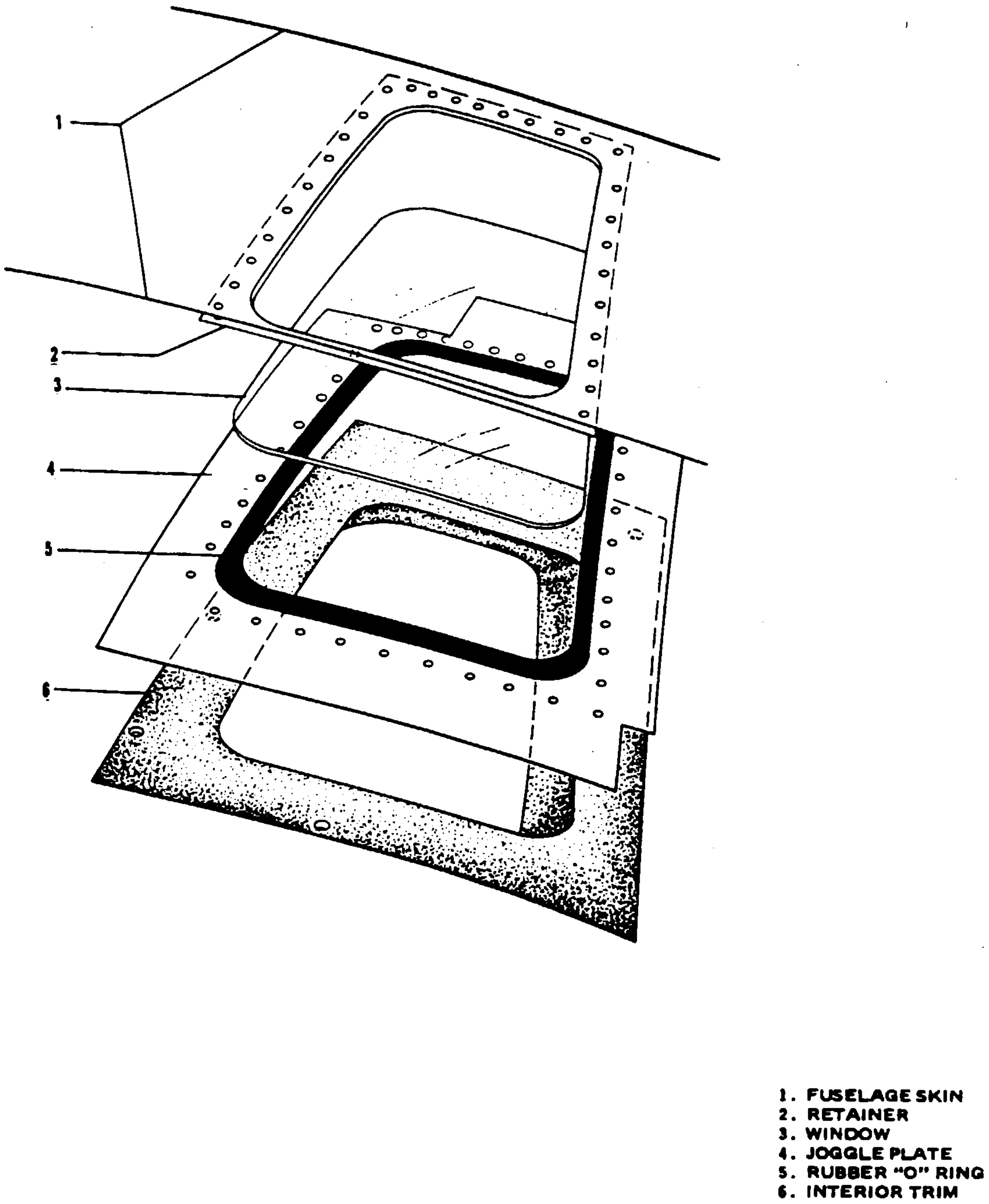


Figure 4-7a. Eyebrow Window

4-52. EMERGENCY EXIT WINDOW. There is a 25.75 inch by 19.75 inch emergency exit window on the right side of the fuselage. A release handle at the top of the window frame is used to open the exit. Pull the: handle to unlock the latch and continue to pull the window and frame into the cabin. This exit window and frame are sealed when it is installed at the factory to keep the cabin pressurized. If the window sticks or is hard, to remove: inspect the rubber seal on the window frame to ensure it is still serviceable. Spray both the window and fuselage frames with silicone. Also, inspect framming fur, and remove any excess lap sealant that might have extruded from structural parts or fittings. Excess sealant can cause the window seal to stick to the fuselage mounting frame. Whenever this exit window is removed, very carefully reinstall it so as not to damage the seal. Removal and installation of the emergency exit window plexiglas is the same as that given for side windows. (Refer to Figure 4-8.)

4-52a. REMOVAL OF EYEBROW WINDOW. (Refer to Figure 4-7a.)

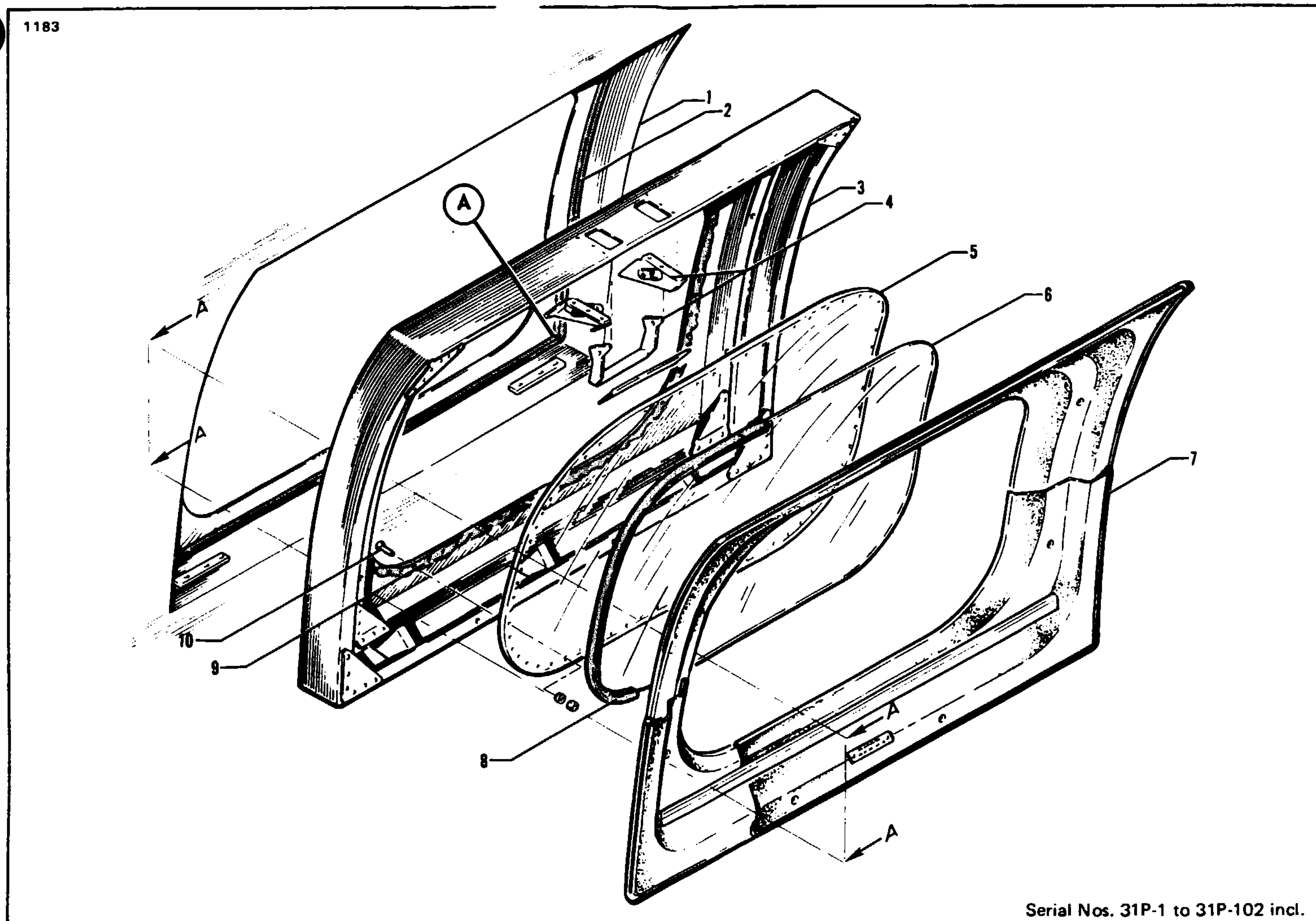
a. Remove the side window trim.
b. Loosen the front overhead panel.
c. Remove the aft overhead panel.
d. Loosen the radio speaker cover.
e. Remove the eyebrow window trim.
f. Remove nuts securing the window in place.
g. Carefully tap the outside of the window to loosen the sealant. Do not push violently on the outside of the window, as this may result in damage to the fuselage skin if there is a strong seal between the window and the fuselage.
h. Remove the rubber cord that fits between the window and the joggle plate.
i. Separate the retainer from the window.
j. Remove all traces of sealant from the retainer and around the window opening on the joggle plate.

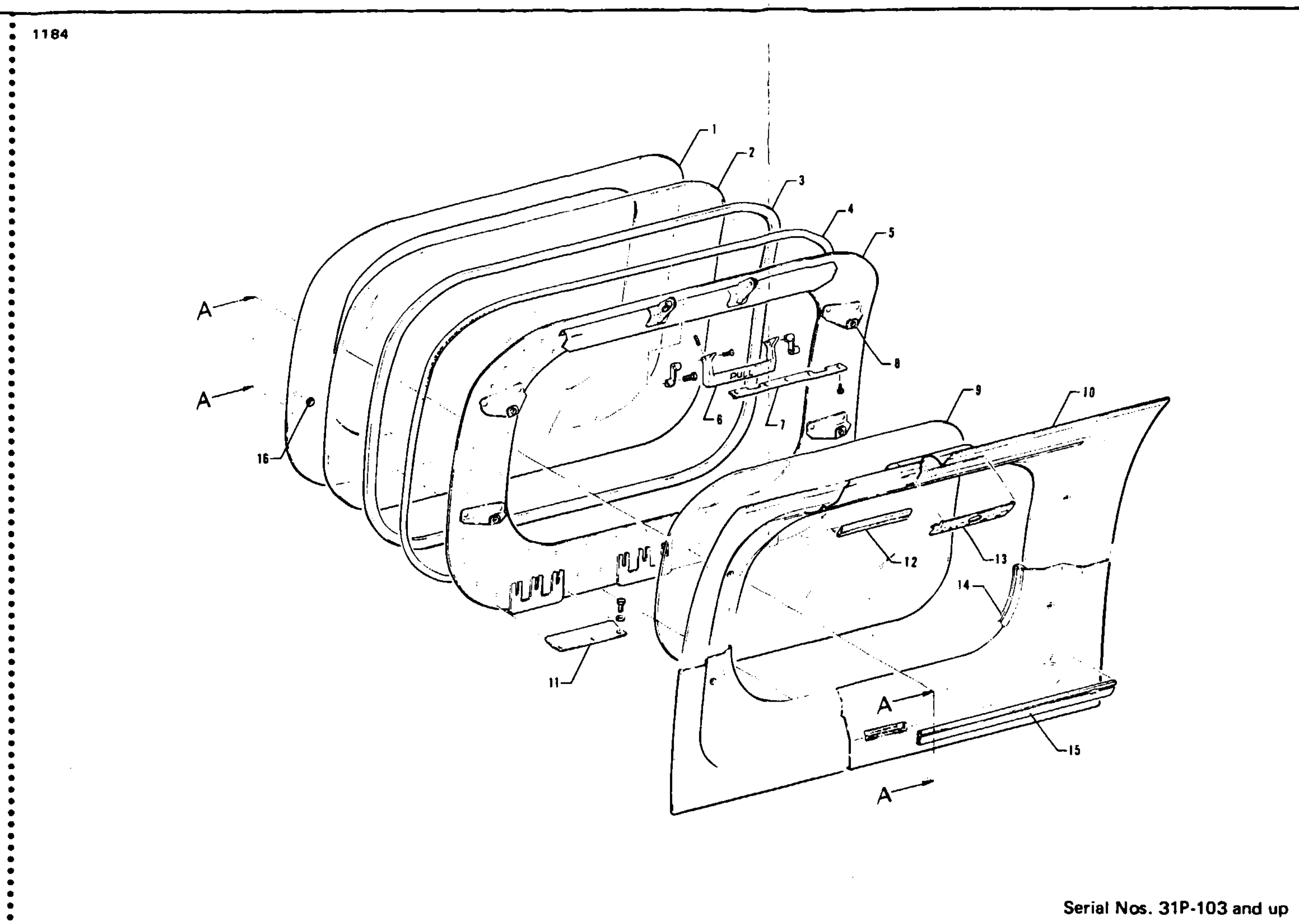
4-52b. INSTALLATION OF EYEBROW WINDOW. (Refer to Figure 4-7a.)

a. Wipe the new window with a naptha solvent using a clean cloth.
b. Install a new rubber cord around the window.
c. Apply a bead of sealant (see Note) around the joggle plate, around both sides of the window and on the window side of the retainer plate.
d. Attach the retainer plate to the window and install the window by aligning the holes in the retainer plate with the screws. Secure the window with the nuts and torque 15 to 20 inch-pounds.
e. Install the eyebrow window trim.
f. Secure the radio speaker cover, aft overhead panel and forward overhead panel.
g. Install the side window trim.

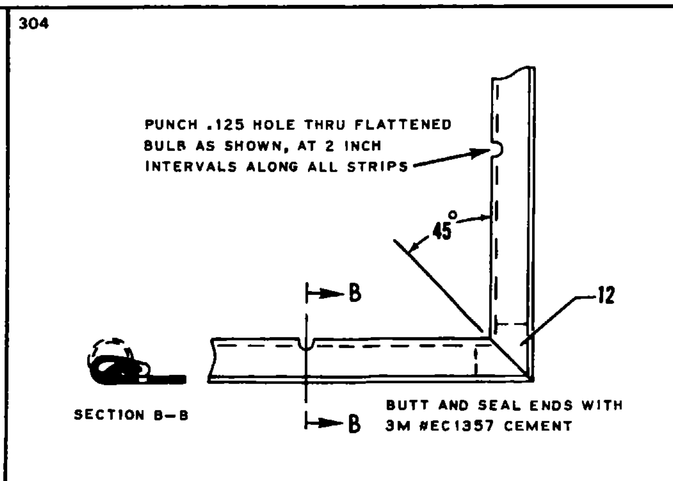
NOTE

Sealant to be used for windows is PR 1221 B-2 Code No. 914 046. This is available in 6 ounce cartridges. Mineral spirits or Apperson solvent No. 120 should be used to remove excess sealant. Toluol may be used in areas away from windows.

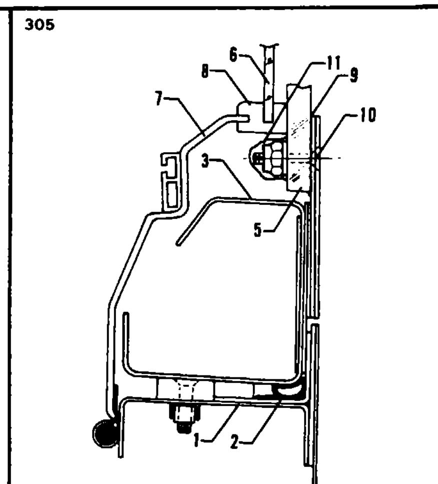




1. FUSELAGE FRAME
2. NEOPRENE "P" STRIP
3. WINDOW FRAME
4. LATCH ASSEMBLY
5. OUTER WINDOW
6. INNER WINDOW
7. WINDOW MOULDING
8. RUBBER SEAL
9. SEALANT
10. SCREW, WASHER, BOLT
11. SEALANT
12. PLUG

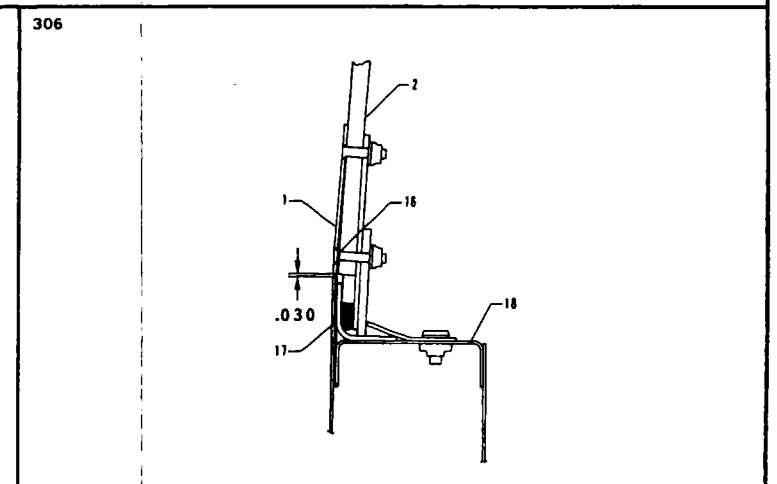


SKETCH A



SECTION A-A

1. OUTER PLATE
2. WINDOW (OUTER)
3. SPACER
4. SEAL
5. INNER PLATE
6. HANDLE
7. STRIKE CATCH
8. CLIP ASSY.
9. WINDOW (INNER)
10. MOULDING
11. PLATE
12. CONTAIN TRACK (UPPER)
13. PLACARD - EMERGENCY EXIT LATCH
14. EXTRUSION
15. CURTAIN TRACK (LOWER)
16. WASHER
17. SKIN
18. INTERCOSTAL CHANNEL



SECTION A-A

Figure 4-8. Emergency Exit Window

4-52c. REMOVAL OF PILOT'S STORM WINDOW.

a. From inside aircraft release storm window friction lock, open window to expose mounting screws.
b. Remove assembly screws from around inside of storm window opening, and gently pull out storm window assembly and seal.
c. Remove trim ring and rubber spacer from outside the aircraft.

4-52d. INSTALLATION OF PILOT'S STORM WINDOW.

a. Thoroughly clean pilot's side window where storm window assembly, spacer, and seal contact side window.
b. Install rubber spacer and storm window trim ring from outside the aircraft.
c. From inside the cockpit hold outside trim ring in place through storm window opening and carefully slide storm window assembly (with seal ring in place) into the outside trim ring.
d. With storm window in normally open position (hinge on bottom) rotate outside trim pins to align mounting screw holes. (No sealant is required.)
e. Reinstall assembly screws around inside of storm window opening.
f. Check storm window operation.

4-53. NOSE CONE.

4-54. REMOVAL OF NOSE CONE.

a. Open the small access door on the left side of the nose cone to gain access to the locking handle.
b. Pull the handle down completely to unlock the four locking pins.
c. Swing the nose cone forward and to the right of the fuselage.
d. Disconnect any electronic cables going into nose cone.
e. The hinge pin is now accessible and can be removed.
f. Support the nose cone before removing the hinge pin.

4-55. INSTALLATION OF NOSE CONE.

a. Position the nose cone hinge with the other half of the hinge on the airplane.
b. Insert the hinge pin and secure in position with screw.
c. Connect any electronic cables removed from nose cone.
d. Close the nose cone and secure in place by pushing the locking handle up and into the small access opening.
e. Close and secure the small access door on the nose cone.

4-56. CABIN ENTRANCE DOOR.

4-57. REMOVAL OF CABIN ENTRANCE DOOR. (Refer to Figure 4-9.)

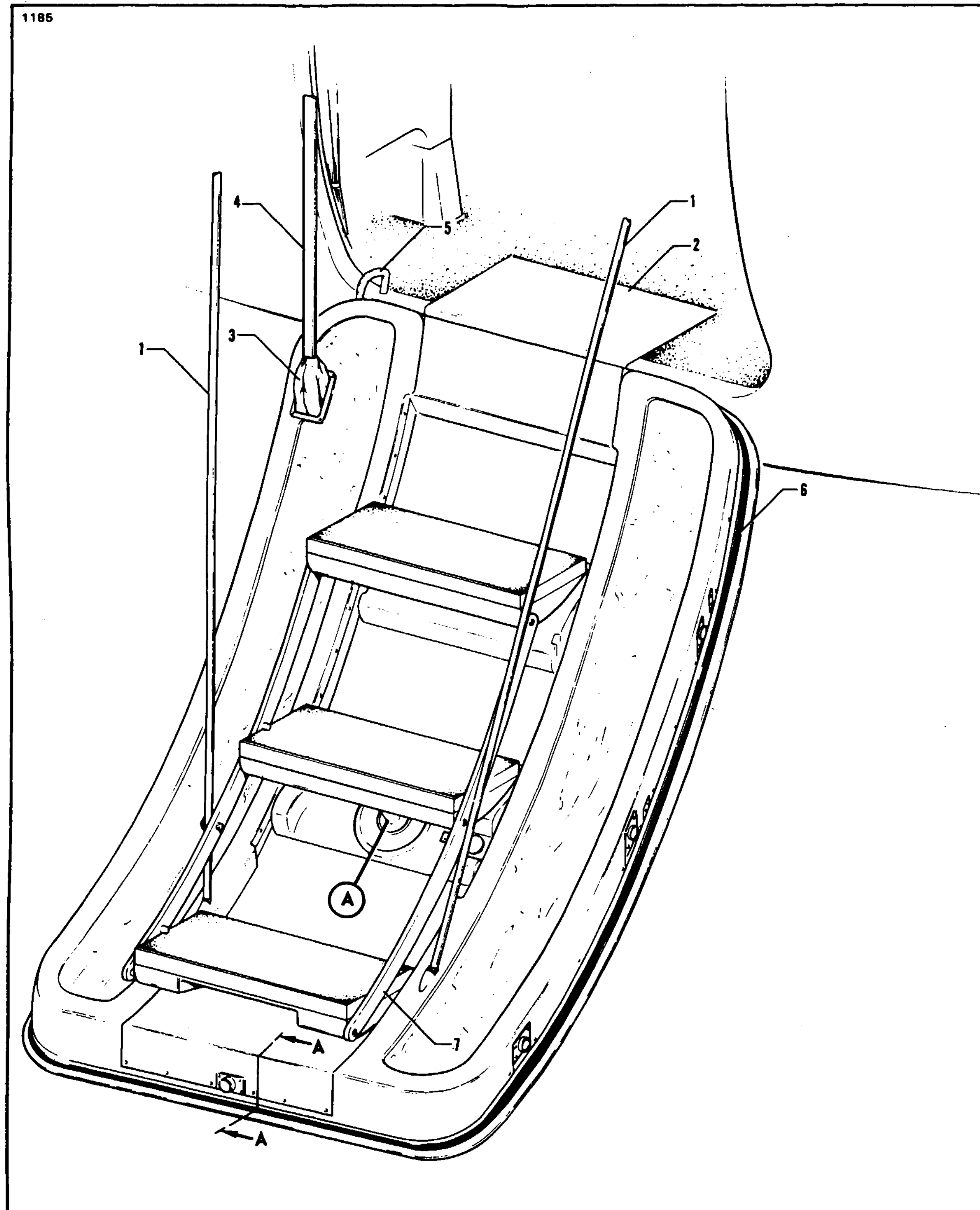
a. Place a padded support under the door to relieve tension from the two support cables.
b. Remove the scuff cover from over the door hinge.
c. Remove the boot over the door snubber attachment point on the door, then disconnect the snubber if installed. (Refer to Paragraph 4-107, Cabin Door Snubber.)
d. Disconnect the two support cables from the door.
e. Disconnect the pressure line to the door seal.
f. Remove the hinge pin and lift the door to separate the hinges and remove the door from the airplane.

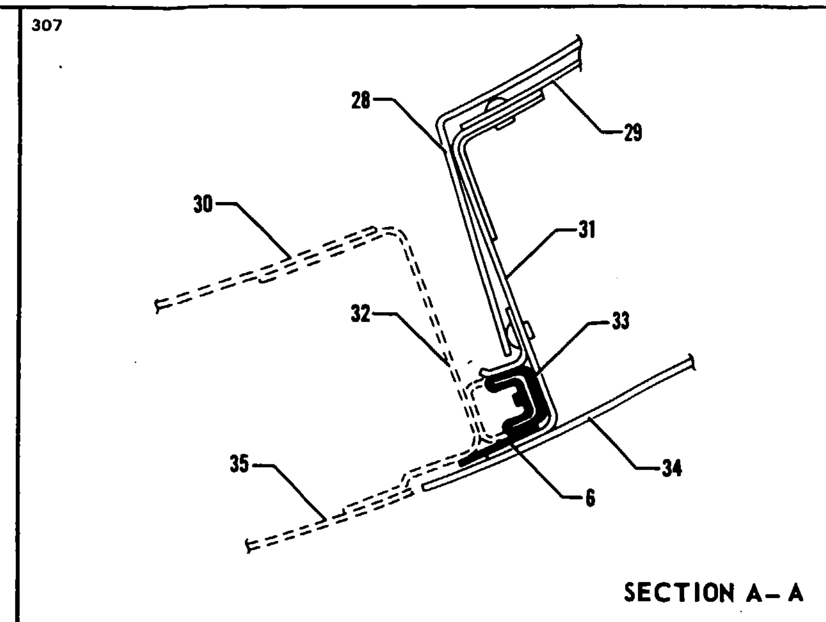
4-58. INSPECTION OF CABIN ENTRANCE DOOR.

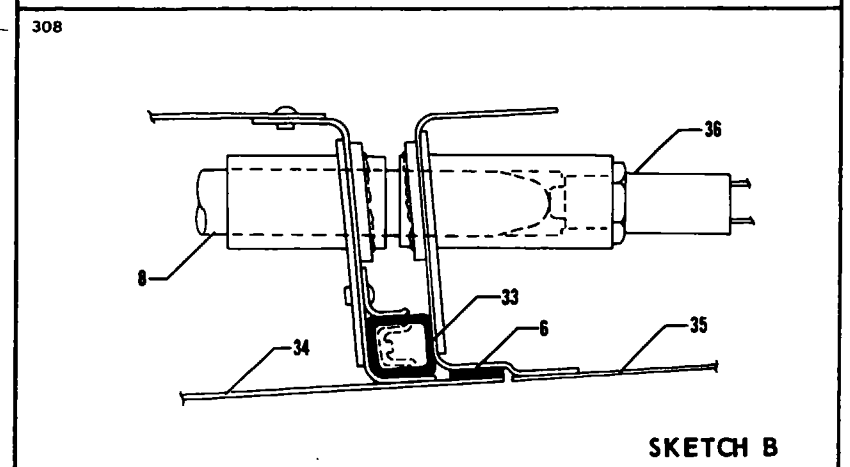
a. Make a visual inspection of parts for excessive wear, metal fatigue and signs of improper adjustments.
b. Operate the door latch mechanism and observe for proper functioning of all locking lugs and for any signs of a binding or loose nature.
c. Refer to paragraphs 4-60 through 4-63 for repair and service instructions of the various door components.
d. Refer to Section II for the proper lubrication of the door and related mechanisms.

4-59. INSTALLATION OF CABIN ENTRANCE DOOR. (Refer to Figure 4-9.)

a. Place a padded support under the door.
b. Position the hinge half on the door with the other half of the hinge on the airplane and install the hinge pin.
c. Connect the two support cables to the door.
d. Connect the pressure line to the door seal.
e. Connect the door snubber and replace the boot if installed.
f. Install the scuff cover over the door hinge.
g. Remove the padded support from under the door and check door fit.







1. SUPPORT CABLE
2. SCUFF COVER
3. BOOT
4. DOOR SNUBBER
5. PRESSURE LINE
6. WEATHER SEAL
7. STEP EXTENDER
8. LOCKING LUG
9. PUSH PULL ROD
10. PUSH PULL ROD
11. COVER PLATE
12. BELLCRANK (UPPER)
13. VERTICAL PUSH ROD
14. BELLCRANK (CENTER)
15. COTTER PIN
16. WASHER
17. O-RING
18. PLUNGER
19. SPRING
20. LOCK BUSHING
21. ROD
22. COVER PLATE
23. KNOB (AUXILIARY LOCK)
24. INSIDE LATCH HANDLE
25. VERTICAL PUSH ROD
26. BELLCRANK (LOWER)
27. COVER PLATE
28. ROYALITE PANEL
29. INNER SKIN
30. GUSSET
31. BULKHEAD
32. DOOR HEADER
33. INFLATABLE SEAL
34. OUTER SKIN
35. OUTER SKIN
36. DOOR WARNING SWITCH

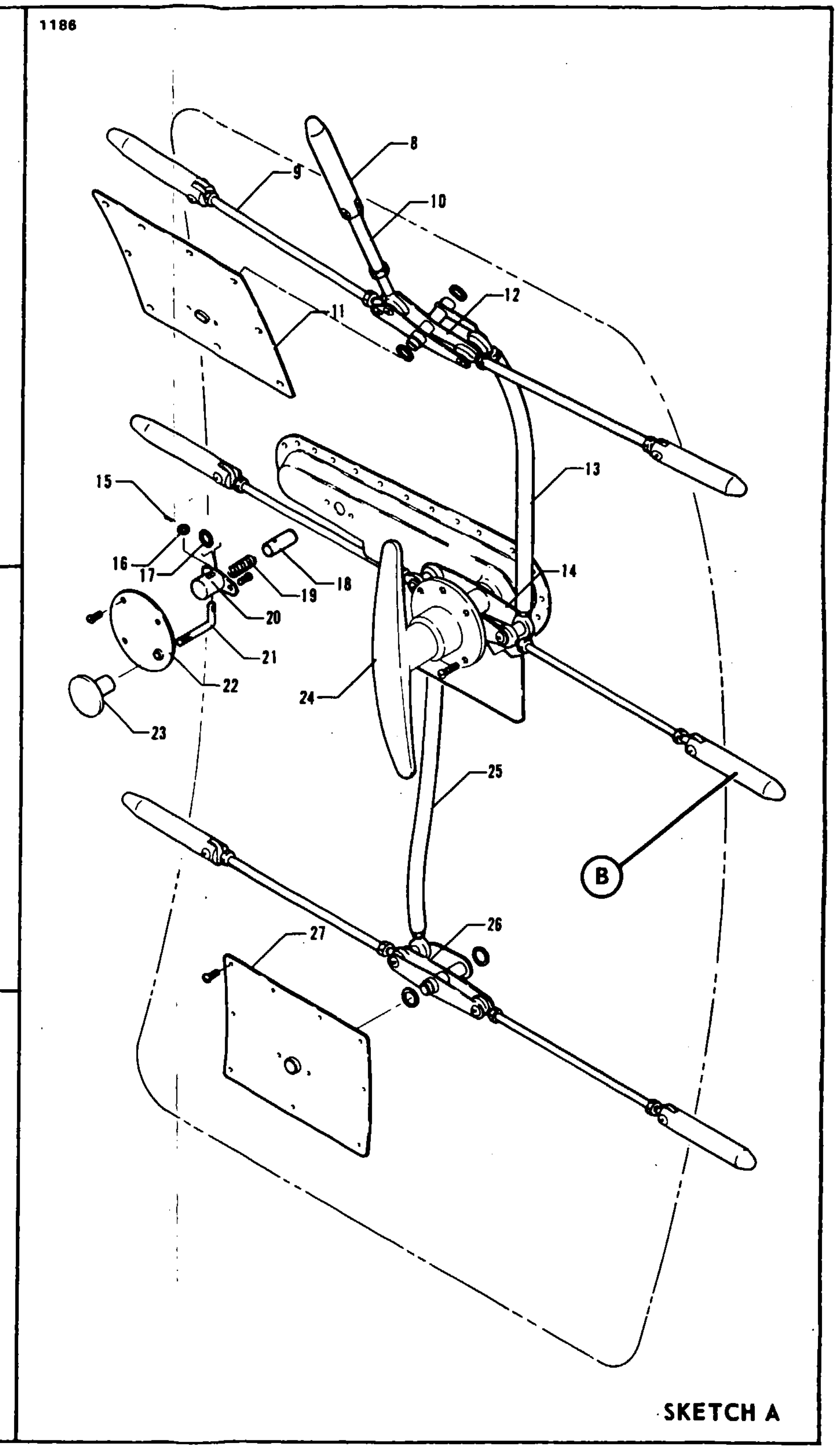


Figure 4-9. Cabin Entrance Door

4-60. CABIN ENTRANCE DOOR LATCH MECHANISM. The latching mechanism consists of seven locking lugs and a series of push-pull rods and bellcranks which are all controlled from a centrally located handle.

4-61. REMOVAL OF LATCHING MECHANISMS. (Refer to Figure 4-9.)

a. Upper and lower latching mechanism.
   1. Remove the interior trim panels from the door.
   2. Remove the cover plate over the bellcrank.
   3. Remove the bolt connecting the vertical push rod to the bellcrank.
   4. Remove the bolts connecting the right or left push rod, or both if necessary, to remove complete assembly.
   5. The bellcrank or the push rod and lugs can now be removed.
b. Center latching mechanism.
   1. Remove the interior trim panels from the door, if not previously removed.
   2. Remove the inside handle and cover plate.
   3. Remove the bolts, spacers and locknuts connecting the vertical push rods extending to the upper and lower latching mechanism bellcranks.
   4. Remove the bolts connecting the right or left push rod, or both if necessary, to remove the complete assembly.
   5. Remove the bolt and locknut to remove the bellcrank.
   6. The outside handle is removed from the outside of the door.
   7. Remove the push rods extending to the sides of the door along with the locking lugs.

4-62. INSTALLATION OF LATCHING MECHANISM. (Refer to Figure 4-9.)

a. Upper and lower latching mechanism.
   1. Install the push rods and locking lugs into the door.
   2. Install the bellcranks, and position the upper bellcrank with the push pull rod attachment point to the forward side of the door and the lower bellcrank with the push pull rod attachment point to the aft side of the door.
   3. Install the upper vertical push rod (the curved end up) to the upper bellcrank and secure along with the right push rod using bolt, washer and locknut.
   4. Connect the left push rod to the bellcrank and secure with bolt, washer and locknut.
   5. Install the lower vertical push rod to the lower bellcrank and secure along with the left push rod using bolt, washer and locknut.
   6. Install the cover plates and adjust lugs in accordance with paragraph 4-63.
b. Center latching mechanism.
   1. Install the push rods and locking lugs into the door.
   2. Install the outside handle, if previously removed.
   3. Install the bellcrank and secure with bolt and locknut.
   4. Connect the push rods to the bellcrank and be sure to install the spacers between the vertical and horizontal push rods as shown in Figure 4-9. Secure with bolts and locknuts.
   5. Install the cover plate and inside handle, and adjust lugs in accordance with paragraph 4-63.

4-63. ADJUSTMENT OF LATCHING MECHANISM. (Refer to Figure 4-9.)

a. Remove the inside trim panels and access plates.
b. With the door opened, position the handle in the open position.
c. Check all seven locking lugs to ascertain that all are even with the ends of the lug guides on the door.
d. If any of the lugs are found to extend beyond the guides, or are inside the guides, loosen the locknuts on the push rod and turn the push rod to get the proper setting.
e. Position the handle in the closed position and check all seven locking lugs for proper extension of approximately 1.75 inches.
f. If any of the lugs are found out of adjustment, loosen the locknuts on the push rod and adjust the push rod to get the proper extension.
g. Ascertain that all the locknuts on the push rods are tight and all the lugs and bellcranks operate freely.
h. Replace the access plates and trim panels removed.

4-64. CABIN DOOR AUXILIARY LOCK.

4-65. REMOVAL OF AUXILIARY LOCK. (Refer to Figure 4-9.)

a. Remove the knob from the auxiliary lock rod extending through the inside surface of the entrance door next to the handle.

NOTE

The interior trim panels must be removed to gain access to the cover plate over the lock mechanism.

b. Remove the four screws securing the cover plate and remove.
c. Remove the cotter pin and washer from the end of the lock rod extending through the lock bushing and remove the rod.
d. To remove the lock bushing, plunger and spring from the door, loosen and remove the two machine screws and nuts securing the assembly to the door.

4-66. INSTALLATION OF AUXILIARY LOCK. (Refer to Figure 4-9.)

a. Install the spring into the plunger and the plunger and spring into the bushing.

NOTE

Ascertain that the "O" ring is installed in the bushing, around the plunger.

b. Place the assembly into the access opening and secure it in place with two screws and nuts.
c. Install the lock rod into the slot in the bushing and through the hole in the plunger, and secure in place with washer and cotter pin.
d. Install the cover plate, being sure the lock rod extends out through the bushing in the cover.
e. Secure the cover to the door with four screws, and replace the trim panels on the interior of the door and the knob on the end of the lock rod.

4-67. REMOVAL OF HANDLE. (INSIDE.) (Refer to Figure 4-9.)

a. Remove the screw pin from the handle.
b. Remove the handle and teflon washer.
c. Remove the screws securing the cover plate and remove the plate.
d. Remove the machine screws and locknuts to remove the spindle from the door.
e. Reach into the opening made by the removal of the cover plate and remove the bolt and locknut securing the outer handle and shaft to the bellcrank.

4-68. CABIN ENTRANCE DOOR SEAL ASSEMBLY. This is an inflatable seal and has an air inlet valve from the lower corner of the seal to an accumulator type pressure tank.

A metal flange is installed around the seal to keep it in place. When the door is closed and the cabin is pressurized, the door seal is pressurized, and expands against the door frame to completely seal the door opening.

4-69. REMOVAL OF CABIN DOOR SEAL.

a. Remove the lower trim from the door and disconnect the rubber hose from the inlet valve on the seal.
b. Remove the rubber seal from around the door using MEK or white gas to cut through the cement.

CAUTION

When removing the inlet valve from the hole in the door, use extreme caution not to damage it.

c. Clean the door and seal with MEK or white gas to remove all traces of old cement.

4-70. INSTALLATION OF CABIN DOOR SEAL.

a. Clean both the door and seal with MEK or white gas prior to applying cement.
b. Apply one even coat of 3M # EC-1403 cement to the cleaned surfaces of the door and seal. Allow to dry and then apply a second coat and allow to dry.

CAUTION

Take care to avoid getting cement on areas not to be cemented.

c. Activate the cement by wiping the cemented surfaces lightly with Toluol. Do approximately two feet at a time and immediately position and press the seal in place. Start at the air inlet on the inflatable seal.

CAUTION

Care must be taken to avoid stretching the inflatable seal. Mark the seal and door at ten inch intervals to gauge length.

d. After positioning the seal correctly on the door, press the seal firmly in place to assure complete adhesion.
e. Clean off excess cement with a cloth dampened in MEK or white gas. Allow cement to set for four hours before using the door and inflating the seal.
f. Connect the rubber hose to the inlet valve and replace the trim panel over the door.

4-71. CABIN ENTRANCE DOOR STEP MECHANISM.

4-72. REMOVAL OF STEPS. (Refer to Figure 4-9.) With the cabin entrance door opened and the steps extended, proceed to remove the steps in accordance with the following instructions:

a. Remove the nuts, bolts and washers from both sides of each step which are used to connect the step support tubes linking the three steps together.
b. Remove the hinge pins which secure the step half of the hinge with the door half of the hinge and remove the steps.

4-73. INSTALLATION OF STEPS. (Refer to Figure 4-9.)

a. Position the steps to the door and install the hinge pins.
b. Position the step support tubes along the sides of the steps, being certain to place the tube with the door support cable guide on the forward side of the door. Be sure that the step stops on the step support tubes are pointing towards the center of the entrance door.

NOTE

Ascertain that the door support cable is routed between the roller and bracket on the forward step support tube assembly.

c. Install the bolts through the step support tubes, and install washers between the tubes and step brackets, then secure with locknuts.

4-74. FORWARD BAGGAGE DOOR.

4-75. REMOVAL OF FORWARD BAGGAGE DOOR.

a. With door open and hinges exposed, remove the cotter pins and washers from the hinge pins.
b. While supporting door, remove the hinge pins and lift the door for removal.

4-76. INSTALLATION OF FORWARD BAGGAGE DOOR.

a. While supporting door, align the hinges in the hinge bracket assemblies and insert the hinge pins.
b. Replace the washers and insert the cotter pins into the ends of the hinge pins.

4-77. REMOVAL OF FORWARD BAGGAGE DOOR LATCH ASSEMBLY.

a. Removal procedure for forward baggage door tube and arm assemblies is as follows:
    1. With the door open, remove the screws holding the inside cover and remove the cover from door assembly.
    2. Disconnect the spring between the link and tube assembly. Also, remove two other springs located on either side of the tube assembly to the baggage door assembly.
    3. Remove the roll pin, located between the tube assembly and door handle. Also, remove the spring link at this time.
    4. Remove six machine screws (three on each end) holding the arm assemblies to the door assembly and remove the tube with both arm assemblies from door.
    5. The arm assemblies can be removed from the clevis end of the tube by removing the cotter pins, washers and pins.
b. Removal procedure for forward baggage door handle assembly is as follows:
    1. Disconnect roll pin located between the tube assembly and the handle, if not previously done.
    2. Remove six locknuts and machine screws holding the handle and bracket and remove from door assembly.

3. The handle can be removed from the bracket by removing the cotter pin, washers and pin.

c. Removal procedure for forward baggage door key lock assembly is as follows:
   1. Remove two screws from the outside of the door to disconnect the lock guide plate assembly located on the inside of door.
   2. The key lock assembly can now be removed by removing the retaining nut and washer from the back of the key lock assembly.

4-78. INSTALLATION OF FORWARD BAGGAGE DOOR LATCH ASSEMBLY.

a. Procedure for installing the key lock assembly is as follows:
   1. Insert the key lock assembly from the back side of door with the latching arm towards the handle cut out on door.
   2. Replace the washer and retaining nut to back of lock and secure.
   3. Install lock guide plate and secure with two screws from outside of door.
b. Procedure for installing baggage door handle assembly is as follows:
   1. The handle and bracket can be assembled if previously taken apart by placing handle into bracket with two washers between handle and bracket and inserting the roll pin.
   2. Replace the handle and bracket assembly into the back of the door with the handle to the outer skin of door. Secure assembly with six machine screws and locknuts.
   3. If tube assembly was not removed, replace the roll pin between the tube assembly and handle and also replace the spring link. Secure with roll pin.
c. Installation procedure for baggage door tube and arm assemblies is as follows:
   1. Secure the arm assemblies to the clevis ends on the tube assembly with pins, washers and cotter pins. Be certain that the proper arm assembly is on each end of tube.
   2. The complete tube and arm assembly can now be placed onto the rear of the door, making certain that the projection on the tube aligns with the projection on the handle. Replace the six machine screws (three on each side) to hold the arm assemblies to the door.
   3. With all holes in both projection and the spring link aligned, insert the roll pin.
   4. Connect the three springs at this time. One between the spring link and the tube, and two between the tube assembly and the door assembly.
   5. Adjustment should be made at this time before replacing cover. (Refer to Paragraph 4-79.) Use the six machine screws to secure the cover on the door assembly.

4-79. ADJUSTMENT OF FORWARD BAGGAGE DOOR LATCH. Adjustment is done through the removal of the cover and adjustment of two clevis fittings located at the ends of the tube assembly.

a. Remove the cotter pin, washer and pin from the clevis and arm assemblies and loosen the locknuts between clevis and tube.
b. With handle in the closed position, turn the clevis in or out to get the arms of the arm assemblies to extend out at a 90 degree angle to the edge of the door assembly.
c. When the adjustment is completed, tighten the locknuts and reconnect the Clevis and arm assemblies with the pins, washers and cotter pins. Replace the cover and secure with six machine screws.

4-80. CONTROL SURFACE BALANCE.

4-81. CONTROL SURFACE BALANCING. The movable control surfaces have been statically balanced at the time of installation at the factory and normally need not be rebalanced unless the surfaces have been repainted, repaired or replaced. Each control surface must be complete including paint, tab where required, balance weights, static wicks, etc. Tabs must be held in neutral position with a small piece of tape. Tab actuating rods must be in place and connected to the tab. The forward end of the actuating rods must be disconnected from the attachment points. Disconnected actuating rods (forward ends) must be positioned to correspond to the neutral tab position.

This balancing information will cover the various control surface assemblies used throughout the production life span of the PA-31P aircraft. Particular attention should be given to assembly numbers being balanced, this will insure that the correct procedures and tolerances as referred to in the text and Table IV-I are correct for the assembly being serviced.

4-82. BALANCING EQUIPMENT. Balancing must be done using the test weights called for in the text and Table IV-I for each surface. Any control surface being balanced must be removed from the aircraft and placed in a test fixture (jig) as shown in Figures 4-10, 4-11 and 4-12. The balancing must be accomplished in a draft free area and in a manner which allows unrestricted movement of the control surface.

4-82a. BALANCING DEFINITIONS. The following is a list of balancing definitions as used in this service manual:

a. Master Test Weight. A fabricated tool temporarily attached to the control surface to determine when the surface is at its lower static balance limits.
b. Balance Weight. Weight attached permanently to a control surface to produce a static hinge moment within the required range (such as 30 inch-pounds ± 10 inch-pounds trailing edge heavy).
c. Trailing Edge Heavy. Positive static hinge moment, trailing edge of the surface moves downward when released from a neutral position.
d. Leading Edge Heavy. Negative static hinge moment, leading edge of the surface moves downward when released from a neutral position.
e. Master Test Weight Arm. Perpendicular distance between the control surface hinge line and the point of application of the master test weight.
f. 0.1 Pound Test Weight. Small weight or weights added to the master test weight during balancing procedure when the surface is trailing edge heavy with the basic master test weight installed.
g. Trim Weight. Small weight or weights added to the surface balance weight to bring the surface within tolerances. (Sometimes required depending on variations in surface conditions.)

4-83. AILERON BALANCING PROCEDURE. (Refer to Figure 4-10.)

a. Remove the aileron from the airplane. (Refer to Paragraphs 4-9 and 4-81.)
b. Place the aileron on the balancing jig as illustrated in Figure 4-10. Establish a horizontal reference mark which aligns with the trailing edge of the aileron when it is held in a horizontally level position (cord line level).
c. Ascertain that the surface rotates freely with no binding at the knife edges.
d. Fabricate a master test weight as required for the particular assembly (see Table IV-I).
e. Hang the master test weight on the front balance weight attachment bolt. The surface should balance so the trailing edge of the aileron lines up with the level reference line scribed on the jig.
f. Add 0.1 pound test weights as required to balance the surface; do not exceed the maximum number specified in Table IV-I.
g. If the aileron does not balance, the cause of the excessive imbalance must be determined, corrected, and the aileron rechecked.
h. With the balance check complete, install the assembly on the aircraft. (Refer to Paragraph 4-10.)

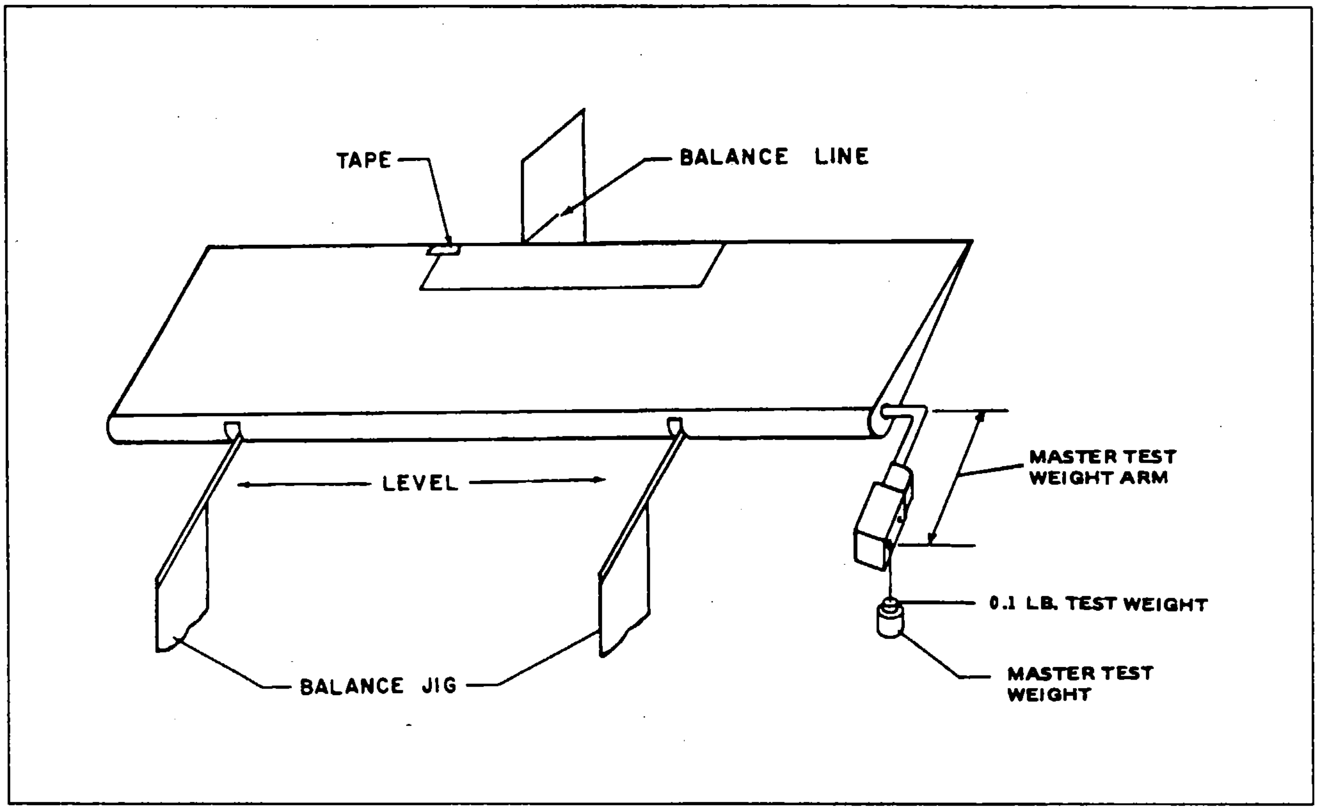


Figure 4-10. Checking Aileron Balance

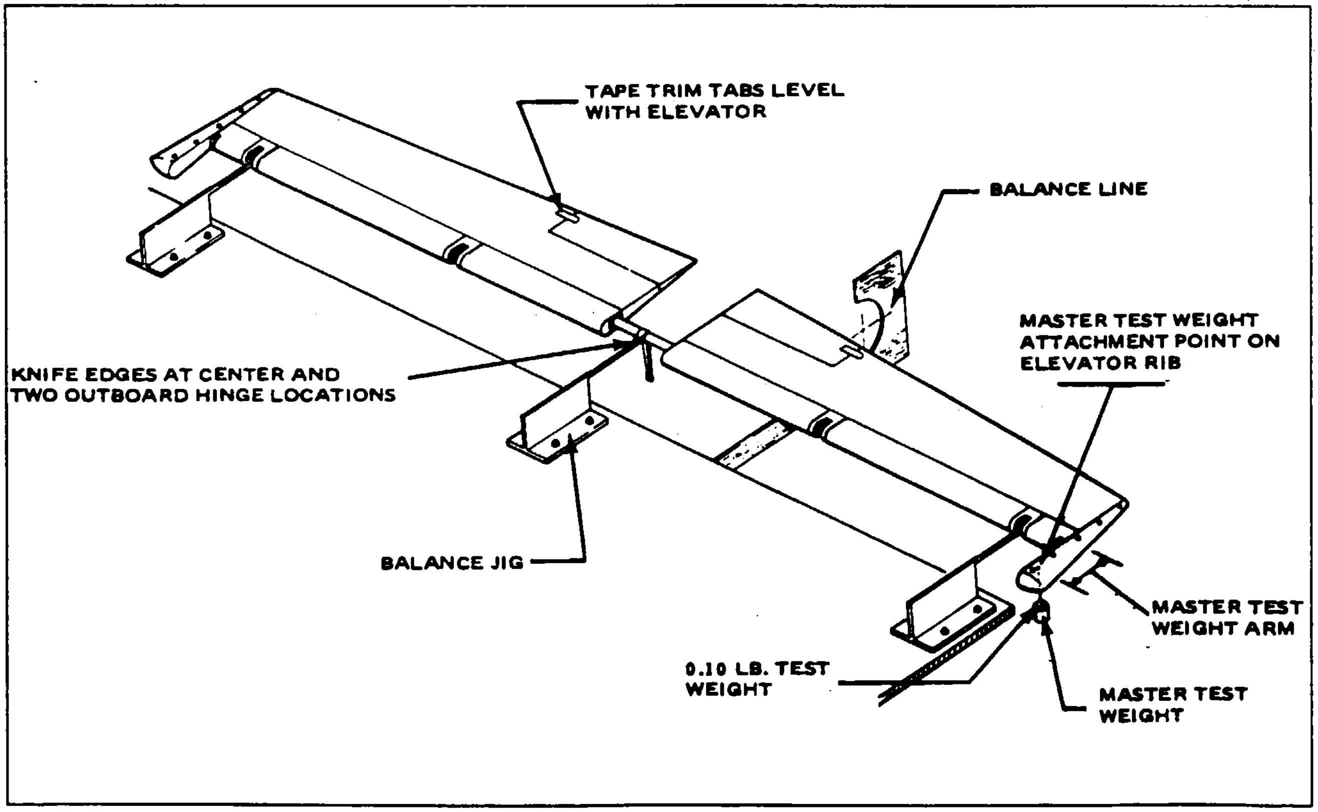


Figure 4-11. Checking Elevator Balance

4-83a. ELEVATOR BALANCING PROCEDURE. (Serial Nos. 31P-1 to 31P-7400219 incl. and 31P-7400228 to 31P-7530012 incl.) (Refer to Figure 4-11.)

a. Remove the complete (both halves) elevator assembly from the airplane. (Refer to Paragraph 4-22.) The complete assembly including trim tab and actuating rod must be assembled and placed on a balancing jig. (Refer to Paragraph 4-81.)
b. Fabricate a test weight in accordance with specifications in Table IV-I.
c. With the elevators assembled and mounted in the jig, establish a horizontal reference mark which aligns with the trailing edge of the elevator when held in a level position (cord line level). Ascertain that the assembly rotates freely with no binding at knife edges.
d. Hang the fabricated master test weight in the tool hole of the elevator counterbalance rib assembly. Check the master test weight arm of 3.94 in.
e. If the elevator is balanced (training edge aligns with reference mark) with just the master test weight, the surface is at the minimum static limit per Table IV-I and is satisfactory.
f. If the elevator is leading edge heavy, balance weight material must be removed to produce a balanced condition with the master test weight in place. Remove trim weights first if installed; then remove material from the main balance weight. Remove material or trim weights evenly from both sides by drilling holes as described in Paragraph 4-83b, Section f.
g. If the elevator is trailing edge heavy with just the specified master test weight installed; then it must be determined that elevator does not exceed the maximum static limits per Table IV-I.
h. Add individual 0.1 pound test weights to master test weight until the elevator balances. If the number of 0.1 pound test weights does not exceed the maximum allowed per Table IV-I, the elevator is within the static balance limits.
i. If the number of 0.1 pound test weights added to the master test weight exceeds the maximum allowable, the elevator balance exceeds the maximum and trim weights must be added to the surface balance weights, equally to each side, to produce a balanced condition. If the sum total of the balance weight plus the trim weight exceeds value stated in Table IV-I, then the reason for the excessive imbalance must be determined, corrected, and the elevator rechecked.
j. With the balance check complete, install the assembly on the aircraft. (Refer to Paragraph 4-23.)

4-83b. ELEVATOR BALANCING PROCEDURE. (Serial Nos. 31P-7400220 to 31P-7400227 incl. and 31P-7530013 and up.) (Refer to Figure 4-11.)

a. Remove the complete (both halves) elevator assembly from the airplane. (Refer to Paragraph 4-22.) The complete assembly including trim tab and actuating rod must be assembled and placed on a balancing jig. (Refer to Paragraph 4-81.)
b. Fabricate a test weight in accordance with specifications in Table IV-I.
c. With the elevators assembled and mounted in the jig, establish a horizontal reference mark which aligns with the trailing edge of the elevator when held in a level position (cord line level). Ascertain that the assembly rotates freely with no binding at knife edges.
d. Hang the fabricated master test weight in the tool hole of the elevator counterbalance rib assembly. Check the master test weight arm of 3.94 in.
e. If the elevator is balanced (trailing edge aligns with reference mark) with just the master test weight, the surface is at the minimum static limit per Table IV-I and is satisfactory.
f. If the elevator is leading edge heavy, holes of equal diameter and depth may be drilled in the balance weights. Maximum hole diameter is 0.75 inch and the maximum hole depth is 1.00 inch. Locate the holes on the outboard surfaces of the weights midway between the attachment bolts. Remove material equally from both weights. This will produce the minimum static balance condition.

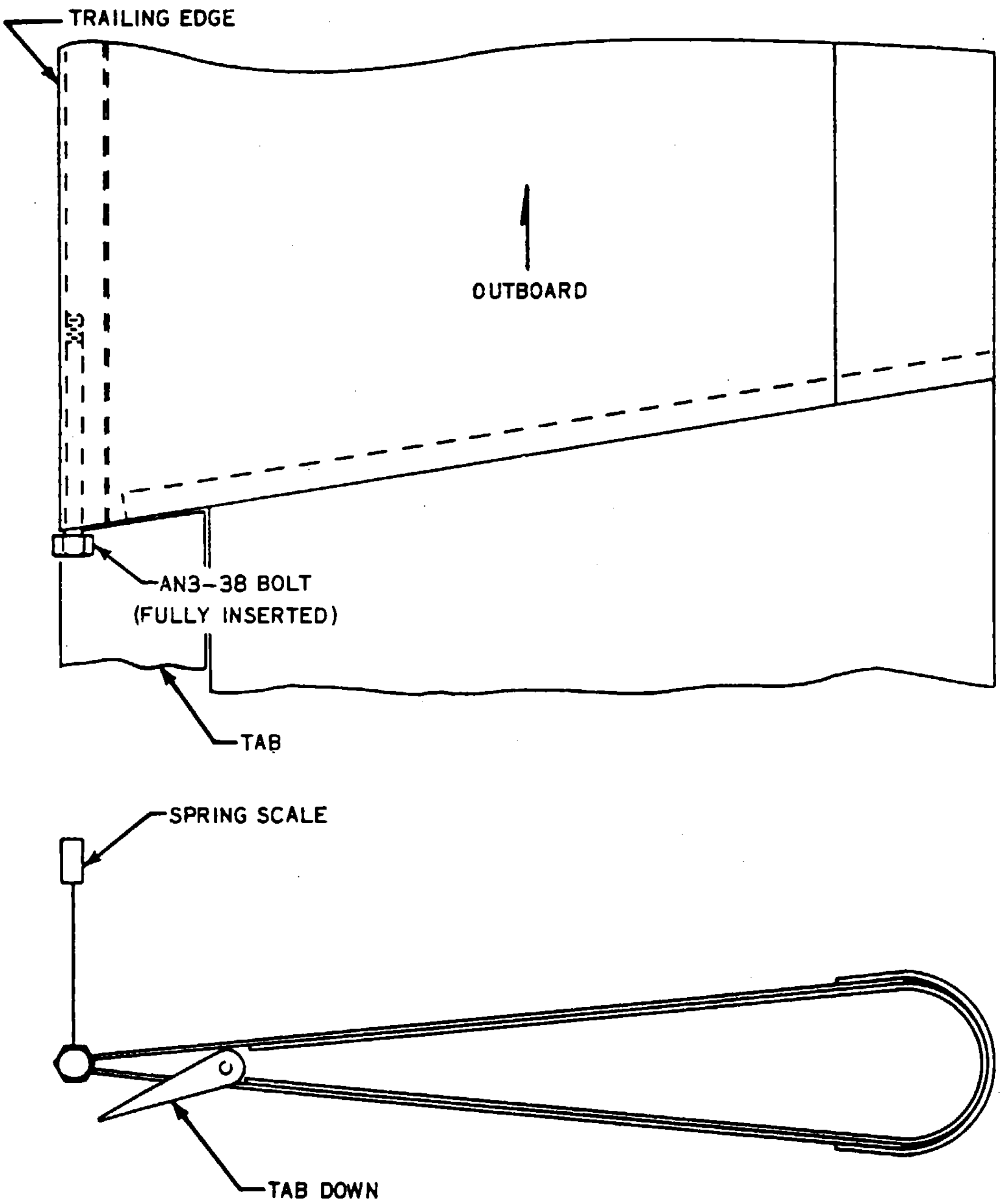


Figure 4-11a. Elevator Friction Movement

g. If the elevator is trailing edge heavy with just the specified master test weight installed, then it must be determined that the elevator does not exceed the maximum static limits per Table IV-I.
h. Add individual 0.1 pound test weights to master test weight until the elevator balances. If the number of 0.1 pound test weights does not exceed the maximum allowed per Table IV-I, the elevator is within the static balance limits.
i. If the number of 0.1 pound test weights added to the master test exceeds the maximum allowable stated in Table IV-I, the elevator balance exceeds static limits. The reason for the excessive imbalance must be determined, corrected, and the elevator rechecked.
j. With the balance check complete, install the assembly on the aircraft. (Refer to Paragraph 4-23.)

4-84. ELEVATOR CONTROL SYSTEM FRICTION MEASUREMENT. (Refer to Figure 4-11a.) The complete control system including Autopilot, if installed, must be checked to determine the total friction. The system must be rigged to its proper travels and cable tensions prior to determining the total friction.

The total friction must not be in excess of 14 pounds with the bungee spring adjusted to 30.0 ± .5 pounds tension. The following procedure will let you determine the actual frictional value of the system:

a. Adjust elevator trim to full nose up.
b. Attach a spring scale to the inboard trailing edge of the elevator, outboard of the tab as shown in Figure 4-11a.
c. With the spring scale attached, position the elevator trailing edge down approximately 2 inches from the neutral position.
d. Record the force (see Note 2) required to raise the elevator through the neutral position until the trailing edge is approximately 2 inches above neutral.
e. Record the restraining force lowering the elevator from the 2 inch up position through the neutral position to the original 2 inch down position.
f. Repeat above raising and lowering processes until average forces are obtained.
g. The "Total Friction" is obtained by subtracting the two forces.

NOTES

1. ***Do not exceed 60 pound force for any measurement.***
2. ***The elevator shall be rotated with a steady movement and the force reading taken when the elevator is passing through the neutral position. Do not stop rotation when taking the reading.***

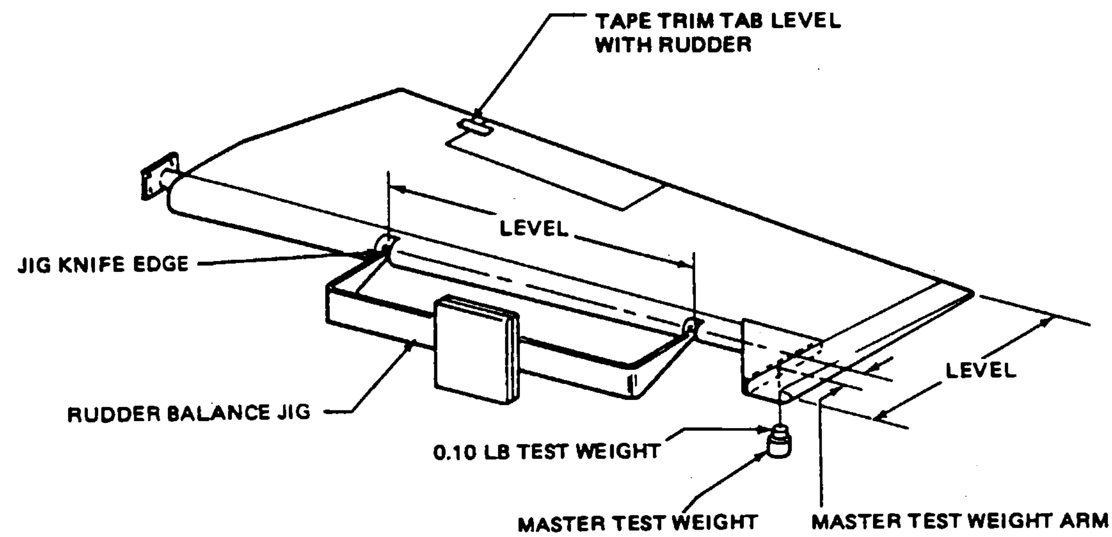


Figure 4-12. Checking Rudder Balance

4-84a. RUDDER BALANCING PROCEDURE. (Refer to Figure 4-12.)

a. Remove the rudder from the airplane. (Refer to Paragraphs 4-31 and 4-81.)
b. Place the rudder horizontally on the balance jig.
c. Fabricate a master test weight per specifications given in Table IV-I and hang it in the existing tool hole in the rudder counterbalance channel, part number 40045. Ascertain that the tool hole is located to provide the proper master test weight arm of 5.03 inches from the hinge centerline.
d. If the rudder balances with just the specified master test weight, the surface is at the minimum static limits per Table IV-I and is satisfactory.
e. If the rudder is leading edge heavy with the master test weight installed, material must be removed from the surface balance weight until a balanced condition is obtained. This would also result in the lower static limit.
f. If the rudder is trailing edge heavy with the master test weight installed, it must be determined that the rudder does not exceed the maximum static limits per Table IV-I.
g. Add individual 0.1 pound test weights to the master test weight until the rudder balances. If the number of 0.1 pound test weights added does not exceed the maximum allowable per Table IV-I, the rudder is within the static limits.
h. If the number of 0.1 pound test weights added to the master test weight to balance the rudder exceeds the maximum allowable per Table IV-I, the rudder balance exceeds the static limits and trim weights must be added to the rudder to produce a balanced condition. (Refer to Table IV-I for the trim weight part number and number allowed.)

TABLE IV-I. BALANCE SPECIFICATIONS

Specification	Aileron	Elevator	Rudder
Test Weight (Pounds)	0.90	2 at 12.7	8.75
Max. No. of .10 Lb. Weights (P/N 43332) Added to Test Weight	6	37	10
Static Balance Limits (Inch-Pounds) Trailing Edge Heavy	8 ± 2	115 +0 -15	49 +0 -5
Trim Weight Part No.	N/A	*51615	43332
Max. No. of Trim Weights per Surface	N/A	*6 (3 per side)	10
Max. Allowable Balance Weight Plus Trim Weight Per Side (Lb.)	3.30	3.30	6.30

* Reference to Paragraph 4-83a only, no trim weight is required for aircraft covered in Paragraph 4-83b.

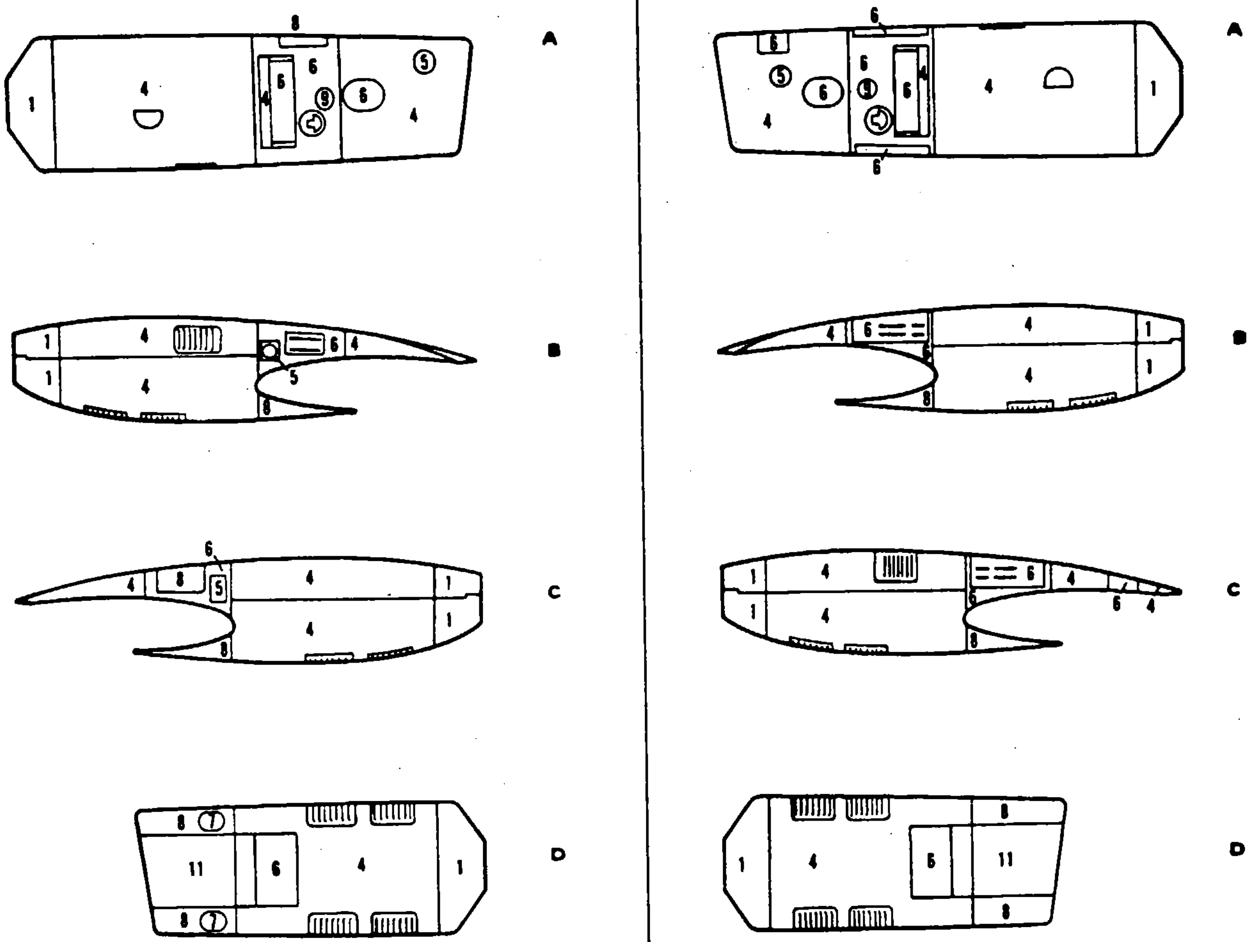
4-85. STRUCTURAL REPAIRS. Structural repair methods used may be made in accordance with the regulations set forth in FAA Advisory Circular 43.13-1A. To assist in making repairs, Figure 4-13 identifies the type and thickness of skin structure used. Never make a skin replacement or patch from a material thinner than the original skin. Original material and thickness is recommended and must result in a surface which is as strong as, or stronger than, the original skin. However, flexibility must be retained so that the surrounding areas will not receive extra stress.

When making major structural repairs, other than using factory manufactured parts, it is recommended the manufacturer be contacted. No major alterations are recommended without contacting the manufacturer. Anytime service is accomplished on the elevator control system, a friction check must be made to insure that system friction is within limits. (Refer to Paragraph 4-84.)

It may be necessary to cut access holes to make skin repairs in some areas of the airplane. (See Figure 4-14 for typical access holes.)

In pressurized area, all skins, formers, stringers, etc., are considered structural members and should be treated as such. All repair material must be free of any defects such as nicks, scratches, etc., which can cause stress risers. Do not countersink deeper than 75% of the material thickness or dimple a structural member by driving the rivet head into the part.

Scratches in acrylic plastic windows may be removed by buffing, providing not more than .031 of an inch of material is removed. No crazing or cracks are permitted in the pressure windows.



NUMBER	MATERIAL	THICKNESS
1	FIBERGLASS	
2	2024-T3	.020
3	2024-T3	.025
4	2024-0 *	.025
5	2024-T3	.032
6	2024-0 *	.032
7	2024-T3	.040
8	2024-0 *	.040
9	2024-T3	.051
10	2024-T3	.064
11	321 ST STL	.015

NOTE: LEFT WING SHOWN, RIGHT OPPOSITE AND NOTED
MATERIAL OUTLINED IN DOTS USED ON RIGHT WING ONLY
CIRCLED MATERIAL NUMBERS INDICATE LEFT WING ONLY
* HEAT TREAT TO 2024-T4 AFTER FORMING

Figure 4-13. Skin Thickness

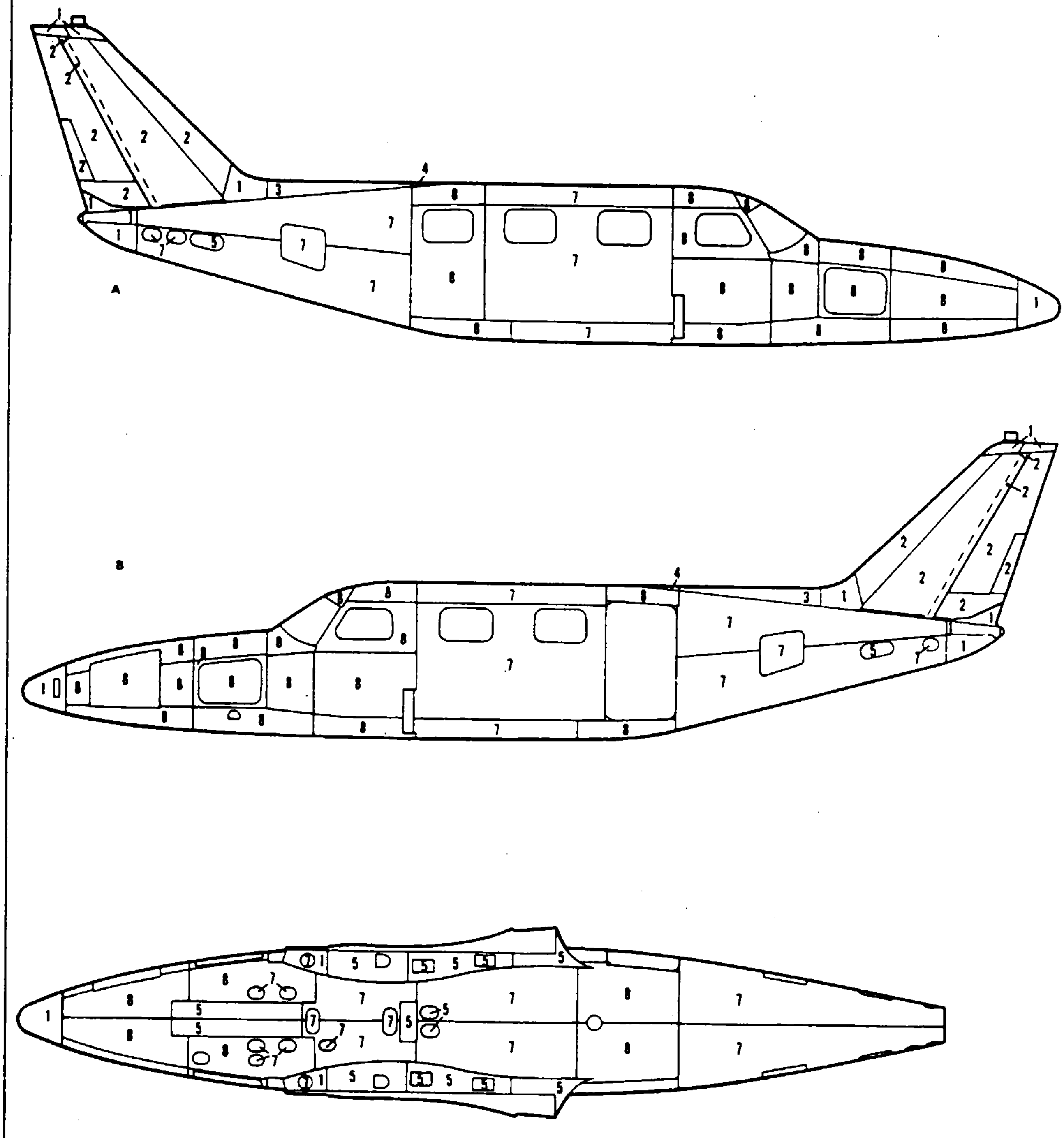


Figure 4-13. Skin Thickness (cont.)

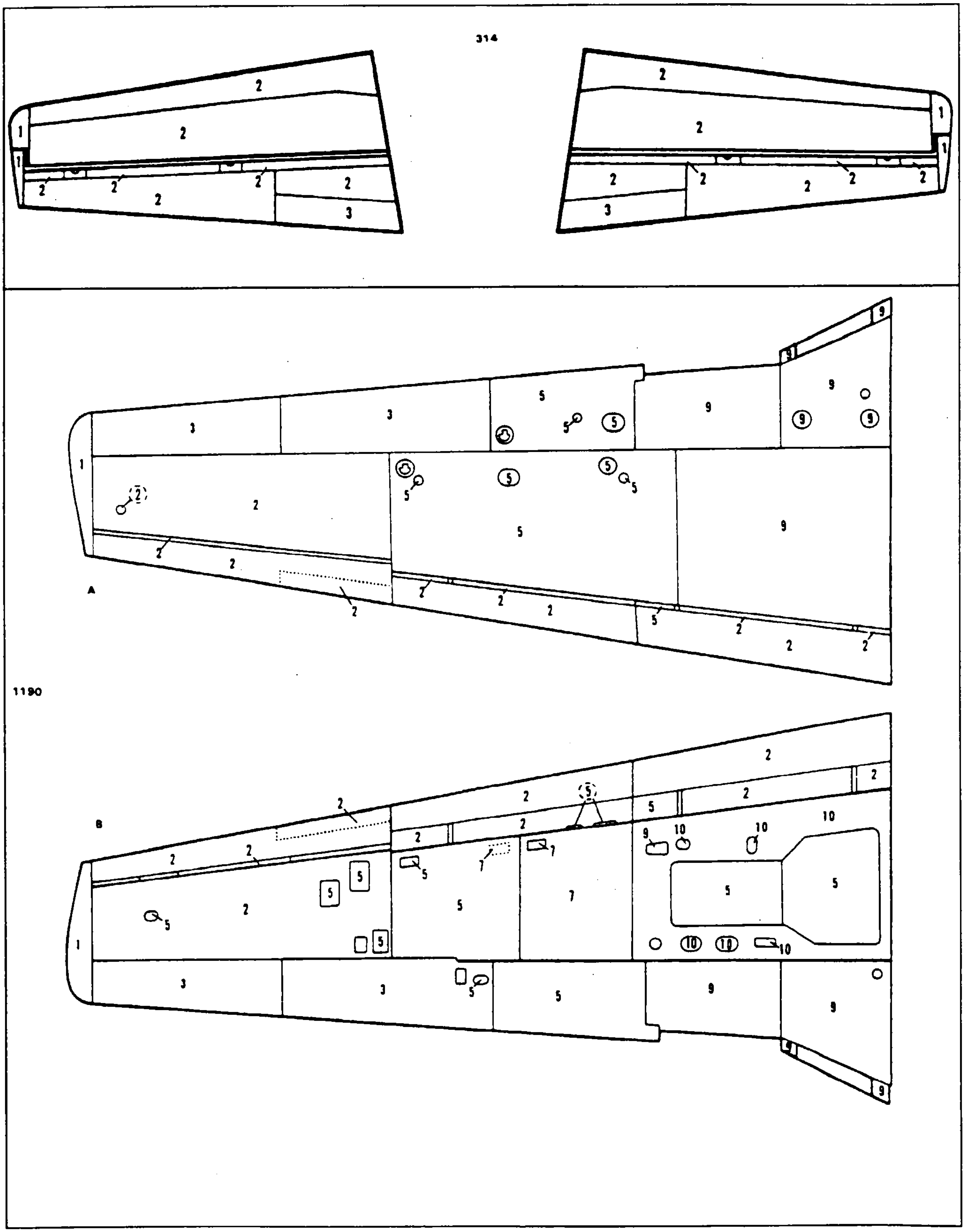


Figure 4-43. Skin Thickness (cont.)

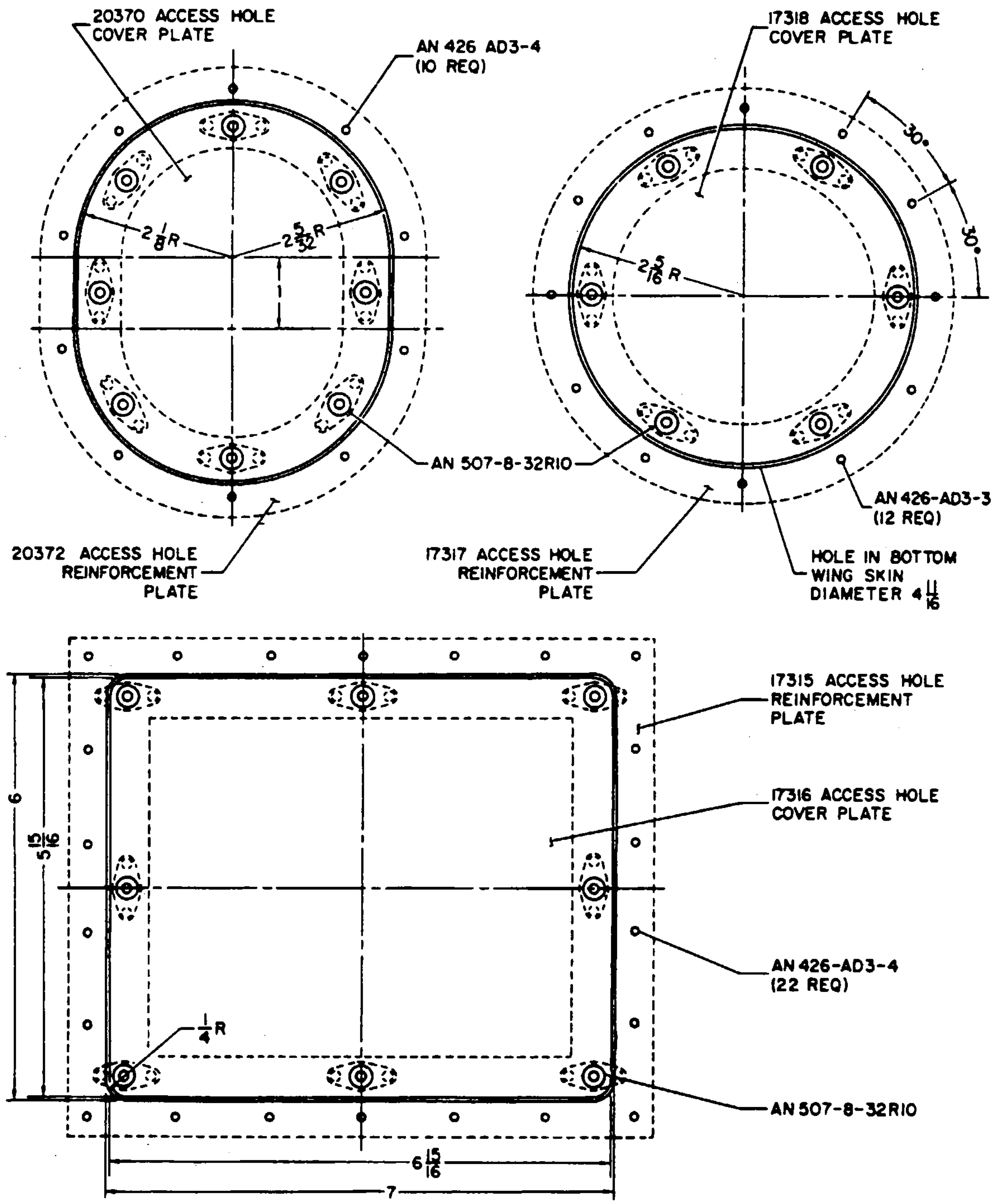


Figure 4-14. Typical Access Holes and Panels

4-86. FUSELAGE SEALING. (Refer to Figures 4-15 and 4-16.) Special sealing compounds have been used to seal sections of the PA-31P pressurized Navajo against leakage of pressurized air. This sealing is done during the course of construction. Any air leakage throughout the pressurized fuselage can normally be detected when carrying out the fuselage pressure check given in Section XIII.

4-87. LIST OF EQUIPMENT.

1. Mixers - Semco No. 285 Portable, or Semco No. 385 Automatic or equivalent. (See Note 1, Paragraph 4-88.)
2. Cartridges - SemKit No. 650 2-1/2 ounces and 6 ounces proportioned with MIL-S-7502 Class B sealants only. (See Note 1, Paragraph 4-88.)
3. Half pint kits of MIL-S-7502 Class A sealants only (5 fluid ounces). (See Note 1, Paragraph 4-88.)
4. Air powered sealant gun (Semco No. 250-6 with extra retainers for 2-1/2 ounce cartridges or equivalents). (See Note 1, Paragraph 4-88.)
5. Assorted nozzles for sealant gun. (See Note 1, Paragraph 4-88.)
6. Extensions for sealant gun. (See Note 1, Paragraph 4-88.)
7. Solvent dispensers (polyethylene squirt bottles).
8. Clean white cotton cloths.
9. Stiff bristle brush (not nylon).
10. Solvent containers with covers for cleaning nozzles, tools, etc.
11. Fillet fairing tools. (Refer to Figure 4-24.)

4-88. LIST OF MATERIALS. Only the following materials should be used:

1. Sealants - MIL-S-7502 - Classes A-1/2, A-2, B-2, B-4, B-6 and B-8. (See Note 1.)
2. Sealant material - 3M - E.C. 612. (See Note 2.)
3. Sealant material - G.E.-SS-4004 Primer. (See Note 3.)
4. Sealant material - G.E. RTV 88 with RTV 9811 catalysts. (See Note 3.)
5. Aluminum Wool- Fine.
6. Release Agent- Polyvinyl Alcohol (P.V.A.).
7. Cleaning Solvents - Methylethylketone (MEK) or Aliphatic Naptha.

The equipment and materials listed in Paragraphs 4-87 and 4-88 are commercially available from the vendors as shown in the following Notes:

Note 1: H. S. Bancroft Corporation
Rockhill Road
Cherry Hill, New Jersey 08034

Note 2: 3M Company
Industrial Specialities Division
3M Center
St. Paul, Minnesota 55101

Note 3: General Electric
Silicone Products Department
Waterford, New Jersey 12188

4-89. SURFACE PREPARATION. All parts which must be sealed should be thoroughly cleaned. Methylethylketone (MEK) or Aliphatic Naptha are recommended cleaning agents.

NOTE

Aliphatic Naptha is preferable since it will not damage painted surfaces or acrylic plastic (Plexiglas) windows.

a. All parts, sub-assemblies, and assemblies to be sealed shall be alodined and primed with zinc-chromate, except pressurized air duct work, air boxes, etc., which shall be alodined only.
b. Remove all filings, chips, loose dirt, and other foreign objects on the surfaces to be sealed by forced air or vacuum cleaning and brush.
c. Clean all surfaces or voids to be sealed, to remove all fingerprints, oil, or grease. To clean, wipe the affected areas with naptha, using a clean cotton cloth. The cleaned surfaces should be wiped dry immediately and not allowed to air dry.

CAUTION

When using these cleaning solvents in a closed area, forced ventilation must be used to protect personnel from toxic fumes.

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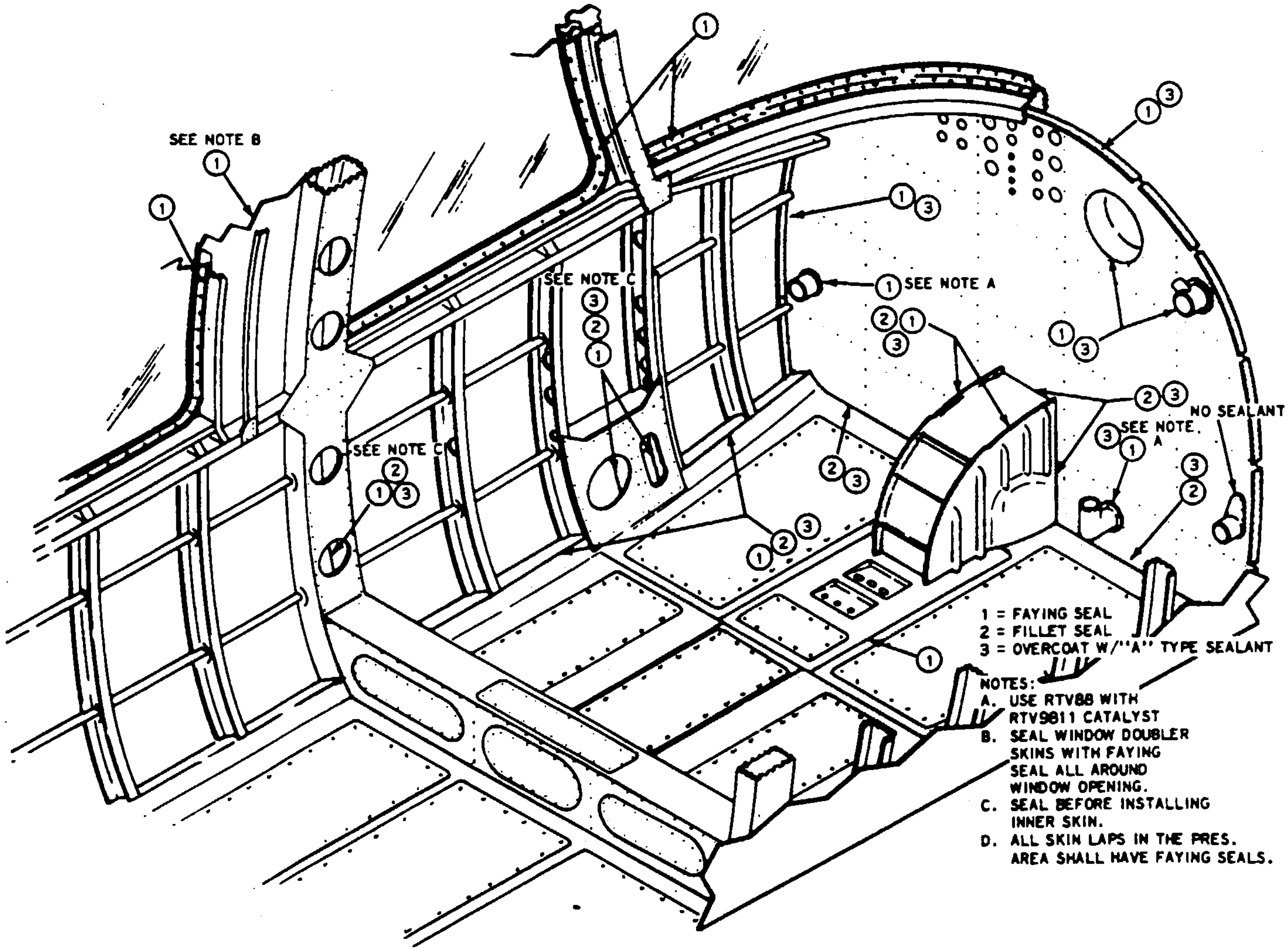


Figure 4-15. Fuselage Sealing Forward

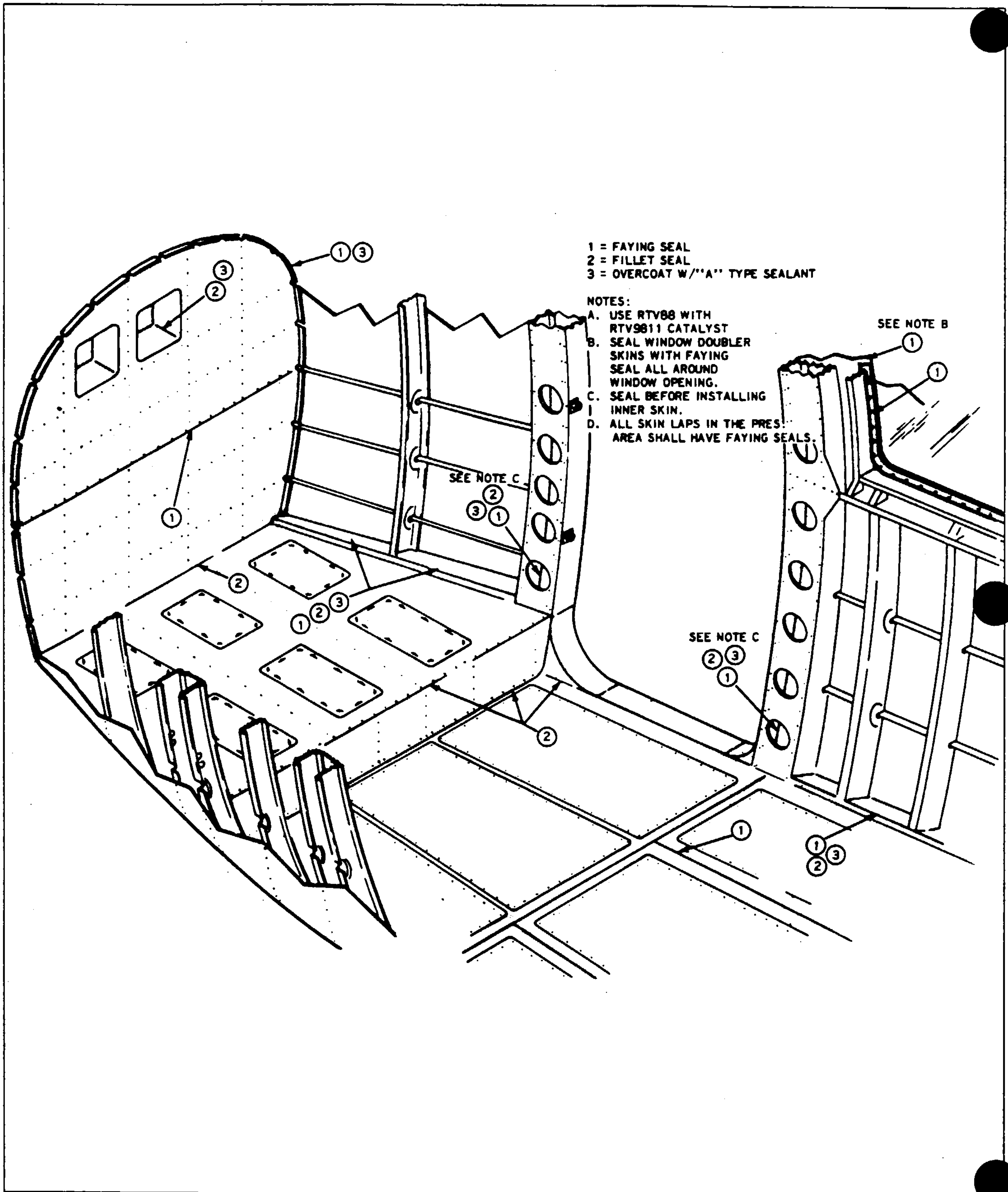


Figure 4-16. Fuselage Sealing Aft

d. It is essential that clean cloths be used for cleaning. When a cloth becomes soiled, it should be discarded. To avoid contamination of the cleaning solvent, it should be poured on the cloth. Repeat the cleaning procedures above until it is certain no contaminants are left on the surfaces to be sealed.

NOTES

The importance of proper cleaning prior or applying sealant cannot be over emphasized. Sealant will not adhere properly to a dirty, oily surface. The entire purpose of the sealant is defeated if it lifts from the structure after it has been applied.

4-90. MATERIAL PREPARATION. The instructions of the sealant manufacturer should be followed exactly with regard to both the mixing and storage of the sealants.

Mix only enough sealant to accomplish the work at hand. The application life of the various sealants is noted by the dash number after the class designation of A or B. (For example - MIL-S-7502 Class A-1/2 is a 1/2 hour sealant and B-1 is a one hour sealant.) The application life noted by the dash number is based on a 75 degrees Fahrenheit and 50 percent relative humidity. For every 10 degrees temperature rise, the application life is reduced by half, and for every 10 degrees drop in temperature the application life is doubled. Increased humidity decreases application life and decreased humidity increases application life.

NOTE

Use care when mixing sealant to avoid incorporating air into the sealant.

4-91. APPLICATION OF SEALANTS. The following sequence of sealing should be observed:

a. Seal faying surfaces of assemblies and sub-assemblies prior to assembly which are not accessible later.
b. Seal joggles, holes, cutout, and any other gaps.
c. Seal remaining seams and joints.
d. Seal bolts, screws, nuts and other fasteners.
e. Seal electrical harness.
f. Seal formed in place gaskets.

NOTE

All sealing is done on the pressure side of the seal plane. This assures that the pressure will help hold the seal in place.

4-92. SEALING FAYING SURFACES. (Refer to Figure 4-17.) Typical parts requiring sealing prior to assembly are bulkhead assemblies that extend above and below the seal plane between bulkhead stations 81 and 274 inclusive, floorboard or floorboard support channels, and angles and skin joints behind box bulkheads, etc. A Class B sealant should be used. Apply a liberal amount of sealant to each mating surface of the applicable parts. Assemble and secure the components together before the sealant dries.

NOTE

Sufficient sealant should be applied to insure a continuous extrusion on both sides of the joint after assembly of the faying surfaces. Refer to Figure 4-17.

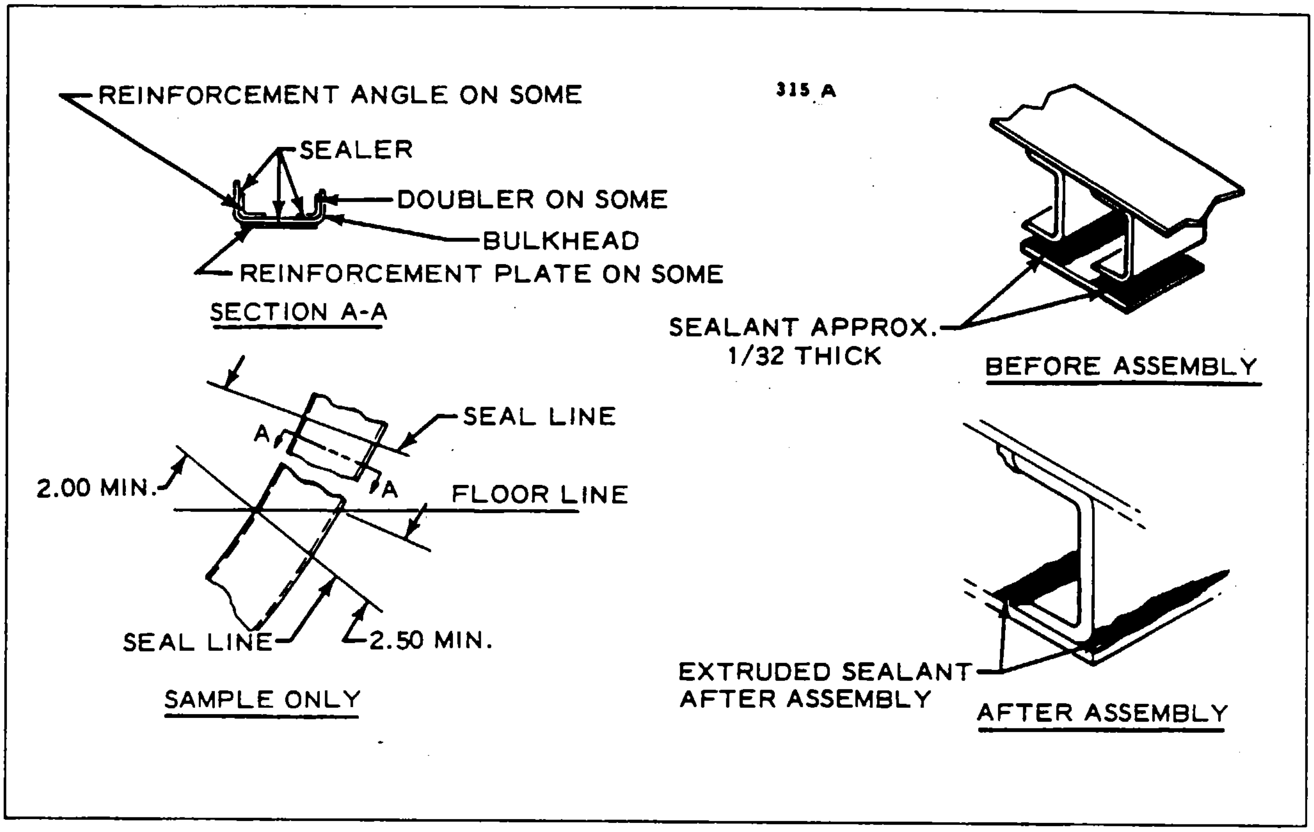


Figure 4-17. Faying Surface Seal

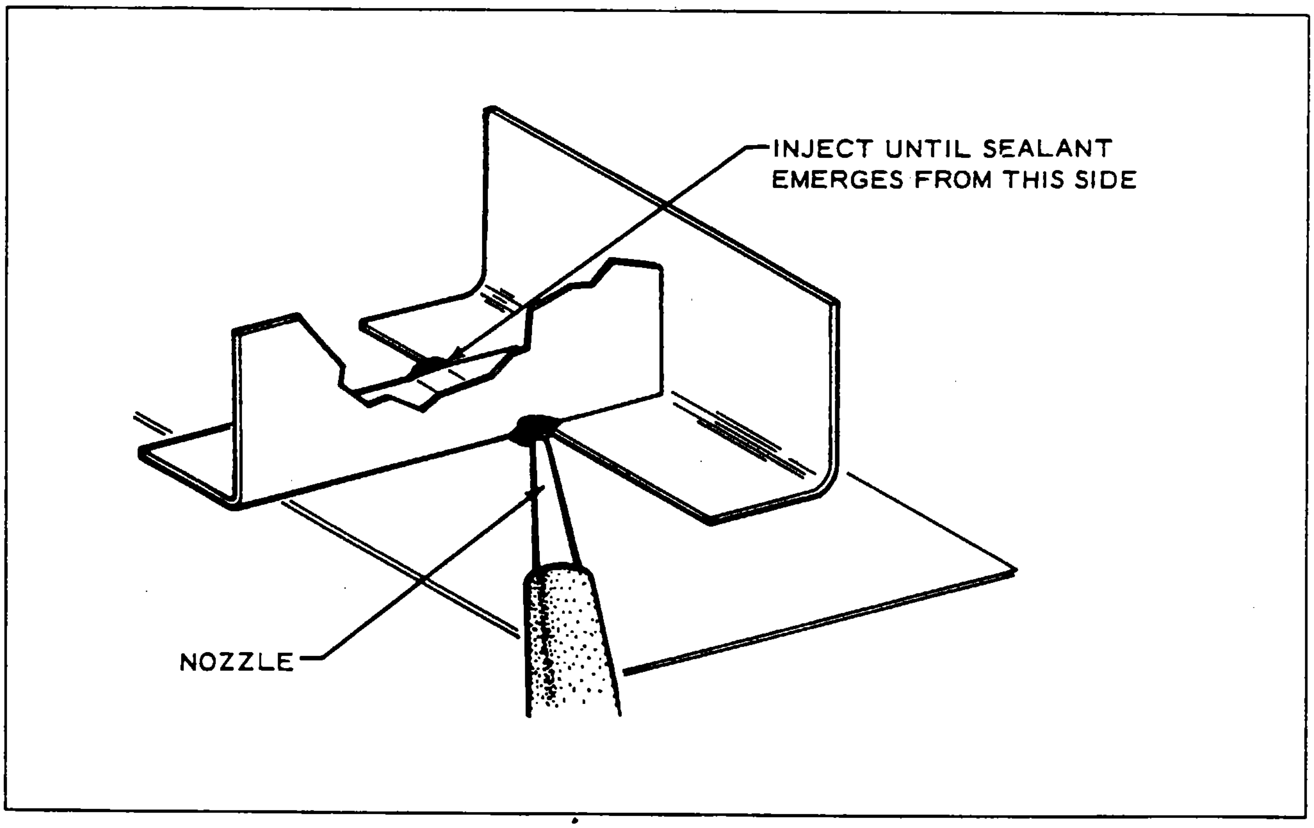


Figure 4-18. Joggle Seal

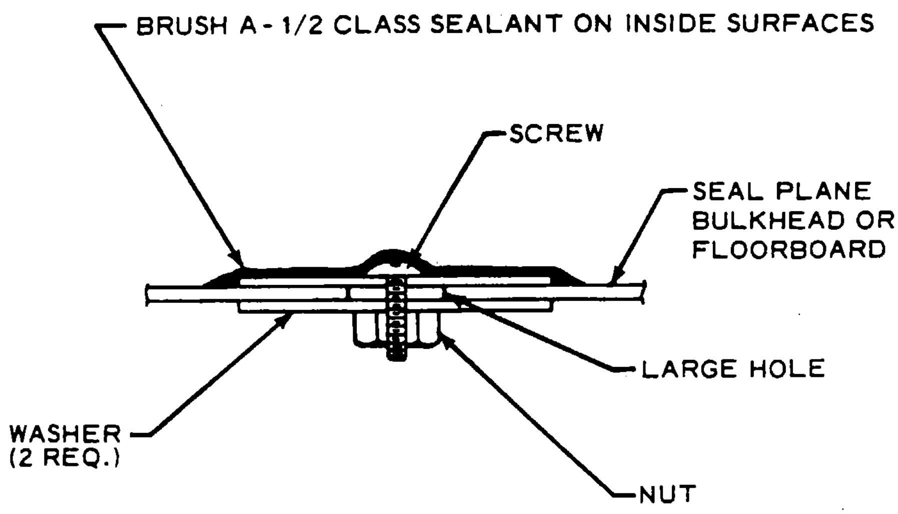


Figure 4-19. Holes and Voids Seals

4-93. SEALING JOGGLES. (Refer to Figure 4-18.) Joggles should be sealed by completely filling them with a Class B sealant. The sealant should be applied by the use of a pressure applicator, forcing the sealant under the joggle from either side until it begins to extrude on the opposite side of the joggle.

4-94. SEALING HOLES AND VOIDS. (Refer to Figure 4-19.) Voids are defined as gaps between airframe members which present a direct opening through the pressure vessel structure. Such gaps occur at stringer cutouts in the pressure bulkheads, forming reliefs and flanges. Holes and voids which are less than .125 wide should be filled with sealant and building up a bead with a minimum thickness of .062. If the gap is larger than .125 wide, it must have a mechanical closure such as a soft rivet or screw and washer, or may be packed with 3M-EC-612 putty type sealant to from a base for the sealant.

4-95. HOLES AND VOIDS IN COLD AIR DUCT WORK. (Refer to Figure 4-19.) Sealing in this area is done to prevent air noises and eliminate undesirable, uncontrollable drafts. Apply sealant to any holes and voids less than .125 inch wide, and apply 3M # 471 plastic tape on inside or outside surface of any holes and voids larger than .125 inch.

4-96. SEALING SEAMS AND JOINTS. (Refer to Figure 4-20.) Fillet seals should be used along the edges of all structures riveted to the skin in the pressurized area, such as frames, stringers, doublers, laps, seams and joints. The sealant is applied with a pressure gun and care is taken to avoid getting any gaps or bridges along the seam joint. The final dimensions of a cross section of the bead must conform to those shown in Figure 4-20.

CAUTION

Be sure the pressure gun has enough sealant to make a complete seal at one injection without any break, as stopping and starting will cause air bubbles in seal and cause a poor seal job.

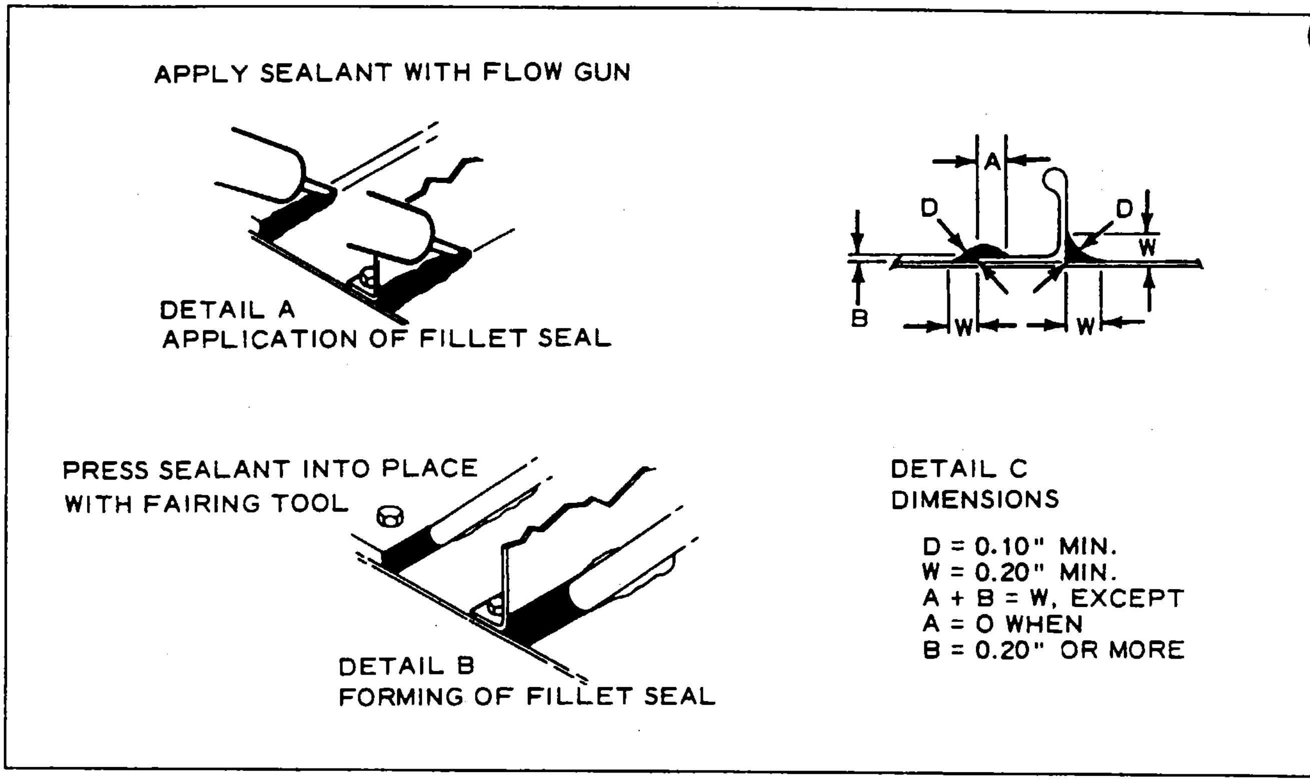


Figure 4-20. Fillet Seal

4-97. SEALING FASTENERS. (Refer to Figure 4-21.) Seal all fasteners installed through a seal plane by filleting around the fasteners after installation with a coat of B-2 class sealant.

NOTE

If a bolt or nut is being sealed, it should be torqued before sealants set. Tightening after sealant sets is not recommended.

4-98. SEALING -AN- STANDARD BULKHEAD FITTINGS. Seal AN fittings passing through the pressure plain of the bulkhead by cleaning around the seal area and applying sealant to the inside surface around the hole and installing the fitting before the sealant sets.

4-99. SEALING ELECTRICAL HARNESS. (Refer to Figure 4-22.) These steps are for the main fuselage and wing harness only. The wire harnesses are sealed at the point where they pass through the pressure bulkhead.

a. Clean the area of the bulkhead where the seal fittings will seal.
b. Pass the wire bundle through the hole provided in the bulkhead.
c. Place the seal fitting halves around the wire harness, on the pressure side of the bulkhead.
d. Fill the groove in the mounting flange of the fitting halves with sealant. (Refer to detail "A" of Figure 4-22.)

NOTE

Use enough sealant to assure that sealant extrudes around the mounting flange after they are secured to the bulkhead.

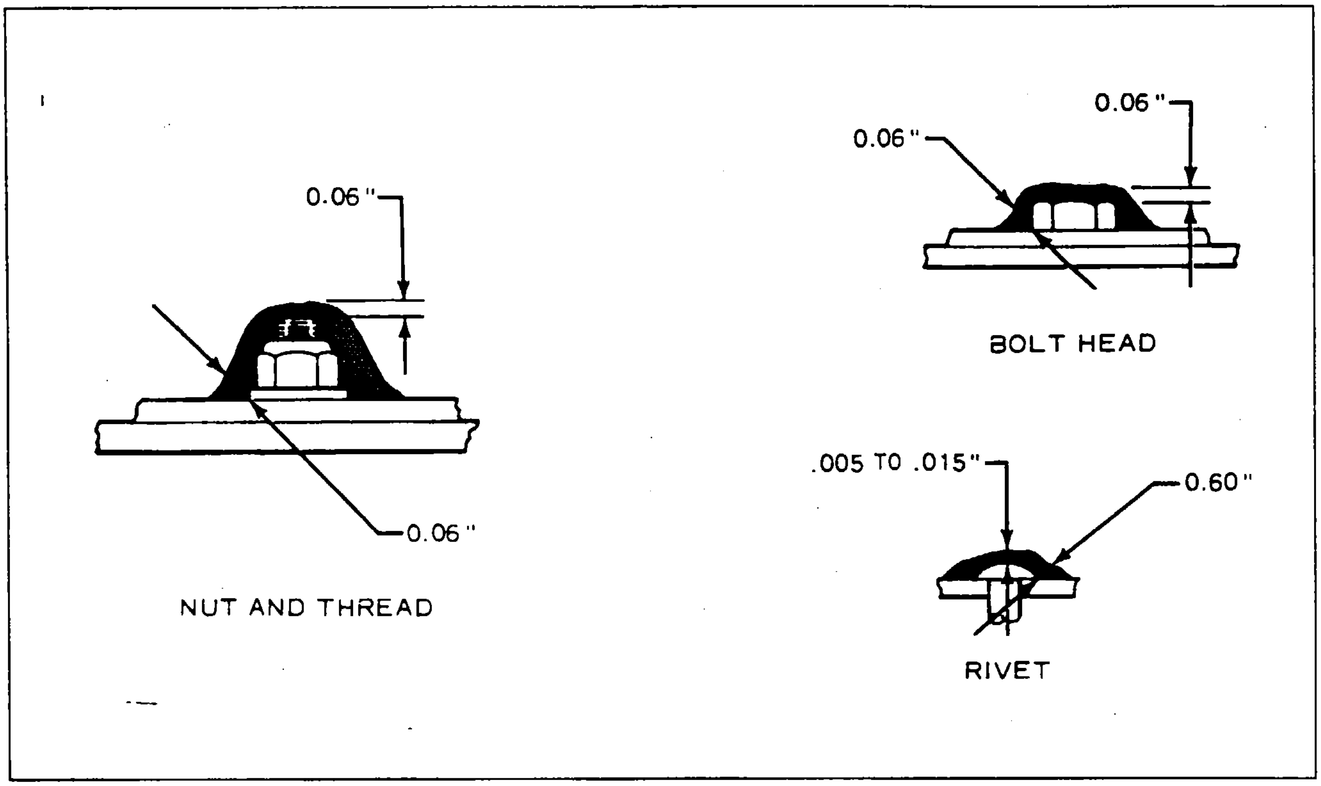


Figure 4-21. Bolts and Rivets Seals

e. Secure the fitting to the bulkhead with fasteners.
f. Fillet seal the extruded sealant around the sides of the mounting flange as shown in detail "B" of Figure 4-22.
g. Put the nozzle of the sealant gun in the center of the wire harness and work sealant throughout the wires inside the seal fitting as shown in detail "C" of Figure 4-22.
h. Place a strong piece of string against the seal assembly, parallel with the wires. (Refer to detail "D" of Figure 4-22.)
i. Wrap the fitting halves with three turns of 1.50 inch wide masking tape. (Refer to detail "D" of Figure 4-22.)
j. Crimp the wide masking tape around the seal assembly to center the wire harness.
k. Wrap the crimped end with three turns of .750 inch masking tape. (Refer to detail "D" of Figure 4-22.)
l. Puncture the masking tape over the most convenient injection hole in the seal fitting and inject sealant with pressure gun.
m. Apply sealant over seal fitting fasteners in accordance with paragraph 4-97.
n. Remove tape after sealant has cured (16 to 24 hours) by pulling the rip string and unwinding the tape.
o. All other electrical harnesses and wires use "O" ring type pressure seal bulkhead connectors per MIL-C-5015 or "Dura-Grom" type seals.

4-100. APPLICATION OF RELEASE AGENT. The edges and faying surfaces of removable or hinged panels shall receive at least two coats of release agent (Polyvinyl Alcohol P.V.A.) prior to the sealant application, applied approximately .50 inch wider than the mating flange. The panel should be allowed to air dry between coats. Only removable covers requiring a formed-in-place gasket shall receive an application of a release agent. Sealant must be applied to the prepared surface within two hours after the completion of surface preparation. Surfaces not sealed within this time must be prepared again.

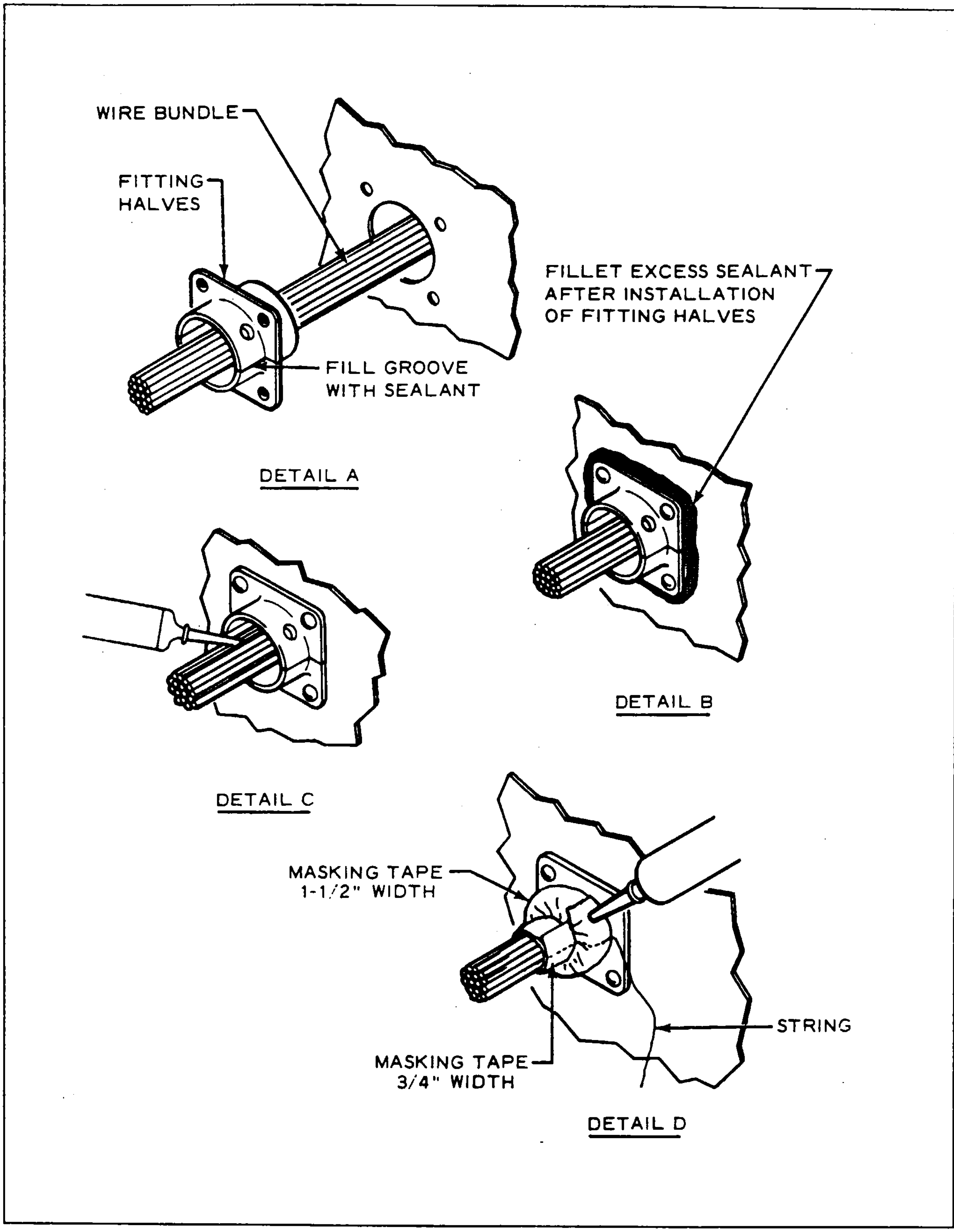


Figure 4-22. Wire Harness Seals

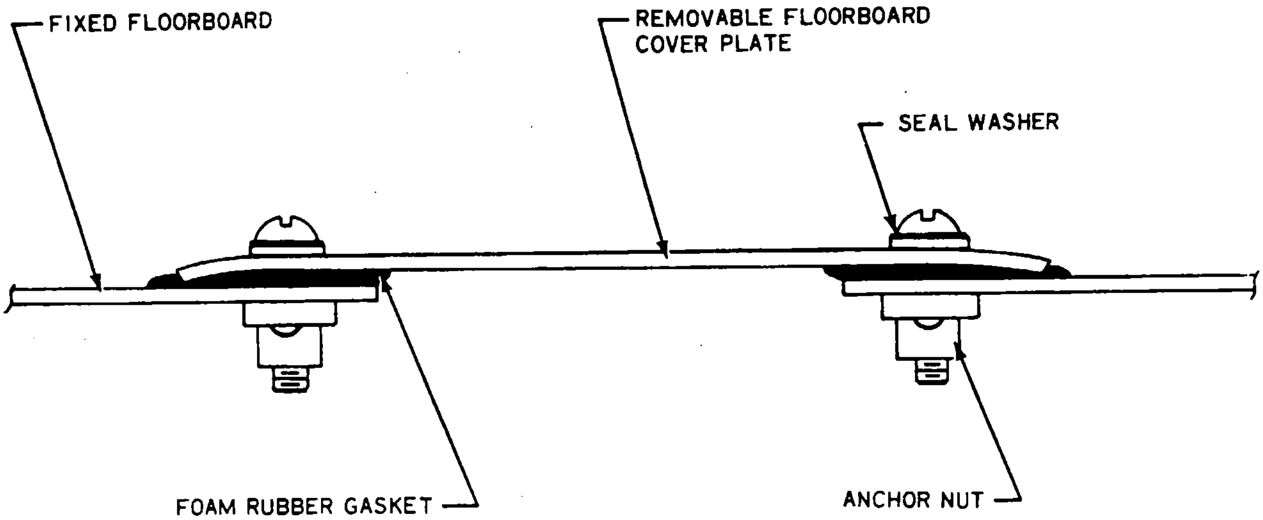


Figure 4-23. Floor Board Seals

CAUTION

Do not use polyvinyl alcohol as a release agent near acrylic (plexiglas) windows. It will craze acrylic plastics.

4-101. SEALING FORMED-IN-PLACE GASKETS.

NOTE

This type of seal is used on the lock handle cover of the Radome of the airplane.

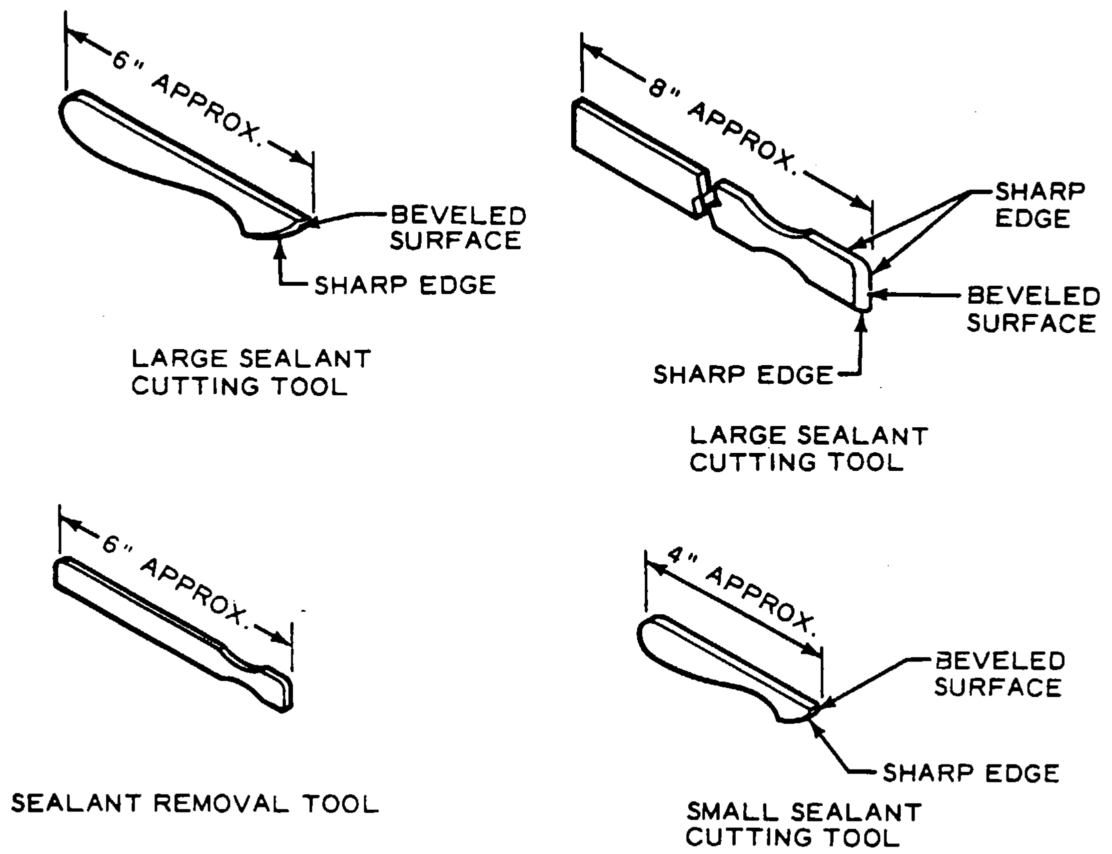
Unless otherwise specified, apply a heavy bead of class B-2 sealant to the mating surfaces not coated with a release agent and spread evenly until the coating is approximately .062 inch thick. While the sealant is still fluid, secure the access cover and smooth the excess sealant flush with the top of the cover. Allow to fully cure for 48 hours at 75° and 50%. After curing, trim the excess sealant from around the cover, then pry one corner of the panel open, using care not to damage the gasket, and progressively free the rest of the panel. Remove all release agent and excess sealant from the panel and mating surface.

NOTE

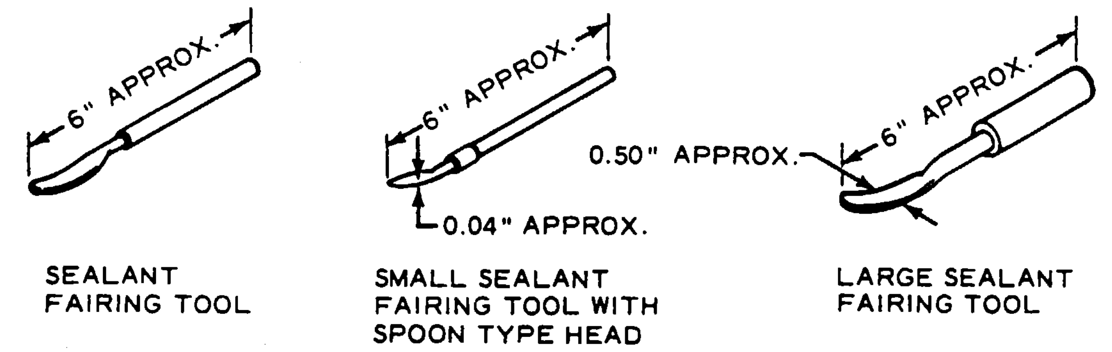
Release agents are removable with water.

NOTE

Do not pressure test the fuselage until the sealing compound has thoroughly cured.



NOTE: THE ABOVE TOOLS SHOULD BE MADE OF HARDWOOD TO REDUCE THE POSSIBILITY OF STRUCTURAL DAMAGE.



NOTE: THESE TOOLS MAY BE MADE OF 1/4 INCH DIAMETER BRONZE OR STEEL WELDING ROD AND MAY BE PLATED TO IMPROVE SMOOTHNESS.

Figure 4-24. Fabricated Tools

4-102. REMOVAL OF SEALANT. (Refer to Figure 4-24.) When it is necessary to remove fillets or beads of sealant because of rework or repair, scrape the sealant off with scrapers made of hardwood or plexiglas as shown in Figure 4-24. It is necessary to remove only the major portion of the fillets or beads. After rework, the area should be cleaned, resealed and tested for leaks.

4-103. EQUIPMENT CLEAN UP. This must be accomplished within three hours after exposure to room temperature using naptha, methylethylketone or toluol as a cleaning material.

4-104. FIBERGLASS REPAIRS. The repair procedure in this manual will describe the methods for the repair of fiberglass reinforced structures. Paragraph 4-105 describes Touch-up and Surface Repairs such as blisters, open seams, delaminations, cavities, small holes and minor damages that have not harmed the fiberglass cloth material. Paragraph 4-106 describes Fracture and Patch Repairs such as puncture, breaks and holes that have penetrated through the structure and damaged the fiberglass cloth. A repair kit, part number 756 729, that will furnish the necessary material for such repairs is available through Piper Aircraft Distributors.

NOTE

Very carefully follow resin and catalyst mixing instructions furnished with repair kit.

4-105. FIBERGLASS TOUCH-UP AND SURFACE REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, Methylethylketone or equivalent and remove paint to gel coat.
b. The damaged area may be scraped with a fine blade knife or a power drill with a burr attachment to roughen the bottom and sides of the damaged area. Feather the edge surrounding the scratch or cavity. Do not undercut the edge. (If the scratch or cavity is shallow and penetrates only the surface coat, continue to step h.)
c. Pour a small amount of resin into a jar lid or on a piece of cardboard, just enough to fill the area being worked on. Mix an equal amount of milled fiberglass with the resin using a putty knife or stick. Add catalyst, according to kit instruction, to the resin and mix thoroughly. A hypodermic needle may be used to inject gel into small cavities not requiring fiberglass millings mixed with the gel.
d. Work the mixture of resin, fibers and catalyst into the damaged area, using the sharp point of a putty knife or stick to press it into the bottom of the hole and to puncture any air bubbles which may be present. Fill the scratch or hole above the surrounding undamaged area about 0.06 inch.
e. Lay a piece of cellophane or waxed paper over the repair to cut off air and start the cure of gel mixture.
f. Allow the gel to cure 10 to 15 minutes until it feels rubbery to the touch. Remove the cellophane and trim flush with the surface, using a sharp razor blade or knife. Replace the cellophane and allow to cure completely for 30 minutes to an hour. The patch will shrink slightly below the structure surface as it cures. (If wax paper is used, ascertain wax is removed from surface.)
g. Rough up the bottom and edges of the hole with the electric burr attachment or rough sandpaper. Feather hole into surrounding gel coat, do not undercut.
h. Pour out a small amount of resin, add catalyst and mix thoroughly, using a cutting motion rather than stirring. Use no fibers.
i. Using the tip of a putty knife or finger tips, fill the hole to about 0.06 inch above the surrounding surface with the gel coat mixture.
j. Lay a piece of cellophane over the patch to start the curing process. Repeat step f, trimming patch when partially cured.

k. After trimming the patch, immediately place another small amount of gel coat on one edge of the patch and cover with cellophane. Then, using a squeegee or the back of a razor blade, squeegee level with area surrounding the patch; leave the cellophane on patch for one to two hours or overnight, for complete cure.
l. After repair has cured for 24 hours, sand patch area using a sanding block with fine wet sandpaper. Finish by priming, again sanding and applying color coat.

4-106. FIBERGLASS FRACTURE AND PATCH REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, methylethylketone or equivalent.
b. Using a key hole saw, electric saber saw, or sharp knife cut away ragged edges. Cut back to sound material.
c. Remove paint three inches back from around damaged area.
d. Working inside the structure, bevel the edges to approximately a 30 degree angle and rough-sand the hole and the area around it using 80 grit dry paper. Feather back for about two inches all around the hole. This roughens the surface for strong bond with patch.
e. Cover a piece of cardboard or metal with cellophane. Tape it to the outside of the structure, covering the hole completely. The cellophane should face toward the inside of the structure. If the repair is on a sharp contour or shaped area, a sheet of aluminum formed to a similar contour may be placed over the area. The aluminum should also be covered with cellophane.
f. Prepare a patch of fiberglass mat and cloth to cover an area two inches larger than the hole.
g. Mix a small amount of resin and catalyst, enough to be used for one step at a time, according to kit instructions.
h. Thoroughly wet mat and cloth with catalyzed resin. Daub resin on mat first, and then on cloth. Mat should be applied against structures surface with cloth on top. Both pieces may be wet out on cellophane and applied as a sandwich. Enough fiberglass cloth and mat reinforcements should be used to at least replace the amount of reinforcements removed in order to maintain the original strength. If damage occurred as a stress crack, an extra layer or two of cloth may be used to strengthen area.
i. Lay patch over hole on inside of structure, cover with cellophane, and squeegee from center to edges to remove all air bubbles and assure adhesion around edge of hole. Air bubbles will show white in the patch and they should all be worked out to the edge. Remove excess resin before it gels on the part. Allow patch to cure completely.
j. Remove cardboard or aluminum sheet from outside of hole and rough-sand patch and edge of hole. Feather edge of hole about two inches into undamaged area.
k. Mask area around hole with tape and paper to protect surface. Cut a piece of fiberglass mat about one inch larger than the hole and one or more pieces of fiberglass cloth two inches larger than the hole. Brush catalyzed resin over hole, lay mat over hole and wet out with catalyzed resin. Use a daubing action with brush. Then apply additional layer or layers of fiberglass cloth to build up patch to surface of structure. Wet out each layer thoroughly with resin.
l. With a squeegee or broad knife, work out all air bubbles in the patch. Work from center to edge, pressing patch firmly against the structure. Allow patch to cure for 15 to 20 minutes.
m. As soon as the patch begins to set up, but while still rubbery, take a sharp knife and cut away extra cloth and mat. Cut on outside edge of feathering. Strip cut edges of structure. Do this before cure is complete, to save extra sanding. Allow patch to cure overnight.
n. Using dry 80 grit sandpaper on a power sander or sanding block, smooth patch and blend with surrounding surface. Should air pockets appear while sanding, puncture and fill with catalyzed resin. A hypodermic needle may be used to fill cavities. Let cure and resand.
o. Mix catalyst resin and work into patch with fingers. Smooth carefully and work into any crevices.

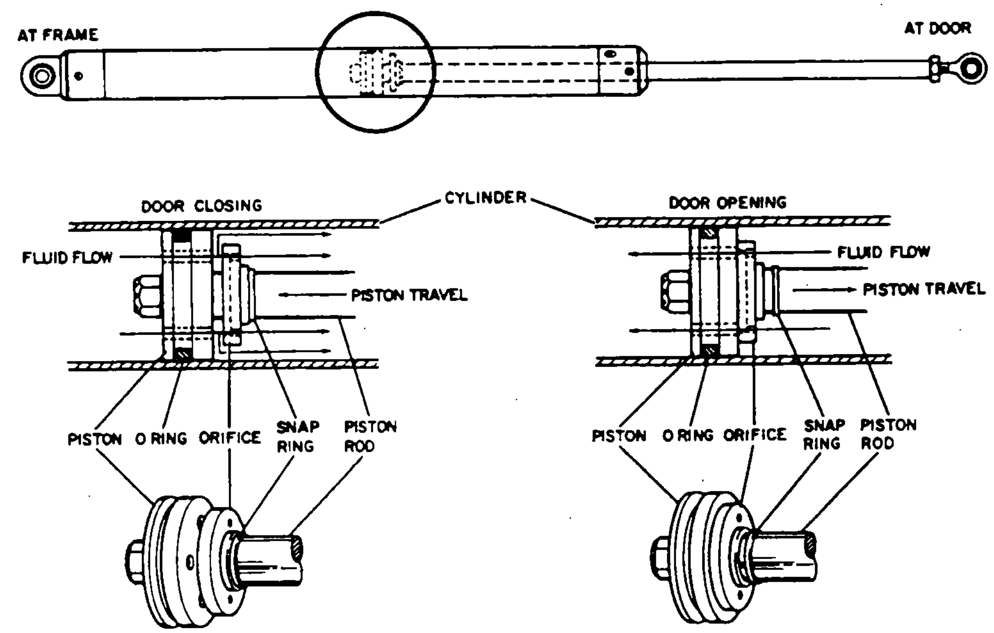


Figure 4-25. Door Snubber Assembly

p. Cover with cellophane and squeegee smooth. Allow to cure completely before removing cellophane. Let cure and resand.

q. Brush or spray a coat of catalyzed resin to seal patch. Sand patch, finish by priming, again sanding and applying color coat.

NOTE

Brush and hands may be cleaned in solvents such as acetone or methylethylketone. If solvents are not available, a strong solution of detergent and water may be used.

4-107. CABIN DOOR SNUBBER.

4-108. DESCRIPTION AND PRINCIPLES OF OPERATION OF DOOR SNUBBER. (Refer to Figure 4-25.) The snubber assembly is a hydraulic cylinder with an orifice type valve on the piston which allows hydraulic fluid to pass at a predetermined rate during the door opening sequence. When the door is being closed, the piston is forced into the cylinder and the orifice valve opens to allow a faster flow rate of hydraulic fluid.

4-109. FILLING SNUBBER ASSEMBLY. With the snubber piston collapsed into the cylinder, remove the plug on the cylinder and fill with MIL-H-5606 hydraulic fluid; insert the plug in the cylinder and extend the piston from the cylinder; work the piston in and out to help remove any trapped air within the cylinder. Collapse the piston into the cylinder and remove the plug; add more fluid as required; then reinsert the plug in the cylinder.

4-110. REMOVAL OF DOOR SNUBBER.

a. With the door extended, remove the screws which secure the boot over the lower end of the snubber.
b. Remove the bolt and locknut which secures the lower end of the snubber to the cabin door.
c. Remove the bolt which secures the snubber assembly to the bracket on the door frame.

4-111. INSTALLATION OF DOOR SNUBBER.

a. Install the snubber to the bracket on the door frame with AN24-16A bolt.
b. Install the lower end of the snubber into the bracket on the door and secure with bolt and nut.
c. Secure the boot over the snubber connection on the entrance door.

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SECTION V

SURFACE CONTROLS

SECTION V

SURFACE CONTROLS

5-1. INTRODUCTION. This section covers the removal, installation, and rigging and adjustment procedures for the various control surfaces of the airplane. The different control surfaces do not have to be removed in order of paragraphs in this section, since individual paragraphs describe the removal, installation, and rigging of each control surface or system. A troubleshooting chart is located at the end of this section.

5-2. DESCRIPTION. The primary flight controls are of the conventional type, operated by dual control wheels and rudder pedals. The rudder pedals also control the action of the brakes and nose wheel steering. For coordinated action of the rudder and ailerons, their control cables are interconnected through a cable-spring system.

Aileron, elevator, and rudder trim are operated by trim control wheels which in turn move cable wrapped drums located in the control pedestal and mating drums in the particular control surface. As the trim control wheels are rotated, they in turn rotate the mating drums at the control surfaces, to actuate the particular trim tab. A sender unit is installed at each trim tab and will transmit a signal to the indicator at the control pedestal indicating the position of the trim tab.

The wing flap system consists of a flap selector switch located on the instrument panel, a reversible electric motor (with braking provided) mounted under the cabin floor panel, a flap transmission in the trailing edge of each wing and interconnecting flexible shafts. Sender units located in the wings and attached to the flaps will transmit a signal to an indicator located on the instrument panel above the flap selector switch indicating the position of the flap.

For a visual description of the various control systems, refer to the illustrated figures throughout this section.

5-3. TROUBLESHOOTING. Troubles peculiar to the control system are listed in Table V-III at the back of this section, along with their probable causes and suggested remedies.

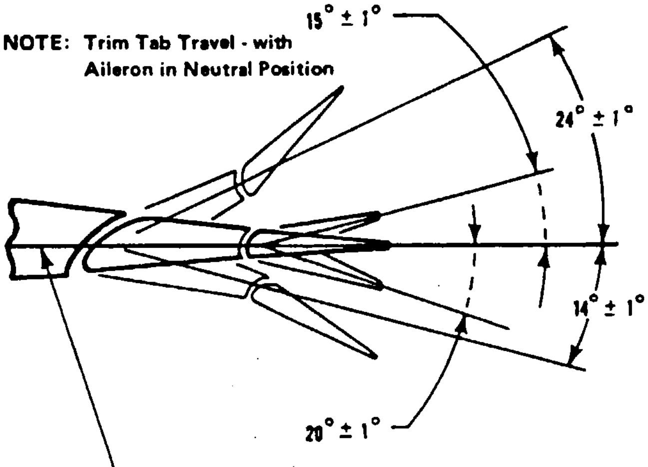
5-4. STANDARD SERVICE PROCEDURES. The following tips may be helpful in the removal, installation, and servicing of the various assemblies:

a. It is recommended, though not always necessary to level and place the airplane on jacks during rigging and adjustment of controls.
b. Remove turnbuckle barrels from cable ends before withdrawing the cables through the structures.
c. Tie a cord to the cable end before withdrawing it through the structure. This will facilitate reinstallation of the cable.
d. Turnbuckle stations are given at neutral position.
e. When referring to marking cable end, etc., before disconnecting, a felt marker may be used.
f. When turnbuckles have been set to correct cable tension, no more than three threads should be exposed from either end of the turnbuckle barrel.
g. Cable tension should be taken with the appropriate surface control in its neutral position.

TABLE V-I. CONTROL SURFACE TRAVEL AND CABLE TENSION

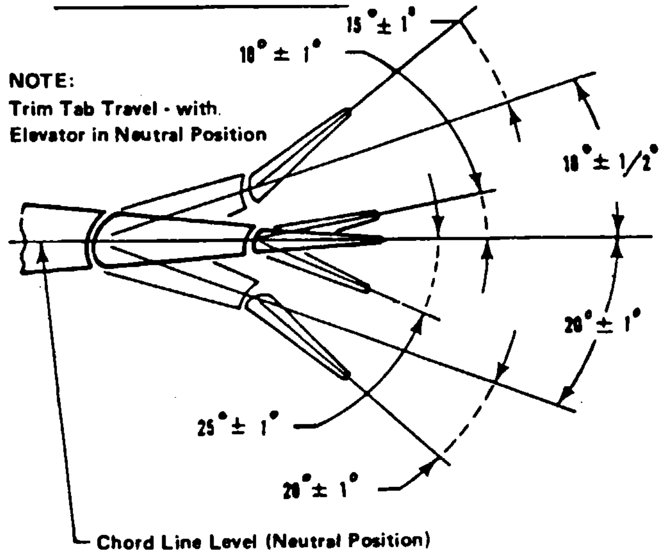
Aileron and Aileron Trim Tab

NOTE: Trim Tab Travel - with Aileron in Neutral Position



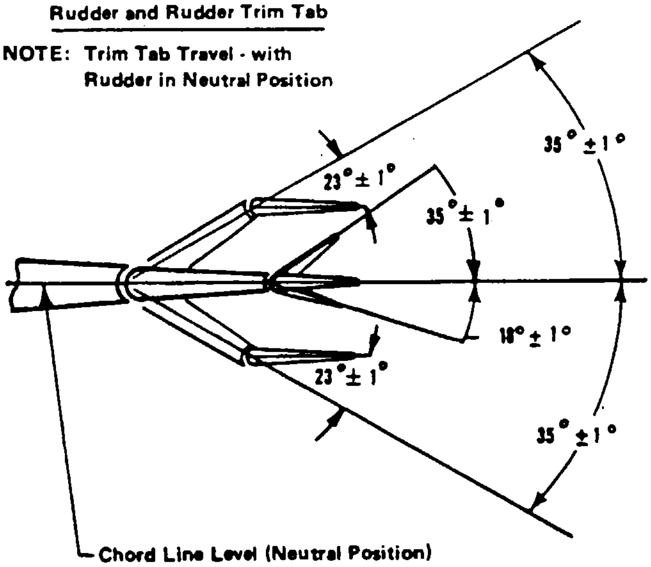
Elevator and Elevator Trim Tab

NOTE: Trim Tab Travel - with Elevator in Neutral Position

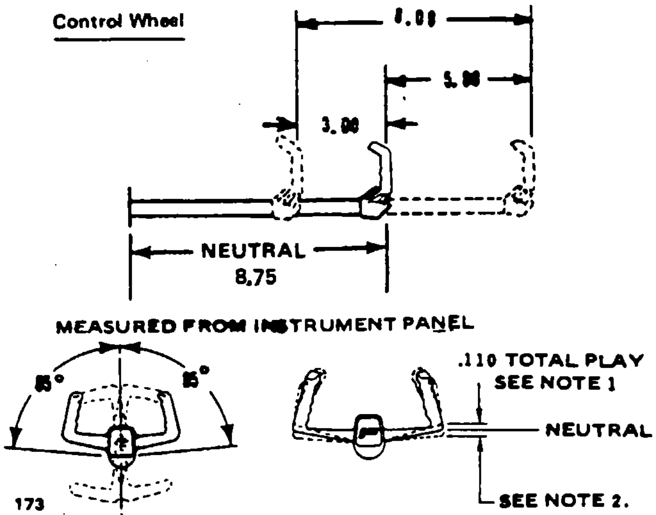


Rudder and Rudder Trim Tab

NOTE: Trim Tab Travel - with Rudder in Neutral Position



Control Wheel



NOTE:
1. The maximum Total Play with Sprocket and Interconnect Chain Locked.
2. Rollers .050 Universal .060

Flap	40° ± 1° down	**Rudder Pedal**	21° 15' each way, Neutral to Fwd 3.87 in. Neutral to Aft 3.63 in. — 7.50 Total

Cable Tensions

Aileron	35 lbs ± 2 lbs
Aileron Trim Tab	14 lbs ± 2 lbs
Elevator	20 lbs ± 2 lbs
Elevator Trim Tab	14 lbs ± 2 lbs
Rudder	25 lbs ± 2 lbs
Rudder Trim Tab	14 lbs ± 2 lbs

NOTE

CABLE TENSIONS GIVEN APPLY ONLY TO AIRPLANES WITHOUT AUTOPILOT BRIDLE CABLES ATTACHED. REFER TO APPROPRIATE AUTOPILOT SERVICE MANUAL FOR PROPER CABLE TENSIONS WHEN ATTACHING BRIDLE CABLES.

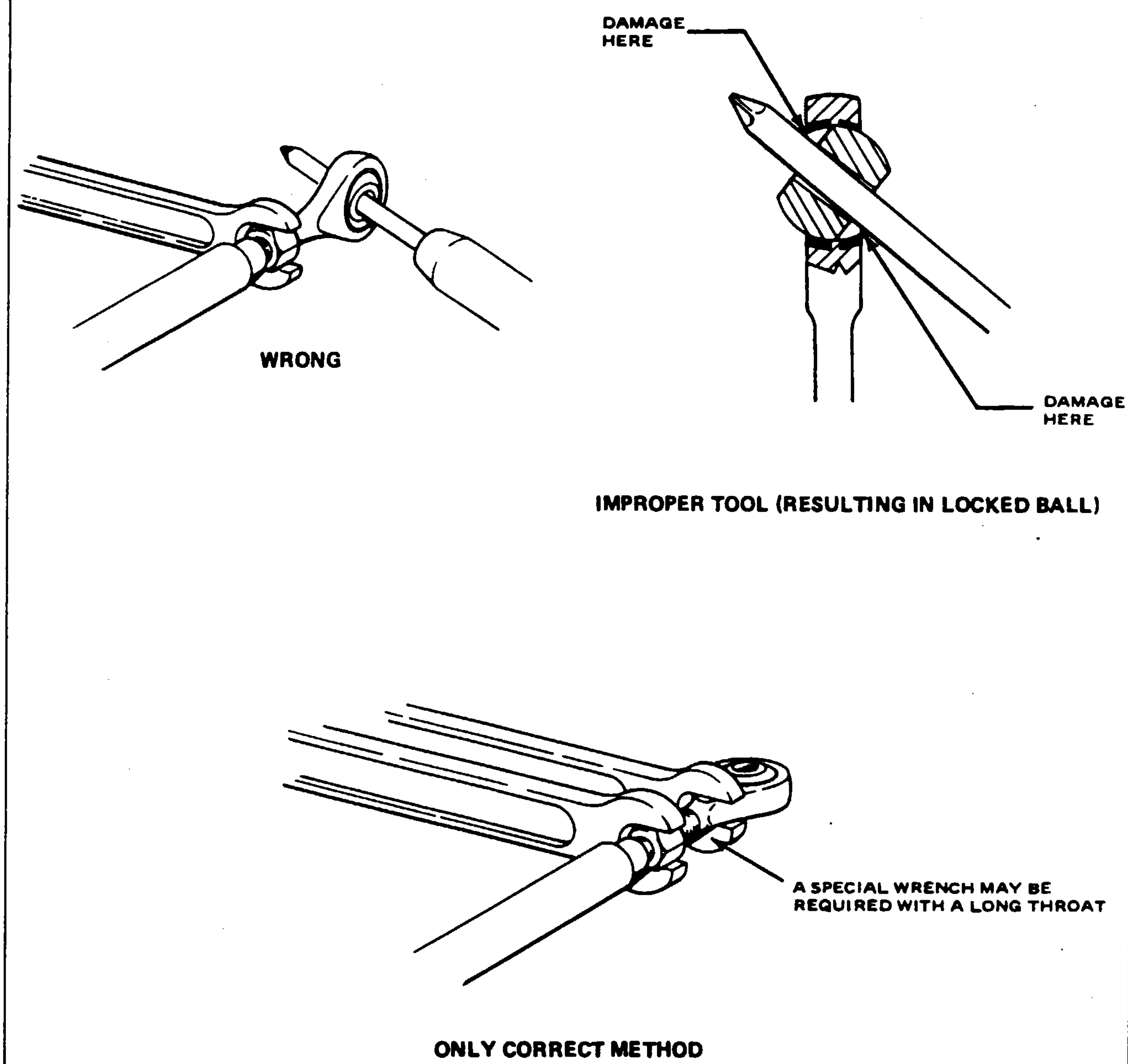


Figure 5-1. Correct Method of Installing Rod End Bearings

NOTE

Whenever the elevator control system of the airplane is serviced, a friction check of the system must be accomplished in accordance with instructions given in Section IV, Paragraph 4-83a, of this manual.

h. Ascertain that all cable guard pins are installed in their proper location, and are not interfering with control cable travel.
i. When installing rod end jam nuts refer to Figure 5-1 for proper installation method.

5-5. CONTROL COLUMN ASSEMBLY.

5-6. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1a.)

a. To remove either control wheel (43) with tube (27 or 44), proceed as follows:
   1. Mark the control tube (27 or 44), ring (26) and collar (21) in relation to their location around the roller fitting (23).
   2. Cut the wire (24) that safeties the cap bolts (25) that secure the control tube (27 or 44) and ring (26) to the roller fitting (23). Remove the cap bolts from the fitting.
   3. Slide the control tube from the roller fitting and ring and draw the tube from the instrument panel. Hold the square tube (31) assembly so that it will not fall.
b. The square tube (31) assembly may be removed and disassembled by the following procedure:
   1. Remove the cotter pins (33) and bolt assemblies (32) that join the links (30) with the control arm (11 and 13 or 16 and 18).
   2. Remove the bolt assembly (35) that joins the forward end of the square tube (31) with the flexible joint (36) of the sprocket assembly. Remove the square tube assembly from behind the instrument panel.
   3. The square tube assembly may be disassembled by first removing the collar (34) from the tube (31). Draw the tube from the roller fitting (23).
   4. Cut the wire (24) that safeties the cap bolts (59) that secure the collar (21) to the roller fitting (23). Remove the bearing housing (22) from the fitting.
   5. Disassemble the rollers (61) from the fitting. Note the number and location of the spacer washers (64).
c. The sprocket assembly may be removed from the bulkhead and disassembled by the following procedure:
   1. Disconnect one of the two turnbuckles (41) that connect the horizontal roller chains (40 and 42). Remove the outboard chain guard (72) from the inside of the sprocket housing (75). Unwrap the chain from the sprocket that is to be removed.
   2. If the left sprocket assembly (75) is to be removed, first remove the floor panel located between the control pedestal and left side of the fuselage. Loosen one of the aileron cable turnbuckles at fuselage station 100 to relieve tension from the vertical roller chain (52). Disconnect one end of the chain where it attaches to the control cable and unwrap the chain from the sprocket.
   3. Remove the cap bolts (39) that attach the sprocket housing to the bulkhead and remove the housing.
   4. To disassemble the sprocket assembly, remove the bolt that secures the sprocket to the sprocket stud (74). Use a Kaynar wrench (P/N W10-3) to remove the hex nut.
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      Fullerton, California
   5. Slide the sprocket stud from the sprocket housing (75).

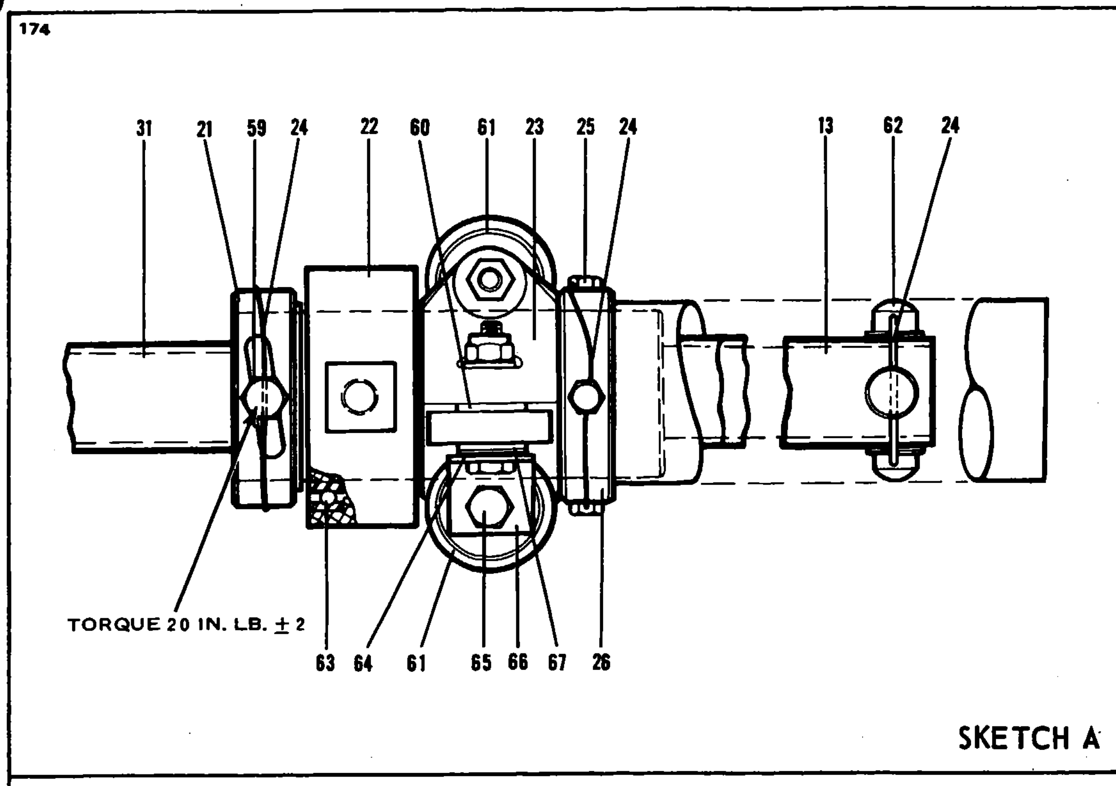
d. To remove the torque tube (14) assembly, use the following procedure:
   1. With the floor panel removed from between the control pedestal and the left fuselage side panel and the links (30) disconnected from between the control tube housing (22) and the torque tube arms (11,13,16 and 18), loosen one of the elevator control cable turnbuckles at fuselage station 110.50 enough to relieve cable tension.
   2. Remove the bolt and roll pins (12,17 and 79).
   3. Disconnect bolt and roll pins (10) and remove elevator control sector (8) by pushing extensions assembly in torque tube (14).
   4. Push the right extension tube inside torque tube (14) and remove the torque tube.
   5. The bearings may be removed if desired.

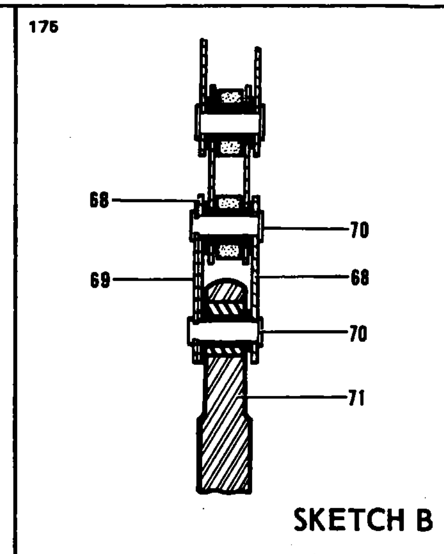
e. The control tube guide located on the right side of the instrument panel may be removed by removing the assembly cover (49) and the screws that secure the housing (47).

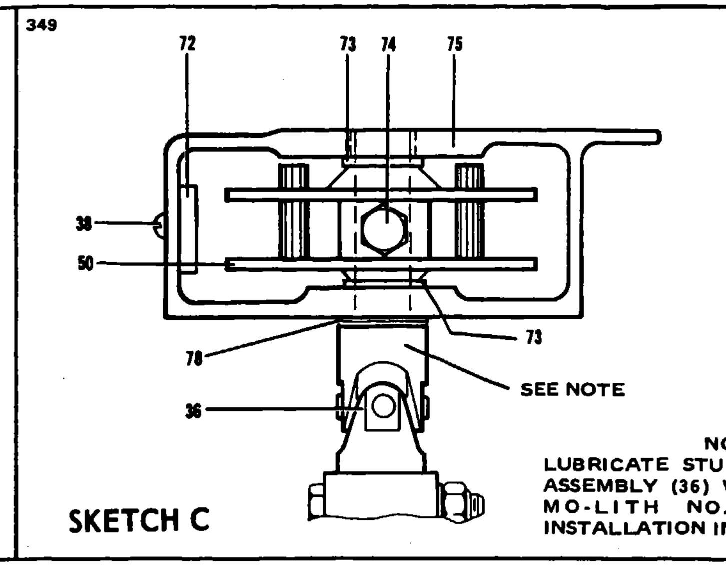
f. The control tube guide and lock assembly, located on the left side of the instrument panel may be removed by removing the assembly cover (49), and the four nuts (58) which hold the bushing (56) and collar (57) to the panel.

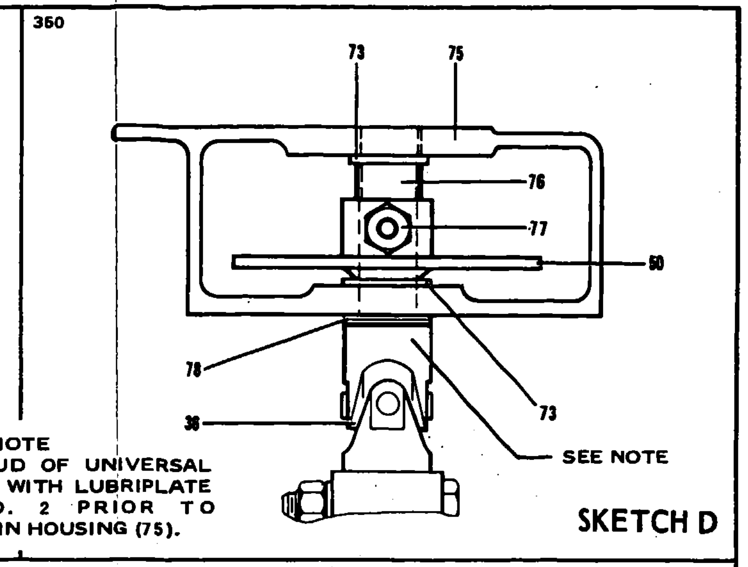
5-7. INSTALLATION OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 51.)

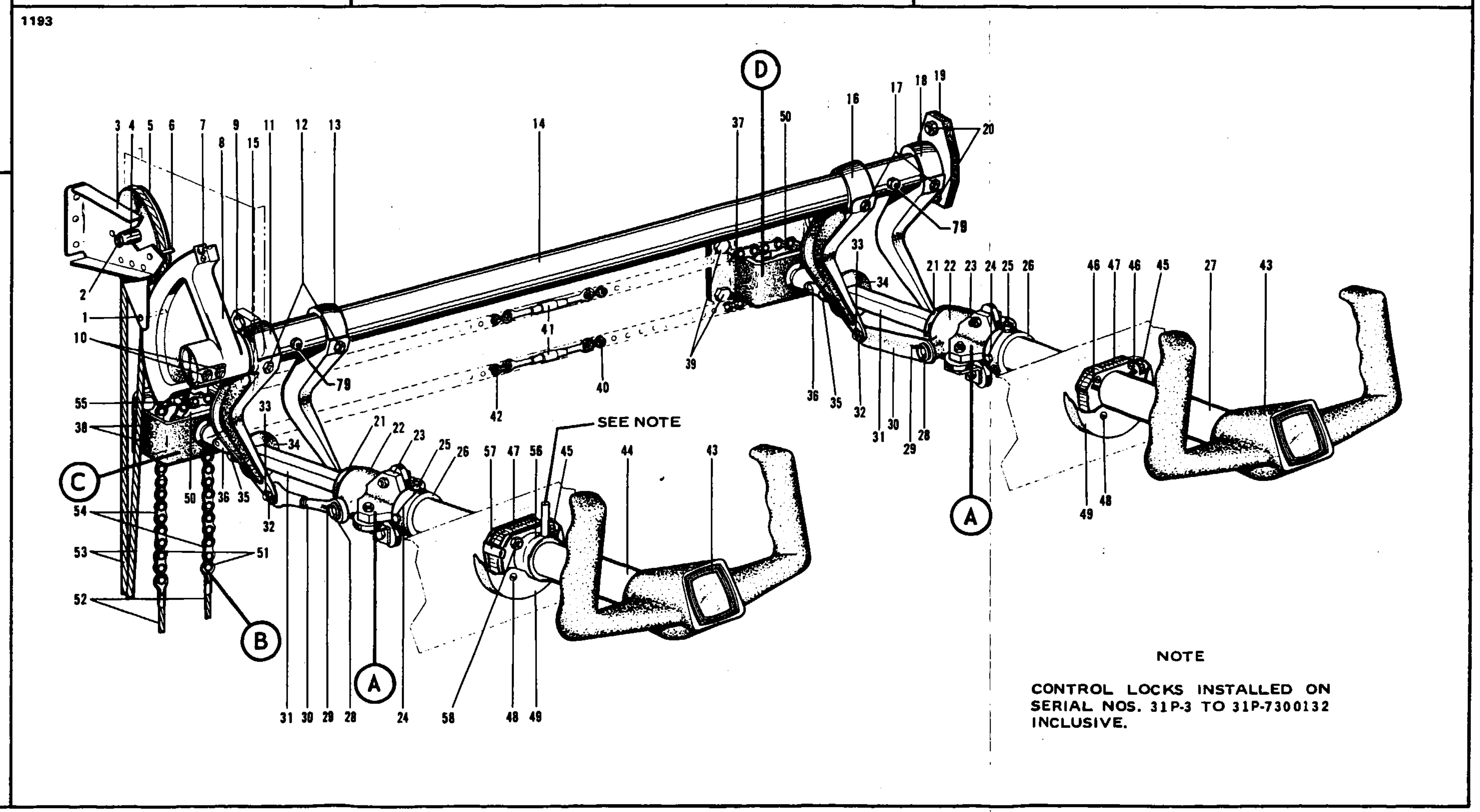
a. Installation of the control column torque assembly may be accomplished by the following procedure:
   1. Position but do not attach control arms (11,13,16 and 18) on uninstalled torque tube assembly (14).
   2. Lubricate bearings (15 and 19) and attach bearings to their mounting locations.
   3. Slide the tube extensions inside torque tube and install the torque tube. Pull the tube extensions through the bearings.
   4. Install the control sector (8), with the cables attached, on the end of extension tube. With the sector, tube extensions and arms in position, install roll pins and bolts (10, 12, 17 and 79). Tighten bolts to a standard torque.
   5. Reconnect elevator cable turnbuckle at station 110.50 and set cable tension per specifications given in Table V-I.











1. PIN, CABLE GUARD
2. BOLT ASSEMBLY
3. BRACKET, MOUNTING
4. BUSHING
5. PULLEY
6. PIN, CABLE GUARD
7. PLATE, CABLE ATTACH
8. SECTOR, CONTROL
9. BOLT ASSEMBLY
10. BOLT ASSY. AND ROLL PIN
11. ARM, CONTROL, L. O.
12. BOLT ASSY. AND ROLL PIN
13. ARM, CONTROL, L. I.
14. TUBE, TORQUE
15. BEARING, BLOCK
16. ARM, CONTROL, R. I.
17. BOLT ASSY. AND ROLL PIN
18. ARM, CONTROL, R. O.
19. BEARING, BLOCK
20. BOLT ASSEMBLY
21. COLLAR, CONTROL SHAFT
22. HOUSING, BEARING
23. FITTING, ROLLER
24. SAFETY WIRE
25. CAP BOLT
26. RING, CONTROL TUBE
27. CONTROL TUBE, RIGHT
28. BOLT
29. SAFETY WIRE
30. LINK ASSEMBLY
31. SQUARE TUBE
32. BOLT ASSEMBLY
33. COTTER PIN
34. COLLAR, STOP
35. BOLT ASSEMBLY
36. UNIVERSAL ASSEMBLY
37. HOUSING, SPROCKET
38. SCREW
39. CAP BOLT
40. CHAIN RIGHT
41. TURNBUCKLE
42. CHAIN LEFT
43. CONTROL WHEEL
44. CONTROL TUBE, LEFT
45. SCREW, ADJUSTMENT
46. BLOCK
47. HOUSING, GUIDE ASSY.
48. SCREW
49. COVER
50. SPROCKET
51. LINK ASSEMBLY
52. CONTROL CABLE, AILERON
53. CONTROL CABLE, AILERON
54. CHAIN, AILERON
55. PLATE, CABLE ATTACH
56. BUSHING
57. COLLAR
58. NUT
59. CAP BOLT
60. WASHER
61. ROLLER
62. BLOCK
63. BEARING
64. WASHER, SPACER
65. BOLT ASSY.
66. ANGLE
67. BUSHING, ECCENTRIC
68. PLATE, LINK
69. LOCK, CHAIN
70. PIN LINK
71. CABLE END
72. GUARD, CHAIN
73. BUSHING
74. BOLT ASSEMBLY
75. HOUSING, SPROCKET
76. BUSHING
77. NUT, KAYNAR
78. WASHERS
79. BOLT ASSY. AND ROLL PIN

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Figure 5-1a. Control Column Installation

b. The aileron chain sprocket assembly may be assembled and installed by the following procedure:
   1. Position the sprocket (50) in the housing (75), spacer bushing (76) (right only) and slide the stud of the universal assembly (36) in place.

NOTE

Lubricate stud of universal assembly (36) with Lubriplate MoLITH No. 2 prior to installation in housing (75).

Insert bolt (74) through the sprocket and stud. Install nut (77) and tighten to a standard torque. Use Kaynar wrench, P/N W-10-3.

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Fullerton, California

NOTE

The left sprocket must be placed in its housing to allow the sprocket to rotate 180° from stop to stop.

   2. Attach the sprocket assembly to the bulkhead and torque.
   3. Position the horizontal roller chain (40 and 42) around the right and left sprocket and temporarily connect turnbuckles. Check chain tension and correct position after both control wheels are installed.
   4. Install chain guard (72) inside sprocket housing (75).
   5. If the left sprocket assembly was removed, wrap the vertical chain around the sprocket and connect the chain to the control cable end. Ascertain that when the sprocket is centered between stops the roller chain is centered. Set elevator cable tension and safety turnbuckle.

c. The square tube (31) assembly may be assembled and installed by the following procedure:
   1. Slide the square tube (31) in the roller housing (23).
   2. Install the rollers (61) and washers (60) on the roller housing and adjust with the use of the eccentric bushings in each roller to allow .003 of an inch between the square tube and rollers. Finish by installing angles (66) shimmed with spacer washers (64) as required, and tighten bolt assemblies to a standard torque. Recheck clearance between rollers and square tube and lubricate the rollers.

3. Install the bearing housing (22) with bearings (63) on the roller housing. Install collar (21) and cap bolts (59). Rotate the collar tight against the bearing housing, tighten cap bolts and safety.
4. Ascertain that the four nylon guides (62) are installed and safetied.
5. Slide the collar (34) on the forward end of the square tube.
6. Place the square tube assembly in position and connect it to the flexible joint (36) of the sprocket assembly. Install bolt assembly and secure.

d. Attach the right control tube guide block (47) to the front (face) side of the instrument panel. Tighten the two top attachment screws and leave the two bottom screws (48) loose until the final adjustment is made.

e. Attach the left control tube guide block (47) and lock assembly by positioning the collar (57) onto the studs, being sure the slotted end is toward the center control pedestal. Install the bushing (56) with the holes in a vertical position and secure the complete assembly with four nuts (58). Leave the two bottom nuts (58) loose until the final adjustment is made.

f. To install the control wheel, the following procedure may be used:
1. Slide the tube guide cover (49) on the control tube and insert the tube through the instrument panel.
2. Place the ring (26) over the end of the control tube and slide the end of the tube over the end of the roller fitting. Install cap bolt (25), torque and safety.
3. Check that when the left sprocket (50) is centered between its stops, the control wheel will also be centered. If the control wheel does not center, it may be necessary to remove the cap bolts (25) and rotate the control tube (44) on the roller housing (23) or remove the bolt (35) that joins the square tube (31) and flexible joint (36), and rotate the tube 180. Reinstall bolts, torque and safety.

g. Adjust the control wheel tube slides (46) at the instrument panel by tightening the adjustment screw (45) to remove any play in the tube without restricting normal tube movement.

h. Adjust the horizontal roller chain so that when the left control wheel is held solid, in center position, the right wheel will also be centered with no play. Safety turnbuckles (41) and secure chain guard (72) in the sprocket housing (75).

i. Check control operation and install and seal access panels removed.

5-8. AILERON CONTROLS.

5-9. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 5-2.)

a. Carefully remove the left floor panels located forward of the main spar and the left floor panel behind the main spar.

b. If the right or left balance cable (15 or 23) is to be removed, carefully remove the center floor panel aft of the main spar.

c. Remove the access plates located under the wing, along the trailing edge, at wing station 151.50 and 178 and the aft plate located on the fillet fairing between the fuselage and wing.

d. To remove the right or left primary control cables (16 and 22), the following procedure may be used:
1. Mark one set of cable ends to facilitate installation, and separate the aileron control cables at the turnbuckles (17) within the fuselage at station 100.
2. Loosen the turnbuckle, separating the ends at the forward end of the aileron bellcrank.
3. Remove the cable guard pins at wing stations 29 and 150 and within the fuselage at station 164.50
4. Draw the cable back through the fuselage, through the wing and out through the access hole at the aileron bellcrank.

e. Removal of the right balance cable (15) may be accomplished by the-following procedure:
1. Loosen the turnbuckle, separating the turnbuckle ends at the aft end of the aileron bellcrank (1).

2. Separate the right and left balance cables at the cable ends (18) at fuselage station 172.50.
3. If not previously accomplished, remove the cable guard pins at wing stations 29 and 150 and fuselage stations 172.50 and 137.
4. Draw the cable through the wing into the fuselage.

f. The left balance cable (23) may be removed by the following procedure:
1. Loosen the turnbuckle, separating the turnbuckle ends at the aft end of the aileron bellcrank (24).
2. Remove the access panels on the aft section of the fuselage and disconnect the interconnecting cables (20 and 21) that lead to the rudder cables, at the turnbuckles (26) at station 283.
3. If not previously accomplished, remove the cable guard pins at wing station 29 and 150 and fuselage station 172.50.
4. Remove the fairleads (19 at fuselage station 171 between where the interconnecting cables attach to the balance cable.
5. Draw the cable from the wing into the fuselage.
6. Remove the cable guard pins at fuselage stations 242.50 and 275.
7. Draw the interconnecting cables forward through the fuselage.

5-10. INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figure 5-2.)

a. The right or left primary control cables (16 or 22) may be installed by the following procedure:
1. From the access hole at the aileron bellcrank, draw the control cable through the wing into the fuselage and then forward through the fuselage.
2. Connect the control cable turnbuckle ends at the forward end of the aileron bellcrank.
3. Connect the control cable turnbuckle end to the forward control cable turnbuckle within the fuselage at station 100.
4. If balance cable is installed, install the cable guard pins at wing stations 29 and 150 and fuselage station 164.5 0.

b. The right balance cable (15) may be installed by the following procedure:
1. Ascertain that the right and left balance cables (15 and 23) are connected, if the left cable (22) is installed.
2. Draw the cable from the fuselage into the wing and attach the turnbuckle at the aft end of the aileron bellcrank (1).
3. With the aileron primary cable (16) installed, install the cable guard pins at wing stations 29 and 150 and fuselage station 172.50.

c. The left balance cable (23) may be installed by the following procedure:
1. Connect the right and left balance cables at the cable ends (18) at fuselage station 172.50.
2. Draw the interconnecting cables (20 and 21) to the rudder back through the fuselage and connect the cable ends to the rudder takeoff cable ends at the turnbuckles (26) at station 283.
3. Install cable guard pins at fuselage stations 242.50 and 274.92.
4. Draw the balance cable from the fuselage through the wing and attach the turnbuckles at the aft end of the aileron bellcrank (24).
5. Install the fairlead (19) at fuselage station 171.25, where the interconnecting cable attaches to the balance cable, and at fuselage station 137. also.
6. Install cable guard pins at fuselage stations 171 and wing stations 29 and 150.

d. Set cable tension per Table V-I and check control cable rigging and adjustment per paragraph 5-11.

e. Install and seal access plates and panels.

5-11. RIGGING AND ADJUSTMENT OF AILERON CONTROLS. (Refer to Figure 5-2.)

a. To rig the aileron controls, set the right and left aileron bellcranks in neutral position by attaching an aligning tool within both wings as shown in Figure 5-3. (This tool may be fabricated from dimensions given in Figure 5-19.) The tool is used by the following procedure:

1. Remove the access plates to the aileron bellcranks at wing station 178.
2. Remove the cotter pin and nut that secures the forward turnbuckles fork end (55) to the bellcrank (1 and 24). The bolt should not be removed.
3. Insert the tool between the bellcrank mounting brackets and over the end of the bolt from which the nut was removed. (It may be necessary to loosen one of the primary control cables or the balance cable.)
4. Position the tool so that it fits tight against the outboard side of the bellcrank stop block (61).
5. Clamp the tool to the lower support bracket with a small "C" clamp. Place a small block of wood or similar material between the clamp and lower bracket so as not to damage the bracket or bend the turned edge that is around the bracket lighting hole.

b. Check or adjust the aileron for neutral position by the following procedure:
1. Place a modified straight edge, as shown in Figure 5-4 against the underside of the wing, next to and outboard of the row of rivets at station 189 with the aft end of the tool even with the trailing edge of the aileron. (This tool may be fabricated from dimensions given in Figure 5-18.) Do not place tool over rivets.
2. With the bellcrank in neutral and the forward edge of the tool and spacer contacting the wing, the trailing edge of the aileron should make contact with the aft end of the tool.
3. Should the three points not contact, loosen the jam nuts (52 and 58) of the control rod ends (51 and 57) and rotate the rod (25) until the three contact points touch the skin surfaces. Tighten the rod end lock nuts.

c. With the bellcrank in neutral position, adjust cable tension as given in Table V-I to maintain neutral-center alignment of control wheels. Carefully remove the floor panel to the left of the control pedestal. Alternately adjust the primary and balance cable turnbuckles (2) at the bellcranks with the turnbuckles (17) within the fuselage at station 100. Cable tension should be taken at the non-ridged primary control cable. Safety turnbuckles.

d. To adjust the interconnecting cables between the aileron and rudder cables, first ascertain that the cable tension has been set for both the aileron and rudder cables. Ascertain that the Aileron and rudder controls and surfaces are neutral, then remove the access panel at the aft section of the fuselage and adjust the interconnecting cable turnbuckles (26) at station 285 so that the springs (28) will extend .060 of an inch.

e. Place a bubble protractor on the inboard section of the aileron and establish neutral or zero on the protractor. Remove the tools holding the aileron bellcranks in neutral, replace the nuts and safety them. Adjust the bellcrank stop bolts (59) to the specific aileron travel from neutral as given in Table V-I. Stops of both bellcranks should contact their stop blocks at the same time and before the control wheel contacts its stops.

NOTE

If provisions are provided for safety wiring the nut and screw on the aileron bellcrank assembly, safety wire with MS20995-C20 as shown in Figure 5-4a.

f. Check control operation, bolts and turnbuckles for safety and installation of cable guard pins.

g. Install access plates and panels.

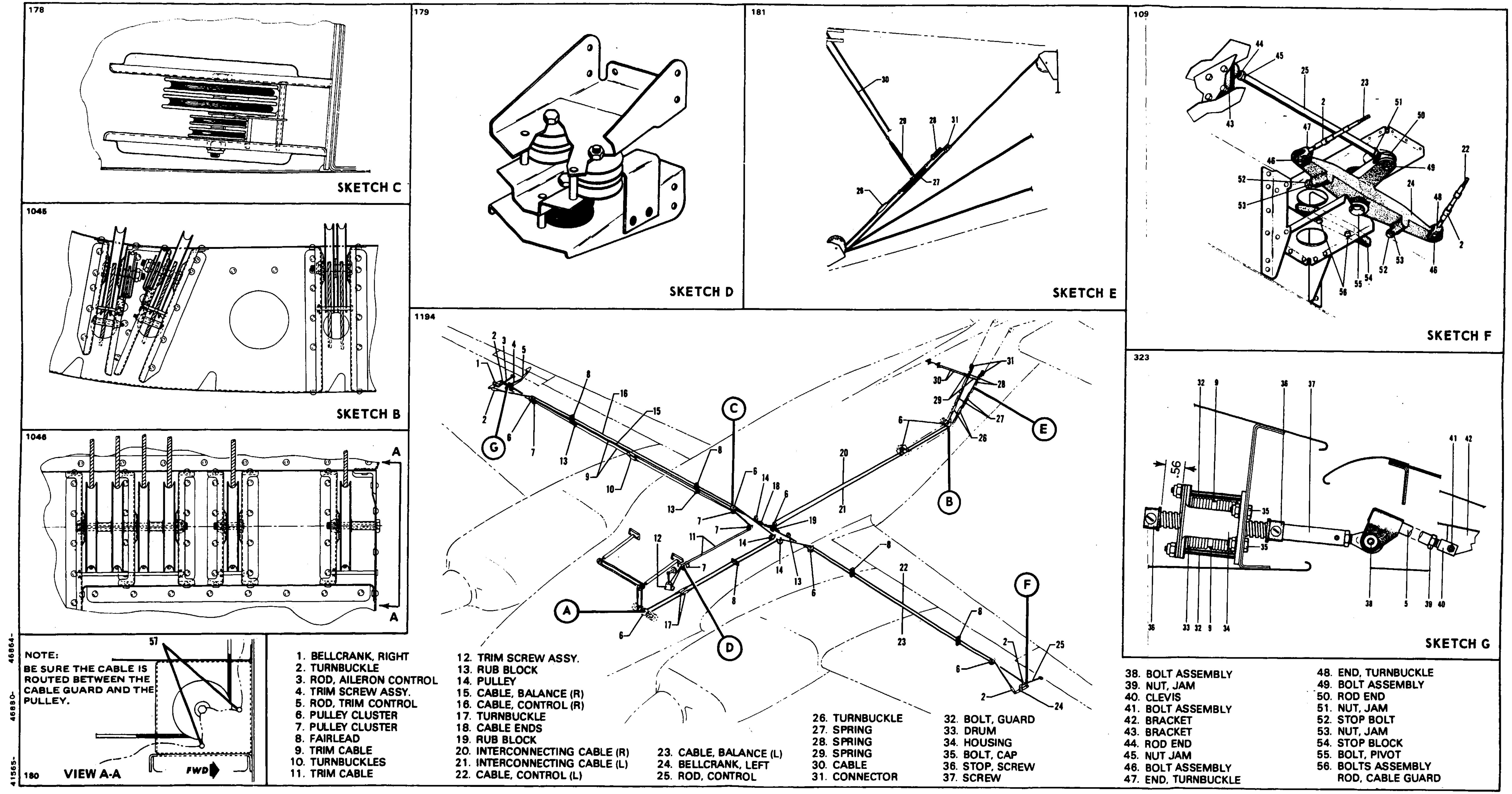
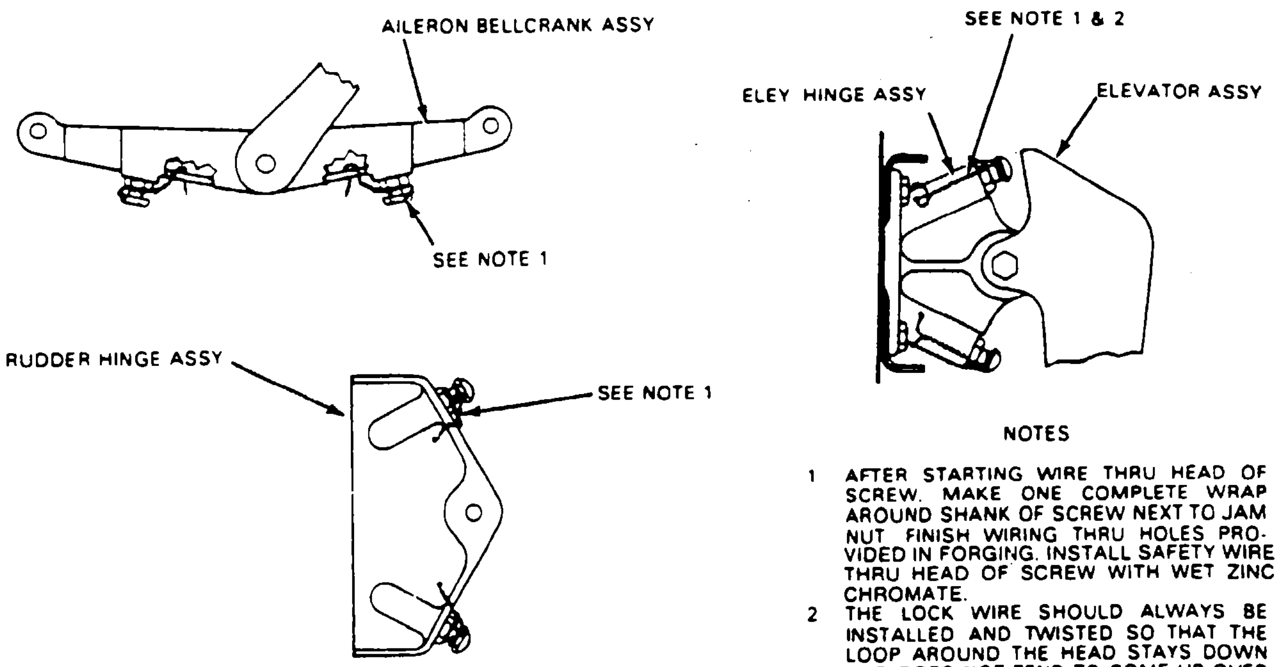


Figure 5-2. Aileron and Aileron Trim Controls

5-12. REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

a. Remove the access plate to the bellcrank assembly.
b. Relieve cable tension from the control system by rotating one of the turnbuckles (2) attached to the bellcrank (1 or 24).
c. Disconnect the turnbuckle ends (54 and 55) from the forward and aft ends of the bellcrank (24).
d. Disconnect the aileron control rod (25) at the bellcrank.
e. Remove the pivot bolt (62) securing the bellcrank and remove the bellcrank from the wing.
f. The stop block (61) may be removed by unbolting and removing from the wing.



NOTES

1 AFTER STARTING WIRE THRU HEAD OF SCREW. MAKE ONE COMPLETE WRAP AROUND SHANK OF SCREW NEXT TO JAM NUT FINISH WIRING THRU HOLES PROVIDED IN FORGING. INSTALL SAFETY WIRE THRU HEAD OF SCREW WITH WET ZINC CHROMATE.

2 THE LOCK WIRE SHOULD ALWAYS BE INSTALLED AND TWISTED SO THAT THE LOOP AROUND THE HEAD STAYS DOWN AND DOES NOT TEND TO COME UP OVER THE BOLT HEAD AND LEAVE A SLACK LOOP

Figure 5-2a. Safety Wiring

5-13. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

a. Place the bellcrank (1 or 24) in its mounting bracket with the adjustable stops (59) toward the outboard end of the wing.
b. Install the pivot bolt (62) and torque.
c. Install the aileron control rod (25), secure bolt assembly (56) and safety.
d. Connect the turnbuckle ends (54 and 55) to the bellcrank (24), secure and safety.

NOTE

The aft end of the bellcrank and balance cable end is painted red to help facilitate proper hook-up. Do not tighten turnbuckle fork ends on bellcrank so tight that the ends cannot rotate.

e. Install stop block (61) and torque bolts.
f. Check aileron controls rigging and adjustment as per paragraph 5-11.
g. Install access plate and secure.

5-14. AILERON TRIM CONTROLS.

5-15. REMOVAL OF AILERON TRIM ASSEMBLY (Fuselage). (Refer to Figure 5-2.)

a. Remove the right and left pilot's seat and the right row of seats within the cabin.
b. Carefully remove the floor panel aft of the control pedestal, and the right panels fore and aft of the main spar.
c. Relieve cable tension from the aileron cables by loosening one of the turnbuckles (17) in the fuselage at station 100.
d. Remove the aft access plate on the right fillet fairing located between the fuselage and wing. Remove the aileron and aileron trim pulleys in the wing at station 29.
e. Remove the outboard access plate located on the aft side of the wheel well. Remove one screw from each set of rub blocks at wing station 58.50 and 121.50 then open the blocks enough to allow the cable ends to pass through.
f. Remove the access plate on the underside of the wing at the trailing edge at station 92.50.
g. Block the trim cables at the screw assembly below the control pedestal and within the wing at station 96.50 to prevent the cables from unwrapping from their drums by one of the methods shown in Figure 5-8. (If the trim assembly within the wing is also being removed, then remove the access plates at wing station 171 and block the cables at the trim screw assembly.)
h. Mark one set of cable ends within the wing at station 90 to facilitate installation and disconnect the cables at the turnbuckles (10).
i. Remove the pulleys within the fuselage at station 102 and the cable guard pins at stations 125.21 and 163.50.
j. Remove the pin holding the shafts together, then unbolt the screw assembly from the mounting bracket (12) and remove the screw assembly, drawing the cables from the wing and fuselage.

5-16. INSTALLATION OF AILERON TRIM ASSEMBLY (Fuselage). (Refer to Figure 5-2.)

a. Ascertain that the cable is evenly wrapped on the trim drum (centered) and blocked to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-54.)
b. Position the screw assembly (12) below the pedestal on the mounting bracket and secure with bolts, washers and nuts.
c. Draw the cable (11) through the fuselage and into the wing.
d. Install the cable pulleys in the fuselage at station 102 and secure.
e. Install the aileron and aileron trim pulleys in the wing at station 29.
f. Set the aileron cable tension per Table V-I and check rigging and adjustment per paragraph 5-11.

g. If the trim cables (9) from the screw assembly (4) within the wing are installed, connect the cable ends at the turnbuckles (10) at wing station 90. (If the trim assembly within the wing is not installed, pull the cables tight and block them, reaching through the access opening in the wing at station 92.50.
h. With the cables connected, install the cable guard pins at fuselage stations 125.21 and 163.38.
i. Close the rub blocks within the wing at station 58.50 and secure.
j. Remove the cable blocks.
k. Install and seal the floor panels.
l. Set cable tension with the turnbuckles (10) in the wing at station 90 per Table V-I and check rigging and adjustment per paragraph 5-19.
m. Install access plates and panels on the fuselage under the wing and in the wheel well and install seats.

5-17. REMOVAL OF AILERON TRIM ASSEMBLY (Wing). (Refer to Figure 5-2.)

a. Remove the access plates located under the wing along the trailing edge at stations 92.50, 117.50, 151.50 and 171.
b. Disconnect the trim control rod (5) located between the trim screw (44) and tab, at the screw.
c. Block the trim cables to prevent them from unwrapping from their drums at the screw assembly and within the wing at station 87.50 by one of the methods shown in Figure 5-8.
d. Mark one set of cable ends at station 90 to facilitate installation and disconnect the cables at the turnbuckles (10).
e. Reach through the access opening at station 117.50, remove one screw from each set of rub blocks and open the blocks enough to allow the cable ends to pass through.
f. Remove the cable guard pin within the wing at station 150.
g. Remove the bolts (42) that secure the screw assembly to the rear spar and remove the assembly from the wing.

5-18. INSTALLATION OF AILERON TRIM ASSEMBLY (Wing). (Refer to Figure 5-2.)

a. Ascertain that the trim cable assembly is evenly wrapped (centered) on the drum, the drum is centered between the stops on the trim screw and the cables are blocked to prevent them from unwrapping.
b. Position the screw assembly in the wing, install the attachment bolts (42) and torque.
c. Draw the cables through the wing and connect them at the turnbuckles (10) at station 90. (If the cables from the fuselage are not installed, block the cables at the rib at station 87.50 by reaching through the access opening at station 92.50.)
d. Remove the cable blocks from next to the trim screw assembly and from the cables leading from the fuselage.
e. Connect the control rod (5) to the trim screw (44).
f. Install the cable guard pin at station 150.
g. Close the rub blocks at station 121.50 and secure.
h. If the complete cable system is installed, set cable tension with the turnbuckles (10) at station 90 per Table V-I and check rigging and adjustment per paragraph 5-19.
i. Install and seal access plates.

5-19. RIGGING AND ADJUSTMENT OF AILERON TRIM. (Refer to Figure 5-2.)

a. To adjust the aileron trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check.
   1. The trim cables are evenly wrapped (centered) on their drums, both below the control pedestal and in the wing, and both cable turnbuckles (10) are located approximately at wing station 90.
   2. That the trim drum (40) in the wing is centered between the stops of the trim screw (49).
   3. The cable tension is set in accordance with Table V-I.
b. Remove the access plates on the underside of the right wing at stations 92.50 and 171.
c. With the trim screw (44) held from rotating, turn the trim drum (40) until .560 of an inch exists between the forward screw stop and the drum housing (41), as measured along the screw. (Neutral position of the screw is at this measurement.)

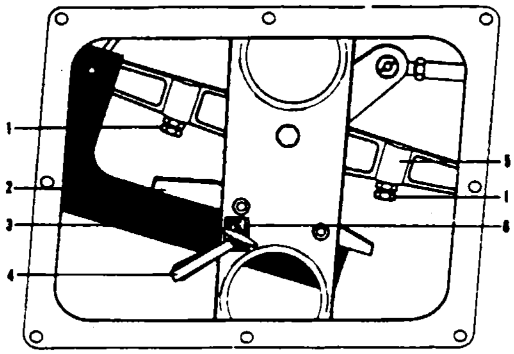


Figure 5-3. Installation of Bellcrank Rigging Tool

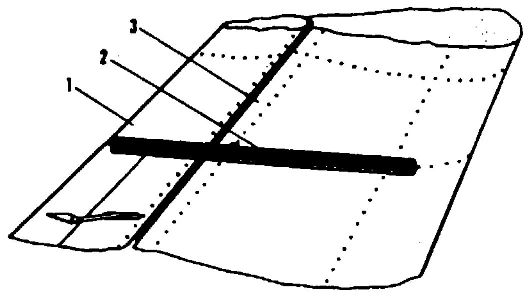


Figure 5-4. Installation of Aileron Rigging Tool

d. With the trim screw in neutral position, the trailing edges of the tab and aileron should align. Should they not, remove the bolt (48) from the aft end of the trim control rod (5) and adjust the rod end (47) until the trailing edges align. Reinstall bolt (48) and tighten it so that the bushing will not rotate, then secure.
e. Turn the trim in each direction, to screw stops, to check the tab angles as given in Table V-I and also check the minimum number of cable wraps left on the drum. (Minimum allowable is one and one quarter turns.)
f. Check the adjustment of trim indicator per paragraph 5-49.

5-20. ELEVATOR CONTROLS.

NOTE

Any time service is accomplished on the elevator control system a friction check must be made to insure system friction is within limits. (Refer to Paragraph 4-83a of Section IV.)

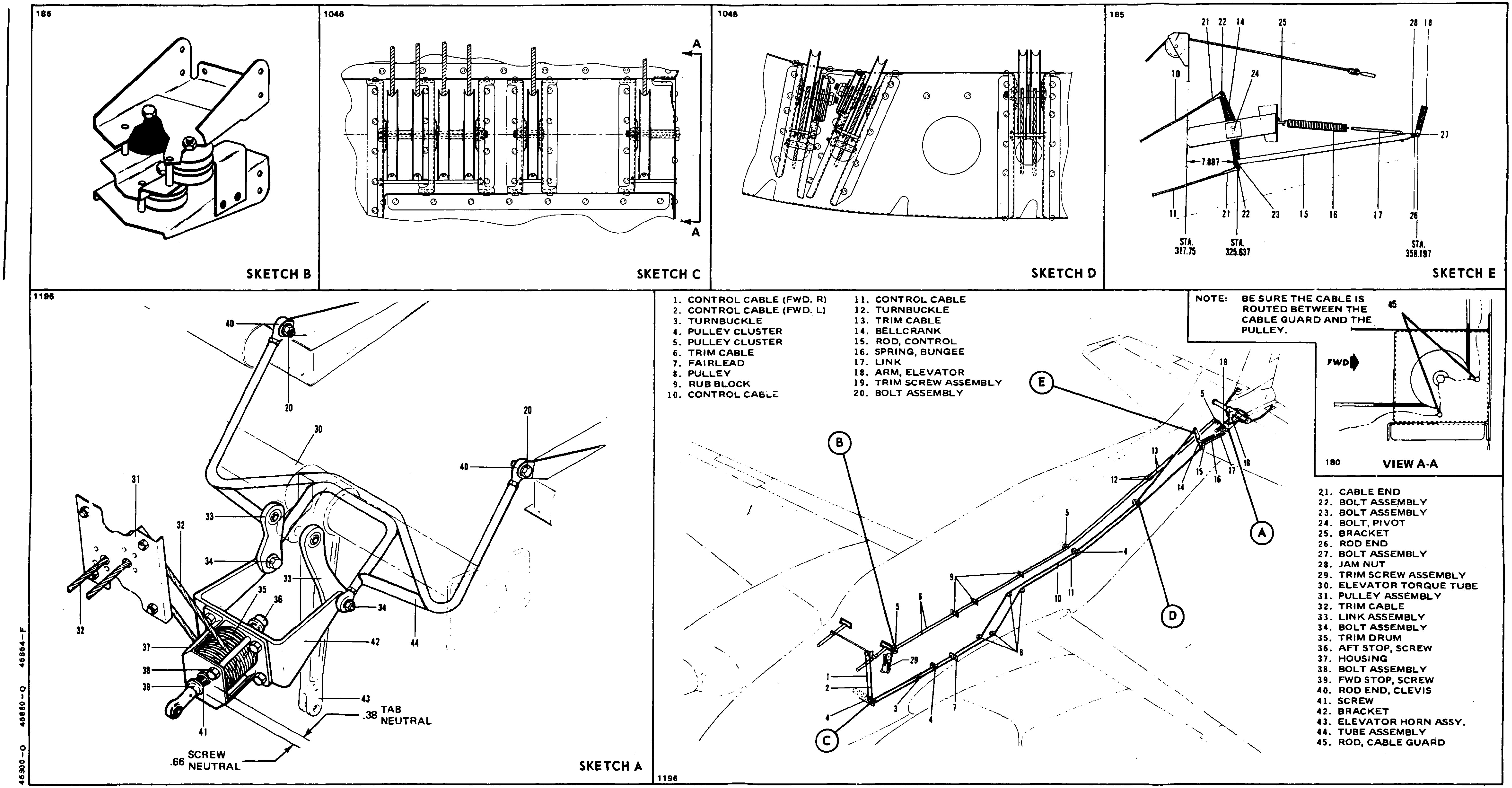


Figure 5-5. Elevator and Elevator Trim Controls

5-21. REMOVAL OF ELEVATOR CONTROL CABLES. (Refer to Figure 5-5.)

a. To remove the control cables (1 and 2) that connect between the elevator control sector and the aft control cables (10 and 11), beginning at fuselage station 110.50, the following procedure should be used:

1. Remove the left pilot's seat and carefully remove the floor panel located on the left of the control pedestal.
2. Mark one set of cable ends to facilitate installation and disconnect the cables at turnbuckles (3) at station 110.50.
3. Remove the cable guard pins at the forward pulley cluster at station 83.34.
4. The inboard (right) cable (1) may be removed by removing the three cable guard pins at the control sector and pulley, disconnecting it from the lower end of the sector and drawing it aft, around the pulleys.
5. The outboard (left) cable (2) may be removed by removing the cable guard pin at the control sector (if not previously removed, when removing the inboard cable), disconnecting it from the upper end of the sector and drawing it aft, around the pulley.

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b. To remove the control cables (10 and 11) that route aft, beginning from fuselage station 110.50 to the elevator bellcrank (14), the following procedure may be used:
   1. Remove the left pilot's seat and the left and right row of seats in the fuselage.
   2. Remove the floor panel to the left of the control pedestal, the left panels fore and aft of the main spar, and the center panels off of the main spar back to station 244.
   3. Remove the left or right access plate located on the aft section of the fuselage.
   4. Mark one set of cable ends to facilitate installation and disconnect the cables at the turnbuckles (3) at station 110.50.
   5. Mark and disconnect the cables (10 and 11) from the elevator bellcrank (14).
   6. To remove the cable (10) that leads to the upper end of the elevator bellcrank (right cable), remove the cable guard pins at stations 121.38, 153.35, 192, 242 and 276.
   7. To remove the cable (11) that leads to the lower end of the bellcrank (left cable), remove the cable guard pins at stations 121.38, 160.20, 203, 242 and 276.
   8. Draw the cables aft through the fuselage.

5-22. INSTALLATION OF ELEVATOR CONTROL CABLES. (Refer to Figure 5-5.)

a. The control cables (1 and 2) that connect between the elevator control sector and the aft control cables (10 and 11) may be installed by the following procedure:
   1. The left cable (1) may be installed by drawing the cable forward from fuselage station 110.50, around the forward pulley cluster at station 83.34, upward and attach it to the upper end of the control sector.
   2. The right cable (2) may be installed by drawing the cable forward from fuselage station 110.50, around the forward pulley cluster at station 83.34, upward and over the pulley above the control column and attach it to the lower end of the control sector.
   3. If aft control cables (10 and 11) are installed, connect the cables at station 110.50.
   4. Install cable guard pins at forward pulley cluster.

b. The control cables (10 and 11) that go aft, beginning at fuselage station 110.50 to the elevator bellcrank, may be installed by the following procedure:
   1. Connect the cables (10 and 11) to the elevator bellcrank (14) ascertain that cable (10) is connected to the top of the bellcrank.
   2. Draw the cables forward through the fuselage as shown in Figure 5-5.
   3. Connect the cables (10 and 11) to the forward cables (1 and 2) at station 110.50.
   4. Install the cable guard pins for cable (10) at stations 121.38, 153.35, 192, 242 and 276.
   5. Install the cable guard pins for cable (11) at stations 121.38, 160.20, 203, 242 and 276.

c. Adjust the cable tension at station 110.50 in accordance with cable tensions given in Table V-I and rigging and adjustment per paragraph 5-23.

d. Install and seal access plates and panels, and install seats.

5-23. RIGGING AND ADJUSTMENT OF ELEVATOR CONTROLS. (Refer to Figure 5-5.)

a. Ascertain that the left pilot's seat, the floor panel to the left of the control pedestal, an access plate on the side of the fuselage under the horizontal stabilizer and tail cone are all removed.

b. Put the elevator in neutral position by placing a modified straight edge as shown in Figure 5-6, against the underside of the horizontal stabilizer, next to and outboard of the row of rivets at station 38 with the aft end of the tool even with the trailing edge of the elevator. (This tool may be fabricated from dimensions given in Figure 5-18.)

c. With the elevator in neutral position, check or adjust the elevator bellcrank (14) for neutral. The bellcrank is neutral when the center of the forward attachment bolt (23) of the elevator control rod (15) is 7.887 inches, when measured perpendicular from the bulkhead at station 317.75. Obtain this setting by turning the control rod end (26) to the desired length and secure with jam nut (28).

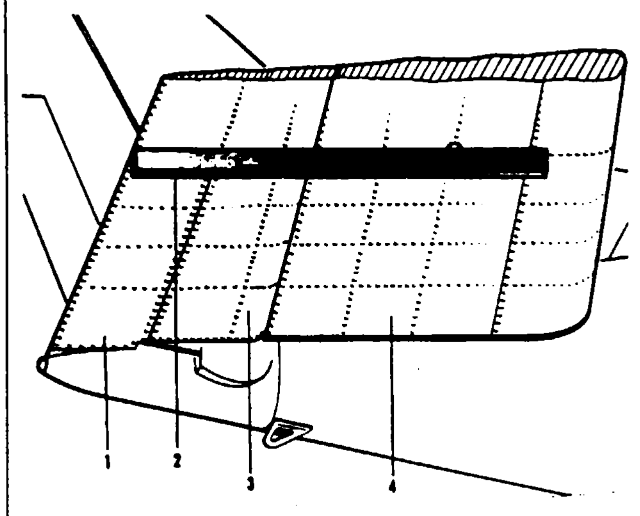
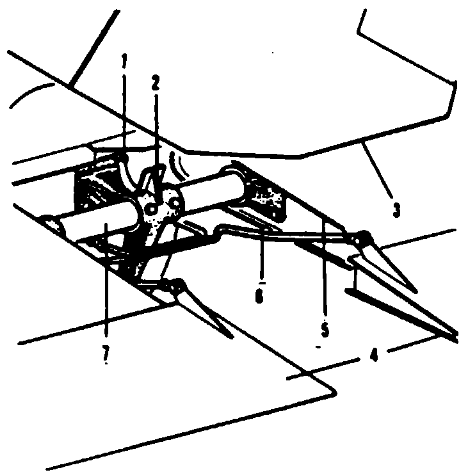


Figure 5-6. Installation of Elevator Figure Rigging Tool



5-7. Elevator Travel Stops

d. With elevator bellcrank in neutral, adjust the turnbuckles (3) of fuselage station 110.50 to obtain cable tension as given in Table V-I, and allow the control wheel to neutralize fore and aft. The neutral position of the control wheel is three inches aft of the full forward position along the underside of the control column to the center of the control wheel.

NOTE

If provisions are provided for safety wiring the nut and screw on the elevator hinge assembly safety wire with MS20995-C20 as shown in Figure 5-7a. The lock wire should always be installed and twisted so that the loop around the head stays down and does not tend to come up over the bolt head and leave a slack loop.

e. To set the proper tension of the elevator balance spring (16), connect a spring scale to the aft end of the spring and pull rearward until 30.0 ± 0.5 pounds tension is obtained with the elevator in the neutral position. At this point observe which hole in the link (17) is in line with the hook at the end of the spring and connect the spring into this hole in the link.

f. With the elevator neutral, place a bubble protractor on the elevator and establish neutral or zero on the protractor. Move the elevator up until the control arm contacts its stop. (Refer to Figure 5-7.) Check the up travel as given in Table V-I. With the elevator in its properly rigged position make sure the stop bolt is sealed with Torque Seal, adjust the screw to the required extension, and torque the locknut 20 to 40 in. lbs. Move the elevator down and check and adjust by the same method. Tighten adjustment screw locknuts. The elevator control arm should contact its stops before the control wheel contacts its stops.

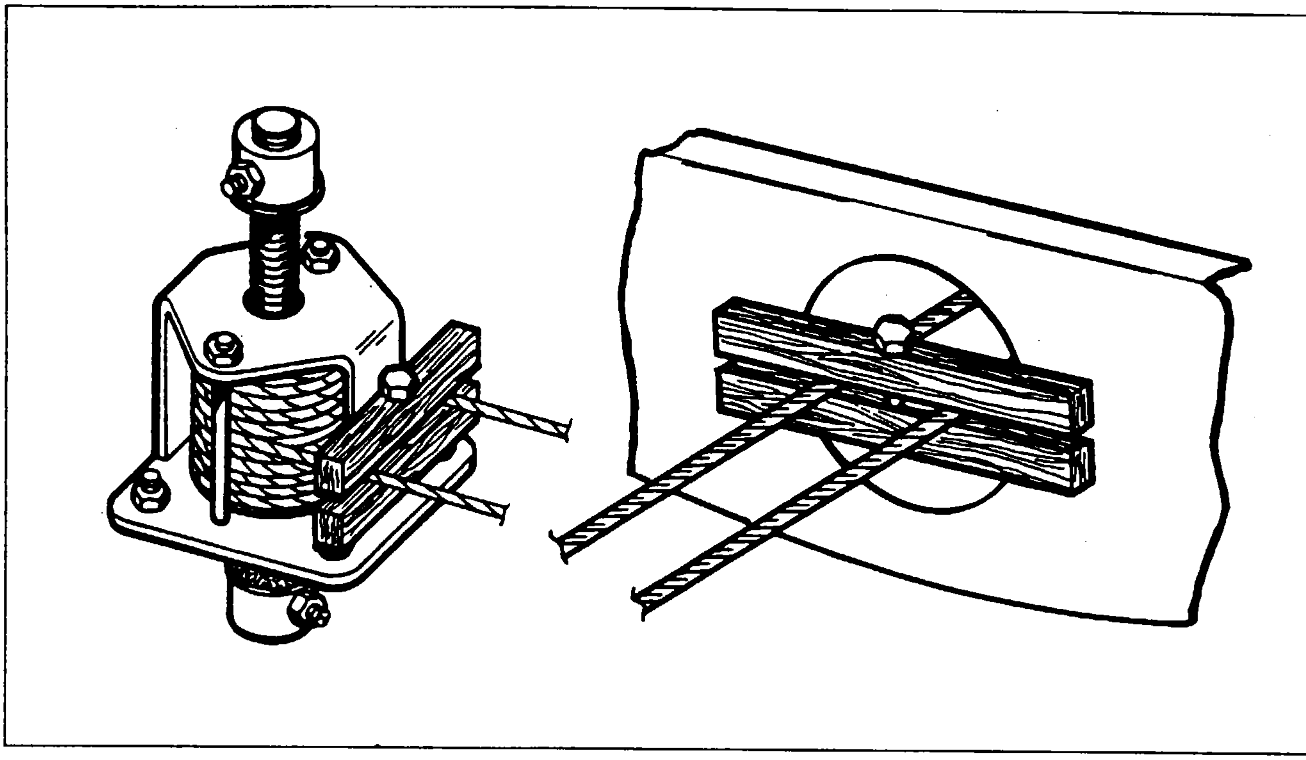


Figure 5-8. Methods of Blocking Trim Cables

g. Check control operation and direction of travel, bolts and turnbuckles for safety and installation of cable guards.
h. Check complete elevator control system (including Autopilot, if installed) to determine the friction in the system. (Refer to Paragraph 4-83a of Section IV.)
i. Install and seal access plates and panels, tail cone and seats.

5-24. REMOVAL OF ELEVATOR BELLCRANK ASSEMBLY. (Refer to Figure 5-5.)

a. Remove the left pilot's seat and the floor panel located to the left of the control pedestal.
b. Relieve cable tension from the control system by loosening one of the cable turnbuckles (3) at station 110.50.
c. Remove the access plate on the side of the fuselage under the horizontal stabilizer and the tail cone.
d. At the bellcrank (14), disconnect the elevator control cables (10 and 11).
e. Disconnect the elevator Bungee spring (16) from between the attachment bracket (25) at the fuselage bulkhead and elevator control rod (15).
f. Disconnect the elevator control rod (15) from between the bellcrank (14) and elevator horn (18).
g. Remove the bellcrank from its mounting bracket.

5-25. INSTALLATION OF ELEVATOR BELLCRANK ASSEMBLY. (Refer to Figure 5-5.)

a. Position the bellcrank (14), install pivot bolt (24) and torque to 60-85 inch-pounds.
b. Attach the forward end of the control rod (15) to the bellcrank (14) and secure.
c. The aft end of the control rod (15) and balance spring (16) are to be connected during rigging and adjustment.
d. Connect the control cables (10 and 11) to the bellcrank (14). Tighten bolts (22) so that the cable ends (21) may turn freely on the bellcrank and safety.
e. Check cable tension per Table V-I and rigging and adjustment as given in paragraph 5-23.

5-26. ELEVATOR TRIM CONTROLS.

5-27. REMOVAL OF FORWARD ELEVATOR TRIM ASSEMBLY. (Refer to Figure 5-5.)

a. Remove the right pilot's seat and the right row of passenger seats.
b. Carefully remove the floor panel located aft of the control pedestal, the right panel forward of the main spar, the right panels off of the main spar, and the aft baggage area.
c. Block the forward trim cables (6) at the trim screw assembly below the control pedestal and the aft cables (13) at bulkhead 317.75, to prevent the cables from unwrapping from their drums, by one of the methods shown in Figure 5-8. (If the aft screw assembly (19) is also to be removed, then remove the access plate attached to the underside of the horizontal stabilizer and block the cables at the screw assembly instead of in the fuselage.)
d. Mark one set of cable ends at station 308 to facilitate installation and disconnect the cables at the turnbuckles (12).
e. Remove the cable guard pins at fuselage stations 125 and 243.50.
f. Remove one screw from each set of rub blocks at stations 137, 162, 174 and 215 and open them far enough to allow the cable ends to pass through.
g. Slide the bushing up the shaft to separate the two halves of the trim screw assembly.
h. Remove the bolts that attach the screw assembly to the mounting bracket and draw the assembly with the cables from the fuselage.

5-28. INSTALLATION OF FORWARD ELEVATOR TRIM ASSEMBLY. (Refer to Figure 5-5.)

a. Ascertain that the cable is evenly wrapped on the trim drum (centered) and blocked to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-54.)
b. Position the forward trim screw (29) on the left side of the mounting bracket below the pedestal at station 100.
c. Draw the cables (6) aft through the fuselage back to station 308.
d. If the trim cables (13) from the elevator are installed, connect the cable ends. (If the cables (13) from the elevator are not installed, pull the cables (6) tight and block them in the fuselage at bulkhead 274. Refer to Paragraph 5-30.
e. With the cables installed and connected, install the cable guard pins at stations 125 and 243.50 also close and secure the rub blocks at stations 137, 162, 174 and 215.
f. Remove the cable blocks.
g. Set cable tension with the turnbuckles (12) at station 308 per Table V-I and check rigging and adjustment per paragraph 5-31.
h. Install and seal access plates and panels, and install seats.

5-29. REMOVAL OF REAR ELEVATOR TRIM ASSEMBLY. (Refer to Figure 5-5.)

a. Remove the access plates located on each side of the fuselage.
b. Block the trim cables to prevent them from unwrapping at the screw assembly within the horizontal stabilizer and within the fuselage at bulkhead station 274 by one of the methods shown in Figure 5-8. (If the forward trim assembly is also being removed, block the cables at the forward trim screw below the pedestal.)
c. Mark one set of cable ends within the fuselage at station 308 to facilitate installation and disconnect the cables at turnbuckles (12).
d. Disconnect the trim tube assembly (44) from the trim screw assembly by removing the two attachment bolts.
e. Remove the bolt that secures the trim screw rod end to the bulkhead attachment at station 352.
f. Remove the cable guard pins at station 354 and then remove the screw assembly and draw the trim cables from the fuselage.

5-30. INSTALLATION OF REAR ELEVATOR TRIM ASSEMBLY. (Refer to Figure 5-5.)

a. Remove the access plates located under the rudder and the fiberglass tail cone.
b. Ascertain that the trim cable is evenly wrapped (centered) on the trim drum and the cables are blocked to prevent them from unwrapping.
c. Position the screw assembly in the mounting bracket at station 352.
d. Install the attachment bolt and secure the trim screw rod end to the bulkhead mounting bracket at station 352.
e. Draw the trim cables over the pulleys and through the bulkhead at station 352 into the fuselage and connect them at the turnbuckles (12) at station 308. (If the forward cables (6) are not installed, draw the cables (13) tight and block them at bulkhead station 317.75. Install the forward trim assembly in accordance with paragraph 5-28.
f. Remove the cable blocks and install the guard pins into the pulley brackets at station 354.
g. With the complete trim control system installed, set the cable tension with the turnbuckles (12) at station 308 per Table V-I and check the rigging and adjustments per paragraph 5-31.
h. Install the access plates and panels.

5-31. RIGGING AND ADJUSTMENT OF ELEVATOR TRIM. (Refer to Figure 5-5.)

a. To adjust the elevator trim, the following steps should be accomplished during installation or as a preadjustment check.
   1. Remove the access panels on the left and right side of the fuselage, aft of the pressure bulkhead at station 274 and also the fiberglass tail cone.
   2. Carefully remove the access panel located in the floor, in front of the control pedestal.
   3. Ascertain that the trim cables are evenly wrapped (centered) on both trim cable drums. This is the neutral position at the drums.
   4. Determine that the trim cable tension is set in accordance with specifications given in Table VI.
   5. Check that there is 0.66 of an inch between the forward screw stop (39) and the screw assembly housing (37) as shown in Figure 5-5, Sketch A. This is the neutral position of the screw assembly. If this measurement is not correct, disconnect the rod end of the trim screw from the attachment point on the forward side of bulkhead station 352 and turn the trim screw until 0.66 of an inch is obtained. Then; reconnect the rod end of the screw to its attachment point on the bulkhead.

NOTE

Hold the trim drum while turning the screw to obtain this measurement.

b. Rotate the trim control wheel to reposition the screw to attain 0.38 of an inch between the forward screw stop (39) and assembly housing (39) as shown in Figure 5-5, Sketch A. This is the neutral position of the trim tab. The trailing edges of the tabs and elevator should align. If they do not align, loosen the jam nuts on the rod ends of the tube assembly (44) and remove the bolts connecting the elevator trim tab horns to the rod ends of the tube assembly.
c. Turn the rod ends to get the trim tabs trailing edges aligned with the elevator trailing edges when the system is in the neutral position.
d. Reinstall the bolts securing the tab horns to the rod ends on the tube assembly with the locknuts towards the center of the airplane, and tighten the jam nuts on the rod ends.
e. Operate the trim in each direction till the screw stops to check the tab angle as given in Table V-I. Also, check the minimum number of cable wraps left on the drums. (The minimum number of wraps allowable is one and one quarter turns.)
f. Check the adjustment of the trim indicator per paragraph 5-49.

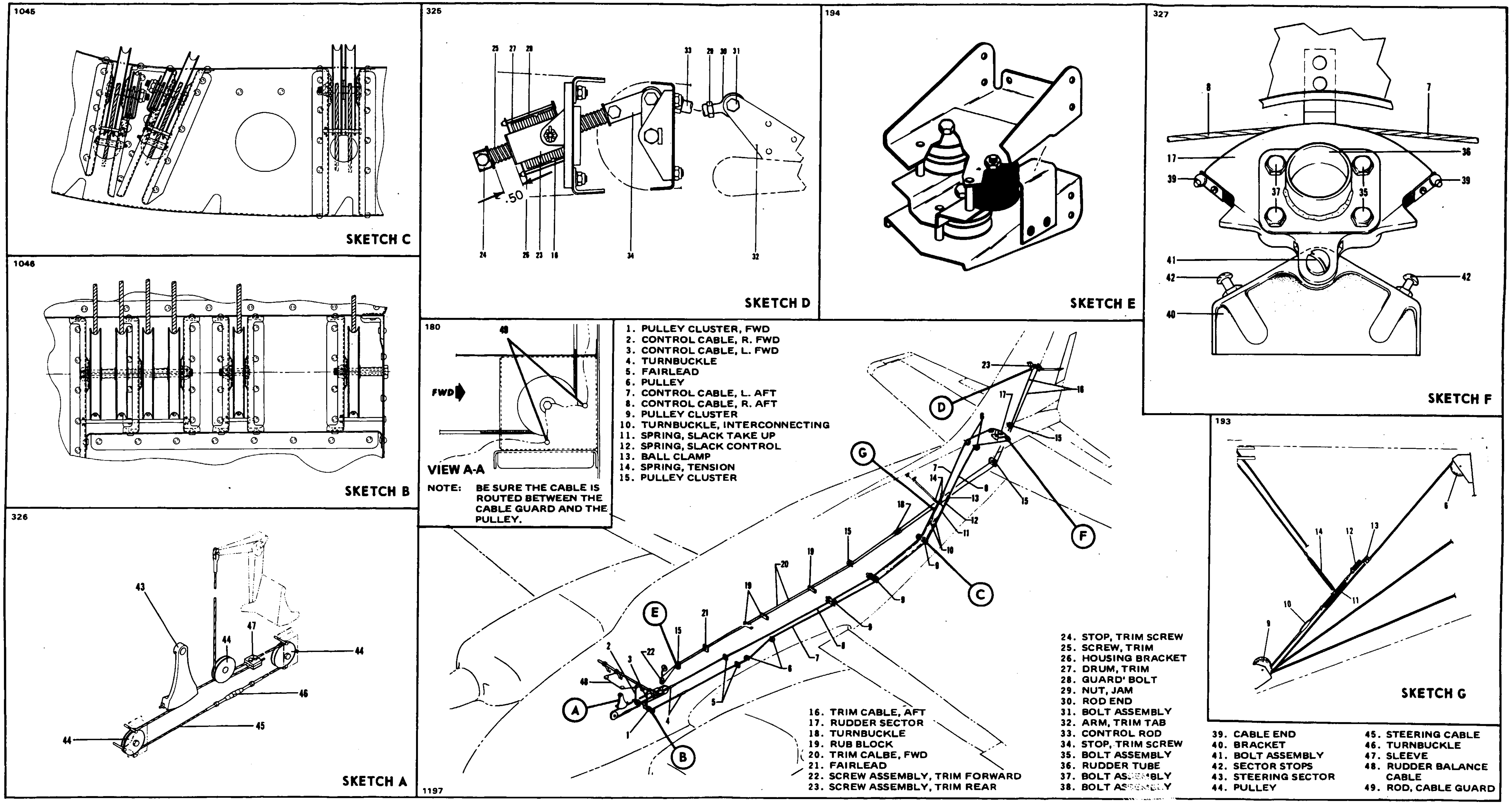


Figure 5-9. Rudder and Rudder Trim Controls

5-32. RUDDER CONTROLS.

5-33. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-9.)

a. Remove the left pilot's seat and left row of passenger seats.
b. Carefully remove the left row of floor panels and outside access panels to the aft section of the fuselage.
c. Remove the tail cone and the access plate under the rudder on the top aft section of the fuselage.
d. Loosen the rudder and aileron interconnecting cables at turnbuckles (10) at station 285, in the aft section of the fuselage, enough to allow the large connecting spring (12) at station 295 to be disconnected from the rudder cable.
e. Mark one set of cable ends to facilitate installation, and disconnect the cables (7 and 8) at turnbuckles (4) at station 100.
f. Mark and disconnect the cables (7 and 8) from the rudder sector (17). (Refer to Paragraph 7-18.)
g. Remove the cable guard pins at fuselage station 213, 242.50, 275, 315 and 345. Also when removing the left cable (17), remove the guard pins at stations 142 and 160.
h. Draw the cables aft through the fuselage and remove them from the airplane.

5-34. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-9.)

a. The control cables (2 and 3) that connect between the rudder pedals and the aft control cables (7 and 8) may be installed by the following procedure:
    1. The left and right cables (2 and 3) are drawn forward from fuselage station 110.50, around the forward pulley cluster at station 83.34, upward and attached to the left and right rudder pedals.
b. The control cable (7 and 8) that route aft, beginning at fuselage station 110.50 to the rudder sector may be installed by the following procedure:
    1. Connect the cable (7 and 8) to the rudder sector (17).
    2. Draw the cable forward through the fuselage as shown in Figure 5-10.
    3. Connect the cables (7 and 8) to the forward cables (2 and 3) at station 110.50.
    4. Install the cable guard pins at stations 345, 315, 275, 242.50, 213, 160 and 142 also at the forward pulley cluster.
    5. Adjust the cable tension at station 110.50 in accordance with cable tensions given in Table V-I.
c. Install the access plates and panels, and install seats.

NOTE

Removal and installation of nose gear steering can be found in Section VII.

5-35. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS. (Refer to Figure 5-9.)

a. Remove the left pilot's seat, the floor panel to the left of the control pedestal, the left rear exterior access panel just aft of the entrance door and the tail cone.
b. Adjustment of the rudder and rudder pedal for neutral may be accomplished as follows:
   1. Clamp the rudder pedals to align them in a lateral position as shown in Figure 5-13.
   2. Adjust the turnbuckles (4) at fuselage station 100 to obtain the proper cable tension, per Table V-I, and to align the rudder at neutral position. Do not allow cables to rotate when adjusting turnbuckles. Neutral position of the rudder may be established by aligning vertically the forward overhang at the upper portion of the rudder with the vertical fin or with the use of a fabricated rudder rigging jig. (Specifications for the fabrication of this jig are given in Figure 5-20.)
c. Rudder travel adjustment with the use of the fabricated rigging tool (refer to Figure 5-10) may be accomplished as follows:
   1. Level the airplane longitudinally and laterally. (Longitudinal leveling is not mandatory if a propeller protractor is used for this adjustment.)
   2. Allow the elevator to remain in its down position.
   3. Position the jig on the elevator torque tube and align with the centerline of the airplane.
   4. Set a bubble protractor to 29° 28' and position it on the centerline of the jig plate. (This angle assures rudder travel measurement perpendicular to the rudder hinge centerline.)
   5. With protractor still set to 29° 28' center the bubble by adjusting the screws at the aft end of the jig plate. (Keep jig legs tight to elevator torque tube.)
   6. Position the pointer along the trailing edge of the rudder with the point approximately .125 inch from plate.
   7. Set rudder with stops to the degree of travel as given in Table V-I and lock stops.

NOTE

If provisions are provided for safety wiring the nut and screw on the rudder hinge assembly, safety wire with MS20995-C20 as shown in Figure 5-7a.

d. To adjust the interconnecting cables between the aileron and rudder cables, first ascertain that cable tension has been set for both the aileron and rudder cables. Ascertain that the aileron and rudder controls and surfaces are neutral and adjust the interconnecting cable turnbuckles (10) at station 288 so that the spring (12) will extend .060 of an inch.
e. Safety turnbuckles and install and seal access plates, panels and seats.

5-36. RUDDER TRIM CONTROLS.

5-37. REMOVAL OF FORWARD RUDDER TRIM ASSEMBLY. (Refer to Figure 5-9.)

a. Remove the right pilot's seat and right row of passenger seats.
b. Carefully remove the right row of floor panels and the access panel to the right aft section of the fuselage.
c. Block the forward trim cables (20) at the trim screw assembly below the control pedestal and also the rear cables (16) at bulkhead 274, to prevent the cables from unwrapping from their drums, by one of the methods shown in Figure 5-8.
d. If the aft screw assembly is also to be removed, then remove the access plate attached to the right side of the vertical fin and block the cables (15) at the screw assembly instead of in the fuselage. Refer to Paragraph 5-39.
e. Mark one set of cable ends at station 287.50 to facilitate installation and disconnect the cables (16 and 20) at the turnbuckles (18).
f. Remove the cable guard pins at stations 125 and 243.25.
g. Remove one screw from each set of rub blocks (19) at stations 137, 162.50, 174 and 215 and open them far enough to allow the cable ends to pass through.
h. Slide the bushing up the shaft to separate the two halves of the trim screw assembly.
i. Remove the bolts that attach the screw assembly to the mounting bracket and draw the assembly with the cables from the fuselage.

5-38. INSTALLATION OF FORWARD RUDDER TRIM ASSEMBLY. (Refer to Figure 5-9.)

a. Ascertain that the cable is evenly wrapped (centered) on the trim drum and block to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-54.)
b. Install the trim screw (22) on the right side of the mounting bracket and secure with attachment bolts.
c. Draw the cables (20) through the fuselage to the aft section of the fuselage at station 287.50.
d. If the trim cables (16) from the rudder are not installed, pull the cables (20) tight and block them in the fuselage at bulkhead 296.
e. With the cables installed and connected, install the cable guard pins at stations 125 and 243.25 also close and secure the rub blocks (19) at stations 137, 162.50, 174 and 215.
f. Remove the cable blocks.
g. Set the cable tension with the turnbuckles (18) at station 287.50 per Table V-I and check rigging and adjustment per paragraph 5-41.
h. Install and seal access plates and panels, and install seats.

5-39. REMOVAL OF REAR RUDDER TRIM ASSEMBLY. (Refer to Figure 5-9.)

a. Remove the access panel on the aft right section of the fuselage and also on the right side of the vertical fin and below the horizontal stabilizer.
b. Block the trim cables (16) to prevent them from unwrapping at the screw assembly within the vertical fin and within the fuselage of bulkhead station 274 by one of the methods shown in Figure 5-8.
c. If the forward trim assembly is also being removed, block the cable (20) at the trim screw assembly below the control pedestal. (Refer to Paragraph 5-37.)
d. Mark one set of cable ends within the fuselage at station 287.50 to facilitate installation and disconnect the cables (16 and 20) at the turnbuckles (18).
e. Remove the cable guard pins at fuselage stations 331.50 and 340.
f. Disconnect the trim control rod (39) from the trim screw (30).
g. Remove the bolts that secure the screw assembly to the spar.
h. Remove the screw assembly and trim cables through the access hole in the fin.

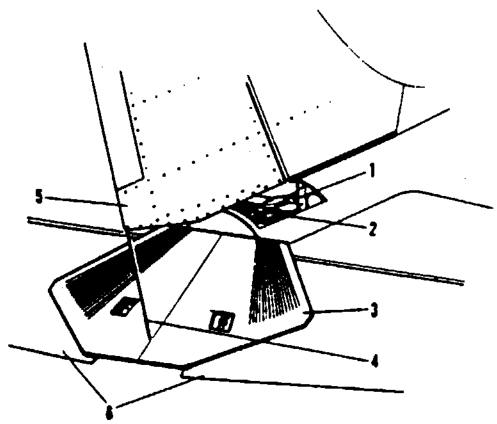


Figure 5-10. Installation of Rudder Rigging Tool

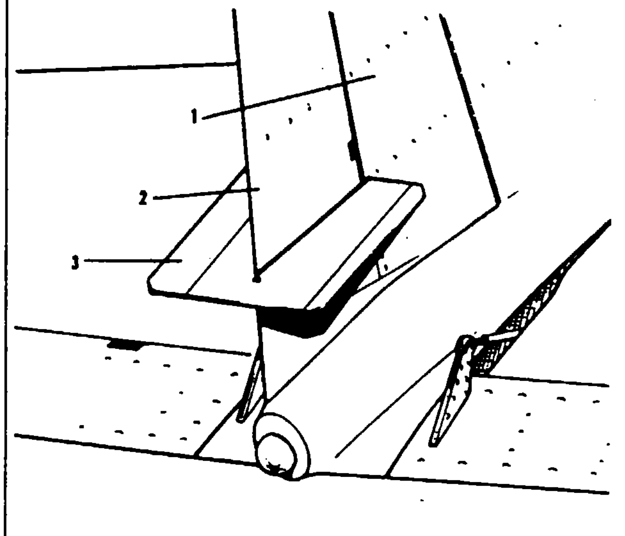


Figure 5-11 . Installation of Rudder Trim Rigging Tool

5-40. INSTALLATION OF REAR RUDDER TRIM ASSEMBLY. (Refer to Figure 5-9.)

a. Ascertain that the trim cable is evenly wrapped (centered) on the drum, and block the cables to prevent them from unwrapping.
b. Position the screw assembly (24) in the vertical fin, install and secure the attachment bolts.
c. Draw the cables (16) through the fin into the fuselage and connect them at the turnbuckles (18) at station 287.50. (If the cables (20) are not installed, draw the cables (16) tight and block them at the bulkhead at station 317.75. Install the forward trim assembly per paragraph 5-38.)
d. Remove the cable blocks from the rear trim screw assembly (24) and from the forward trim cables (20).
e. Connect the control rod (39) to the trim screw (30) until the trim cable, drum and screw are rigged and adjusted.
f. Install the cable guard pins at fuselage stations 331.50 and 340.
g. With the complete trim control system installed, set cable tension with the turnbuckles (18) at station 287.50 per Table V-I and check rigging and adjustment per paragraph 5-41.
h. Install and seal access plates and panels.

5-41. RIGGING AND ADJUSTMENT OF RUDDER TRIM. (Refer to Figure 59.)

a. To adjust the rudder trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check:
    1. Trim cables are evenly wrapped (centered) on their drums, and both cable turnbuckles are located approximately at fuselage station 287.50
    2. The cable tension is set in accordance with Table V-I.
b. Remove the access plate on the right side of the vertical fin.
c. With the trim screw (30) disconnected from the control rod and allowed to rotate, turn the trim drum until 11.25 turns of cable are on the forward end of the drum and 7.25 turns of cable on the aft end of the drum.

d. Now rotate the screw (30) so .50 of an inch exists between the forward screw stop (29) and the drum housing (31), as measured along the screw. (Neutral position of the screw is at this measurement.) Connect the control rod to the screw.
e. With trim screw in neutral position, the trailing edges of the tab and rudder should align. If they do not, remove the attachment bolt (37) and loosen the jam nut (35) on the rod end (36) at the aft end of the tab control rod. Turn the rod end until the trailing edges align. Install and secure the attachment bolt (37) and rod end jam nut (35).
f. Turn the trim in each direction to screw stops to check tab angles from the center line of the rudder as given in Table V-I and also check minimum number of wraps left on trim drum. (Minimum allowable is one and one quarter turns.)
g. Check adjustment of trim indicator per paragraph 5-49.

5-42. REMOVAL OF RUDDER SECTOR. (Refer to Figure 5-9.)

a. Remove the left pilot's seat and floor panel to the left of the control pedestal.
b. Remove the access plate, under the rudder, on top of the aft section of the fuselage.
c. Relieve cable tension from the rudder control cables by loosening one of the turnbuckles (4) at fuselage station 100.
d. Mark one end of the rudder sector (17) and cable end (39) to facilitate installation.
e. Disconnect the cables from the rudder sector ends.
f. Unbolt the rudder sector (17) from the rudder torque tube (36) and the hinge bracket (40). Remove the sector.

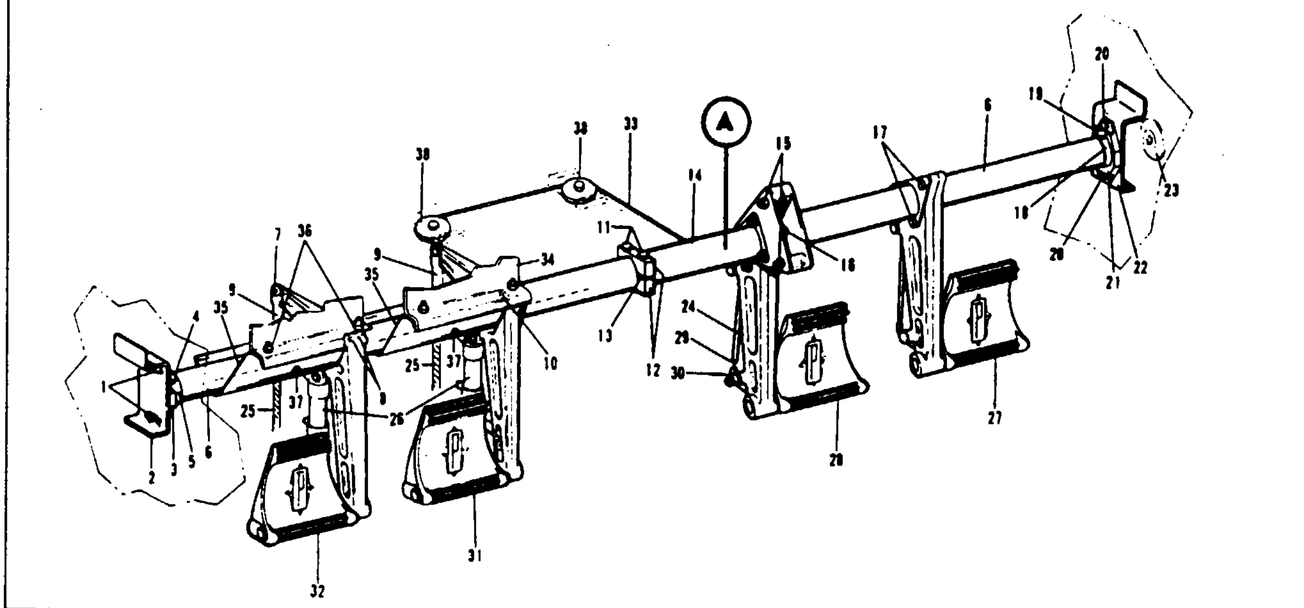
5-43. INSTALLATION OR RUDDER SECTOR. (Refer to Figure 5-9.)

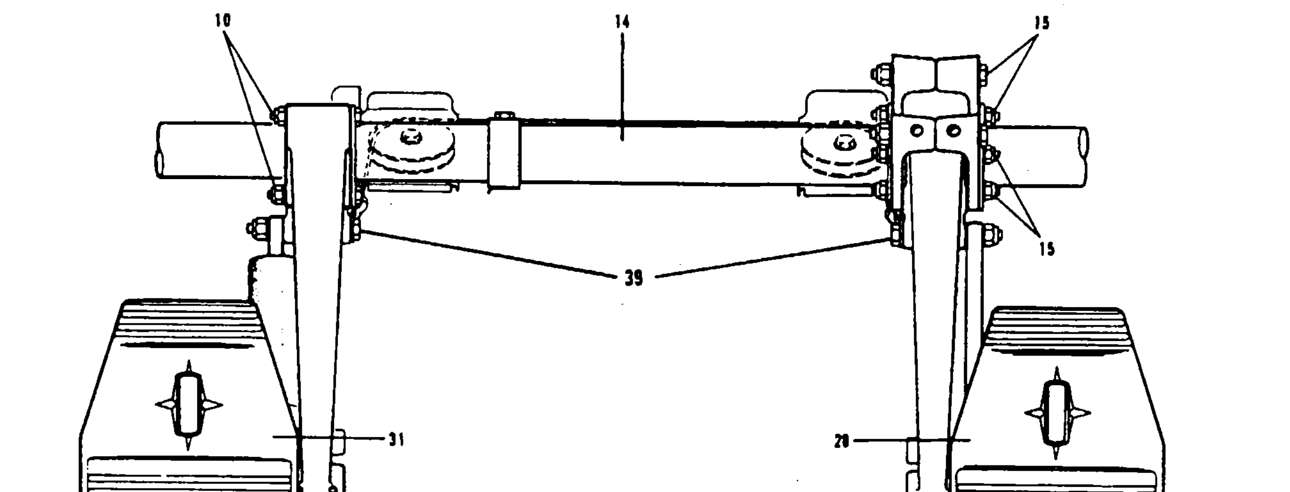
a. Position the rudder sector (17) under the rudder torque tube (36) and hinge (40) and secure with bolts, and torque.
b. Connect the rudder cables (7 and 8) to the rudder sector (17) and secure. Allow the cable ends (39) to rotate freely.
c. Set cable tension per Table V-I and check control cable rigging and adjustment per paragraphs 5-35 and 5-41.
d. Install and seal access plates and panels, also install left pilot's seat.

5-44. RUDDER PEDAL ASSEMBLY.

5-45. REMOVAL OF PEDAL ASSEMBLY. (Refer to Figure 5-12.)

a. Remove the pilot's seat and the floor panel to the left of the control pedestal.
b. Relieve the tension from the rudder control cables by loosening one of the cable turnbuckles at fuselage station 100.
c. Disconnect the rudder control cables (25) from the pedal assembly.
d. Disconnect the brake master cylinders (26) from the pedal assembly.
e. Disconnect the balance cable (33) from the inboard pedals (28 and 31) by removing the flat head pins (39).
f. Remove the rudder torque tube guards (35), if installed, by removing the machine screws, nuts, and clamps (37) positioning the guards to the torque tube and remove the attaching hardware (36) securing each guard to the brake line support channel (34).
g. Remove the small round access plate (23) located on the right side of the fuselage at station 87.25.
h. Remove the bolts that secure the retainer collars (5 and 18) and the left pedals (28 and 32) on the torque tube (6).
i. Slide the torque tube out through the right side of the fuselage. (Note the number of spacer washers between each set of collars (5 and 18) and bearings (3 and 21).





1. NUT, ANCHOR
2. BRACKET, MOUNTING
3. BLOCK, BEARING
4. BOLT ASSEMBLY
5. RETAINER
6. TORQUE TUBE
7. BOLT ASSEMBLY
8. ROLL PIN-BOLT
9. CABLE END
10. BOLT ASSEMBLY
11. BOLT ASSEMBLY
12. BLOCK, BEARING
13. SPACER
14. TORQUE TUBE, OUTER
15. BOLT ASSEMBLY
16. ROLL PIN-BOLT
17. BOLT ASSEMBLY
18. RETAINER
19. BOLT ASSEMBLY
20. BOLT, CAP
21. BLOCK, BEARING
22. BRACKET, MOUNTING
23. ACCESS PLATE
24. ROD
25. CONTROL CABLE
26. BRAKE CYLINDER
27. PEDAL, RIGHT OUTER
28. PEDAL, RIGHT INNER
29. NUT, JAM
30. BOLT ASSEMBLY
31. PEDAL, LEFT INNER
32. PEDAL, LEFT OUTER
33. BALANCE CABLE
34. BRAKE LINE SUPPORT CHANNEL
35. TORQUE TUBE GUARD
36. MACHINE SCREWS AND NUTS
37. SCREWS, NUTS AND CLAMPS
38. PULLEY
39. FLAT HEAD PINS

Figure 5-12. Rudder Pedal Installation

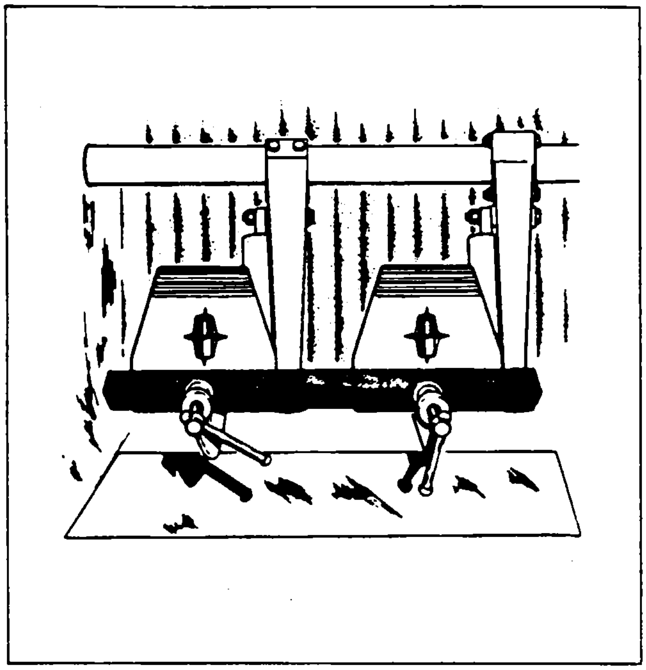


Figure 5-13. Clamping Rudder Pedals in Neutral Position

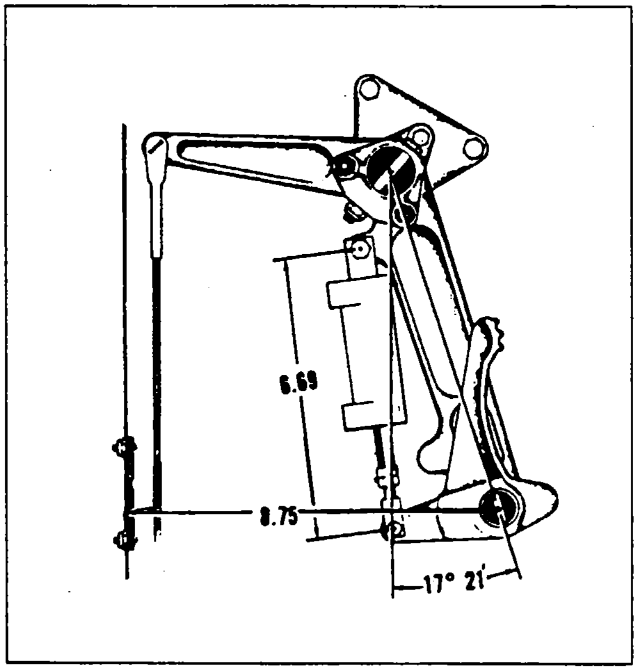


Figure 5-14. Rigging of Rudder Pedals

j. The left pedals (28 and 32) are free to be removed.
k. To remove the outer torque tube assembly (14) with the right pedals (27 and 31), unbolt and separate the tube bearing blocks (12) located on top of the wheel housing. (Note the number of spacer washers (13) between the bearing blocks.)
l. Remove the outer tube assembly (14) and disassemble.
m. The torque tube bearings may be removed by removing the cap bolts that secure the bearings to their mounting brackets.
n. If desired, the balance cable (33) may be removed by removing the pulley guard pins at both pulleys (38).

5-46. INSTALLATION OF PEDAL ASSEMBLY. (Refer to Figure 5-12.)

a. If the balance cable (33) has been removed, install before proceeding with the rest of the installation and replace pulley guard pins.
b. Install and secure the torque tube bearings (3 and 21) to their mounting brackets (2 and 22) with cap bolts (20).
c. Assemble the outer torque tube assembly (14) including both right pedals (27 and 31).
d. Position the outer torque tube assembly (14) over the wheel housing and install bearing blocks (12). Spacers (13) are installed between the blocks so that when the blocks are bolted together the tube will be free to rotate with minimum up and down play. (Spacers are available in thickness of .012 ± .02, P/N 81102-35; .018 ± .02, P/N 81102-36 and .032, P/N 8110737.)
e. Lubricate and slide torque tube (6) through the side of the fuselage and right bearing (21) far enough to slide the right retainer collar (18) on the tube.
f. Slide the tube (6) through the outer torque tube assembly (14) installing the left pedals (28 and 31) and the left retainer collar (5).
g. Insert bolts (4 and 19) through bolt retainer collars (5 and 18) and tube (6) (do not install nut) and determine number of spacer washers required to allow minimum side play. The tube may be slid to either side when the collar bolts are removed to allow the spacer washers to be divided and installed evenly between each set of retainers (5 and 18) and bearings (3 and 21).

h. With the spacer washers installed, install the bolts through the retainers (5 and 18) and both left rudder pedals (28 and 32). Install nuts with washers and secure.
i. Wipe off excessive lubricant from torque tube.
j. Install the rudder torque tube guards (35) by positioning each guard in front of the torque tube and securing it in place with the two machine screws and nuts (36) at the brake line support channel (34). Install the clamps around torque tube and fasten to the guards with the machine screws and nuts (37).
k. Connect the balance cable (33) to the rudder pedals. Pedal alignment may be checked by referring to Paragraph 5-47.
l. Connect the rudder cables (25) to the pedal assembly and set cable tension per Table V-I, and check rigging and adjustment per Paragraph 5-47.
m. Install and seal access plates, panels and seats.

5-47. RIGGING AND ADJUSTMENT OF RUDDER PEDALS. (Refer to Figures 5-13 and 5-14.)

a. Clamp the rudder pedals on the left or right side to align in a lateral position.
b. Adjust the brake master cylinders (26) and rods (24) to obtain 6.69 inches measured from the upper fitting to the lower fitting on the pedal assembly as shown in Figure 5-14.
c. The neutral angle of the rudder pedals is 17° 21' aft of the vertical position, with the airplane level, as shown in Figure 5-14.

5-48. TRIM INDICATORS.

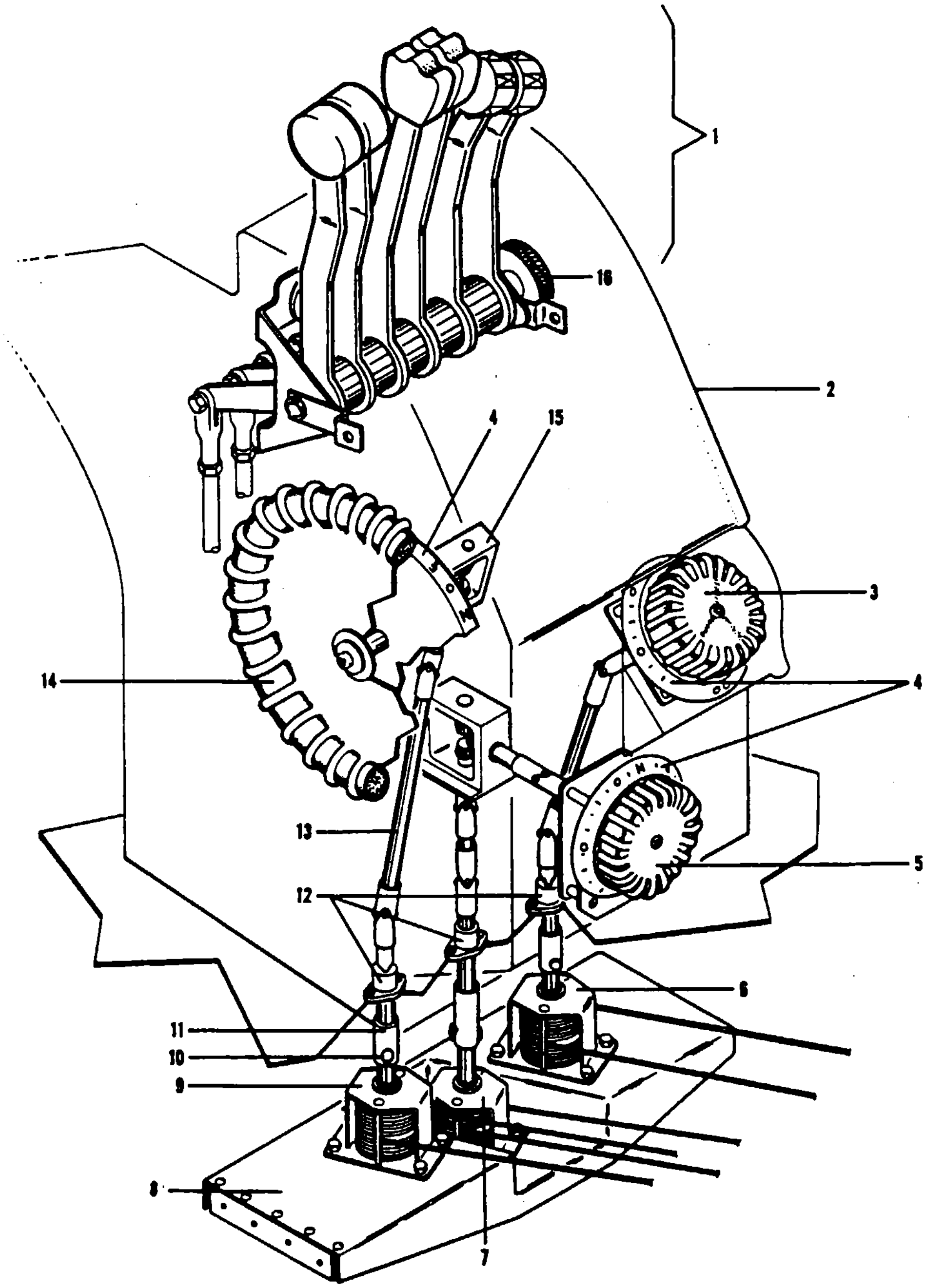
5-49. ADJUSTMENT OF TRIM INDICATORS.

a. Check the indicator mechanism for freedom of movement and proper lubrication in accordance with the lubrication chart in Section II.
b. Maintain the trim tabs at the control surfaces in a neutral position.
c. Ascertain that the trim drums are at their neutral positions.
d. If the trim indicators are not aligned with the neutral marker on the pedestal, proceed with the following steps:
   1. Remove the trim control wheel from the shaft.
   2. Loosen the three screws which hold the indicator discs to the indicator mechanism.
   3. Rotate the discs to the right or left to align the neutral position of the discs with the marker on the pedestal.
   4. Tighten the three screws and replace the trim control wheel.

5-50. FORWARD TRIM MECHANISM. (Refer to Figure 5-15.) All three forward trim screw assemblies are mounted on the same bracket located below the floor level of the control pedestal and should be removed and installed in accordance with the following procedures.

5-51. REMOVAL OF FORWARD TRIM MECHANISM.

a. Carefully remove the access panel located on the floor in front of the control pedestal and at the turnbuckles for the particular trim system being serviced.
b. Block the particular trim cables at the screw mechanism and aft of the turnbuckles for that system.
c. Disconnect the turnbuckles and remove the cotter pin and clevis pin (10) from the sleeve (11) of the trim mechanism being serviced.
d. Remove the four bolts which secure the screw assembly to the mounting bracket (8).
e. Slide the sleeve (11) up on the shaft and disengage the male and female shaft ends and remove the screw assembly from the mounting bracket.
f. It is now possible to remove the complete trim screw assembly and forward trim cables from the airplane for any further service.



1. ENGINE AND PROP CONTROLS
2. CONTROL PEDESTAL
3. RUDDER TRIM CONTROL
4. TRIM POSITION INDICATOR
5. AILERON TRIM CONTROL
6. RUDDER TRIM SCREW
7. AILERON TRIM SCREW
8. MOUNTING BRACKET
9. ELEVATOR TRIM SCREW
10. PIN AND COTTER PIN
11. SLEEVE
12. BUSHING AND PLATE
13. SHAFT
14. ELEVATOR TRIM CONTROL
15. GEAR BOX
16. FRICTION CONTROL

Figure 5-15. Control Pedestal

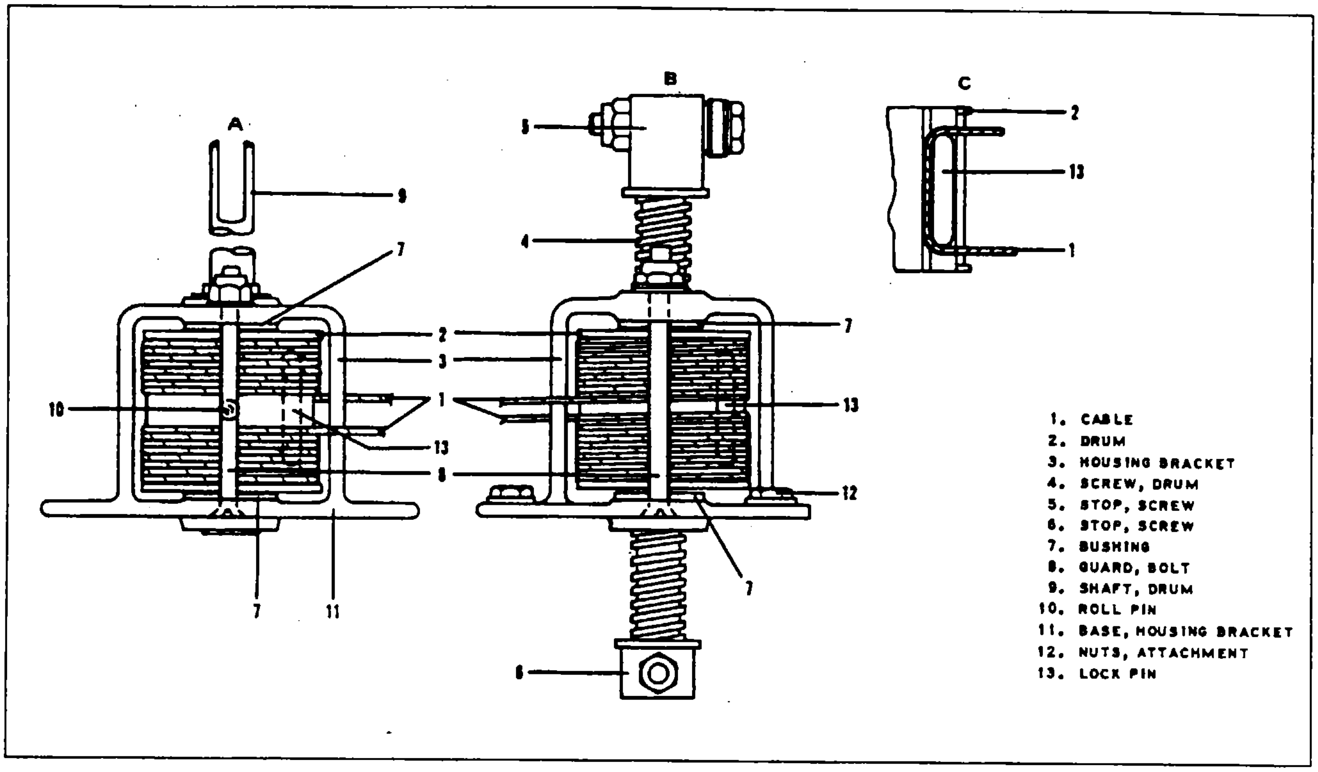


Figure 5-16. Trim Screw Assembly

5-52. INSTALLATION OF FORWARD TRIM MECHANISM.

a. Install the trim screw assembly and forward trim cables into the airplane, through the access panel opening in front of the control pedestal.
b. Connect the forward trim cables to the aft trim cables and secure the turnbuckles.
c. Position the trim screw assembly on the mounting bracket and align the male and female shaft ends together.
d. Slide the sleeve over the shaft connection and install the four bolts to secure the trim mechanism to the mounting bracket.
e. Install the clevis pin through the sleeve and shaft and secure it in place with a new cotter pin.
f. Remove the blocks from the trim cables and rig the particular trim system in accordance with the instructions given in this section of the service manual for the system being serviced.
g. Replace the access panels and any other items removed to accomplish the servicing of the mechanism.

5-53. TRIM DRUM.

5-54. WRAPPING THE TRIM DRUM. (Refer to Figure 5-16.) All trim drums are wrapped basically by the same procedure and must be removed from the airplane.

a. Mark the end of the drum (2) toward the base (11) of the housing bracket (3) for a reference when later installing and wrapping the cable on the drum.
b. With the drum housing bracket (3) firmly held, remove one of the cable guard bolts (8) from the housing bracket.
c. Remove the drum screw (4) or the drum shaft (9) from the trim screw assembly. The screw (4) is removed by removing the stop (5) located on the end of the screw, opposite the base (11) of the housing bracket. Turn the screw from the drum (2). The shaft (9) is removed by driving the roll pin (10) from the center of the drum (2). Press the shaft from the drum.
d. Remove the drum from the housing.

e. Unwrap the trim cable (1) and remove the cable and lock pin (13) from the drum. (If one end of the cable has been marked to facilitate hook-up of the cable ends, note this location in relation to the drum when installing a new cable on the drum.)
f. Check the condition of the bushings (7) in the housing bracket for excess wear.
g. To install and wrap the trim cable, locate the center of the cable, measuring from end to end.
h. Insert the center of the cable into the cable slot in the drum and install the lock pin (13).
i. Hold the drum (2) with the previously marked or base end of the drum down.
j. Looking down on the drum, wrap the cable that leads from the base end up nine and one-quarter turns in a counterclockwise direction. The cable from the upper end, wrap down in a clockwise direction, nine and one-quarter turns.
k. Insert the drum in the housing bracket, position the drum and route the cables from the assembly as shown in Figure 5-16.
l. Install the screw (4) and screw stop (5) or the drum shaft (9) and secure with the roll pin (10).
m. Block the trim cables in center position to keep them tight and from unwrapping, by the method shown in Figure 5-8.
n. Center the drum between the stops on the screw by rotating the screw.

5-55. WING FLAP CONTROLS.

5-56. REMOVAL OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-17.)

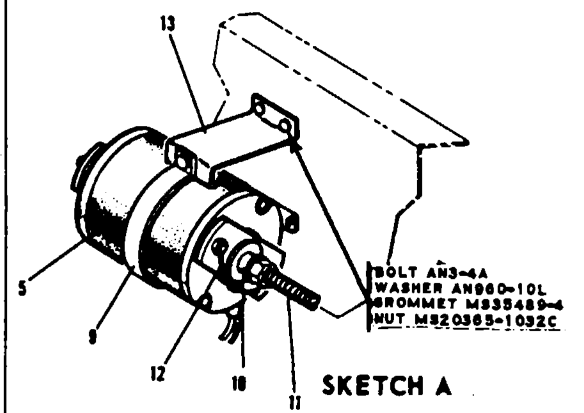
a. Remove the center floor panel located in the main cabin area. The flap actuator motor (5) is located on the forward side of the fuselage bulkhead at station 174.
b. Disconnect the electrical leads from the motor.
c. Cut safety wire (12) and disconnect the flexible drive shaft ends (4 and 6) from the motor.
d. Remove the clamp (9) that holds the motor on its mounting bracket (13). Remove the motor.
e. If desired to replace the shock grommets in the bulkhead, the motor with its mounting bracket may be removed together by removing the bracket mounting bolts at the bulkhead.

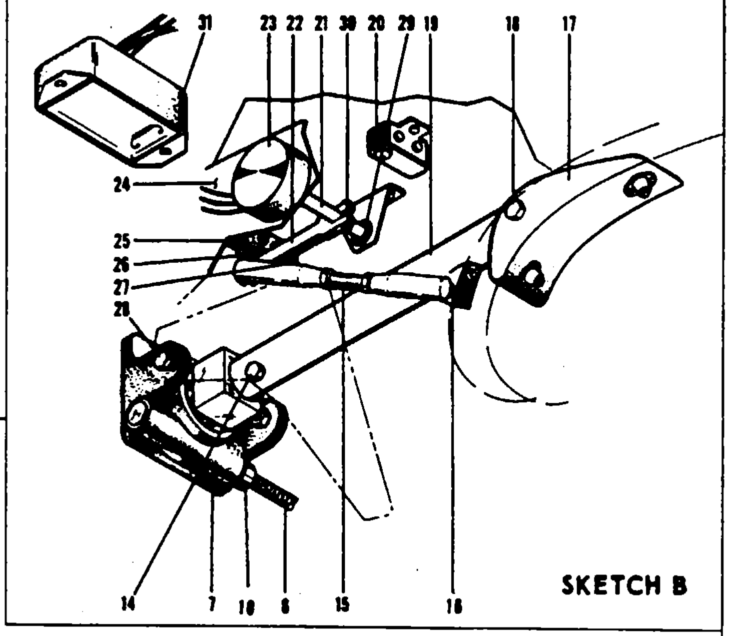
5-57. INSTALLATION OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-17.)

a. Install the shock grommets in the bulkhead at station 174.
b. Install the flap actuator motor (5) and bracket (13) on the forward side of the bulkhead. Ascertain that the anti-rotation pin on the motor fits in the pin hole in the mounting bracket. Secure the holding clamp (9).
c. Connect the flexible drive shaft ends (4 and 6) to the motor (per Paragraph 5-59) and secure nut (10) with .040 safety wire (12).
d. Connect the electrical leads.
e. Check flap rigging and adjustment per paragraphs 5-64 and 5-65.
f. Install access plates and panels.

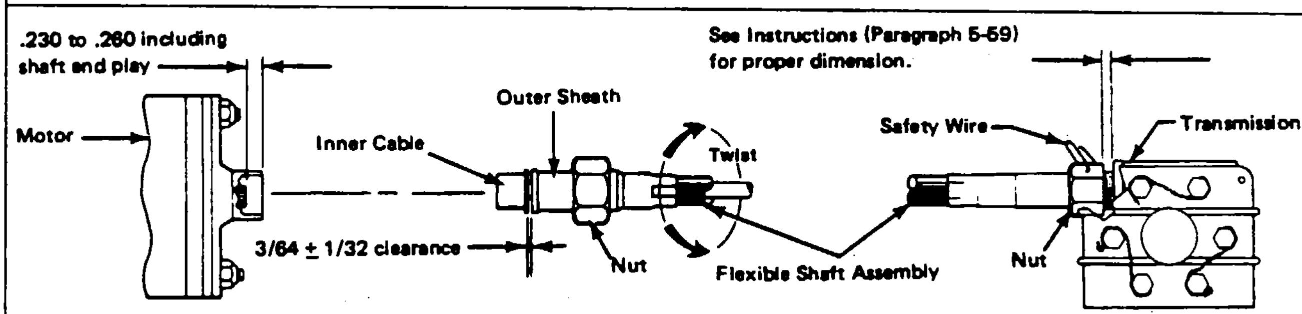
5-58. REMOVAL OF FLEXIBLE FLAP ACTUATOR SHAFT. (Refer to Figure 5-17.)

a. Remove the center floor panel located in the main cabin area.
b. Remove the right and/or left row of seats and floor panels aft of the main spar.
c. Remove the aft access plate on the fairing located on the underside between the fuselage and wing.
d. Remove the access plates at the aft side of the wheel well at stations 34.50, 44.50 and 54 and on the under side of the wing at the trailing edge at stations 65, 82.75 and 92.50.
e. Cut the safety wire (12) and disconnect the shaft (4 and 6) from the actuator motor (5) and flap transmission (3 and 7).
f. Remove the support clamp on the fuselage bulkhead and the support grommets within the wing and fuselage.
g. Remove the actuator shaft.





1. INDICATOR, FLAP POSITION
2. SELECTOR SWITCH
3. TRANSMISSION ASSY, RIGHT
4. SHAFT ASSEMBLY, RIGHT
5. MOTOR
6. SHAFT ASSEMBLY, LEFT
7. TRANSMISSION ASSY, LEFT
8. FLAP POSITION SENDER ASSY
9. STRAP, MOTOR SUPPORT
10. NUT
11. SHAFT ASSEMBLY
12. WIRE, SAFETY .040
13. MOUNTING BRACKET, MOTOR
14. SPREADER ASSEMBLY
15. ROD, LINKAGE
16. BUSHING AND SCREW ASSY
17. FLAP HORN
18. BOLT ASSEMBLY
19. TUBE, TRANSMISSION
20. SWITCH, DOWN LIMIT
21. SHAFT, SENDER
22. ARM, SENDER
23. SENDER, FLAP POSITION
24. MOUNTING BRACKET, SENDER
25. SWITCH, UP LIMIT
26. ADJUSTMENT BOLT, UP LIMIT
27. ADJUSTMENT BOLT, DOWN LIMIT
28. ATTACHMENT BOLT ASSY
29. GROMMET
30. BOLT ASSY, SENDER ARM
31. TIME DELAY SWITCH



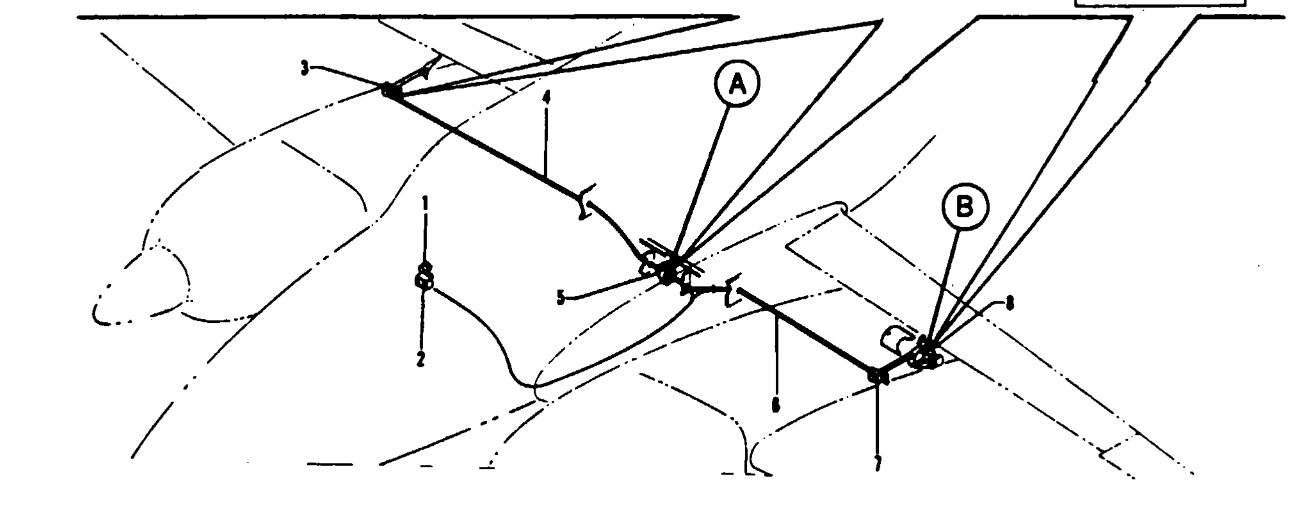


Figure 5-17. Flap Controls

5-59. INSTALLATION OF FLEXIBLE FLAP ACTUATOR SHAFT. (Ref. Fig. 5-17.)

a. Draw the flexible shaft, 1 or 6, through the wing into the fuselage.
b. Align and insert tang on shaft assembly into slot in transmission. Tighten nut finger tight and wrench not over 1/16 turn from finger tight when installed by this method, the dimension between the nut and transmission will bottom, or be within 3/16 of an inch of bottoming, against transmission. Safety nut with .040 wire.
c. After the transmission end of shaft has been connected, observe the clearance between the outer sheath and inner cable. Twist outer sheath in proper direction; bring clearance to 3/64 ± 1/32 of an inch. It may be necessary to loosen clamp on fuselage bulkhead in order to twist outer sheath if cable has not been removed from aircraft. Holding outer sheath in this position, insert spline into flap motor and tighten nut. Safety nut with .040 wire. The clearance check noted above must be conducted on every occasion that the flexible shaft is disconnected from the motor or transmission.
d. Check the flap rigging and adjustments per Paragraphs 5-64 and 5-65.
e. Install the access plates, panels, clamps, grommets and seats.

5-60. REMOVAL OF FLAP TRANSMISSION ASSEMBLY. (Refer to Figure 5-17.)

a. Lower the flap and remove the access plate on the aft underside of the wing and at the false spar area, both of which are at station 92.50.
b. Disconnect the transmission tube (19) from the flap horn bracket (17).
c. Remove the safety wire (12) and disconnect the flexible actuator shaft (4 and 6).
d. Remove the spreader bushing and washers (14) from between the transmission attachment brackets.
e. Remove the transmission from its mounting brackets and draw the unit through the access opening in the wing false spar.

5-61. INSTALLATION OF FLAP TRANSMISSION ASSEMBLY. (Refer to Figure 5-17.)

a. Lubricate the flap transmission assembly in accordance with lub chart.
b. Insert the transmission through the access opening in the wing false spar and attach to its mounting brackets. To allow the transmission to rotate, tighten the attachment bolts (28) only finger tight and safety.
c. Install the spreader bushing with one washer (14) between each mounting bracket and bushing. Install the through bolt and secure.
d. If working with the left transmission (7), connect the flexible actuator shaft (6) (per Paragraph 5-59) and safety with .040 safety wire. Attach the right flexible shaft (4) during rigging and adjustment.
e. Check the flap rigging and adjustment per Paragraphs 5-64 and 5-65.
f. Install access plates.

5-62. REMOVAL OF FLAP POSITION SENDER. (Refer to Figure 5-17.)

a. Lower the flap and remove the access plates on the left wing false spar at stations 92.50 and 101.
b. Loosen the arm (22) on the sender shaft (21).
c. Disconnect the electrical leads from the sender (23).
d. Loosen the sender attachment nut and slide the sender from its mounting brackets.
e. The flap limit switches (20 and 25) may be removed through these access openings if desired.

5-63. INSTALLATION OF FLAP POSITION SENDER. (Refer to Figure 5-17.)

a. Start the sender shaft (21) through its mounting bracket (24) hole and install the attachment washer and nut over the shaft. Continue to slide the shaft through the hole and install the arm (22) on the shaft. Secure the sender (23) in position. Allow the sender arm (22) to be free to rotate.
b. Connect the electrical leads.
c. Check rigging and adjustment per Paragraph 5-65.

5-64. RIGGING AND ADJUSTMENT OF FLAP. (Refer to Figure 5-17.)

a. Remove the access plate on the right wing false spar at station 92.50 and on the left wing false spar at stations 92.50 and 101.
b. The rigging and adjustment of the flap may be accomplished by the following procedure:
   1. Ascertain that the flexible actuator shaft (6) to the left transmission assembly (7) is connected and safetied and that the right shaft (4) is disconnected from the right transmission (4). (Refer to Paragraph 5-59.)
   2. Ascertain that the position sender arm (22) is free to rotate on the sender shaft (21) or the linkage rod (15) is disconnected at the flap and taped back inside the wing.
   3. With the flap disconnected from the transmission tube (19), turn the actuator tube out 28 turns from its forward stop position, align the attachment hole in the tube with the holes in the flap horn and temporarily install bolt (18).
   4. Check alignment of the actuator and flap horn (17) by sighting along the actuator tube (19) while the flap is in both the near extended and retracted positions. Do not run flap to its extreme position (end of tracks).
   5. Should the tube (19) and horn (17) not align, disconnect the tube and loosen the bolts securing the horn to the flap enough to allow the horn to be moved by tapping with a soft hammer. Connect the tube to the horn, and tap the horn to achieve a satisfactory alignment. Lower the flap to the near extended position, disconnect the tube from the horn and torque the horn attachment bolts.
   6. With the actuator tube (19) and flap horn (17) aligned, connect the tube to the horn with bolt assembly (18). Tighten the castellated nut so as to allow .03 inches thrust play of the bolt and safety.
   7. Connect the right flexible actuator shaft (4) to the right transmission assembly (3). (Refer to Paragraph 5-59.)
   8. With the right flap disconnected from the transmission tube, turn the right tube out as far as necessary to give the right flap the same angular setting as the left flap. (Rigging the right flap to the left flap may require a smaller angular adjustment than can be accomplished by rotating the transmission actuator sleeve 180° on the screw. This can be done by disconnecting the flexible shaft from the transmission and turning the transmission worm gear with a short slot head screwdriver.)

NOTE

When measuring flap deflection angles, lift the trailing edge of the flap to eliminate play between rollers and track slots.

WARNING

Refer to Service Bulletin No. 739.

c. The adjustment of the flap limit switches may be accomplished by the following procedure:
   1. Run the flaps to the full down position and if not previously accomplished loosen the screw that clamps the sender arm (22) on the sender shaft (21).
   2. Laterally locate the arm on the sender shaft so the adjustment bolts (26 and 27) on the arm (22) will contact the limit switch (20 and 25) plungers in the center of the bolt head.
   3. Tighten the arm clamping screw (30) in such a way that moving the arm (22) will rotate the sender shaft (21), but the arm will slip on the shaft if the shaft is securely held.
   4. Connect the linkage rod (15) to the tab on the flap using the rod attachment bushing (16) and screw with nylon insert. The rod should extend through the bushing (16) and screw with nylon insert. The rod should extend through the bushing .12 of an inch.

5. Adjust the flaps to an extended setting as given in Table V-I by loosening the jam nut on the proper adjustment bolt (27) and turning in or out as required to actuate the down limit switch (20). Tighten the jam nut.
6. Run the flap up to a near retracted position. Make a full extension run to insure that the momentum of the flap going down and tightening of the jam nut has not moved the flap setting from the setting tolerance.
7. Adjustment of the up limit switch (25) is accomplished in the same manner except that the flaps should be stopped in the retracted position just as the flap rollers approach the end of track slots. (Approximately 1/16 of an inch on the closest roller both flaps.)

d. Check adjustment of the flap position indicator.
e. Refer to Section III, Paragraph 3-11 for information on reduction of friction or Paragraph 3-12 for wing flap motor no load RPM check if operational problems exist in the flap system.
f. Flexible shaft assemblies disconnected from transmissions or from flap motor necessitates a check of the clearance between the inner cable and outer cable sheath with the transmission end of the cable connected per Paragraph 5-59. (Ref. S.B. 739)
g. Check that all necessary bolts are safetied, clamps secured and access plates installed.

5-65. RIGGING AND ADJUSTMENT OF FLAP POSITION SENDER.

a. Lower the flaps and remove the access plates on the left wing false spar at stations 92.50 and 101.
b. Lower the flap to an angle of 15° ± 1 (lift flap trailing edge to obtain angle measurement), loosen sender arm (22) on the sender shaft (21) and rotate the shaft until the wing flap indicator on the instrument panel shows the flap at the take-off position (bottom of white arc).
c. Tighten the arm (22) on the sender shaft. Check the three flap positions (retracted, take-off and extended) with respect to the angular settings and indicated positions on the wing flap indicator.
d. Install the access plates.

5-66. INSPECTION OF TIME DELAY SWITCH OPERATION. This inspection should be done after the flaps have been rigged and checked for normal operation. The time delay switch is installed in the flap electrical system so that when the flap switch is actuated (flaps completely extended or retracted), and if after one second the left flap does not move off the limit switches, the time delay switch shuts off the flap motor. The right flap will travel approximately 9 ± 1 degrees.

a. Lower the flaps and remove the access plates to the limit switches in the left wing false spar at stations 92.50 and 101.
b. With the flaps part way down, depress the up limit switch and select flap down. The system should shut down within one second. With the limit switch still depressed (If the limit switch is opened the time delay switch will reset and allow the system to become operative), return the flap selector switch to neutral position and again select flaps down. The system should be inoperative. Determine that the flap travel was not more than 9 ± 1 degrees.
c. Repeat step b except depress the down limit switch and select flaps up. The system should again shut down in one second and the flap travel should not exceed 9 ± 1 degrees.

NOTE

The only way that further right flap extension can occur after the time delay switch shuts off the motor, is if the pilot would cycle the master switch off and on, and again select flaps.

The time delay switch does not affect or shut off the flap motor if a failure occurs when the left flap is between the up and down limit switches.

The time delay switch is passive in the flap electrical system during normal flap operation.

d. Reinstall the access plates in the left wing false spar at stations 92.50 and 101.

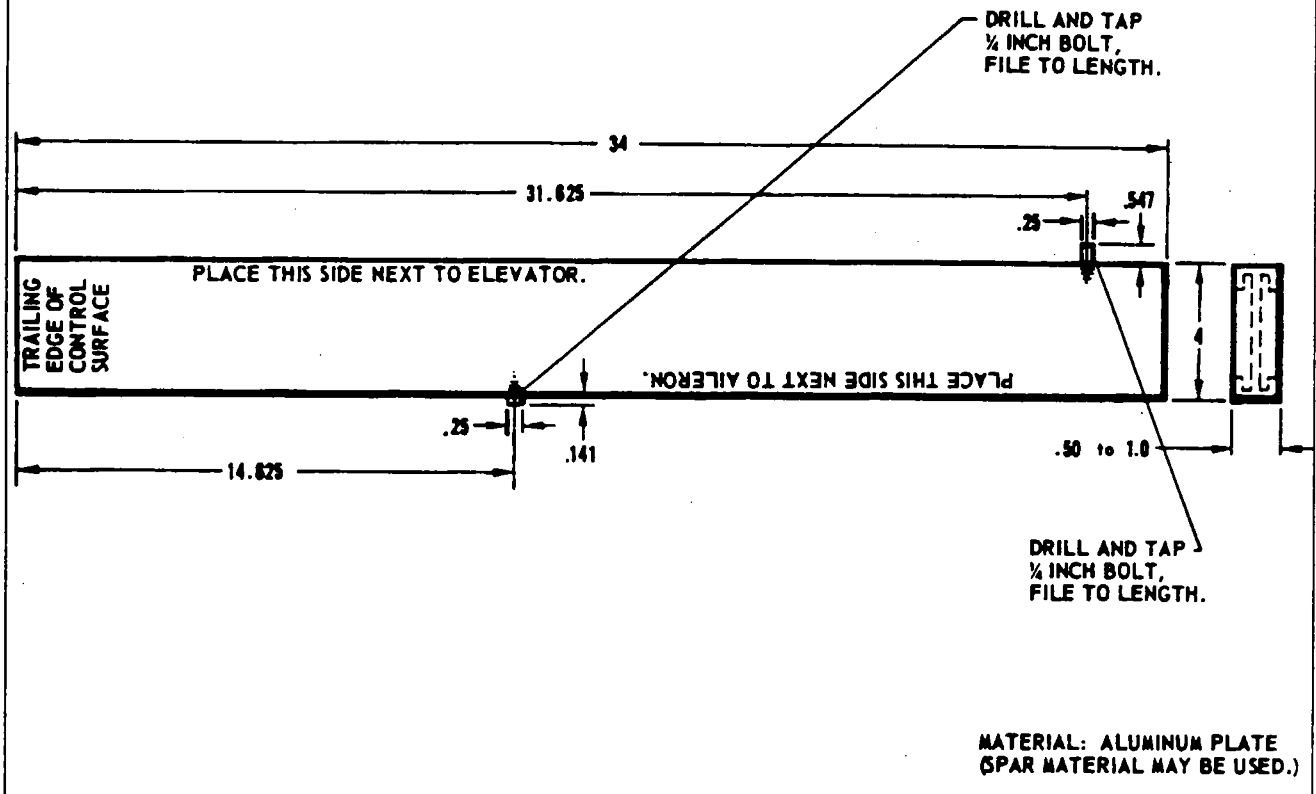


Figure 5-18. Fabricated Aileron-Elevator Rigging Tool

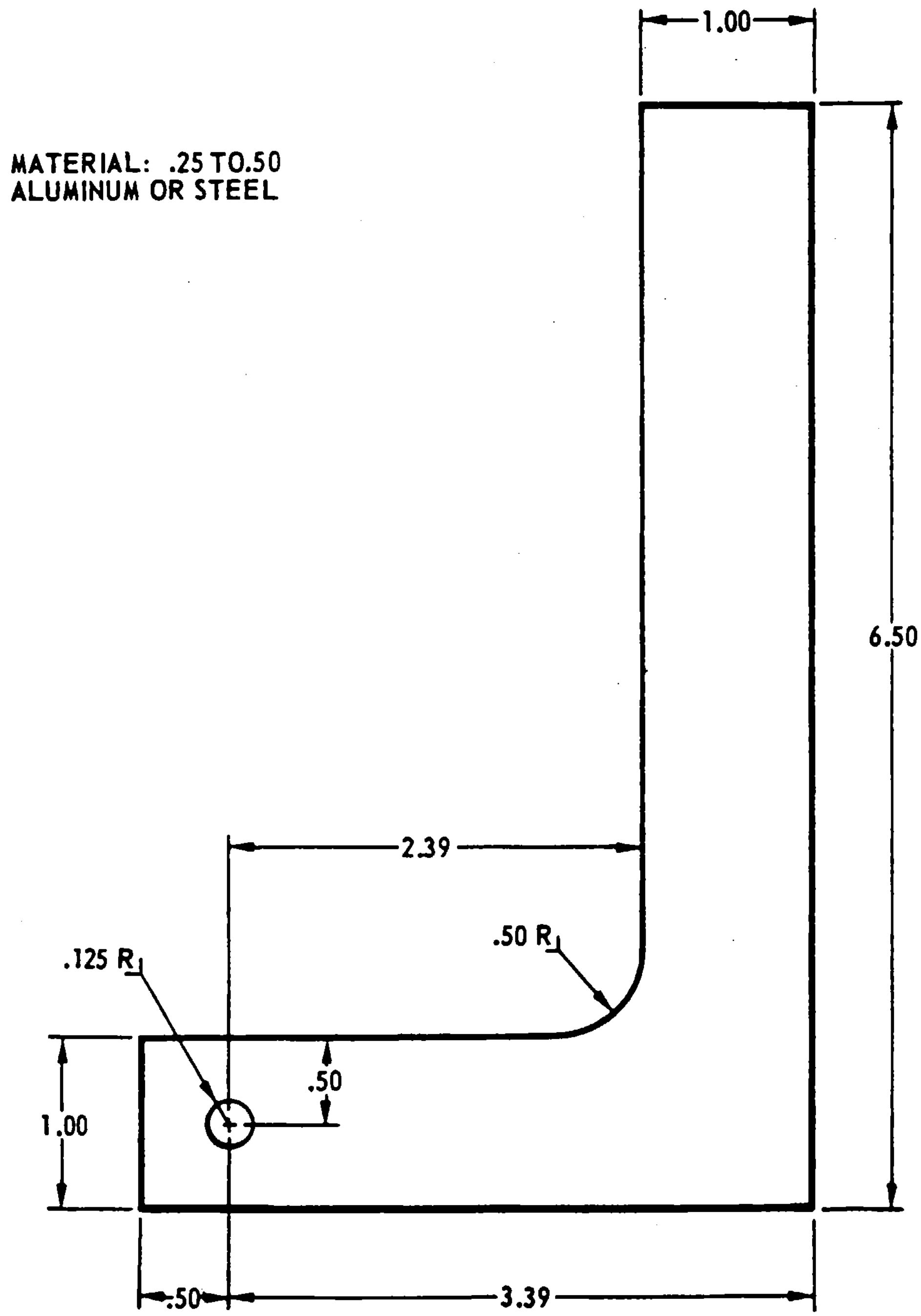


Figure 5-19. Fabricated Bellcrank Rigging Tool

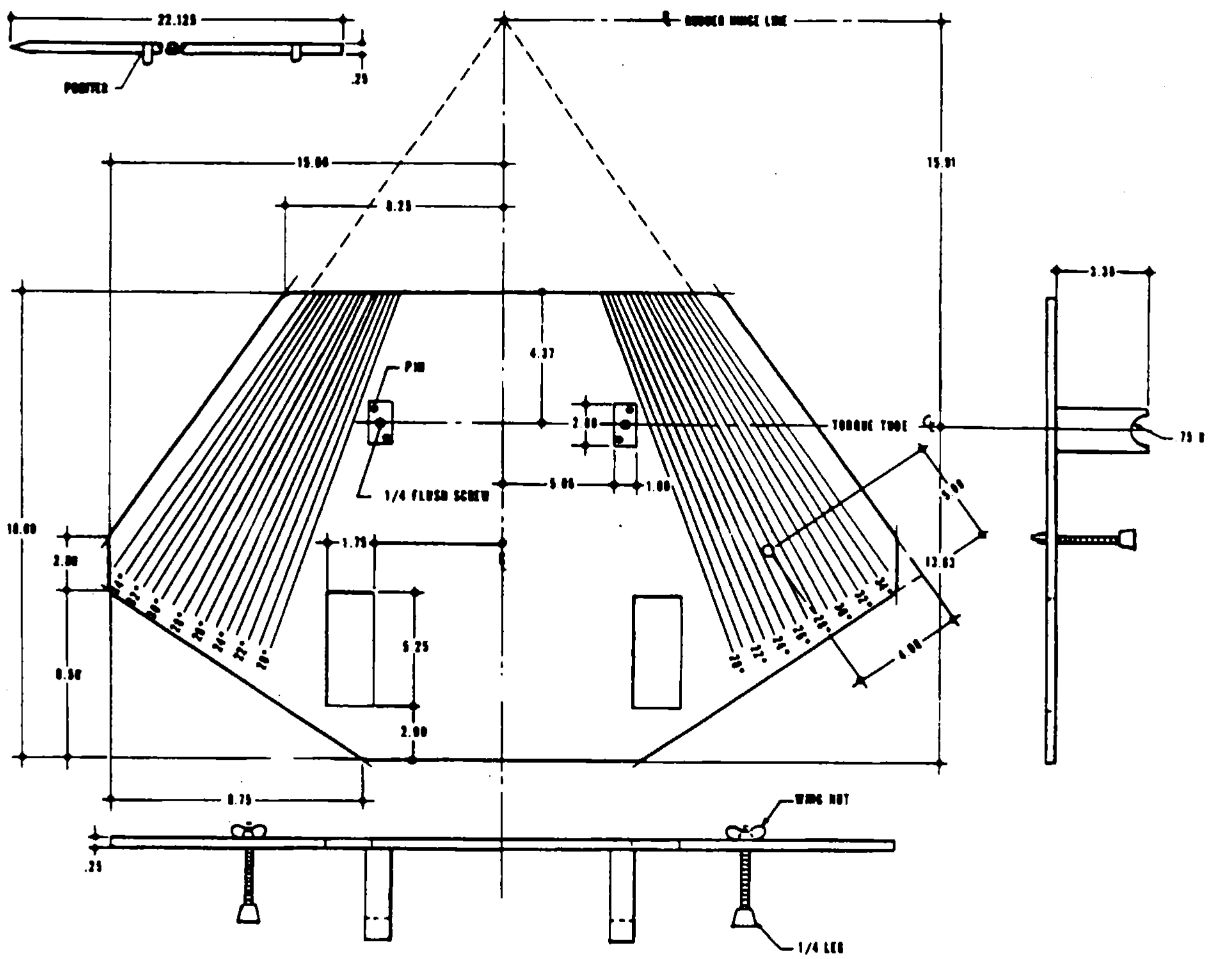


Figure 5-20. Fabricated Rudder Rigging Tool

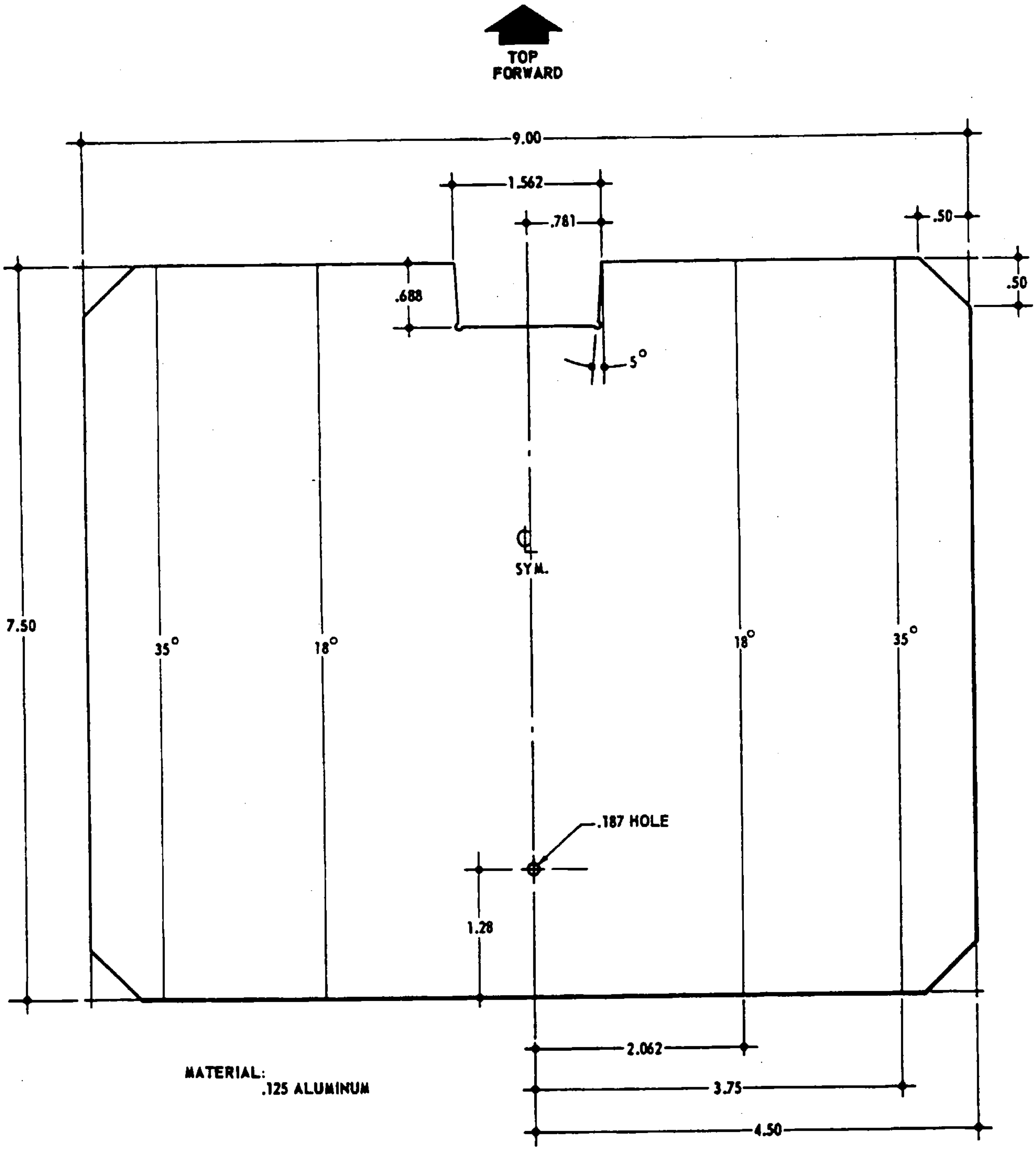


Figure 5-21. Fabricated Rudder Trim Tab Rigging Tool

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM		
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension. (Refer to Paragraph 5-11.)
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
Resistance to control wheel rotation.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension. (Refer to Paragraph 5-11.)
	Control column horizontal chain improperly adjusted.	Adjust chain tension. (Refer to Paragraph (5-7.)
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge.	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Control wheels not synchronized.	Incorrect control column rigging.	Rig in accordance with Paragraph 5-7.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM (cont.)		
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with Paragraph 5-11.
Incorrect aileron travel.	Aileron control rods not adjusted properly.	Adjust in accordance with Paragraph 5-11.
	Aileron bellcrank stops not adjusted properly.	Adjust in accordance with Paragraph 5-11.
Correct aileron travel cannot be obtained by adjusting bellcrank stops.	Incorrect rigging of aileron cables, control wheel and control rod.	Rig in accordance with Paragraph 5-11.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rig in accordance with Paragraph 5-11.
AILERON TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-19.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-16, 5-18 and 5-19.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
AILERON TRIM CONTROL SYSTEM (cont.)		
Trim control wheel moves with excessive resistance. (cont.)	Cable tension too high.	Adjust in accordance with Paragraph 5-19.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to Paragraphs 5-16, 5-18 and 5-19.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.
	Shaft binding at floorboard bushing.	Clean, align, lubricate or replace bushing.
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-19.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-19.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with Paragraph 5-49.

Table V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
ELEVATOR CONTROL SYSTEM		
Lost motion between control wheel and elevator.	Cable tension too low.	Adjust cable tension per Paragraph 5-23.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly.
Resistance to elevator control movement.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension per Paragraph 5-23.
	Binding control column.	Adjust and lubricate per Paragraph 5-7.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly.
	Bent elevator or hinge.	Repair or replace elevator or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Incorrect elevator travel.	Elevator arm stops incorrectly adjusted.	Adjust stop screws per Paragraph 5-23.
	Elevator control rod incorrectly adjusted.	Adjust control rod per Paragraph 5-25.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
ELEVATOR CONTROL SYSTEM (cont.)		
Correct elevator travel cannot be obtained by adjusting elevator arm stops.	Elevator cables incorrectly rigged.	Rig cables in accordance with Paragraph 5-23.
ELEVATOR TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-31.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-28, 5-30 and 5-31.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with Paragraph 5-31.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to Paragraphs 5-28, 5-30 and 5-31.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.
	Shaft binding at floorboard bushing.	Clean, align, lubricate or replace bushing.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
ELEVATOR TRIM CONTROL SYSTEM (cont.)		
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-23.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-19.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance Paragraph 5-48.
RUDDER CONTROL SYSTEM		
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per Paragraph 5-35.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Bolts attaching rudder to bellcrank are loose.	Tighten bellcrank bolts.
Excessive resistance to rudder pedal movement.	System not lubricated properly.	Lubricate system.
	Rudder pedal torque tube bearing in need of lubrication.	Lubricate torque tube bearings.
	Cable tension too high.	Adjust cable tension per Paragraph 5-35.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM (cont.)		
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with Paragraph 5-35.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with Paragraph 5-35.
	Nose wheel contacts stops before rudder.	Rig in accordance with Paragraph 5-35.
RUDDER TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-41.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-38, 5-40 and 5-41.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
RUDDER TRIM CONTROL SYSTEMS (cont.)		
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-38, 5-40 and 5-41.
	Trim tab hinge binding.	Lubricate hinge. Replace if necessary.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-41.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-41.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with Paragraph 5-49.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM		
Flaps fail to extend or retract though flap solenoid actuates. (Motor circuit.)	Battery switch off.	Turn switch on.
	Flap motor circuit breaker open.	Reset circuit breaker.
	Defective flap selector switch.	Replace selector switch.
	Defective flap motor circuit relay.	Replace relay.
	Ground open from flap motor circuit relay.	Check ground connection.
	Ground open from flap selector switch.	Check ground connection.
	Defective flap motor.	Replace motor.
	Defective circuit wiring.	Isolate cause and repair.
Flaps fail to extend or retract. Flap solenoid does not actuate. (Solenoid circuit.)	Battery switch off.	Turn switch on.
	Flap solenoid circuit breaker open.	Reset circuit breaker.
	Defective flap selector switch.	Replace selector switch.
	Defective up or down limit switch.	Replace defective switch.
	Defective flap solenoid.	Replace flap solenoid.
	Ground open from flap solenoid.	Check ground connection.
	Defective circuit wiring.	Isolate cause and repair.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM (cont.)		
Flaps fail to retract completely.	Up limit switch incorrectly adjusted.	Adjust flap in accordance with Paragraph 5-64.
Flaps do not extend completely.	Down limit switch incorrectly adjusted.	Adjust in accordance with Paragraph 5-64.
Flaps not synchronized or fail to fit evenly when retracted.	Incorrect adjustment of the transmission tube.	Rig in accordance with Paragraph 5-64. (Ref. S.B. 739)
Flaps have erratic operation during extension and retraction.	Binding between flexible shaft and motor.	Isolate cause and lubricate cable if required.
	Binding between track and rollers.	Refer to Rigging and Adjustment, Paragraph 5-64.
	Slipping or stripped transmission.	Replace transmission.
	Loose electrical connection.	Check and repair electrical connections.
	Transmission needs lubrication.	Lubricate transmission.
Flap on one side fails to operate.	Broken flexible actuator shaft.	Replace flexible shaft. (Ref. S.B. 739)
	Defective transmission.	Determine cause and replace or repair.
	Faulty time delay switch.	Check operation in accordance with Paragraph 5-66.

TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM (cont.)		
No indication of flap position on indicator.	Battery switch off.	Turn switch on.
	Circuit breaker open.	Reset circuit breaker.
	Sender unit ground open.	Check ground connection.
	Defective indicator unit.	Replace indicator unit.
	Defective sender unit.	Replace sender unit.
	Sender unit not adjusted properly.	Adjust sender unit in accordance with Paragraph 5-65.
	Defective wiring.	Check and repair wiring.

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PIPER

Customer Services

PA-31P **PRESSURIZED NAVAJO**

Service Manual

CARD 2 OF 4

PIPER AIRCRAFT CORPORATION

753 770

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material:

Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 770 issued July, 1972 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG720700	July 1972	—
PR730223	February 23, 1973	—
PR741122	November 22, 1974	—
PR750926	September 26, 1975	—
PR760715	July 15, 1976	1, 2, 3 and 4
PR761130	November 30, 1976	1, 2, 3, 4 and 5
PR771130	November 30, 1977	1, 2, 3, 4 and 5
PR790131	January 31, 1979	1, 2, 3 and 4
PR790907	September 7, 1979	1, 2 and 3
PR810320	March 20, 1981	1, 2, 3 and 4
PR821110	November 10, 1982	1, 2, 3 and 4
IR860430	April 30, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March 13, 1990	1
IR941012	October 12, 1994	1 and 2

INTERIM REVISION

Revisions appear in Sections III and IV of card 1, and Section VIII of card 2. Please dispose of your current cards 1 and 2, and replace them with the revised cards. DO NOT DISPOSE OF CARDS , 3, 4, or 5.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

LIST OF TABLES

SECTION VI

HYDRAULIC SYSTEM

Paragraph			Aerofiche Grid No.

Paragraph		Aerofiche Grid No.
6-90.	Assembly of Hand Pump Suction Screen	2C12
6-91.	Assembly of Reservoir	2C12
6-92.	Assembly of Manifold	2C12
6-93.	Assembly of Power Pack Handle Release Mechanism	2C13
6-94.	Installation of Manifold	2C14
6-95.	Installation and Adjustment of Inboard Gear Doors Switch	2C15
6-96.	Power Pack Bench Test Adjustment	2C15
6-97.	Adjustment of Handle- Release Mechanism	2C15
6-98.	Adjustment of Hand Pump Relief Valve	2C16
6-99.	Adjustment of Main Relief Valve	2C16
6-100.	Adjustment of Priority Valve	2C17
6-101.	Adjustment of Door Solenoid Valve	2C17
6-102.	Adjustment of Door Vent Valve	2C17
6-103.	Assembly of Power Pack	2C17
6-104.	Testing Reservoir for Leakage	2C17
6-104a.	Installation of Power Pack	2C20
6-105.	Landing Gear Selector Handle Mechanism	2C20
6-106.	Operation of Gear Selector Handle Mechanism	2C20
6-106a.	Removal of Gear Selector Handle Mechanism	2C20
6-106b.	Installation of Gear Selector Handle Mechanism	2C20
6-107.	Inspection of Landing Gear Selector Handle	2C21
6-108.	Adjustment of Landing Gear Selector Handle	2C21
6-109.	Filling Hydraulic Reservoir	2C22
6-110	Bleeding the Hydraulic System	2C22
6-111.	Hand Pump (Emergency) (Ozone)	2C22
6-112.	Removal of Hand Pump	2C22
6-113.	Disassembly of Hand Pump	2C22
6-114.	Cleaning, Inspection and Repair of Hand Pump	2C24
6-115	Assembly of Hand Pump	2C24
6-116.	Installation of Hand Pump	2C24
6-117.	Bleeding Hand Pump	2C24
6-118.	Hand Pump Test	2C24
6-119.	Hand Pump (Emergency) (Wiebel Tool)	2D1
6-120.	Removal of Hand Pump	2D1
6-121.	Disassembly of Hand Pump	2D1
6-122.	Cleaning, Inspection and Repair of Hand Pump	2D1
6-123.	Assembly of Hand Pump	2D1
6-124.	Installation of Hand Pump	2D3
6-125.	Bleeding Hand Pump	2D3
6-126.	Hand Pump Test	2D3
6-127.	Gear Actuating Cylinders (Ozone)	2D3
6-128.	Removal of Gear Actuating Cylinders	2D3
6-129.	Disassembly of Gear Actuating Cylinder	2D5
6-130.	Cleaning, Inspection and Repair of Gear Actuating Cylinder	2D5
6-131.	Assembly of Gear Actuating Cylinder	2D5
6-132.	Installation of Gear Actuating Cylinder	2D5

Paragraph			Aerofiche Grid

SECTION VI

HYDRAULIC SYSTEM

6-1. INTRODUCTION. The hydraulic system components covered in this section consist of Power Pack, hand pump, actuating cylinders, hydraulic lines, filters and hydraulic pump. The brake system, although hydraulically operated, is not included in this section. The brake system along with landing gear is covered in Section VII.

This section also provides instructions for remedying difficulties which may arise in the operation of the hydraulic system. The instructions are organized so that the mechanic can refer to: Principles of Operation, for a basic understanding of the system; Troubleshooting, for a methodical approach in locating the difficulty; Corrective Maintenance, for removal, repair and installation of components; and Adjustments and Tests, for the operation of the repaired system.

CAUTION

Prior to starting any investigation of the hydraulic system, place the airplane on jacks. (Refer to Jacking, Section II.)

6-2. DESCRIPTION AND PRINCIPLES OF OPERATION. The hydraulic power pack is located in the fuselage nose section just aft of the nose baggage compartment and is operated by a selector levers in the shape of a wheel mounted to the right of the left control column. The power pack contains the system reservoir and assorted valves which control the system operation. The power pack works in conjunction with various electrical switches and solenoid valves to perform the desired sequences of operation as selected by the control lever in the cockpit. Movement of the selector lever operates a control arm on the power pack through the use of a flexible cable assembly and connecting arms. A solenoid operated lock is located behind the instrument panel as part of the selector assembly to prevent the lever from being moved to the up position while the airplane is on the ground. This solenoid is spring-loaded to the locked position and activated by an anti-retraction (squat) switch mounted on the left main gear, upper torque link. The anti-retraction switch will also sound a warning horn if the selector lever is moved to the gear up position while the aircraft is on the ground and the master switch is ON. If the selector handle can be moved to the up position with the airplane on the ground, it is an indication of an improperly adjusted selector mechanism or the anti-retraction system is inoperative. The anti-retraction switch is actuated by the last .250 of an inch of oleo extension. When the selector is moved to either the up or down position, it is locked in place by action of the handle release valve at the power pack, acting against the release mechanism detent. The handle will remain in this position until it is manually released or until fluid pressure in the actuator and lock release reaches a preset pressure. At this time, the pressure forces the plunger in the lock release up, allowing the lever to return to up or down neutral position. An electrically operated door solenoid valve located in the power pack will position itself in the door (main inboard gear doors) open position when the selector lever is placed in the up or down position with the master switch on; this valve is spring-loaded in the open position and requires electrical current to remain in the closed position. In the event of electrical failures the valve will position itself in the open position and allow the doors to open when the selector lever is actuated and hydraulic pressure routed through the system.

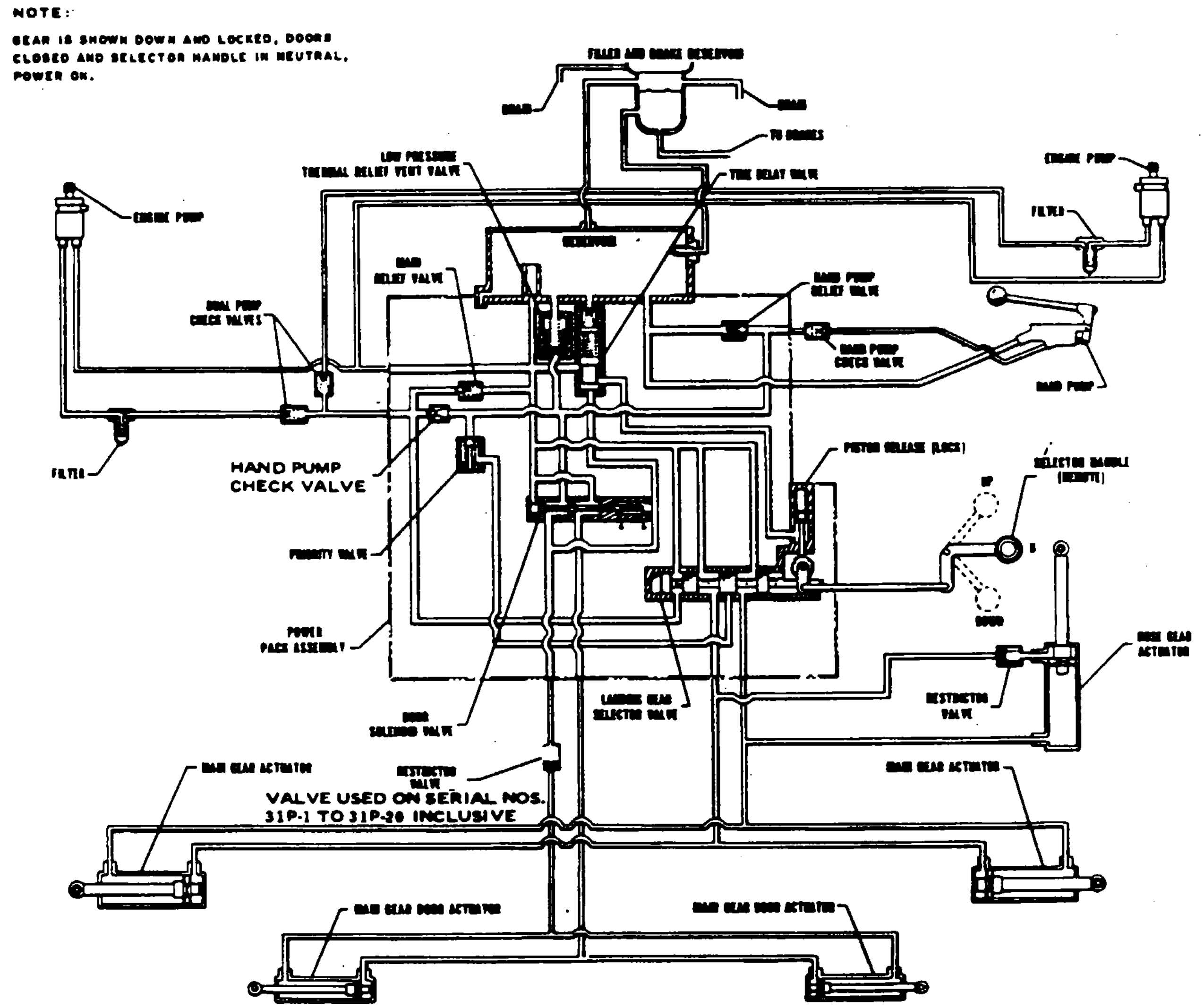


Figure 6-1. Schematic Diagram of Hydraulic System Serial Nos. PA-31P-1 to PA-31P-47 inclusive

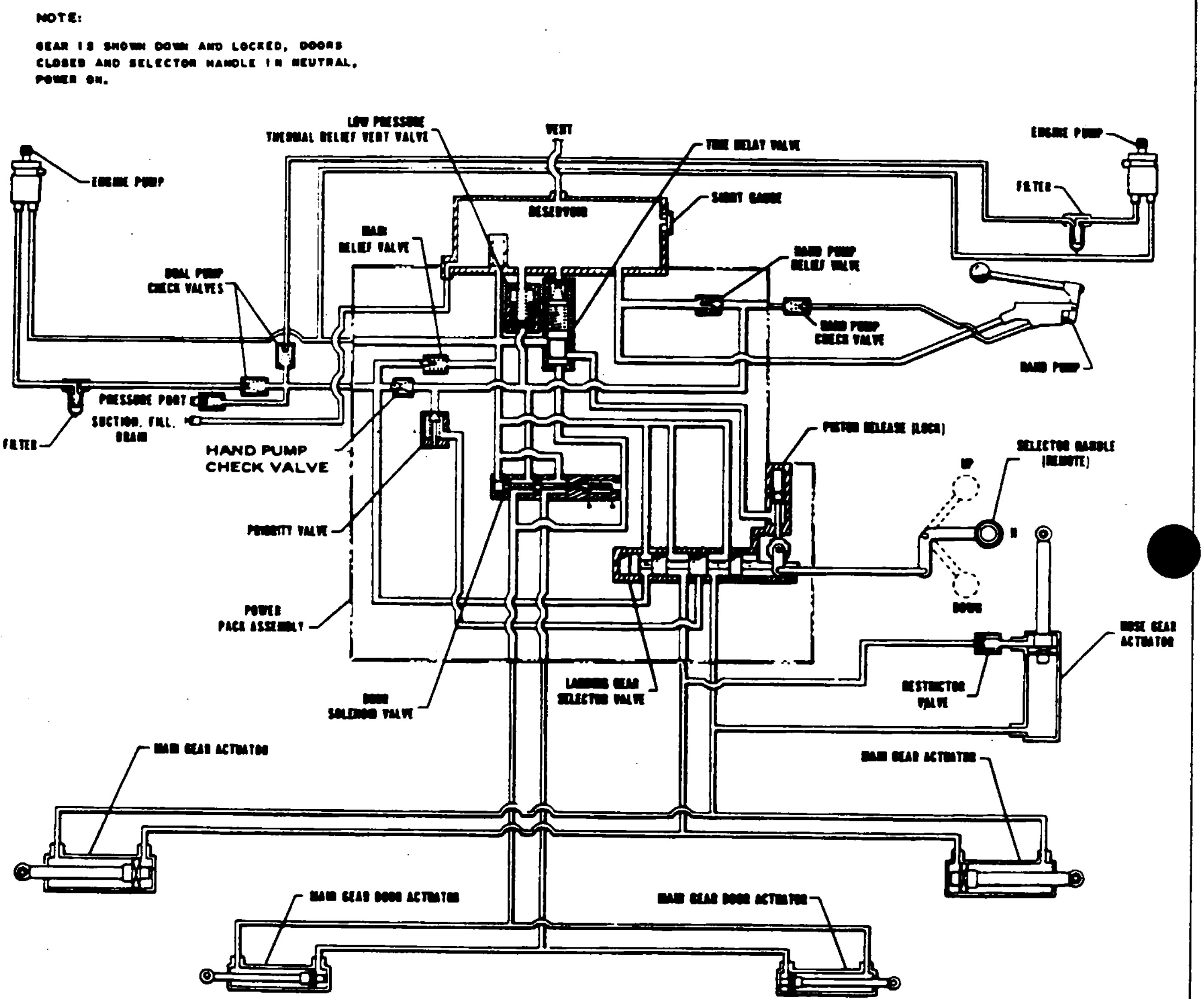


Figure 6-1a. Schematic Diagram of Hydraulic System, Serial Nos. PA-31P-48 and up

The engine driven hydraulic pumps draw fluid from the power pack reservoir and pump it through the system filters mounted on the engine side of the fire wall and check valves back to the pressure port of the power pack. Within the power pack, fluid travels into the gear door solenoid valve and landing gear selector pressure chamber. When the selector valve is in the neutral position, the fluid travels through the landing gear selector valve back to the reservoir.

When the selector valve is moved either to the up or down position, it electrically actuates the door solenoid valve to the open position, thus allowing fluid to flow through the door solenoid valve and opening the doors. During the time the doors open, the gear priority valve remains closed as less pressure is required to operate the doors. After the gear doors have opened, pressure continues to build up enough to allow the priority valve to open and permit fluid to flow through the gear selector valve to the gear actuating cylinders, thus allowing the gear to move to the up or down position.

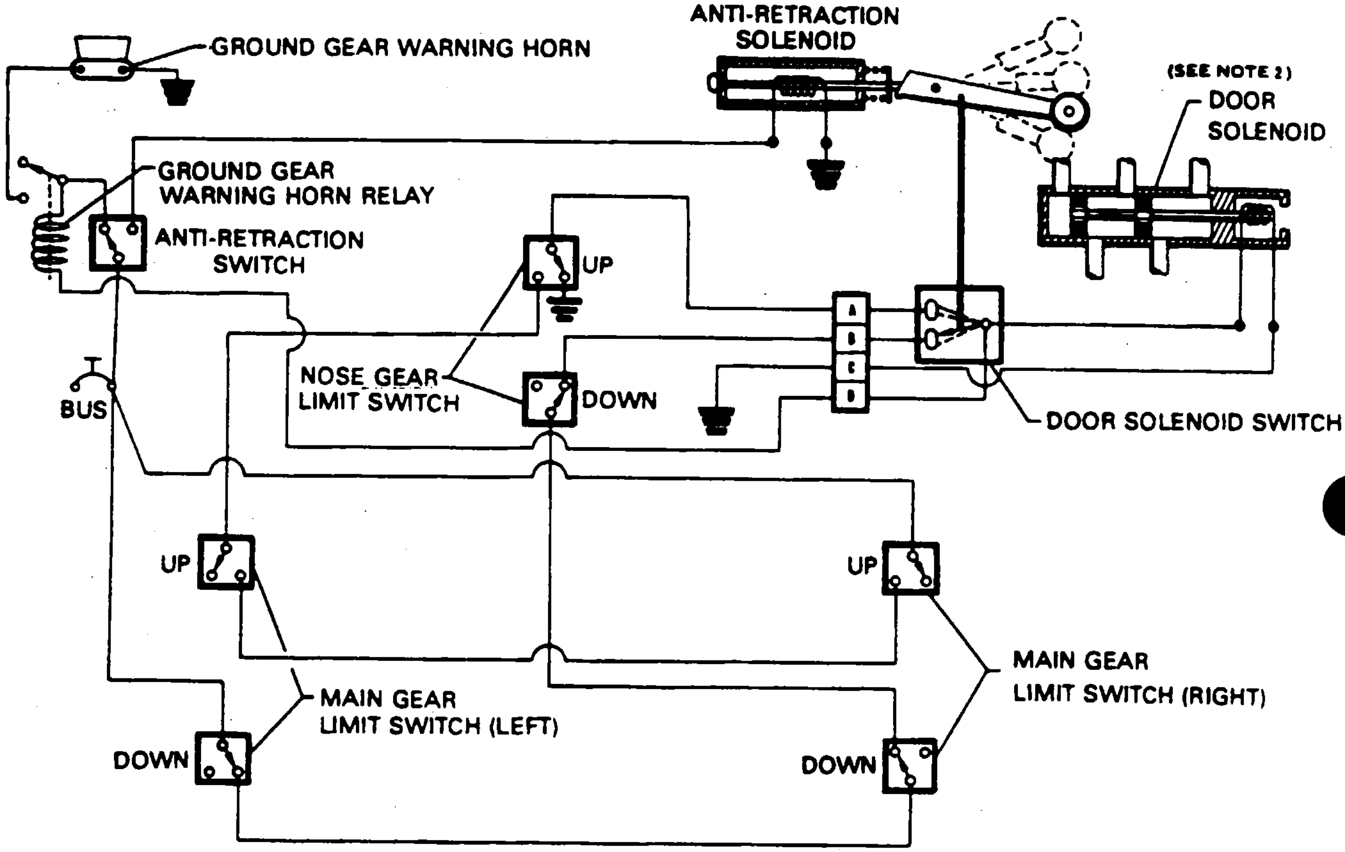
After the gear has moved to the full up or down position, limit switches are actuated which cause the electrically operated door solenoid valve to move to the closed door position, which allow the door actuating cylinders to close the gear doors. When the doors have fully closed, pressure builds up in the time delay valve operated by pressure in the closed door cylinders. The valve opens and allows fluid to flow to the handle release valve, thus returning the selector lever to neutral. With the selector in neutral, fluid is allowed to circulate back to the reservoir.

The main relief valve functions as a safety between the pump and selector valves. When the main relief valve opens, fluid is directed back to the reservoir. The hand pump relief valve also serves as a secondary relief valve. Valve operating pressures can be found in Table VI-I for Ozone Power Pack or Table VI-II for Wiebel Tool Power Pack.

The thermal relief vent valve functions as a safety to relieve pressure due to thermal expansion in the gear door actuating cylinders.

The hand pump serves as an emergency pump, should the engine driven pumps fail. The system check valves prevent the fluid from backing up through the engine driven pumps into the reservoir. In the event of severe leakage of the hydraulic fluid, the standpipe in the reservoir prevents the fluid level from dropping below the emergency quantity required for the operation of the system by means of the hand pump. The engine driven pumps are supplied with fluid through the standpipe, so that when the fluid level goes below the top of the standpipe, no fluid will flow. Thus, even though the system may develop a break and the engine driven pumps continue to operate, devoiding the system of fluid, the standpipe insures enough fluid in the system for hand pump operation.

In case of an electrical failure, the door solenoid valve will move to the door open position and remain in that position.



NOTES:

1. GEAR IS SHOWN DOWN AND LOCKED, DOORS CLOSED AND SELECTOR HANDLE IS DOWN NEUTRAL, POWER ON
2. POWER ON - DOORS CLOSED
   POWER OFF - DOORS OPEN

Figure 6-2. Schematic of Power Pack Electrical System

6-3. TROUBLESHOOTING. Malfunctions of the hydraulic system will result in failure of the landing gear to operate properly. When trouble arises, jack up the airplane (Refer to Jacking, Section II) and then proceed to determine the extent of the trouble. Generally, hydraulic system troubles fall into two types; troubles involving the hydraulic supplying system and troubles in the landing gear hydraulic system. The extent of trouble can be found by operating the selector valve on the Power Pack. Table VI-IV, at the back of this section, lists the troubles which may be encountered and their probable cause, and suggests a remedy for the trouble involved. A hydraulic system operational check may be conducted beginning with paragraph 6-5. When the trouble has been recognized, the first step in troubleshooting is isolating the cause. Hydraulic system troubles are not always traceable to one cause. It is possible that a malfunction may be the result of more than one difficulty within the system. Starting first with the most obvious and most probable reasons for the trouble, check each possibility in turn and, by process of elimination, isolate the troubles.

NOTE

If it is found that the Power Pack is at fault and requires disassembly, it is recommended that it be replaced on an exchange basis or overhauled by a recommended overhaul shop. If, however, this cannot be achieved, the Power Pack may be repaired in accordance with the instructions in this manual.

6-4. FLUSHING HYDRAULIC SYSTEM. When contamination of the hydraulic system is suspected the complete system including brakes if incorporated should be drained and flushed to remove the contaminated fluid. The cause and type of contamination should be determined and corrected. Use the following steps to perform this operation:

a. Remove the engine cowlings as explained in Section VIII.
b. Disconnect the hydraulic lines at the engine driven pumps.
c. Drain the hydraulic fluid from the Power Pack reservoir.
d. Disconnect the hydraulic lines at the actuating cylinders and drain the fluid from all the hydraulic lines.
e. Remove the filter elements and flush out the filter bowls, and install new filter elements. (Refer to paragraphs 6-153 to 6-155).
f. Flush the hydraulic system with clean hydraulic fluid (MIL-H-5606). Examine several seals and cylinder bores for damage.
g. When the hydraulic system is completely flushed and there is no more indication of contamination, reconnect the previously disconnected fittings and replenish the system with clean hydraulic fluid.
h. Bleed the hydraulic system and check for leaks. (Refer to paragraph 6-110.)
i. Replace the engine cowlings as explained in Section VIII.

6-5. HYDRAULIC SYSTEM OPERATIONAL CHECKS.

6-6. HYDRAULIC TEST UNIT (PIPER NO. 753 080.)

6-7. INTRODUCTION (PIPER TEST UNIT). This test unit would offer invaluable assistance in checking hydraulic systems, hydraulic Power Pack and related components in the PA-31P. Examples are: gear cycling operation, Power Pack operating pressure, main relief valve cracking pressure, thermal relief vent valve cracking pressure, landing gear detent release pressure etc.

This unit consists of an electric motor driven hydraulic pump, bypass valve, fluid reservoir, filter, pressure gauge, hoses and adapter fittings housed in a metal cabinet mounted on casters.

TABLE VI-I. LEADING PARTICULARS, HYDRAULIC POWER PACK (OZONE)

NOMENCLATURE	OAS2930-3, OAS2930-5 & OAS2930-7
Main Relief Valve Pressure (Primary)	1800 PSI (-3, -5) 1900 PSI (-7)
Hand Pump Relief Valve Pressure (Secondary)	1950 PSI (-3) 2000 PSI (-5) 2100 PSI (-7)
Hand Pump Relief Valve Reseat Pressure	1500 PSI
Low Pressure Thermal Relief (Door Vent) Valve Cracking Pressure	50 PSI
Low Pressure Thermal Relief (Door Vent) Valve Reseat Pressure	150 PSI
Priority Valve Cracking Pressure	600 PSI
Hand Pump Check Valve Cracking Pressure	10 PSI
Landing Gear Handle Position Release	750-1250 PSI (-3,-5) 1650-1775 PSI (-7)
Time Delay Valve	5 to 9 seconds
Hydraulic Fluid Required	MIL-H-5606
Reservoir Operating Capacity (Engine Pump)	2.46 pints
Reservoir Capacity (Emergency)	0.935 pints
Weight Dry - Power Pack	10.50 pounds
Hydraulic Fluid Flow Rate	1.6 G.P.M.

TABLE VI-II. LEADING PARTICULARS, HYDRAULIC POWER PACK (WIEBEL TOOL)

NOMENCLATURE	WTC 2135-1	WTC 2135-3
Operating Pressure	1900 P.S.I.	1800 P.S.I.
Main Relief Valve Pressure (Primary)	1900 P.S.I.	1800 P.S.I.
Hand Pump Relief Valve Pressure (Secondary)	2100 P.S.I. Max.	2000 P.S.I. Max.
Hand Pump Relief Valve Reseat Pressure	1900 P.S.I. Min.	1800 P.S.I. Min.
Low Pressure Thermal Relief Vent Valve "Open"	0 to 100 P.S.I.	0 to 100 P.S.I.
Low Pressure Thermal Relief Vent Valve "Closed"	150 P.S.I. Max.	150 P.S.I. Max.
Priority Valve Cracking Pressure	600 P.S.I.	600 P.S.I.
Hand Pump Check Valve Cracking Pressure	1 to 3 P.S.I.	1 to 3 P.S.I.
Landing Gear Position Release	750-1250 P.S.I.	750-1250 P.S.I.
Time Delay Valve	5 to 9 seconds	5 to 9 seconds
Hydraulic Fluid Required	MIL-H-5606	MIL-H-5606
Weight Dry - Power Pack	10.50 pounds	10.50 pounds
Hydraulic Fluid Flow Rate (Both Pumps Operating)	1.6 G.P.M.	1.6 G.P.M.

6-8. CONNECTING TEST UNIT. There are two methods of connecting the hydraulic test unit to the airplan

1. Serial Nos. PA-31P-1 to 47 incl.
   a. Remove the lower engine cowl. (Refer to Removal of Engine Cowl, Section VIII.)
   b. Disconnect the engine driven hydraulic pump suction hose from the fitting at the engine fire wall and connect the suction hose of the test unit to the fitting. Cap the disconnected suction hose.
   c. Disconnect the engine driven hydraulic pump pressure hose from the inlet side of the hydraulic filter on the firewall and connect the pressure hose of the test unit. Cap the disconnected pressure hose.
   d. Operate the test unit per instructions supplied with it.
2. Serial Nos. PA-31P-48 and up.
   a. Remove the access panel on the right side of the nose section.
   b. If the system requires filling only, remove the protective cap from the suction, fill and drain valve and connect the pressure hose from the test unit. Open the valve on the suction port and by placing the control lever in the up position, proceed to fill the system per instructions with test unit. Observe the sight gauge to determine when the reservoir is full or stop filling operation when fluid is seen draining from the overflow.
   c. If the system must be operated during various ground checks, overhaul, or inspection of its components, remove the protective caps from both the suction and the pressure ports and connect the test unit pressure hose to the pressure port and the test unit suction hose to the suction port. Open the valve on the suction port and proceed to operate the test unit according to instructions furnished with it.

6-9. CYCLING LANDING GEAR.

a. Connect hydraulic test unit in accordance with paragraph 6-8 and jack the airplane as outlined in Section II.
b. Set hydraulic test unit bypass valve open.
c. Start test unit pump motor.
d. Slowly close bypass valve completely.
e. Using landing gear control handle in airplane, operate gear as desired.

NOTE

Gear cycling time can be prolonged by slowly opening the test unit bypass valve part way. This will bleed off part of the pump flow.

f. After completion of cycling, ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
g. Disconnect hydraulic test unit in accordance with Paragraph 6-17.
h. Remove the airplane from jacks.

6-10. CHECKING TIME DELAY VALVE.

a. Connect the hydraulic test unit in accordance with paragraph 6-8.
b. With test unit operating and airplane master switch ON, move the landing gear selector handle to the down position. Note the delay of the handle returning to the neutral position.

NOTE

The time delay between moving the selector handle to the down position (master switch must be ON) and the automatic releasing of the selector handle to neutral should be (refer to Tables VI-I or VIII) at room temperature. Colder temperature will cause a longer delay.

c. If the time delay fails specification given in preceding "Note" ascertain that valve is not air locked. Bleed air out by holding selector down for 30 seconds, then make three or four rapid movements to neutral and back to down.
d. There is no adjustment of the time delay valve. If it is defective, refer to Paragraphs 6-32 or 6-67 for disassembly and repair of the Power Pack.
e. Disconnect hydraulic test unit in accordance with paragraph 6-17.

6-11. CHECKING HANDLE RELEASE TO NEUTRAL.

a. Place airplane on jacks. (Refer to Jacking, Section II.)
b. Connect hydraulic test unit in accordance with paragraph 6-8.
c. Cycle the landing gear through two complete cycles in accordance with paragraph 6-9, ending with gear down and locked, and the doors closed.
d. Set the hydraulic test unit bypass valve full open.
e. Place the landing gear selector handle in the full down position.
f. Very slowly close the bypass valve until the handle trips back to neutral. Read the gauge at the point of handle trip. The pressure should be as indicated in Tables VI-I or VI-II. Be sure to allow for time delay valve to open.

NOTE

One release valve serves to release the handle from both the gear down and gear up positions. If the handle return springs are adjusted correctly, the release valve should release the handle from both positions at the same pressure. The preceding procedure checks the release pressure from the gear down position, and the following procedure checks the release pressure from the gear up position. This is performed only to assure satisfactory operation of other equipment relative to handle release operations.

g. Set hydraulic test unit bypass valve full open.
h. Place landing gear selector handle in the full up position.
i. Very slowly close the bypass valve until the handle trips back to neutral. Read the gauge at the point of handle trip. The pressure should be as indicated in Tables VI-I or VI-II. Be sure to allow for time delay valve to open.
j. Refer to Paragraphs 6-56 or 6-97 for handle release adjustment
k. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
l. Disconnect test unit in accordance with Paragraph 6-17 and remove airplane from jacks.

6-12. CHECKING PRIORITY VALVE.

a. Connect hydraulic test unit in accordance with Paragraph 6-8 and place airplane on jacks in accordance with Jacking, Section II.
b. Cycle landing gear through two complete cycles in accordance with Paragraph 6-9.
c. With gear down and locked and test unit operating, turn the master switch off to open gear doors. Leave the switch off to permit the doors to remain open, thereby making it easier and faster to complete this check.
d. Open hydraulic test unit bypass valve.
e. Place landing gear selector handle full up. Very slowly close bypass valve, observing pressure gauge of test unit and noting pressure at which priority valve opens. Priority valve should open at the pressure indicated in Tables VI-I or VI-II.

NOTE

As the priority valve opens, the nose gear downlock starts to release. Read the pressure gauge at this point.

f. Refer to Paragraphs 6-59 or 6-100 for priority valve adjustment.
g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
h. Disconnect the test unit in accordance with Paragraph 6-17 and remove the airplane from jacks.

6-13. CHECKING MAIN RELIEF VALVE.

a. Connect test unit in accordance with Paragraph 6-8.
b. Open test unit bypass valve.
c. Hold the landing gear selector handle in the full down position.
d. Slowly close bypass valve, observing pressure build-up and point at which pressure stabilizes on test unit gauge. Stabilization indicates relief valve setting. The relief valve pressure and flow rate are given in Tables VI-I and VI-II.
e. The Ozone power pack must be removed and partially disassembled to adjust the main relief valve setting. (Refer to Paragraph 6-58.) The Wiebel Tool power pack main relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-99.)
f. Disconnect the hydraulic test unit in accordance with Paragraph 6-17.

6-14. CHECKING HAND PUMP RELIEF VALVE.

a. Place landing gear selector handle in the full down position. With master switch off, operate emergency hand pump to open landing gear doors.
b. Disconnect door open line (upper fitting) from main gear door cylinder and connect hydraulic test unit pressure hose to door open line. Cap actuator fitting.
c. Close bypass valve on hydraulic test unit.
d. Operate emergency hand pump in airplane, observing hydraulic test unit pressure gauge for pressure at which hand pump relief valve opens. This pressure should be as indicated in Tables VI-I of VI-II.
e. The Ozone power pack must be removed and partially disassembled to adjust hand pump relief valve setting. (Refer to Paragraph 6-57.) The Wiebel Tool power pack hand pump relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-98.)
f. Open bypass valve on test unit to release the pressure, disconnect the test unit pressure hose from door open line. Remove cap from actuator fitting and reconnect door open line to main gear door actuator.
g. Replenish hydraulic reservoir fluid as required.

6-15. CHECKING FOR SUCTION AIR LEAKAGE.

a. Remove engine cowling for access.
b. Disconnect hydraulic pump suction (larger) hose from the pump and connect test unit suction hose to airplane suction hose, using a suitable fitting.
c. Disconnect hydraulic pump pressure (smaller) hose from pump and connect test unit pressure hose to airplane pressure hose, using a suitable fitting.
d. Connect test unit electrical cable to appropriate electrical power source.
e. Jack the airplane and cycle the landing gear through five complete cycles.
f. Observe the test unit reservoir for any air bubbles which would indicate leakage in suction line, hose, or fittings. Replace defective parts.

NOTE

If replacement of parts stops any visible air in test unit reservoir, but air still enters hydraulic system, engine driven pump may have a suction leak.

g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
h. Remove the airplane from jacks and disconnect the test unit in accordance with paragraph 6-17.

6-16. CHECKING LANDING GEAR CYCLE TIME. When the hydraulic system on the airplane is suspected of malfunction because gear cycle time is slow, it could be caused by low fluid in airplane reservoir causing system to be full of air. The following procedure will purge air from system and fill the reservoir:

a. Place the airplane on jacks in accordance with Jacking, Section II.
b. Cycle the landing gear through two complete cycles in accordance with paragraph 6-9.
c. With landing gear extended, place gear handle in full up position and record time required for gear to retract and doors to close. Time should not exceed 9 seconds ± .5 seconds plus the time required for the time-delay valve to operate. (Refer to paragraph 6-10.)
d. With landing gear retracted, place gear handle in full down position and record time required for gear to extend and doors to close. Time should not exceed 8 seconds ± .5 seconds plus the time required for the time-delay valve to operate. (Refer to paragraph 6-10.)

NOTE

These times are taken using a single test unit. These times can be reduced considerable with the use of two test units, one hooked to each fire wall fitting.

NOTE

If time is within limit when operated by test unit, but exceeds limit when operated by engine driven pump, there is internal leakage in the pump. Repair or replace the pump. If time exceeds the limit when operated either by the test unit or engine driven pump, internal leakage is in the hydraulic system. Check actuators for internal leakage. Repair or replace actuators as required. If actuators are not defective, Power Pack internal leakage is indicated. Repair or replace Power Pack. Refer to Paragraphs 6-30 or 6-65 for repair of hydraulic components.

6-17. DISCONNECTING TEST UNIT.

a. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
b. Shut down the test unit per instruction supplied with unit.
c. On models, Serial Nos. PA-31P-1 to 47 incl. disconnect the test unit suction and/or pressure hoses at the firewall and/or filter fittings. Ascertain that there is fluid in the suction and/or pressure hoses from the airplane's hydraulic pump before reconnecting the hoses to the respective fittings.
d. On models, Serial Nos. PA-31P-48 and up, close the suction, fill and drain valve in the airplane by placing the control lever in the down position and disconnecting the test unit hose from the fitting. Reinstall the protective cap over the fitting. Also disconnect and remove the test unit pressure hose from the pressure fitting in the airplane if previously connected. Reinstall the protective cap on the fitting.
e. Check fluid level in the Power Pack reservoir and check system for leaks.
f. Install the engine cowl if removed, (refer to Installation of Engine Cowl, Section VIII) or right access panel of nose section on later models.

6-18. HYDRAULIC TEST UNIT (OPTIONAL).

6-19. INTRODUCTION, OPTIONAL TEST UNIT. The following instructions are given for the use of an optional test unit, or one which has many capabilities. Some of the uses are: to flush or fill the airplane's system with micronically filtered hydraulic fluid, to provide hydraulic flow and pressure for testing leakage, and operation of the airplane hydraulic system without the necessity of operating the airplane's engines, and to test and adjust the various components of the airplane hydraulic system. This test unit must be capable of duplicating the same operating pressures and flow rate as given in Tables VI-I or VI-II.

6-20. CONNECTING HYDRAULIC TEST UNIT.

1. Serial Nos. PA-31P-1 to 47 incl.
   a. Remove the lower engine cowl. (Refer to Removal of Engine Cowl, Section VIII.)
   b. Disconnect the hydraulic pump suction hose from the fitting at the engine fireball and connect the suction hose of the test unit. Cap the disconnected suction hose.
   c. Disconnect the hydraulic pump pressure hose from the fitting at the engine fireball and connect the pressure hose of the test unit. Cap the disconnected pressure hose.
   d. Connect the vent hose of the test unit to the vent fitting of the Power Pack.
   e. Operate the test unit per instructions with the unit.
2. Serial Nos. PA-31P-48 and up.
   a. Remove the access panel on the right side of the nose section.
   b. If the system requires filling only, remove the protective cap from the suction, fill and drain valve and connect the pressure hose from the test unit. Open the valve on the suction port and by placing the control lever in the up position, proceed to fill the system per instructions with test unit. Observe the sight gauge to determine when the reservoir is full or stop filling operation when fluid is seen draining from the overflow.
   c. If the system must be operated during various ground checks, overhaul, or inspection of its components, remove the protective caps from both the suction and the pressure ports and connect the test unit pressure hose to the pressure port, the test unit suction hose to the suction port, and the test unit vent hose to the vent fitting of the Power Pack. Open the valve on the suction port and proceed to operate the test unit according to instructions furnished with it.

6-21. CYCLING LANDING GEAR.

a. Connect hydraulic test unit in accordance with paragraph 6-20 and jack the airplane as outlined in Section II.
b. Observe color of hydraulic fluid through sight gauge in airplane's reservoir or the hydraulic test unit if equipped with one. If fluid appears discolored, or any other reason exists to suspect fluid contamination, draw off a fluid sample by uncapping the reservoir drain at the forward side of the Power Pack.

NOTE

Fluid sampling is necessary only when good reason exists to suspect contamination. If examination of fluid reveals contamination, flush complete hydraulic system with clean hydraulic fluid (MIL-H-5606) and examine several seals and cylinder bores for damage.

c. Operate the hydraulic test unit per instructions furnished with the unit.
d, Set hydraulic test unit flow valve closed, lockout valve open, and bypass valve open.
e. Start hydraulic test unit pump motor.
f. Slowly close bypass valve completely.
g. Observe fluid flowing through test unit sight gauge if test unit is equipped with one. When all air bubbles have dissipated, operations may be continued.
h. Using landing gear control handle in airplane, operate gear as desired.

NOTE

Gear cycling time can be prolonged by slowly opening the test unit bypass valve part way. This will bleed off part of the pump flow.

i. After completion of cycling, open test unit bypass valve and stop pump motor.
j. Disconnect hydraulic test unit in accordance with paragraph 6-29.
k. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
l. Remove the airplane from jacks as outlined in Section II.

6-22. CHECKING TIME DELAY VALVE.

a. Connect hydraulic test unit in accordance with paragraph 6-20.
b. Set the hydraulic test unit according to the pressure and flow rate given in Tables VI-I or VI-II.
c. With airplane master switch ON, move landing gear handle to down position. Note the delay of the handle returning to neutral position.

NOTE

The time delay between moving the selector handle to the down position (master switch must be ON) and the automatic releasing of the selector handle to neutral should be (refer to Tables VI-I or VI-II) at room temperature. Colder temperature will cause a longer delay.

d. If the time delay fails specification given in preceding "Note" ascertain that valve is not air lock Bleed air out by holding selector down for 30 seconds, then make three or four rapid movements to neutral and back to down.
e. There is no adjustment of the time-delay valve. If it is defective, refer to Paragraphs 6-30 or 6-65 for disassembly and repair of the Power Pack.
f. Disconnect hydraulic test unit in accordance with paragraph 6-29.

6-23. CHECKING HANDLE-RELEASE TO NEUTRAL.

a. Place the airplane on jacks, refer to Jacking, Section II.
b. Cycle the landing gear through two complete cycles in accordance with paragraph 6-21 ending with the gear down and locked, and the doors closed.
c. Set hydraulic test unit bypass valve full open.
d. Place landing gear handle to full down.
e. Very slowly close bypass valve until handle trips back to neutral. Read gauge at point of handle trip. This pressure should be as indicated in Tables VI-I or VI-II. Be sure to allow time for time delay valve to open.

NOTE

One release valve serves to release the handle from both the gear down and the gear up position. If the handle-return springs are adjusted correctly, the release valve should release the handle from both positions at the same pressure. The preceding procedure checks the release pressure from the gear down position, and the following procedure checks the release pressure from the gear up position. This is performed only to assure satisfactory operation of other equipment relative to handle release operations.

f. Set hydraulic test unit bypass valve full open.
g. Place landing gear handle full up.
h. Very slowly close bypass valve until handle trips back to neutral. Read gauge at point of handle trip. This pressure should be as indicated in Tables VI-I or VI-II. Be sure to allow time for time delay valve to open.
i. Refer to Paragraphs 6-56 or 6-97 for handle-release adjustment.
j. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
k. Disconnect hydraulic test unit in accordance with Paragraph 6-29, and remove the airplane from jacks.

6-24. CHECKING PRIORITY VALVE.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Cycle landing gear through two complete cycles in accordance with Paragraph 6-21.
c. With landing gear down and test unit operating, turn master switch OFF to open gear doors. Leave the switch OFF to permit doors to remain open, thereby making it easier and faster to complete this check.

d. Open hydraulic test unit bypass valve.
e. Place landing gear selector handle full up. Very slowly close bypass valve, observing test pressure gauge and flow gauge, noting at which pressure the priority valve opens. Priority valve should open at the pressure indicated in Tables VI-I or VI-II.

NOTE

As the priority valve opens, the nose gear downlock starts to release. Read the hydraulic pressure gauge at this point. The flow gauge will also aid in positively establishing opening of the priority valve. As pressure slowly builds up in the door system, there is practically no flow of fluid and the flow indicator will be resting on the bottom of the sight glass. As the priority valve opens, the sudden increase in flow will cause the indicator to rise in the sight glass.

f. Refer to Paragraphs 6-59 or 6-100 for priority valve adjustment.
g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
h. Disconnect the test unit in accordance with paragraph 6-29, and remove the airplane from jacks.

6-25. CHECKING MAIN RELIEF VALVE.

a. Connect hydraulic test unit in accordance with paragraph 6-20.
b. Open hydraulic test unit bypass valve.
c. Hold landing gear handle full down, and maintain this position.
d. Slowly close bypass valve, observing pressure build-up and point at which pressure stabilizes on hydraulic test gauge. Stabilization indicates relief valve setting. Refer to Table VI-I or VI-II for proper pressure and flow rate.
e. The Ozone power pack must be removed and partially disassembled to adjust the primary relief setting. (Refer to Paragraph 6-58). The Wiebel Tool power pack primary relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-99.)
f. Disconnect hydraulic test unit in accordance with paragraph 6-29.

6-26. CHECKING HAND PUMP RELIEF VALVE.

a. Place landing gear selector handle full down and maintain in this position. With master switch OFF, operate emergency hand pump to open landing gear doors.
b. Disconnect door open line from main gear door cylinder and connect hydraulic test pressure hose to door open line.
c. Close bypass valve on hydraulic test unit.
d. Operate emergency hand pump in airplane, observing hydraulic test pressure gauge for pressure at which hand pump relief valve opens. (Refer to Tables VI-I or VI-II for proper pressure.)
e. The Ozone power pack must be removed and partially disassembled to adjust hand pump relief valve setting. (Refer to Paragraphs 6-57.) The Wiebel Tool power pack hand pump relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-98.)
f. Open lockout valve on hydraulic test unit to release the pressure, disconnect hydraulic test unit pressure hose from door open line, and reconnect door open line to main gear door actuator.
g. Replenish hydraulic reservoir fluid as required.

6-27. CHECKING FOR SUCTION AIR LEAKAGE.

a. Remove engine cowling as necessary for access.
b. Disconnect hydraulic pump suction (larger) hose from pump and connect hydraulic test unit suction (larger) hose to the airplane suction hose, using a suitable fitting.
c. Disconnect hydraulic pump pressure (smaller) hose from pump and connect test unit pressure (smaller) hose to airplane pressure hose, using a suitable fitting.
d. Connect test unit vent hose to airplane reservoir vent line leading from the top of the reservoir.

NOTE

Before making this connection, be certain the line is wiped clean and is free of any dirt or foreign material which might have worked into the line. If the line is dirty internally, remove and flush with solvent, then dry with compressed air and reinstall.

e. Connect hydraulic test unit electrical cable to appropriate electrical power source.
f. Jack the airplane and cycle the landing gear through five complete cycles. No air should be visible in test unit sight gauge, if unit is equipped with one.
g. Air visible in sight glass indicates leakage in suction line, hose, or fittings. Replace defective parts.

NOTE

If replacement of parts stops any visible air in test unit sight glass but air still enters hydraulic system, engine driven pump may have a suction leak.

6-28. CHECKING LANDING GEAR CYCLE TIME. When the hydraulic system or airplane pump is suspected of malfunction because gear cycle time is slow, it could be caused by low fluid in airplane reservoir causing system to be full of air. The following procedure will purge air from system and fill the reservoir.

a. Place airplane on jacks, refer to Jacking, Section II.
b. Cycle the landing gear through two complete cycles in accordance with paragraph 6-21.
c. With landing gear extended, place gear handle in full up position and record time required for gear to retract and doors to close. Time should not exceed 6.5 seconds (±.5 second), plus the time required for the time-delay valve to operate at the flow rate indicated in Tables VI-I or VI-II. (Refer to Paragraph 6-22.)

NOTE

If time is within limit when operated by test unit but exceeds limit when operated by engine driven pump, there is internal leakage in pump. Repair or replace pump. If time exceeds limit when operated either by test unit or engine driven pump, internal leakage is in hydraulic system. Check actuators for internal leakage. Repair or replace actuators as required. If actuators are not defective, Power Pack internal leakage is indicated. Repair or replace Power Pack. (Refer to Paragraphs 6-30 or 6-65 for repair of hydraulic components.)

6-29. DISCONNECTING HYDRAULIC TEST UNIT.

a. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
b. Shut down the test unit per instruction supplied with unit.
c. On models, Serial Nos. PA-31P-1 to 47 incl., disconnect the test unit suction and/or pressure hoses at the firewall and/or filter fittings, and the vent hose from the Power Pack vent fitting. Ascertain that there is fluid in the suction and/or pressure hoses from the airplane's hydraulic pumps before reconnecting the hoses to the respective fittings.
d. On models, Serial Nos. PA-31P-48 and up, close the suction, fill and drain valve in the airplane by placing the control lever in the down position and disconnecting the test unit hose from the fitting. Reinstall the protective cap over the fitting. Disconnect and remove the test unit pressure hose from the pressure fitting in the airplane if previously connected and reinstall the protective cap on the fitting. Also disconnect and remove the test unit vent hose from the Power Pack fitting.
e. Check fluid level in the Power Pack reservoir and check system for leaks.
f. Install the engine cowl if removed, (refer to Installation of Engine Cowl, Section VIII) or right access panel of nose section on later models.

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1. ACCESS COVER
2. HYDRAULIC SYSTEM RESERVOIR
3. FILLER TUBE
4. OVERFLOW, DRAIN
5. FITTING, ELBOW
6. LINE, RETURN L. ENGINE
7. CONNECTOR, ELECTRICAL
8. LINE, PRESSURE L. ENGINE
9. BRACKET, MOUNTING
10. LINE, GEAR DOWN
11. OVERFLOW, RESERVOIR
12. LINE, VENT
13. TO BRAKE SYSTEM
14. POWER PACK
15. BOLT
16. SAFETY WIRE
17. DRAIN
18. LINE, GEAR UP
19. PANEL, WHEEL WELL
20. BLOCK
21. LINE, RETURN R. ENGINE
22. LINE, PRESSURE R. ENGINE
23. LINE, DOOR CLOSE
24. LINE, GEAR UP
25. LINE, DOOR OPEN
26. LINE, GEAR DOWN
27. LINE, HAND PUMP PRESSURE
28. LINE, HAND PUMP SUCTION

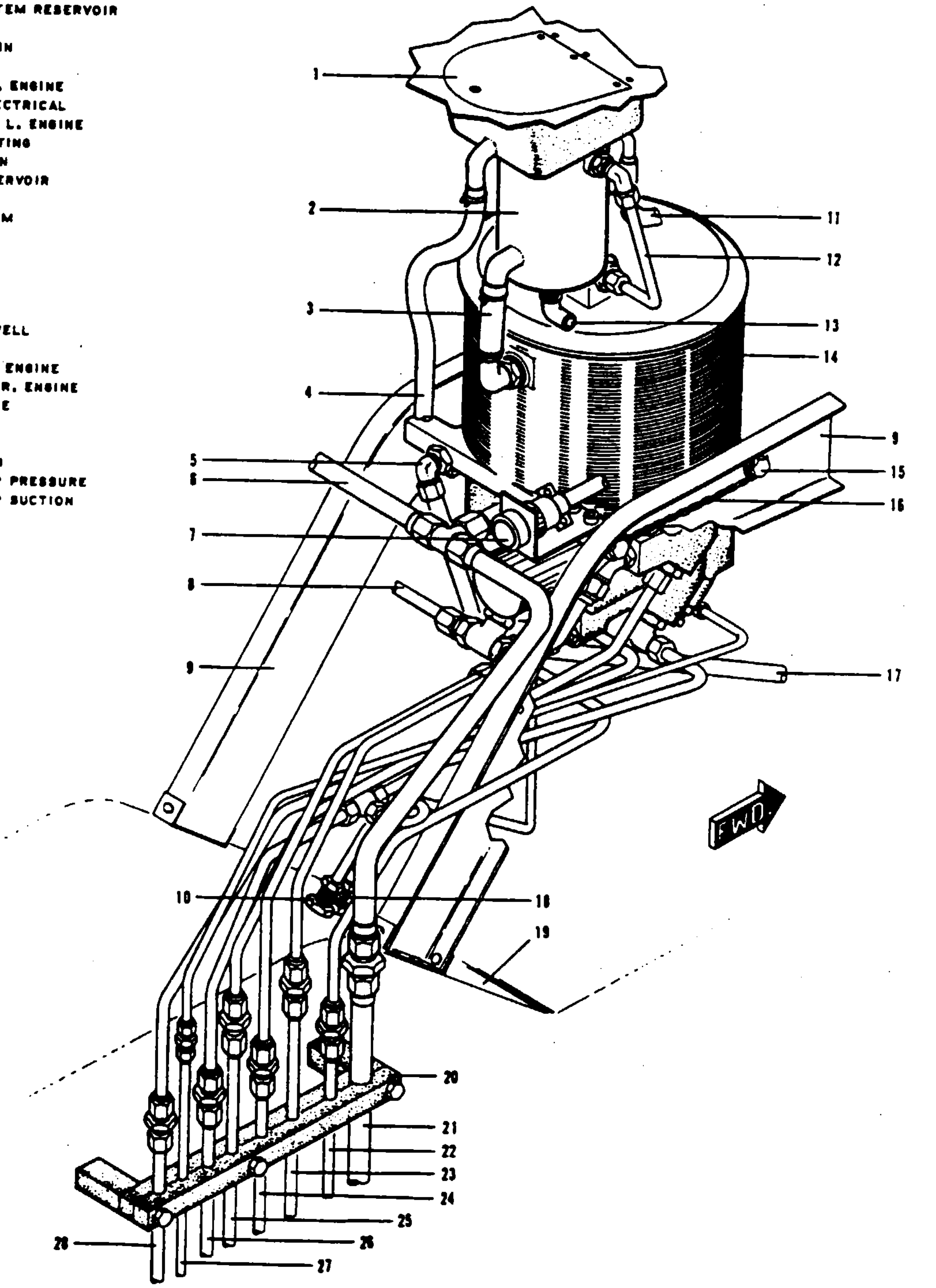
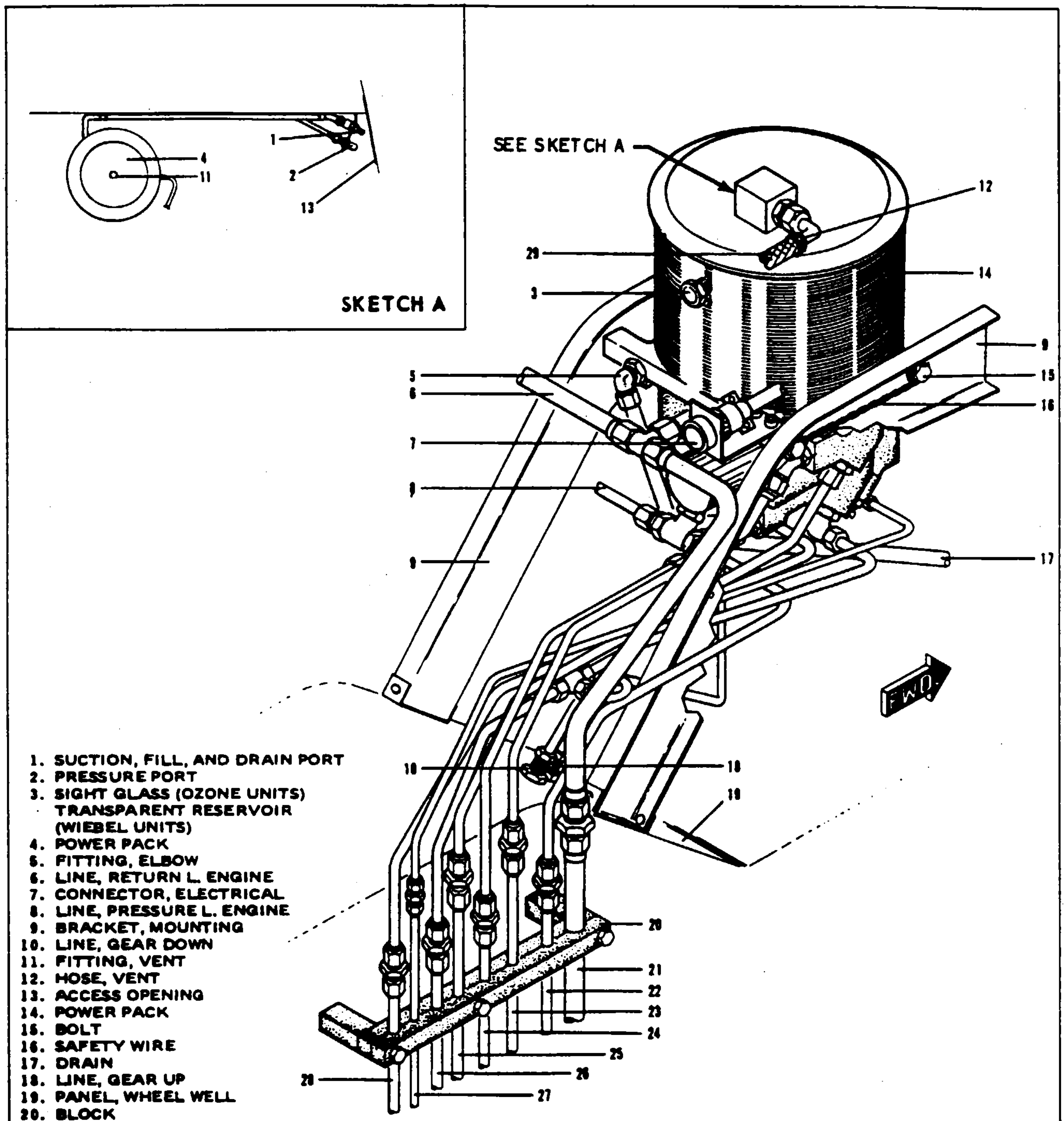


Figure 6-3. Power Pack Installation, Serial Nos. PA-31P-1 to PA-31P-47 inclusive



1. SUCTION, FILL, AND DRAIN PORT
2. PRESSURE PORT
3. SIGHT GLASS (OZONE UNITS) · TRANSPARENT RESERVOIR (WIEBEL UNITS)
4. POWER PACK
5. FITTING, ELBOW
6. LINE, RETURN L. ENGINE
7. CONNECTOR, ELECTRICAL
8. LINE, PRESSURE L. ENGINE
9. BRACKET, MOUNTING
10. LINE, GEAR DOWN
11. FITTING, VENT
12. HOSE, VENT
13. ACCESS OPENING
14. POWER PACK
15. BOLT
16. SAFETY WIRE
17. DRAIN
18. LINE, GEAR UP
19. PANEL, WHEEL WELL
20. BLOCK
21. LINE, RETURN R. ENGINE
22. LINE, PRESSURE R. ENGINE
23. LINE, DOOR CLOSE
24. LINE, GEAR UP
25. LINE, DOOR OPEN
26. LINE, GEAR DOWN
27. LINE, HAND PUMP PRESSURE
28. LINE, HAND PUMP SUCTION
29. TO DRAIN TUBE

Figure 6-3a. Power Pack Installation, Serial Nos. PA-31P-48 and up

6-30. HYDRAULIC POWER PACK. (Ozone)

6-31. REMOVAL OF POWER PACK. (Refer to Figures 6-3 or 6-3a.)

a. Remove the access panels to the Power Pack on both sides of the fuselage nose section between stations 80.0 and 49.0. Also remove the upper access panel on the aft bulkhead of the forward baggage compartment.

NOTE

All disconnect and removal work can be accomplished from the upper baggage compartment access or right access panel.

b. Drain the power pack by removing the drain cap from the end of the drain line (17) on the right side of the fuselage nose section at station 49.6. Place a suitable container under the drain to catch the fluid. Replace the cap after the reservoir is empty.
c. To gain access to Power Pack, remove return air duct muffler, combustion air blower and appropriate hoses from right side of fuselage nose section.
d. Disconnect the electrical connector (7) located at the aft end of the power pack (14).
e. Disconnect the vent line (12) from the power pack cap.
f. Disconnect the gear selector control cable from the power pack control arm on the left side of the power pack.
g. Disconnect the various hydraulic lines from the power pack. Cap the open lines to prevent contamination.
h. Cut the safety wire and remove the attachment bolts (15) which secure the power pack to the mounting brackets (9).
i. Move the Power Pack to the rear and then out the right access panel.

6-32. DISASSEMBLY OF POWER PACK. (Refer to Figure 6-5.) After the Power Pack has been removed from the airplane and all ports are capped or plugged, spray with cleaning solvent (Federal Specification P-S-661, or equivalent) to remove all accumulated dust or dirt. Dry with filtered compressed air. To disassemble the unit, proceed as follows:

a. Remove retaining nut (85) "O" ring (86) and reservoir cover (55). Cover is a snug fit on reservoir. Use a soft mallet and tap cover lightly to remove. Remove large "O" ring (84).
b. Remove the filler assembly with screen (20) or sight gauge (20A).
c. Remove spacer (83) from cover center stud (21), cut safety wire and remove baffle (80) from reservoir. Drain remaining hydraulic fluid from reservoir.
d. Remove the reservoir cover center stud (21). This stud may be removed by using a double locknut at the top of the stud. Use care to prevent damage to the stud threads.
e. Turn the Power Pack upside down so that the top of the reservoir series as a support base.

NOTE

All electrical wires are coded with color stripes. Disregard color of wire terminals or plastic sleeving. If color codes are matched when wires are reinstalled, the wires will be connected correctly.

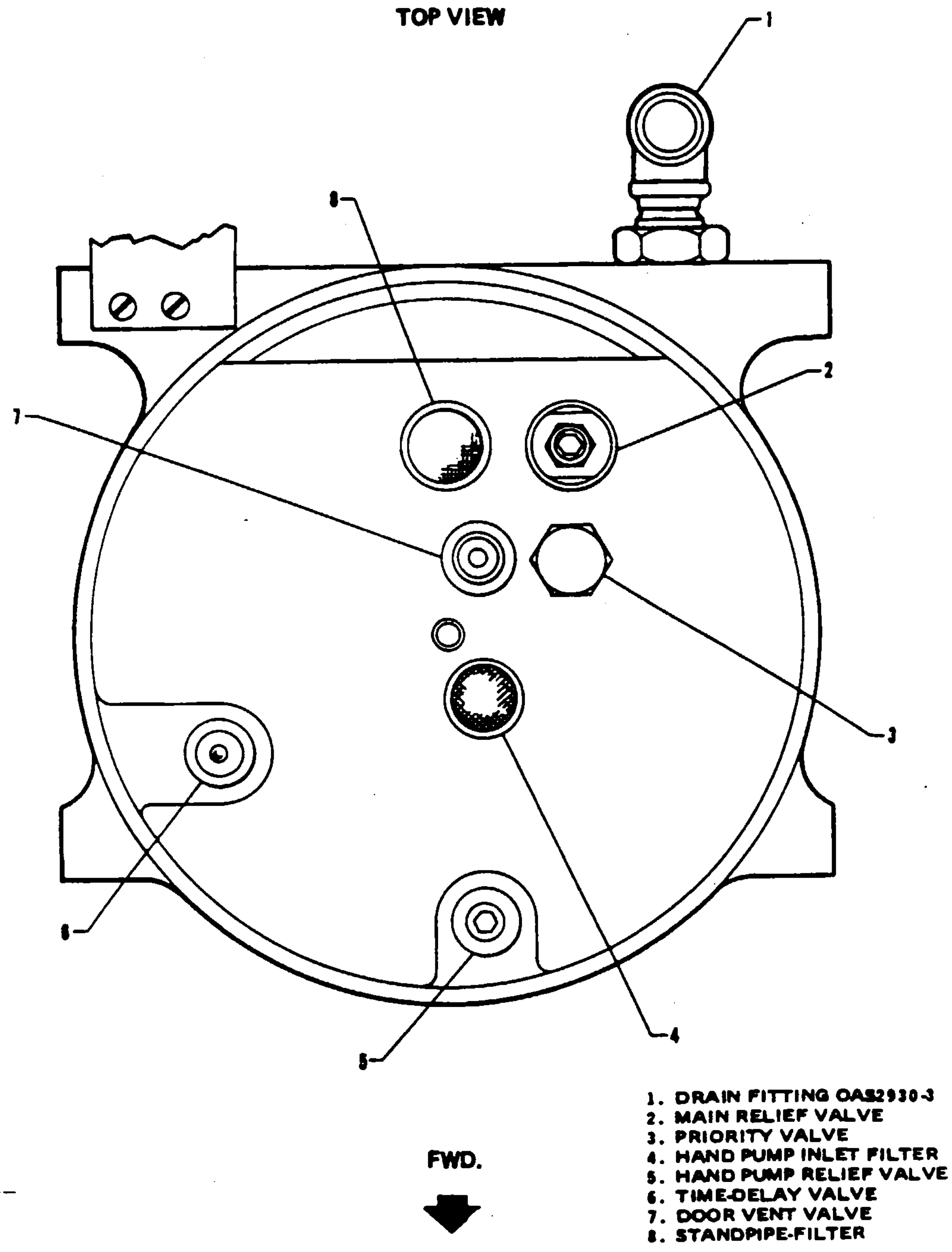


Figure 6-4. Location of Power Pack Components (Ozone)

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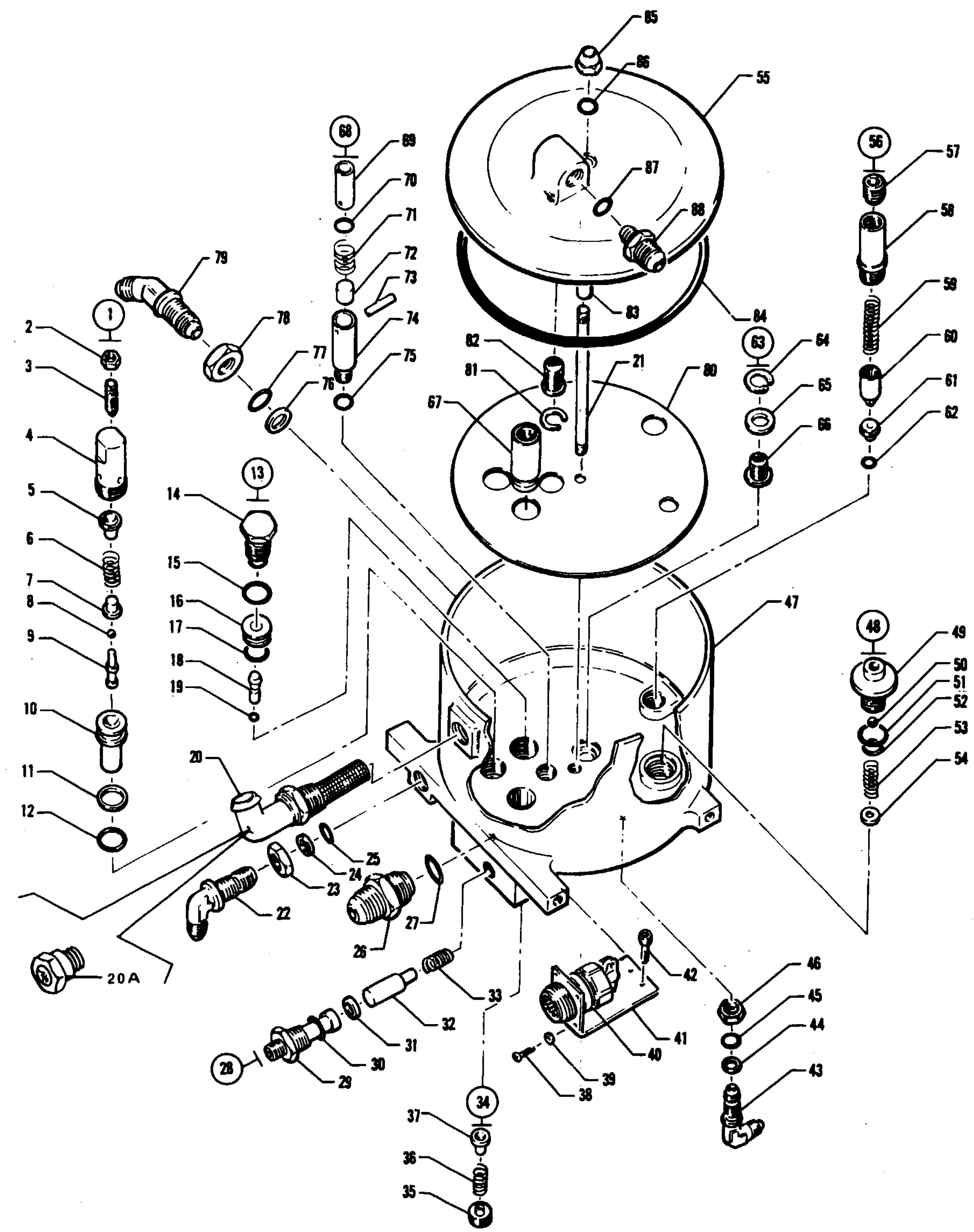
1. MAIN RELIEF VALVE
2. LOCK NUT
3. ADJUSTING SCREW
4. RETAINER
5. BUTTON
6. SPRING
7. BUTTON
8. BALL
9. POPPET
10. POPPET SEAT
11. BACK-UP RING
12. "O" RING
13. PRIORITY VALVE
14. RETAINER, PRIORITY
15. "O" RING, RETAINER
16. POPPET SEAT
17. "O" RING, POPPET SEAT
18. POPPET
19. "O" RING, POPPET
20. FILLER TUBE & SCREEN OAS2930-3 ONLY
20A SIGHT GAUGE OAS2930-5 ONLY SERIAL NO'S PA-31P-48 & UP
21. CENTER STUD
22. FITTING
23. NUT
24. BACK-UP RING
25. "O" RING
26. FITTING
27. "O" RING
28. HAND PUMP CHECK VALVE
29. SYSTEM PRESSURE PORT FITTING
30. "O" RING, FITTING
31. "O" RING
32. PLUNGER
33. SPRING
34. PRIORITY VALVE ADJUSTMENT
35. RETAINER, ADJUSTING PLUG
36. SPRING
37. BUTTON
38. SCREW
39. WASHER
40. PLUG
41. BRACKET
42. SCREW
43. FITTING
44. BACK-UP
45. "O" RING
46. NUT
47. BODY
48. TIME DELAY VALVE
49. RETAINER
50. BALL
51. "O" RING, RETAINER HEX
52. "O" RING, RETAINER BODY
53. SPRING
54. SPACER
55. COVER, RESERVOIR
56. HAND PUMP RELIEF VALVE
57. ADJUSTING PLUG
58. RETAINER, HAND PUMP RELIEF
59. SPRING
60. POPPET
61. SEAT
62. "O" RING
63. HAND PUMP SUCTION SCREEN
64. SNAP RING
65. SPACER
66. SCREEN, SUCTION
67. STANDPIPE - FILTER
68. DOOR VENT VALVE
69. RETAINER
70. "O" RING
71. SPRING
72. POPPET
73. PIN
74. BODY, VALVE
75. "O" RING
76. BACK-UP
77. "O" RING
78. NUT
79. FITTING
80. PLATE
81. SNAP RING
82. FILTER, VENT
83. SPACER
84. "O" RING, LARGE
85. NUT, RETAINER
86. "O" RING, COVER
87. "O" RING, VENT
88. FITTING, VENT



OAS 2930-3 & OAS2930-5

Figure 6-5. Hydraulic Power Pack (Ozone)

f. Cut safety wire and remove screws attaching landing gear up-down switch and bracket. Retai washers between bracket and Power Pack. (Refer to Figure 6-6.)
g. Turn Power Pack over and cut safety wire at time-delay valve.
h. Remove time-delay valve ball, spring, spacer, and spring by removing time-delay retainer.

NOTE

Do not remove the time-delay plunger until after the manifold assembly has been removed.

i. Cut the safety wire and remove the screws attaching the gear and rack protective cover. Remove the cover.
j. Remove the clamp attaching the electrical wires to the door solenoid valve and remove the safety wire from the door solenoid valve.
k. Cut the safety wire and remove the four screws attaching the manifold assembly. Work the manifold assembly from the Power Pack, taking care to prevent loss of transfer tubes between the manifold and Power Pack.
l. Remove the seven transfer tubes from the manifold or Power Pack.

CAUTION

As the manifold is separated from the Power Pack body, the rack on the landing gear selector spool becomes disengaged from the gear. This will permit the selector spool to move. Do NOT remove the selector spool from its position. Never move it to a position that is more than flush with the manifold body at the end opposite the selector spool rack. If moved beyond this position, an "O" ring will become caught and the selector spool will then be extremely difficult to remove.

6-33. DISASSEMBLY OF MANIFOLD. (Refer to Figure 6-6.)

a. Cut the safety wire (30) and remove the door solenoid (11) by unscrewing from the manifold (24). This solenoid is hand tightened. Use a strap wrench or strip of sandpaper to grip the door solenoid for removal. Remove the plunger return spring (13).
b. Remove the plunger retainer pin (14) and then remove the plunger (15) from the spool (7) by carefully pulling from the manifold.
c. Using a hook formed from a brass welding rod, withdraw the transfer sleeve from the manifold, by inserting the hook into the oil hole in the transfer sleeve (5).

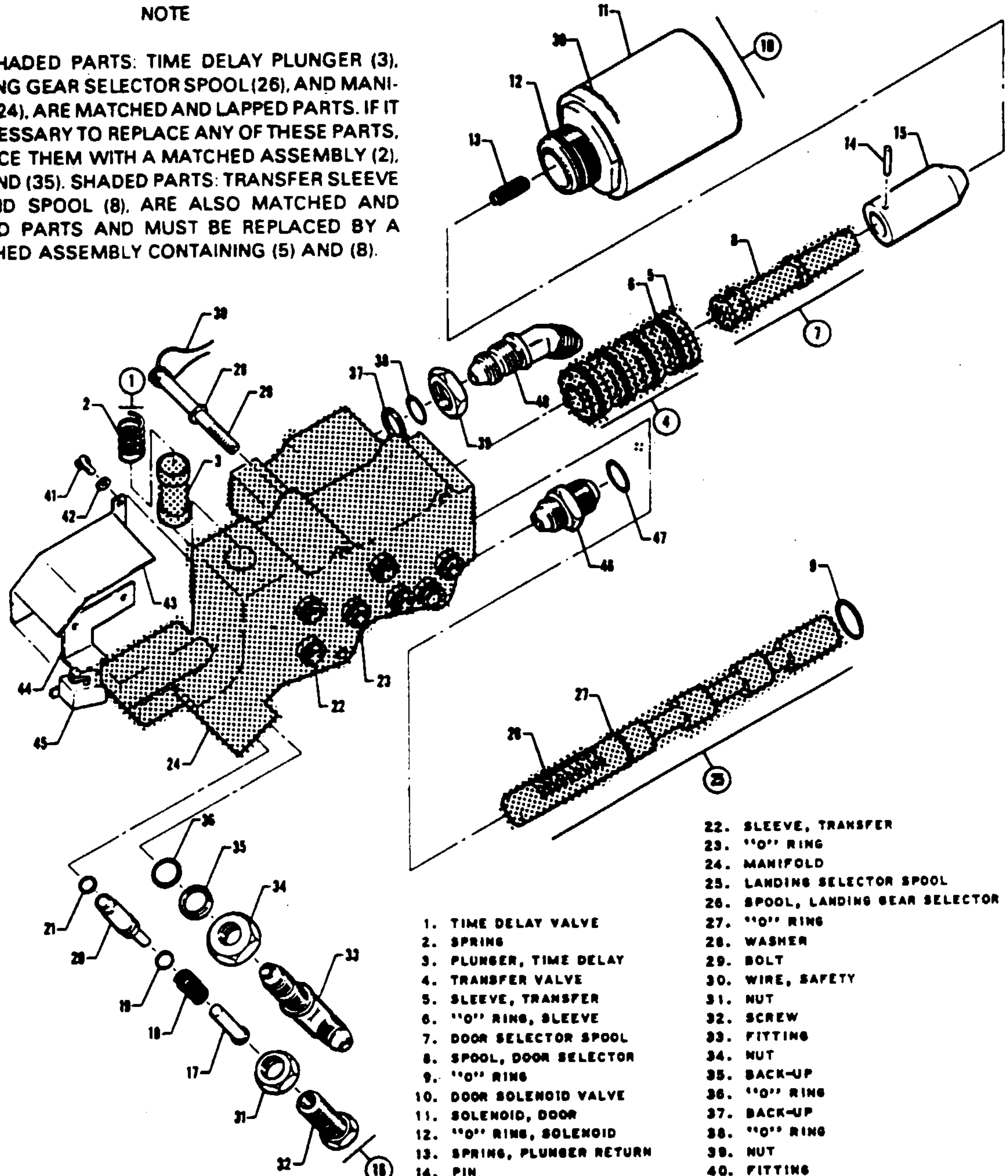
NOTE

Be sure that the end of the hook is not over .062 inch long, and use the hook with care to prevent scratching the bore in the manifold. The sleeve will be hard to withdraw due to "O" ring friction.

d. Remove the plunger (3) of the time-delay valve, using a small wooden dowel inserted in the center of the plunger. The plunger should slide out of the manifold easily.
e. Remove the landing gear selector spool (26) by grasping the rack end of the spool and carefully pulling it from the manifold.

NOTE

THE SHADED PARTS: TIME DELAY PLUNGER (3), LANDING GEAR SELECTOR SPOOL (26), AND MANIFOLD (24), ARE MATCHED AND LAPPED PARTS. IF IT IS NECESSARY TO REPLACE ANY OF THESE PARTS, REPLACE THEM WITH A MATCHED ASSEMBLY (2), (19), AND (35). SHADED PARTS: TRANSFER SLEEVE (5), AND SPOOL (8), ARE ALSO MATCHED AND LAPPED PARTS AND MUST BE REPLACED BY A MATCHED ASSEMBLY CONTAINING (5) AND (8).



1. TIME DELAY VALVE
2. SPRING
3. PLUNGER, TIME DELAY
4. TRANSFER VALVE
5. SLEEVE, TRANSFER
6. "O" RING, SLEEVE
7. DOOR SELECTOR SPOOL
8. SPOOL, DOOR SELECTOR
9. "O" RING
10. DOOR SOLENOID VALVE
11. SOLENOID, DOOR
12. "O" RING, SOLENOID
13. SPRING, PLUNGER RETURN
14. PIN
15. PLUNGER
16. HANDLE RELEASE VALVE
17. RETAINER, ADJUSTING PLUG
18. SPRING
19. "O" RING, POPPET
20. POPPET
21. "O" RING
22. SLEEVE, TRANSFER
23. "O" RING
24. MANIFOLD
25. LANDING SELECTOR SPOOL
26. SPOOL, LANDING GEAR SELECTOR
27. "O" RING
28. WASHER
29. BOLT
30. WIRE, SAFETY
31. NUT
32. SCREW
33. FITTING
34. NUT
35. BACK-UP
36. "O" RING
37. BACK-UP
38. "O" RING
39. NUT
40. FITTING
41. SCREW
42. WASHER
43. COVER
44. BRACKET
45. SWITCH
46. FITTING
47. "O" RING

Figure 6-6. Power Pack Manifold (Ozone)

NOTE

Do not bend the selector spool. Pull straight out. The landing gear selector spool (26), time-delay plunger (3), and manifold (24) are matched, lapped parts. If it is necessary to replace any one of these parts, replace them as an assembly only.

f. Remove the landing gear handle-release retainer (17) (adjusting plug), nut (31), spring (18), screw (32), and poppet (20) from the manifold. The end of the poppet has a ball which should remain in the poppet. If it doesn't, remove the ball from the manifold.

g. Remove the caps from the fittings and wash the manifold in cleaning solvent (Federal Specification P-S-661 or equivalent) and dry with filtered compressed air. Be sure internal passages are clean, then reinstall caps on fittings.

6-34. DISASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-5.)

a. Remove the suction screen (66) by removing the snap ring (64) and spacer (65).

6-35. DISASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-5.)

a. Remove the adjusting plug (57) at the top of the hand pump relief valve.
b. Remove the hand pump relief valve retainer (58) by unscrewing from the body.
c. Remove the spring (59) and poppet (60) from the body.
d. Use a brass hook to remove the seat (61) from the body. Use care to prevent scoring the bore.
e. Remove the "O" ring (62) from the bottom of the cavity.

6-36. DISASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-5.)

a. Loosen the locknut (2) at the top of the main relief valve.
b. Remove the adjusting screw (3) and locknut (2) from the top of the relief valve.
c. Unscrew the retainer (4).
d. Remove the two buttons (5 and 7), spring (6) and ball (8).
e. Remove the poppet (9) from the poppet seat (10) by lifting out of the poppet assembly. The poppet and poppet seat are matched parts.
f. Using a brass hook not over .125 inch long, pull the poppet seat up out of the body. Hook through holes in the side of the seat and use care not to damage the bore in the body.

6-37. DISASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-5.)

a. Remove the priority retainer (14) from the reservoir.
b. Turn the Power Pack upside down and remove the retainer (35) (adjusting plug), spring (36) and button (37) from the bottom of the Power Pack.
c. While the Power Pack is upside down, push the poppet (18) and poppet seat (16) into the reservoir, using a punch of .125 inch maximum diameter. Make sure that the face of the punch is square and flat.

6-38. DISASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-5.)

a. Remove the system pressure port fitting (29). The spring (33) and plunger (32) should fall out of the Power Pack after the "O" ring (31) is removed. Use hook, if necessary to remove the "O" ring.

6-39. DISASSEMBLY OF STANDPIPE AND FILTER. (Refer to Figure 6-5.)

a. The standpipe and filter assembly (67) should not be removed unless it is damaged, since it is a press fit in the reservoir.
b. Remove the vent filter (82) by removing the snap ring (81).

6-40. DISASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-5.)

a. Remove the door vent valve (68) from the reservoir. Remove the "O" ring (75) from the body. The door vent valve should not be disassembled except for replacement of parts.
b. Remove the pin (73) from the valve body (74) and retainer (69). Use care when removing the pin, as the spring (71) is under a slight load.
c. Remove the retainer (69), "O" ring (70), and poppet (72) from the valve body (74).

NOTE

The valve body and poppet are matched parts. If necessary to replace, replace as an assembly only.

6-41. DISASSEMBLY OF LANDING GEAR HANDLE AND HANDLE-RELEASE MECHANISM. (Refer to Figure 6-7.)

a. Remove the two hex-head retainers (12) (adjusting plugs), springs (11), and plungers (10) from the handle return housing.
b. Cut the safety wire (9) and remove the two screws (8) attaching the handle release housing to the Power Pack, and remove the housing.
c. Using a punch, drive the roll pin from the cam, and remove the cam from the landing gear handle shaft.
d. Pull the assembly from the Power Pack.

6-42. CLEANING, INSPECTION AND REPAIR OF POWER PACK.

a. Discard all old "O" rings and gaskets.
b. Remove the line fitting caps and wash all parts in dry cleaning solvent (Federal Specifications P-S-661, or equivalent) and dry with filtered compressed air.
c. Inspect all parts for scratches, scores, chips, cracks and indications of excess wear.
d. Repairs are limited to replacement of parts, "O" rings and gaskets.
e. The Parts Catalog should be used to obtain the proper parts for the Power Pack being serviced.

6-43. ASSEMBLY OF POWER PACK.

a. Use new "O" rings and gaskets during assembly.
b. Lubricate all "O" rings with petrolatum per VV-P-236 or equivalent during assembly.
c. Lubricate all threaded surfaces on the various valves in the Power Pack with MIL-G-7711 grease or equivalent before installing.

6-44. ASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-5.)

NOTE

The valve body and poppet are matched parts. If necessary to replace, replace as an assembly only.

a. Install the poppet (72) in the valve body (74) and insert the spring (71) in the body. Be sure that the spring enters the poppet.
b. Lubricate and install the "O" ring (70) on the retainer (69) and insert the retainer in the valve body (74). Align the holes in the retainer with the holes in the valve body.
c. Install the pin (73) through the valve body and retainer.
d. Lubricate threads, install "O" ring (75) on the valve body and install the assembly in the reservoir. Tighten securely.

6-45. ASSEMBLY OF STANDPIPE AND FILTER. (Refer to Figure 6-5.)

a. If the standpipe and filter assembly (67) was removed, press into the body until the standpipe bottoms.
b. Replace the vent filter (82) and the snap ring (81).

6-46. ASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-5.)

a. With the pressure port up, drop the spring (33) into the port.
b. Drop in the plunger (32), making sure that the small end of the plunger goes into the spring. Check freeness of the plunger in the body by depressing the plunger against the spring. Use a small wooden dowel or plastic rod to depress the plunger when checking for freedom of movement. The plunger must move freely in the body bore.
c. Lubricate and install the "O" rings (30 and 31) on the flange of the fitting (29) and at the end of the fitting. Lubricate the threads, insert the fitting. Start threads and tighten securely.

6-47. ASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-5.)

a. Lubricate and install the "O" ring (19) on the poppet (18) and insert the poppet in the body through the reservoir. Push the poppet down firmly. Either surface may be used as the seating surface.
b. Inspect the poppet seat for a sharp seating edge. Lap as necessary to obtain a sharp seating edge. Lubricate and install the "O" ring (17) on the poppet seat (16).
c. Install the poppet seat in the body through the reservoir, with the sharp seating edge toward the poppet. Push the poppet seat (16) down firmly against the poppet (18).
d. Lubricate and install the "O" ring (15) on the retainer (priority) assembly (14), lubricate the retainer threads, and install the retainer. Tighten securely.
e. Turn the Power Pack upside down, lubricate the spring (36) and button (37) and install the body (47). Apply lubricant to hold the button in the spring and install with the button in the hole first.
f. Lubricate the threads on the retainer (35) (adjusting plug) and install. This plug provides adjustment for the priority valve. Install flush at this time.

6-48. ASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-5.)

a. Inspect the poppet (9) and poppet seat (10) for pitting or scoring. Since they are matched parts, if either or both are pitted or scored, replace as an assembly only.
b. Lubricate and install the "O" ring (12) and back-up ring (11) on the poppet seat (10), insert the poppet (9) in the seat (10), and install the assembly in the body.
c. Lubricate the ball (8), buttons (5 and 7), and spring (6). Install with the ball entering the hole first. Be sure that the ball enters the cavity at the top of the poppet.
d. Lubricate the threads on the retainer (4) and install over the button (5) and spring (6). Tighten securely.
e. Lubricate the threads of the adjusting screw (3) and install at the top of the retainer (4). TD the adjusting screw full down to lock the main relief valve closed, but do not tighten the locknut (2). This is done so that the hand pump relief valve, which opens at a higher pressure, can be adjusted before the main relief valve is adjusted.

6-49. ASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-5.)

a. Lubricate and install the "O" ring (62) in the body (47). Make sure the "O" ring seats properly.
b. Inspect the seating surface of the seat (61). It should have a very sharp edge. The seat may be lapped to obtain a sharp edge.
c. Install the seat (61) in the body, with the sharp edge of the seating surface up.
d. Install the poppet (60) and spring (59) together, and insert in the body with the ball end toward the seat.
e. Lubricate the threads on the retainer, hand pump relief (58). Start the retainer over the spring (59) and tighten securely.
f. Lubricate the threads on the adjusting plug (57) and install at the top of the retainer (58). Do not tighten the adjusting plug. Screw it down only until the spring is contacted. This is done so that air may be bled from the valve during adjustment.

6-50. ASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-5.)

a. Install the suction screen (66) and spacer (65) secure with snap ring (64).

6-51. ASSEMBLY OF MANIFOLD. (Refer to Figure 6-6.)

a. Lubricate and install the "O" ring (27) on the landing gear selector spool (26), and the "O" ring (9) in the manifold (24) at the opposite end.

NOTE

The landing gear selector spool, time-delay valve plunger, and manifold are matched, lapped parts. If necessary to replace, replace as an assembly only.

b. Insert the selector spool (26) in the manifold (24) from the landing gear handle end of the manifold. Insert only until the end of the selector spool is flush with the solenoid end of the manifold.

CAUTION

If the selector spool is moved much more than flush with the manifold at the end opposite the rack (before the manifold is installed and the rack engaged properly with the gear), an "O" ring will become caught. The selector spool will then have to be removed, the manifold cleaned to remove all "O" ring particles, and a new "Of" ring installed. The selector spool then must be reinstalled correctly.

c. Check that the landing gear selector spool (25) slides freely.
d. Inspect the door solenoid spool for freedom of movement within the transfer sleeve assembly.

NOTE

The spool and sleeve are matched parts. If necessary to replace, replace as an assembly only.

e. Lubricate and install the "Of" ring (23) on the transfer sleeve (22) and install the sleeve in the manifold.
f. Attach the plunger (15) to the door selector spool (8) and pin (14).
g. Lubricate and install the "O" ring (12) on the door solenoid (11).

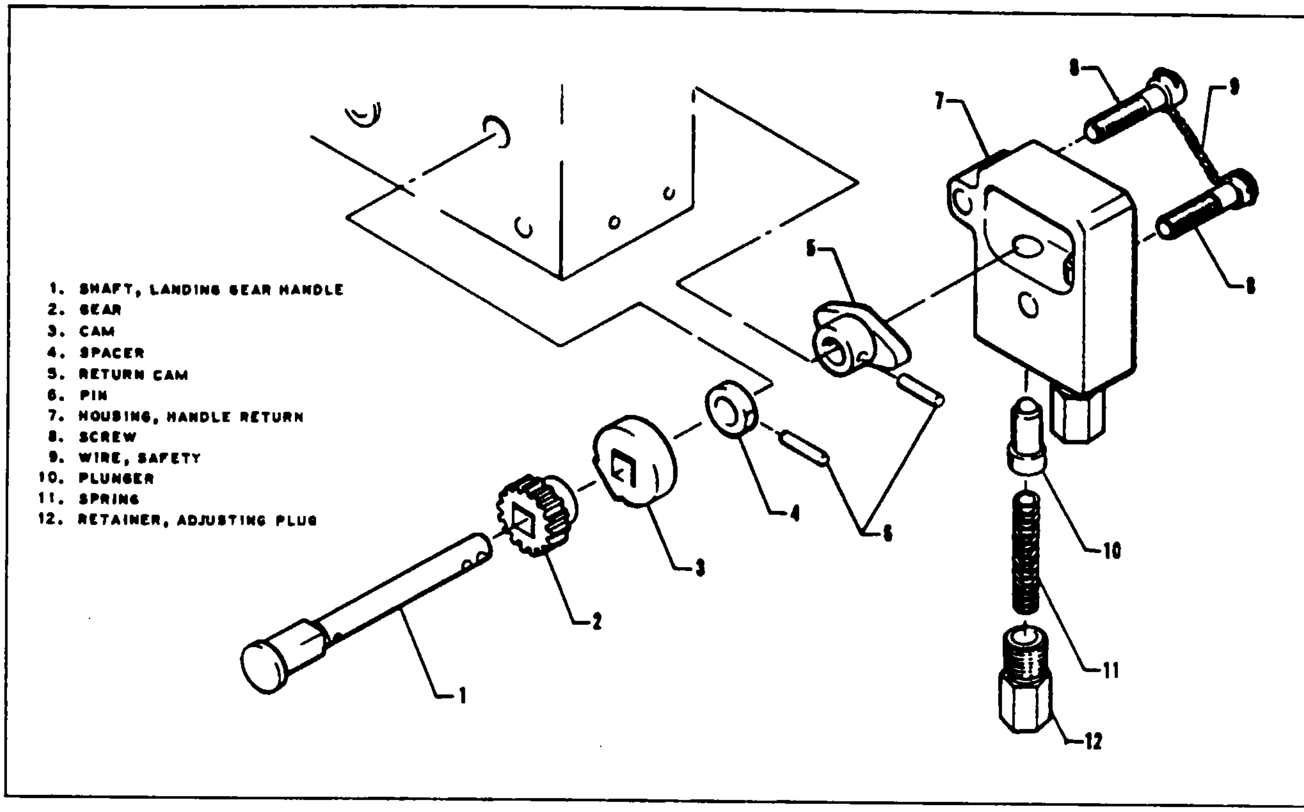


Figure 6-7. Power Pack Handle Release (Ozone)

h. Lubricate the door solenoid (11) threads and plunger return spring (13) and insert the plunger (15), then install the solenoid over the spring and plunger. Screw the solenoid into the manifold. Do not over tighten the solenoid, but tighten securely by hand. Safety the solenoid to the adjacent Power Pack mounting lug.

6-52. ASSEMBLY OF POWER PACK HANDLE-RELEASE MECHANISM. (Refer to Figure 6-7.)

a. If the landing gear handle shaft (1) or gear (2) was removed, the parts must be indexed and assembled as shown in Figure 6-9.
b. Lubricate the shaft (1), install the cam (3) and spacer (4) on the shaft and insert the shaft into the Power Pack.
c. Install the return cam (5) with the roll pin (6). Both sides of the cam surfaces are identical. Check the landing gear handle shaft for freedom of movement in the Power Pack. Check for slight endplay in the shaft. If shaft binds, remove the cam and lap inside boss of cam to obtain slight endplay in the shaft with the cam installed.
d. Install the handle-release housing and safety the attaching screws. Check the landing gear shaft for freedom of movement.
e. Install the Power Pack control arm on the end of the shaft with the arm pointing down. Align the holes between the shaft and the arm assembly and install the roll pin. Install .040 safety wire through the roll pin and around half of the arm. Roll the twisted end of the safety wire around the other half of the arm assembly. (Refer to Figure 6-8.)

NOTE

Do not install the plungers, springs and hex-head retainers (adjusting plugs) at this time.

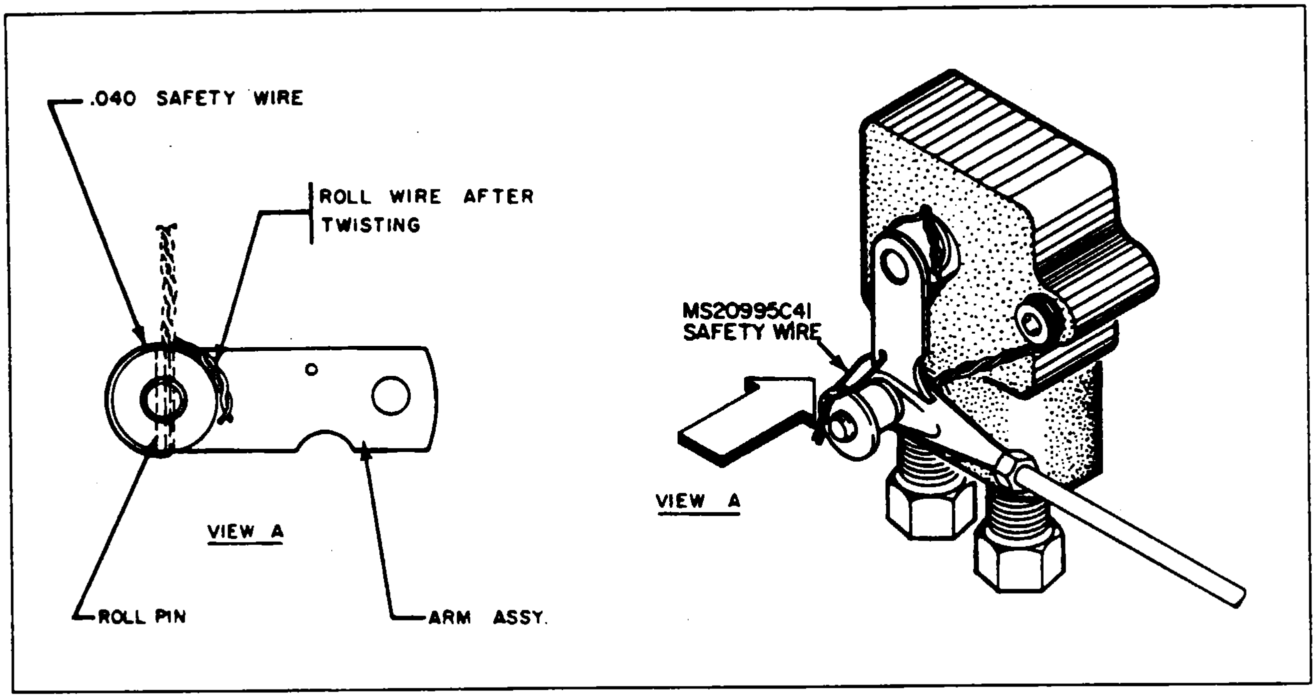


Figure 6-8. Safetying Control Arms (Ozone)

6-53. INSTALLATION OF MANIFOLD. (Refer to Figure 6-6.)

a. Lubricate and install the "O" rings (23) on the seven transfer tubes (22).
b. Insert the transfer tubes into the Power Pack body.
c. Install the time-delay valve plunger (3) in the manifold. The plunger must move freely in the manifold without binding.
d. Mate the manifold to the Power Pack body, using care to prevent damage to the "O" rings on the transfer tubes. Align the dowel pin on the Power Pack with the dowel hole in the manifold.

NOTE

When installing the manifold, time the landing gear assembly to the rack on the selector spool as shown in Figure 6-9. Refer to the following steps if binding exists.

e. Install the four manifold attaching screws (29) and washers (28). Torque the screws to 35 inch-pounds and safety. Do not over-torque the screws, as this will cause binding in the movement of the landing gear handle.
f. Lubricate and install the two "O" rings on the time-delay valve retainer. (Refer to Figure 6-5.)
g. Lubricate and insert the larger spring and spacer in the body through the reservoir.
h. Lubricate and insert the ball and smaller spring in the time-delay valve retainer (ball next to the top of the retainer).
i. Lubricate threads on the time-delay valve retainer and install the retainer in the body through the reservoir. Do not over tighten the time-delay valve retainer as this will cause the landing gear selector to bind in the manifold. After tightening the time-delay valve retainer, check for freedom of movement of the landing gear selector spool.
j. Thoroughly lubricate the handle return springs and plungers and install in the housing with the hex-head retainers. Do not tighten the retainers at this time.

k. Lubricate and install the two "O" rings on the landing gear handle release plunger and insert the plunger in the body.
l. Lubricate the landing gear handle release spring, guide, retainer and nut and install in the body. Tighten the retainer (adjusting plug) until approximately .312 inch of thread is engaged.
m. Install the gear and rack protective cover. Safety the attaching screws.

6-54. INSTALLATION AND ADJUSTMENT OF INBOARD GEAR DOORS SOLENOID VALVE SWITCH. (Refer to Figure 6-6.)

a. Install the landing gear up-down switch and the switch attaching bracket. Note that the washers are used between the bracket and Power Pack. The switch bracket has slotted holes for switch adjustment.
b. Adjust the top edge of the bracket (44) to be flush with the edge of the manifold assembly. Tighten the screws securely and safety wire them.
c. Adjust the switch to the full up position in the slot provided.
d. Move the selector spool to the gear up position and check that the switch retraction arm does not bottom on the switch body.
e. Move the selector spool to the gear up and gear down position to ensure switch actuates on and off.
f. If removed, install the terminal strip and place the capacitor along side the strip. Connect electrical wires to the terminal strip and ground, clamp wires to the door solenoid valve.

NOTE

Electrical wires are coded with color stripes. Disregard the color of wire terminals or plastic sleeving. If the color codes are matched when the wires are installed, the wires will be connected correctly.

g. Continue reassembly of the Power Pack after pressure adjustments have been completed.

6-55. POWER PACK BENCH TEST ADJUSTMENT. After completion of the overhaul, the Power Pack may be bench tested prior to installation in the airplane using a hydraulic test unit or similar test equipment. This procedure requires a minimum of test equipment for testing the Power Pack.

a. Use only clean hydraulic fluid (MIL-H-5606).
b. Minimum equipment needed is as follows:
    1. Test unit pump or hand pump with a capacity of over 2100 psi.
    2. One hydraulic pressure gauge with a capacity of over 2100 psi.
    3. One hydraulic pressure gauge of 150 psi capacity.
c. Connect the test pressure hose to the pressure inlet port of the Power Pack. The higher pressure gauge is used to operate off of the pressure line.
d. Connect the suction hose to the suction port of the Power Pack.
e. If a vent hose is part of the test unit, connect it to the vent port at the top of the Power Pack.
f. Cap all other fittings with high pressure caps.

NOTE

For control of the door valve solenoid it will be necessary to fabricate an electric harness as shown in Figure 6-27. This harness, when collected to a 24-volt battery, will allow control of the electrical current to the door valve solenoid, permitting operation of the door hydraulic circuits.

6-56. ADJUSTMENT OF HANDLE-RELEASE MECHANISM. (Refer to Figure 6-10.)

The following procedure outlines preliminary adjustments to set the handle-release detent spring load and the handle-return spring load adjusting plugs in approximately their correct positions before installing the Power Pack in the airplane. After it has been installed, the system must be checked and final adjustments, if needed, made at that time. Use a .078 inch punch to rotate the gear handle shaft.

a. Ascertain that the handle-return spring adjusting plugs (1 and 2) are not tightened, and the detent spring adjusting plug (3) has been screwed in until approximately .312 inch of thread is engaged. The spring, however, must not bottom out.
b. Place the handle in the up-detent position, then hold it beyond this position (in overtravel).
c. Tighten the forward handle-return spring adjusting plug (2) until the handle just starts to move out of overtravel, then loosen the adjusting plug one turn.
d. Place the handle in the down-detent position, then hold it beyond this position (in overtravel).
e. Tighten the aft handle-return spring adjusting plug (1) until the handle just starts to move out of overtravel, then loosen the adjusting plug one turn.
f. Place the handle in the up-detent position and tighten the handle-release detent spring adjusting plug (3) until the spring bottoms out, then back the adjusting plug out two turns.
g. The handle must hold in both detent positions, but must return with a positive snap when manually released from either detent position. Connect a spring scale to the arm and pull both fore and aft, perpendicular to the centerline of the arm, to determine that it will leave the detent at a force of 9 ± 1-2 pounds. The handle-release detent spring adjusting plug (3) may be readjusted slightly more or less than the two turns specified in the proceeding step, if necessary. When proper detent adjustment has been obtained, tighten the nuts and safety.

6-57. ADJUSTMENT OF HAND PUMP RELIEF VALVE.

a. With the landing gear handle in either the up or down position, apply test unit pressure very slowly until fluid flows from the hand pump relief valve.

CAUTION

It is very important that the test unit be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the test pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

b. Bleed air from the Power Pack by cracking the cap on the door-open fitting.
c. Adjust the retainer plug at the top of the valve until the valve cracks at the pressure stated in Table VI-I (using a slow flow). Bleed pressure by cracking the cap on the door-open fitting after each adjustment.
d. Safety wire the hand pump relief valve to the time-delay valve.

6-58. ADJUSTMENT OF MAIN RELIEF VALVE.

a. Loosen the locknut and back out the adjusting screw at the top of the valve until very little load is left on the spring.
b. With the landing gear handle in the down position, apply pressure until fluid flows from the main relief valve.
c. Adjust the main relief valve until the valve cracks at the pressure stated in Table VI-I. Bleed prepare after each adjustment by cracking the cap on the door-open fitting. Tighten the locknut on the adjusting screw after obtaining the correct adjustment.

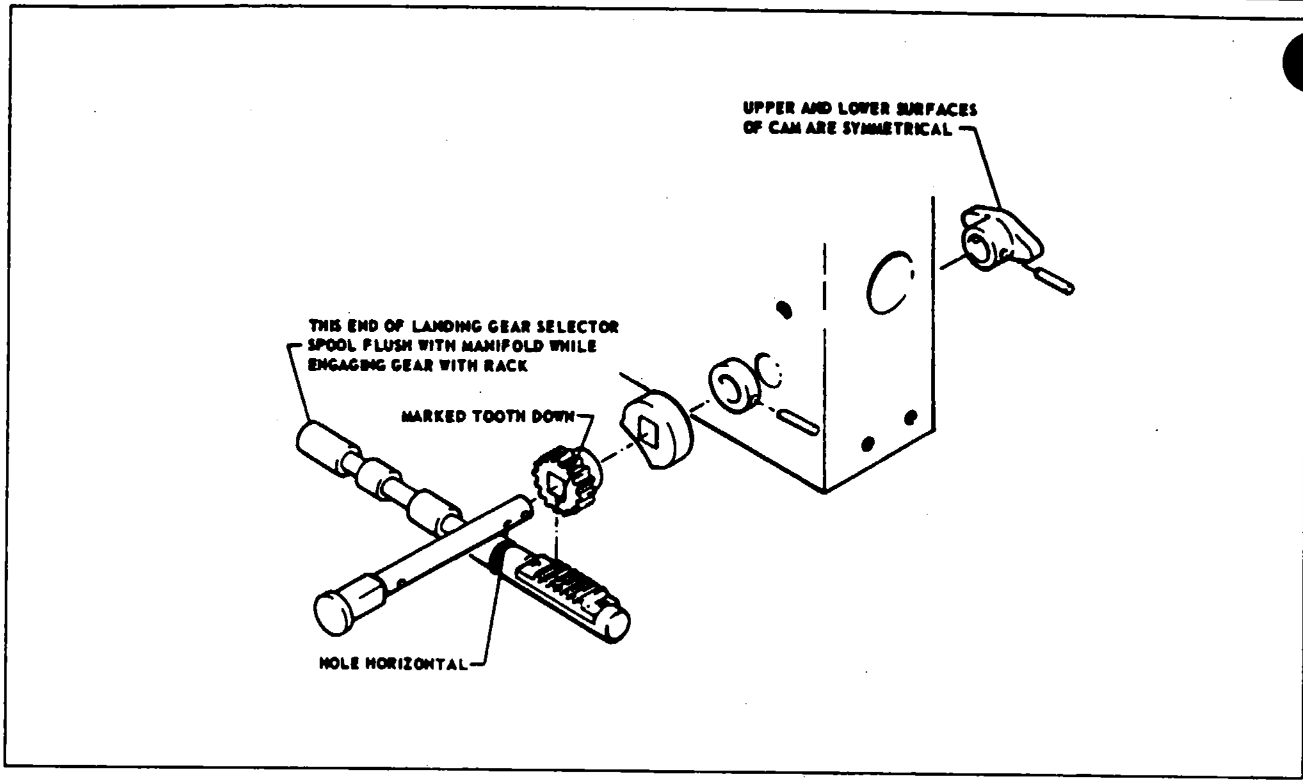


Figure 6-9. Timing of Selector Spool (Ozone)

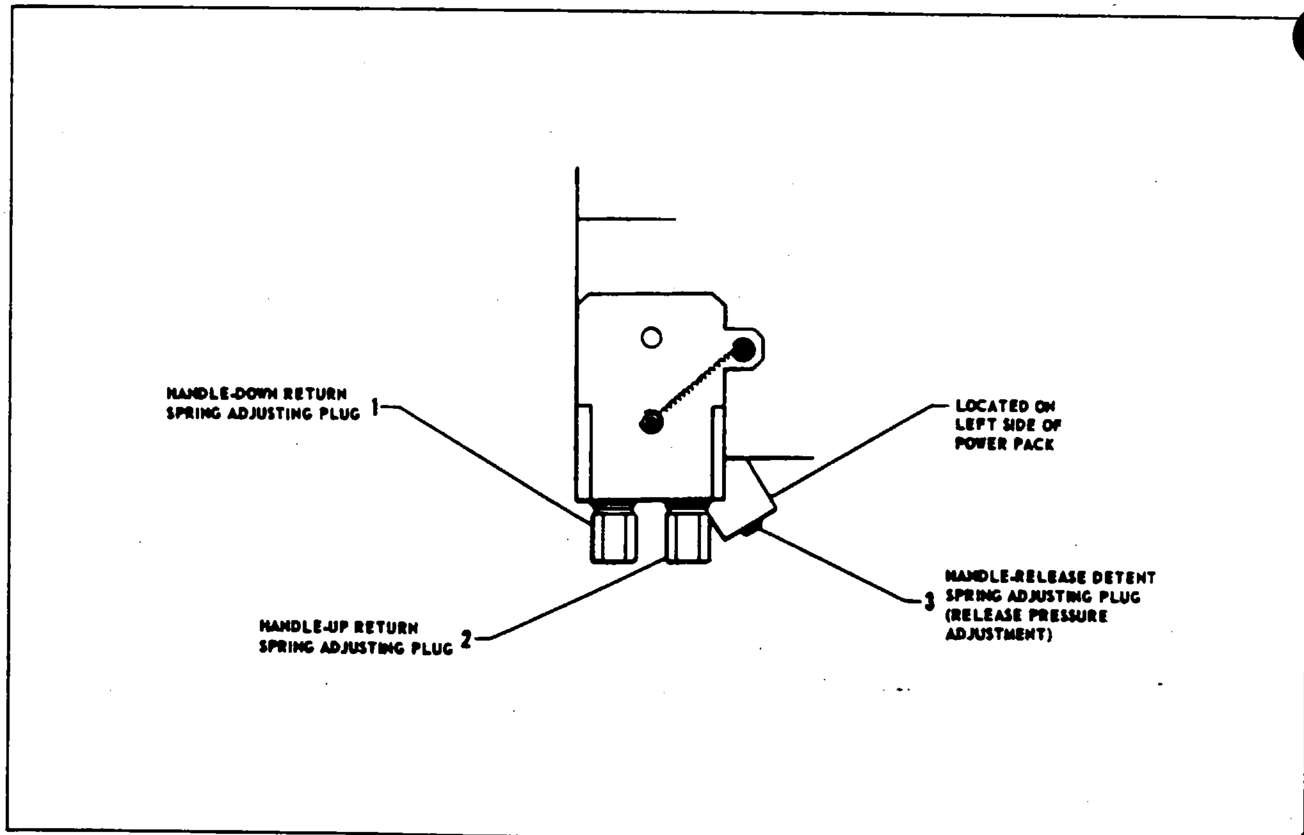


Figure 6-10. Handle Release Adjustment (Ozone)

6-59. ADJUSTMENT OF PRIORITY VALVE.

a. Place the landing gear handle in the up position and remove the cap from the gear up fitting.
b. Apply pressure and note the priority valve cracking pressure by observing the pressure gauge when fluid first starts to flow from the gear-up port.
c. Adjust the priority valve to crack at the pressure stated in Table VI-I. Bleed pressure after each adjustment by cracking the cap on the door-open fitting.
d. Disconnect the test unit and cap all open fittings.

6-60. ADJUSTMENT OF DOOR SOLENOID VALVE.

a. Remove the caps from the door-open and door-close fittings on Power Pack.
b. Connect a test harness to the electrical plug of the Power Pack and power source. (A test harness may be fabricated as shown in Figure 6-27.)
c. With the test harness switch in the OFF position, and the landing gear handle in either the up or down neutral position, apply pressure and note that fluid flows from the door-open fitting.
d. With the test harness switch in either the gear up or down position, the landing gear handle in either the up or down neutral position, apply pressure and note that fluid flows from the door-close fitting.
e. Disconnect the test equipment and cap all open fittings.

6-61. TESTING DOOR VENT VALVE.

a. Remove the cap from the door-open fitting on the Power Pack, and attach the pressure hose from the hand pump with the 150 psi pressure gauge to the door-open fitting.
b. Check for fluid seepage while slowly applying the stated pressure in Table VI-I.
c. Check to see that the door vent valve shuts off fluid flow when the pressure stated in Table VI-I is applied. (Slow decrease in pressure from the valve leakage is normal.)
d. Relieve pressure by cracking the hose fitting from the hand pump.
e. Disconnect the test unit and cap all open fittings.

6-62. ASSEMBLY OF POWER PACK. (Refer to Figure 6-5.) To complete the reassembly of the Power Pack, proceed as follows:

a. Install the reservoir cover attaching center stud (21). Install with the longer threaded end down, and screw in until the stud bottoms in the reservoir.
b. Install the plate (80) and spacer (83) of the center stud. Safety wire the main relief valve locknut (2) to the screened standpipe (67).
c. Lubricate and install the "O" ring (84) in the groove of the reservoir cover.
d. Position the cover (55) on the reservoir, aligning the index marks on the reservoir and cover.

CAUTION

Be sure that the large "O" ring is positioned properly in the groove of the reservoir cover and that the "O" ring is not pinched as the cover is installed.

e. Lubricate and install the "O" ring of the cover (86) at the top of the cover and around the center stud (21).
f. Install the cover retaining nut (85) (cap nut), tighten and safety.

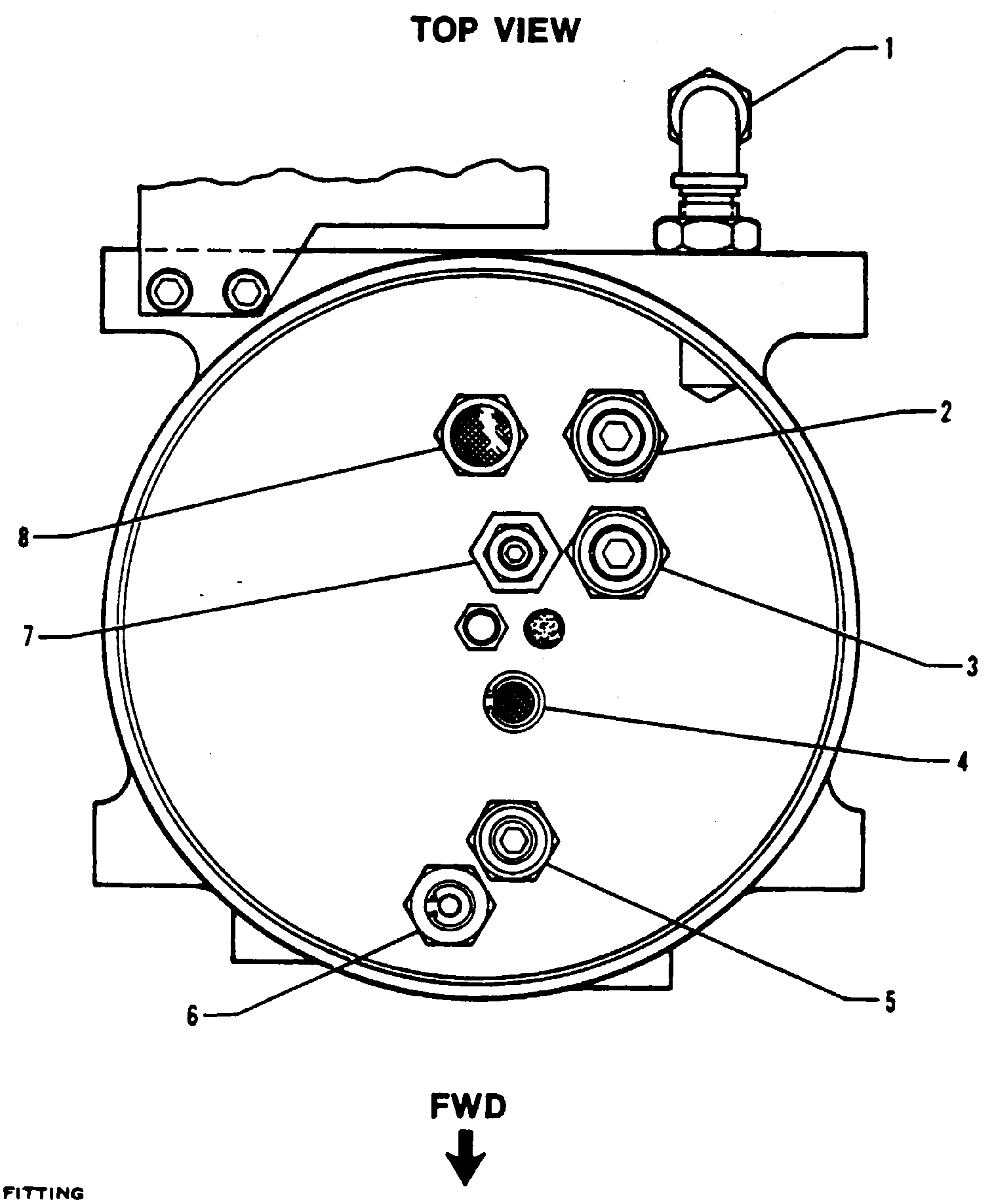
6-63. TESTING RESERVOIR FOR LEAKAGE.

a. Remove the filler and drain tee or drain fitting as applicable, and attach a test unit and 150 psi gauge to the filler or drain port.
b. Remove the cap from the reservoir vent fitting at the top of the reservoir and operate the test pump until the reservoir is completely full, as indicated by fluid coming out of the fitting.

c. Cap the reservoir vent fitting.
d. Operate the test hand pump very slowly until the pressure gauge indicates 15 psi maximum.
e. Check for leaks. There should be no external leakage.
f. Crack the vent fitting to release pressure, remove the test equipment, drain the reservoir, and cap the fittings.
g. The hydraulic Power Pack is now ready to be installed in the airplane.

6-64. INSTALLATION OF POWER PACK. (Refer to Figures 6-3 or 6-3a.)

a. Reach through the nose baggage compartment upper aft access panel and position the power pack within the mounting brackets (9). Install the bolts (15) to secure it in place. Safety wire the bolts (15)
b. Uncap and connect the various hydraulic lines to the power pack.
c. Connect the electrical connector (7) to the aft end of the power pack and landing gear selector cable to the selector arm.
d. Replace the return air duct muffler, combustion air blower and appropriate hoses from right side of fuselage nose section.
e. Fill the reservoir with MIL-H-5606 hydraulic fluid by attaching a hose from a pressure tank to the filler tube of the power pack. (Refer to Filling Hydraulic Reservoir, Section II.)
f. Bleed the hydraulic system (Refer to Paragraph 6-110) and check for fluid leaks.
g. After bleeding the system, it may be checked as described in Paragraphs 6-21 thru 6-28.
h. Install the access panels.



1. DRAIN FITTING
2. MAIN RELIEF VALVE
3. PRIORITY VALVE
4. FILTER, HAND PUMP SUCTION
5. HAND PUMP RELIEF VALVE
6. TIME DELAY CHECK VALVE
7. DOOR VENT VALVE
8. STANDPIPE, FILTER

Figure 6-11. Location of Power Pack Components (Wiebel Tool)

6-65. HYDRAULIC POWER PACK (WIEBEL TOOL).

6-66. REMOVAL OF POWER PACK. (See Paragraph 6-31.)

6-67. DISASSEMBLY OF POWER PACK. (Refer to Figure 6-12.) After the Power Pack has been removed from the airplane and all ports are capped or plugged, spray with cleaning solvent (Federal Specifications P-S-661, or equivalent) to remove all accumulated dust or dirt. Dry with filtered compressed air. To disassemble the unit, proceed as follows:

a. Remove wire (37), nut (35), reservoir cover (36) and "O" ring (47). Cover is a snug fit on reservoir. Use a soft mallet and tap cover lightly to remove.
b. Remove snap ring (44) from center stud (41) and remove baffle plate (45) from reservoir. Drain remaining hydraulic fluid from reservoir.
c. Remove the reservoir (46) and "O" ring (104). Reservoir is a snug fit in Body (67) and requires a hard pull to disengage from Body.
d. Remove center stud (41) and "O" ring (40).

NOTE

All electrical wires are color coded. Disregard color of wire terminals. If colored wires are matched when wires are re-installed, the wires will be connected correctly.

e. Remove screws (46), washers (45), switch assembly (44) and insulating plate (43). Switch will remain hanging from the electrical wires. (Refer to Figure 6-13.)
f. Remove plastic strap (48) attaching the electrical wires to the door solenoid valve (11) and remove the safety wire (47) from the door solenoid valve. (Refer to Figure 6-13.)
g. Disconnect electrical wires of switch and door solenoid from terminal block (80).
h. Remove four bolts (42) attaching the manifold assembly. Work the manifold assembly from the Power Pack, taking care to prevent the loss of the transfer sleeves (36) between the manifold and the Power Pack. (Refer to Figure 6-13.)
i. Remove the five transfer sleeves (36) from the manifold (35). (Refer to Figure 6-13.)

NOTE

As the manifold is separated from the Power Pack body, the teeth on the landing gear selector spool become disengaged from the gear. This will permit the selector spool to move. DO NOT remove the selector spool from its position. Never move it to a position that is more than flush (± .06 inch) with the manifold body at the end opposite the selector spool teeth. If moved beyond this position, an "O" ring will become caught and the selector spool will then be difficult to remove.

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NOTE

The shaded parts, poppet (6) and poppet seat (7) are matched parts and must be replaced as an assembly.

1. MAIN RELIEF VALVE
2. ADJUSTING SCREW
3. SPRING
4. BUTTON
5. BODY, RELIEF VALVE
6. POPPET
7. POPPET SEAT
8. BACK UP
9. "O" RING
10. PRIORITY VALVE
11. ADJUSTING SCREW
12. SPRING
13. BUTTON
14. BODY, PRIORITY VALVE
15. BACK UP
16. "O" RING
17. BACK UP
18. "O" RING
19. POPPET
20. POPPET SEAT
21. "O" RING
22. FITTING
23. NUT
24. BACK UP
25. "O" RING
26. DOOR VENT VALVE
27. ADJUSTING SCREW
28. SPRING
29. STEM
30. RETAINER
31. "O" RING
32. PISTON
33. BODY, VENT VALVE
34. "O" RING
35. NUT
36. COVER, RESERVOIR
37. WIRE, SAFETY
38. "O" RING
39. FITTING
40. "O" RING
41. CENTER STUD
42. FILTER, VENT
43. SNAP RING
44. SNAP RING
45. BAFFLE PLATE
46. RESERVOIR
47. "O" RING
48. FILTER, HAND PUMP SUCTION
49. SNAP RING
50. FILTER, HAND PUMP
51. HAND PUMP RELIEF VALVE
52. ADJUSTING SCREW
53. SPRING
54. STEM
55. BODY, SECONDARY RELIEF VALVE
56. BALL
57. SEAT
58. "O" RING
59. CHECK VALVE, TIME DELAY
60. SNAP RING
61. "O" RING
62. SEAT
63. BALL
64. SPRING
65. BODY, CHECK VALVE
66. "O" RING
67. BODY
68. "O" RING
69. BACK UP
70. NUT
71. FITTING
72. BOLT
73. WASHER
74. BRACKET
75. BOLT
76. WASHER
77. PLUG, ELECTRICAL
78. SCREW
79. WASHER
80. TERMINAL BLOCK
81. SPRING CARTRIDGE
82. SNAP RING
83. BUTTON
84. SPRING
85. PLUNGER
86. BODY, HANDLE RELEASE
87. SCREW, STOP
88. HAND PUMP CHECK VALVE
89. FITTING
90. "O" RING
91. BACK UP
92. "O" RING
93. POPPET
94. SPRING
95. GUIDE
96. SNAP RING
97. FITTING
98. "O" RING
99. STANDPIPE-FILTER
100. FITTING
101. NUT
102. BACK UP
103. "O" RING
104. "O" RING
105. WIRE SAFETY
106. BRACKET ASSEMBLY
107. DEFLECTOR PLATE

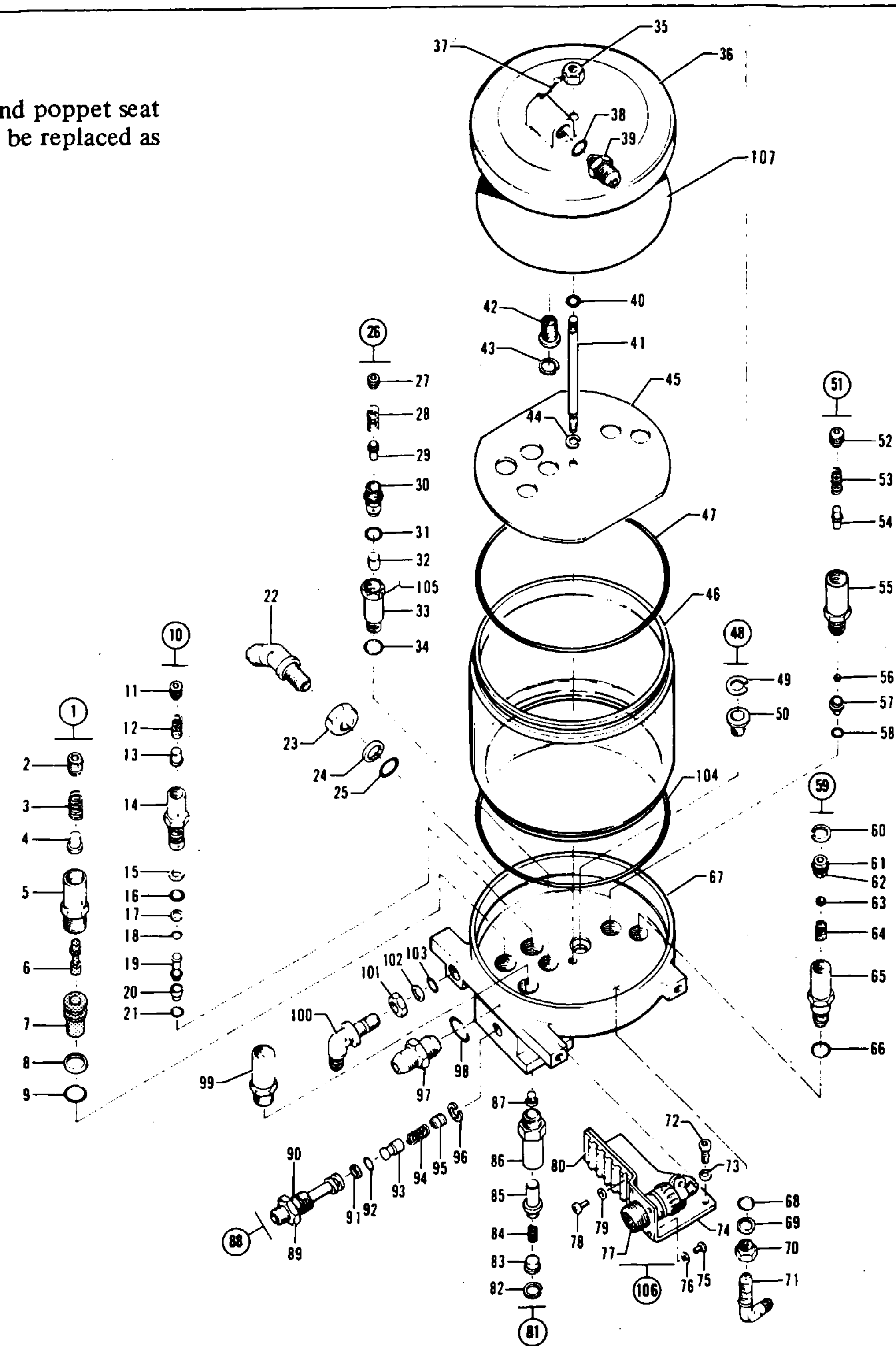


Figure 6-12. Hydraulic Power Pack (Wiebel Tool)

6-68. DISASSEMBLY OF MANIFOLD. (Refer to Figure 6-13.)

a. Remove the door solenoid (12) by unscrewing it from the manifold (35). Use proper wrench. Remove the plunger return spring (14).
b. Remove the pin (16), and then remove the plunger (15) from the spool (10) by carefully pulling it from the manifold.
c. Using a hook formed from a brass welding rod, withdraw the transfer sleeve (7) from the manifold, by inserting the hook into one of the oil holes in the transfer sleeve.

NOTE

Be sure that the end of the hook is not over .06 inches long and use the hook with care to prevent scratching the bore in the manifold. The sleeve will be hard to withdraw due to "O" ring friction.

d. Remove screw (5), spring (3) and the plunger (2) using a small wooden dowel inserted in the center of the plunger. The plunger should slide out very easily.
e. Remove the landing gear selector spool (19) by grasping the rack (teeth) end of the spool and pulling it from the manifold.

NOTE

DO NOT bend the selector spool, pull straight out. The landing gear selector spool (19), time delay plunger (2) and the manifold (35) are matched, lapped parts. If it is necessary to replace any of these three parts, replace them as an assembly only.

f. Remove the landing gear handle — release retainer (26), spring (25) and plunger (23) from the manifold. The end of the plunger has a ball which should remain in the plunger. If it does not, remove the ball from the manifold.
g. Remove the caps and the fittings and wash the manifold in cleaning solvent (Federal Specification P-S-661 or equivalent) and dry with filtered, compressed air. Be sure internal passages are clean. Reinstall caps on fittings.

6-69. DISASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-12, item 48.)

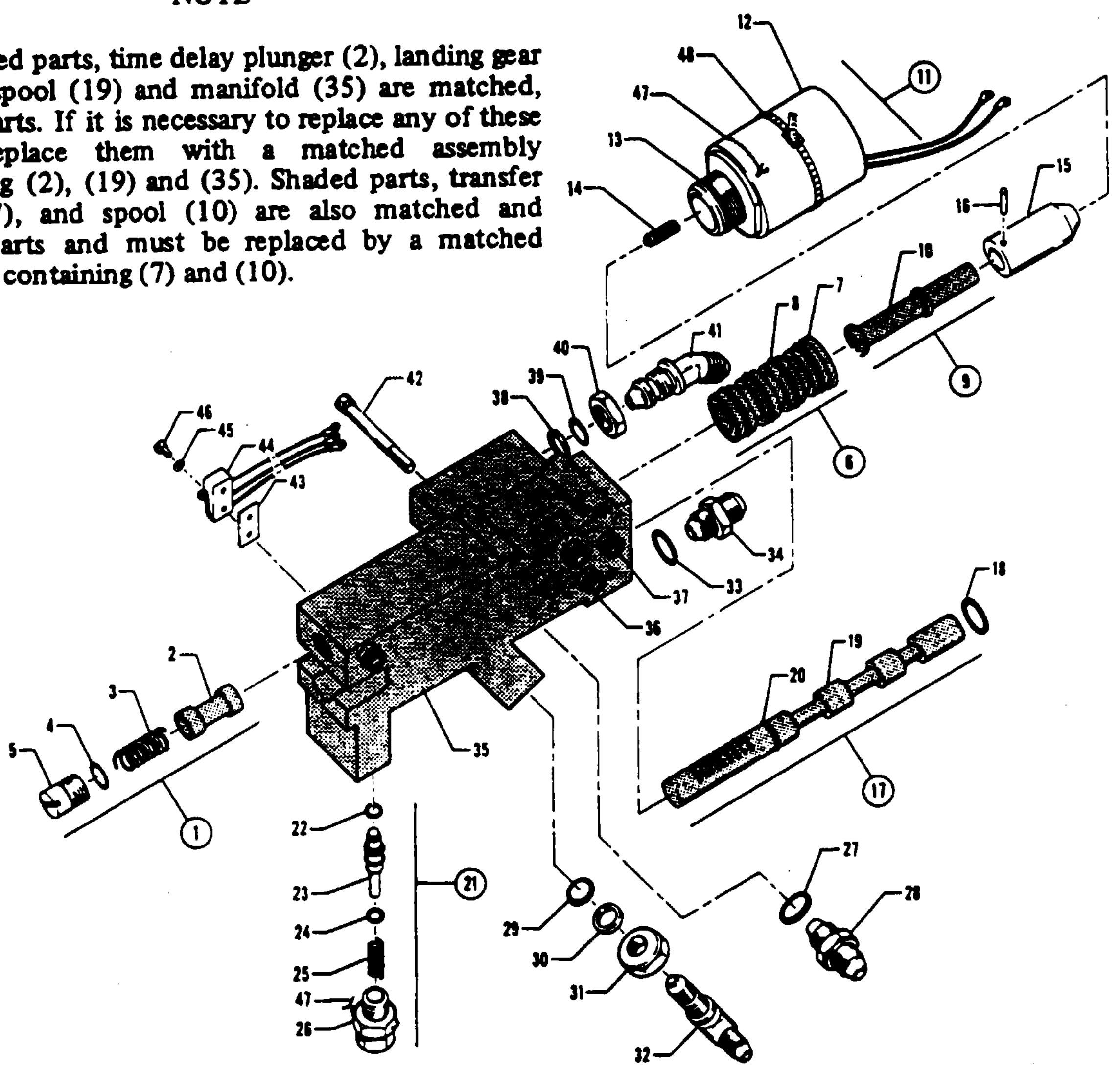
a. Remove the suction screen (50) by removing the snap ring (49).

6-70. DISASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-12, item 51.)

a. Remove the adjusting screw (52) at the top of the hand pump relief valve.
b. Remove the hand pump relief valve body (55) by unscrewing from the body (67).
c. Remove the spring (53) and the stem (54) from body (55).
d. Remove ball (56).
e. Use a brass hook and remove the seat (57) from the body (67). Be careful not to score the bore.
f. Remove the "O" ring (58) from the bottom of the cavity.

NOTE

The shaded parts, time delay plunger (2), landing gear selector spool (19) and manifold (35) are matched, lapped parts. If it is necessary to replace any of these parts, replace them with a matched assembly containing (2), (19) and (35). Shaded parts, transfer sleeve (7), and spool (10) are also matched and lapped parts and must be replaced by a matched assembly containing (7) and (10).



1. TIME DELAY VALVE
2. PLUNGER, TIME DELAY
3. SPRING
4. "O" RING
5. SCREW
6. TRANSFER VALVE
7. SLEEVE, TRANSFER
8. "O" RING, SLEEVE
9. DOOR SELECTOR SPOOL
10. SPOOL, DOOR SELECTOR
11. DOOR SOLENOID VALVE ASSEMBLY
12. SOLENOID, DOOR
13. "O" RING, SOLENOID
14. SPRING, PLUNGER RETURN
15. PLUNGER
16. PIN
17. LANDING GEAR SELECTOR SPOOL
18. "O" RING
19. SPOOL, LANDING GEAR SELECTOR
20. "O" RING
21. HANDLE DETENT ASSEMBLY
22. "O" RING
23. PLUNGER
24. "O" RING
25. SPRING
26. RETAINER
27. "O" RING
28. FITTING
29. "O" RING
30. BACK UP
31. NUT
32. FITTING
33. "O" RING
34. FITTING
35. MANIFOLD ASSEMBLY
36. SLEEVE, TRANSFER
37. "O" RING
38. "O" RING
39. BACK UP
40. NUT
41. FITTING
42. BOLT
43. INSULATING PLATE
44. SWITCH ASSEMBLY
45. WASHER
46. SCREW
47. WIRE, SAFETY
48. STRAP, PLASTIC

Figure 6-13. Power Pack Manifold (Wiebel Tool)

6-71. DISASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-12, item 1.)

a. Remove the adjusting screw (2) at the top of the main relief valve.
b. Remove relief valve body (5) with spring (3) and button (4).
c. Remove the poppet (6) from the poppet seat (7).
d. Use a brass hook, not over .125 inches long, and pull the poppet seat (7) up and out of the body (67). Hook through the holes in the side of the seat and use care not to damage the bore in the body (67).
e. Reassemble poppet (6) into poppet seat (7). The poppet and poppet seat are matched parts.

6-72. DISASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-12, item 10.)

a. Remove the adjusting screw (11) at the top of the priority valve.
b. Remove priority valve body (14) with spring (12), button (13) and poppet (19).
c. Use a brass hook and remove the poppet seat (20) from the body (67). Be careful not to score the bore.
d. Remove the "O" ring (21) from the bottom of the cavity.

6-73. DISASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-12, item 88.)

a. Remove the fitting (89) from the body (67).
b. Remove the snap ring (96) from fitting (89).
c. Remove guide (95), spring (94) and poppet (93).

6-74. DISASSEMBLY OF STANDPIPE-FILTER. (Refer to Figure 6-12.)

a. Remove the standpipe-filter (99) from body (67).

6-75. DISASSEMBLY OF VENT FILTER. (Refer to Figure 6-12.)

a. Remove snap ring (43) and pull out filter (42).

6-76. DISASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-12, item 26.)

a. Remove adjusting screw (27) from top of retainer (30).
b. Remove vent valve body (33) from body (67).
c. Remove spring (28) and stem (29).
d. Cut wire (105) and remove retainer (30) from vent valve body (33).
e. Remove "O" ring (31) and piston (32).

6-77. DISASSEMBLY OF TIME DELAY CHECK VALVE. (Refer to Figure 6-12, item 59.)

a. Remove check valve body (65) from body (67).
b. Remove snap ring (60).
c. Using a brass hook, pull out seat (62).
d. Remove ball (63) and spring (64).

6-78. DISASSEMBLY OF LANDING GEAR SPRING CARTRIDGE ASSEMBLY. (Refer to Figure 6-12, item 81.)

a. Remove the two handle release bodies (86) from body (67).
b. Remove snap rings (82), buttons (83), springs (84) and plungers (85).

CAUTION

Take care when removing snap rings (82), cartridges are spring loaded.

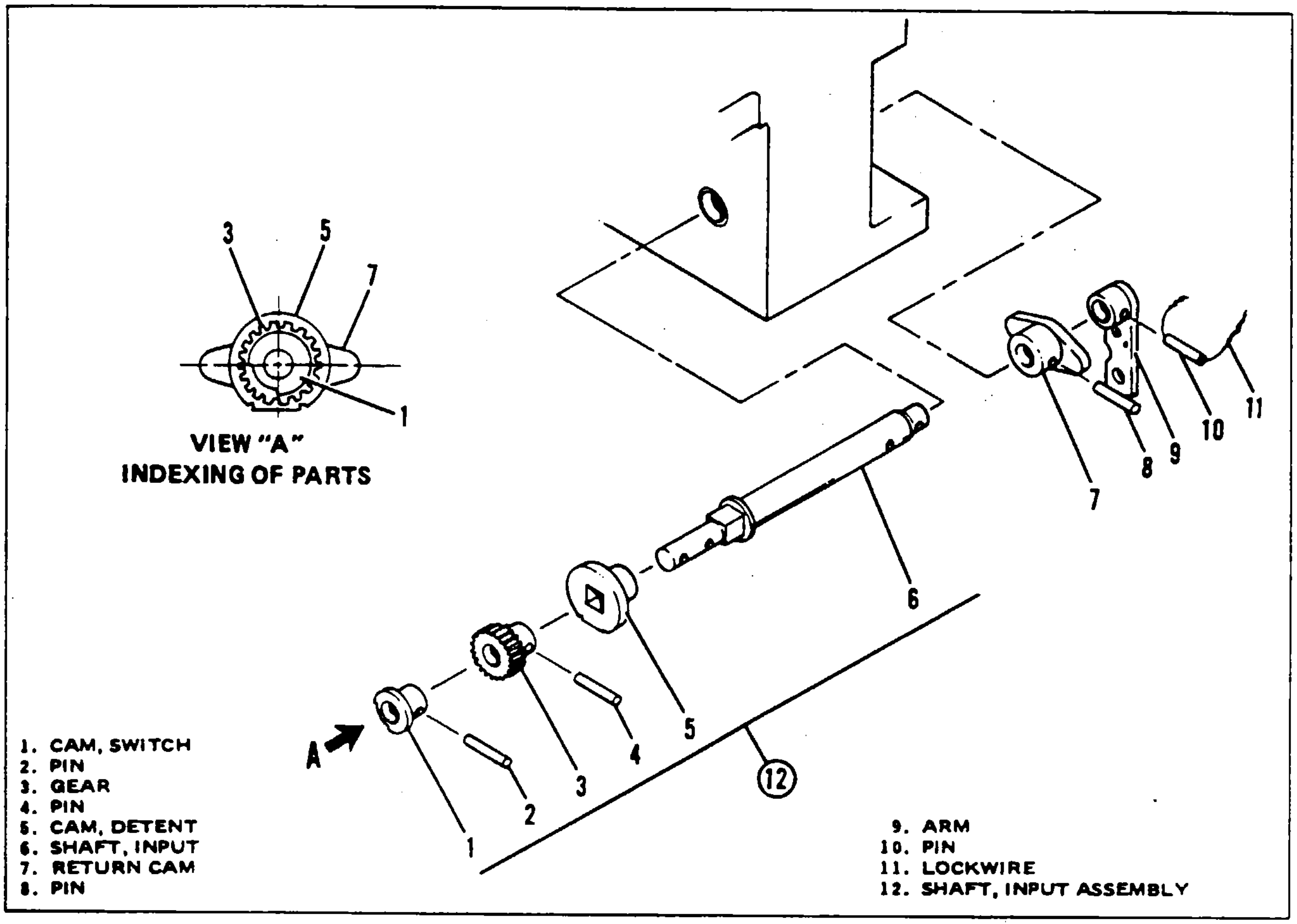


Figure 6-14. Power Pack Handle-Release Mechanism (Wiebel Tool)

6-79. DISASSEMBLY OF LANDING GEAR HANDLE RELEASE MECHANISM. (Refer to Figure 6-14.)

a. Remove lockwire (11).
b. Using a punch, drive the roll pin (10) out of the arm (9) and remove arm.
c. Using a punch, drive the roll pin (8) out of the return cam (7), and remove return cam.
d. Pull the input shaft assembly (12) from Power Pack.

6-80. CLEANING, INSPECTION AND REPAIR OF POWER PACK.

a. Discard all old "O" rings and gaskets.
b. Remove the line fitting caps and wash all parts in dry cleaning solvent (Federal Specification P-S-661, or equivalent) and dry with filtered compressed air.
c. Inspect all parts for scratches, scores, chips, cracks and indications of excess wear.
d. Repairs are limited to replacement of parts, "O" rings and gaskets.
e. The parts catalog should be used to obtain the proper parts for the Power Pack being serviced.

6-81. ASSEMBLY OF POWER PACK.

a. Use new "O" rings and gaskets during assembly.
b. Lubricate all "O" rings with petrolatum per VV-P-236 or equivalent during assembly.
c. Lubricate all threaded surfaces on the various valves in the Power Pack with MIL-G-7711 grease or equivalent before installing.

6-82. ASSEMBLY OF TIME DELAY CHECK VALVE. (Refer to Figure 6-12, item 59.)

a. Install spring (64) and ball (63) into check valve body (65).
b. Lubricate and install the "O" ring (61) in the seat (62).
c. Install seat (62) into check valve body (65) and secure with snap ring (60).
d. Lubricate threads, install "O" ring (66) on the valve body (65) and install the assembly into the body (67). Torque to 45 inch-pounds.

6-83. ASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-12, item 26.)

a. Install the piston (32) into the vent valve body (33).
b. Lubricate and install the "O" ring (31) on the retainer (30) screw retainer into the valve body (33), tighten and secure with wire (105).
c. Install stem (29), spring (28) and adjusting screw (27) into the retainer (30). Install adjusting screw (27) flush.
d. Lubricate threads, install "O" ring (34) on the valve body (33) and install assembly into body (67).

6-84. ASSEMBLY OF VENT FILTER. (Refer to Figure 6-12.)

a. Install vent filter (42) into reservoir cover (36) and secure with snap ring (43).

6-85. ASSEMBLY OF STANDPIPE-FILTER. (Refer to Figure 6-12.)

a. Install standpipe-filter (99) into body (67).

6-86. ASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-12, item 88.)

a. Install poppet (93), spring (94) and guide (95) into fitting (89) and secure with snap ring (96).
b. Lubricate threads, install "O" ring (90), back up (91) and "O" ring (92) on the fitting (89) and install assembly into body (67). Torque to 55 inch-pounds.

6-87. ASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-12, item 10.)

a. Lubricate and install the "O" ring (18) and the back up (17) on the poppet (19) and insert the poppet into the priority valve body (14).
b. Lubricate "O" ring (21) and install into the body (67).
c. Inspect the poppet seat (20) for a sharp seating edge. Lap as required to obtain a good, sharp seating edge. Push the poppet seat into the valve body (14) and install assembly into body (67). Torque to 70 inch-pounds.
d. Install button (13) and spring (12) and secure with adjusting screw (11). The adjusting screw provides adjustment for the priority valve. Install flush at this time.

6-88. ASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-12, item 1.)

a. Inspect the poppet (6) and the poppet seat (7) for pitting or score marks. The two parts are matched parts. If either or both are damaged, replace as an assembly only.
b. Lubricate and install the "O" ring (9) and back up ring (8) on the poppet seat (7); insert the poppet (6) into the seat (7) and install the assembly into the body (67).
c. Lubricate threads and install relief valve body (5) into the body (67). Torque to 70 inch-pounds.
d. Install button (4) and spring (3) into the relief valve body (5) and secure with adjusting screw (2). The adjusting screw provides adjustment for the main relief valve. Install flush at this time.

6-89. ASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-12, item 51.)

a. Lubricate and install "O" ring (58) into the body (67).
b. Inspect the seating surface of the seat (57). Seating edge has to be sharp, lap if necessary to obtain a clean, sharp edge.
c. Drop ball (56) into the cavity of the hand pump relief valve body (55) and install seat (57) into the body (55), trapping the ball between the two parts.
d. Lubricate threads and install assembly into the body (67). Torque to 70 inch-pounds.
e. Insert the stem (54) and the spring (53) into the valve body (55) and install adjusting screw (52). The adjusting screw provides adjustment for the hand pump relief valve. Install flush at this time.

6-90. ASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-12, item 48.)

a. Install the filter (50) into the body (67) and secure with snap ring (49).

6-91. ASSEMBLY OF RESERVOIR. (Refer to Figure 6-12.)

a. Lubricate "O" ring (40) and install onto center stud (41).
b. Install center stud (41) into body (67).
c. Lubricate "O" ring (47) and "O" ring (104) and install on reservoir (46).
d. Push reservoir (46) into body (67).
e. Drop baffle plate (45) into reservoir (46) and secure by placing snap ring (44) onto center stud (41).

6-92. ASSEMBLY OF MANIFOLD. (Refer to Figure 6-13.)

a. Lubricate and install the "O" ring (20) on the landing gear selector spool (19), and the "O" ring (18) into the manifold (35) at the opposite end.

NOTE

The landing gear selector spool, time delay valve plunger and manifold are matched, lapped parts. If necessary to replace, replace as an assembly only.

b. Insert the selector spool (19) into the manifold (35) from the landing gear handle end of the manifold. Insert only until the taper of the selector spool is protruding out the manifold end, approximately .06 inches.

CAUTION

If the selector spool is not protruding .06 inches out of the manifold opposite the rack when installing into the body (67) (see Figure 6-12), the gear will not be engaged in its proper position. Also, do not move the selector spool more than .12 inches out of the manifold opposite the rack. "O" ring (18) could be caught and damaged, and would have to be replaced by a new "O" ring (18).

c. Check that the landing gear selector spool (17) slides freely.
d. Inspect the door solenoid spool (10) for freedom of movement within the transfer sleeve (7).

NOTE

The spool (10) and the transfer sleeve (7) are matched, lapped parts. If necessary to replace, replace as an assembly only.

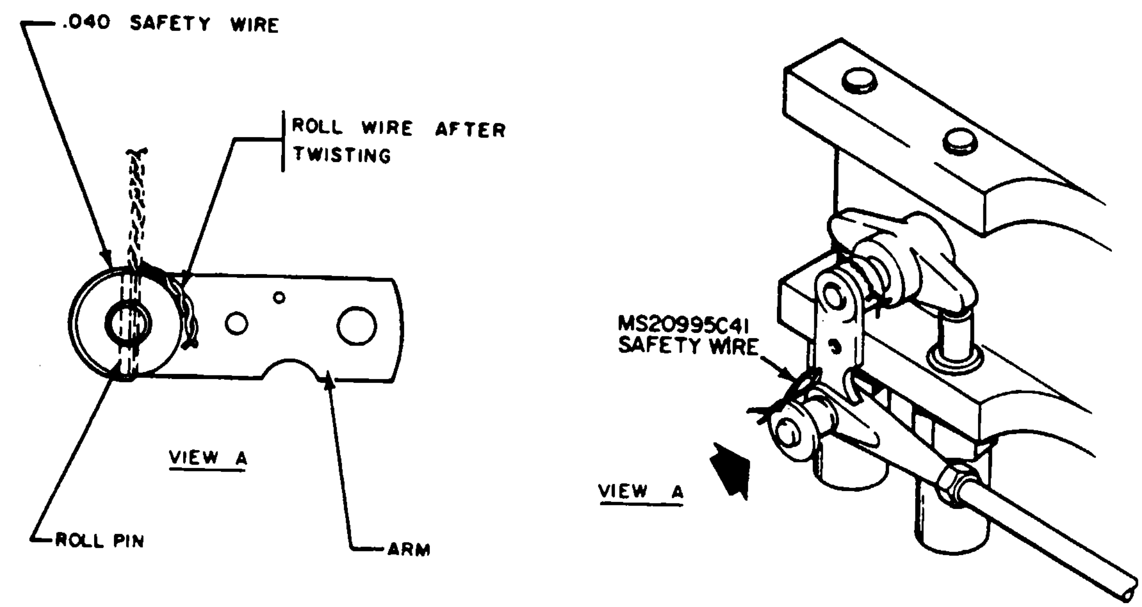


Figure 6-15. Safetying Control Arm (Wiebel Tool)

e. Lubricate "O" rings (8) and install on transfer sleeve (7).
f. Install transfer sleeve (7) into manifold (35).
g. Attach the plunger (15) to the door selector spool (10) with a pin (16) and install into the transfer sleeve (7).
h. Lubricate "O" ring (13) and install on solenoid (12).
i. Lubricate the door solenoid (12) threads, insert the plunger return spring (14) into the plunger (15) cavity and screw assembly into the manifold (35). Torque to 70 inch-pounds.
j. Install time delay plunger (2) and spring (3) into manifold (35).
k. Lubricate "O" ring (4) and install onto screw (5) and screw assembly into manifold (35). Screw (5) to be flush with outside of manifold (35).

6-93. ASSEMBLY OF POWER PACK HANDLE RELEASE MECHANISM. (Refer to Figure 6-14.)

a. If the switch cam (1), the gear (3) and the detent cam (5) was removed from the input shaft (6), then the parts must be assembled and indexed as shown in Figure 6-14, View "A."
b. Lubricate the input shaft (6), slide detent cam (5) and gear (3) into place and secure gear (3) with roll pin (4).
c. Slide switch cam (1) onto input shaft (6) and secure with roll pin (2). Install assembly into Power Pack body.
d. Install the return cam (7) and secure with roll pin (8). Check the landing gear shaft for freedom of movement in the Power Pack body. Check for slight end play between the input shaft and the Power Pack body. If shaft binds, remove return cam (7), lap face on return cam boss and reinstall return cam.
e. Install the Power Pack control arm (9) on the end of the shaft with the arm pointing down. Align the holes between the shaft and the arm assembly and install the roll pin (10). Install .041 safety wire (11) through the roll pin and around half of the arm. Pull the twisted end of the safety wire around the other half of the arm assembly. (Refer to Figures 6-14 and 6-15.)

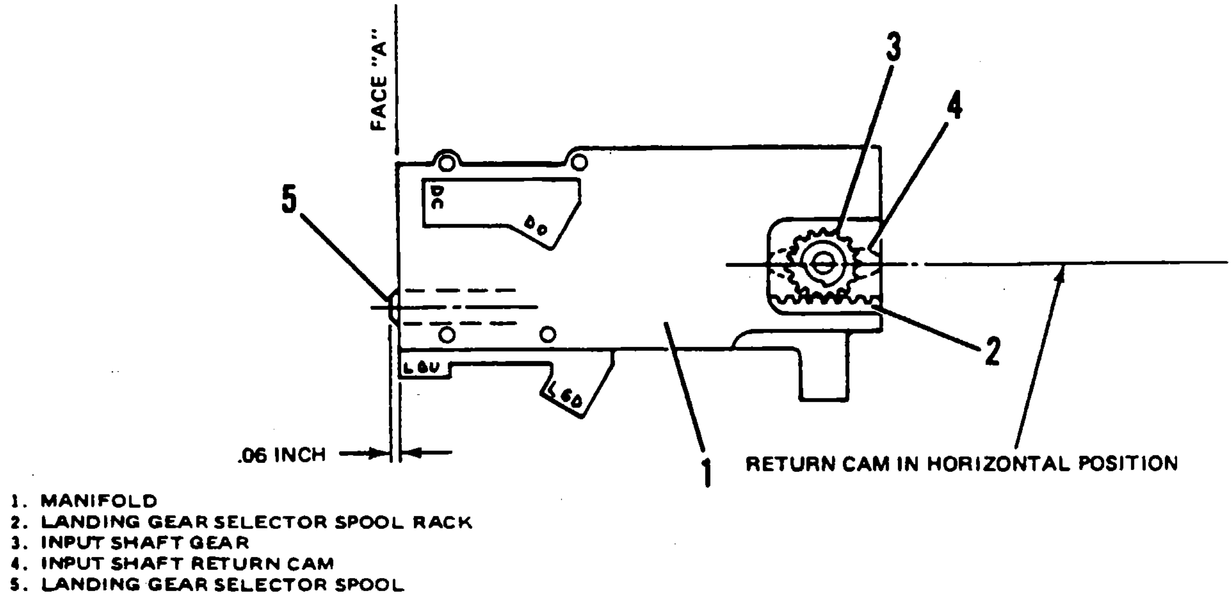


Figure 6-16. Indexing of Selector Spool (Wiebel Tool)

6-94. INSTALLATION OF MANIFOLD. (Refer to Figure 6-13.)

a. Lubricate the "O" rings (37) and install on the five transfer sleeves (36).
b. Insert the transfer sleeves (36) into the manifold (35).
c. Mate the manifold (35) to the Power Pack body, using care to prevent damage to the "O" rings on the transfer sleeves.

NOTE

When mating the manifold with the Power Pack body, index the landing gear selector spool rack with the input shaft gear as shown in Figure 6-16. With landing gear selector spool (5) protruding .06 inches from face "A" of manifold (1) and the input shaft return cam (4) in the horizontal position, tooth of input shaft gear (3) will match with tooth space in the landing gear selector spool rack (2).

d. Install the four manifold attaching bolts and torque to 35 inch-pounds. Do not over torque bolts as this will cause binding of the landing gear selector spool (17).
e. Lubricate "O" ring (22) and "O" ring (24) and install on plunger (23).
f. Install plunger (23) and lubricated spring (25) into manifold (35).
g. Lubricate threads of retainer (26), install into manifold (35). Torque to 25 inch-pounds and safety wire retainer (26) to manifold (35) using wire (47).

6-95. INSTALLATION AND ADJUSTMENT OF INBOARD GEAR DOORS SWITCH. (Refer to Figure 6-13.)

a. Install switch assembly (44) with insulating plate (43) between switch and manifold (35) and secure with washers (45) and screws (46). Tighten screws lightly.
b. Move the selector spool to the gear up and down position a couple of times to insure proper actuating of switch from "on" to "off." Torque switch screws to 20 inch-pounds.
c. Safety wire solenoid (12) to bracket (74) (see Figure 6-12) using safety wire (47).
d. Connect the electrical wires from switch to the terminal block (80) (see Figure 6-12) and secure to solenoid (12) using plastic strap (48).

NOTE

Electrical wires are color coded. Disregard the color of the wire terminals. If the colors are matched when installing the wires, the wires will be connected correctly.

e. (Refer to Figure 6-12.) Install plungers (85), springs (84) and button (83) into the handle release bodies (86) and retain with snap rings (82).
f. (Refer to Figure 6-12.) Install the handle release assemblies (81) in the body (67). Install assemblies loose, they will be adjusted later.

6-96. POWER PACK BENCH TEST ADJUSTMENT. After completion of the overhaul, the Power Pack may be bench tested prior to installation in the airplane using a hydraulic test unit or similar test equipment. This procedure requires a minimum of test equipment for testing the Power Pack.

a. Use only clean hydraulic fluid per MIL-H-5606.
b. Minimum equipment needed is as follows:
   1. Test unit pump and hand pump with a 2500 PSI capacity.
   2. One hydraulic pressure gauge of 2500 PSI capacity.
   3. One hydraulic pressure gauge of 200 PSI capacity.
c. Connect the test pressure hose to the pressure inlet port of the Power Pack. The 2500 PSI gauge is to operate off the pressure line.
d. Connect the suction hose to the suction port of the Power Pack.
e. If a vent hose is part of the test unit, connect it to the vent port at the top of the reservoir cover.
f. Cap all other fittings with high pressure caps.

NOTE

For the control of the door valve solenoid, it will be necessary to fabricate an electric harness as shown in Figure 6-27. This harness, when connected to a 24 volt battery will allow control of the electrical current to the door valve solenoid, permitting operation of the hydraulic door circuits.

6-97. ADJUSTMENT OF HANDLE-RELEASE MECHANISM. (Refer to Figure 6-17.) The following procedure outlines the adjustments to set the handle release cartridges and stops in the correct position before installing the Power Pack into the airplane.

a. Rotate the input shaft into the "gear up" detent position and adjust stop screw (1) to allow a slight overtravel past the detent position.
b. Rotate the input shaft into the "gear down" detent position and adjust stop screw (8) to allow a slight overtravel past the detent position.

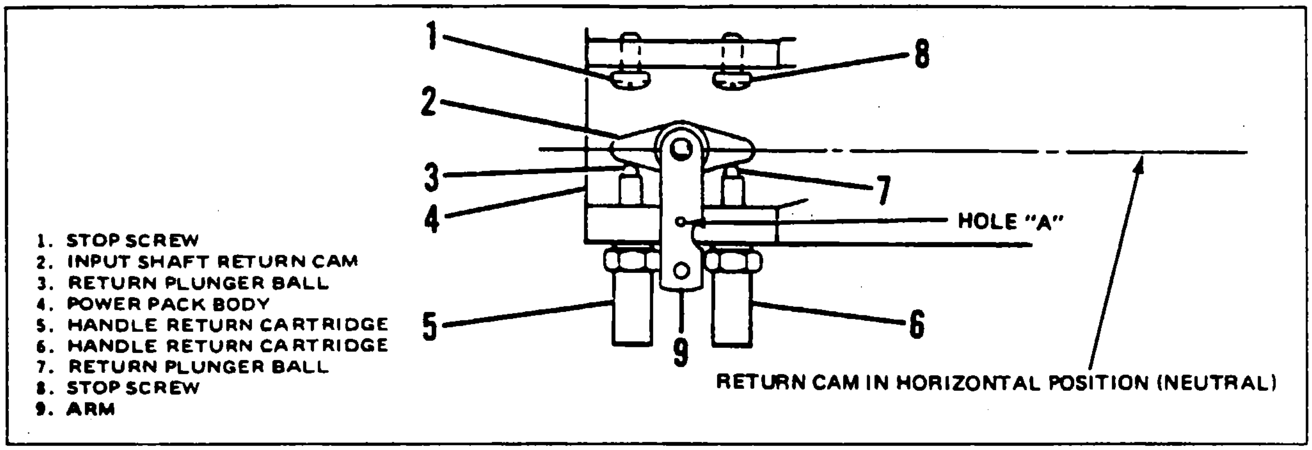


Figure 6-17. Handle Release Adjustment (Wiebel Tool)

c. Rotate the input shaft to the neutral position, which will bring the input shaft return cam (2) to the horizontal position.
d. Hold the input shaft return cam (2) in the horizontal (neutral) position by inserting a .125 dia. drill or punch through hole in the arm (9) and into rigging hole in body (4). Rigging hole is noted as hole "A" in Figure 6-17. Adjust handle return cartridges (5) and (6) in such a manner that their return plunger balls (3) and (7) touch the surface of the input shaft return cam (2) slightly.

CAUTION

Remove drill or punch from rigging hole "A".

e. The detent must hold in both detent positions and must return with a positive snap when manually released from either detent position.

6-98. ADJUSTMENT OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-12, item 51.)

a. With the input shaft in either the "gear up" or "gear down" position, apply hand pump pressure very slowly until fluid flows from the hand pump relief valve.

CAUTION

It is important that the hand pump be operated slowly as pressure is being increased to bleed the hand pump relief valve.

b. Bleed air from the Power Pack by cracking the cap on the "door open" fitting.
c. Adjust the adjusting screw (52) at the top of the valve until the valve cracks at the maximum required pressure as given in Table VI-II, pumping slowly. Bleed pressure by cracking the cap on the "door open" fitting after each adjustment.

6-99. ADJUSTMENT OF MAIN RELIEF VALVE. (Refer to Figure 6-12, item 1.)

a. With the input shaft in the "gear up" or "gear down" position, apply pressure until fluid flows from the main relief valve.
b. Adjust the adjusting screw (2) at the top of the main relief valve until the valve cracks at the required pressure given in Table VI-II. Bleed pressure after each adjustment by cracking the cap on the "door open" fitting.

6-100. ADJUSTMENT OF PRIORITY VALVE. (Refer to Figure 6-12, item 10.)

a. Place the input shaft in the "gear up" position and remove cap from the "gear up" fitting.
b. Apply pressure and note the priority valve cracking pressure by observing the pressure gauge when fluid first starts to flow from the "gear up" port.
c. Adjust the adjusting screw (11) until the valve cracks at the required pressure given in Table VI-II. Bleed pressure after each adjustment by cracking cap on "door open" fitting.
d. Disconnect the test unit and cap all open fittings.

6-101. ADJUSTMENT OF DOOR SOLENOID VALVE. (Refer to Figure 6-13, item 11.)

a. Remove the caps from the "door open" and "door closed" fittings on Power Pack.
b. Connect a test harness to the electrical plug of the Power Pack and to power source. (Test harness may be fabricated as shown in Figure 6-27.)
c. With the test harness switch in the "OFF" position and the input shaft in either the "up neutral" or "down neutral" position, apply pressure and note that fluid flows from the "door open" fitting.
d. With the test harness switch in either the "gear up" or "gear down" position, the input shaft in either the "up neutral" or "down neutral" position, apply pressure and note that fluid flows from the "door closed" fitting.
e. Disconnect the test equipment and cap all open fittings.

6-102. ADJUSTMENT OF DOOR VENT VALVE. (Refer to Figure 6-12, item 26.)

a. Remove the cap from the "door open" fitting on the Power Pack and attach the pressure hose from the hand pump with the 200 PSI pressure gauge to the "door open" fitting.
b. Slowly apply pressure to see that fluid seeps from the door vent valve.
c. Adjust the adjusting screw (27) so that fluid flows from the vent valve from 0 to 100 PSI (see Table VI-II).
d. Increase pressure to 150 psi max. and check to see that the door vent valve is shut off. If pressure falls below 100 PSI, fluid must resume flowing from door vent valve (also see Table VI-II).
e. Relieve pressure by cracking the hose fitting from the hand pump.
f. Disconnect the test unit and cap all open fittings.

6-103. ASSEMBLY OF POWER PACK. (Refer to Figure 6-12.) To complete the reassembly of the Power Pack, proceed as follows:

a. Install the reservoir cover (36) on the reservoir (46) and secure with nut (35) and safety wire nut (35) to reservoir cover (36) by using safety wire (37). Torque nut (35) to 35 inch-pounds.

NOTE

When positioning reservoir cover (36) make sure that the vent fitting (39) points to the left when Power Pack is installed in the airplane. Also when installing reservoir cover (36), be sure large "O" ring (47) is not being pinched.

6-104. TESTING RESERVOIR FOR LEAKAGE. (Refer to Figure 6-12.)

a. Remove the drain fitting (100) as applicable, and attach hand pump with 200 PSI gauge to the drain port.
b. Remove the cap from the reservoir vent fitting (39) at the top of the reservoir and operate the hand pump until the reservoir is completely full, as indicated by fluid coming out of vent fitting (39).
c. Cap the reservoir vent fitting (39).

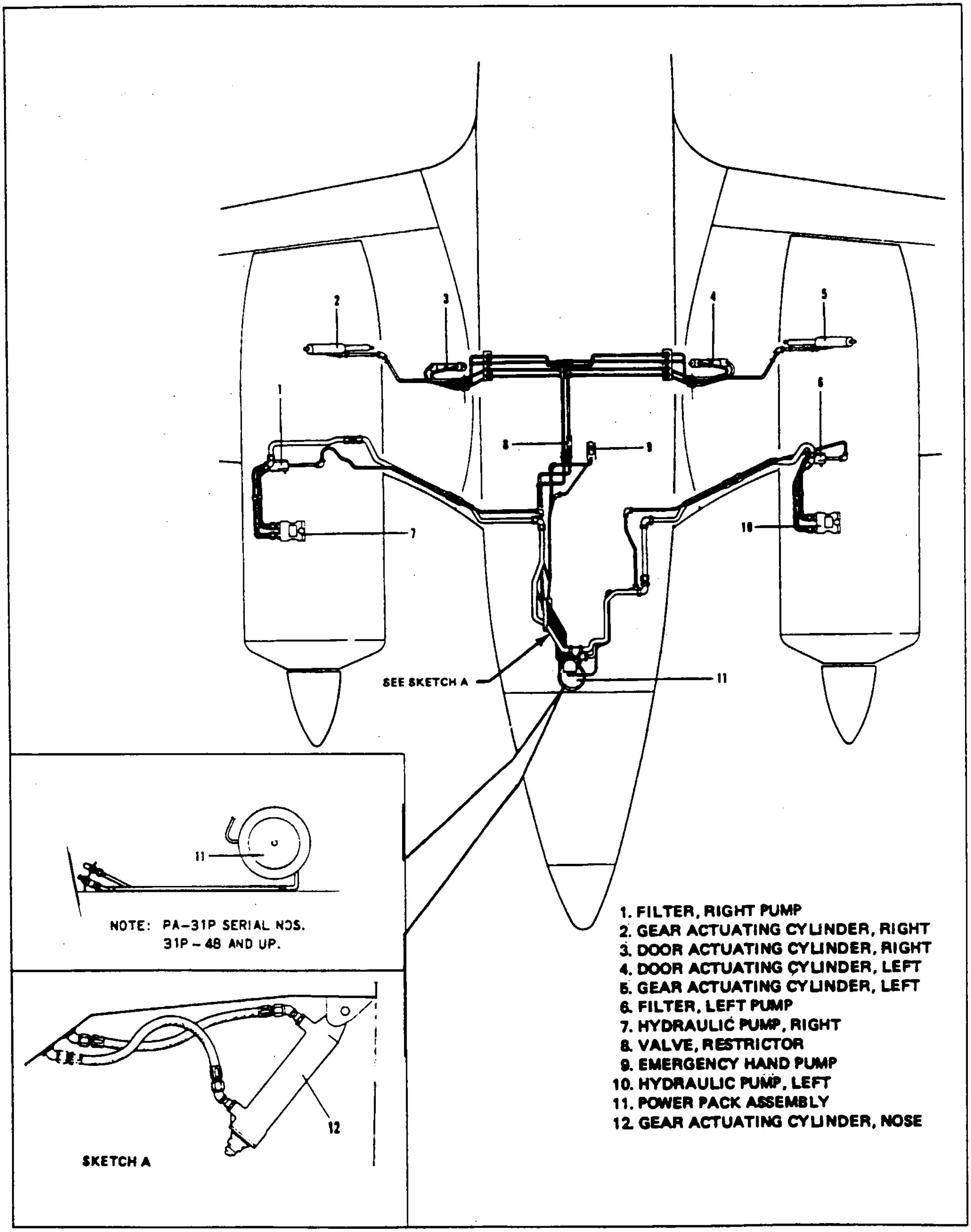
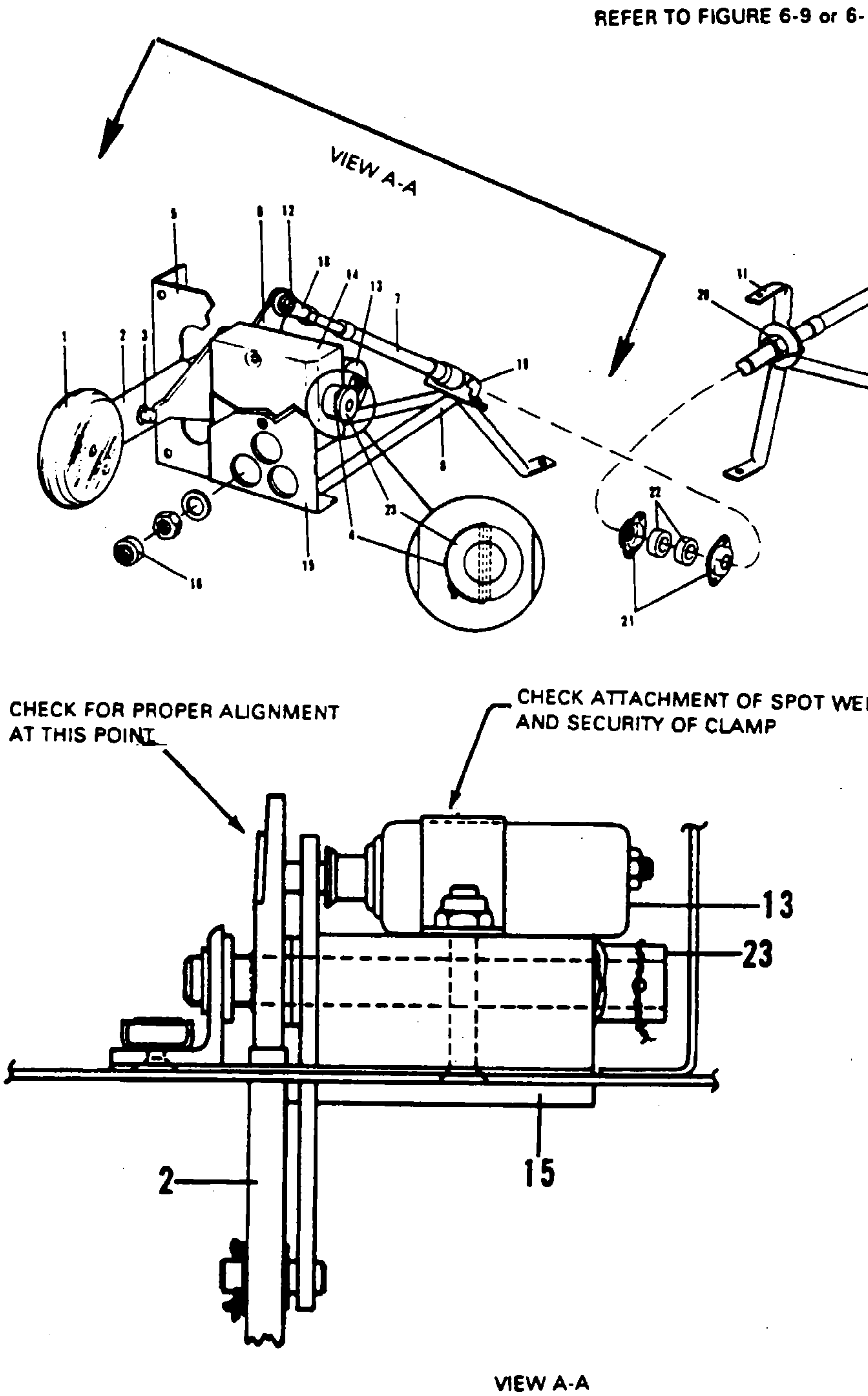


Figure 6-18. Hydraulic System Installation



1. CONTROL KNOB
2. SLEEVE
3. STOP PIN
4. SAFETY WIRE
5. PLATE ASSY.
6. LEVER ASSY.
7. CABLE ASSY.
8. BRACKET ASSY.
9. POWER PACK
10. CONTROL ARM
11. BRACKET ASSY.
12. PIN, WASHER & COTTER PIN
13. SOLENOID
14. MOUNTING BLOCK
15. PANEL ASSY.
16. LIGHT ASSY.
17. CABLE ATTACHMENT PIN
18. TERMINAL
19. CLAMP
20. LOCKNUT
21. FIREWALL PLATE
22. GROMMET
23. BUSHING

Figure 6-18a. Landing Gear Selector Mechanism

d. Operate the test hand pump to raise the pressure in the reservoir until the pressure gauge indicates 50 PSI maximum.
e. Check for leaks, there should be no external leakage.
f. Crack the vent fitting to release the pressure, remove the test equipment, drain the reservoir and cap the fittings.
g. The hydraulic Power Pack is now ready to be installed in the airplane.

6-104a. INSTALLATION OF POWER PACK. (See Paragraph 6-64.)

6-105. LANDING GEAR SELECTOR HANDLE MECHANISM.

6-106. OPERATION OF GEAR SELECTOR HANDLE MECHANISM. The operation of the landing gear selector handle must give the feel of having made a positive engagement with a detent. With the selector handle in the up or down position and in a detent, a force of 3-1/2 to 6 pounds applied perpendicular to the centerline of the handle at the centerline of the knob will be required to move the handle from the detent and return it to the neutral position. To check the operation of the gear selector handle mechanism, place the airplane on jacks (refer to Jacking, Section II) and operate the landing gear selector handle through its entire travel, both up and down.

6-106a. REMOVAL OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-19.)

Removal of the gear selector mechanism can be divided into three individual assemblies. The Solenoid Assembly; The Selector Handle Assembly; and The Flexible Cable Assembly.

a. Removal of Solenoid Assembly.
   1. Disconnect the two wires leading from the solenoid (13).
   2. Remove two locknuts securing the solenoid to the mounting block (14) and remove the solenoid.
b. Removal of Selector Handle Assembly.
   1. Remove stop pin (3) and pull the control knob (l) and sleeve (2) from the lever assembly (6).
   2. Disconnect the wires leading from the panel assembly (15). Remove four light assemblies (16) securing the panel assembly to the plate assembly (5).
   3. Remove pin, washer and cotter pin (12) securing the terminal (18) to the lever assembly.
   4. Remove the selector assembly from the instrument panel.
c. Removal of Flexible Cable Assembly.
   1. Remove screws and clamp (19) securing cable assembly (7) to bracket assembly (8).
   2. Push cable assembly through grommet adjacent to the bracket assembly.
   3. Remove pin (17) securing the terminal to the control arm (10) of the power pack (9). Remove the lock nut and terminal from the end of the cable assembly.
   4. Cut safety wire and remove locknut (20) nearest the end of the cable assembly. Carefully pull the cable assembly through the hole in bracket assembly (11).
   5. Disassemble the firewall plates (21) and grommets (22) and pull cable assembly through the hole in the bulkhead at station 57.0.

6-106b. INSTALLATION OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-19.)

a. Installation of Flexible Cable Assembly.
   1. Insert the end of the cable assembly with locknuts through the hole in the bulkhead at station 57.0.
   2. Insert the cable assembly through bracket assembly (11). An equal number of threads should appear on each side of the plate in the bracket assembly. Tighten and safety wire the two locknuts.
   3. Install locknut and terminal on the end of the cable assembly. Position the control arm (10) in the terminal and insert pin and safety.

4. Position the free end of the cable assembly into the slot in bracket assembly (8) and secure in position with clamp (19).
5. Assemble firewall plates (21) and grommets (22).

b. Installation of Selector Handle Assembly.
1. Install the selector assembly on the instrument panel.
2. Position the terminal (18) on lever assembly (6) and secure in position with pin, washer and cotter pin (12).
3. Carefully thread the wires from the panel assembly (15) through the hole provided in the plate assembly (5). Position the panel assembly on the plate assembly. Insert the base assemblies of the lights through the plate and panel assemblies and install nylomatic washer and locknut, and light cap. Connect wires to their appropriate terminals.
4. Insert the sleeve (2) on the lever and install the control knob (1) and stop pin (3).

c. Installation of Solenoid Assembly.
1. Position the solenoid (13) on mounting block (14) and secure in position with two locknuts.
2. Connect the solenoid wires to their appropriate terminals.

6-107. INSPECTION OF LANDING GEAR SELECTOR HANDLE.

a. Ascertain that the handle does not contact the ends of the slot in the instrument panel when actuated to the extremes of its travel.
b. Inspect and be certain there is adequate clearance between the selector gear mechanism and wiring harness which runs laterally across the aircraft.
c. Determine that locknuts are securely tightened and that all grommets have been properly installed .
d. Check security of control cable connections to the actuator arms on both the power pack and selector handle.
e. Inspect anti-retraction solenoid for security, and verify the solenoid plunger operates freely and engages properly into the selector lever stop assembly.

6-108. ADJUSTMENT OF LANDING GEAR SELECTOR HANDLE.

a. Ascertain that the selector arm on the lever assembly is safety wired as shown in Figure 6-8 or Figure 6-15.
b. Depress the button on the solenoid lock to allow the handle to travel freely between the two neutral positions.
c. To check the handle release mechanism, disconnect the control cable from the arm at the power pack. Connect a spring scale to the arm and pull both fore and aft, perpendicular to the centerline of the arm to determine that it will leave the detent at a force of 9 ± 1-2 pounds. If it does not release at the required force, adjust the mechanism in accordance with instructions given in Paragraph 6-56 for Ozone units or Paragraph 6-97 for Wiebel Tool units.
d. Position the control arm on the power pack in neutral and the selector handle in the down neutral position. Refer to Paragraph 6-97 for a method of holding the control arm in the neutral rigging position on Wiebel Tool units.
e. Connect the terminal ends of the cable assembly to the power pack control arm and the selector handle.
f. The terminal ends can be adjusted to obtain the neutral position in both the control arm and selector handle.

NOTE

Whenever the cable assembly is removed from the airplane and then reinstalled, be sure to seal the cable where it passes through the pressure bulkhead at station 81.0. Refer to Section IV for sealing.

g. Recheck that the handle will leave the detent at 3-1/2 to 6 pounds.

6-109. FILLING HYDRAULIC RESERVOIR. (Refer to Section II, Servicing Hydraulic Reservoir.)

6-110. BLEEDING THE HYDRAULIC SYSTEM.

a. Jack the airplane as described in Section II.
b. Ascertain that the reservoir is full.
c. Connect a hydraulic test unit to the airplane as described in paragraph 6-8 or 6-20.
d. Cycle the landing gear system through several cycles.
e. Check that hydraulic reservoir is full.
f. Disconnect the hydraulic test unit as described in paragraph 6-17 or 6-29.
g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
h. Remove the airplane from jacks.

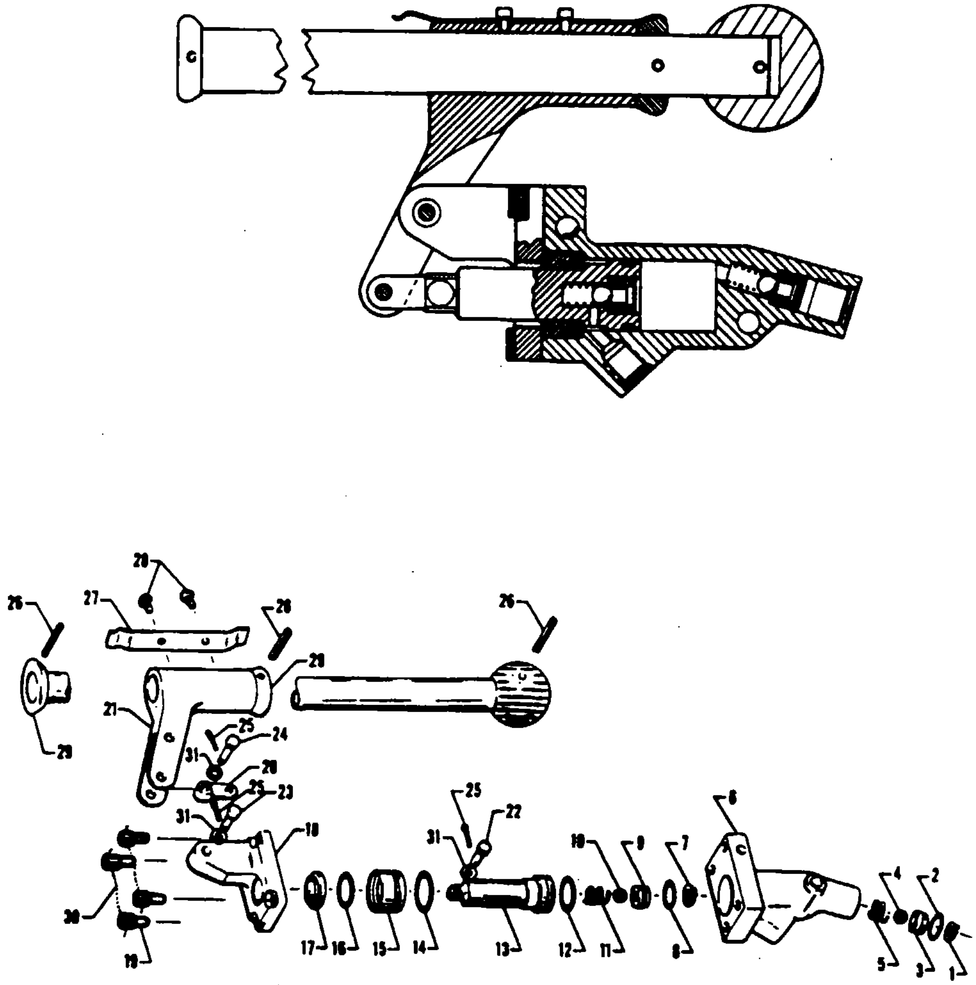
6-111. HAND PUMP (EMERGENCY) (OZONE).

6-112. REMOVAL OF HAND PUMP.

a. Remove the pump access panel located aft of the control pedestal.
b. Disconnect the hydraulic pressure and suction lines from the forward end of the pump.
c. Remove the pump from its mounting bracket by removing attachment bolts.
d. Remove the pump from the airplane.
e. Cover the pressure and suction lines to prevent contamination.

6-113. DISASSEMBLY OF HAND PUMP. (Refer to Figure 6-19.)

a. To remove the plunger (13) and component parts, remove pin (22) and Allen screws (19) allowing the bracket (18) to separate from the pump body (6).
b. Pull the plunger assembly from the pump body.
c. Slide the scraper (17) and packing gland (15) from the plunger (13).
d. To remove the check ball assembly from the plunger, remove the snap ring (7) in the end of the plunger and with a low charge of air injected into the hole in the side of the plunger, blow the check ball (10) and seat (9) from the plunger. Remove the spring (11).
e. To remove the check ball assembly located in the suction port, reach into the port with a pair of long snap ring pliers and remove the snap ring (1). With a low charge of air injected into the interior of the pump body, blow the seat (3) and check ball from the suction port. Remove the spring (5).



1. SNAP RING
2. "O" RING PACKING
3. SEAT
4. BALL, CHECK
5. SPRING
6. BODY, PUMP
7. SNAP RING
8. "O" RING PACKING
9. SEAT
10. BALL, CHECK
11. SPRING
12. "O" RING PACKING
13. PLUNGER
14. "O" RING PACKING
15. GLAND, PACKING
16. "O" RING
17. SCRAPER
18. BRACKET
19. SCREW, ALLEN
20. LINK
21. LEVER
22. PIN, FLAT HEAD
23. PIN, FLAT HEAD
24. PIN, FLAT HEAD
25. PIN, COTTER
26. PIN, ROLL
27. SPRING
28. SCREW
29. STOP
30. SAFETY WIRE
31. WASHER

Figure 5-19. Hand Pump (Ozone)

6-114. CLEANING, INSPECTION AND REPAIR OF HAND PUMP.

a. Clean the pump parts with a suitable solvent and dry thoroughly.
b. Inspect the pump body for scratches, burrs, etc., that could damage "O" rings and threaded areas for damage.
c. Inspect the plunger for enlarged pinhole, surface area for scratches, burrs, etc. that could damage "O" rings.
d. Inspect check balls and seats for damaged seating areas and corrosion.
e. Check general condition of remaining parts.
f. Repairs to the pump are limited to polishing out small scratches, burrs, etc., replacing "O" rings and worn or damaged parts.

6-115. ASSEMBLY OF HAND PUMP. (Refer to Figure 6-19.)

a. To install the plunger assembly, first install the check ball assembly in the plunger by placing "O" ring packing (8) on seat (9). Lubricate the seat (9) with hydraulic fluid, MIL-H-5606, and install check ball spring (11), check ball (10) and seat (9) in the end of the plunger. Install snap ring (7) to secure parts in place.
b. Install "O" ring packing (12) on the plunger.
c. Install "O" rings (14 and 16) on the exterior and in the interior of the packing gland (15).
d. Lubricate the packing gland and plunger assemblies. Slide the packing gland onto the small end of the plunger (13) with the recessed end toward the small end of the plunger and insert the plunger with the packing gland (15) into the pump body (16).
e. Position the scraper (17) on the plunger (13), with the flat end toward the gland (15), and slide it into the pump body (6).
f. Attach the bracket (18) to the pump body (6), install Allen screws and safety with MS20995C20 lock wire.
g. Position link (20) and install pins (22 and 23), washers (31) and cotter pins (25).
h. To install the check ball assembly in the suction port of the pump body, install "O" ring (2) on ball seat (3). Lubricate the seat assembly with hydraulic fluid, install spring (5), check ball (4), seat (3) and secure in place with snap ring (1).

6-116. INSTALLATION OF HAND PUMP.

a. Position the hand pump on its mounting bracket and secure with bolts.
b. Connect the hydraulic pressure and suction lines to the forward end of the pump.
c. Bleed the hand pump as described in Paragraph 6-117 and test the hand pump as described in Paragraph 6-118.
d. Install access panel.
e. Ascertain that hydraulic fluid is visible through the sight gauge at the front of the Power Pack.

6-117. BLEEDING HAND PUMP. The hand pump may be purged by operating the pump until all air has been expelled from the pump. This will usually require approximately 15 cycles of the pump.

6-118. HAND PUMP TEST.

a. Ascertain that the reservoir is filled with hydraulic fluid.
b. Remove cap from door-open port and operate emergency hand pump until fluid flows from port with no evidence of air in the system. Replenish reservoir with clean hydraulic fluid as necessary to maintain fluid level.
c. After pump is primed and bled of all air, remove fitting and install 2100 psi gauge at door-open port.
d. Operate emergency hand pump very slowly until pressure on gauge stops increasing, indicating that the hand pump relief valve has opened.

CAUTION

It is very important that the hand pump be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the hand pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

Maximum indication of the gauge should be as indicated in Table VI-I. During the pumping operation, the emergency hand pump should not feel spongy in either the up or down stroke.

e. Crack the gauge in the door-open port to release pressure; remove the gauge; reinstall and cap the door-open fitting, and drain the fluid from reservoir.

6-119. HAND PUMP (EMERGENCY) (WIEBEL TOOL).

6-120. REMOVAL OF HAND PUMP. (Same as Paragraph 6-112.)

6-121. DISASSEMBLY OF HAND PUMP. (Refer to Figure 6-20.)

a. To remove the plunger (13) and component parts, remove quick click pin (14) and the four screws (25) allowing the bracket (21) to separate from the pump body (6).

NOTE

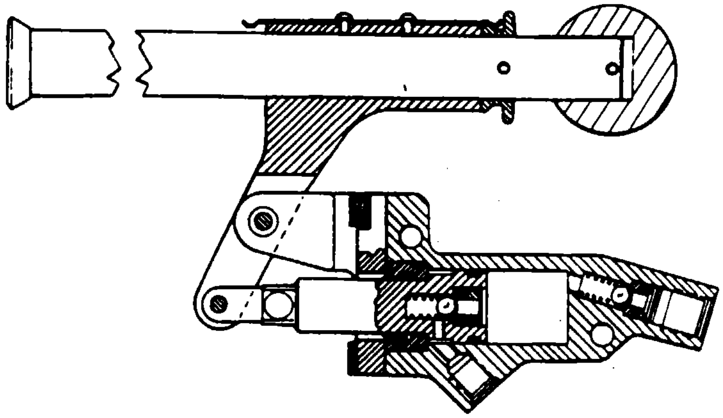
To remove the quick click pins (14), (22) and (24), use a hollow steel rod having an outside diameter of .186-.184 inches and an inside diameter (bore) of .166 inches. The inside diameter should have a minimum depth of .125 inches.

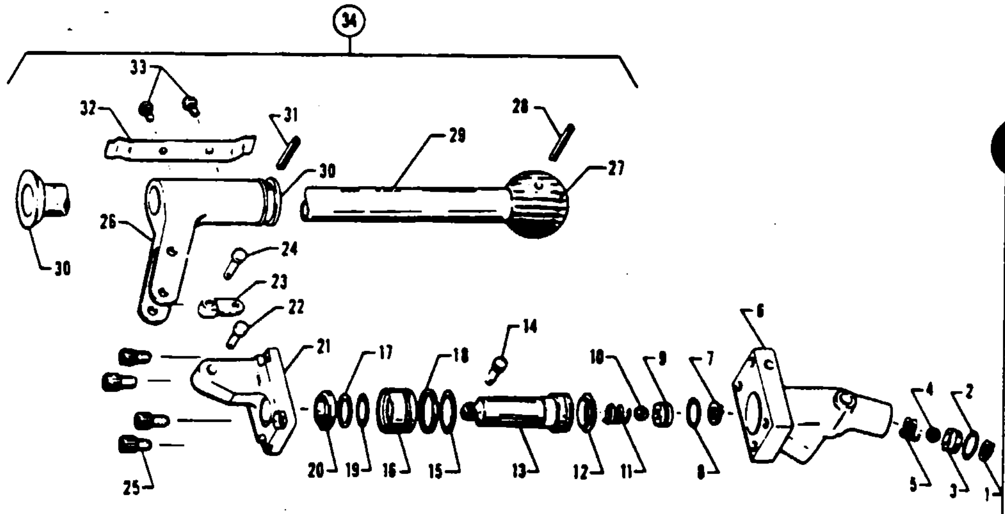
b. Pull the plunger assembly from the pump body.
c. Slide the scraper (20) and the gland (16) from the plunger (13).
d. To remove the check valve assembly from the plunger, remove the snap ring (7) from the plunger cavity and with a low charge of air injected into the hole in the side of the plunger, remove the seat (9), ball (10) and the spring (11).
e. To remove the check valve assembly located in the suction port of the pump body (6) remove the snap ring (1). Inject a low charge of air into the plunger bore in the pump body to remove the seat (3), the ball (4) and the spring (5).

6-122. CLEANING, INSPECTION AND REPAIR OF HAND PUMP. (Same as Paragraph 6-114.)

6-123. ASSEMBLY OF HAND PUMP. (Refer to Figure 6-20.) Lubricate all parts with oil per MIL-H-5606 prior to assembly.

a. Lubricate "O" ring (8) and install on seat (9).
b. Install spring (11), ball (10) and lubricated seat (9) into the plunger (13) and retain with snap ring (7).
c. Install GT-ring (12) on the plunger (13).
d. Install "O" ring (19) and back up (17) into inside groove of gland (16).
e. Install "O" ring (15) and back up (18) into outside groove of gland (16).
f. Lubricate the complete gland (16) and slide onto the plunger (13) with the recessed end on the outside.
g. Lubricate the bore of the pump body (6) and slide plunger (13) with gland (16) into the pump body (6).
h. Install the scraper (20) into the recess of gland (16) by sliding scraper over plunger (13). Tapered lip of scraper (20) to face outward.





1. SNAP RING
2. "O" RING
3. SEAT
4. BALL
5. SPRING
6. BODY, PUMP
7. SNAP RING
8. "O" RING
9. SEAT
10. BALL
11. SPRING
12. QT-RING
13. PLUNGER
14. QUICK CLICK PIN
15. "O" RING
16. GLAND
17. BACK UP
18. BACK UP
19. "O" RING
20. SCRAPER
21. BRACKET
22. QUICK CLICK PIN
23. LINK
24. QUICK CLICK PIN
25. SCREW
26. LEVER
27. GRIP
28. ROLL PIN
29. HANDLE
30. STOP
31. ROLL PIN
32. SPRING
33. DRIVE SCREW
34. HANDLE ASSEMBLY

Figure 6-20. Hand Pump (Wiebel Tool)

i. Attach the bracket (21) to the pump body (6) with the four screws (25). Torque to 70 inch-pounds.
j. Position link (23) and install quick click pin (14).
k. Lubricate "O" ring (2) and install on seat (3).
l. Install spring (5), ball (4) and lubricated seat (3) into the suction port of the pump body (6) and secure with snap ring (1).

6-124. INSTALLATION OF HAND PUMP.

a. Position the hand pump on its mounting bracket and secure with bolts.
b. Connect the hydraulic pressure and suction lines to the forward end of the pump.
c. Bleed the hand pump as described in Paragraph 6-125 and test the hand pump as described in Paragraph 6-126.
d. Install access panel.
e. Ascertain that the reservoir is filled with hydraulic fluid.

6-125. BLEEDING HAND PUMP. The hand pump may be purged by operating the pump until all air has been expelled from the pump. This will usually require approximately 15 cycles of the pump.

6-126. HAND PUMP TEST.

a. Ascertain that the reservoir is filled with hydraulic fluid.
b. Remove cap from door-open port and operate emergency hand pump until fluid flows from port with no evidence of air in the system. Replenish reservoir with clean hydraulic fluid as necessary to maintain fluid level.
c. After pump is primed and bled of all air, remove fitting and install 2100 psi gauge at door-open port.
d. Operate emergency hand pump very slowly until pressure on gauge stops increasing, indicating that the hand pump relief valve has opened.

CAUTION

It is very important that the hand pump be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the hand pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

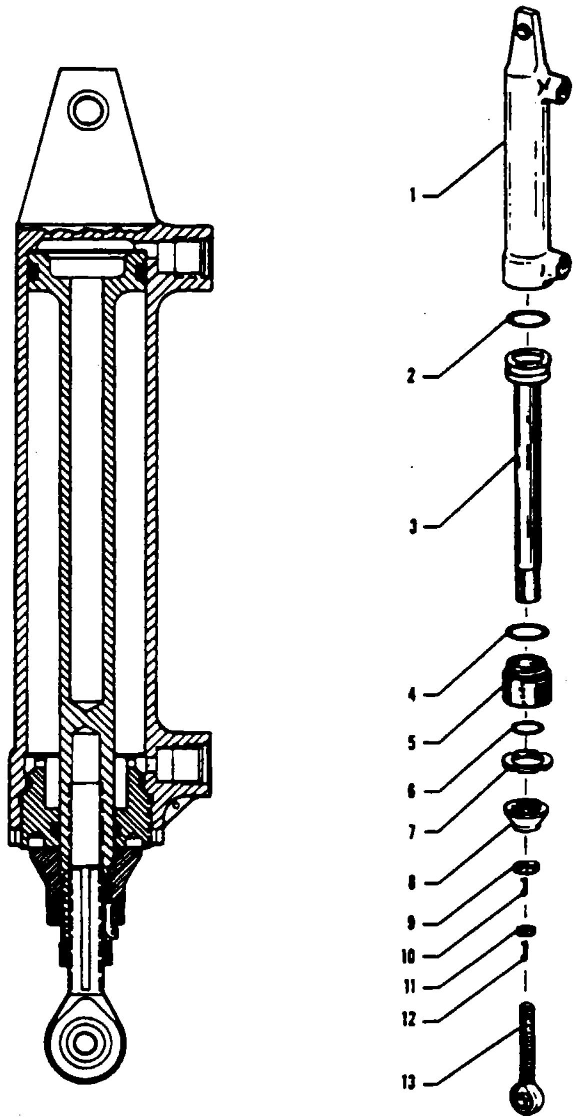
Maximum indication of the gauge should be as indicated in Table VI-II. During the pumping operation, the emergency hand pump should not feel spongy in either the up or down stroke.

e. Crack gauge in door-open port to release pressure, remove gauge, reinstall and cap door-open fitting, and drain fluid from reservoir.

6-127. GEAR ACTUATING CYLINDERS (OZONE).

6-128. REMOVAL OF GEAR ACTUATING CYLINDERS.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.
c. Disconnect the cylinder operating rod end from the link assembly.
d. Disconnect the attachment end of the cylinder by removing the bolt that secures the cylinder and nose gear uplock rod or the main gear uplock crank assembly.
e. Remove the cylinder from the wheel well.



1. CYLINDER BODY
2. "O" RING
3. PISTON
4. "O" RING
5. GLAND
6. "O" RING
7. LOCK NUT, GLAND
8. STOP
9. LOCK NUT
10. LOCK
11. LOCK NUT
12. LOCK
13. ROD END

Figure 6-21. Gear Actuating Cylinder (Ozone)

6-129. DISASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-21.)

a. Before disassembly establish rod end engagement distance to aid in preliminary assembly of the actuating cylinder.
b. With the cylinder removed from the airplane, remove the safety wire attached to the rod end locknut (11) and lock (12). Loosen the locknut and remove the rod end (13).
c. Remove the safety wire attached to the locknut (9) of the stroke control stop and lock (10). Remove the stop (8) from the piston rod end.
d. Remove the safety wire between the cylinder body (1) and gland locknut (7). Loosen the gland locknut and with a spanner wrench remove the gland (5).
e. Draw the piston (3) from the cylinder body.

6-130. CLEANING, INSPECTION AND REPAIR OF GEAR ACTUATING CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.
b. Inspect the cylinder interior walls and piston exterior surfaces for scratches, burrs, corrosion, etc.
c. Inspect threaded areas for damage.
d. Inspect the rod end fitting for wear and corrosion.
e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing parts.

6-131. ASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-21.)

a. Install "O" rings (2) on the body of the piston assembly (3).
b. Install "O" rings (4 and 6) on the exterior and in the interior of the packing gland (5).
c. Lubricate the piston assembly (3), interior of the cylinder body (1) and the packing gland (5) with hydraulic fluid, MIL-H-5606.
d. Slide the packing gland onto the shaft of the piston assembly.
e. Slide the piston assembly into the cylinder and with spanner wrench turn the packing gland into the cylinder to a snug fit. Install gland locknut (7) and safety to the cylinder with MS20995C32 lock wire.
f. Turn the stop (8) of the stroke control on the cylinder rod and install locknut (9) and lock (10).
g. Install the rod end (13), locknut (11) and lock (12) on the piston rod.
h. Adjust rod end (13) to preliminary length obtained before disassembly. Before securing the locknuts of the stroke control stop and rod end with MS20995C32 lock wire, ascertain that the stroke control stop and rod end fitting are properly adjusted. (Refer to Adjustment of Nose Landing Gear, Section VII.)

6-132. INSTALLATION OF GEAR ACTUATING CYLINDER.

a. Position the attachment end of the cylinder and the uplock rod end of the nose gear or the uplock crank assembly of the main gear on their mounting bracket, install attachment bolt and secure.
b. Connect the operating rod end of the cylinder to the gear link assembly.
c. Connect the hydraulic lines to the cylinder.
d. Check operation of the installation and landing gear rigging as given in Section VII.
e. Remove the airplane from jacks.

6-133. GEAR ACTUATING CYLINDERS (WIEBEL TOOL).

6-134. REMOVAL OF GEAR ACTUATING CYLINDERS. (Same as Paragraph 6-128.)

6-135. DISASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-22.)

a. Before disassembly establish rod end engagement distance to aid in preliminary assembly of the actuating cylinder.
b. Loosen nut (11) to disengage Key (15) and remove rod end (12).
c. Cut safety wire (14) and remove. Remove nut (10), Key (13) and stop (9) from piston (3).

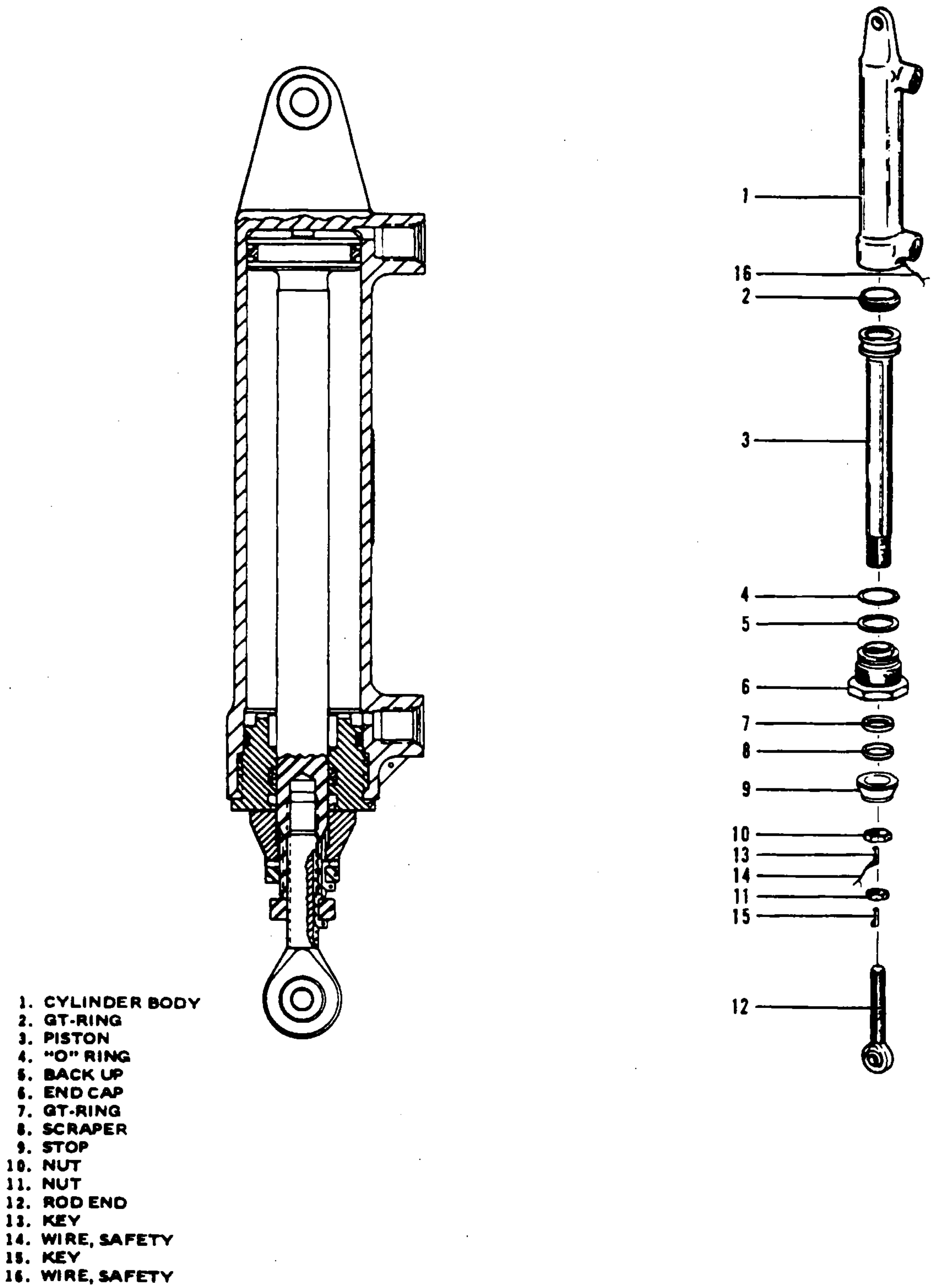


Figure 6-22. Gear Actuating Cylinder (Wiebel Tool)

d. Remove safety wire (16) and end cap (6) from the cylinder body (1) by unthreading end cap (6) and pulling out the piston (3).
e. Slide end cap (6) from the piston. (3).

6-136. CLEANING, INSPECTION AND REPAIR OF GEAR ACTUATING CYLINDER. (Same as Paragraph 6-130.)

6-137. ASSEMBLY OF GEAR ACTUATING. CYLINDER. (Refer to Figure 6-22.) Lubricate all parts with oil per MIL-H-5606 prior to assembly.

a. Install GT-ring (2) on the head of the piston (3).
b. Install back up (5) and "O" ring (4) into outside groove of end cap (6).
c. Install GT-ring (7) and scraper (8) into inside groves of end cap (6). Tapered lip of scraper (8) to face outward.
d. Lubricate the piston assembly (3), the end cap assembly (6) and the bore of the cylinder body (1).
e. Slide the end cap assembly (6) onto the piston assembly (3).
f. Slide the piston with the end cap into the cylinder, tighten the end cap (6) by torquing to 65 inch-pounds and secure to the cylinder body (1) using safety wire (16).
g. Install the stop (9) and the nut (10) with key (13) on the piston (3).
h. Install the rod end (12) with nut (11) and key (15) into the piston (3).
i. Adjust stop (9) for proper piston stroke, tighten nut (10) by torquing to 65 inch-pounds and secure by wiring nut (10) to key (13) using safety wire (14).
j. Adjust rod end (12) to preliminary length obtained before disassembly. Refer to adjustment of Nose Landing Gear, Section VII for final adjustments. Engage key (15) and tighten nut (11) to a torque of 85 inch-pounds.

6-138. INSTALLATION OF GEAR ACTUATING CYLINDER. (Same as Paragraph 6-132.)

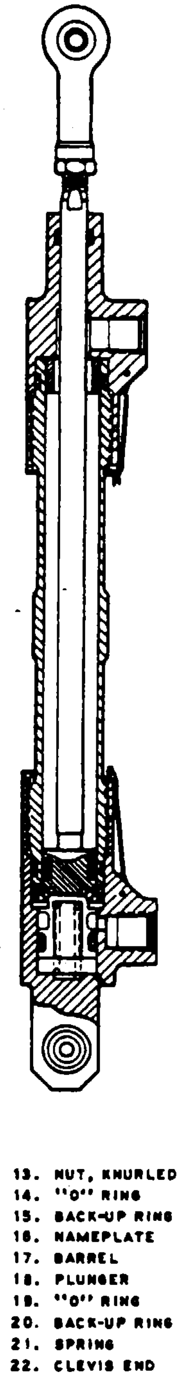
6-139. GEAR DOOR ACTUATING CYLINDERS (OZONE).

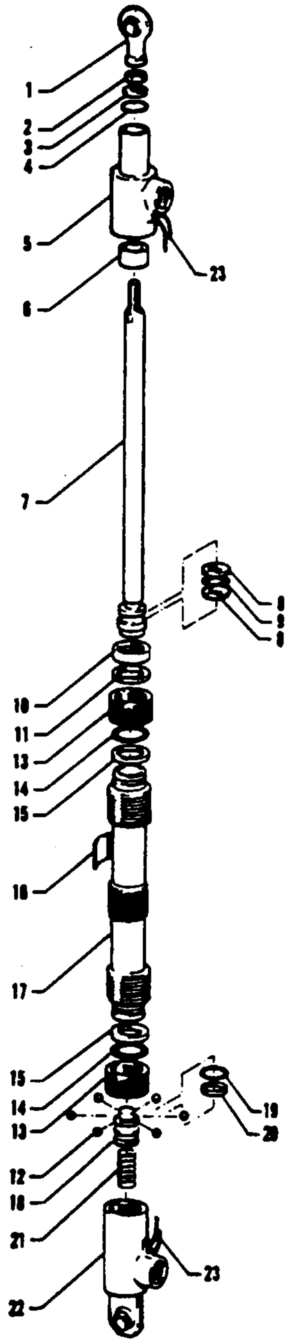
6-140. REMOVAL OF GEAR DOOR ACTUATING CYLINDERS.

a. With master switch off, actuate the hand pump handle to bring the gear door down.
b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.
c. Disconnect the cylinder from the door and its mounting bracket.
d. Remove the cylinder from the wheel well.

6-141. DISASSEMBLY OF GEAR DOOR ACTUATING CYLINDERS. (Refer to Figure 6-23.)

a. Unlock cylinder by applying hydraulic pressure to port in clevis end (22) of actuator. Loosen locknut (2) and remove rod end (1) from piston rod.
b. Remove locknut from piston.
c. Remove safety wire from knurled nuts (13) and loosen knurled nuts.
d. Remove gland end (5) from barrel (17), using a strap wrench on barrel.
e. Remove clevis end (22) from barrel, then push piston (7) from barrel. Use care when pushing piston from barrel, to prevent the loss of the six balls (12).
f. Remove spacer (6) from barrel.
g. Remove "O" ring (4) and back-up ring (3) from gland end (5).
h. Apply a sharp blast of air to hydraulic port of clevis end (22) to remove plunger (18), washer (11), and race (10). Remove spring (21) from clevis end.
i. Remove "O" rings and back-up rings from barrel, piston and plunger.





1. ROD END
2. LOCK NUT
3. BACK-UP RING
4. "O" RING
5. GLAND END
6. SPACER
7. PISTON
8. BACK-UP RING
9. "O" RING
10. RACE
11. WASHER
12. BALLS
13. NUT, KNURLED
14. "O" RING
15. BACK-UP RING
16. NAMEPLATE
17. BARREL
18. PLUNGER
19. "O" RING
20. BACK-UP RING
21. SPRING
22. CLEVIS END
23. SAFETY WIRE

Figure 6-23. Gear Door Actuating Cylinder (Ozone)

6-142. CLEANING, INSPECTION AND REPAIR OF GEAR DOOR ACTUATING CYLINDERS.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.
b. Inspect all threaded surfaces for cleanliness and for freedom from cracks and excessive wear.
c. Inspect the plunger spring (21) of the plunger for evidence of breaks and distortion. The free length of the spring must be 1.055 inches and compressed to .875 inch under a 35 ± 3.5 pound load.
d. Inspect the gland end (5), spacer (6), piston (7), barrel (17), plunger (18) and clevis end (22) for cracks, chips, scratches, scoring, wear or surface irregularities which may effect their function or the overall function of the door actuator cylinder.
e. Repair of most parts of the landing gear door actuator assembly is impractical. Replace defective parts with serviceable parts. Minor scratches and scores may be removed by polishing with fine abrasive crocus cloth (Federal Specification P-C-458) providing their removal does not affect the operation of the unit. Install all new "O" rings and back-up rings during reassembly of the actuator.

6-143. ASSEMBLY OF GEAR DOOR ACTUATING CYLINDER. (Refer to Figure 6-23.)

a. Install "O" ring (19) and back-up ring (20) in the groove on the plunger (18).
b. Insert the spring (21) and plunger (18) into the clevis end (22). Install the washer (11) and race (10) over the end of the plunger (18).
c. With knurled nuts (13) on the barrel (17), install "O" rings (14) and back-up rings (15) in grooves on barrel.
d. Install "O" ring (9) and back-up rings (8) in groove on piston (7) and install balls (12) in holes of piston.
e. Insert piston into barrel. Be sure that all six balls (12) are in place in the piston as the piston is inserted in the barrel.
f. Screw the barrel (17) into the clevis end (22). Tighten the barrel down snugly against race, then tighten knurled nut (13).
g. Insert spacer (6) in barrel (17). Spacer (6) is used only in main landing gear wheel door actuator.
h. Install "O" ring (4) and back-up ring (3) in bore groove of gland end (5), lubricate piston rod and slide gland end over rod. Tighten the gland end on the barrel, aligning the hydraulic port fittings of the gland end with the port fitting in the clevis end.
i. Tighten knurled nuts (13) to a torque value of 130 ± 10 pounds. Install lock wire on both knurled nuts.
j. Install locknut (2) and rod end (1).

6-144. INSTALLATION OF GEAR DOOR ACTUATING CYLINDER.

a. Position the cylinder on its mounting bracket and secure with attachment bolt.
b. Extend the cylinder control rod enough to attach the rod end to the door and secure with attachment bolt.
c. Connect the hydraulic line to the cylinder.
d. To bring the gear door back to the closed position, turn the master switch ON, place the gear selector switch in the down position and actuate the hand pump until the door closes.

6-145. GEAR DOOR ACTUATING CYLINDERS (WIEBEL TOOL).

6-146. REMOVAL OF GEAR DOOR ACTUATING CYLINDERS. (Same as Paragraph 6-140.)

6-147. DISASSEMBLY OF GEAR DOOR ACTUATING CYLINDERS. (Refer to Figure 6-24.)

a. Unlock the cylinder by applying hydraulic pressure to the clevis end (22) port. Extend piston (6) all the way.
b. Loosen locknut (2) and remove rod end (1) from piston (6). Remove locknut (2) from piston (6).
c. Remove safety wire (5) and (21) from nut (11) and nut (13). Loosen both nuts (11) and (13).
d. Remove end cap (4) from barrel (12) but leave end cap (4) on piston (6).
e. Remove clevis end (22) from barrel (12). Pull piston (6) with end cap (4) from barrel (12). Use care when pulling piston out of barrel to prevent the loss of the six balls (7) which are nested in the head end of the piston (6).
f. Remove end cap (4) from piston (6).
g. Pull race (16), plunger (19) and spring (20) out of the clevis end (22).
h. Remove GT-ring (3) from end cap (4).
i. Remove "O" rings (9) and (15) and the back up rings (10) and (14) from the barrel (12).
j. Remove GT-ring (8) from piston (6).
k. Remove "O" ring (17) and back up ring (18) from plunger (19).

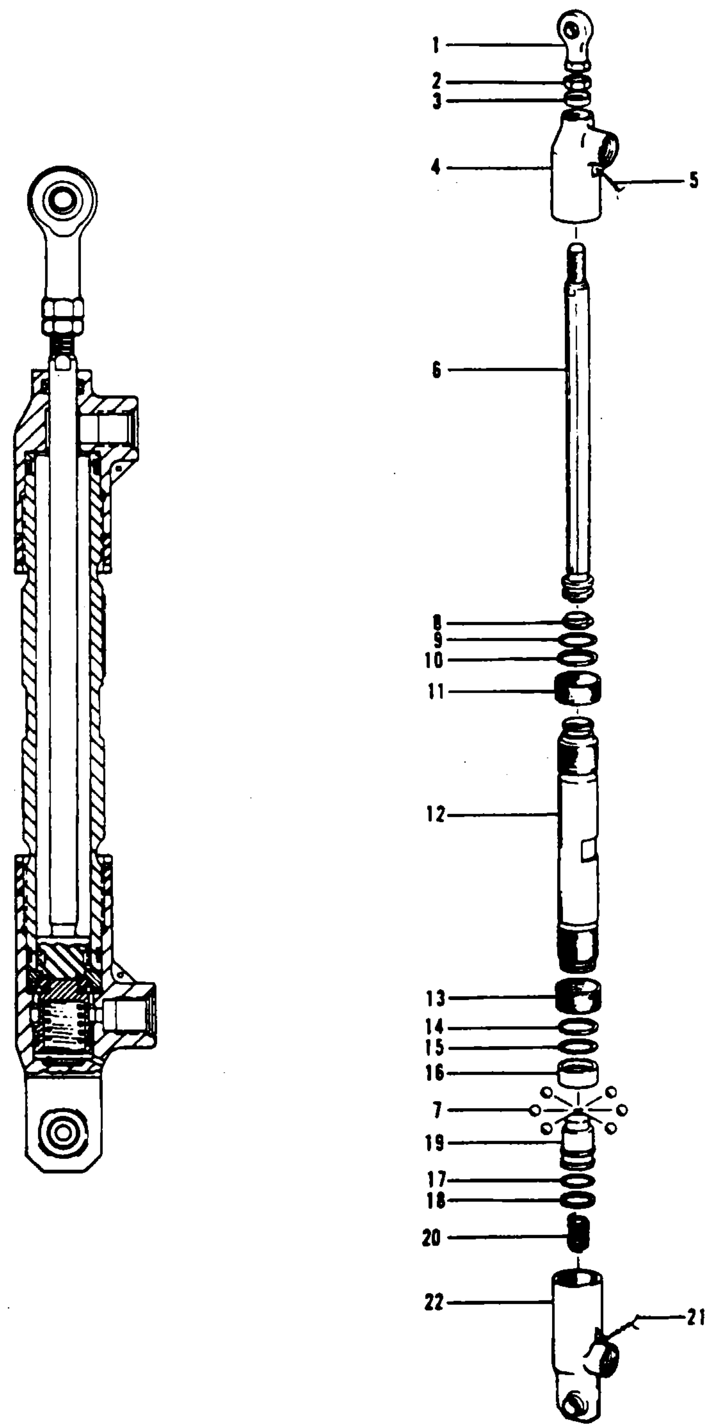
6-148. CLEANING, INSPECTION AND REPAIR OF GEAR DOOR ACTUATING CYLINDERS.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.
b. Inspect all threaded surfaces for cleanliness and for freedom of cracks and excessive wear.
c. Inspect the plunger spring (20) for evidence of breaks and distortion. Compress the spring (20) to a length of .750 inches and measure load. Load should be 30 ± 2 pounds.
d. Inspect the end cap (4), piston (6), barrel (12), race (16), plunger (19) and clevis end (22) for cracks, chips, scratches, scoring, wear and surface irregularities which may effect proper function of the door actuator cylinder.
e. Repair of most parts of the landing gear door actuator assembly is impractical. Replace defective parts with new parts. Minor scratches and scores may be removed by polishing with "fine abrasive" crocus cloth (Federal Specification P-C458) providing their removal does not affect the operation of the actuator assembly. Replace all "O" rings, back up rings and GT-rings with new ones during the reassembly of the actuator.

6-149. ASSEMBLY OF GEAR DOOR ACTUATING CYLINDER. (Refer to Figure 6-24.) Lubricate-all parts with oil per MIL-H-5606 prior to assembly.

a. Install "O" ring (17) and back up ring (18) into groove of plunger (19).
b. Install nut (11) and nut (13) on barrel (12).
c. Install back up rings (10) and (14) and "O" rings (9) and (15) into grooves of barrel (12).
d. Install spring (20), plunger (19) and race (16) into clevis end (22) and secure by screwing barrel (12) into clevis end (22). Tighten barrel down against the race (16), and torque to 120 to 140 inch-pounds. Then tighten nut (13) against the clevis end (22) and torque to 120 to 140 inch-pounds.
e. Install GT-ring (8) into groove of piston (6).
f. Install GT-ring (3) into groove inside the end cap (4).
g. Slide piston (6) into the end cap (4), install six balls (7) into holes in piston head (6) and insert assembly into bore of barrel (12). Screw end cap (4) onto barrel (12) and align port in end cap (4) with port in clevis end (22). Tighten nut (11) against end cap (4) and torque to 120 to 140 inch-pounds.
h. Secure nut (11) to end cap (4) using safety wire (5).
i. Secure nut (13) to clevis end (22) using safety wire (21).
j. Install lock nut (2) and rod end (1) on piston (6).
k. Adjust rod end (1) to achieve proper length of actuator assembly and lock with lock nut (2).

6-150. INSTALLATION OF GEAR DOOR ACTUATING CYLINDER. (Same as Paragraph 6-144.)



1. ROD END
2. LOCK NUT
3. GT-RING
4. END CAP
5. SAFETY WIRE
6. PISTON
7. BALL
8. GT-RING
9. "O" RING
10. BACK UP
11. NUT
12. BARREL
13. NUT
14. BACK UP
15. "O" RING
16. RACE
17. "O" RING
18. BACK UP
19. PLUNGER
20. SPRING
21. SAFETY WIRE
22. CLEVIS END

Figure 6-24. Gear Door Actuating Cylinder (Wiebel Tool)

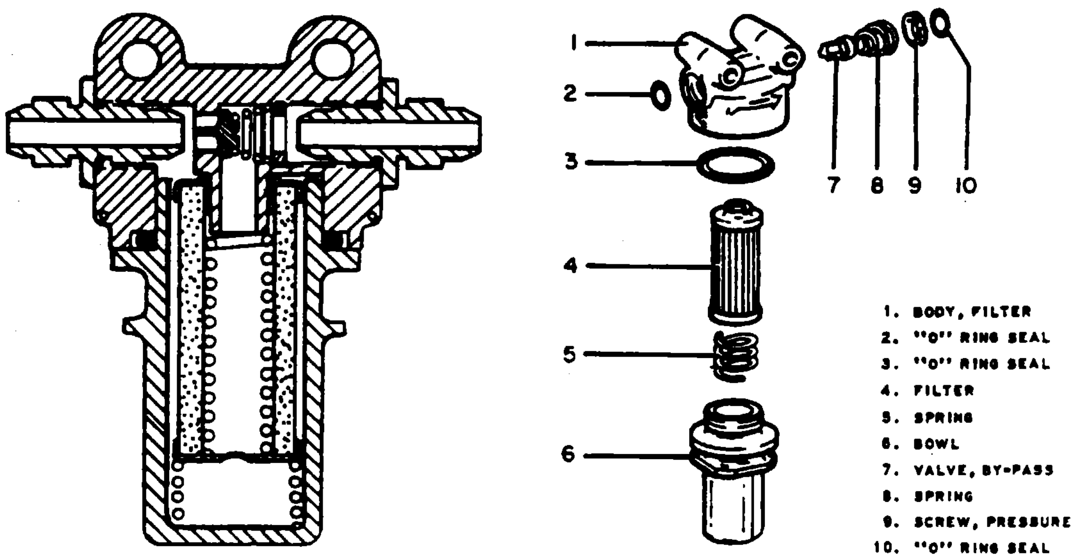


Figure 6-25. Hydraulic Filter

6-151. HYDRAULIC LINES.

6-152. REMOVAL AND INSTALLATION OF HYDRAULIC LINES. Remove a damaged hydraulic line by disconnecting the fittings at each end and by disconnecting where secured by brackets. Refer to Figure 6-18 as an aid in the location of attaching brackets and bends in the lines. Provide a small container for draining the line. Install a new or repaired line in reverse order and refill the Power Pack with hydraulic fluid in accordance with Filling Hydraulic Reservoir, Section II.

NOTE

Where straight thread type fittings are used, the locknuts are to be tightened so that the "O" ring seals are on the non-threaded portion of the fitting.

6-153. HYDRAULIC FILTER.

6-154. REMOVAL AND INSTALLATION OF HYDRAULIC FILTER. The hydraulic filter, located on the lower right forward side of each engine fire wall, is removed by the following procedure:

a. Remove the lower engine cowl and the right access plate on the engine nacelle aft of the firewall.
b. Disconnect the filter inlet hose and the outlet line from the filter.
c. Remove the filter from the firewall by holding the bolts at the aft side of the firewall and turning off the nut at the filter.
d. The filter may be installed in the reverse procedure.
e. After engine has been operated, check for leaks.

6-155. REPLACEMENT OF FILTER ELEMENT. (Refer to Figure 6-25.)

a. Remove the lower engine cowl.
b. Cut safety wire, unscrew bowl and remove filter element.
c. Clean filter bowl with a suitable cleaning solvent and dry.
d. Replace filter element and "O" ring on bowl.
e. Half fill filter bowl to minimize trapped air in the hydraulic system and replace bowl.
f. Safety filter bowl with MS20995C20 safety wire and replace cowl.
g. After engine has been operated, check for leaks.

6-156. HYDRAULIC PUMP.

6-157. HYDRAULIC PUMP OPERATIONAL CHECK. To determine the operable condition of each hydraulic pump, the following check may be conducted:

a. Start one engine and allow it to warm up.
b. With the engine operating at 1200 RPM, move the gear selector handle to the gear down position. The one pump should build up pressure within the hydraulic system and return the selector handle to neutral position within three to nine seconds. Again select the down position and check the handle return time.
c. Shut down the engine and repeat the proceeding steps for the other engine.
d. Should it be found that the selector handle will not return to neutral during the operational check for one pump, but will return within the required time with the check of the other, then it can be assumed that the pump is at fault and it should be removed to determine the cause of malfunction.

6-158. PROCEDURE AFTER ENGINE-DRIVEN HYDRAULIC PUMP FAILURE.

Should a pump breakage occur, there may be metal particles in the hydraulic system. To rectify this condition the hydraulic system should be flushed. Proceed with the following steps:

a. Replace the defective engine-driven hydraulic pump and prime it in accordance with paragraph 6-164. Do not connect the pump to the rest of the hydraulic system until the system has been flushed.
b. Proceed to flush the system in accordance with paragraph 6-4.
c. Remove the filter elements and check for metal particles. If metal particles are evident in the filter, clean the filter bowl with dry cleaning solvent and dry with compressed air. Install new filter elements in accordance with paragraph 6-155.

6-159. REMOVAL OF HYDRAULIC PUMP.

a. Remove left or right engine cowls, as required by skin fasteners and separate the two halves.
b. Place a drip pan under the engine to catch spillage.

NOTE

If desired, to facilitate easier removal of the pump, the right magneto and the oil return line may be removed from the engines.

c. Disconnect the two hydraulic hoses from the end of the pump.
d. Disconnect drain hose from bottom of pump.
e. Remove the four nuts, lockwashers, and flat washers from the base of the pump.
f. Remove the pump from the engine housing.
g. Upon removal of the pump from its drive gear, remove and destroy or discard the gasket from the pump mounting face. The gasket and all seal rings should be replaced with new parts upon reassembly. Never reinstall an old gasket or seal ring.

6-160. DISASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-26.)

a. Clean outside of pump thoroughly.
b. Mark a line from the rear side, across the centerplate to the drive side with blue Dykem or some equivalent removable substance. This will assure proper reassembly.

CAUTION

During disassembly do not use a screw driver or sharp tool to separate the parts.

c. Remove the four socket head cap screws (12), securing the rear side (13), centerplate (10) and drive side (7) together. These screws are threaded into the drive side.
d. Remove the four locknuts (8) from the studs (14) extending out of the drive side flange that mates with the centerplate.
e. Remove the rear side by rocking it from side to side and sliding it from the four dowels (11). In case of sticking, tap gently with a plastic or rubber hammer.
f. Remove the four studs (14) from the rear side. Remove and discard the large "O" ring seal (15) from the rear side. Pull the drive (1) and secondary shafts (17) until drive pins (16 and 2) clear gears. Remove drive pins.
g. Remove drive gear (19), secondary gear (18), and secondary shaft (17) by pulling from centerplate (10).
h. Remove drive shaft by pushing out of drive side. Remove centerplate, with dowels, by rocking it from side to side.
i. Remove large "O" ring seal (9) from drive side and discard.
j. Remove retainer ring (3) securing seal (4 or 5) in drive side seal bore. Note proper position of seal (4 or 5) upon disassembly. Seal must not be reversed at reassembly. Remove and discard the two pa seal.

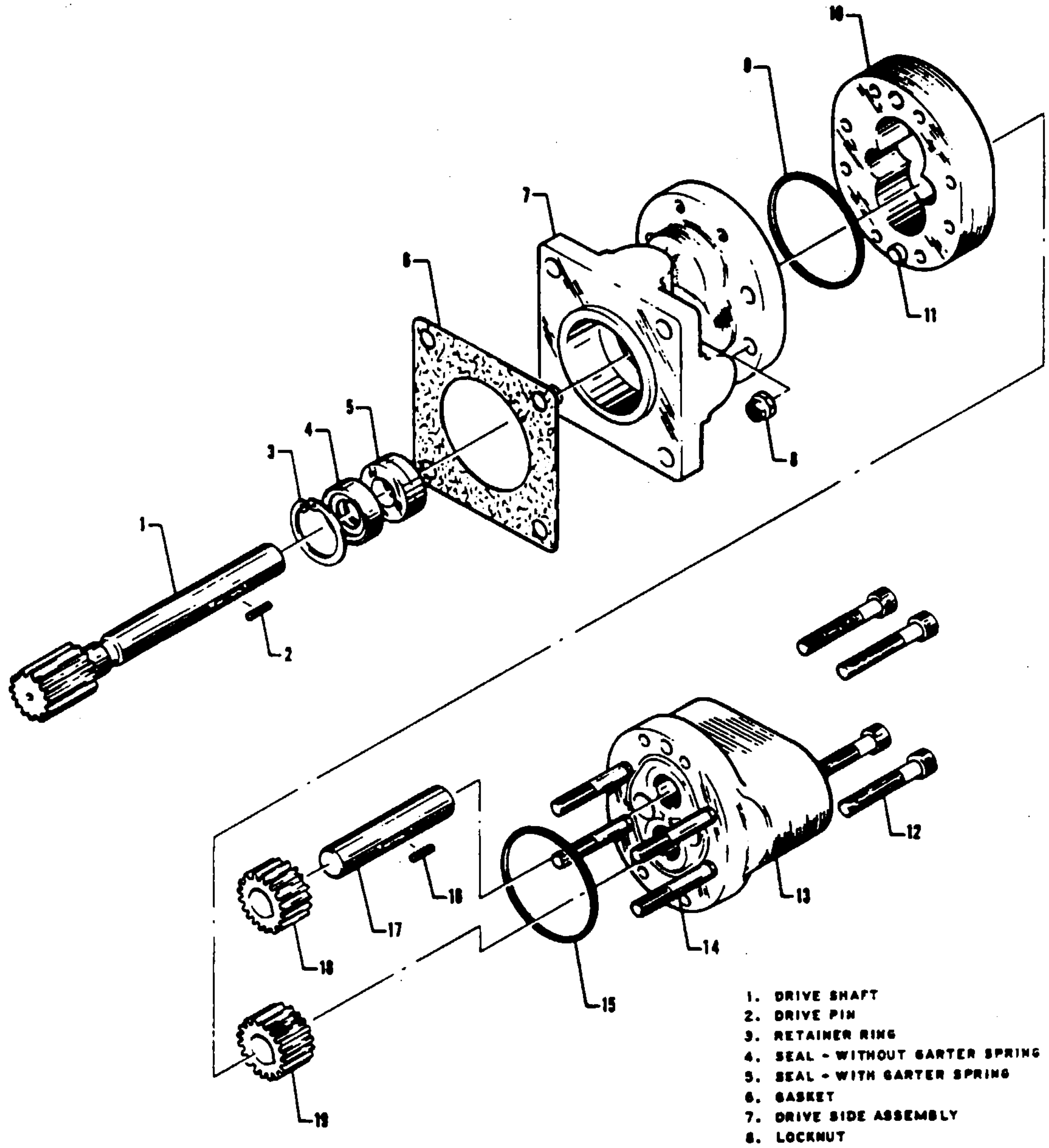


Figure 6-26. Hydraulic Pump

TABLE VI-III. INSPECTION AND REPAIR, HYDRAULIC PUMP

ITEM (Refer to figure 6-26.)	INSPECTION	REPAIR
Rear Side (13)	Visually inspect the lapped face for scratches or or signs of scoring.	Lap the surface to remove any scratches.
Centerplate (10)	Visually inspect the two lapped faces for scratches or scoring. Inspect the gear pockets for deep scratches.	Lightly stone any burrs around the gear pockets. Lap the faces, but do not remove more than 0.0001" total of metal from both sides.
Drive Side (7)	Visually inspect the lapped surface for scratches or signs of scoring.	Lap the surface to remove any scratches. If deep scratches are present replace part.
Secondary Shaft (17)	Inspect the shaft for deep scratches in the bearing area.	If deep scratches are present, replace secondary Shaft.
Gears (18) and (19)	Visually inspect gears for evidence of chipped teeth or cracks around the bore. Measure the gear O.D., which should be 1.1646"/1.1644".	If gears are not within tolerance or if there are any cracked teeth, replace the pump.
Bearings	Visually inspect the bearing bores for scratches and/or scoring.	If badly scored, replace pump.

NOTE

The PA-31P Parts Catalog should be used to obtain repair kits to service this pump.

6-101. CLEANING, INSPECTION, REPAIR OF HYDRAULIC PUMP.

a. Immerse and wash all metallic parts in trichlorethylene (Military Specification MIL-T-7003) or some equivalent commercial cleaning solvent. Clean all openings and passages with a fine fiber brush, or equivalent, dipped in solvent. Do not scrub any surface with a tool that will scratch surface.

WARNING

Wear goggles, rubber gloves and provide adequate ventilation when using trichlorethylene or cleaning solvents. Repeated contact of solvent with skin may produce irritation. If vapors are inhaled, serious damage may result.

b. Dry all parts thoroughly with a clean, lint-free cloth or with dry, filtered compressed air at 20 psi maximum. Blow out all parts, bores, and passages with compressed air.

c. Under strong light and preferably under magnification, inspect all parts for scoring, nicks, scratches, pitting, corrosion, cracks and excessive wear. Inspect all threaded surfaces for chipping and crossed or stripped threads. Inspect parts for conformance to information given in Table VI-III. The table gives the items which should be inspected and the corrective action necessary when the pump parts do not pass this inspection.

NOTE

Although the pump may still operate under conditions where some of the parts exceed the wear limits, it will probably be found that the pump is not producing its rated capacity and therefore, the system may not be doing an adequate job. Therefore, it is necessary to repair or replace any parts that are not within the stated limits.

6-162. ASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-26.) The seal and seal rings should be soaked in the Hydraulic (MIL-H-5606) fluid for two hours minimum time before installation.

a. Replace drive shaft seal (4 or 5) into drive side seal bore. Be sure to install drive shaft seal, "back to back", as noted during disassembly.
b. Replace retainer ring (3) into drive side seal bore.
c. Install new "O" ring seal (9) on drive side.
d. Mate centerplate assembly (10) with drive side assembly (7) and align dowel pins.
e. Install drive shaft (1) from engine side of drive side assembly.
f. Install secondary shaft (17) into centerplate. Install drive and secondary gears (19 and 18) onto drive and secondary shafts (1 and 17). Be sure the drive pin counter bore on the drive gear faces the pump rear side. Install drive pins.
g. Install the four studs (12) and new "O" ring seal (15) on the rear side assembly (13).
h. Lightly oil gear teeth with hydraulic fluid before completing assembly.
i. Mate the rear side assembly (13) with the centerplate (10), using caution to align the drive and secondary shafts with the respective holes in the rear side assembly.
j. Replace the four locknuts (8) on the studs (14) extending out of the drive side flange that mates with the centerplate.

k. Replace the four socket head cap screws (12) that secure the rear side, centerplate and drive side assemblies together. Torque the socket head cap screws and locknut to 60 inch pounds.
l. When the pump is assembled, turn drive shaft by hand to make sure the pump turns freely. If there is any sticking or binding at all, disassemble pump and determine the trouble. Do not apply power to the pump until it turns freely by hand.

NOTE

If possible run pump at rated speed while gradually increasing the pressure up to rated pressure by the end of a thirty minute period.

6-163. INSTALLATION OF HYDRAULIC PUMP.

a. Place a new gasket on the base of the housing.
b. Install pump on the housing.

NOTE

When installing pump keep the drain fitting facing to the lower right, in the downward position.

c. Line shaft up with the gear inside of the housing.
d. Install flat washers, lock washers and nuts on the base of the pump and tighten.
e. Install the two hydraulic hoses and prime the pump before completing the hookup to the firewall fittings in accordance with paragraph 6-164.
f. Install and time magnetos.
g. Check to be sure that system reservoir contains the required amount of clean fluid.
h. Change system fluid filters, in accordance with paragraph 6-95.

6-164. PRIMING HYDRAULIC PUMP. The following instructions for priming the hydraulic pump assures that the pump will not be operated in a dry condition and shall be followed whenever a pump is serviced or replaced.

a. Remove the hydraulic suction and pressure lines from the firewall fittings.
b. Install caps on suction and pressure fitting at the firewall to prevent the loss of fluid prior to the hookup of the hydraulic lines.
c. Holding both lines at a level higher than the pump, pour hydraulic fluid, MIL-H-5606, into the lines.
d. Remove one cap at a time from the firewall fittings and connect the appropriate line to the fitting, trying not to spill any of the hydraulic fluid previously put into the lines.
e. After the engine has been operated, check the hookups for leaks.

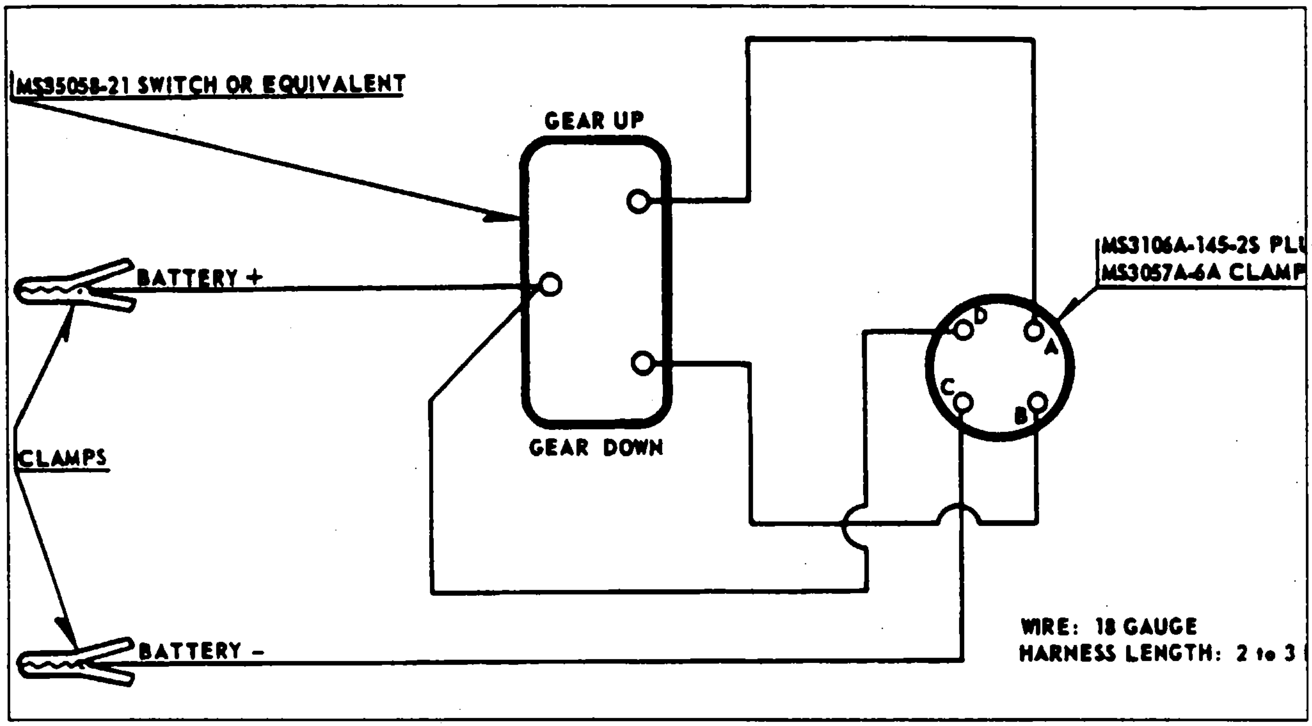


Figure 6-27. Power Pack Test Harness Schematic

6-165. HYDRAULIC SYSTEM FAILURE. The emergency use of the hand pump to extend the gears indicates the engine driven pumps were operating without sufficient fluid. This condition causes additional wear on the engine driven pumps. Therefore, the filter elements must be removed and check even if pump, failure is not apparent and/or the primary cause of the problem.

a. Remove the filter elements and check for metal particles.
b. If no metal particles are evident proceed with the following:
   1. Replace filter element per Paragraph 6-155.
   2. Replenish fluid as noted in Section II.
c. If metal particles are evident in either filter proceed with the following:
   1. Inspect, replace or repair both hydraulic pumps. (Refer to Paragraphs 6-159 to 6-163.)
   2. Prime pumps in accordance with Paragraph 6-164. Do not connect the pumps to the rest of the hydraulic system until the system has been flushed.
   3. Proceed to flush the system in accordance with Paragraph 6-4.

6-166. HIGH ALTITUDE GEAR OPERATION. Should it be necessary to operate the landing gear above 15,000 feet, the landing gear selector may return to its neutral position before the gear door closing cycle is complete. If this occurs, manual override of the time delay cycle must be used to close the gear doors.

During gear extension, if the selector returns to neutral at the same time the gears are locked down, and before the gear doors have had time to close, again select the gear down position and hold the handle down for an additional 3 to 4 seconds. This allows completion of the door closing cycle.

During gear retraction, if the selector returns to neutral and the gear unsafe light remains lit, again select the gear up position and hold the handle up for 4 seconds after the gear unsafe light extinguishes. Be sure that the light has extinguished before exceeding the maximum gear extended speed.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM

Trouble	Cause	Remedy
Landing gear system fails to operate.	Selector lever disconnected.	Connect lever.
	Selector lever out of adjustment.	Adjust lever.
	Selector lever (Note: Selector lever cannot be moved to gear up while left main gear strut is compressed or with electrical power off.)	Adjust lever.
	Hydraulic fluid reservoir below operating level.	Refer to paragraph 6-165. Then fill the power pack with hydraulic fluid.
	Leak or obstruction in hydraulic lines.	Refer to paragraph 6-165. Then check the system with hydraulic test unit or hand pump.
	Internal leakage in main relief valve.	Check system operation per paragraph 6-13 or 6-25.
	Internal leakage in hand pump relief valve.	Check system operation per paragraph 6-14 or 6-26.
Gear operates abnormally slow or partially.	Low fluid level.	Refer to paragraph 6-165. Then fill power pack with hydraulic fluid.
	Leaking or kinked line.	Refer to paragraph 6-165. Then replace line.
	Internal leak in cylinder. Priority valve out of adjustment or leaking.	Repair or replace cylinder. Check valve operation per paragraph 6-12.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM (cont.)

Trouble	Cause	Remedy
Gear operates abnormally slow or partially. (cont.)	Priority valve out of adjustment or leaking.	Check valve opera tion per paragraph 6-12 or 6-24.
	Slow leak in main relief valve. (Engine pump.)	Check system operation per paragraph 6-13 or 6-25.
	Slow leak in hand pump relief valve.	Check system operation per paragraph 6-14 or 6-26.
	External leakage at selector valve.	Refer to paragraph 6-165. Then replace damaged "O" rings.
	One engine pump inoperative.	Refer to paragraph 6-158 before replacing pump.
Selector handle returns to neutral before cycle is complete.	Cable, line or obstruction restricting the travel required to fully select gear up or down.	Check and remove obstruction.
	Selector lever out of adjustment.	Adjust control.
	If gear completes cycle (red light out) but doors do not close, battery output may be low.	Check voltage.
	Time delay valve and/or piston release lock out of adjustment.	Check operation per paragraphs 6-10 and 6-11 or 6-22 and 6-23.
	Time delay valve air locked.	Bleed air out by holding selector down for 30 seconds, then make three or four rapid movements to neutral and back to down.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM (cont.)

Trouble	Cause	Remedy
Gear retracts or extends before doors open.	Priority valve leaks in power pack.	Check valve cracking pressure.
	Solenoid valve stuck in closed position.	Turn off power and hand pump doors open. (Note: With power off solenoid valve shuttles to door open and the doors may be opened without selecting gear up or down.)
	Micro switch on power pack out of adjustment.	Check for loose wire or mounting, Of bent bracket.
Doors come open in flight. NOTE Refer to Landing Gear Troubleshooting Chart. Table VII-III.	Micro switch on power pack out of adjustment.	Adjust micro switch. (Door solenoid should remain in door close position when handle returns to neutral.)
Doors fail to close.	Cannon plug on power pack loose.	Tighten
	Solenoid valve stuck in door open position.	Check wiring to solenoid valve.
	Faulty limit switch.	Check all indicator lights.
	Low electric power supply.	Check battery.
	Aircraft above 15,000 FT.-MSL	Refer to 6-169 High ALT. Gear Operation.
	Circuit breaker open.	Check breaker. (Note: without electrical power, doors will open, but not close.)

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

Par.		Aerofiche Grid No.
7-35.	Landing Gear Light Switches	2F10
	7-36. Adjustment of Nose Gear Up Light Switch	2F10
	7-37. Adjustment of Nose Gear Down Light Switch	2F10
	7-38. Adjustment of Main Gear Up Light Switch	2F11
	7-39. Adjustment of Main Gear Down Light Switch	2F11
	7-39a. Adjustment of Main Inboard Gear Door Ajar Switches	2F12
	7-40. Adjustment of Landing Gear Safety Switch	2F13
7-41.	Landing Gear Warning System	2F13
	7-42. Removal of Gear Warning Switches	2F13
	7-43. Installation of Gear Warning Switches	2F13
	7-44. Adjustment of Gear Warning Switches	2F14
7-45.	Wheels (Cleveland)	2F15
	7-46. Removal and Disassembly of Nose Wheel	2F15
	7-47. Inspection of Nose Wheel Assembly	2F16
	7-48. Assembly and Installation of Nose Wheel	2F16
	7-48a. Repair of Nose Wheel Assembly	2F17
7-49.	Wheels (Goodyear)	2F18
	7-50. Removal and Disassembly of Main Wheel	2F18
	7-51. Cleaning and Inspection of Main Wheel Assembly	2F19
	7-52. Repair of Main Wheel Assembly	2F20
	7-52a. Assembly and Installation of Main Wheel	2F22
7-53.	Brake System	2F23
	7-54. Brake Wear Check	2F23
	7-55. Removal and Disassembly of Brake Assembly	2F23
	7-56. Cleaning and Inspection of Brake Assembly	2G2
	7-57. Repair of Brake Assembly	2G2
	7-58. Assembly and Installation of Brake Assembly	2G6
7-59.	Brake Master Cylinder	2G13
	7-60. Removal of Brake Master Cylinder	2G13
	7-61. Disassembly of Brake Master Cylinder	2G14
	7-62. Cleaning, Inspection and Repair of Brake Master Cylinder	2G14
	7-63. Assembly of Brake Master Cylinder	2G14
	7-64. Installation of Brake Master Cylinder	2G15
7-65.	Parking Brake Valve	2G15
	7-66. Removal of Parking Brake Valve	2G15
	7-67. Disassembly of Parking Brake Valve	2G15
	7-68. Cleaning, Inspection and Repair of Parking Brake Valve	2G16
	7-69. Assembly of Parking Brake Valve	2G16
	7-70. Installation of Parking Brake Valve	2G16
7-71.	Bleeding Procedure	2G16

SECTION VII

LANDING GEAR AND BRAKE SYSTEM

7-1. INTRODUCTION. This section provides instructions for remedying difficulties which may arise in the operation of the landing gear and brake systems. The instructions are organized so that the mechanic can refer to Descriptions and Principles of Operation for a basic understanding of the systems; Troubleshooting for a methodical approach in locating the difficulty; Corrective Maintenance for the removal, repair and installation of components; and Adjustment and Test for the operation of the repaired systems.

7-2. DESCRIPTION AND PRINCIPLE OF OPERATION. The tricycle landing gear system incorporates air-oil oleo type struts that are hydraulically operated and fully retractable with the nose gear retracting aft into the nose section and the main gear retracting inboard into the wing. Doors completely cover the gear when retracted. The nose and outboard main gear doors operate by mechanical linkage and remain open when the gear is extended. The main gear inboard doors operate hydraulically and are controlled by the limit switches opening during gear extension and closing again when the gear has fully extended. To prevent the gear from retracting while the airplane is on the ground, an anti-retraction safety switch is located on the left gear upper torque link, which will not allow the gear actuator lever to move to the gear up position until weight is off the landing gear allowing the strut to extend to within one quarter of an inch of full extension.

The nose gear is steerable through a 28 degree arc by the use of the rudder pedals and an 80° arc by the use of differential engine power and brakes. As the gear retracts, the steering linkage becomes separated from the gear and is centered, so that the rudder pedal action with the gear retracted is not impeded by the nose gear operation.

Located on the instrument panel, to the right of the gear selector control, are one red and three green indicator lights. The red light will show an indication when the gear is not locked in either the up or down position and the green lights will show when each individual gear is down and locked. There is no indication light when the gear is up and locked. The red light will also show an indication whenever the inboard gear doors are not completely closed. A warning horn in the cockpit will sound whenever power from one or both engines is reduced below 10 to 12 inches of manifold pressure when the gear are not in the down locked position. This horn will also sound whenever the landing gear selector handle is in the gear up position while the airplane is on the ground and the master switch is on. If the gear selector handle can be moved to the up position with the airplane on the ground, it is an indication of an improperly adjusted selector mechanism or the anti-retraction system is inoperative.

Located in the cockpit between the pilot seats, under the floor access panel, is a hand pump to be used should the primary hydraulic system fail.

The brakes are hydraulically actuated by individual master cylinders mounted on the left (optional on right) set of rudder pedals. A reservoir, accessible through the access door on the upper right portion of the nose section, supplies fluid to each master cylinder. From these cylinders, hydraulic fluid is routed through lines and hoses to a parking brake valve located on the left aft side of the forward cabin bulkhead, through the cabin and wings, to the brake assemblies on each main landing gear. To operate the brakes, apply toe pressure against the top of the rudder pedal. The parking brake may be actuated by applying toe pressure and at the same time pulling out on the brake handle. To relieve parking brake pressure, apply toe pressure on the pedals and at the same time push in on the parking brake handle.

Servicing of the hydraulic and brake system is found in Section II.

7-3. TROUBLESHOOTING. Mechanical and electrical switch troubles peculiar to the landing gear system are listed in Table VII-III at the back of this section. When troubleshooting, first eliminate hydraulic malfunctions functions as listed in Section VI. Then proceed to switch malfunctions and last to the mechanical operation of the gear itself, both of which are listed in this section. Always place the airplane on jacks before attempting any troubleshooting of the gear.

7-4. LANDING GEAR SYSTEM.

7-5. NOSE LANDING GEAR SYSTEM.

7-6. DISASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1.) The nose gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Place a drip pan under the nose gear to catch spillage.
c. Remove air and fluid from the oleo. (Refer to Oleo Struts, Section II.).
d. To remove the complete cylinder and fork assembly from the oleo housing (35), cut the safety wire (44) and remove the cap bolts (37) that attach the steering arm (42) and aligner guide bracket (40) to the top of the oleo cylinder (12).
e. Disconnect the shimmy dampener (27) by removing the bolt assembly (28) that connects the dampener to the cylinder.
f. Release and remove the retainer ring (10) at the top of the housing (35) and pull the complete cylinder assembly from the bottom of the housing. The upper and lower housing bushings (11 and 13) should remain pressed in the housing.
g. To remove the piston tube (26) assembly from the cylinder (12), separate upper and lower torque links (25 and 22) by removing the connecting bolt (24) with washer, nut and cotter pin (43). Note spacer washer (23) between the two links.
h. Compress the piston tube (26), reach up along the tube and release the snap ring (9) from annular slot at the bottom of the oleo housing.

NOTE

Prior to disassembling the upper bearing (2) with retaining pins (1) from the piston tube (26), place a reference mark, with a grease pencil, from the upper bearing to the piston tube. This will ensure proper indexing of parts upon reassembly.

i. Pull the piston tube (26) with component parts from the cylinder.
j. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing (2) and retaining pins (1). Slide off the tube, the upper bearing (2), spacer (3), lower bearing (5) with outer and inner "O" rings (4 and 6), wiper strip (7), washer (8) and retainer ring (9).
k. To remove the orifice tube (15), remove the large bolt (38) partially from the top of the cylinder. Tap bolt gently to loosen orifice tube from cylinder; then completely remove bolt. Pull the tube from the cylinder.
l. The orifice plate (16) is removed from the bottom of the orifice tube by releasing the retainer ring (17) that holds the plate in position.

NOTE

Do not remove piston plug (48), "O" ring (47), from piston tube (26), or piston tube (26) from fork (19).

7-7. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.
b. Inspect the landing gear oleo assembly component for the following:
    1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
    2. Retaining pins for wear and damage.
    3. Lock rings for cracks, burrs, etc.
    4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.

1. PIN, RETAINER
2. BEARING, UPPER
3. SPACER
4. "O" RING, OUTER PACKING
5. BEARING, LOWER
6. "O" RING, INNER PACKING
7. WIPER STRIP
8. WASHER
9. RING, RETAINER
10. RING, RETAINER
11. BUSHING, HOUSING TOP
12. CYLINDER, OLEO
13. BUSHING, HOUSING BOTTOM
14. "O" RING PACKING
15. TUBE, ORIFICE
16. PLATE, ORIFICE
17. RING, RETAINER
18. GREASE FITTING
19. FORK
20. BOLT ASSEMBLY
21. BOLT ASSEMBLY
22. TORQUE LINK, LOWER
23. WASHER, SPACER
24. BOLT ASSEMBLY
25. TORQUE LINK, UPPER
26. TUBE, PISTON
27. SHIMMY DAMPENER
28. BOLT ASSEMBLY
29. BOLT ASSEMBLY
30. BOLTS AND SAFETY WIRE
31. BRACKET
32. BUSHING
33. STUD, DOOR UPLOCK
34. PLACARD, SERVICE
35. HOUSING, OLEO
36. BUSHING
37. BOLT, CAP
38. BOLT
39. PLUG, FILLER
40. ALIGNER GUIDE BRACKET
41. VALVE, AIR
42. ARM, STEERING
43. PIN, COTTER
44. SAFETY WIRE
45. PISTON RING
46. BUSHING, STEERING
47. "O" RING, PACKING
48. PLUG, PISTON TUBE
49. SCREW, FLUSH HEAD
50. BUSHING

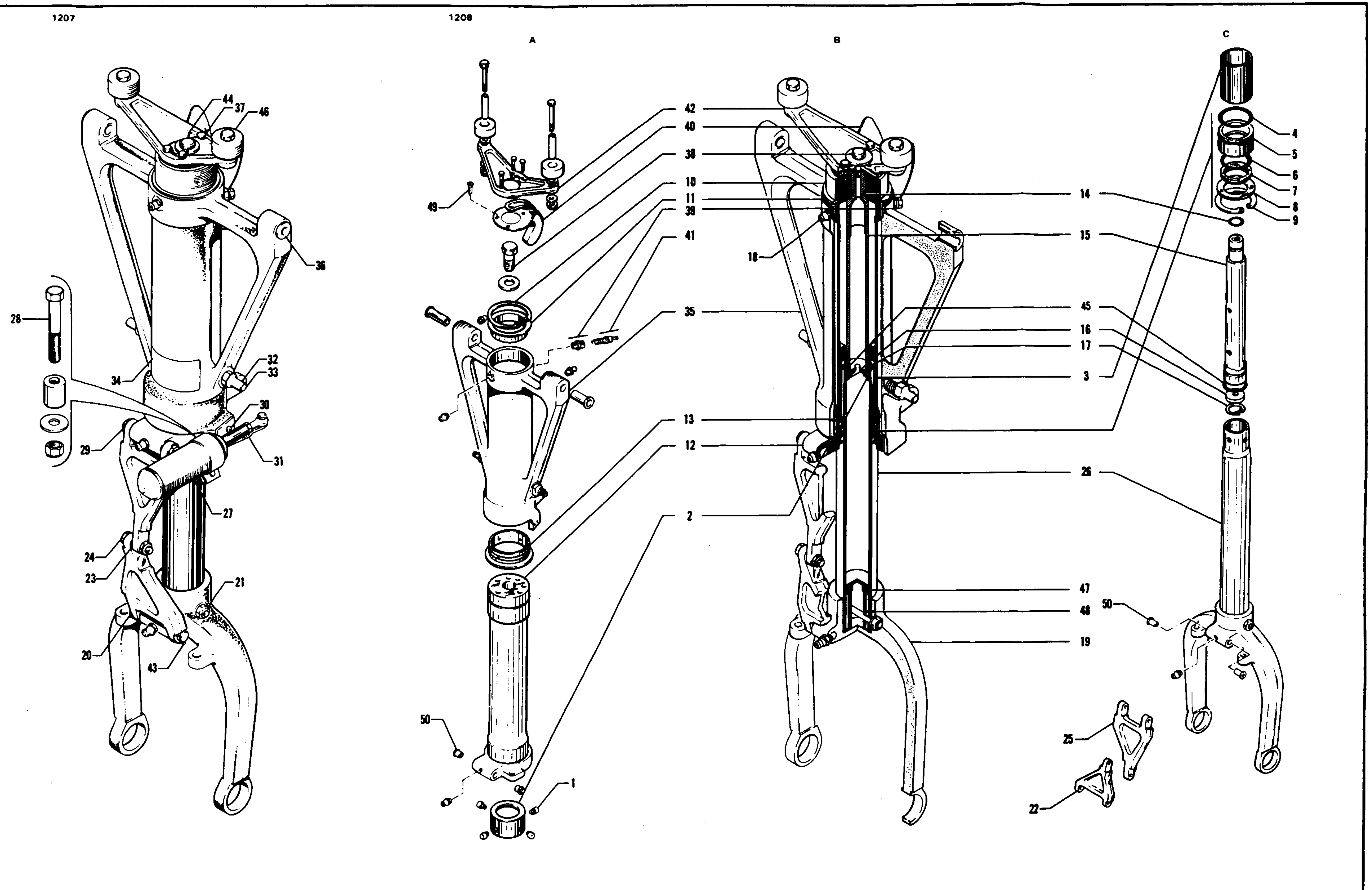

Figure 7-1. Nose Gear Oleo Strut Assembly

5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.

c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts.

d. Individual replacement of wiper strips may be achieved per paragraph 7-34.

7-8. ASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1.)

a. Ascertain that parts are clean and inspected.

b. To assemble the orifice tube (15), insert the orifice plate (16) into the bottom of the tube, with the countersunk side of the orifice hole exposed. Secure the plate with the retainer ring (17). Lubricate and install the O-ring (14) on the upper end of the tube.

c. Insert the tube up through the bottom of the cylinder (12). Orifice tube (15) is fully installed in cylinder housing (12) when the upper end of the orifice tube is approximately .062 lower then flush with the upper end of cylinder assembly.

d. The fork tube assembly may be assembled by installing the tube components on the tube (26). In order, slide onto tube; retainer ring (9), washer (8), lower bearing (5) with outer and inner O-rings (4 and 6), spacer (3) and upper bearing (2). Using the reference marks applied during disassembly, align lock pin holes of the upper bearing and piston tube, and install pins (1).

e. Lubricate the inner wall of the cylinder. Carefully insert the piston tube assembly into the bottom of the cylinder (12), allowing the orifice tube to guide itself into the piston tube, until the retainer ring (9) can be installed in the annular slot at the end of the cylinder. Install wiper strip (7), slide washer (8) into position and secure assembly with retainer ring.

f. At the top of the cylinder (12) tighten the orifice tube bolt (38).

g. Install the upper and lower torque links (22 and 25).

h. Ascertain that the upper and lower oleo housing bushings (11 and 13) are installed. Install-the cylinder into the oleo housing and secure with retainer ring (10).

i. At the top of the oleo housing, install on the cylinder the aligner guide bracket (40) and steering arm (42). Torque cap bolts (37), 30-35 in.-lbs. and safety with MS20995C40 wire (44).

j. At the top of the oleo housing on later models as shown in Figure 7-2, install on the cylinder the aligner guide bracket (13) and the plate assembly (12). Torque cap bolts (11), 50-55 in.-lbs. and safety with MS20995C51 wire. Install steering arm (8), special washers (7), spring (6), washer (5), nut (4) with torque of 550-560 in.-lbs., washer (3), bolt (2) with torque of 45-70 in.-lbs., and safety with MS20995C51 wire.

NOTE

Bearing surface of cam, cam follower to be greased on installation. Use MIL-G-23827.

k. Install the shimmy damper (27). On aircraft which utilize shimmy damper Piper P/N 73010-2, follow instructions listed below.

1. Place the shimmy damper in the clamp and secure with bolt, washers and nut.
2. Rotate the nose gear to full right tow limit and retain.
3. Extend shimmy damper to full travel.
4. Adjust the rod end bearing until the attachment bolt fits the hole in the bracket.
5. Remove the bolt and turn the rod end bearing "out" one full turn.
6. Complete the installation by securing the rod end to the bracket.

l. Lubricate the gear assembly. (Refer to Lubrication Chart, Section 11.)

m. Service oleo strut with fluid and air. (Refer to Oleo Struts, Section 11.)

n. Check the nose gear for alignment (refer to Paragraph 7-13) for operation.

7-9. REMOVAL OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

a. Remove right and left nose section side access panels.
b. Remove lower radios and radio shelf.
c. Remove oxygen cylinder. (Refer to Section XIV.)
d. Remove Heater assembly. (Refer to Section XIII.)
e. Place the airplane on jacks. (Refer to Jacking, Section II.)
f. With the hand pump, retract the nose gear slightly to relieve the gear from its downlocked position.
g. To remove the drag link assembly, the following procedure may be used:
   1. Disconnect gear retraction rod (36) from the upper right drag link (39).
   2. Disconnect the lower drag link (41) from the gear oleo housing (44).
   3. The upper and lower link assemblies may be removed as one unit by removing the upper drag links (37 and 39) attachment bolts at their attachment plates.
h. With the lower drag link (41) disconnected from the gear housing (44), the gear may be removed by removing the attachment bolt assemblies at the attachment plates (38 right) on each side of the gear housing. Note, if any, the number and location of spacer washers between the gear housing and attachment plates.
i. The idler link (24) may be removed after the gear operating rod has been disconnected, by the following procedure:
   1. Remove the downlock spring (22) and the eye bolt (51) which is attached to the idler link.
   2. Disconnect the gear actuating cylinder (25) rod from the link.
   3. Remove the link pivot bolt (19) by sliding the bolt out of the link, allowing the head to enter the hole in the side of the limit switch bracket. With the head through the bracket hole, the threaded end of the bolt can continue out of the link.
   4. Remove the idler link (24).
j. The uplock rod (18) may be removed by removing the nut (20) from the actuating cylinder support bolt and sliding the rod off the bolt. Retain the bolt in place to support the cylinder.
k. The uplock hook (10) may be removed after the removal of the uplock rod (18) and the hook pivot bolt. Remove the hook with the uplock spring (11).

NOTE

The idler link (24), uplock rod (18) and uplock hook may also be removed with support tube (17) as one unit.

l. To remove the support tube (17) first remove the up limit switch (15) and wire support clamps. Hold the support nuts within the nose section with a wrench, while removing the bolts. Then remove the support tube.
m. The gear housing (44) attachment plates (43 right) may be removed by grinding the rivet heads flush with the plate and removing the rivets.
n. The upper drag links (37 and 39) and attachment plates (38 right) may be removed by holding the attachment nuts within the nose section with a wrench, while removing the support bolts.

7-10. CLEANING, INSPECTION AND REPAIR OF NOSE LANDING GEAR.

a. Clean all parts with a suitable cleaning solvent.
b. Inspect bolts, bearing, bushings and ball joints for excessive wear, corrosion and damage.
c. Inspect the gear housing, drag links, idler link, rods and attachment plates for cracks, bends or misalignment.
d. Inspect the downlock spring for the following:

1. Check for excess wear or corrosion, especially around the lock portion of the spring. Spring n returning to complete compression. A spring should be rejected if wear or corrosion exceeds one quarter the diameter of the spring. Clean away all corrosion and repaint the springs.
2. Check the right and left gear door actuator springs for load tensions below the minimum allowable tolerances. The minimum tension for the actuator springs is 10 pounds at 3 inch extension. If one spring is rejected, replace both springs.
3. Check the downlock spring at the idler link for load tension. The minimum tension is 20.5 pounds at 7.312 inches extension and 47 pounds at 11.312 inches extension.
4. Check the uplock spring at the uplock hook for load tension. The minimum tension is 4 pounds. This check is performed by fastening a fish type scale to the hook and spring and pulling steadily against the hook and spring to get a reading.

e. Inspect the uplock hook for wear and oversized bearing surfaces.
f. Inspect the uplock roller for freedom of movement and minimum wobble.
g. Inspect the uplock rod sliding surface for corrosion and freedom of movement.
h. Inspect lock rod end bearings for corrosion, damage and freedom of movement.
i. Check general condition of limit switches and wiring for fraying, poor connections or conditions that may lead to failures.
j. Attach the upper and lower drag links and check that when stop surfaces touch, linkage is 0.063 to 0.156 inch through center. Should this distance exceed the required through center travel and bolt and bushings are tight, replace one or all drag links.
k. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.
l. Repair to the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

7-11. INSTALLATION OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

NOTE

When assembling any units of the landing gear, lubricate bearings and friction surfaces with proper lubricant as described in Section II.

a. Position the right and left upper drag link plates (38 right) and bolt in place.
b. Position the right and left gear housing attachment plates (43 right) and rivet in place.
c. Install the support tube (17) and secure. Connect the up limit switch (15) and secure electrical wiring to the tube.

NOTE

The uplock hook (10), uplock rod (18), idler link (24) and retraction rod (36) may be assembled on the support tube as a unit and then installed on the airplane, or each component installed individually after the support tube has been installed.

d. The uplock hook (10) with uplock spring (11) may be installed as follows:
   1. Place the "U" end of the uplock spring (11) over the back of the hook with the loops toward the back.
   2. Spread the spring and snap the loops over the bushing that extends through the hook.

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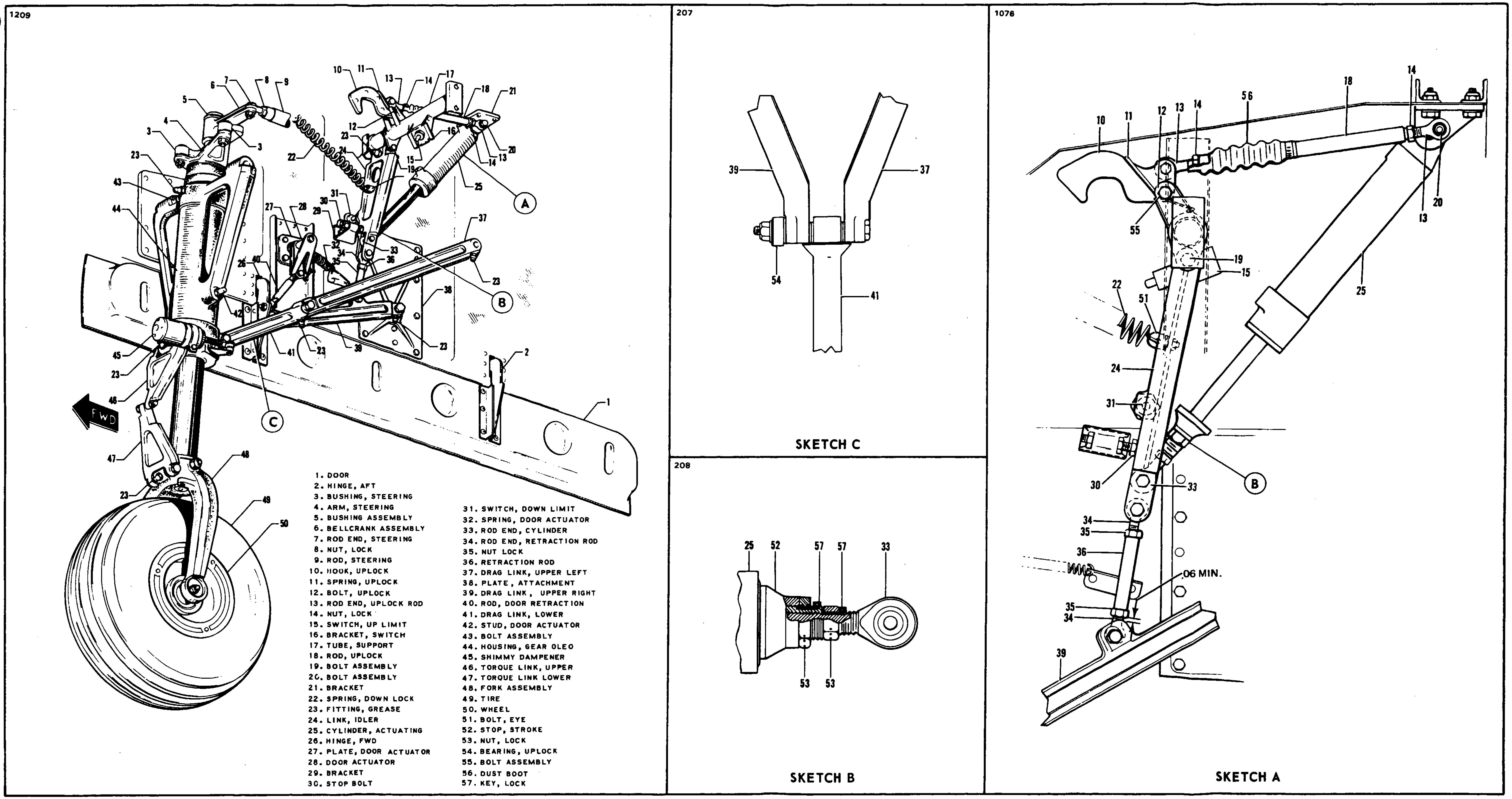

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Figure 7-2. Nose Landing Gear Installation

3. Hook the ears of the spring over the aft side of the hook bracket and push the hook forward until the bolt holes in the bracket align with the holes in the hook.
4. Bolt the hook in position and ascertain that it rotates freely with no side play and safety.

e. Install the uplock rod (18) by attaching and securing the sliding end to the uplock hook and the other end on the gear actuating cylinder support bolt.

f. The idler link (24) may be installed by the following procedure:
1. Align the bolt hole in the link (24) with the lug holes of the support tube (17) and with the down limit switch contact boss to the right.
2. Insert the head of the pivot bolt into the hole in the side of the up limit switch bracket far enough to allow the threaded end of the bolt to be inserted into the tube lug and link. Tighten the nut on the bolt allowing the link to turn free with no side play.
3. Attach the retraction rod (36) and actuating cylinder rod end (33) to the link (24). Do not connect retraction rod (36) to link (39) until gear adjustment has been completed.
4. The downlock spring (22) may be attached after gear check and adjustment has been completed.

g. To install the gear housing assembly, position the gear so that the attachment points on the housing align with the attachment plates. If needed, install spacer washers between attachments to allow a minimum amount of side play. Tighten the pivot bolt nuts to a snug fit, allowing the gear to swing free, and safety.

h. The drag links may be installed as follows:
1. Align upper (37 and 39) and lower (41) drag link bolt holes. Install bolt, uplock bearing (54) and secure.
2. Ascertain that the linkage through center travel is within tolerance.
3. Attach the upper drag links (37 and 39) to the attachment plates, tighten nuts to a snug A, allowing the links to swing free, and safety.
4. Attach the lower drag link (41) to the landing gear housing (44) and temporarily install bolt. Secure and safety bolt after gear has been adjusted.
5. Manually retract and extend the landing gear several times to ascertain smoothness of operation.
6. Attach the retraction rod (36) to the upper right drag link (39) and adjust the rod to obtain approximately .06 of an inch clearance between the lower locknut (35) and link (39).

NOTE

Ascertain that the locknut (35) are tightened against the retraction rod (36).

j. Grasp the gear fork (48) and rotate to determine that there are no gaps existing between steering arm travel bushings (3) and steering bellcrank (6) which could cause the nose wheel to shimmy. Bushings (3) are available in several different diameters to establish the proper clearance. Adjuster should be made when there is no load at these points. (Ref. Paragraph 7-12.)

k. Lubricate the landing gear assembly. (Refer to Lubrication Chart, Section II.)

l. Check the nose gear for alignment and operation.

7-12. ADJUSTMENT OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

a. With the airplane on jacks and gear extended, disconnect both gear door retraction rods (40) and leave the doors in the open position.

b. To facilitate adjustment of the uplock, observe the following steps.
1. Disconnect the lower drag link (41) from the landing oleo housing (44).
2. Disconnect the actuating cylinder rod end (33) from the idler link (24).
3. Disconnect the end of the downlock shrine (22) from the idler link (24).
4. Disconnect and slip the boot (56) over the uplock rod end, locknut (14) back along the rod.(18) until the adjustment is complete.

5. Rotate the drag link assembly up by hand until the uplock hook (10) engages the uplock bearing (54).
6. Pull the actuating cylinder barrel (25) down and forward until the actuator attaching bolt is at the bottom of the slots in the attachment bracket (21).
7. With the uplock rod (18) fully extended and the hook (10) resting fully on the uplock roller (54), adjust the rod end (13) until the attaching bolt on the hook (10) can be freely inserted.

NOTE

The actuating cylinder (25) and uplock rod (18) attaching bolt (20) must remain in the bottom of the attachment bracket (21) slots during this adjustment.

8. Remove the bolt from the hook (10) and uplock rod end (13) then extend the rod end one full turn and lock the rod end. Reinstall the bolt and secure.
9. Slip the boot (56) over the uplock rod end locknut (14) and secure after the adjustment of nose gear is complete.

c. Attach the lower drag link (41) to the landing gear housing (44), secure and safety unless checking link through travel.
d. The through travel of the link is checked in the following procedure:
   1. With the gear in the down position and the stop surfaces of the drag links touching, ascertain that the linkage is 0.063 to 0.156 inch through center

NOTE

A fabricated tool may be constructed to check through center travel of the drag link assembly while the links are installed on the airplane. (Refer to Figure 7-20.)

   2. To use the fabricated tool, ascertain that the gear is in the downlocked position with no hydraulic pressure on the system.
   3. Remove the cotter pins that safety the nuts which secure both upper drag links (39 and 37) to their attachment plates (38) and the lower link (41) to the gear housing.
   4. Place the tool tube through the elongated hole in the tool plate and place the tube over and between the upper link attaching nuts.
   5. Swing the plate up and against the head of the bolt that connects the upper and lower links. The plate sleeve slides over the nut of the bolt that connects the lower link to the gear housing.
   6. Look through the sight hole in the plate to ascertain that the center of the bolt is 0.063 to 0.156 inch below the centerline on the plate.
   7. Remove the tool and reinstall the cotter pins.

e. The retraction rod (36) is adjusted to provide a distinct snap-through action as the idler linkage passes through center.
f. Adjust the idler link stop bolt (30) on the right side of the wheel well so that the link is 0.220 to 0.280 of an inch through center.
g. A straightedge laid from the attaching bolt heads of the idler link (24) and retraction rod (36) will give the through travel measurement.
h. Connect the downlock spring (22) to the idler link (24).
i. Extend the actuator cylinder (25) with hydraulic pressure from the hand pump and adjust the red end (33) until the attaching bolt can be freely inserted. Release pressure and extend the rod end one full turn.

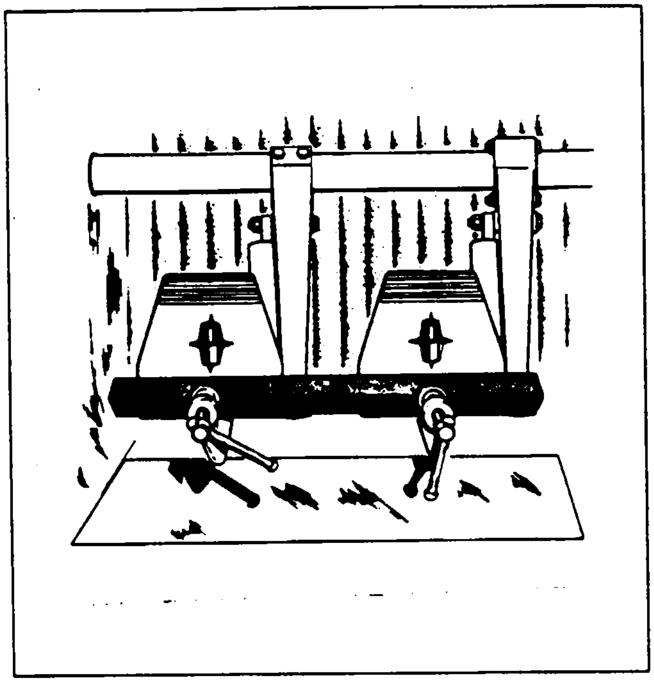

Figure 7-3. Clamping Rudder Pedals in Neutral Position

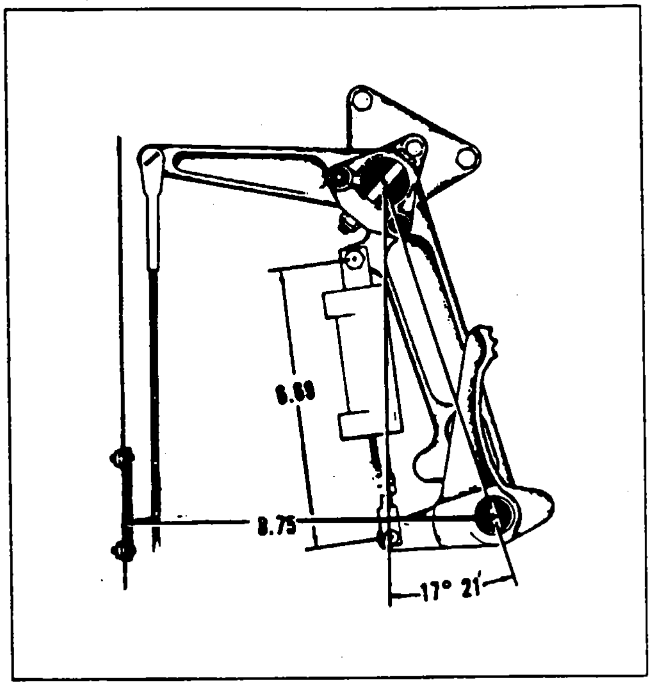

Figure 7-4. Rudder Pedals Neutral Angle

NOTE

Actuating cylinder attaching bolt must remain at the top of the attachment bracket (21) slot during adjustment.

j. Reinstall attaching bolt and secure. Place the key locks (57) between the locknuts (53) and the keyway in the rod. Screw the locknut on the rod and keep the key lock centered in the keyway while tightening the locknut. With the locknut torqued, install the lock wire from the key locks (57) to the locknuts. Refer to Figure 7-2 which shows the proper installation of the locks and locknuts on the piston rod end.

NOTE

It may be necessary to partially retract the gear to tighten locknuts.

k. Retract the gear and adjust the stroke control stop (52) actuator until the uplock bearing (54) clears the inside of the uplock hook (10) surface by 0.030 to 0.060 of an inch. Tighten the locknut on the stroke control stop. (Refer to Figure 7-8.)

l. Connect landing gear doors and adjust in accordance with paragraph 7-33.

CAUTION

Check all rod ends for adequate thread engagement.

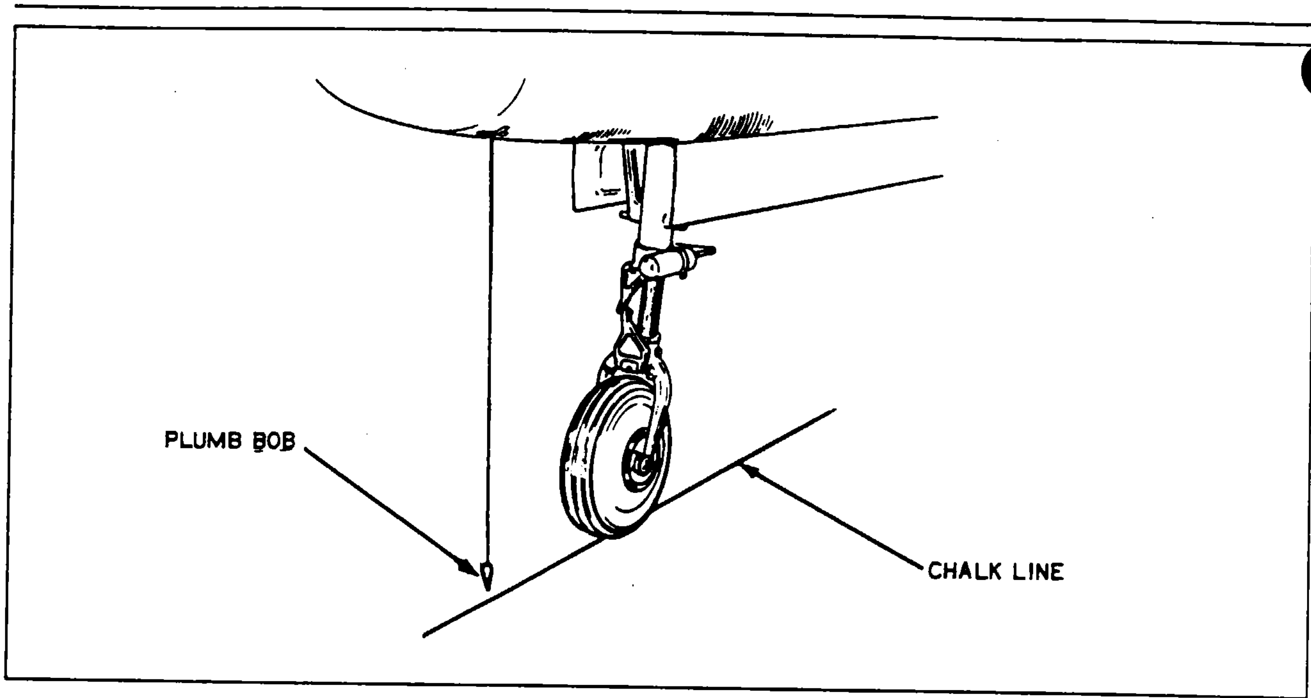

Figure 7-5. Aligning Nose Gear

7-13. ALIGNMENT OF NOSE LANDING GEAR.

a. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.

b. Place the airplane on jacks. (Refer to Jacking, Section II.)

c. Level airplane laterally and longitudinally. (Refer to Leveling, Section II.)

d. From the center of the tail skid, extend a plumb bob and mark the contact point on the floor.

e. Extend and attach a plumb bob from a point that is approximately 24 inches forward along the bottom-center row of rivets as measured from the wheel well opening. Mark the point of contact on the floor.

f. Using the two plumb bob marks as a guide, snap a chalk line, extending several feet beyond each mark.

g. Clamp the rudder pedals in neutral position. (Refer to Figure 7-3).

NOTE

Rudder control system must be properly rigged before aligning nose gear steering.

h. Adjust the rod end bearings of the steering rod to align the nose wheel with the chalk line. To align the nose wheel straight forward, stand in front of the nose gear and align the center rib of the tire with the chalk line or lay a straightedge along the side of the tire and parallel the straightedge with the chalk line. One end of the rod must be disconnected and jam nuts loosened to make this adjustment, but do not attempt to make the adjustment by means of one bearing, but divide the adjustment between the bearings at each end of the rod. Check that rod ends have sufficient thread engagement, reinstall rod and secure jam nuts. (Refer to Figure 7-6.)

i. To check nose gear steering for its 40 degree maximum right and left travel, mark on each side of the nose wheel a 40 degree angle line from centerline and wheel pivot point. Turn wheel to maximum travel in both directions to check for allowable travel. Should travel be exceeded in one direction and not enough in the other direction, check for possible damage to the gear fork, torque links or steering torque tube.

NOTE

To insure full travel of nose wheel, make sure no gaps exist at points where the steering arm travel bushings contact with the steering bellcrank. Make adjustment according to step j, paragraph 7-12.

7-14. REMOVAL OF NOSE GEAR DOOR ASSEMBLY.

a. To remove the gear door, disconnect the retraction rod at the door and remove the hinge bolts at each side of the wheel well.
b. To remove the door retraction mechanism, ascertain that the retraction rod is disconnected, disconnect the downlock spring and remove the snap ring that holds the retraction mechanism on its support shaft. Pull the retraction mechanism from the shaft.

7-15. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.
b. Inspect the door for cracks or bent skin, loose hinge brackets and worn or corroded bearings.
c. Check the retraction mechanism for worn downlock spring and worn or damaged surfaces.
d. Repair to the door assembly is limited to replacing hinge bearings or rivets and mechanism parts, minor skin repairs and repainting.

7-16. INSTALLATION OF NOSE GEAR DOOR ASSEMBLY.

a. To install the door retraction mechanism, position and bolt the unit in place and connect the downlock spring.
b. The gear door is installed by aligning the bracket bolt hole with the hinge, installing bolt assembly and securing. Attach and secure retraction rod.

7-17. ADJUSTMENT OF NOSE GEAR DOOR.

a. Ascertain that the nose landing gear has been properly adjusted.
b. With gear up and locked, close one door at a time and adjust door operating rods until bolts can be freely inserted. Shorten rods one full turn of rod end bearings. Do not install bolts.
c. Extend gear and install door operating rod bolts. Adjust "door open" stop bolts to allow door linkage to pass 0.060 to 0.120 inches through center.
d. Retract gear slowly and observe that all parts are operating satisfactorily.
e. If gear fails to remain retracted after cockpit handle returns to neutral, it will be necessary to readjust either or both of the following items until gear will lock up.
   1. Increase actuator stroke by turning out stroke control stop.
   2. Relieve door "pinch" by lengthening door operating rods.

7-18. REMOVAL OF NOSE GEAR STEERING MECHANISM. (Refer to Figure 7-6.)

a. Remove the left pilot seat and floor panel.
b. Remove the left access panel on the nose section of the aircraft.
c. Remove the lower radios and radio shelf.
d. Remove the oxygen bottle in accordance with instructions given in Section XIV.
e. Disconnect the steering cable turnbuckle (22) at station 96.0, also disconnect the rudder cable (14) at the outboard turnbuckle and at rudder pedal.
f. Remove the cable guard pins (16) around the pulley at stations 104.0 and 68.0.
g. Disconnect the steering cable ends (23) from the steering sector (2) and draw the cable out of the aircraft.
h. Disconnect the rod end bearings (5) of the steering tube assembly (8) from the arm (1) and the steering bellcrank (3) by removing the hardware.
i. Remove the steering tube assembly (8) from the aircraft.

WARNING

Do not remove the retainer clips from the tube assembly. This assembly is spring loaded and should be handled with care. Check lock wire to be sure it is holding the retainer clips in place.

NOTE

Do not rotate rod end bearings (5) unless meant as an adjustment to the nose gear steering.

j. Remove the arm (1), sector (2), shaft (13) and washer (11) at station 76.38 in the left rear portion of the nose wheel well.
k. To remove the two bracket halves (12), remove the hardware securing the brackets to the longitudinal beam of the aircraft.

7-19. CLEANING AND INSPECTION OF STEERING MECHANISM. If the push-pull tube should have to be removed from the airplane for any type of service, the following procedure and warning should be observed:

a. Ascertain that the nose wheel is centered.
b. Remove the nuts and bolts which secure the rod ends of the push-pull tube to the nose gear steering bellcrank and lever assembly.

WARNING

The push-pull tube assembly should be handled cautiously. If it is found to be defective or damaged in any way, it should be replaced with a new assembly. Under no condition should this part be disassembled. There are springs under compression located inside the tube and the locking clips should not be removed.

c. Install the push-pull tube with the rod toward the forward end of the airplane.
d. Secure the forward end of the push-pull tube to the nose gear steering bellcrank with bolt, washer, nut and cotter pin.
e. Secure the aft end of the push-pull tube to the lever assembly with bolt, washer, nut and cotter pin.
f. Inspect the nose gear steering cable. Refer to the latest revision of Piper Service Bulletin 372 and Figure 7-6.

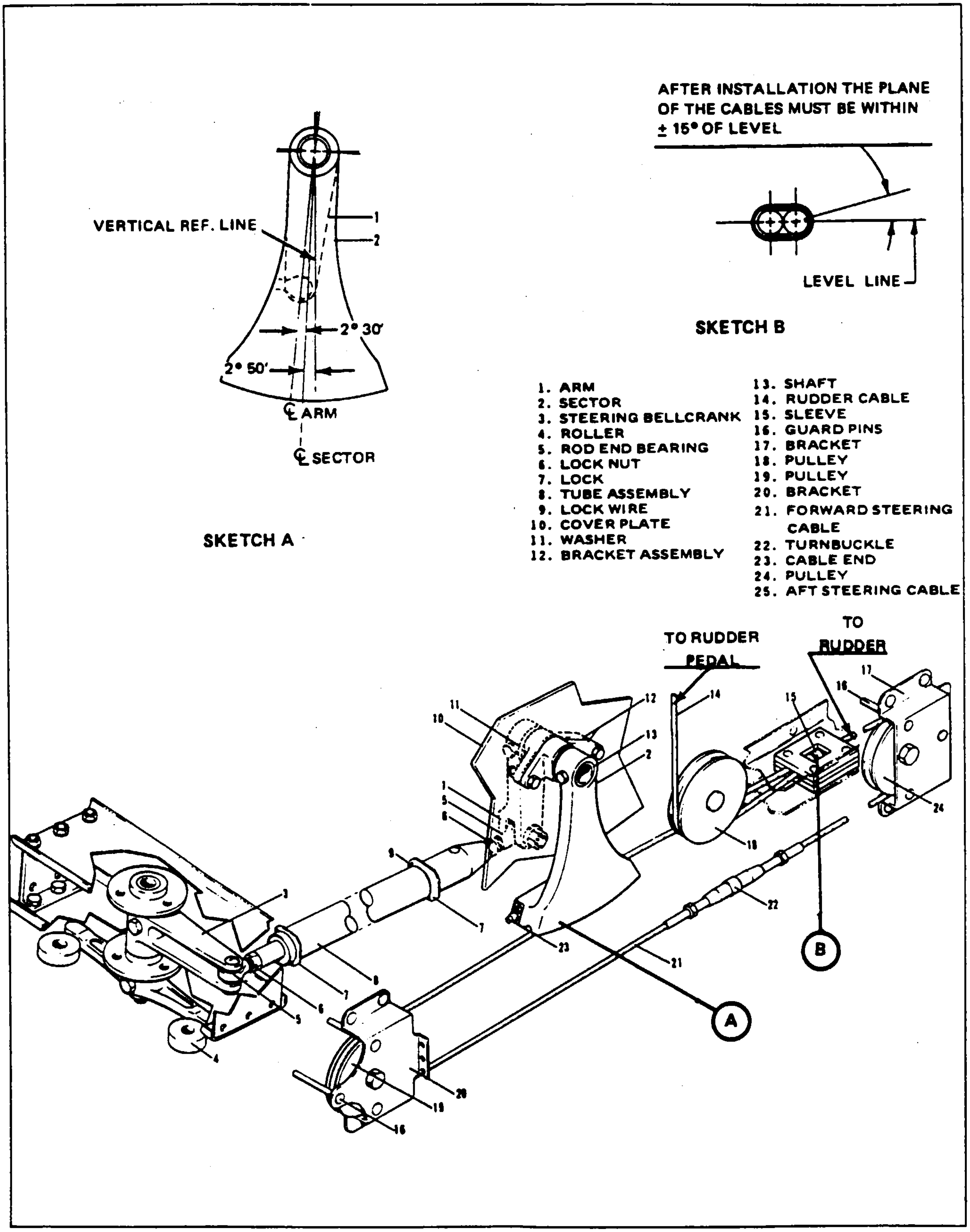

Figure 7-6. Nose Gear Steering Adjustment

7-20. INSTALLATION OF NOSE GEAR STEERING MECHANISM. (Refer to Figure 7-6.)

a. Install the bracket assembly (12) and secure with the hardware.
b. Assemble the arm (I) and shaft (13) if previously separated and secure with nut and bolt.
c. Install the shaft and arm into the bracket from the wheel well side of the longitudinal beam.
d. Install the sector (2) on the shaft, align the holes and secure with the bolt and nut.
e. Connect the forward steering cable (21) to sector (2) and route the cable around the pulley (19).
f. Connect aft steering cable (25) to sector (2) and route around pulley (24). Connect aft steering cable (25) to forward steering cable (21) at turnbuckle (22).
g. Route the rudder cable (14) around pulley (18) and connect at both ends (refer to Figure 5-9 Sketch A) by means of clevis bolt on the rudder pedal assembly end and turnbuckle on rudder cable end.
h. Rig the rudder (refer to Section V).
i. Adjust the cable tension on the steering cable to 25 lbs. Install all cable guard pins.
j. Adjust the steering tube assembly (8) rod ends to obtain 24.12 inches from the center of the rod end bearing on one end to the center of the rod end bearing on the opposite end.
k. Install the tube assembly (8) with the push pull rod end toward the nose. Connect the rod ends to the arm and nose gear steering lever with the bolts and nuts.
l. The nose gear alignment should also be checked in accordance with paragraph 7-13.
m. Replace the oxygen bottle in accordance with instructions in Section XIV.
n. Replace any radio equipment removed and install the nose section access panel.
o. Replace the access panel and seat removed from the pilots compartment.

7-21. MAIN LANDING GEAR SYSTEM.

7-22. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-7.) The main gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Place a drip pan under the main gear to catch spillage.
c. Remove the air and fluid from the oleo. (Refer to Oleo Struts, Section II.)
d. To remove the piston tube (22) assembly from the oleo housing (21), remove the upper and lower torque link connecting bolt assembly (32) and separate the links. Note the number and thickness of spacer washers (35) between the two links (31 and 33).
e. Compress the piston tube (22), reach up along the tube and release the retainer ring (15) from the annular slot at the bottom of the oleo housing (21).
f. Pull the piston tube (22) with component parts from the (housing) cylinder.

NOTE

Prior to removing the upper bearing (8) with retaining pins (7), from the piston tube (22), place a reference mark with a grease pencil, from the upper bearing to the piston tube. This will ensure proper indexing of parts upon reassembly.

g. The fork tube components may be removed by reaching in the tube and pushing out the upper bearing (8) retaining pins. Slide off the upper bearing (8), spacer (9), lower bearing (11) with "O" rings (10 and 12), wiper (13), washer (14) and retainer ring (15).
h. To remove the orifice tube (4) from the oleo housing, cut safety wire (39) and remove cap bolt (1) and washer (2) from top of the housing.
i. The orifice plate (5) is removed from the orifice tube by releasing the retainer ring (6) that holds the plate in position.

NOTE

Do not remove piston plug (17) from piston tube (22) or piston tube (22) from fork (24).

7-23. CLEANING, INSPECTION AND REPAIR OF THE MAIN GEAR OLEO.

The instructions for cleaning, inspection and repair of the main gear oleo are the same as those given for the nose gear oleo, paragraph 7-7.

7-24. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-7.)

a. Ascertain that all parts are cleaned and inspected.
b. To assemble and install the orifice tube (4) insert the orifice plate (5) into the bottom of the tube, with the countersunk side of the orifice hole exposed. Secure the plate with retainer ring (6). Lubricate and install the "O" ring (3) on the upper end of the tube. Insert the tube up through the bottom oleo housing (21). With the tube exposed through the top of the housing, install washer (2) and tighten cap bolt (1) finger tight.
c. The piston tube assembly may be assembled to the oleo housing (21) by first installing the tube components on the tube (22). In order slide onto the tube the retainer ring (15), washer (14), lower bearing (11) with inner (12) and outer (10) "O" rings, spacer (9) and upper bearing (8). Using the reference marks applied during disassemblys align the lock pin holes of the upper bearing (8) and tube (22) and install retainer pins(7).
d. Carefully insert the piston tube assembly into the oleo housing, guiding the orifice tube (4) into the piston tube until the retainer ring (15) can be installed in the annular slot at the lower end of the housing. Install wiper strip (13), slide washer (14) into position and secure assembly with retainer ring. At the top of the housing, tighten the cap bolt (1).
e. Install the upper and lower torque links (31 and 33). (Use same thickness spacer washers (35) between the two links as those removed to maintain correct wheel alignment.)
f. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)
g. Service the oleo strut with fluid and air (Refer to Oleo Struts, Section II.) and safety with MS20995C40 wire (39) between the filler plug (20) and cap bolt (1).
h. Check the gear alignment (Refer to paragraph 7-29.) and gear operation.

7-25. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7-8.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Remove the two access plates forward and two access plates aft of the outboard wheel door.
c. With the hand pump, retract the main gear slightly to relieve the gear from its downlocked position and to lower the inboard gear door (7) out of the way.
d. Disconnect brake line.
e. To remove side brace link assembly, the following procedure may be used:
   1. Disconnect the actuating cylinder (15) and downlock rod (23) from the upper side brace link arm (26) by removing clevis bolt (63). Disconnect the other end of the downlock rod at the downlock hook (34).
   2. Remove downlock hook (34) and spring (68) by removing pivot bolt (66).

2E22

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1. BOLT, ORIFICE TUBE
2. WASHER
3. O-RING, PACKING
4. TUBE, ORIFICE
5. PLATE, ORIFICE
6. RING, RETAINER
7. PIN, RETAINER
8. BEARING, UPPER
9. SPACER
10. O-RING, GASKET
11. BEARING, LOWER
12. O-RING, PACKING
13. WIPER STRIP
14. WASHER
15. RING, RETAINER
16. O-RING, PACKING
17. PLUG
18. GREASE FITTING
19. VALVE, AIR
20. PLUG, FILLER
21. HOUSING, OLEO
22. TUBE, PISTON
23. BOLT ASSEMBLY
24. FORK
25. PIN, COTTER
26. NUT, AXLE
27. BOLT ASSEMBLY
28. PIN, COTTER
29. BOLT ASSEMBLY
30. BEARING, UPLOCK
31. TORQUE LINK, LOWER
32. BOLT ASSEMBLY
33. TORQUE LINK, UPPER
34. BOLT ASSEMBLY
35. WASHER, SPACER
36. CONTACT, SAFETY SWITCH
37. BUSHING
38. PLACARD, SERVICE
39. SAFETY WIRE
40. SCREW
41. AXLE

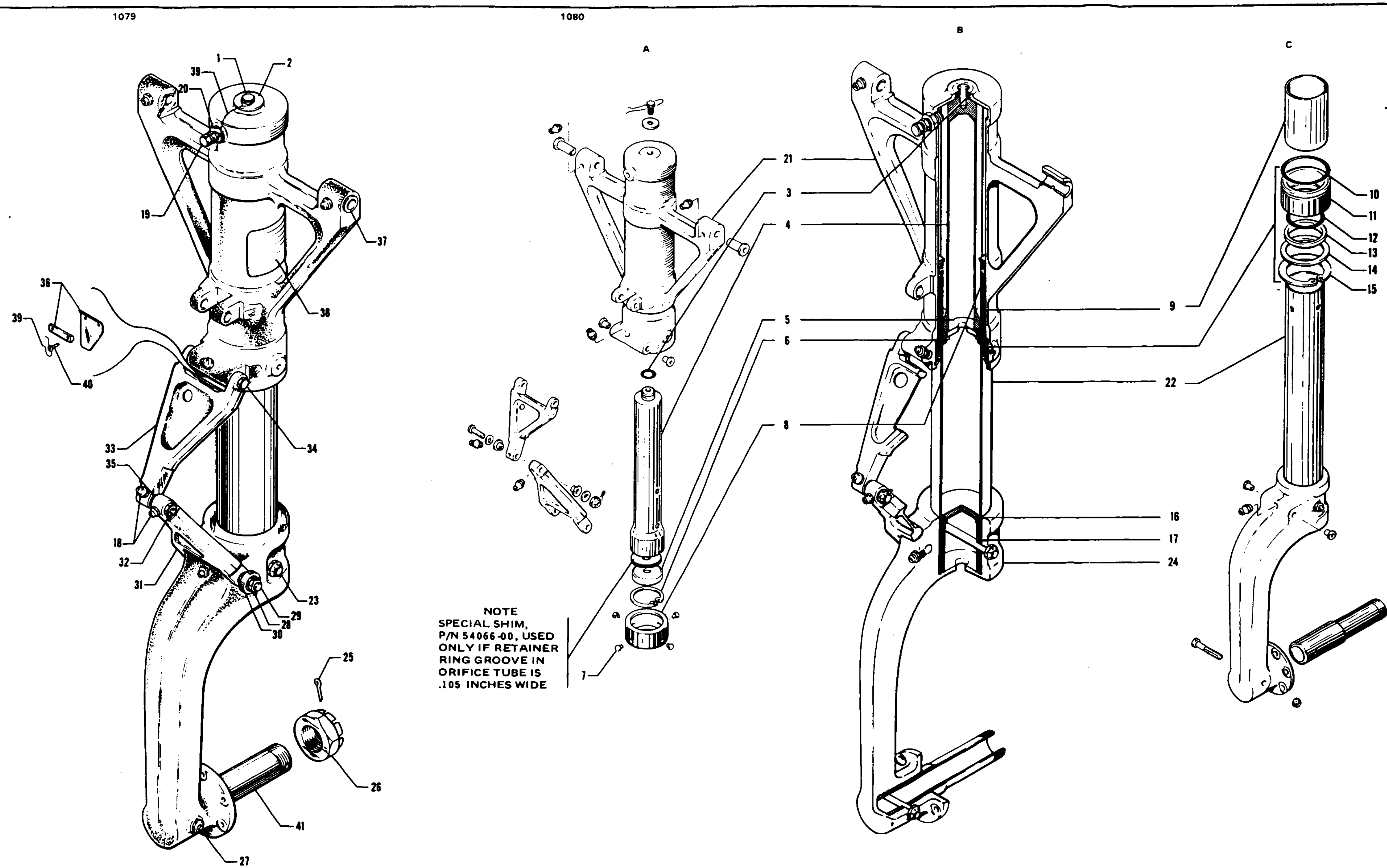

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Figure 7-7. Main Gear Oleo Strut Assembly

3. Remove the downlock switch bracket (33) with switch (32) by removing the four screws that attach the bracket between the forward and aft side brace links (31 and 31). Remove the clamps that secure the electrical wiring to the side brace link.
4. Disconnect the lower side brace link (35) from the gear oleo housing (40) and let the link assembly swing down.
5. Remove the bolt (67) that connect the upper and lower side brace links.
6. Disconnect the aft link (36) from its attachment plate.
7. To remove the forward link (31), remove the nut with washers that is holding the link on its pivot shaft (28). Slide the link from the pivot shaft.
8. The pivot shaft (28) may be removed by reaching through the pivot shaft bracket access hole, removing the bolt securing the shaft to the shaft fitting (29). Slide the tube through the attachment bracket (27). The shaft fitting (29) is attached with cap bolts, washers and anchor nuts.

f. Disconnect the outboard gear door retraction rods (54) at the gear housing (40). With the lower side brace link (35) disconnected from the housing, the gear may be removed by removing the attachment bolt assemblies at the attachment plates (37 forward) on each side of the gear housing. Note, if any, the number and location of spacer washers between the gear housing and attachment plates.
g. The uplock hook (11) and spring (9) may be removed by disconnecting the uplock rod (14) from the hook and then the hook pivot bolt.
h. The uplock rod (14) may be removed by disconnecting the rod at the lock crank (21).
i. The landing gear and upper drag link attachment plates may be removed by reaching through the access holes to the nuts that secure the plates. While holding the nuts with a wrench, remove the attachment bolts.

7-26. CLEANING, INSPECTION AND REPAIR OF MAIN LANDING GEAR.

a. Clean all parts with a suitable cleaning solvent.
b. Inspect bolts, bearings, bushings and ball joints for excess wear, corrosion and damage.

—WARNING—

Refer to latest revision of Piper Service Bulletin 845 for specific inspection/replacement instructions for the Main Landing Gear Forward Side Braces. Piper considers compliance with service bulletins mandatory.

c. Inspect the gear housing, side brace links, idler links, rods and attachment plates for cracks, bends or misalignment.
d. Inspect lock hook for wear and oversized bearing surfaces.
e. Inspect the lock hook spring for the following:
   1. Excess wear or corrosion, especially around the hook portion of the springs. A spring should be rejected if wear or corrosion exceeds one-quarter the diameter of the spring. Clean away all corrosion and repaint the springs.
   2. Check the lock hook springs for load tensions below the minimum allowable tolerances. The minimum tension for the uplock hook spring is 4 pounds, and the minimum tension for the downlock hook spring is 7 pounds. These checks are performed by fastening a fish type scale to the particular hook and spring and pulling against the hook and spring to get a reading on the scale.
f. Inspect the uplock roller for freedom of movement and minimum wobble.
g. Inspect the lock rod sliding surfaces for corrosion and freedom of movement.
h. General condition of limit switches and wiring for fraying, poor connections or conditions that may lead to failures.
i. Attach the upper and lower drag links and check that when stop surfaces of the two links contact, linkage is 0.063 to 0.156 inch through center. (Refer to Figure 7-8.) Should this distance exceed the required through center travel and all bolts and bushings are tight, replace one or both side brace links.
j. Repair of the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

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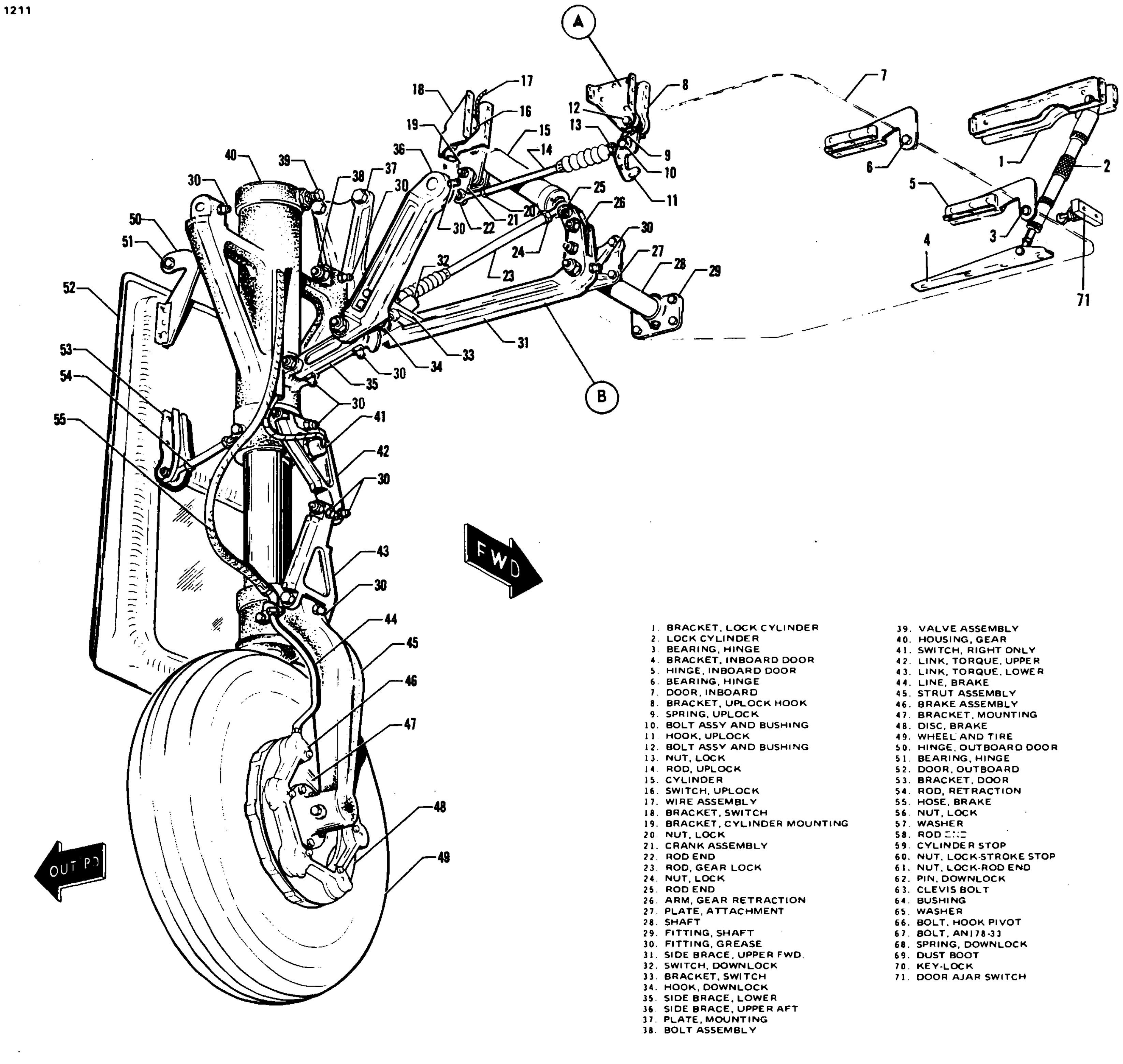
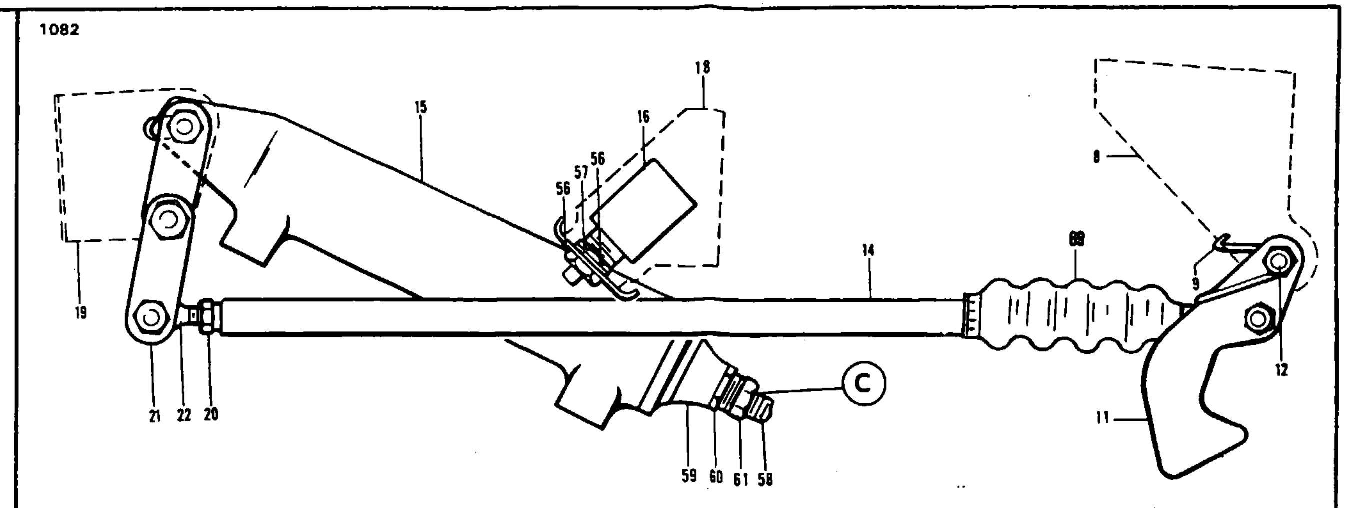
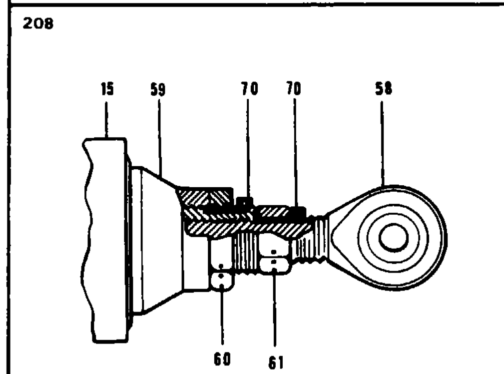




SKETCH A



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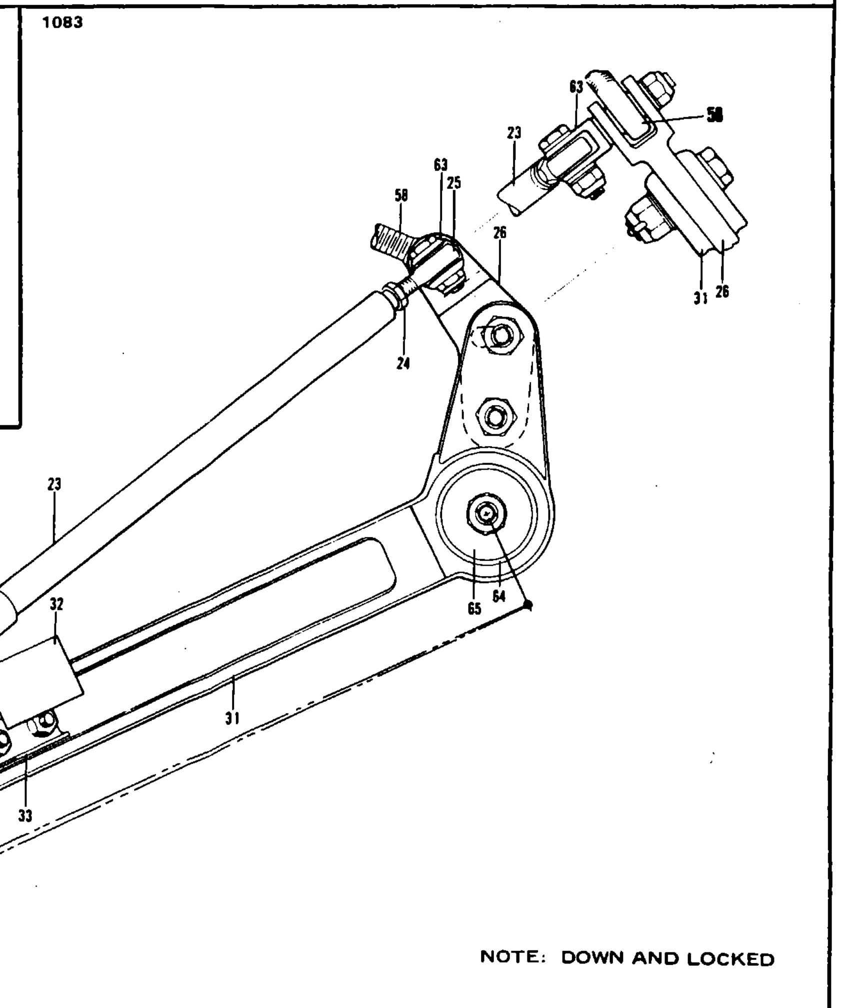

SKETCH B

1. BRACKET, LOCK CYLINDER
2. LOCK CYLINDER
3. BEARING, HINGE
4. BRACKET, INBOARD DOOR
5. HINGE, INBOARD DOOR
6. BEARING, HINGE
7. DOOR, INBOARD
8. BRACKET, UPLOCK HOOK
9. SPRING, UPLOCK
10. BOLT ASSY AND BUSHING
11. HOOK, UPLOCK
12. BOLT ASSY AND BUSHING
13. NUT, LOCK
14. ROD, UPLOCK
15. CYLINDER
16. SWITCH, UPLOCK
17. WIRE ASSEMBLY
18. BRACKET, SWITCH
19. BRACKET, CYLINDER MOUNTING
20. NUT, LOCK
21. CRANK ASSEMBLY
22. ROD END
23. ROD, GEAR LOCK
24. NUT, LOCK
25. ROD END
26. ARM, GEAR RETRACTION
27. PLATE, ATTACHMENT
28. SHAFT
29. FITTING, SHAFT
30. FITTING, GREASE
31. SIDE BRACE, UPPER FWD.
32. SWITCH, DOWNLOCK
33. BRACKET, SWITCH
34. HOOK, DOWNLOCK
35. SIDE BRACE, LOWER
36. SIDE BRACE, UPPER AFT
37. PLATE, MOUNTING
38. BOLT ASSEMBLY
39. VALVE ASSEMBLY
40. HOUSING, GEAR
41. SWITCH, RIGHT ONLY
42. LINK, TORQUE, UPPER
43. LINK, TORQUE, LOWER
44. LINE, BRAKE
45. STRUT ASSEMBLY
46. BRAKE ASSEMBLY
47. BRACKET, MOUNTING
48. DISC, BRAKE
49. WHEEL AND TIRE
50. HINGE, OUTBOARD DOOR
51. BEARING, HINGE
52. DOOR, OUTBOARD
53. BRACKET, DOOR
54. ROD, RETRACTION
55. HOSE, BRAKE
56. NUT, LOCK
57. WASHER
58. ROD END
59. CYLINDER STOP
60. NUT, LOCK-STROKE STOP
61. NUT, LOCK-ROD END
62. PIN, DOWNLOCK
63. CLEVIS BOLT
64. BUSHING
65. WASHER
66. BOLT, HOOK PIVOT
67. BOLT, AN178-33
68. SPRING, DOWNLOCK
69. DUST BOOT
70. KEY-LOCK
71. DOOR AJAR SWITCH

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Figure 7-8. Main Landing Gear Installation (Left)

7-27. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7-8.)

NOTE

When assembling any units, lubricate bearings and friction surface with proper lubricant as described in Section II.

a. Position the attachment plates of the landing gear housing and upper drag links and bolt in place.
b. The uplock hook (11) may be installed by the following procedure:
   1. Place the "U" end of the uplock spring (9) over the back of the hook with the loops also toward the back.
   2. Spread the spring and fit the loops over the bushing that extends through the hook.
   3. Slide the hook inboard through the bracket until the bracket hole aligns with the bolt hole in the hook.
   4. Install the pivot bolt and tighten so the hook will rotate freely, yet without side play.
c. Attach the uplock rod (14) with the sliding end attached to the hook (11) and the other end to the crank fitting (21).
d. To install the main gear housing assembly, position the gear so that the attachment points on the housing align with the attachment plates (37 forward). If needed, install spacer washers between attachments to allow a minimum amount of end play. Tighten nut on each pivot bolt to a snug fit, allowing the gear to swing free, and safety.
e. The upper and lower side brace link assembly may be installed by the following procedure:
   1. Install the forward upper link pivot tube attachment fitting (29) to the spar and secure with cap bolts.
   2. Slide the pivot shaft (28) through the attachment plate (27) and into the attachment fitting (29). Secure the pivot shaft to the attachment fitting.
   3. Ascertain that the forward upper arm (26) is installed on the link (31). Install the link (31) on the pivot shaft and secure with washers and nut.
   4. The aft upper drag link (36) may be installed by sliding the link on the aft attachment plate pivot bolt. Tighten the nut to allow the link to swing free with no side play and safety.
   5. Position the lower link (35) between the upper drag link ends, install bolt assembly and tighten to allow the link to turn free with no side play.
   6. Attach the lower drag link (35) to the landing gear housing (40), secure and safety. Move the gear in and out of the downlock position several times to determine that there is no binding.
f. Position the downlock switch bracket (33) between the forward and aft upper drag links and bolt in place.
g. The downlock hook (34) may be installed on the drag link assembly by the following procedure:
   1. Place the "U" end of the downlock spring (68) over the back of the hook (34) with the loops also toward the back.
   2. Spread the spring and fit the loops over the bushing that goes through the hook.
   3. Insert the ends of the spring into holes located in the downlock switch bracket (33) on each side of the drag link assembly. Push the hook down between the two upper drag links until the bolt holes in the links align with the bushing hole of the hook.
   4. Insert the pivot bolt and on each side of the bushing install spacer washers to maintain a minimum amount of side play. Secure bolt and safety.
h. The downlock rod (23) may be installed by bolting the sliding end of the rod to the downlock hook and the other end to the upper drag link arm, at the same time attaching the landing gear actuating cylinder (15).
i. Lubricate the landing gear assembly. (Refer to Lubrication, Section II.)
j. Check the main gear adjustment, operation and alignment.

7-28. ADJUSTMENT OF MAIN LANDING GEAR. (Refer to Figure 7-8.)

a. With the airplane on jacks and the gear extended, disconnect the inboard and outboard gear door operating rods and keep the doors in the open position.
b. Disconnect the downlock operating rod (23) from the downlock hook (34).
c. The through center adjustment of the side brace links is accomplished as follows:
   1. Maintain the gear in the downlocked position and both stop surfaces of the side brace links touching.
   2. Ascertain that the linkage is 0.063 to 0.156 of an inch through center.
   3. If one side of the stop surfaces does not touch, it can be filed to obtain the desired through travel.
   4. If filing brings the through travel beyond the 0.156 inch tolerance then a link or links must be replaced.

NOTE

A fabricated tool may be constructed to check through center travel of the side brace link assembly while the links are installed. (Refer to Figure 7-21.)

d. Use the fabricated tool in the following procedure:
   1. The gear is down and locked with no hydraulic pressure on the system.

NOTE

The airplane may be either on or off jacks.

   2. Remove the cotter pins that safety the nuts that secure both upper side brace links to their attachment plates.

NOTE

On the right gear only, remove the pin at the nut that secures the lower link to the gear housing. Do not remove the nuts.

   3. Place the tool tube through the elongated hole in the tool plate and place the tube over and between the upper link attachment nuts.
   4. Swing the plate up and against the head of the bolt that connects the upper and lower links. The plate sleeve slides over the nut or the head of the bolt that connects the lower link to the gear housing.
   5. Look through the sight hole in the plate to ascertain that the center of the bolt is 0.062 to 0.156 of an inch below the centerline on the plate.
   6. Remove the tool and reinstall the cotter pins.

e. Operate the downlock hook (34) by hand to determine that it engages freely and then open and close the joint several times to assure that the hook is operating properly.
f. If the hook operates properly, determine proper clearance between the hook (34) and pin (62) by engaging the hook and pushing up on the side brace link assembly, where the upper and lower links hinge, until the hook is tight against the pin. This will allow the link stops to separate. Clearance between the stops should not exceed 0.020 of an inch. If clearance exceeds 0.020 of an inch and pin is not worn and the link through travel is within limits, then hook must be replaced.
g. If hook will not clear pin, file inside surface of hook until minimum clearance is reached between the link stops as indicated in paragraph "f". Be careful to maintain the new surface parallel with the original surface. Replace pin if worn.

CAUTION

Do not file pin.

h. To replace pin (62), cut the pin, file off any burrs left by the cut and drive the pin out from each side. Do not try to drill the pin out as this may damage the link. Install new pin and flange.
i. With the downlock hook engaged, pull the retraction arm (26) located at the top of the forward side brace towards the downlock hook to the limits of its travel. Also pull the downlock operating rod (23) out to its full length and adjust the rod end until the hook bolt can be freely inserted through the hook lugs.
j. Remove the bolt and extend the rod end one full turn, tighten the locknut and install the attaching bolt.
k. To adjust the uplock hook (11) use the following procedure, and put the airplane on jacks.
   1. Disconnect the uplock operating rod (14) from the hook.
   2. Retract the gear, being careful to keep the rod clear of moving parts.
   3. As the uplock roller approaches the hook, operate the hook by hand until the roller is engaged.
   4. Determine that the actuator cylinder (15) and crack attaching bolt are outboard in the slots of the attachment bracket (19).

NOTE

This may also be obtained with the actuator (15) attached to the retraction arm (26) and pressure maintained on the actuator.

   5. Pull the uplock rod (14) out to its full length and adjust the rod end until the attaching bolt can be freely inserted. Remove the bolt and turn the rod end out one full turn and install bolt and spacer bushing. Tighten the locknut on the rod end.
   6. Reinstall the dust boot (69) after the uplock rod is completely adjusted.

l. Adjust the gear actuator rod end (58) until the uplock roller clears inner hook surface when the piston is bottomed.

NOTE

Bottom the piston with hydraulic pressure. It may require several adjustments to attain this dimension because of deflection in the linkage.

CAUTION

When installing the fork bolt in the actuator rod end be sure that the forked end is properly aligned with the downlock operating rod.

m. Extend gear and as side braces approach the locked position, apply a side force to the wheel so that the hydraulic actuator must force the linkage into the locked position.
n. Adjust the stroke control stop (59) on the lower end of the actuator to stop the piston travel at this point. Repeat several times to determine that the stroke control is properly adjusted.
o. Back off the stroke stop one-half turn and tighten locknut on stop. Place the key locks (70) between the locknut (60 or 61) and the keyway in the rod. Screw the locknut on the rod and keep the key lock centered in the keyway while tightening the locknut. With the locknut torqued, install the lock wire

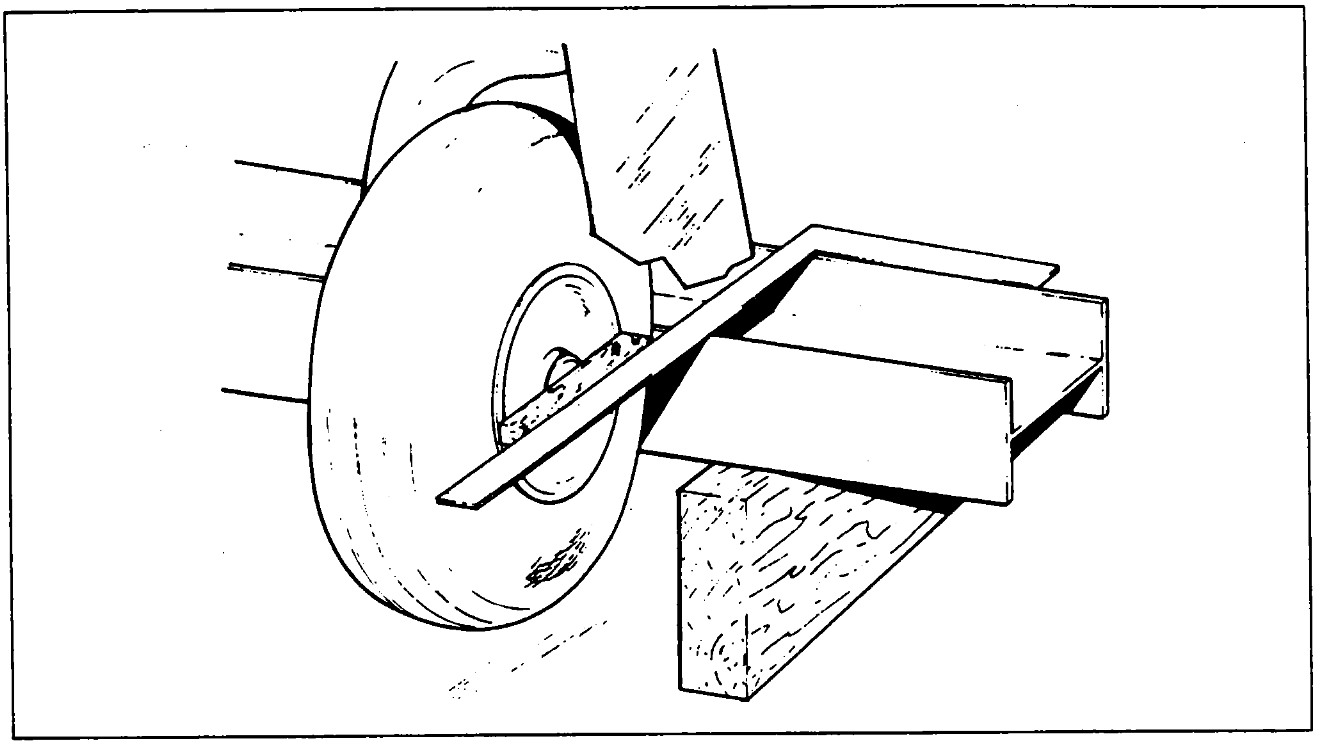

Figure 7-9. Aligning Main Gear

from the key lock (70) to the locknut. Refer to Figure 7-2, which shows the proper installation of the locks and locknuts on the piston rod end.

CAUTION

Be sure that all rod ends have sufficient gripping thread by determining that a wire will not go through the check hole in the rod.

7-29. ALIGNMENT OF MAIN LANDING GEAR. The following steps should be completed prior to checking and/or adjusting main wheel alignment:

a. Ascertain that the airplane is parked on a level surface.
b. The full weight of the airplane must be on the landing gear.
c. Roll the airplane a minimum of two main wheel revolutions by the use of the tow bar. Move the airplane in a straight line. This will stabilize the landing gear position.
d. Place a straightedge no less than fifteen feet long across the front of both main landing gear wheels. Butt the straightedge against the tires at the hub level of the landing gear. Ascertain that the straightedge is the same distance from the forward side of the axle hubs. Devise a support to hold the straightedge in position. (Refer to Figure 7-9.)
e. Fabricate a spacer block per dimensions given in Figure 7-22, and place this spacer block against the wheel rim at the hub line, with the wide end of the spacer towards the front of the wheel. (Refer to Figure 7-9.)

NOTE

The fabricated spacer block has been laid out to give the proper toe-in of .5 degrees.

f. Set a square against the straightedge and spacer block, and check to see if its outstanding leg be against the spacer block.

NOTE

A carpenter's square, because of its especially long legs, is recommended for checking the main landing gear wheel alignment.

g. If a gap appears at the rear, between the block and square, the wheel is toed-out and must be realigned. If a gap appears at the forward end, between the block and the square, the wheel has too much toe-in and must be realigned to get .5 degree toe-in.

h. To correct toe-in or toe-out conditions, remove the bolt connecting the upper and lower torque links and remove or add spacer washers to move the wheel in the desired direction and reinstall the bolt.

i. Recheck wheel alignment. If alignment is correct, safety the castellated nut with a new cotter pin. If the misalignment still exists, separate the torque links and add or remove a spacer washer. Limit the number of spacers installed to allow for installation of the cotter pin in the bolt.

7-30. REMOVAL OF MAIN GEAR DOOR ASSEMBLY.

a. To remove the outboard gear door, disconnect the retraction rods from the door and remove the hinge bolts.

b. To remove the inboard gear door, place the airplane on jacks and retract the gear enough to allow the door to open. Disconnect the actuating cylinder rod and remove hinge bolts.

7-31. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect the outboard or inboard doors for cracks or bent skin. Loose hinge brackets and worn or corroded bearings.

c. Repair to the door assemblies is limited to replacing hinge bearing, brackets or rivets, minor skin repairs and painting.

7-32. INSTALLATION OF MAIN GEAR DOOR ASSEMBLY.

a. The inboard gear door is installed by aligning the hinge bracket holes with the bearings, installing bolt assembly and securing. Install the actuating cylinder rod to the door.

b. The outboard gear door is installed by aligning the hinge bracket holes with the bearings, installing bolt assemblies and securing. Attach the actuating rods between the door and landing gear housing.

7-33. ADJUSTMENT OF MAIN LANDING GEAR DOORS.

a. Ascertain that the main landing gear has been properly adjusted.

b. Adjust outboard door rods to their maximum length and bolt to the bosses on the gear housing. Retract gear and observe the amount of gap. Shorten rods by several turns of the rod ends and retract gear again. Repeat until door closes properly.

CAUTION

Damage to the door may result if rods are too short.

c. Adjust inboard door using same procedure as used for outboard door.

NOTE

Should it be necessary to fit new doors or refit the present doors, maintain a gap of approximately 0.062 of an inch, except at the hinge side, between the door and the skin surface of the wing. A gap of approximately 0.093 of an inch should be maintained at the hinge side of the door.

7-34. REPLACEMENT OF WIPER STRIP ON LANDING GEAR STRUTS.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Jack the airplane only high enough to take weight off the gear.
c. Release the air pressure from the strut by depressing the valve core pin until the pressure has diminished.
d. Using snap ring pliers, disengage the snap ring from the annular slot in the oleo housing and allow it to lay at the lower end of the piston tube along with the wiper strip retainer washer.
e. Remove the old wiper strip from the housing, and clean and inspect the housing to determine that no pieces remain in it.
f. Wipe the piston tube and check it for any abrasions which may damage the new wiper. Polish the tube to remove any abrasions found.
g. A new wiper strip should be cut with a 30 degree bevel), a little longer than needed, to circle the piston tube.
h. Insert the new wiper strip up into the oleo housing with the tapered edge down. Slide the retainer washer and snap ring up the piston tube and insert them into the oleo housing. Using snap ring pliers to compress the snap ring, install it into the annular slot in the oleo housing.
i. Inflate the oleo strut in accordance with instructions given in Oleo Struts, Section II, and remove the airplane from the jack.

7-35. LANDING GEAR LIGHT SWITCHES.

7-36. ADJUSTMENT OF NOSE GEAR UP LIGHT SWITCH.

a. Ascertain that the nose landing gear uplock is properly adjusted.
b. Retract gear fully and ascertain that the uplock roller is engaged and resting against the uplock hook. (No pressure on hydraulic system.)
c. Adjust the gear uplock switch toward the hook until it actuates. The red indicator light in cockpit should go out.

NOTE

Main gear up switches must be actuated also to extinguish red light.

d. Extend and retract to ascertain proper adjustment.

7-37. ADJUSTMENT OF NOSE GEAR DOWN LIGHT SWITCH.

a. Ascertain gear is properly adjusted for downlock position.
b. With gear down and locked, adjust gear down switch toward the link until it actuates. The green indicator in cockpit should come on.
c. Check switch operation by partially retracting and extending gear several times.

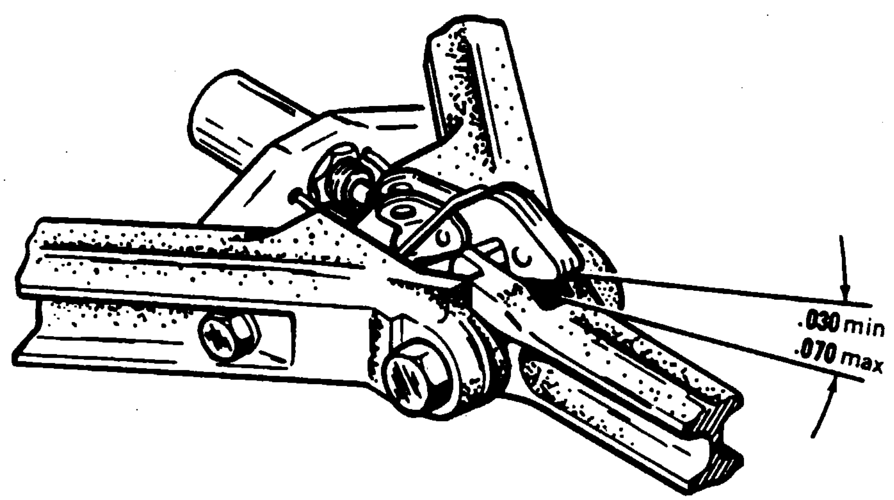

Figure 7-10. Adjusting Main Gear Down Limit Switch

7-38. ADJUSTMENT OF MAIN GEAR UP LIGHT SWITCH.

a. Ascertain that the main landing gear uplock is properly adjusted.
b. Retract gear fully and ascertain that the uplock roller is engaged and resting on the uplock hook. (No pressure on hydraulic system.)
c. Adjust the gear uplock switch toward the link until it actuates. The amber indicator light in cockpit should go out.

NOTE

Opposite main gear switch and nose gear switch must be actuated also to extinguish amber light.

d. Extend and retract gear to ascertain proper adjustment.

7-39. ADJUSTMENT OF MAIN GEAR DOWN LIGHT SWITCH. (Refer to Figure 7-10.)

a. Ascertain that the main landing gear downlock is properly adjusted.
b. With the gear down and locked, the green indicator light in the cockpit should come on when the downlock hook is lowered to within 0.030 to 0.070 of an inch of bottoming in the hook slot of the lower side brace link. The following check and adjustment may be accomplished:
   1. By hand, raise the downlock hook until the downlock switch is heard to actuate (click).
   2. With hook raised, place a 0.070 of an inch wire feeler gauge between the hook and bottom surface of the slot in the side brace link. (Refer to Figure 7-10.)
   3. Lower the hook, allowing it to rest on the feeler gauge. (The end of the gauge should be even with the lock pin.) The switch should not be heard to actuate.
   4. Again raise the hook, allowing the switch to actuate, and place a 0.030 gauge in the slot of the side brace link.

1. LEVER, L. THROTTLE
2. LEVER, R. THROTTLE
3. ACTUATOR, L. THROTTLE
4. ACTUATOR, R. THROTTLE
5. SCREW, ADJUSTMENT
6. BRACKET, MOUNTING
7. SCREW, ADJUSTMENT
8. BRACKET, MOUNTING
9. SWITCH, HORN
10. SPACER BLOCK
11. SWITCH, HORN
12. SPACER BLOCK
13. SPRING, TENSION

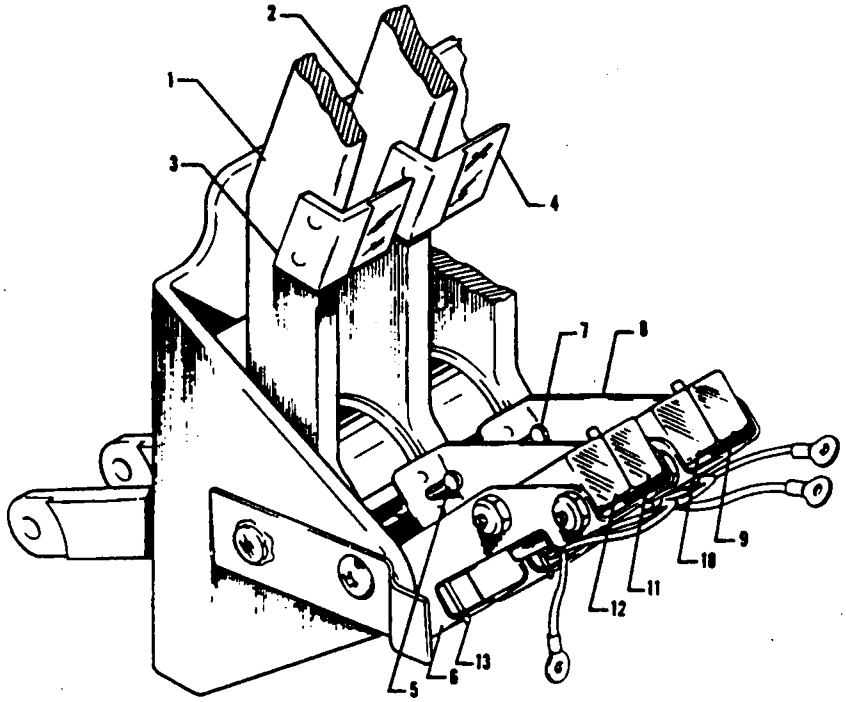

Figure 7-11. Gear Warning Switches Installation

5. Lower the hook. The switch should actuate allowing the green indicator light in the cockpit to come on.
6. When lowering hook, if the switch actuates too soon, adjust the switch toward the hook. If it actuates too late, adjust the switch away from the hook.

7-39a. ADJUSTMENT OF MAIN INBOARD GEAR DOOR AJAR SWITCHES.

a. Ascertain Main Inboard Gear Doors are adjusted properly.
b. With master switch off, actuate the hand pump to bring gear doors down.
c. Disconnect the actuator cylinder rod from the doors so they hang free.
d. Locate the switch by adjusting the retainer nuts so that when the door is closed by hand, a click can be heard approximately one inch before the door is completely closed.

CAUTION

Avoid extreme outward adjustment that would cause the switch mounting tab to bend back when the door is closed, resulting in damage to the switch unit.

NOTE

An ohmmeter or continuity tester can be used to indicate switch actuation.

e. Install the actuator cylinder rod to the door.
f. Turn master switch ON and with gear selector in down position, actuate the hand pump until the door closes.

7-40. ADJUSTMENT OF LANDING GEAR SAFETY SWITCH. The landing gear safety switch, located the left main gear upper torque link, is adjusted so that the switch is actuated at the last .25 ± .13 of an inch of gear extension.

a. Compress the strut until nine inches is obtained between the top of the gear fork and the bottom of the gear housing. Hold the gear at this measurement.
b. Adjust the switch down until it actuates at this point. Secure the switch.
c. Extend and then compress the strut to ascertain that the switch will actuate at the last quarter, plus or minus one eighth, of an inch of oleo extension.

7-41. LANDING GEAR WARNING SYSTEM.

7-42. REMOVAL OF GEAR WARNING SWITCHES. (Refer to Figure 7-11.) The gear warning switches are located within the control pedestal, directly under the throttle controls. Each switch will actuate the warning horn.

a. The switches may be removed from their mounting brackets by the following procedure:
   1. Remove the top cover plates of the pedestal, one of which is forward of the control levers, the other surrounds the levers, by removing their attachment screws.
   2. Remove the switch from its mounting bracket by removing the two screws that secure either switch and spacer block. First remove the nut from each screw, and allow the bracket of the other switch and spacer block to swing full forward by turning the adjustment screw counterclockwise. Pull aft on the switch bracket to be removed and push out the attachment screws.
   3. Disconnect the necessary electrical leads.
b. The switch mounting brackets may be removed by removing the control lever assembly as follows:
   1. Disconnect the engine control cables from the control levers by removing the-connecting clevis pins.
   2. Remove the flush head screw at each side of the pedestal housing.
   3. Remove the friction knob with washer from the right side of the pedestal.
   4. Remove the cap bolts that secure the frame.
   5. Pull the assembly from the pedestal housing.
   6. Remove the control keeper tube that holds the switch brackets in the control frame by removing the tube attachment screws from each side of the frame.

7-43. INSTALLATION OF GEAR WARNING SWITCHES. (Refer to Figure 7-11.)

a. The switch mounting brackets, as part of the control lever assembly, may be installed as follows:
   1. Assemble the mounting brackets (switches and spacer blocks may be installed with mounting brackets), tension springs and spacer washers in the control frame and secure with keeper tube. Secure keeper tube in frame.
   2. Install control lever assembly in the pedestal housing and secure with cap bolts and screws.
   3. Install the friction knob with washer on the end of the lever shaft at the right side of the pedestal.
   4. Connect the engine control cables to their respective levers using clevis pins. Place washer on ends of clevis pins and secure cotter pins.
b. The switches may be installed on their mounting brackets by the following procedure:
   1. Connect the electrical leads to their respective switch terminals. (Refer to Electrical System Schematic, Section XI, for wire installation.)
   2. Place the switch and spacer block in its mounting bracket and install attachment screws. It will be necessary to swing the bracket of the other switch and spacer block forward to install the attachment screws. Install nuts on the screws and secure.
   3. Position the pedestal cover plates on the pedestal, install screws and secure.
   4. Adjust the switches per paragraph 7-44.

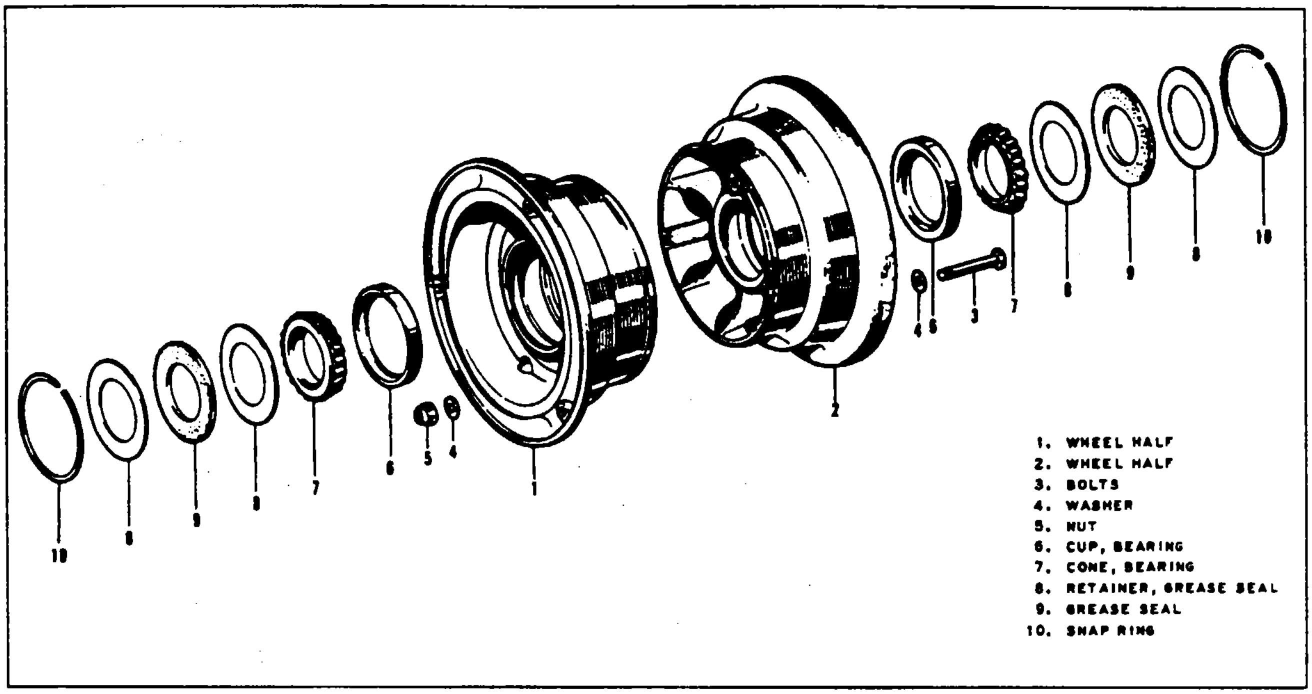

Figure 7-12. Nose Wheel Assembly

7-44. ADJUSTMENT OF GEAR WARNING SWITCHES. The gear warning horn switches are installed in the control pedestal, with each controlled by a throttle lever. Each switch actuates the warning horn when either or both throttles are reduced below 10 to 12 inches of manifold pressure. The following is a procedure for the adjustment of the gear warning switches:

a. Ground Adjustment:
   1. Start and run the engines with the propeller set for full increase RPM.
   2. To set the throttle switches to actuate at a desired throttle setting, retard the throttles until approximately five inches of manifold pressure is indicated above the desired in-flight pressure. Mark the throttle cover in some manner in relation to the throttle levers for the adjustment of the gear up warning horn switches.
   3. Shut down the engines.
   4. Set the throttle at the locations marked. With the adjustment screw on the switch bracket, adjust each switch separately toward the actuator angle until the switch is heard to actuate. (On airplanes with an inactive switch, substituting for spacer block, adjust until the active switch is heard to actuate.) The adjustment screw may be reached by inserting a long screwdriver through the travel slot of the throttle lever in the pedestal cover.
b. Horn Operational Check:
   1. To check the horn operation, jack the airplane and retract the landing gear. With the master switch on, retard either throttle until the gear up indicator horn sounds. Check the location of the throttle to the adjusting mark. The warning horn will operate when either or both throttles are retarded.
   2. With the warning horn operating, lower the gear to insure that the horn ceases to operate when the gear is down and locked.
   3. Remove the airplane from the jacks.
c. Flight Adjustment:
   1. Flight test the airplane to insure operation of the warning system when the gear is up and power is reduced to the desired manifold pressure.

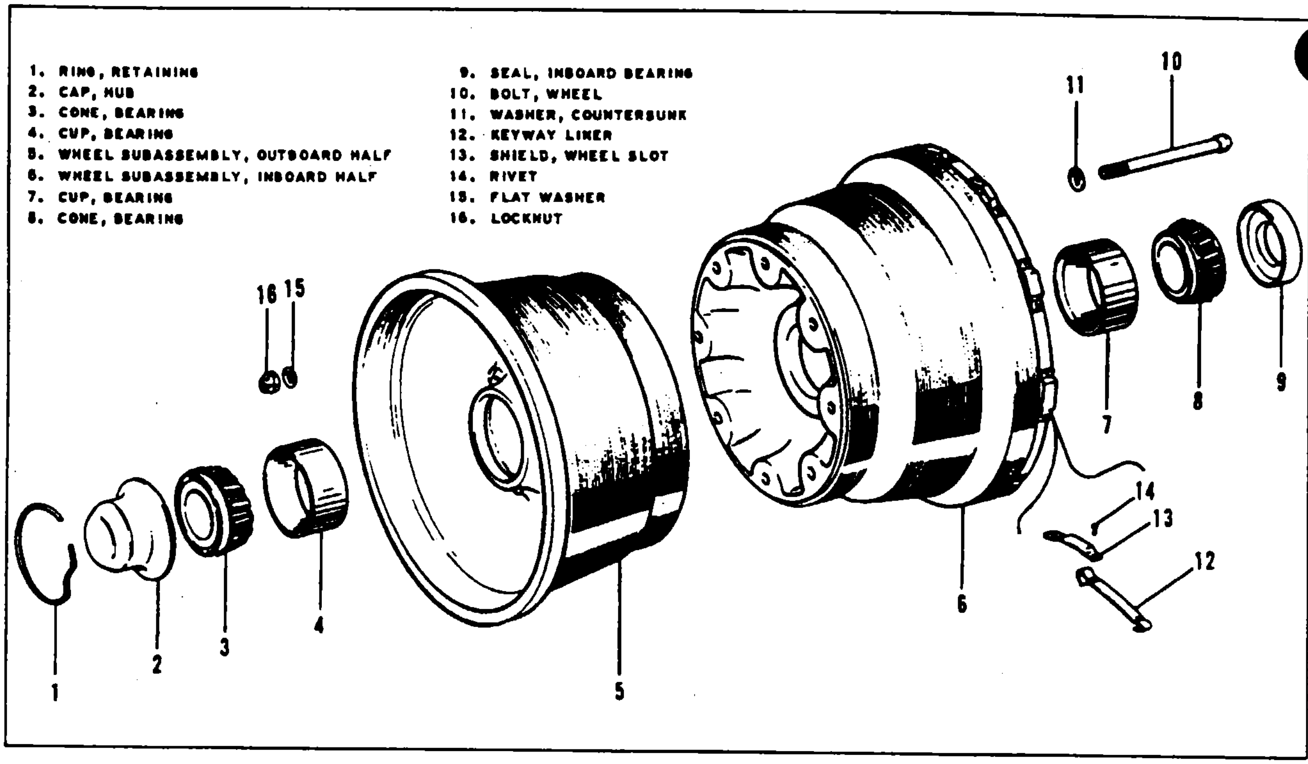

Figure 7-13. Main Wheel Assembly

2. If the horn fails to operate at the desired setting, mark the throttles at the proper manifold pressure and repeat the preceding adjustment procedure as described in step a. The switches may be adjusted with the airplane in flight using caution not to let the presence of the screwdriver interfere with the operation of the controls.

7-45. WHEELS (CLEVELAND).

7-46. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7-12.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. To remove the nose wheel, remove the axle tie rod nut, tie rod and axle plugs. Insert a 1-7/16 inch diameter tube into the fork and tap out the axle from the wheel assembly.
c. Flex the fork enough to remove the wheel spacers and to allow the wheel to clear the fork assembly.
d. The wheel halves (1 and 2) may be separated by removing the valve core and completely deflating the tire. Break tire bead from wheel by using a mallet. Remove the wheel through bolts (3). Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.

CAUTION

Do not pry between the wheel flange and tire bead with sharp tools, as this could damage the wheel and tire.

e. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (10) that secure the grease seal retainers, and then the retainers (8), grease seals (9) and bearing cones (7). The bearing cups (6) should be removed only for replacement. See Paragraph 7-48a for bearing cup replacement instructions.

7-47. INSPECTION OF NOSE WHEEL ASSEMBLY.

a. Degrease all parts and dry thoroughly.
b. Visually check all parts for cracks, distortion, defects and excess wear.
c. Check tie bolts for looseness or failure.
d. Check internal diameter of felt grease seals for distortion or wear. Replace the felt grease seal if surface is hard or gritty. Lightly coat felt grease seals with SAE 10 oil. (Do not soak felts in oil.)
e. Check tire for cuts, internal bruises and deterioration.
f. Check bearing cones and cups for wear and pitting and relubricate per lubrication chart.
g. Replace any wheel casting having visible cracks.

7-48. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7-12.)

a. Ascertain that the bearing cup (6) in each wheel half is properly installed. Lubricate the bearing cones (7) per lubrication chart in Section II. Reassemble the cones, grease seal retainers (8), grease seal felts (9) and snap rings (10) into the proper wheel halves.
b. Inflate the tube sufficiently to round it out. Install tube into tire so that balance mark (yellow or white band) is radially aligned with the tire balance mark (red dot).
c. Place outer wheel half into tire and pull tube valve stem through valve hole. Turn tire and outer wheel half over and place inner wheel half into the tire and align the bolt holes with the outer wheel half. Install bolts through the inner wheel half and washers and nuts on the outer wheel half. Torque wheel nuts per recommended torque value on name plate of wheel.
d. Inflate tire to recommended operating pressure per Table II-I.
e. Flex the fork enough to allow for the installation of the wheel and spacer tubes. Insert the axle tube, fork caps and tie bolt. Adjust the tie bolt nut to allow the wheel to turn free, yet not fit loose on the axle.

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7-48a. REPAIR OF NOSE WHEEL ASSEMBLY. Repairs are limited to blending out small nicks, scratches, gouges and areas of slight corrosion, plus the replacement of parts which are cracked or badly corroded.

NOTE

Remove rust and blend out small nicks, using fine 400 grit sandpaper.

Wheels may also be repainted if the parts have been repaired and thoroughly cleaned. Paint exposed areas with one coat zinc chromate primer and one coat of aluminum lacquer.

NOTE

Never paint working surfaces of the bearing cups.

a. Bearing Cup Replacement:
   1. Removal:
      (a) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250 °F (121°C) for 15 minutes.
      (b) Remove from source of heat and invert wheel half. If the cup does not drop out, tap the cup evenly from the axle bore with a fiber drift pin or suitable arbor press.
   2. Installation:
      (a) To replace a new cup apply one coat of zinc chromate primer to wheel half bearing bore.
      (b) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250°F (121°C) for 15 minutes. Chill new bearing cup in dry ice for a minimum of 15 minutes.
      (c) Remove wheel half from source of heat and bearing cup from the dry ice. Install the chilled bearing cup into the gearing bore of the heated wheel half. Tap gently to seat evenly in place, using a fiber drift pin or suitable arbor press.

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7-49. WHEELS (GOODYEAR).

7-50. REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7-13.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Deflate the tire and remove the valve core from the valve stem.
c. Remove the wire retaining ring (1) and hub cap (2) from the wheel.
d. Remove the wheel assembly from the axle.

CAUTION

Use care during removal of wheel from axle to avoid damage to the bearing cones (3) and inboard bearing seal (9).

e. Remove the inboard bearing cone (3) and inboard bearing seal (9) from the airplane axle.
f. Place the wheel on a clean, flat surface with the valve stem up.
g. Break the tire beads free of both wheel flanges by applying pressure around the entire sidewall as close to the tire beads as possible.

CAUTION

Do not pry between the wheel flange and tire bead with sharp tools, as this could damage the wheel and tire.

h. Remove the self-locking nuts (16), flat washers (15), wheel bolts (10) and countersunk washers (11). Then separate the wheel sub-assemblies (5 and 6).

NOTE

Do not use power or impact wrenches to remove wheel bolts or nuts.

NOTE

Bearing cups (4 and 7) are a shrink fit in the wheel sub-assembly hubs (5 and 6) and should not be removed unless replacement is necessary. (Refer to Paragraph 7-52 for removal procedures if replacement is required.)

TABLE VII-I. MAIN WHEEL INSPECTION LIMITS

Part (Ref. Fig 13)	Defect	Remedy
Wheel Sub-assem blies (5 and 6).	Small nicks, scratches, gouges and areas of slight corrosion to a depth of 0.015 inch.	Blend out and polish with fine (400 grit) wet-or-dry sandpaper.
Bearing cones (3) and (8) bearing cups (4 and 7.)	Scratches, nicks, corrosion, or evidence of wear or overheating.	Replace.
Inboard bearing seal (9).	Cuts, wear, cracks, or distortion.	Replace.
Wheel bolts (10).	Cracks or deep nicks in thread or shank.	Replace.
Keyway Liners (12).	Cracked or badly worn.	Replace.

7-51. CLEANING AND INSPECTION OF MAIN WHEEL ASSEMBLY.

a. Remove dirt and grease with a quick drying, cleaning solvent, Federal Specification P-D-680 (Stoddard Solvent). A soft bristle brush may be used to remove hardened grease, dust or dirt.

CAUTION

Dry cleaning solvents are toxic and volatile. Use in a well ventilated area. Avoid contact with skin or clothing. Do not inhale the vapors.

b. Clean the bearing cones in a separate container of clean fluid. Then dry them thoroughly using filtered and dried compressed air.

NOTE

Do not spin bearings with compressed air.

c. Inspect bearing cones for nicks, scratches, water staining, spalling, heat discoloration, roller wear, cage damage, cracks and distortion. Replace if any of these conditions exist or if cones show signs of wear. Repack bearing cones with clean bearing grease MIL-G-81322.
d. Wash the inboard bearing seal (9) in isopropyl alcohol and dry with a clean, soft cloth.
e. Visually inspect all parts for cracks, distortion, defects and excessive wear.
f. Inspect inboard bearing seal (9) for wear or damage to sealing lip or to metal reinforcing ring. Replace if damaged or deformed.

g. Inspect wheel sub-assemblies (5 and 6) for cracks, corrosion or other damage. Cracked or badly corroded casting should be replaced. Particular attention should be given the underside of the tubewell area for cracks or potential cracks, paying particular attention to the area from the bead seat radius to the end of the toe of the tire. Small nicks, scratches, or pits in the castings should be blended out with fine (320-360 grit) wet-or-dry aluminum oxide cloth.
h. Check bearing cups (7) for tightness, scratches, pitting, corrosion, or evidence of overheating. If any of these defects exists, replace the cup in accordance with Paragraph 7-52.
i. Inspect valve stem hole of outboard wheel assembly (5) for cracks or corrosion. Replace cracked assembly. Pits, nicks, or corrosion may be polished out with fine (320-360 grit) aluminum oxide cloth, wet-or-dry.
j. Inspect wheel bolts (10). Carefully check for cracks in radius under bolt head and in first two threads adjacent to the bolt shank. Replace cracked bolts.

NOTE

No refinishing of bolts is permissible.

k. Check self-locking nuts (16) for self-locking feature. Replace if nut can be turned onto bolt with finger pressure.
l. Inspect keyway liners (12) on inboard wheel sub-assembly (6) for wear. If distance between surfaces of liners across any tang slot of inboard wheel sub-assembly exceeds 0.620 of an inch, drill out rivets and replace liners in accordance with instructions given in Paragraph 7-52.
m. Inspect keyway liners for tightness. If loose, either tighten or replace rivets.

7-52. REPAIR OF MAIN WHEEL ASSEMBLY. Repairs to the main wheel assembly are limited to blending out small nicks, scratches, gauges, and areas of slight corrosion plus the replacement of parts which are cracked or badly corroded.

NOTE

Corrosion originates at points where the protective wheel coating is ruptured. All traces of corrosion and residue must be removed before wheel halves are treated and repainted. (Corrosion residue accelerates the corrosion process.)

a. Bearing Cup Replacement:
   1. Removal:
      (a) Heat wheel sub-assembly in boiling water for one hour, or in an oven not exceeding 250°F (121°C) for 30 minutes.
      (b) Remove sub-assembly from source of heat and remove bearing cup.

NOTE

The bearing cup should be loose enough to fall out of the bearing bore after heating the wheel sub-assembly and inverting it. If the cup does not drop out, tap it evenly from the bore with a fiber drift pin.

2. Installation:
   (a) Place wheel sub-assembly in boiling water for one hour, or in an oven not exceeding 250°F (121°C) for 30 minutes. Chill the bearing cup on dry ice.
   (b) Remove wheel half from source of heat and dry chilled bearing cup thoroughly. Coat contacting surfaces of cup with zinc chromate primer or paste.
   (c) Install the chilled bearing cup into the heated wheel sub-assembly and tap into place evenly with a fiber drift pin.

NOTE

The bearing cup should be installed while the primer or paste is still wet.

b. Keyway Liner Replacement:
   1. Removal:
      (a) Center punch keyway liner rivet head on inside of wheel flange and drill out rivet head using a 0.109 drill.

CAUTION

Ascertain that the punch mark is centered on the rivet and that the wheel is not damaged by the drill. Avoid enlarging rivet holes in wheel flange.

      (b) Punch out the rivet shank and remove the slot shield (13) and keyway liner (12).

NOTE

Inspect area under keyway liner for corrosion. Blend out corrosion pits to 0.010 of an inch deep and retreat reworked areas in accordance with Paragraph 7-52a.

   2. Installation:
      (a) Position the new liner (12) on the inboard wheel sub-assembly with the tab extension on ends of liner towards the centerline of the wheel. The edge of the liner should be flush with the outer edge of the wheel.
      (b) Place the slot shield (13) over the keyway of the wheel assembly and install rivet (14) through the wheel flange, keyway liner and slot shield.

NOTE

Shop (peened) head of rivet must be on the outside of slot shield. Chamfered head of rivet must be installed in countersink in wheel flange.

      (c) Support the rivet head solidly and peen the end of the rivet.

7-52a. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7-13.)

a. Retreating and Repainting:
   1. Thoroughly clean repaired surfaces and areas of the wheel from which paint has been removed.
   2. Treat the cleaned surfaces with Dow No. 1 solution, Specification MIL-M-3171, and paint with two coats of zinc chromate primer, Specification MIL-P-8585 and two coats of aluminum lacquer, Specification TT-L-32.

NOTE

Never paint working surfaces of bearing cups. Wheel register surfaces and bolt bosses should receive one mist coat of zinc chromate primer only.

b. Place the outboard wheel sub-assembly (5) on a clean, flat surface.
c. Use a lint-free cloth dampened with isopropyl alcohol to clean tire beads, wheel flange bead seat and wheel register areas.
d. Inflate the inner tube just enough to round it out, and place it in the tire with the yellow stripe on the base of the inner tube at the red dot on the tire.

NOTE

Both the yellow stripe on the tube and the red dot on the tire must be mated to bring the tire and tube into proper balance.

e. Install the tire and tube on the outboard wheel sub-assembly (5) and insert the valve through the valve hole.
f. Position the inboard wheel sub-assembly (6) in the tire and align the bolt holes with those in the outboard wheel sub-assembly (5).
g. Install the countersunk washer (11) on the bolts (10) with the washer countersink facing the bolt head. Install the bolt with washer through the inboard sub-assembly (6) and outboard sub-assembly (5).
h. Install the flat washer (15) and self-locking nut (16) on the bolt (10). Tighten the nuts in increments of 20 inch-pounds to a final torque of 120 inch-pounds.

CAUTION

Applying uneven torque to nuts may cause bolt fatigue. Do not use impact or power wrenches on wheel bolts or nuts.

i. Inflate the tire just enough to seat the tire beads against the wheel flanges.
j. Remove the valve core and allow the tire to deflate completely to allow the tube to equalize within the tire.
k. Install the valve core and inflate the tire to 20 psi. Do not inflate the tire to full operating pressure until the wheel is mounted on the aircraft.
l. If not already accomplished, pack the bearing cones (3 and 8) and coat the bearing cups (4 and 7) and lips of the inboard bearing seal (9) with clean bearing grease, Specification MIL-4-81322.

NOTE

Apply grease sparingly, but thoroughly. Do not over-lubricate.

m. Install bearing cones and inboard bearing seal (9) in the wheel assembly, being careful that the seal properly seated against the bearing cup (7).

CAUTION

Exercise care when installing the wheel assembly on the airplane so as not to damage the bearing cones and bearing seal.

n. Install the axle nut and adjust the bearing. For proper seating of the bearings, rotate the wheel in the forward direction while torquing the axle nut.
o. Torque the axle nut to 80 inch-pounds; then back off the nut to 0 inch-pounds and retorque to 40 inch-pounds. If the cotter pin cannot be installed, it is permissible to advance the axle nut (not more than 30 degrees) to install the cotter pin.
p. Upon completion, install hubcap (2) and retaining ring (1).

7-53. BRAKES (GOODYEAR).

7-54. BRAKE WEAR CHECK. (Refer to Figure 7-14.)

a. Apply and release the brakes twice; then apply the parking brake.
b. Using the small hole or four slots in the snow shield (16), measure the distance from the inside surface of the snow shield to the back of the pressure plate (8), note the dimension.

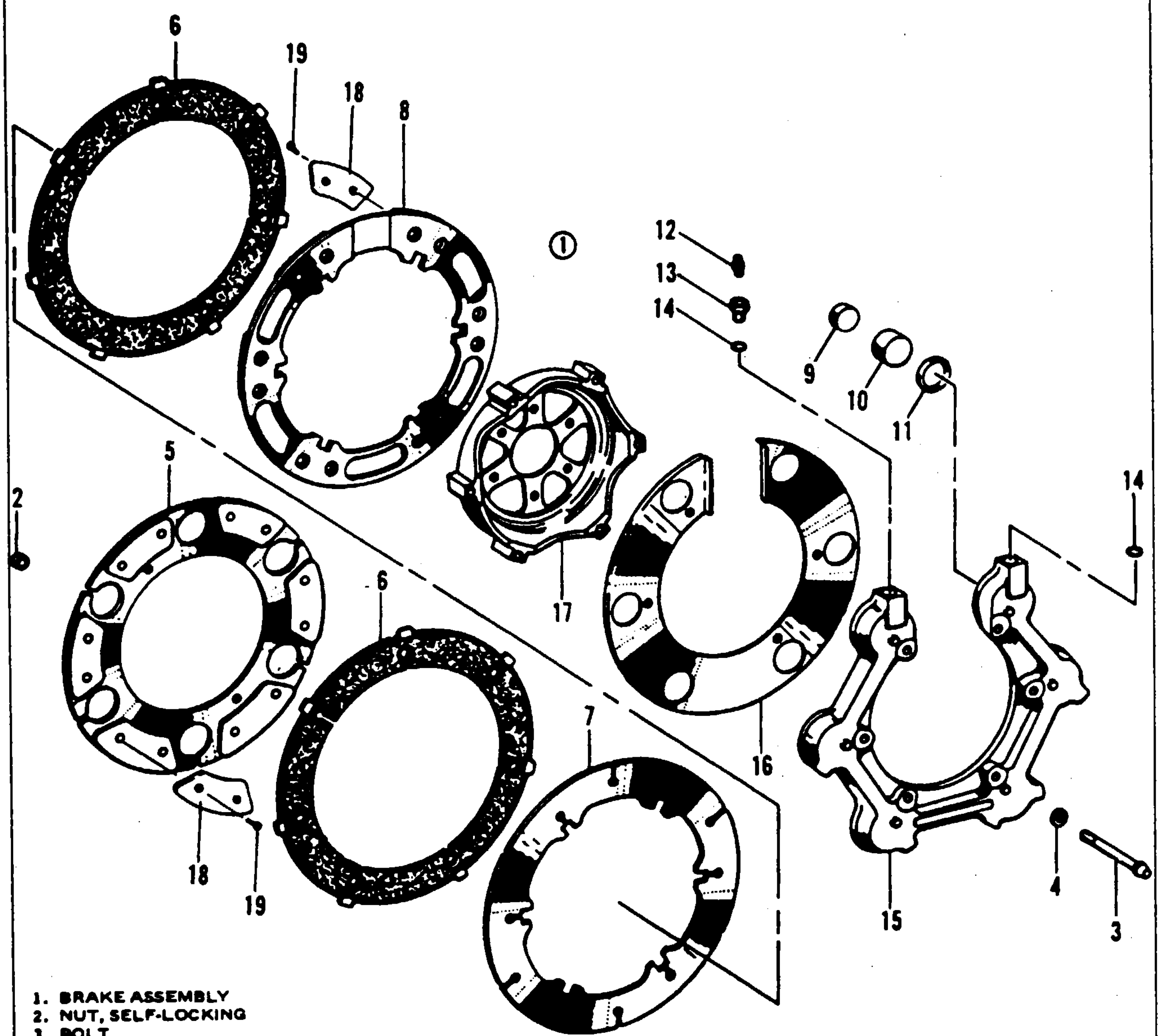
NOTE

A simple modification to the snow shield will simplify the wear check. Refer to Figure 7-14a for modification details. Compliance with this modification does not alter the FAA TSO conformance.

c. Release the parking brake and rotate the wheel 120 degrees and recheck in accordance with Step "b". Perform this step again to obtain dimensions from three different wheel positions, note the dimensions. (Wheels with modified snow shields need not be rotated.)
d. When the dimensions obtained are 0.348 of an inch or more at any given check, remove the brake assembly for overhaul.

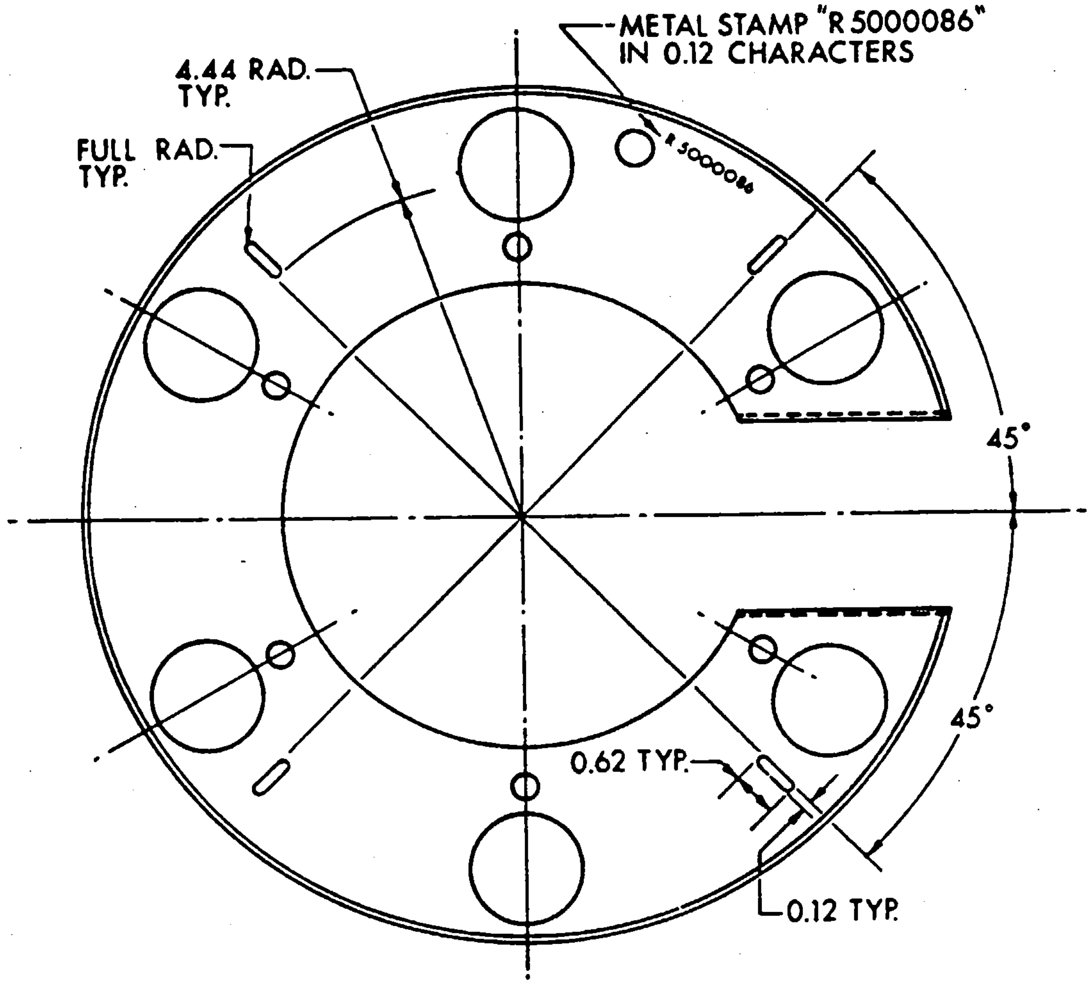
7-55. REMOVAL AND DISASSEMBLY OF BRAKE SYSTEM. (Refer to Figure 7-14.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Remove the main wheel assembly in accordance with Paragraph 7-50.
c. Disconnect and cap the hydraulic brake line at the brake assembly and remove the six bolts securing the brake assembly to the landing gear strut.
d. Place the brake assembly with the housing down on a clean flat surface.
e. Remove the six self-locking nuts (2), bolts (3), and countersunk washers (4) holding the assembly.



1. BRAKE ASSEMBLY
2. NUT, SELF-LOCKING
3. BOLT
4. WASHER
5. PLATE, BACK
6. DISC, ROTATING
7. DISC, STATIONARY
8. PLATE, PRESSURE
9. INSULATOR, PISTON
10. PISTON
11. O-RING PACKING
12. VALVE, BLEEDER
13. ADAPTER, BLEEDER
14. O-RING PACKING
15. HOUSING
16. SHIELD, SNOW
17. TUBE, TORQUE
18. PAD, BRAKE
19. RIVET

Figure 7-14. Wheel Brake Assembly



INSTRUCTIONS:

1. Disassemble brake assembly per Paragraph 7-55 and remove snow shield.
2. Add four slotted holes to snow shield as shown above. Pilot drill and cut slots as required. No special tools required.
3. Metal stamp R5000086 in 0.12 inch characters as shown above.
4. Touch-up slots with Aluminum Lacquer Specification TT-L-32.
5. Reassemble brake assembly per Paragraph 7-58.

Figure 7-14a. Snow Shield Modification

NOTE

Do not use impact or power wrenches to remove the brake bolts or nuts.

f. Remove the back plate (5), rotating discs (6), stationary disc (7), pressure plate (8), torque tube (17), and snow shield (16) from the brake housing sub-assembly (15).
g. Remove the bleeder valve (12) from the bleeder adapter (13).
h. Remove the piston insulators (9) from the pistons (10).
i. Remove the pistons (10) and O-ring packings (11) from the cylinder cavities in the housing sub-assembly (15).
j. Unscrew the bleeder adapter (13) from the housing sub-assembly (15) and remove the O-ring packing (14), completing the disassembly.

7-56. CLEANING AND INSPECTION OF BRAKE ASSEMBLY. (Refer to Figure 7-14.)

a. Clean all metal parts of the brake assembly except the rotating discs (6), in dry cleaning solution, Federal Specification P-D-680 (Stoddard Solvent), and dry with filtered compressed air. A soft bristle brush may be used when necessary.

CAUTION

Dry cleaning solvents are toxic and volatile. Use in a well ventilated area. Do not inhale the vapors and avoid contact with skin or clothing.

b. Clean the rotating disc (6) with compressed air and a soft wire or stiff bristle brush.
c. Clean piston insulators (9) with isopropyl alcohol. Dry with compressed air or a clean cloth.

NOTE

New O-ring packings should be installed at each overhaul. If the packings must be reused, they should be cleaned with isopropyl alcohol and dried with a clean, soft cloth. Reinstall packings in the same location from which they were removed.

d. Inspect all parts for cracks, nicks, scratches, damaged threads, or other damage called out in Table VII-II, Brake Inspection Limits.

NOTE

Replace all parts which are cracked or have damaged threads.

7-57. REPAIR OF BRAKE ASSEMBLY.

a. Replace all parts of the brake assembly which are cracked or worn in excess of the limits given in Table VII-II.
b. Pressure plate (8) and back plate (5) can be repaired in accordance with the following steps:
   1. To remove the wear pads from either plate, drill out the shop heads of old rivets using a 0.218 inch drill and punching out the old rivets.

CAUTION

Exercise care to avoid damaging or enlarging the rivet holes.

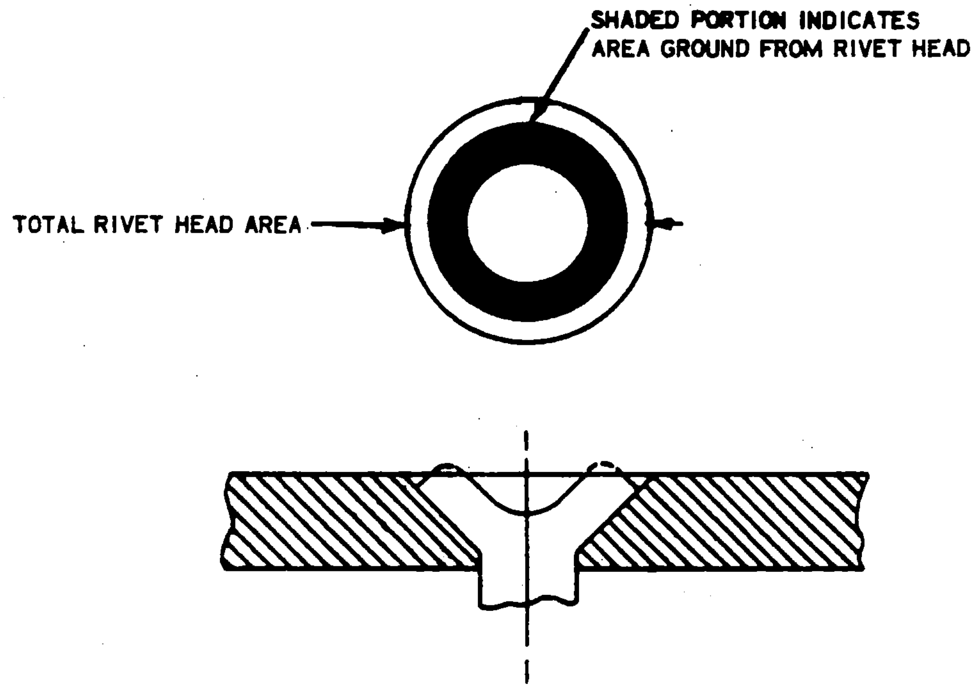


Figure 7-15. Rivet Head Grinding Limits

2. Before repadding either plate, inspect it for cracks using zyglo or dye-penetrant method. Replace plates which are cracked or dished 0.015 inch or more.
3. Install new wear pads using the proper rivets and rivet tools shown in Figure 7-15a, which can be fabricated from dimensions given by a local shop. Ascertain that the formed (shop) head of the rivet is flush with or below the surface of the wear pad.

NOTE

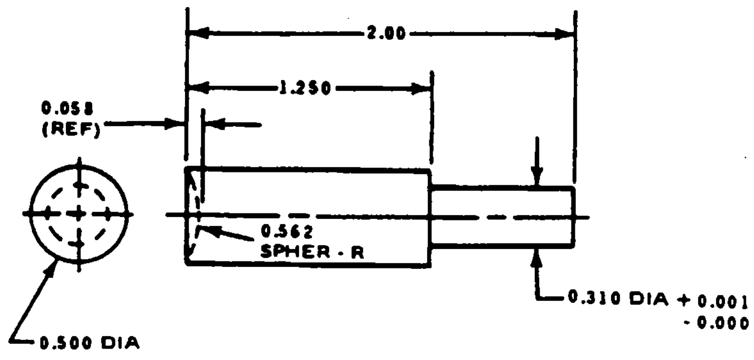
After pad installation, check rivets for snugness. A slight movement of wear pads is desirable. It should be determined that a force of not less than 2 pounds or more than 100 pounds is required to cause movement of pad.

A maximum of one crack is permitted in the shop head of a tubular rivet, but it must not extend into the rivet shank. To check rivets that appear unseated, insert a 0.0015 inch feeler gauge between the disc and the pad. It should not slide past the rivet.

4. After repadding, grind the wear padded sub-assembly to the thickness as shown in Figure 7-17.

NOTES

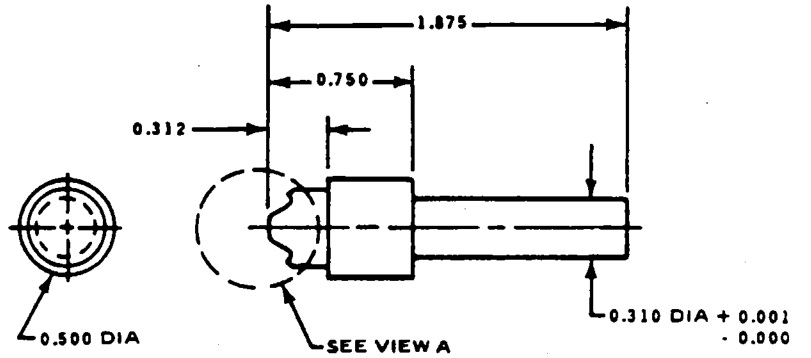
1. MATERIAL - AISI TYPE S5 HARDEN TO ROCKWELL C-50-55 AND GRIND.
2. TO BE USED ON ROUND-HEAD RIVETS ONLY - STYLE GY18B (1/4 DIA.).
3. FOR USE ON COMPRESSION RIVETER - CHICAGO PNEUMATIC TOOL CO. P/N 450.

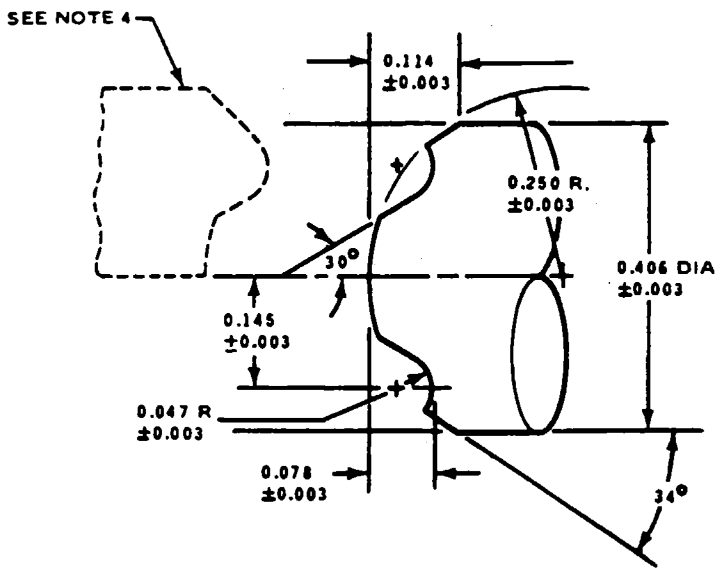


ROUND-HEAD RIVET DRIVER 49523-2

NOTES

1. MATERIAL - AISI TYPE S5
2. HEAT TREAT - ROCKWELL "C" (48-50) AND POLISH CONTOUR AREA FREE OF TOOL MARKS 5 TO 10 RMS AFTER HND
3. SERVICE - GY18A, GY18B RIVETS (SEMI-TUBULAR RIVETS)
4. EDGE OF FORMING TOOL MUST BE ON CENTER LINE OF PEEN (AS SHOWN WHEN FORMING CONTOUR OF PEEN). (TOOL NO. ST1-71219)





VIEW A

SWAGING PEEN 49523-3

Figure 7-15a. Fabricated Rivet Tools. Piper P/N 49523

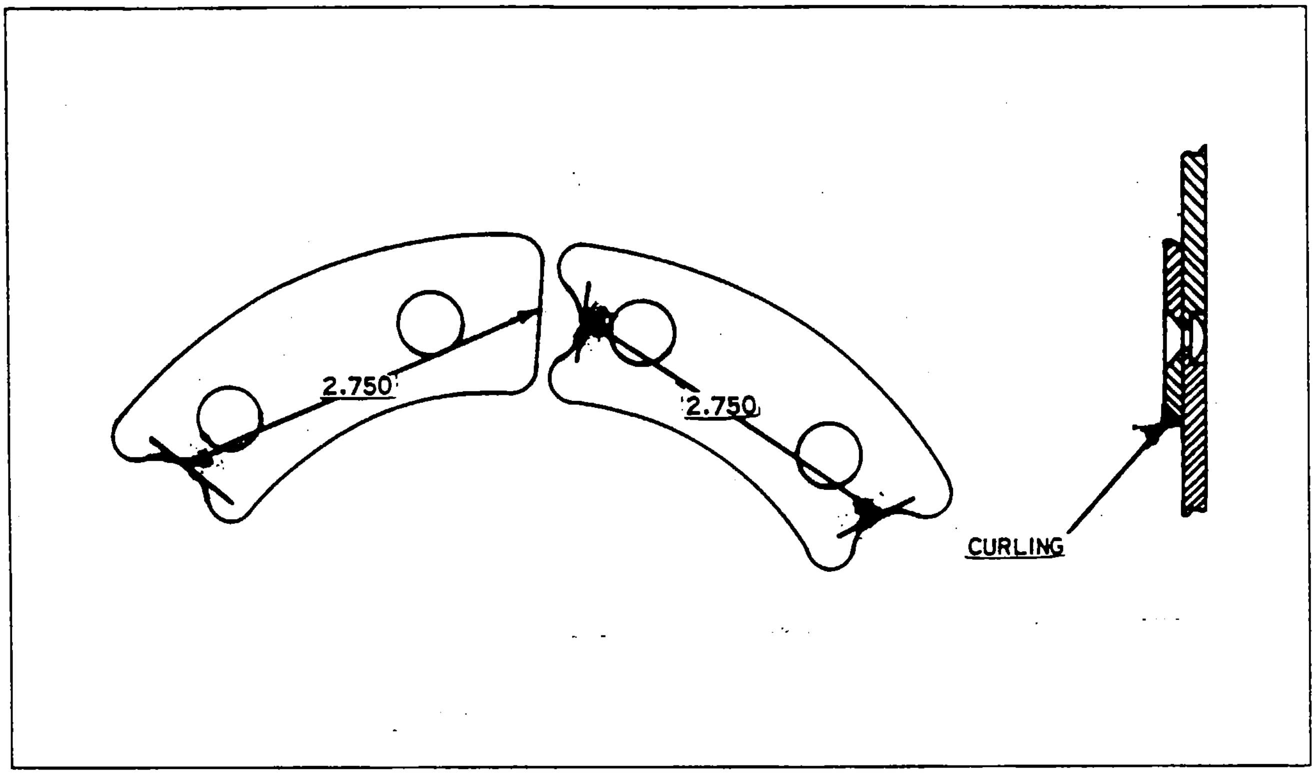


Figure 7-16. Wear Pad - Wear Limits

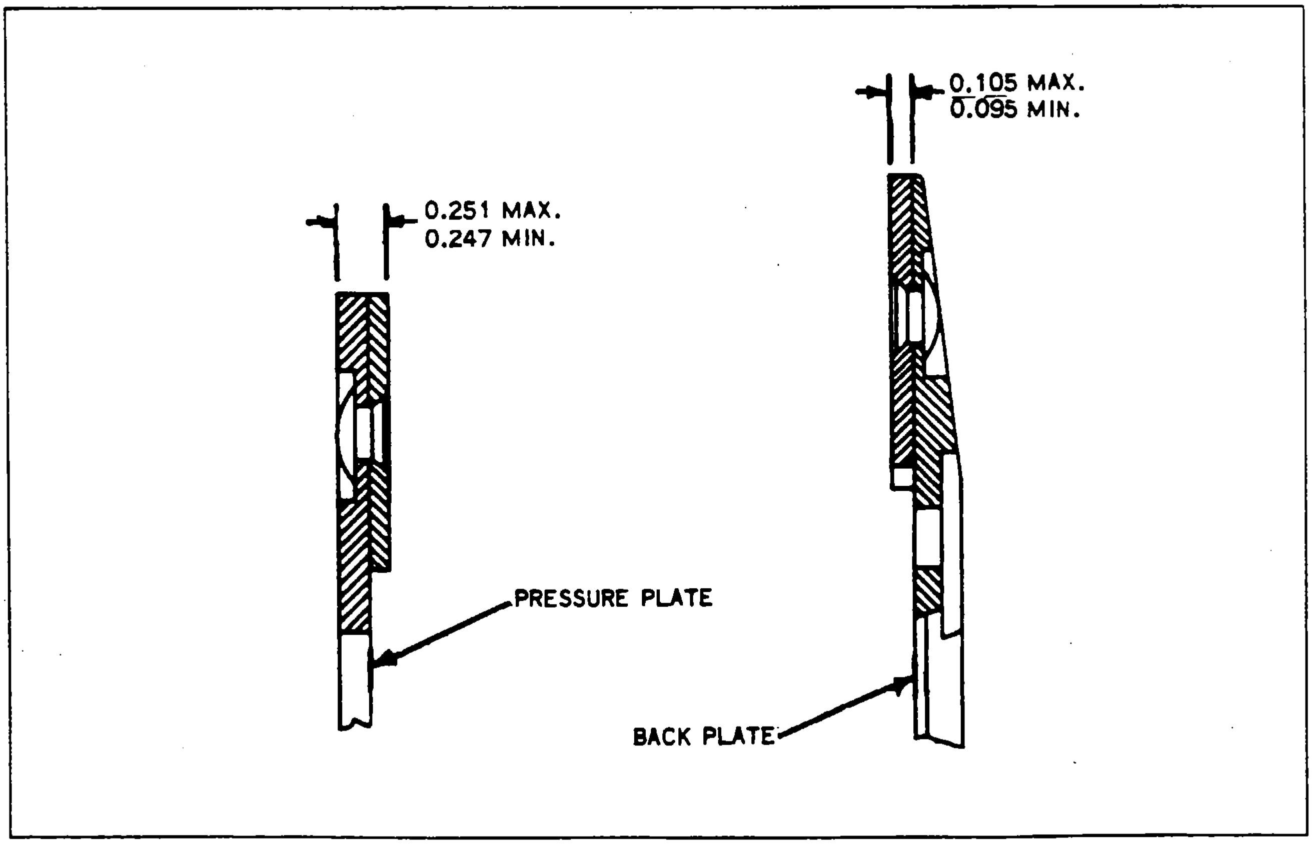


Figure 7-17. Limits for Repadded Pressure and Back Plates

NOTE

Wear pads must be ground flat to each other with assurance that the minimum dimensions shown in Figure 7-17 are held. Not more than 25 percent of the rivet head shall be removed by grinding. (Refer to Figure 7-15.)

c. Protective Coating. Treat newly ground back and pressure plates which are not being put into immediate service as follows:
   1. Degrease discs in a vapor degreaser to remove all oil and grinding residue.
   2. Immerse disc in Houghton's Rust Veto 377 or equivalent. Use in the as-received condition without dilution. Let discs drip and air dry for five minutes or more. Clean, compressed air may be used to help speed drying time.

CAUTION

Rust Veto is highly flammable. Observe all fire precautions when using this material.

d. Torque tube (10) repair is limited to blending out indentations in drive keys if they don't exceed 0.545 of an inch.
e. Housing (18) repairs are as follows:
   1. Blend and polish out burrs, nicks, and scratches not deeper than 0.030 of an inch on the outside of the housing with 320-360 grit (wet-or-dry) aluminum oxide cloth.
   2. Blend and polish out scratches in piston cavities not exceeding 0.003 of an inch deep with fine 320-360 grit (wet-or-dry) aluminum oxide cloth. Also remove burrs and rough edges from seal grooves to a 0.010 to 0.015 of an inch radius with 320-360 grit (wet-or-dry) aluminum oxide cloth.
f. Piston (16) repairs consists of blending out and polishing scratches, nicks and burrs on edges, and seal contacting surfaces of the piston to 0.003 of an inch deep. Blend repairs to avoid local indentation of piston seal surfaces. Replace pistons damaged deeper than 0.003 of an inch.
g. Retreating and Repainting Housing:
   1. Rinse reworked areas with hot water and dry thoroughly with filtered, dried compressed air.
   2. Re-treat reworked areas with Dow No. 1 solution MIL-M-3171, Type I.
   3. Repaint reworked areas with two coats of zinc chromate primer, Specification MIL-P-8585, and two coats of aluminum lacquer, Specification TT-L-32.

7-58. ASSEMBLY AND INSTALLATION OF BRAKE ASSEMBLY. (Refer to Figure 7-14.)

a. Lubricate the piston O-ring packing (11), piston cylinder walls, and cylinder contacting surfaces of the piston (10) with hydraulic fluid MIL-H-5606.

CAUTION

Assemble brake parts with care to avoid damaging.

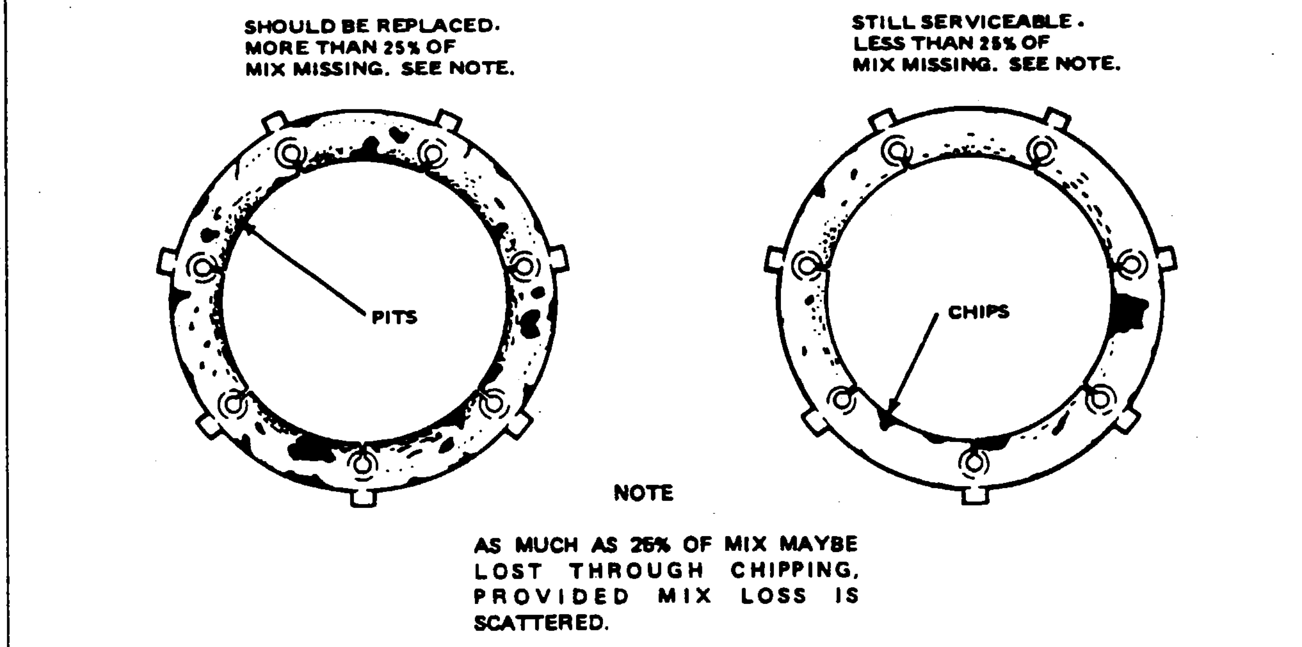


Figure 7-17a. Brake Disc Visual Check For Serviceable Limits

b. Install lubricated piston packings (11) in packing grooves in cylinders in brake housing, being careful not to stretch or twist packings.
c. Install insulator (9) in recess in pistons and install pistons in cylinders in housing (15). Bottom the pistons in the cylinders.

CAUTION

To avoid damaging or displacing O-ring packings during piston installation, a slight twisting of the piston will aid installation.

d. Lubricate the threads of the adapter (13) and O-ring packing (14) with a light coat of hydraulic fluid, MIL-H-5606. Install the packing on the bleeder adapter and screw the adapter into the bleeder port in the housing (15) and tighten.

NOTE

Both the inlet and bleeder ports on the housing are identical to permit mounting the brake on either side of the airplane.

TABLE VII-II. BRAKE INSPECTION LIMITS

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
Rotating Discs (6)	Relief slot terminal holes and drive tang radii cracked.	Replace.
	Wear, minimum thickness across unchipped mix of 0.127 inch or worn to 0.010 inch at any location on either face of disc.	Replace.

NOTE

As much as 25 percent of mix may be lost through chipping, provided the mix loss is scattered. (Refer to Figure 7-17a.)

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
	Dishing of discs in excess of 0.030 inch.	Replace.
	Discs which are 0.125 inch or more out of round.	Replace.
	Battered tangs which are less than 0.615 inch in width.	Replace.
	Shrunken discs with an inside diameter of less than 7.79 inches.	Replace.

TABLE VII-II. BRAKE INSPECTION LIMITS (cont.)

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
Pressure Plate (8)	Key-slot corners cracked.	Replace.
	Worn to 0.225 inch or less between wear pad rivets.	Replace.
	Sheared rivets or cracked wear pads and worn to 2.75 inches as shown in Figure 7-16.	Replace all wear pads in accordance with Paragraph 7-57.
	Key-slot width is less than 0.615 or greater than 0.640 inch.	Replace.
	Dished 0.030 inch or more.	Replace plate.
	Out of round 0.120 inch or more.	Replace plate.
Torque Tube (17)	Cracked torque tube.	Replace.
	Key width is 0.545 inch or less at any point on key.	Replace.

TABLE VII-II. BRAKE INSPECTION LIMITS (cont.)

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
Brake Housing (15)	Cracked housing.	Replace.
	Stripped or badly damaged threads in inlet and bleeder bosses.	Replace.
	Cylinder cavities worn in excess of 1.380 inches in diameter.	Replace.
	Nicks, scratches and corrosion.	Repair in accordance with Paragraph 7-57.
Piston (10)	Diameter of pistons is 1.362 inches or less measured at three places around circumference.	Replace.
	Burrs, scratches, or nicks greater than 0.003 inch deep on seal surfaces.	Replace.

NOTE

Pistons with damage less than 0.003 of an inch can be repaired in accordance with Paragraph 7-57.

TABLE VII-II. BRAKE INSPECTION LIMITS (cont.)

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
Stationary Disc (7)	Cracked relief slot terminal holes and key-slot corners.	Replace.
	Disc worn to 0.130 inch or less.	Replace.
	Disc dished in excess of 0.030 inch.	Replace.
	Inside diameter of disc interferes with torque tube.	Replace.
	Key-slots worn and battered to less than 0.590 inch or greater than 0.640 inch in width.	Replace.
	Inside diameter of disc to 7.10 inches or less, measured between ends of keyway tangs.	Replace.
Back Plate (5)	Cracks around relief slot holes.	Replace.
	Wear pads worn to 0.090 inch or less in thickness from face of pad to surface of back plate, or if pad width is less than 2.75 inches, as shown in Figure 7-14.	Replace all pads in accordance with Paragraph 7-57.
	Plate dished in excess of 0.015 inch.	Replace.

TABLE VII-II. BRAKE INSPECTION LIMITS (cont.)

PART (Refer to Figure 7-14.)	DEFECT	REMEDY
Bolts (3)	Thread damage, cracks under head and in threads adjacent to bolt shank and bent bolts.	Replace.
Insulators (9)	Small blisters not exceeding 0.010 inch.	Grind OFF.
	Worn to 0.385 inch or less in thickness.	Replace.

BRAKE PARTS TOLERANCES

PA-31P

PARTS	NEW	MIN. THICKNESS
STATIONARY DISC	.156	.130
ROTATING DISC	.174	.127
INSULATORS	.414	.385
PRESSURE PLATE ASSY.	—	.225
BACK PLATE ASSY.	—	.090

NOTE: Refer to Service Manual for detailed service instructions, and Parts Catalog for specific part numbers. Dimensions for new parts win insure using the correct part for the particular installation.

e. Screw the bleeder valve (12) into the bleeder adapter (13).
f. Install washers (4) on brake bolts (3) with the countersink facing the bolt head and install bolts through bolt holes in the housing (15).

CAUTION

Washer countersink must face the bolt head or bolt failure may result.

g. Place the brake housing (15), with bolt in bolt holes, on a clean flat surface with the pistons facing up.
h. Install the snow shield (16) over the brake bolts (3) and against the brake housing (15). The rim flange of the snow shield must be toward the brake stack and the cut out portion must be located between the open arms of the housing (15).
i. Place the torque tube (17) over the brake bolts with the open end of torque tube toward the housing and against the snow shield.
j. Install the pressure plate (8) with the wear pads up over the torque tube with the thin section of the pressure plate located at the top of the housing between the open housing arms.
k. Install one rotating disc (6) over the torque tube.
l. Install the stationary disc (7) on the torque tube with torque tube keys in key-slots in the disc. Place the second rotating disc (6) on the stationary disc (7).
m. Install the back plate (5), with wear pads down, on the torque tube with bolts through bolt holes in the back plate.
n. Install self-locking nuts (2) on brake bolts (3). Draw nuts up evenly and torque to 120 inch-pounds.

CAUTION

Do not use impact or power wrenches to install or tighten brake bolt nuts.

o. Install the brake assembly on the airplane and secure with six mounting bolts.
p. Connect the hydraulic brake line and bleed the brakes in accordance with Paragraph 7-71.
q. Apply and release brake pressure (600 psi) several times and check for proper brake action. The rotating discs (5) should be free to rotate when brakes are released. Reapply pressure (600 psi) and hold for 15 to 30 seconds and check the brake assembly for fluid leaks. No leaks are permitted.
r. Align the rotating disc tangs and install the wheel assembly. Adjust the wheel bearings and safety. Re-inflate the tire to operating pressure and remove the airplane from jacks.

7-59. BRAKE MASTER CYLINDER.

7-60. REMOVAL OF BRAKE MASTER CYLINDER.

NOTE

If, during the following removal for service or repair, either of the master cylinders are found to need replacement as complete units they are to be replaced with similar units. That is, both installed master cylinders should be either No. 10-17 or No. 10-23. In no case should they be mixed

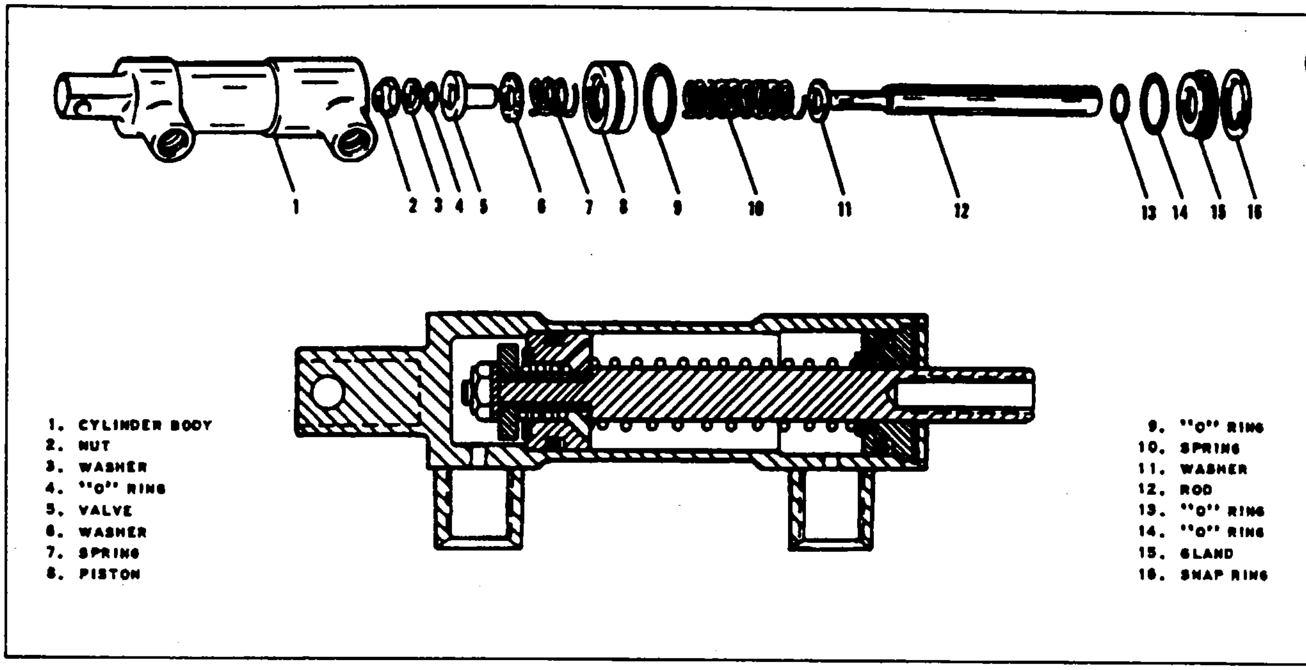


Figure 7-18. Brake Master Cylinder Assembly

a. Disconnect the brake lines from the cylinder and place a protective cover over the line openings to prevent contamination of the system.
b. Remove the cylinder from the pedal assembly by removing the clevis pin at the piston rod and the bolt at the top of the cylinder body.

7-61. DISASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-18.)

a. The internal parts of the brake master cylinder (1) may be removed by removing the snap ring (16) from the annular slot at the lower end of the cylinder. Pull the complete piston assembly from the cylinder.
b. Slide the packing gland (15), "O" ring (13), washer (11) and spring (10) from the piston rod (12).
c. The piston valve assembly may be removed by first removing the self-locking nut (2) from the piston rod (12). This will allow the piston (8) with component parts to be removed.

7-62. CLEANING, INSPECTION AND REPAIR OF BRAKE MASTER CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.
b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.
c. Inspect the general condition of the fitting threads of the cylinder.
d. Check the piston and valve for scratches, burrs, corrosion, etc.
e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing valve washer seal and "O" rings.

7-63. ASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-18.)

a. Install "O" ring (9) on the cylinder piston (8). Assemble onto the piston rod (12), the piston (8), spring (7), washer seal (6) and valve (5). Allow the valve to extend into the base of the piston. Slide the "O" ring and washer (3) in place and secure with self-locking nut (2).

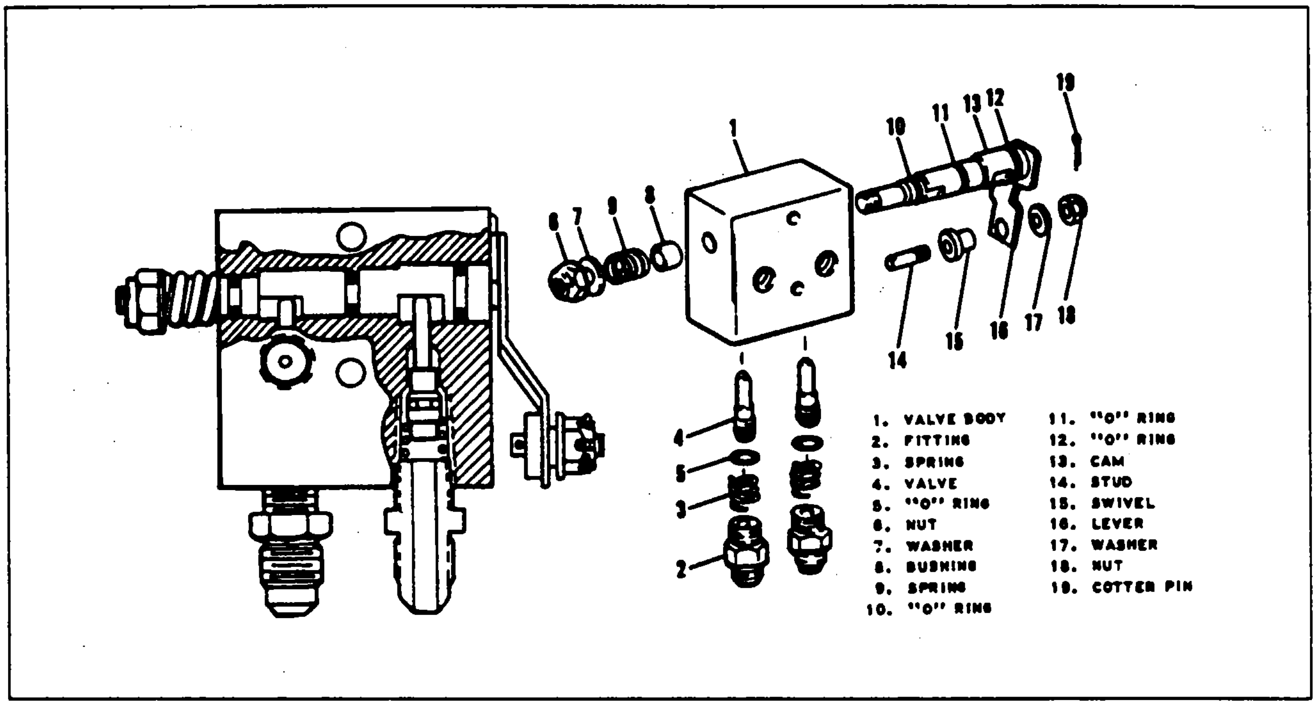


Figure 7-19. Parking Brake Valve Assembly

b. Install "O" ring seal (14) on the packing gland (15). Onto the piston rod (12), slide spring (10), washer (11), "O" ring (13) and packing gland (15).
c. Dip the piston assembly in fluid (MIL-H-5606) and install the assembly into the cylinder (1). Push the packing gland into the cylinder until the snap ring (16) can be installed into the annular slot at the bottom of the cylinder.

7-64. INSTALLATION OF BRAKE MASTER CYLINDER.

a. Compress the piston within the cylinder and adjust the clevis end of the piston rod to obtain 6.69 inches between attachment holes of the cylinder body and the piston rod clevis. Lock clevis in position with locknuts.
b. Attach the cylinder to the rudder pedal by securing at the cylinder body with bolt assembly and at the clevis with clevis pin.
c. Connect the fluid lines to the cylinder.

7-65. PARKING BRAKE VALVE.

7-66. REMOVAL OF PARKING BRAKE VALVE.

a. Disconnect the parking brake cable from the valve actuating arm.
b. Disconnect the fluid lines from the valve.
c. Remove the screws that attach the valve to its mounting bracket.
d. Place a protective material over the line openings to prevent contamination of the system.

7-67. DISASSEMBLY OF PARKING BRAKE VALVE. (Refer to Figure 7-19.)

a. Remove the two fittings (2) from the outside of the valve body (1). A valve spring (3) is held in place by the fittings. Use caution not to loosen these when removing the fittings.
b. From the valve body, remove the valve spring (3) and valve (4).
c. To remove the valve cam (13), remove the nut (6), washer (7), bushing (8) and spring (9) and pull the cam from the valve body.

7-68. CLEANING, INSPECTION AND REPAIR OF PARKING BRAKE VALVE.

a. Clean the valve parts with a suitable solvent and dry thoroughly.
b. Inspect cam and seat surfaces of valve body for excess wear and corrosion.
c. Inspect the cam assembly for burrs, scratches, excess wear, loose operating lever, etc.
d. Check general condition of valves and springs.
e. Repair to the valve is largely limited to smoothing burred or scratched surfaces and replacing "O" rings.

7-69. ASSEMBLY OF PARKING BRAKE VALVE. (Refer to Figure 7-19.)

a. Install "O" rings (10, 11 and 12) on valve cam (13).
b. Lubricate "O" rings with fluid (MIL-H-5606), insert cam (13) into valve body (1) and secure with spring (9), bushing (8), washer (7) and self-locking nut (6).
c. Install "O" ring (5) on valve (4), insert valve in hole of out port, install valve spring (3) and secure with outlet fitting (2).

7-70. INSTALLATION OF PARKING BRAKE VALVE.

a. Attach the valve to the bulkhead mounting bracket with screws.
b. Connect the fluid lines to the valve.
c. Connect the control cable to valve lever and determine that when valve lever fits in the closed detent, parking brake handle is .062 to .125 inch of being full in against stop.

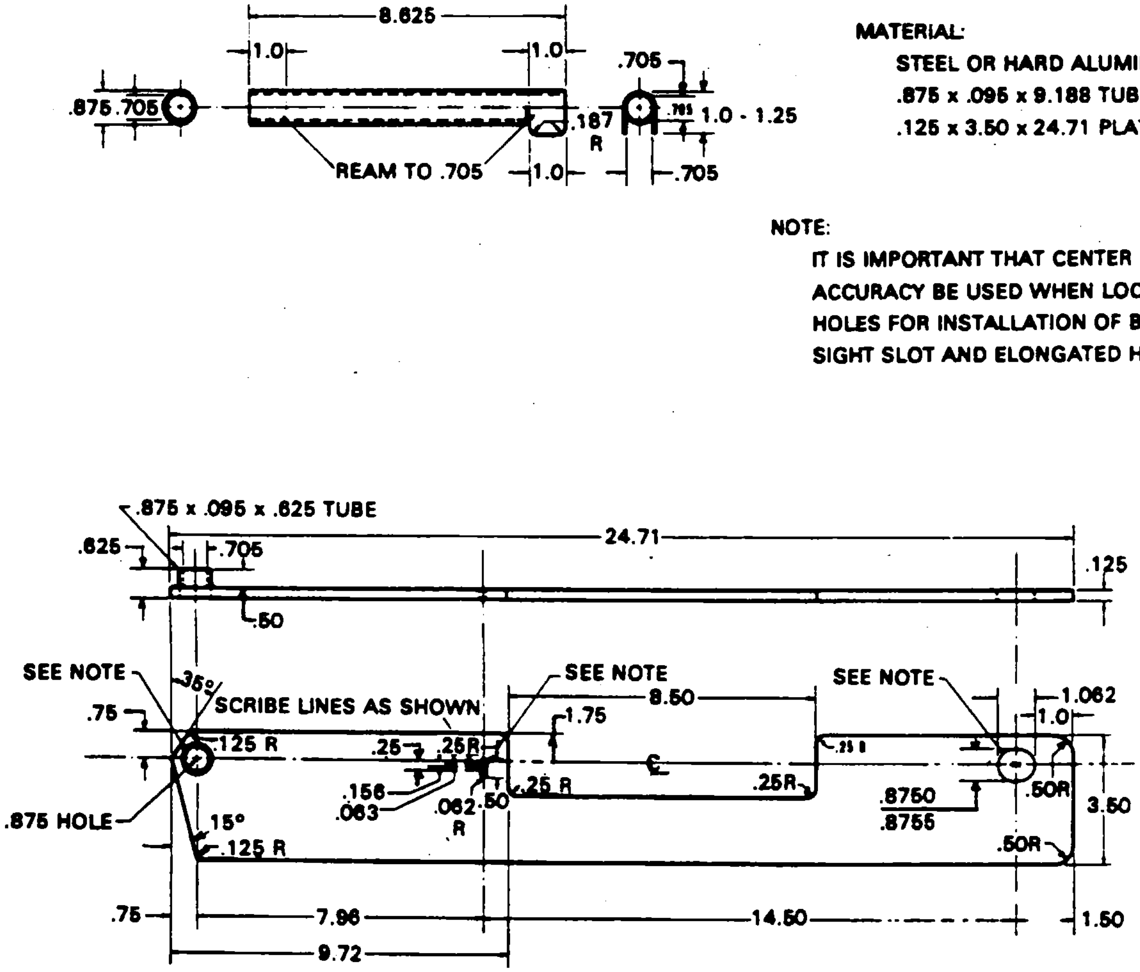
7-71. BLEEDING PROCEDURE. If the brake line has been disconnected for any reason, it will be necessary to bleed the brake system as described below:

a. Place a suitable container at the reservoir drain to collect fluid overflow.
b. Remove the rubber bleeder fitting cap located on the bottom of the brake unit housing on the landing gear.
c. Slide a hose over the bleeder fitting, loosen the fitting one turn and pressure fill the brake system with MIL-H-5606 fluid.

NOTE

By watching the fluid flowing into the reservoir, it can be determined whether any air has entered the system. If air bubbles are evident, filling of the system shall be continued until all of the air is out of the system and a steady flow of fluid is obtained.

d. Tighten bleeder fitting and remove the hose. Check brakes for proper pedal pressure.
e. Repeat this procedure on the other gear.
f. Drain excess fluid from reservoir to fluid level line with a syringe.



MATERIAL:

STEEL OR HARD ALUMINUM

.875 x .095 x 9.188 TUBE

.125 x 3.50 x 24.71 PLATE

NOTE:

IT IS IMPORTANT THAT CENTER LINE ACCURACY BE USED WHEN LOCATING HOLES FOR INSTALLATION OF BUSHING, SIGHT SLOT AND ELONGATED HOLE.

Figure 7-20. Fabricated Tool, Nose Gear Gauge Link Travel

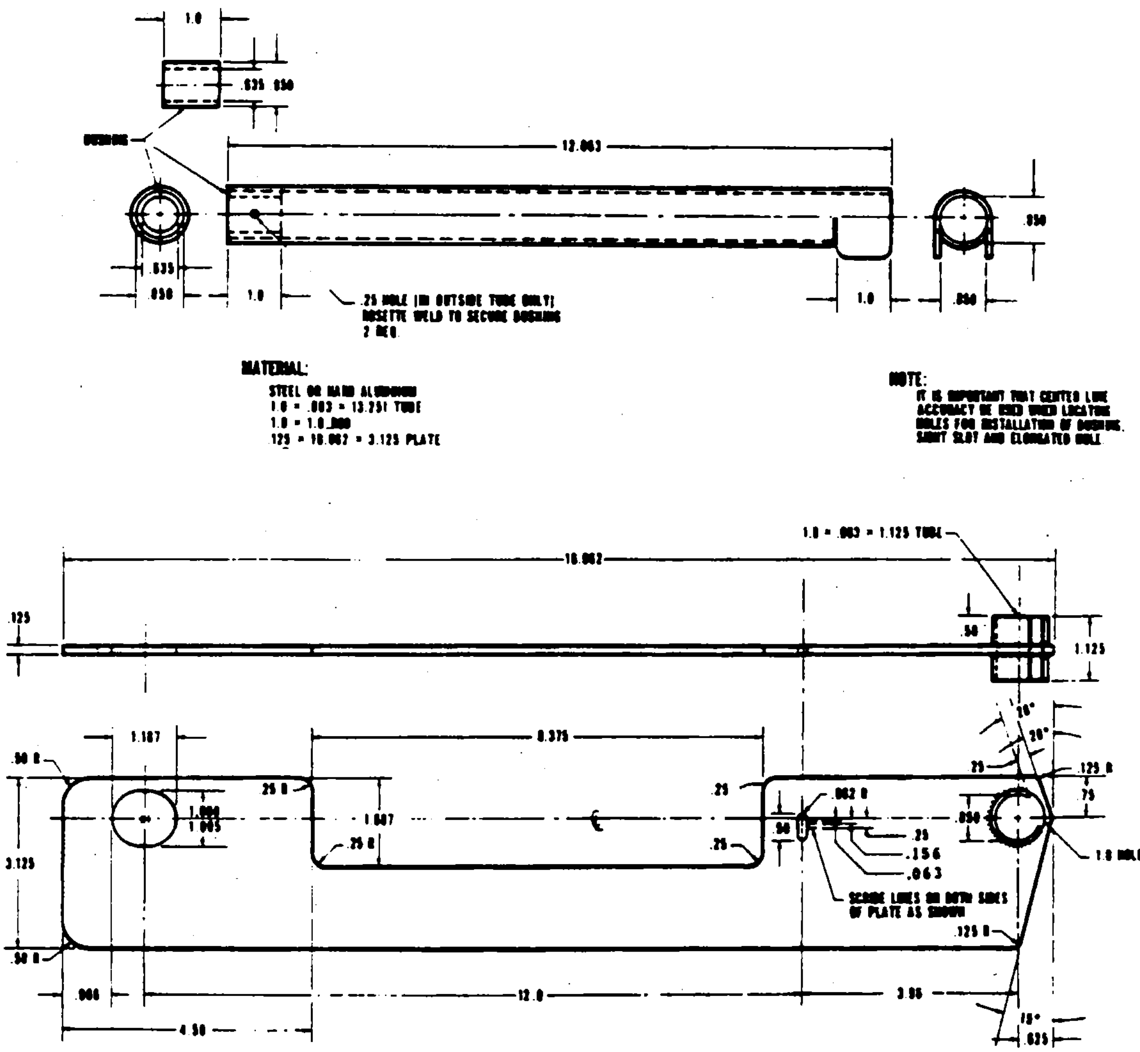


Figure 7-21. Fabricated Tool, Main Gear Side Brace Link Travel

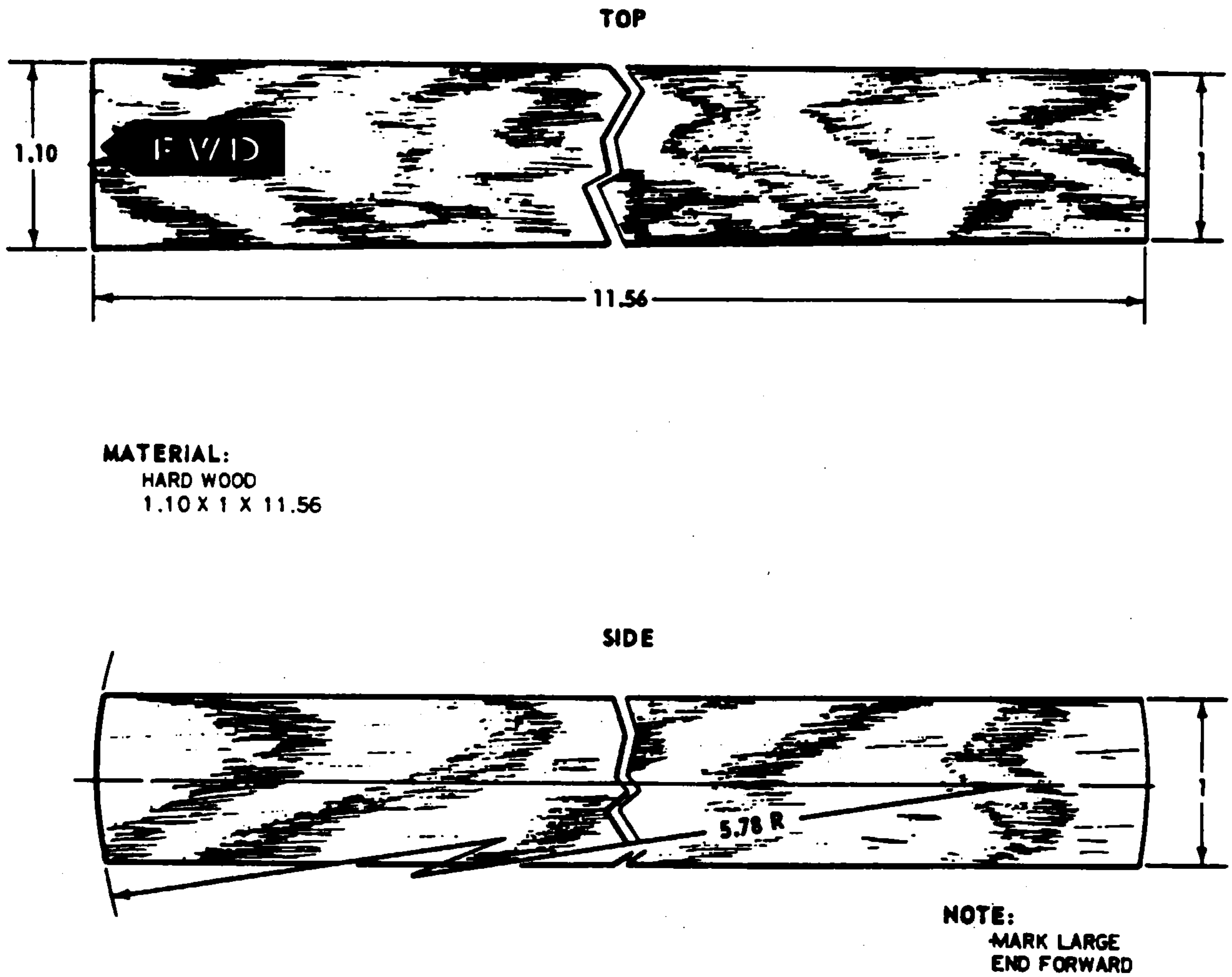


Figure 7-22. Fabricated Tool, Main Gear Toe-In Adjustment

TABLE VII-III. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM)

Trouble	Cause	Remedy
Landing gear selector handle fails to operate to gear up position.	Selector lever cannot be moved to the gear up position while the LEFT main gear strut is compressed or with the power off.	Ascertain that the LEFT main gear strut is ex tended and that the power is on.
	Faulty safety switch on left main gear.	Adjust or replace safety switch.
Gear retracts or extends before the doors open.	Priority valve leaks in power pack.	Check priority valve cracking pressure.
	Solenoid valve stuck in closed position.	Turn off power and hand pump doors open.
	Micro switch on power pack out of adjustment.	Check for bent bracket or loose mounting or wire and adjust.
Doors come open in flight.	Doors are rigged too tight.	Adjust rigging of doors.
	Micro switch on power pack out of adjustment.	Adjust micro switch.
Doors fail to close.	Circuit breaker out.	Check circuit breaker.
	Limit switch out of adjustment.	Adjust limit switch.
	Gear not fully retracted.	Check adjustment.
	Cannon plug on power pack loose.	Tighten plug.
	Solenoid valve stuck in door open position.	Check wiring to solenoid valve.

TABLE VII-III. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Nose gear fails to lock up when handle returns to neutral.	Not enough actuator stroke.	Increase the actuator stroke.
	Gear doors pinching.	Relieve door pinch by lengthening door oper ating rods.
Main gear fail to lock up.	Uplock rod out of adjustment.	Adjust rod.
	Actuator out of adjust- ment.	Adjust actuator.
No red light on panel when gear are in transit.	Circuit breaker out.	Checks circuit breaker.
	Indicator light burned out.	Replace indicator light.
	Circuit wire broken.	Check wiring.
No green light on panel when gear are down.	Circuit breaker out.	Check circuit breaker.
	Indicator light burned out.	Replace indicator light.
	Lock switch defective or out of adjustment.	Replace and/or adjust lock switch.
	Gear not locked in down position.	Adjust the gear.
Flashing red indicator light or warning horn sounding when power from one or both en- gines is above 15 inches of manifold pressure.	Throttle switches are faulty.	Replace switches.
	Throttle switches out of adjustment.	Adjust throttle switches.
Red indicator light stays on with gear up and locked.	Doors could be open.	Adjust doors.
	Switch defective.	Replace defective switch.

TABLE VII-III. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Flashing red light and warning horn fail to operate when power from both engines is reduced below 14 or 15 inches manifold pressure.	Throttle switches out of adjustment.	Adjust throttle switches.
	Throttle switches are defective.	Replace switch.
	Horn or light defective.	Replace defective part.
	Defective wiring.	Check wiring.
Nose gear shimmies during fast taxi, take-off and landing.	Internal wear in shimmy dampener.	Replace shimmy dampener.
	Shimmy dampener or bracket loose at mounting.	Replace necessary parts and bolts.
	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings	Replace bolts and/or bushings.
Main landing gear shimmies during fast taxi, take-off and landing.	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Strut bottoms on normal landing or when taxiing over rough ground.	Insufficient air and/or fluid in strut.	Service strut with air and/or fluid.
	Defective internal parts in strut.	Replace defective parts.

TABLE VII-III. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
Excessive or uneven wear on main tires. (cont.)	Wheel out of alignment (toe-in or toe-out).	Check wheel alignment.
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing.
	One brake dragging.	Determine cause and correct.
	Steering arm roller sheared at top of strut.	Replace defective roller.

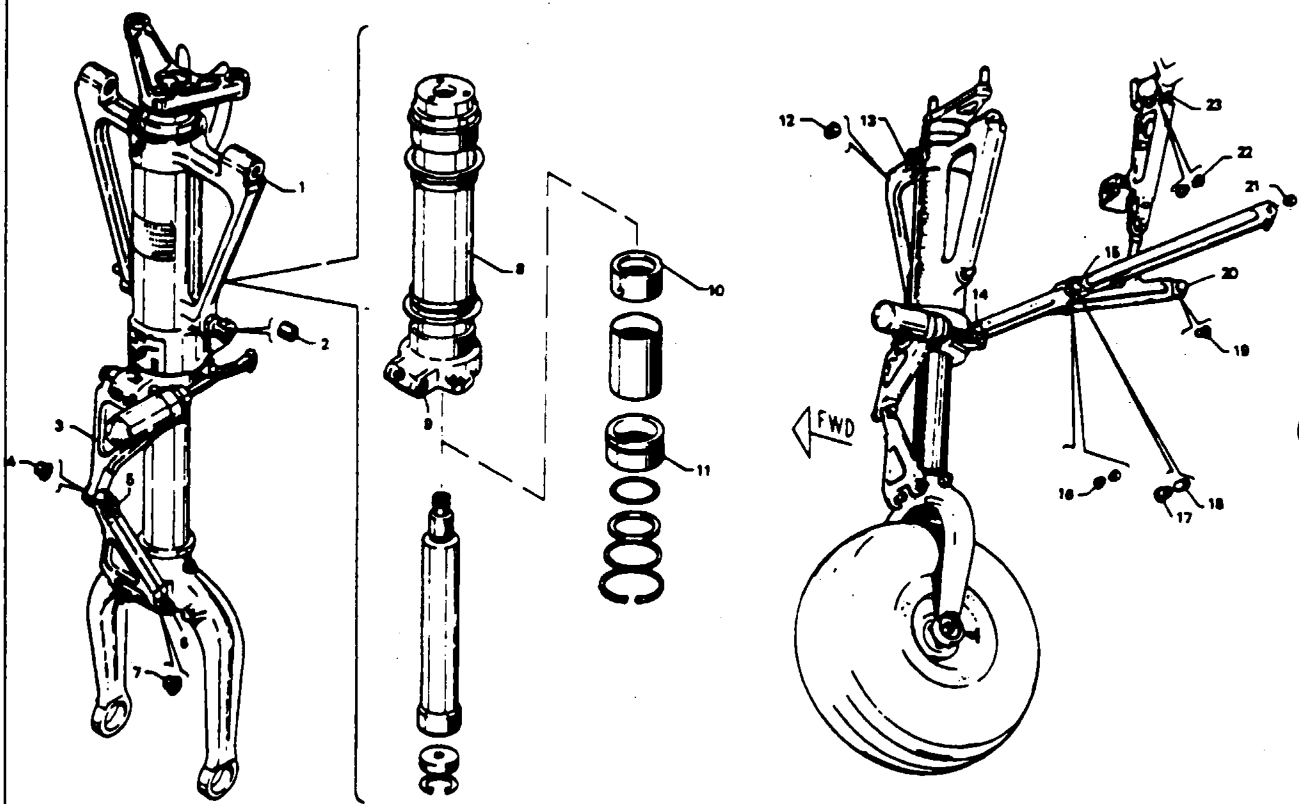


Figure 7-23. Nose Gear Wear Limits

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
1	31766-2	Trunnion Bushing	.5625 +.0015 -.0000	.5625	.5650
13	AN9-30	Trunnion Bolt - AN179 may be used to reduce play.	.5620 +.0000 -.0040	.5570	.5620
12	NAS77-9-36	Trunnion Plate Bushing	.5625 +.0015 -.0000	.5625	.5645
2	NAS75-7-016	Drag Link Lug Bushing	.4375 +.0015 -.0000	.4375	.4410
14	AN177-25	Drag Link Lug Bolt	.4367 +.0000 -.0005	.4350	.4367
16	NAS77-7-38	Lower Drag Link - Applies to both ends of link.	.4375 +.0015 -.0000	.4375	.4410
15	AN177-37	Bolt - Drag Link Joint	.4367 +.0000 -.0005	.4355	.4367
18 17 21	NAS75-7-014 NAS77-7-38 NAS77-7-68	Bushing - Upper Drag Link - L & R - Both ends	.4375 +.0015 -.0000	.4375	.4410
20	AN177-21	Bolt - Drag Link - Top L & R	.4367 +.0000 -.0005	.4350	.4367
19	NAS77-7-40	Bushing - Drag Link Plate - L & R	.4375 +.0015 -.0000	.4375	.4410
22	NAS77-4-50	Bushing - Nose Gear Idler - Top	.2500 +.0015 -.0000	.2500	.2520

Figure 7-23. Nose Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
23	AN433	Bolt - Nose Gear Idler - Top - AN174 may be used to reduce play.	.2490 +.0000 -.0030	.2455	.2490
4	31796	Bushing - Torque Link	.2510 +.0010 -.0000	.2510	.2530
5	AN17413	Bolt - Torque Link Joint	.2492 +.0000 -.0005	.2475	.2492
3	31850	Link - Torque	.3120 +.0010 -.0000	.3120	.3140
6	AN175-32	Bolt - Torque Link Attachment	.3117 +.0000 -.0005	.3105	.3117
7	31785	Bushing - Fork - Torque Link Attachment	.3130 +.0020 -.0000	.3130	.3160
9	NAS77-5-42	Bushing - Cylinder - Torque Link Attachment	.3125 +.0015 -.0000	.3125	.3160
11	31780	Bearing - Oleo Strut - Lower	1.9375 +.0020 -.0000	1.9375	1.9405
10	31799	Bearing - Oleo Strut - Upper	2.3730 +.0000 -.0020	Chrome Plate Worn Thru	2.3730
8	40275	Cylinder Assembly (Cylinder Bore)	2.3750 +.0030 -.0000	2.3750	2.3795

Figure 7-23. Nose Gear Wear Limits (cont.)

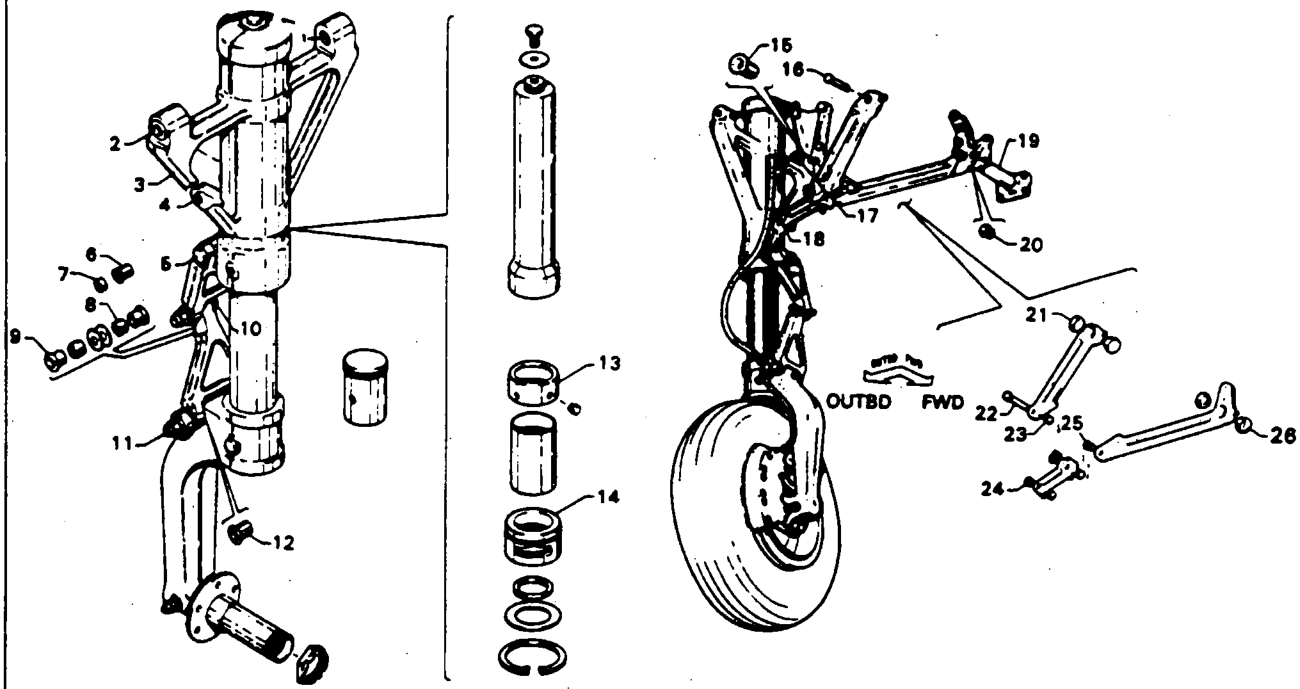


Figure 7-24. Main Gear Wear Limits

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
2 1	20737-23 43256-4 61402-99 43256-5	Bushing - Trunnion	.6245 +.0015 -.0000	.6245	.6270
17	AN 10-35	Bolt - Trunnion - AN 180 may be used to reduce play.	.6240 +.0000 -.0040	.6190	.6240
15	NAS77-10-94	Bushing - Trunnion Plate	.6250 +.0015 -.0000	.6250	.6270
4	61402-98 43256-3	Bushing - Side Brace Lug	.4990 +.0010 -.0000	.4990	.5025
18	AN178-26	Bolt - Side Brace Lug	.4991 +.0000 -.0005	.4981	.4991
24	NAS77-8-44	Bushing- Side Brace - Lower Link - Applies to both ends of link.	.5000+.0015 -.0000	.5000	.5020
22	AN178-33	Bolt - Side Brace Joint	.4991 +.0000 -.0005	.4981	.4991
23,25	NAS77-8-72	Bushing - L & R Side - Brace Link - Lower End	.5000 +.0015 -.0000	.5000	.5020
21	NAS77-8-38	Bushing - Aft Side Brace - Upper End	.5000 +.0015 -.0000	.5000	.5025
16	AN8-27	Bolt - Aft Side Brace - Upper End -AN178 may be used to reduce play.	.4990 +.0000 -.0040	.4940	.4990

Figure 7-24. Main Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
20	NAS77-8-84	Bushing - Aft Side - Brace Fitting	.5000 +.0015 -.0000	.5000	.5025
26	NAS77-18-50	Bushing - Forward Side - Brace - Upper End	1.1250 +.0015 -.0000	1.1250	1.1280
19	42058	Shaft - Forward Side - Brace Pivot	1.1245 +.0000 -.0010	1.1225	1.1245
6	20737-40 43256-2	Bushing - Housing - Torque Link Attachment	.3740 +.0020 -.0000	.3745* * Ream at install. if req.	.3775
5	AN176-42	Bolt - Torque Link to Housing	.3742 +.0000 -.0005	.3732	.3742
7	NAS75-6-011	Bushing - Torque Link	.3750 +.0015 -.0000	.3750	.3775
8 9	NAS75-7-011 NAS77-7-35	Bushing- Torque Link - Center	.4375 +.0015 -.0000	.4375	.4400
10	AN7-22	Bolt - Torque Link - Center - AN177 may be used to reduce play.	.4370 +.0000 -.0040	.4330	.4370
12	20737-40 43256-2	Bushing - Fork - Torque Link Attachment	.3740 +.0020 -.0000	.3745* * Ream at install. if req.	.3775

Figure 7-24. Main Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
11	AN176-51	Bolt - Torque Link to Fork	.3742 + 0000 -.0005	.3732	.3742
14	40246	Bearing - Oleo Strut - Bottom	2.7500 +.0020 -.0000	2.7500	2.7530
13	40247	Bearing - Oleo Strut - Top	3.2480 +.0000 -.0020	Chrome Plate Worn Thru	3.2480
3	40327	Housing Assembly (Cylinder Bore)	3.2500 +.0030 -.0000	3.2500	3.2545

Figure 7-24. Main Gear Wear Limits (cont.)

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SECTION VIII

POWER PLANT

SECTION VIII

POWER PLANT

8-1. INTRODUCTION. This section provides instructions for remedying difficulties which may arise in the operation of the power plant and its related components. The instructions are organized so that the mechanic can refer to: Description and Principles of Operation for a basic understanding of the power plant and its various components; Troubleshooting for a methodical approach in locating the difficulty; Corrective Maintenance for the removal, repair and installation of components; and Adjustments and Tests for the operation of the repaired power plant and related components.

8-2. DESCRIPTION. The PA-31P-Pressurized Navajo is powered by two Avco-Lycoming TIGO-541-E1A six cylinder, gear drive, wet sump, fuel injected, turbocharged, horizontally-opposed, air-cooled engines with a compression ratio of 7.3:1, rated at 425 HP at 2133 propeller RPM and designed to operate on 100/130 (minimum) octane aviation grade fuel.

The cowling completely enclose the engines and consist of an upper and lower section. The cowling is of cantilever construction attached at the firewall. There are doors located on the left side of the upper cowls that hinge upward when their fasteners are released to allow inspection of the accessory section and turbocharger area, and also to gain access to the oil dipstick. A cowl flap door is an integral part of the lower cowl and is operated through mechanical linkage and an electric motor with a solenoid brake.

The propellers are Hartzell full feathering, constant speed, each controlled by a governor mounted on the engine supplying oil through the propeller shaft at varying pressures. Oil pressure from the governor moves the blades into low pitch (high RPM). The centrifugal twisting moment of the blades also tends to move the blades into low pitch. Opposing these two forces are blade counter weights and the force produced by compressed air between the cylinder head and the piston which tends to move the blades into high pitch in the absence of governor oil pressure. Included in the system are unfeathering accumulators capable of storing oil at governor pump pressure during normal operation. A check valve in the governor closes and traps the oil in the accumulator under pressure when the propeller is feathered. To unfeather the propeller the check valve is opened. Thus, if the propeller is unfeathered in flight it will windmill and crank the engine for an easy air start.

The induction system consists of a dry type air filter, an alternate air door, a Bendix fuel injector which meters fuel in proportion to air flow to a nozzle cluster at a central distribution zone. The fuel pump is an integral part of the fuel injector system, and the turbocharger is mounted as an integral part of the engine. Automatic waste gate control of the turbocharger provides constant air density at the fuel injector inlet from sea level to critical altitude.

Bendix Scintilla S-1200 series magnetos are installed with their associated components. Each system consists of a single contact magneto, a dual contact magneto to obtain the retard spark necessary for starting, a starter vibrator, magneto switches, and starter switch.

In addition to the above-mentioned components, each engine is equipped with a 100 amp alternator, geared starter, hydraulic pump, pneumatic pump and sonic nozzle on the turbocharger to provide air for cabin pressurization. The exhaust stacks and extensions are positioned along each bank of cylinders extending aft to the turbocharger exhaust transition, through the turbine, and exhaust wastegate and overboard at the bottom of the engine nacelle.

This engine has a wet sump pressure oil system with a capacity of eighteen quarts. The oil pump, which is located in the lower aft portion of the crankcase, draws oil through a drilled passage leading to the oil suction screen located in the sump. The oil from the pump then enters a passage in the left crankcase half, where a flexible line leads the oil to the external oil cooler. Oil from the cooler returns to engine and is directed to the oil filter. In the event of an obstruction, or cold oil should restrict the oil flow to the cooler, a bypass valve is provided to pass the oil directly from the oil pump to the oil filter. The oil filter element is located on the aft portion of the right crankcase half and provides a means of filtering any solid particles from the oil that may have passed through the suction screen in the sump. After being filtered, the oil is fed through a passage to the oil pressure relief valve. This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the oil pressure is fed to the main oil gallery in the crankcase. Residual oil is returned by gravity to the sump, where it passes through the screen and filter and again recirculated through the engine.

The complete engine assembly is supported on a mount made of steel tubing, incorporating vibration absorbing dynafocal mounts, and attached at the firewall.

8-3. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-III in the back of this section, along with their probable causes and suggested remedies. The table is divided into two parts, engine and turbocharger. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

8-4. ENGINE COWLING.

8-5. REMOVAL OF ENGINE COWLING. (Refer to 8-1.) The procedure for removing the cowling is the same for either engine.

a. Release the fasteners (8 and 10) that attach the two cowl halves (1 and 2).
b. To remove the cowl half (2), disconnect the transmission tube (4) from the flap (3), support the cowl and release the screw fasteners (8) that secure the aft section to the nacelle.
c. The upper half may be removed by releasing the screw fasteners (9) that secure the aft section to the nacelle.

CAUTION

Ground running with the cowling removed, maximum power ground running is limited to two (2) minutes or cylinder head temperature of 450° F, whichever is reached first. Prolonged ground running with the cowling removed could cause local hot spots in the cylinders and irreversible engine damage.

8-6. CLEANING, INSPECTION AND REPAIR OF ENGINE COWLING.

a. The cowling should be cleaned with a suitable solvent and then wiped with a clean cloth.
b. Inspect the cowling for dents, cracks, loose rivets, damaged or missing fasteners and damaged fiberglass areas.
c. Repair all defects to prevent further damage. Fiberglass repair procedures may be accomplished according to: Fiberglass Repairs, Section IV.

8-7. INSTALLATION OF ENGINE COWLING. (Refer to Figure 8-1.) The procedure for installing the cowl is the same for either engine.

a. Position the upper cowl half (1) and secure with screw fasteners (9) along the aft section of the cowl.

WARNING

The cowling fastener locked position stripe must be maintained.
Refurbish or replace stripe if faded, missing or cowling is repainted

b. Raise the lower half (2) to join the upper half, secure the screw fasteners (8) along the aft section of the cowl and lock the fasteners (8 and 10) that join the two halves. Fasteners (8 and 10) have a dark line painted along the top half of the fastener and cowling. This is done so a visual check can distinguish when the fasteners are open or closed. In addition to the paint stripe, each fastener has a pin in the center of the screw slot that, when properly locked, will protrude into the slot when screw driver is removed.
c. Connect the transmission tube (4) to the cowl flap (3).

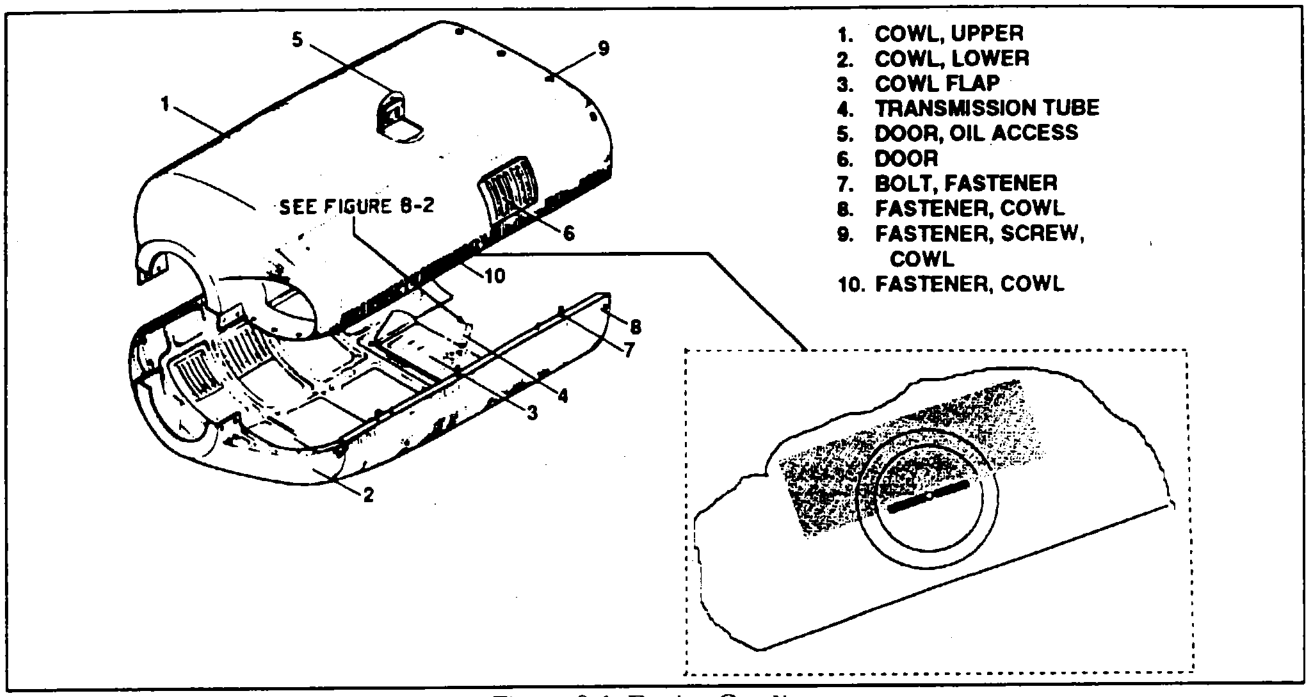


Figure 8-1. Engine Cowling

8-8. ENGINE COWL FLAP.

8-9. REMOVAL OF COWL FLAP TRANSMISSION. (Refer to Figure 8-2.)

a. Disconnect the electrical leads at the transmission motor.
b. Disconnect the transmission rod end from the attaching bracket on the cowl flap.
c. Disconnect the transmission from the mounting bracket on the firewall, and remove the complete assembly from the engine compartment.

8-10. CLEANING, INSPECTION, AND REPAIR OF COWL FLAP TRANSMISSION.

a. Clean the transmission assembly with a suitable solvent.
b. Inspect the transmission tube for excessive end or side play on the-transmission screws.
c. Check that the transmission tube, screw and rod end are not distorted or bent.
d. Check that the screw bearing is not loose on the transmission screw or within the transmission housing. Excess wear can be determined by holding the transmission and moving the screw up and down.
e. Check for excess wear within the transmission by turning the screw by hand and noting the end and side play in the transmission drive shaft. End play should not be great enough to cause end pressure on the motor drive shaft.
f. Should any of these checks show excess wear, corrosion or damage, the transmission or its components should be replaced.
g. Check the solenoid brake assembly for any excess wear, broken parts, sticking or burned out solenoid, and repair or replace the assembly.
h. After the transmission screw and tube have been cleaned and dried, a coating of Aircraft Grease and Actuator Grease, MIL-G-23827, should be applied to the screw on Dukes transmissions. Use MIL-G-7118 for Dura transmissions.
i. When the transmission assembly is disassembled for any reason, or at 500 hours, it should be repacked three-fourth minimum full with Dukes Formula No. 2, P/N 2196-74-1 grease (for Dukes units), or one-half full with MIL-G-7118 grease (for Dura units)

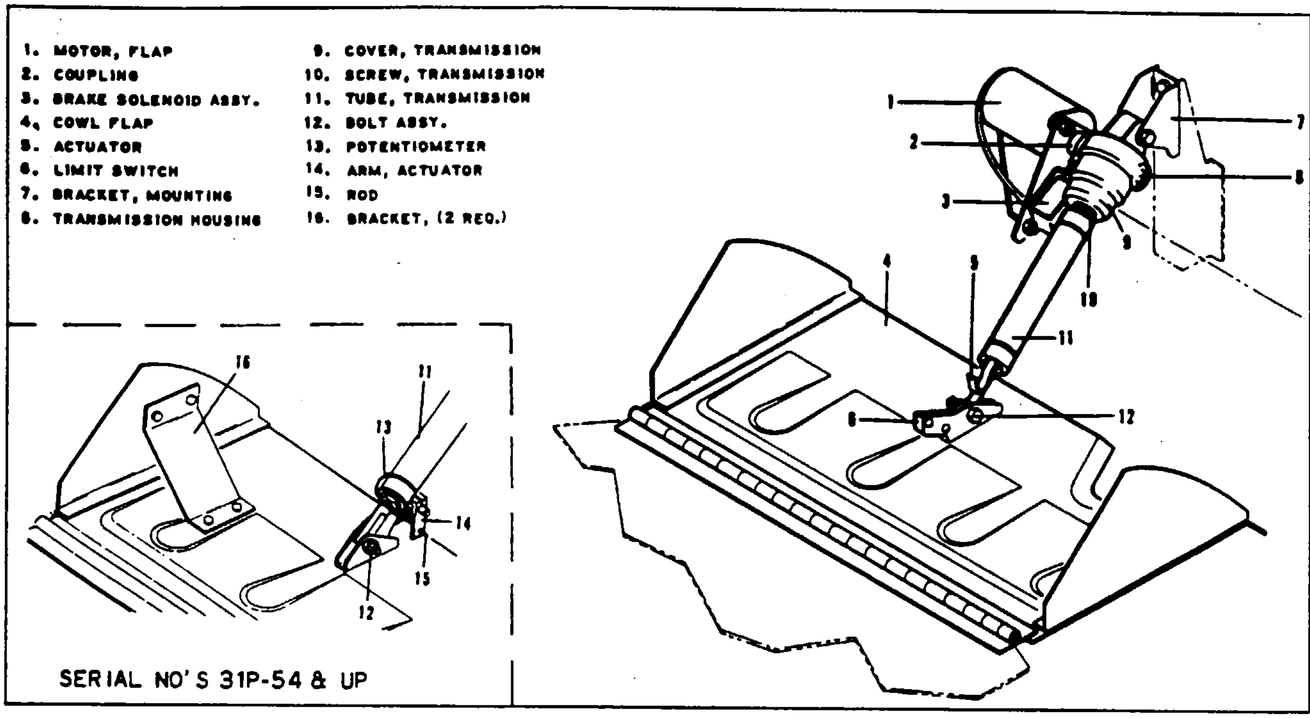


Figure 8-2. Cowl Flap Transmission Installation

8-11. INSTALLATION OF COWL FLAP TRANSMISSION. (Refer to Figure 8-2.)

a. Position the transmission assembly on its mounting bracket against the firewall and secure. Allow the transmission to rotate on its mounting bolt.
b. Attach the transmission actuating rod end to the mounting bracket on the cowl flap and secure. Tighten the connecting bolt finger tight and safety.
c. Adjust the nuts on the rod which aligns the brake assembly with the transmission tube to obtain an even application of braking pressure to the motor coupling.
d. Connect the electrical leads.
e. Check the adjustment of the cowl flap per paragraph 8-12.

8-12. RIGGING AND ADJUSTMENT OF COWL FLAP.

a. Adjust the rod end so the cowl flap is flush with the cowling in the fully closed position and the transmission tube approximately 0.25 inch from its upper limit.
b. On models PA-31P-1 to 53, adjust the cowl flap switch actuator on the rod end to activate the switch just before the cowl flap is fully opened. On models PA-31P- 54 and up with the potentiometer (rheostat) installed, see paragraph 11-72a for adjustment procedure.
c. Check all bolts and adjusting jam nuts for security.
d. Check the complete operation of the cowl flaps and indicator lights or indicator meters.

8-13. PROPELLER.

WARNING

Before performing any service functions on the propeller, ascertain that the master switch is OFF, the magneto switches are OFF (ground) and the mixture control is in the IDLE CUT-OFF position.

CAUTION

Under no condition should blade arms be used on this propeller.

8-14. REMOVAL OF PROPELLER. (Refer to Figure 8-3.) When removing the propeller, it is unnecessary to remove the spinner and air charge or for the blades to be feathered. When removing the propeller for overhaul, the blades should be feathered and the spinner removed.

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Remove the spinner nose cap (14) by removing attaching screws (13).
b. Remove the spinner (4) by removing the safety wire (15) and check nut (19) from the propeller at the forward side of the forward spinner bulkhead and the screws (5) that secure the spinner to the aft bulkhead.
c. Remove the engine cowling. (Refer to paragraph 8-5.)
d. Place drip pan under propeller to catch oil spillage.
e. Remove safety wire (1) and elastic stop nuts (2) from mounting studs (7).

NOTE

A special adapter P/N TL-846583 is available through Piper Service Dept. to facilitate the removal and installation of the stop nuts (2).

f. Remove propeller from engine flange (3) by removing attachment nuts and washers (23).
g. Cap engine flange to prevent contamination.
h. Remove deicer slip ring from propeller hub (if installed).
i. Remove spinner bulkhead from propeller hub.

CAUTION

When the propeller is removed in the feathered position be sure control lever is not moved out of the feathered position releasing trapped oil under pressure in the accumulator.

8- 15. CLEANING, INSPECTION AND REPAIR OF PROPELLER.

a. Check for oil and grease leaks.
b. Clean the spinner, propeller hub interior and exterior, and blades with a noncorrosive solvent.
c. Inspect the hub parts for cracks.
d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if necessary, or replate during overhaul.
e. Check all visible parts for wear and safety.
f. Remove air charge and check blades to determine whether they turn freely on the hub pivot - tube. If they appear tight, the propeller should be overhauled.
g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. Refer to Figure 8-4 for propeller blade care.
h. Check condition of propeller mounting nuts and studs.

i. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or A Certified Propeller Repair Station.
j. Each blade face should be sanded lightly and painted, when necessary, with a flat black paint to retard glare. A light application of oil or wax may be applied to the surfaces to prevent corrosion.
k. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply four to six shots of grease in each zerk fitting.
l. Install air charge and check for air leaks by applying soap solution around air valve and stop adjustment nut. Internal leakage will show up as air flows through the piston tube.

8-16. INSTALLATION OF PROPELLER. (Refer to Figure 8-3.)

a. Clean propeller and engine flanges.
b. Install spinner bulkhead and deicer slip ring (Optional Equipment) on propeller and torque bolts to specifications given in Table VIII-I.
c. Lubricate and install "O" ring (6) in propeller shaft hole.
d. Mount propeller on engine flange and secure with new elastic stop nuts and washers. Screw each nut a few threads at a time until all are tight.
e. Torque nuts to specifications given in Table VIII-I. Safety the attaching nuts with MS20995C41 wire.

NOTES

1. *Do not lubricate propeller mounting bolts. Torques given in Table VIII-I are based on dry thread values.*
2. *The use of special adapter, P/N TL-846583 will simplify the installation and torquing of the elastic stop nuts. This adapter is available through Piper Service Department.*

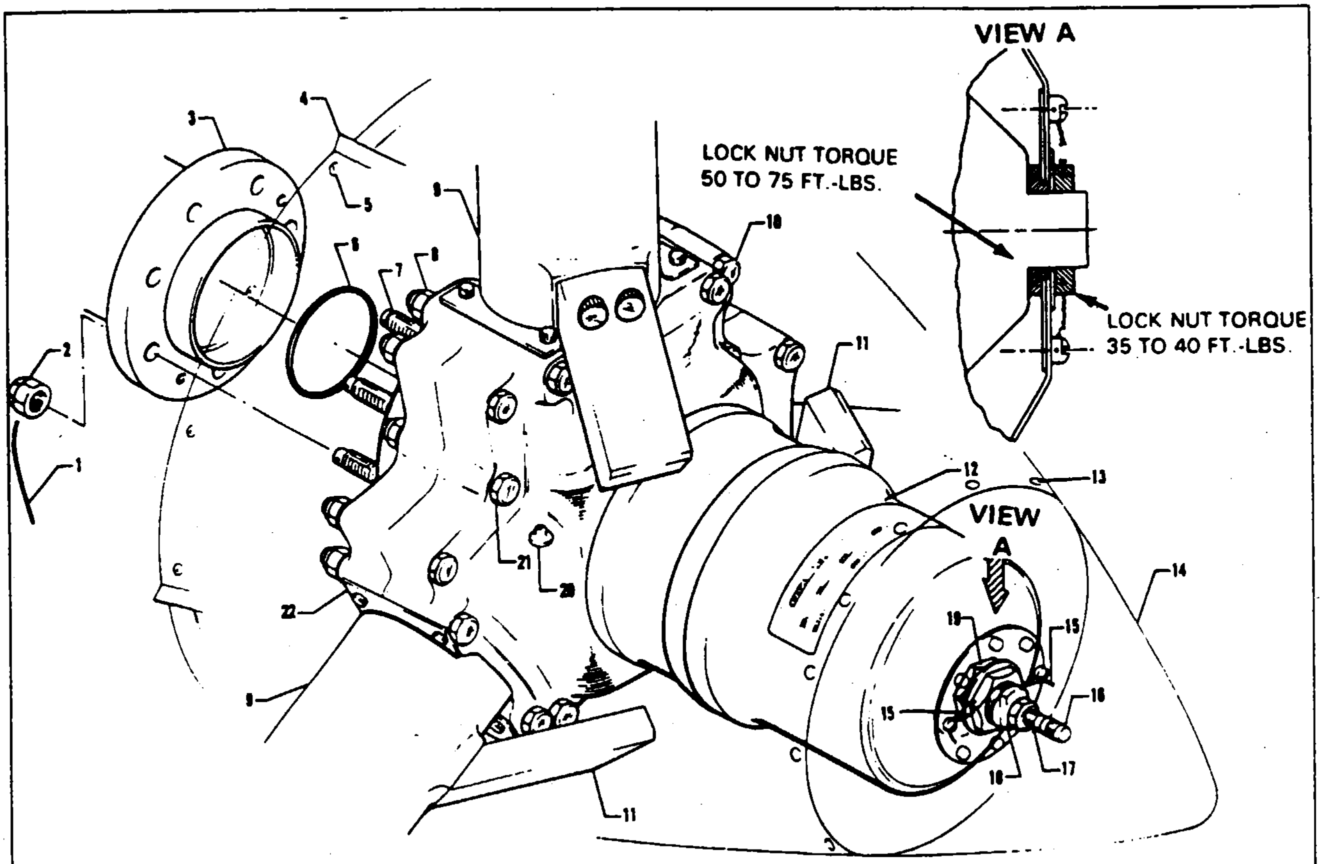
f. Install spinner (4). Torque spinner screws (5) and check nut (19) per Table VIII-I. Safety check nut with MS20995C41 wire (15) two places.
g. Charge the cylinder through air valve (17) with dry air or nitrogen gas to the prescribed pressure. Refer to the placard in the spinner cap (14) or Table VIII-I of this manual for an exact pressure for the existing temperature. It is most important that an accurate air charge be maintained.

NOTE

Do not check pressure or charge with PROPELLER in feather position.

CAUTION

To obtain an accurate pressure reading when checking propeller dome air pressure or to insure complete release of all air pressure, place the propeller CONTROL in the feather detent before measuring or releasing propeller air pressure. This procedure will insure the free flow of all air within the prop dome and prevent possible error in pressure readings or injury to service personnel should the low pitch stop be removed.



1. SAFETY WIRE
2. NUT, ELASTIC STOP
3. ENGINE MOUNTING FLANGE
4. SPINNER
5. SCREW, SPINNER ATTACHMENT
6. "O" RING
7. MOUNTING STUDS
8. NUT, ELASTIC STOP
9. BLADE, PROPELLER
10. BOLT
11. COUNTERWEIGHT
12. PROPELLER DOME
13. SCREW, CAP ATTACHMENT
14. CAP, SPINNER
15. SAFETY WIRE
16. CAP, AIR VALVE
17. AIR VALVE
18. LOW PITCH ADJUSTMENT
19. CHECK NUT, SPINNER
20. GREASE FITTING
21. BOLT
22. WEIGHT, BALANCE
23. WASHER

Figure 8-3. Propeller Installation

h. The amount of air pressure per existing temperature, as shown by the placard, is very important and should always be used. If excessive pressure is used in the propeller, there is a possibility of feathering taking place at idle speed when the engine is warm and the oil is thin. An accurate air pressure gauge should always be used. A pressure gauge and valve kit, part number 756 771, may he purchased through a Piper Service Spares Dealer or Distributor.
i. When recharging the propeller, dry air or nitrogen gas should be used. The main thing is not to allow moisture to enter the air chamber as this could cause the piston to freeze during cold weather operation.
j. Test for leakage by using a soap solution or equivalent and applying it around valve and stop adjustment nut.

CAUTION

Use blade arms on all three blades to unfeather propeller. Position blade arms as close to the hub as possible.

k. If the propeller is in feather on the ground and it is undesirable to run it out of feather through engine operation due to the roughness which will occur, then remove the air charge, turn the blades by hand, and replace the air charge.

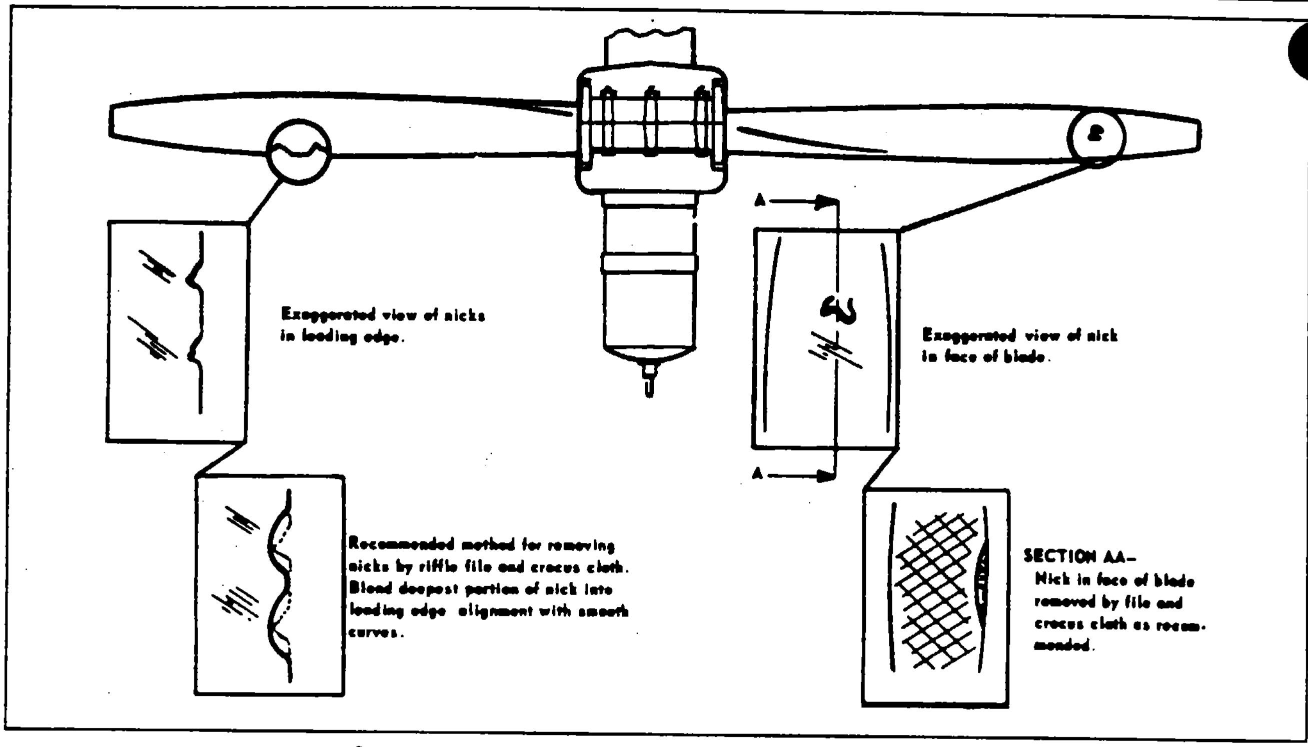


Figure 8-4. Typical Nicks and Removal Method

l. Install engine cowling and spinner cap.

8-17. ADJUSTMENT OF LOW PITCH BLADE ANGLE AND STOP. (Refer to Figure 8-3.)

a. The propeller comes from the factory with the low pitch stop adjusted for proper blade angle. If, however, this adjustment has been disturbed, the following procedure is given for obtaining blade angle:

   1. The blade angle (refer to Table VIII-I) is determined by placing a propeller protractor on the face side of the propeller at the 30 inch station as measured from the hub center line. The blade must be horizontal.
   2. The low pitch stop adjustment is made by a screw in the nose of the propeller cylinder. Remove spinner and loosen stop screw jam nut. Rotating the screw clockwise increases the low pitch and reduces the static RPM by about 100 RPM for each half turn, or vice versa.

CAUTION

Before adjusting the low pitch stop screw, the air pressure should be dropped to zero. Unless this is done, it is possible to unscrew the low stop far enough to disengage the threads, allowing the air pressure to blow the stop screw out with great force. To insure the complete discharge of all air pressure within the dome, place the propeller CONTROL in the feather detent. There should be at least four of the twenty threads of the stop screw engaged.

b. After the low pitch stop has been adjusted for proper blade angle, the governor should then be adjusted to obtain maximum rated engine RPM during takeoff and climb.

TABLE VIII-I

PROPELLER SPECIFICATIONS

Blade Angle (3 Blades)	Low Pitch (High RPM) High Pitch (Feathered)	17.2° (1) 85.7°±1° (1)
(1) MEASUREMENT TAKEN AT 10 INCH STATION		
Propeller RPM Setting	Engine Static High RPM	2133 RPM Max.
Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead (Aft)	22 foot pounds
	Propeller Mounting Nuts	85 to 95 foot-pounds
	Spinner Bulkhead Check Nut	35-40 foot pounds
	Spinner Attachment Screws	40 inch pounds

Without Feather Assist Spring Assembly				CHAMBER PRESSURE REQUIREMENTS WITH TEMPERATURE	With Feather Assist Spring Assembly
HC-C3YN-2L or HC-C3YN-2LF				HC-C3YN-2LUF	
Temp. °F	Press. (psi)	Temp. °F	Press. (psi)	Temp. °F	Press. (psi)
100	86	30	72	70 to 100	41 ± 1 lb.
90	84	20	70	40 to 70	38 ± 1 lb.
80	82	10	68	0 to 40	36 ± 1 lb.
70	80	0	66	-30 to 0	33 ± 1 lb.
60	78	-10	64		
50	76	-20	62		
40	74	-30	60		

NOTE: Do not check pressure or charge with propeller in feather position.

c. In order to test whether the governor or the propeller low stop is limiting the static RPM, the operator can run the engine up on the ground. With the throttle wide open, increase RPM slowly with the RPM control. If the propeller low stop is limiting the RPM, the RPM will stabilize before the RPM control reaches the limit of its travel. If the RPM increases continuously during the entire movement of the RPM control, the governor is limiting the static RPM and not the propeller low stop.

8-18. BLADE TRACK. Blade track is the ability of one blade tip to follow the other, while rotating, in almost exactly the same plane. Excessive difference in blade track - more than .062 inch - may be an indication of bent blades or improper propeller installation. Check blade track as follows:

a. With the engine shut down and blades vertical, secure to the airplane a smooth board just under the tip of the lower blade. Move the tip fore and aft through its full "blade-shake" travel, making small marks with a pencil at each position. Then center the tip between these marks and scribe a line on the board for the full width of the tip.
b. Carefully rotate propeller by hand to bring the remaining blades down. Center the tips and scribe a pencil line as before and check that lines are not separated more than .062 inch.
c. Propellers having excess blade track should be removed and inspected for bent blades, or for parts of sheared "O" ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly. Other conditions will require installation in the prescribed manner. (Refer to paragraph 8-16.)

8-19. PROPELLER GOVERNOR.

8-20. REMOVAL OF PROPELLER GOVERNOR. (Refer to Figure 8-5.)

CAUTION

Always make sure propeller control is in low pitch position to bleed off accumulator oil pressure before disconnecting accumulator line from governor.

a. Remove top engine cowl. (Refer to paragraph 8-5.)
b. Remove outer half of governor control shield by removing the aft clamp and forward screw securing the shield halves together.
c. Remove control arm by removing attaching nut and screw.
d. Remove control cable from bracket by removing nuts, screws and clamp.
e. Loosen clamp securing inner half of governor control shield to governor and remove shield.
f. Remove accumulator oil line from governor. Do not remove fitting (5) from governor.
g. Remove nuts washers and cap screw securing governor and governor control bracket to engine.
h. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit is not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8-21. INSTALLATION OF PROPELLER GOVERNOR. (Refer to Figure 8-5.)

a. Clean the mounting pad thoroughly making very certain that there are no foreign particles in the recess around the drive shaft.
b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.
c. Position governor and control cable bracket on mounting studs and secure with washers, lock washers and nuts.
d. Secure cable bracket to engine with lock washer and cap screw.
e. Connect the accumulator oil line to the governor.
f. Install inner half of governor control shield on governor head and secure with clamp.
g. Secure control extension arm to governor control arm with screw and nut.
h. Install the outer governor control shield and secure with screw and clamp.

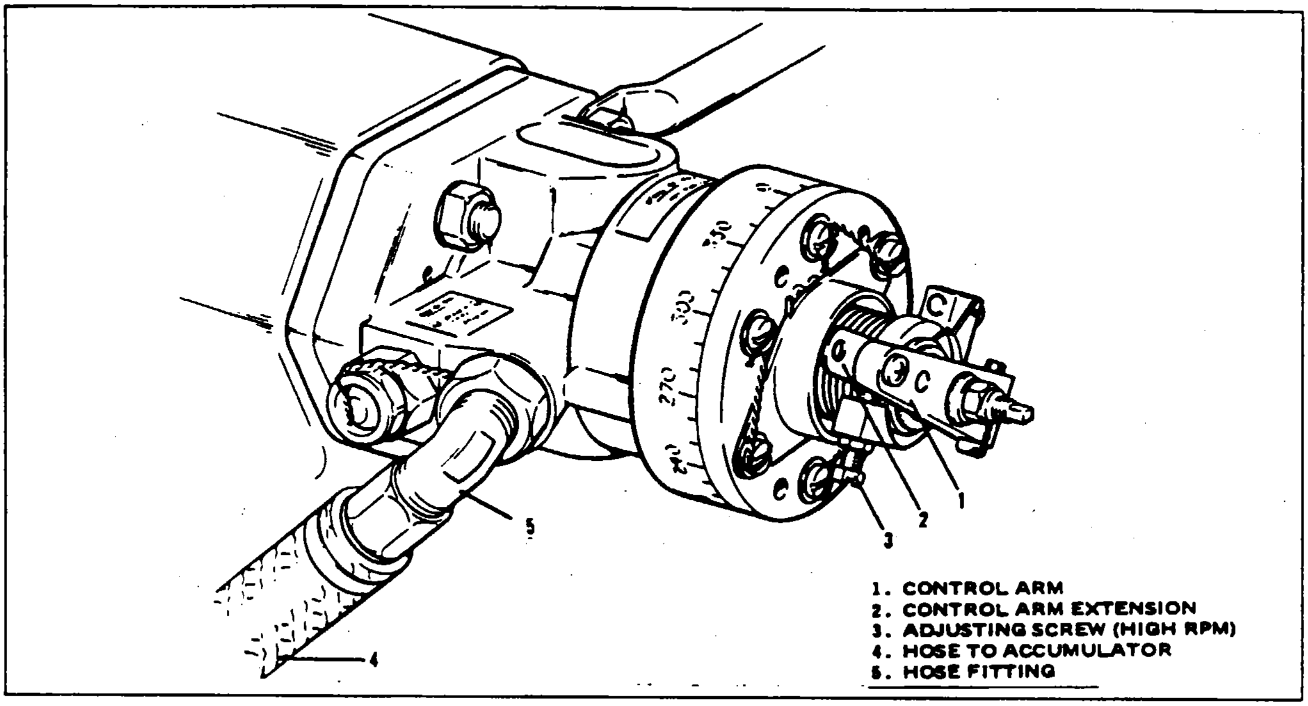


Figure 8-5. Propeller Governor

8-22. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8-5.)

a. Start engine and warm up in the normal manner.

b. To check high RPM, low pitch setting, move the propeller control all the way forward to the increase propeller position. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (3). With the throttle full forward, observe propeller RPM, which should be 2133 RPM with high RPM properly adjusted.

c. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

   1. Shut down the engine and remove the upper engine cowl.
   2. Adjust the governor by means of the fine adjustment screw (3) for 2133 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

   3. Reinstall upper engine cowl and repeat step b, to ascertain proper RPM setting.
   4. After setting the proper high RPM adjustment, run the locknut on the fine adjustment screw against the stop ring projection to lock.

d. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the cockpit lever is 0.062 to 0.125 inch from its full forward stop, which is located in the control pedestal. To adjust the control lever travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the end to obtain the desired lever clearance. Reconnect the cable end and tighten jam nut.

e. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8-23. PROPELLER UNFEATHERING SYSTEM. The unfeathering system consists of a nitrogen charged accumulator, a special governor, and a hose running from the governor to the accumulator. The governor contains a spring-loaded check valve which is unseated while the propeller control is in any position except FEATHER thus permitting governor pressurized oil to flow to and from the accumulator. When the propeller control is moved to the FEATHER position, the check valve is seated and oil under pressure is trapped in the accumulator and hose. As the propeller control is moved out of the FEATHER position, the trapped oil flows back through the governor to the propeller to unfeather it.

CAUTION

Always release system pressure by placing the propeller control in UNFEATHER position, before disconnecting the hose between accumulator and governor or removing accumulator.

The gas charge should be checked every 50 hours and replenished as required. (Refer to Paragraph 8-26 for charging instructions.) If a unit will not hold 70 to of its charge from one check to the next, it should be overhauled.

NOTE

The unfeathering accumulator is part of the propeller system and must be overhauled by an approved propeller governor repair station.

An accumulator that has lost its gas charge and is filled solid with oil may fail from overpressure during flight, if the unfeathering check valve in the propeller governor is improperly set or after engine shutdown, if the propeller controls are left in or near the feather position. In either case, the oil may be trapped in the accumulator with no expansion space. An 84°F temperature rise will expand the trapped oil enough to create about 1400 psi pressure which could fail the accumulator allowing the loss of engine oil.

8-24. REMOVAL OF PROPELLER ACCUMULATOR. (Refer to Figure 8-6.)

a. Ascertain propeller control is in the UNFEATHERED position.
b. Remove top engine cowl. (Refer to Paragraph 8-5.)

CAUTION

Always make sure pressure is bled off the accumulator before disconnecting pressure line.

c. Disconnect oil pressure line at accumulator and cap end of line.
d. Remove accumulator from engine by removing bolts, nuts, and capscrews securing mounting bracket to engine.
e. Remove mounting bracket from accumulator by removing nuts and screws.

8-25. INSTALLATION OF PROPELLER ACCUMULATOR. (Refer to Figure 8-6.)

NOTE

Check rubber mount in accumulator support bracket on number two (2) cylinder for deterioration and cracking.

a. Install mounting bracket on oil end of accumulator and secure with screws and nuts.
b. Position accumulator and insert fiber spacer between bracket and engine crankcase. Secure with washers, lock washers and capscrews.
c. Secure air end of accumulator to existing bracket with bolts and nuts.
d. Attach oil line to governor.
e. If not already done, charge accumulator with nitrogen to 125-130 psi. (Refer to Paragraph 8-26.)

8-26. CHARGING PROPELLER ACCUMULATOR.

a. Place propeller control in the UNFEATHER position before charging the accumulator to prevent the possibility of oil under pressure being trapped in the accumulator.
b. Although the accumulator will function properly when charged with compressed air, dry nitrogen gas is recommended to minimize corrosion and prevent moisture from freezing inside the accumulator.
c. Either too much pressure or not enough pressure in the accumulator will reduce efficiency of the unfeathering system. With a normal amount of friction within the propeller, the accumulator should be charged to 125-130 psi pressure.
d. Always check that the filler valve does not leak after charging an accumulator.

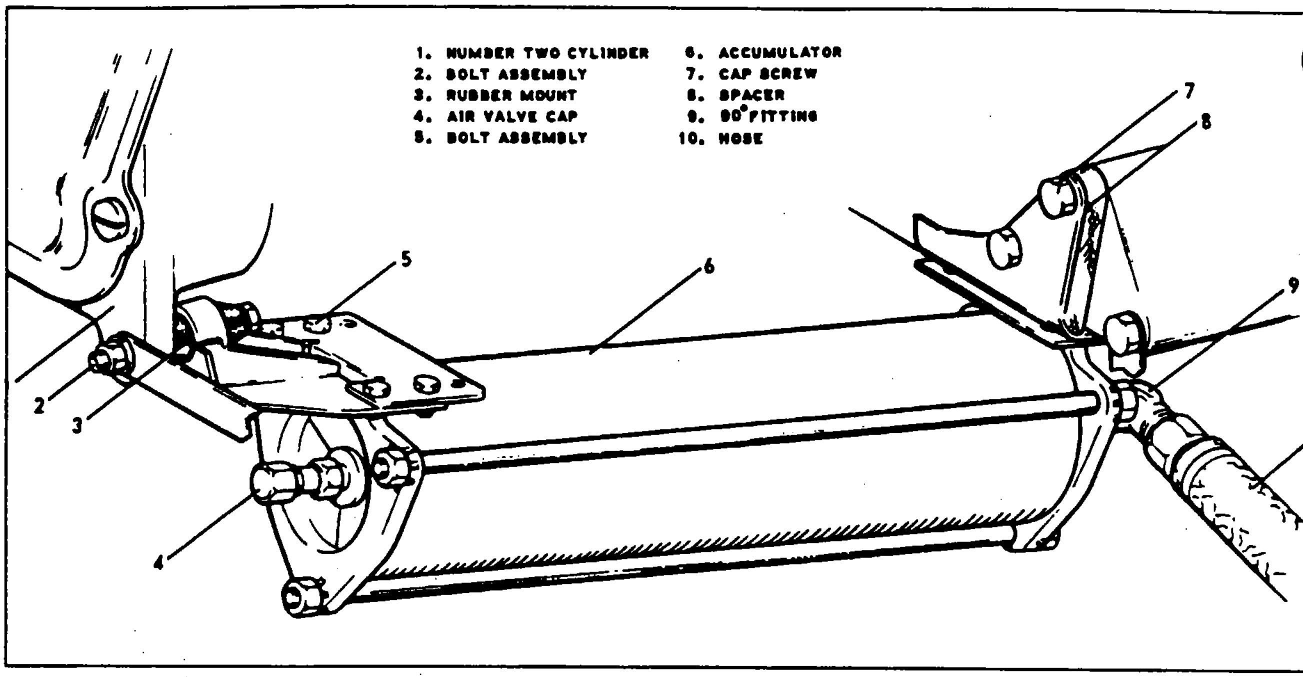


Figure 8-6. Propeller Accumulator Installation

8-27. OPERATIONAL CHECK OF PROPELLER UNFEATHERING SYSTEM.

a. With engines operating at 1500 RPM, move propeller controls to the FEATHER position, (ascertain that a positive detent is felt), then move mixture to IDLE-CUTOFF. The propellers should move, to the feathered position.
b. Move propeller controls to an unfeathered position. Propellers should unfeather.
c. If propellers do not unfeather, check system for leaks and proper pressure.

8-28. ENGINE.

8-29. REMOVAL OF ENGINE. (Refer to Figure 8-7.) The removal of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc. does vary between engines. Each line should be identified to facilitate reinstallation and covered, where disconnected to prevent contamination.

a. Turn off all cockpit switches and then disconnect the battery ground wire at the battery.
b. Move the fuel valve control lever located on the outboard side of the fuel selector panel labeled "Emergency Fuel Shut-off," to the OFF position.
c. Remove the engine cowling per paragraph 8-5.
d. Remove the access panels on the top, sides and inboard bottom of the nacelle, just aft of the firewall.
e. Drain the engine oil, if desired, and reinstall drain plug.
f. Remove the propeller per paragraph 8-14.
g. Disconnect the starter cable at the starter, remove the cable clamps at the left side of the engine and engine mount, and draw the cable aft through the engine baffle to the firewall.
h. Disconnect the governor control cable at the governor, remove cable clamps and draw cable aft through the engine baffle to the firewall.
i. Disconnect mixture control cable at injector unit, remove cable clamps and draw cable aft through the engine baffle to the firewall.

j. Disconnect magneto "P" lead and retard lead from left magneto.
k. Disconnect oil temperature leads from sender located aft of number five cylinder and ground lead from left rear engine baffle.
l. Remove exhaust gas temperature probe from exhaust transition.
m. Disconnect induction air control cable from inlet duct valve assembly, remove clamps and draw cable aft through the engine baffle to the firewall.
n. Disconnect throttle control cable at injector unit, remove clamps and draw cable aft through the engine baffle to the firewall.
o. Disconnect the propeller deicer electrical leads (optional equipment). Alternator primary lead, alternator field leads, ammeter shunt wires, cylinder head temperature probe (number two cylinder on left engine and number three cylinder on right engine), electrical lead from compressor unit (right engine only) and ground leads from left engine bonding strap fitting.
p. Disconnect tach generator electrical leads at disconnects at firewall.
q. Disconnect magneto "P" lead from right magneto.
r. Disconnect the following lines at the firewall: Fuel flow pressure, Heater fuel, Instrument air deck pressure, Manifold pressure, Hydraulic suction, Fuel supply, Oil pressure, Hydraulic pressure and air conditioning compressor lines (right engine only).
s. Disconnect the alternate air duct by loosening clamps.
t. Disconnect pneumatic pump pressurization tube at pneumatic pump.
u. Disconnect turbo pressurization tube at coupling aft of the firewall by removing safety wire and cap screws from coupling and attaching screws securing tube to firewall.
v. Attach a one-half ton (minimum) hoist to the hoisting hooks and relieve the tension on the engine mount.
w. Remove the nuts and washers from the bolts that attach the engine mount to the firewall.
x. Remove the engine mount mounting bolts and swing the engine a few inches from the firewall. Check the engine for any attachments remaining to obstruct its removal.
y. Swing the engine clear and place on a suitable support.

8-30. INSTALLATION OF ENGINE. The installation of either engine is basically the same procedure though the routing of some wires, cables, lines, etc. does vary between engines. Before starting, refer to latest revision of Lycoming Service Instruction No. 1241 for correct procedure on Pre-Oiling. Ascertain that all components of the engine such as engine mount, turbocharger unit, exhaust stacks, etc., are installed.

a. With a one-half ton hoist (minimum) attached, swing the engine in position.
b. Align the mounting holes in the engine mount with the mounting-holes in the firewall. Install the mounting bolts through from the aft side of the firewall. Install washers and nuts, and torque bolt head to 13 to 16 ft. lbs.
c. Connect turbo pressurization tube at coupling aft of firewall by the following procedure:
    1. Ascertain that roll pin is installed in flange of aft tube section.
    2. Install "O" ring on check valve assembly and position valve in aft flange with valve hinge center line to the top and horizontal. Position valve flapper aft to allow air to enter the tube.
    3. Secure fore and aft sections together with cap screws and safety.
    4. Secure forward tube section to firewall with screws.
d. Connect alternate air duct to firewall and secure with clamps.
e. Connect the following lines to the firewall: Air conditioning compressor lines (right engine only) hydraulic pressure, oil pressure, fuel supply, hydraulic suction, manifold pressure, instrument air deck pressure, heater fuel and fuel flow pressure.
g. Connect tach generator electrical leads at connectors at firewall and ground lead to left engine bonding strap fitting.

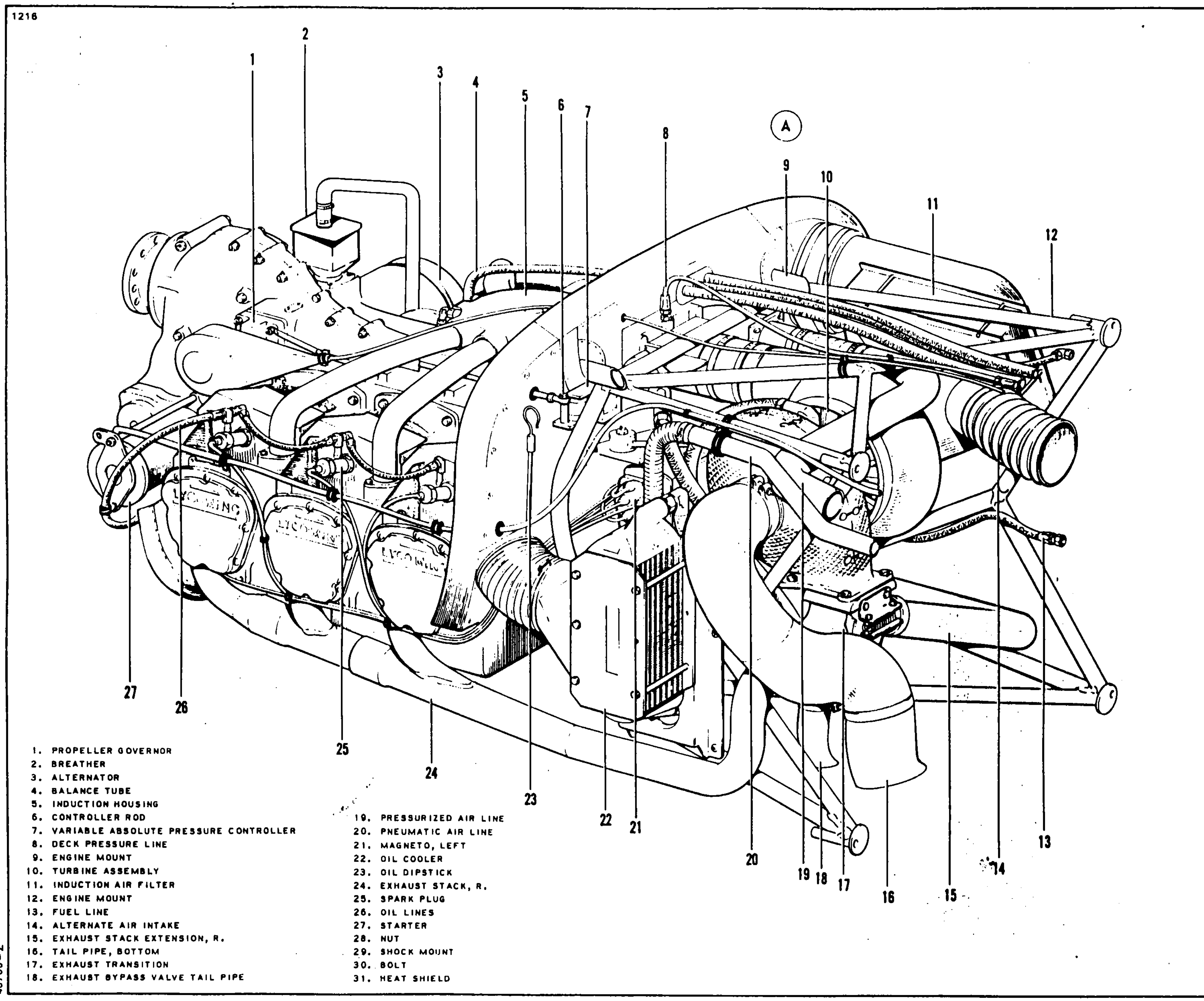
h. Connect the propeller deicer electrical leads (optional equipment), ammeter shunt wires, alternator primary lead, alternator field leads and cylinder head temperature probe (number two cylinder on left engine and number three cylinder on right engine) and compressor electrical lead (right engine only) and ground wire to right engine bonding strap fitting.
i. Connect induction air control cable to inlet duct valve assembly and adjust to allow 0.120 inch between knob and stop with valve control lever arm against the full open stop.
j. Connect throttle and mixture control and adjust. (Refer to paragraph 8-56.)
k. Connect pneumatic pump pressurization line to pneumatic pump.
l. Install exhaust gas temperature probe in exhaust transition.
m. Connect oil temperature leads to sender located aft of number five cylinder and ground wire to left rear engine baffle.
n. Connect magneto "P" lead and retard lead to left magneto.
o. Route the starter cable through the upper portion of the left aft engine baffle and attach the cable end to the starter. Secure cable with clamps at the engine mount and the engine.
p. Connect governor control cable to governor and adjust (Refer to paragraph 8-22.)
q. Secure electrical wires and control cables with clamps to engine and engine mount.
r. Secure lines and tubing with clamps to engine mount.
s. Ascertain that the magneto switches are off and install the propeller per paragraph 8-16.
t. Install the proper grade and amount of engine oil.
u. Connect the battery ground wire at the battery.
v. Turn on the fuel valve, open the throttle full and turn on the electric fuel pump and check the fuel lines for leaks.
w. Install the access plates on the engine nacelle and the cowling per paragraph 8-7.
x. Perform an engine operational check.

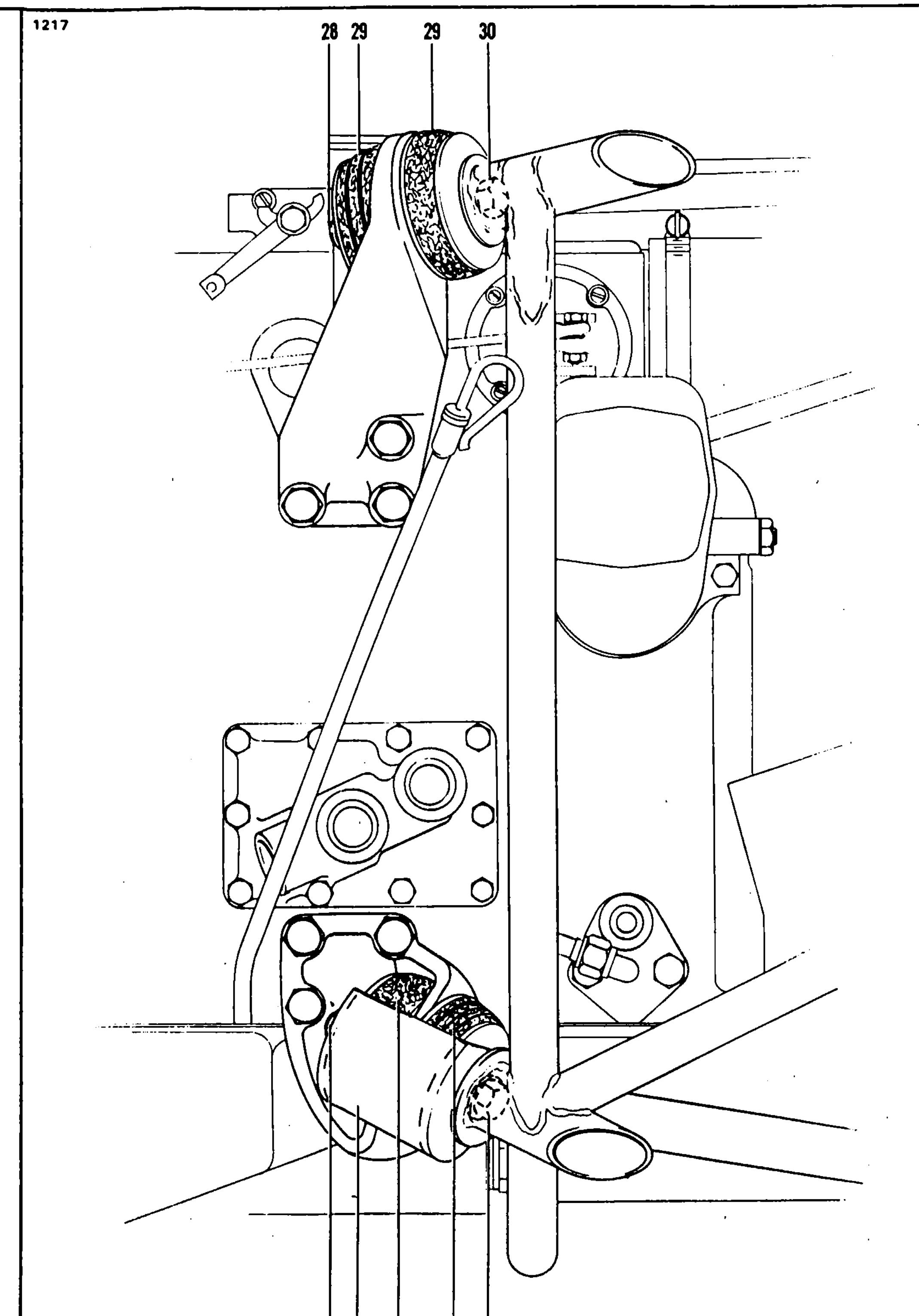
8-31. ENGINE SHOCK MOUNTS.

8-32. REPLACEMENT OF SHOCK MOUNTS. Refer to Figure 8-7 for the proper arrangement of the shock mount assemblies. The top shocks are assembled so that shocks with part no. J-9612-8 are aft and shocks with part no. J-7763-26 are forward. The lower shocks are assembled so that shocks with part no. J-7763-26 are aft and shocks with part no. J-9612-8 are forward. When installing lower shock mounts position heat shield to provide greatest protection against exhaust heat. Tighten mounting bolts to 34-42 ft. lbs. with torque on bolt head.

8-33. ENGINE TURBOCHARGER. The turbocharger system requires little attention between turbo overhauls. However, it is recommended that the items outlined in the Inspection Report of Section III be checked during required inspection intervals. Should trouble occur, refer to the Troubleshooting Table in this section and seek out the possible cause. Do not break the clamp seal joining the turbine and compressor units.

8-34. REMOVAL OF TURBOCHARGER. Remove the turbocharger unit from the engine by using the following procedure: (Refer to Figure 8-9.)
a. Remove the engine cowling. (Refer to paragraph 8-5.)
b. Remove tail pipe assembly by the following procedure:
   1. Remove clamp securing tail pipe waste gate tail pipe.
   2. Remove cotter pins, nuts and washers securing tail pipe hanger to exhaust transition.
   3. Remove tail pipe support bracket and clamp.
   4. Remove tail pipe by removing V band clamp at turbocharger unit.





SKETCH A

Figure 8-7. Power Plant Installation.

NOTE

Cap or plug oil lines and seal turbine compressor air openings to prevent the entry of foreign materials.

c. Remove exhaust waste gate assembly from exhaust transition by disconnecting oil lines, drain line and removing upper V band clamp.
d. Remove the exhaust transition from the turbocharger unit by the following procedure:
   1. Remove exhaust temperature probe from the forward side of the exhaust transition.
   2. Disconnect exhaust manifold pipes from transition by removing V band clamps.
   3. Remove exhaust transition by removing mounting bolts securing it to the turbocharger unit.
e. Remove oil drain tube from bottom of turbocharger by removing cap screws.
f. Loosen compressor outlet hose clamps.
g. Disconnect turbocharger oil inlet line at turbocharger.
h. Remove center bolt from top turbocharger mounting bracket.
i. Remove the turbo pressurization tube by the following procedure:
   1. Disconnect pressurization tube from sonic nozzle by removing hose clamp.
   2. Remove access panels on the inboard side of the engine nacelle aft of the firewall.
   3. Disconnect turbo pressurization tube at coupling aft of the firewall by removing safety and cap bolts from coupling and attaching screws securing tube to firewall.
j. Remove induction air plenum and filter assembly by removing duct clamps. wire
k. Remove nut, washers and bolts securing turbocharger compressor inlet support bracket to turbocharger mount.
l. Remove nut and washer securing compressor inlet support bracket to engine.
m. Remove nuts, washers and bolts securing turbocharger unit to mounting bracket.
n. Slide turbocharger unit aft and remove compressor inlet support bracket.
o. Remove turbocharger unit through the right side of the engine mount.

8-34a. TURBOCHARGER LUBRICATION SYSTEM PRIMING. Immediately prior to mounting the unit, prime the lubrication system as follows:

a. Invert turbocharger and fill center housing with new clean engine oil through oil drain.
b. Turn rotating assembly by hand to coat bearings and thrust washer with oil.
c. Coat threads of attaching bolts or studs with high temperature thread lubricant.
d. After installing turbocharger, flush oil through oil inlet line and ensure that line is clean and unobstructed.
e. Fill engine and oil inlet line with new, clean lubricating oil, and connect line.
f. Connect oil return line. (Refer to latest revision of Lycoming Service Instruction No. 1241.)

NOTE

If the turbocharger is to be installed on a new or newly overhauled engine, operate the engine with a separate oil filter in the oil supply line to the turbocharger during the first hour of operation. This must be done to ensure that no metal particles are carried from the engine into the turbocharger lubrication system.

8-35. INSTALLATION OF TURBOCHARGER. (Refer to Figure 8-9.) When installing a new or overhauled turbocharger unit, the relation of the turbine housing and compressor housing to the center housing may vary from the turbocharger unit removed.

If the turbine housing is not in correct relationship to the center housing, remove attaching cap screws and rotate turbine housing for correct relationship. Install lock plates and cap screws, torque to specifications given in Table VIII-II and safety. Align the compressor housing by loosening V band clamp and rotating housing. Torque V band clamp to specification given in Table VIII-II.

a. Install blanket on turbine assembly and secure with MS20995-C41 safety wire.
b. Install top mounting bracket on turbine housing and secure with lock plates and cap screws.
c. Install turbo oil inlet fitting with a new gasket and secure with washers, lock washers and cap screws.
d. Mount turbocharger unit by the following procedure:
   1. Install turbocharger compressor outlet hose and clamps on controller housing.
   2. Insert turbocharger unit through right side of engine mount.
   3. Slide compressor support bracket on compressor inlet.
   4. Position turbocharger unit and compressor mounting bracket on mount and secure with bolts, washers and nuts. Torque to specifications given in Table VIII-II.
   5. Tighten compressor outlet hose clamps.
e. Connect turbo pressurization tube at coupling aft of firewall by the following procedure:
   1. Ascertain that roll pin is installed in flange of aft tube section.
   2. Install "O" ring on check valve assembly and position valve in aft flange with valve hinge.
   center line to the top and horizontal. Position valve flapper aft to allow air to enter the tube.
   3. Secure fore and aft sections together with cap screws and safety.
   4. Secure forward tube section to firewall with screws.
   5. Secure hose to sonic nozzle with clamp.
f. Position induction air plenum and filter assembly and secure ducts with clamps.
g. Connect turbocharger oil inlet line.
h. Secure oil drain tube and new gasket to turbocharger unit with washers, lock washers and cap screws.
i. Position exhaust transition on turbine housing with exhaust gas temperature probe fitting forward and secure with bolts, washers and nuts. Torque to specification given in Table VIII-II.
j. Connect exhaust manifold pipes with gaskets to exhaust transition and secure with V band clamps. (Refer to Table VIII-II, Note 1.)
k. Install exhaust manifold retainer assemblies per instructions given in the latest revision of Piper Service Bulletin No. 492 and latest revision of Lycoming Service Bulletin No. 393.
l. Install exhaust temperature probe in transition.
m. Position waste gate assembly with gasket on exhaust transition and secure with V band clamp.
n. Secure tail pipe and waste gate tail pipe together with clamps, bolt, washer, nut and cotter pin.

NOTE

For all "V" band couplings on the exhaust system, be sure parts are concentric before tightening couplings. Coupling will not center parts automatically.

o. Install access panels on inboard side of nacelle.
p. Install engine cowling (Refer to paragraph 8-7).

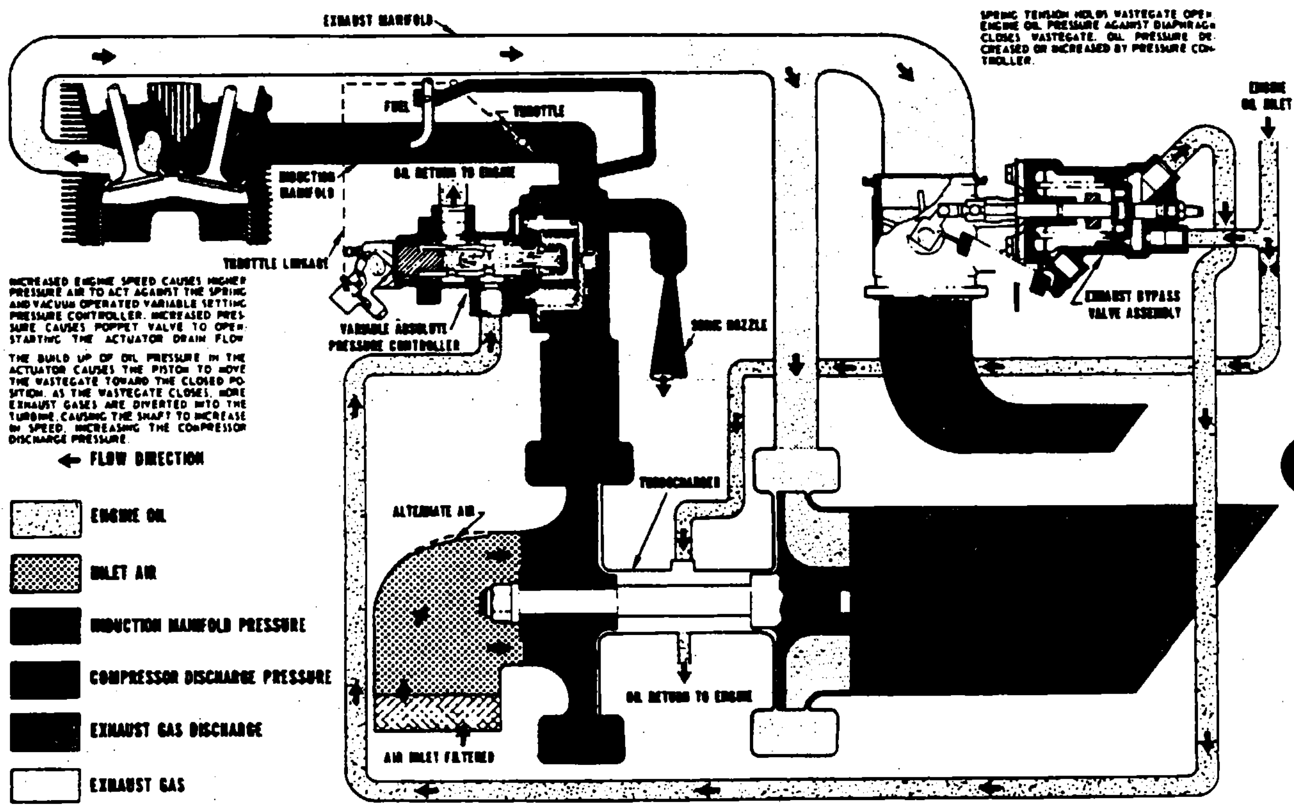
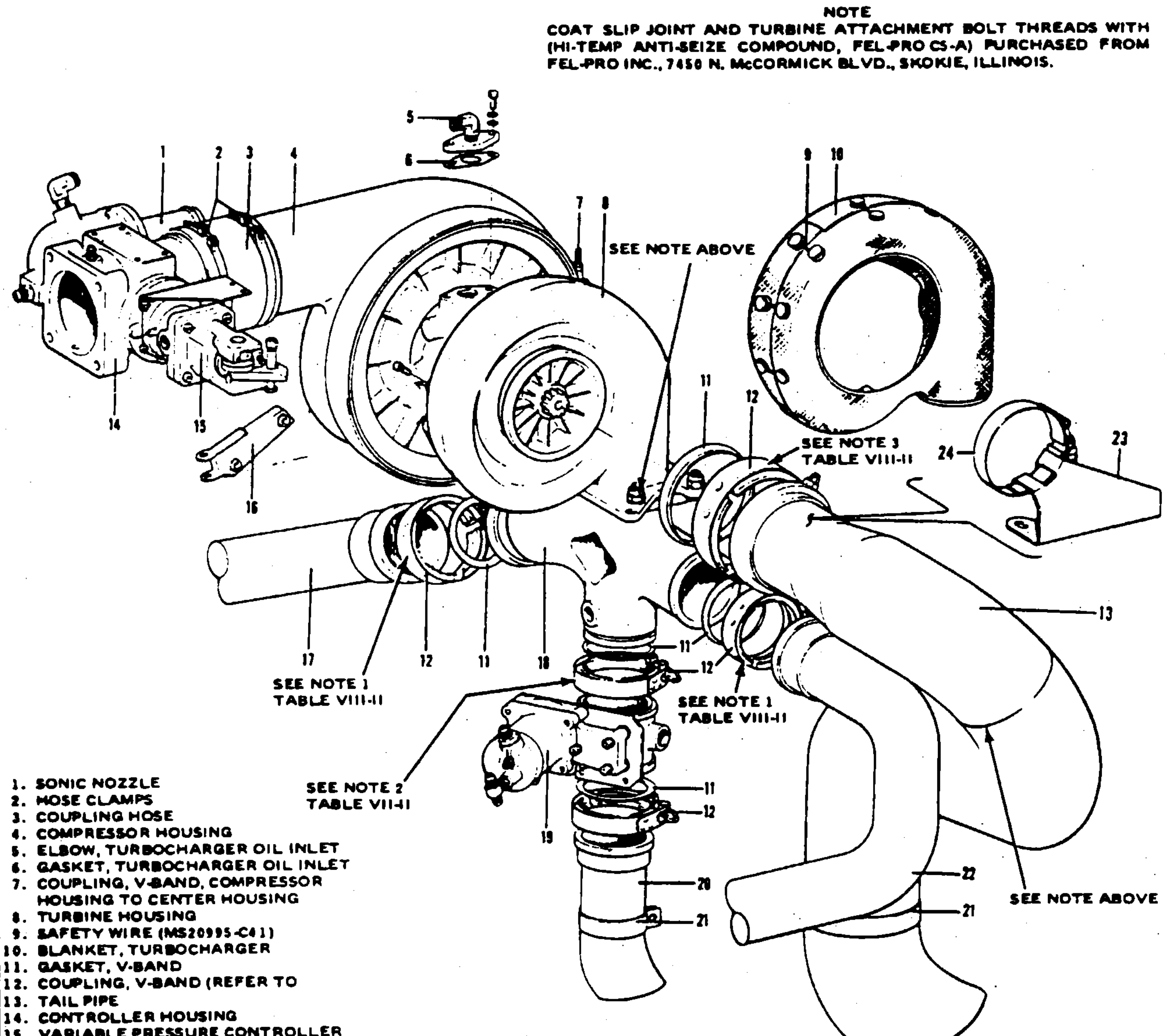


Figure 8-8. Schematic Diagram of Turbocharger System



1. SONIC NOZZLE
2. HOSE CLAMPS
3. COUPLING HOSE
4. COMPRESSOR HOUSING
5. ELBOW, TURBOCHARGER OIL INLET
6. GASKET, TURBOCHARGER OIL INLET
7. COUPLING, V-BAND, COMPRESSOR HOUSING TO CENTER HOUSING
8. TURBINE HOUSING
9. SAFETY WIRE (MS20995-C41)
10. BLANKET, TURBOCHARGER
11. GASKET, V-BAND
12. COUPLING, V-BAND (REFER TO
13. TAIL PIPE
14. CONTROLLER HOUSING
15. VARIABLE PRESSURE CONTROLLER
16. BRACKET, TURBOCHARGER STRUT
17. EXHAUST PIPE, RIGHT REAR
18. EXHAUST TRANSITION
19. EXHAUST BYPASS VALVE
20. TAIL PIPE, WASTE GATE
21. CLAMP
22. EXHAUST PIPE, LEFT REAR
23. BRACKET, TAIL PIPE SUPPORT
4. CLAMP, TAIL PIPE SUPPORT BRACKET

Figure 8-9: Turbocharger Installation

TABLE VIII-II. TURBO CHARGER INSTALLATION TORQUE VALUES IN INCH POUNDS

Turbine and freon compressor mount to engine	225-300
Turbine housing to center housing capscrews	100-130
Turbo oil inlet and outlet flange capscrews	200-270
Compressor housing to center housing clamp	40-60
Turbine to mount bolts	225-300
Compressor housing to controller housing duct clamps	40-45
Turbine to exhaust transition bolts	225-300
Exhaust manifolds to transition clamps	See Note 1
Waste gate to transition clamp	See Note 2
Tailpipe to waste gate clamp	120-130
Absolute pressure controller mounting screws	20-30
Tailpipe to turbine clamp	See Note 3
Tailpipe support bracket clamp	25-35

CAUTION

Do not spread the couplings to force them over the outside of the pipe. They must be passed over the end of the pipe. If the clamps are spread open excessively, their sealing properties will be destroyed.

NOTES

1. *Before installing the coupling around the adapter pipes, make sure the entire exhaust assembly is in alignment; that is, mating flanges must match each other. Support the exhaust system in this position and proceed to install couplings around flange and engage latch. Tighten coupling nut to 50 inch pounds initial torque. Tap outer periphery of coupling with mallet to distribute band tension. Check torque and continue tightening to a final torque of 70-80 inch pounds. Tapping coupling until torque reading stabilizes.*
2. *With the flanges together, position the coupling over the flanges. Press the coupling around the flanges and engage the latch. Tighten the coupling nut to about 60 inch pounds torque. Then tap around the outer periphery of the coupling with a mallet to distribute band tension. Check the torque on the coupling nut and this time tighten to 80-90 inch pounds. Again tap around the periphery of the coupling and recheck the torque. Repeat this procedure until the maximum torque of 80-90 inch pounds is attained. Refer to the latest revision of Lycoming Service Bulletin 395.*
3. *Fit tailpipe flange to turbine flange making certain flange faces are butted together with no gap. Position tailpipe for clearance with exhaust pipe. Slide clamp over flanges, position and tighten. Torque clamps without torque identification tag to 45-55 inch pounds. Torque clamps with torque identification tags to 40 inch pounds as noted on tag.*

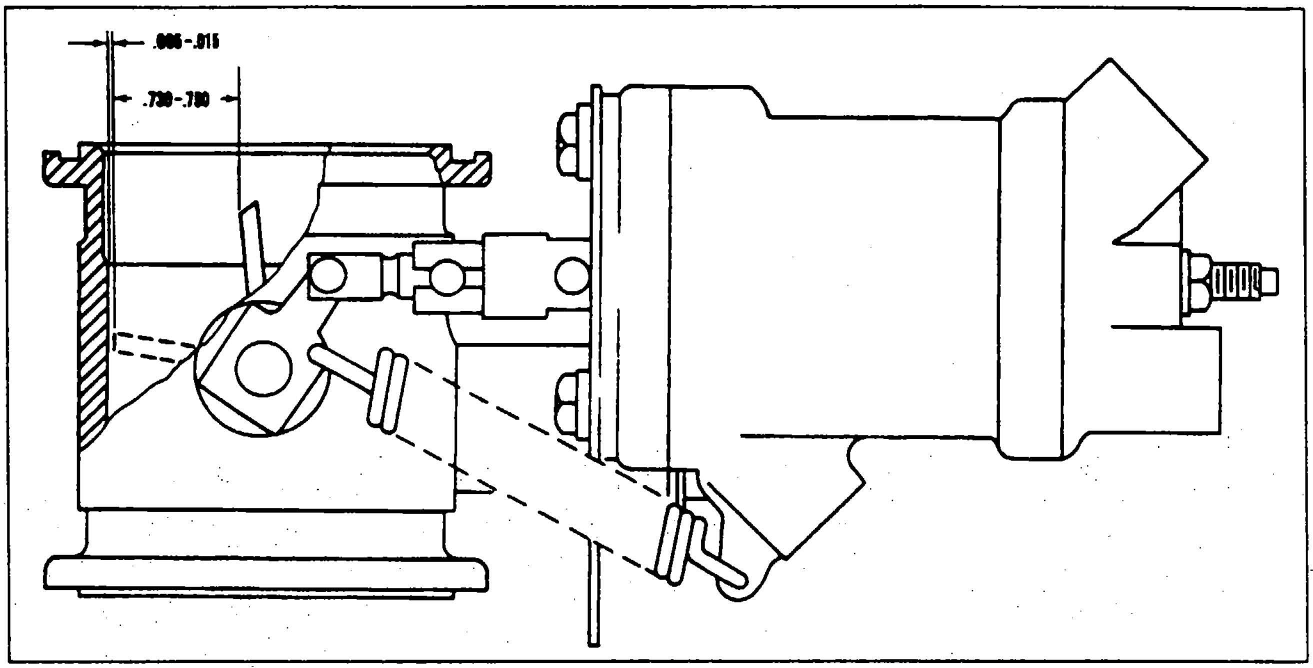


Figure 8-10. Exhaust Waste Gate

8-36. ADJUSTMENT OF TURBOCHARGER. It is recommended that adjustments of the turbocharger be conducted by an authorized overhaul facility.

8-37. ABSOLUTE PRESSURE CONTROLLER.

8-38. REMOVAL OF ABSOLUTE PRESSURE CONTROLLER.

a. Remove engine cowling. (Refer to paragraph 8-5.)
b. Disconnect controller control rod.
c. Disconnect oil lines at controller unit.
d. Remove safety wire and screws securing controller to housing.
e. Remove controller from housing.

8-39. INSTALLATION OF ABSOLUTE PRESSURE CONTROLLER.

a. Clean controller mounting pad.
b. Install pressure controller with gasket on controller housing.
c. Secure mixture control cable bracket and pressure controller with screws and safety.
d. Connect oil lines to controller.
e. Connect control rod with bolt, spacer, washer, nut and cotter pin to controller cam arm.

8-40. EXHAUST WASTE GATE ASSEMBLY.

8-41. REMOVAL OF EXHAUST WASTE GATE ASSEMBLY.

a. Remove engine cowling. (Refer to paragraph 8-5.)
b. Disconnect oil lines and drain line from waste gate assembly.
c. Remove V band clamps securing waste gate to exhaust transition and tail pipe.

8-42. EXHAUST WASTE GATE VALVE SETTINGS. (Refer to Figure 8-10.)

The butterfly valve in the exhaust waste gate assembly is set to a predetermined open and closed clearance. With 50-60 psi pressure in the waste gate cylinder, adjust closed position of valve so that clearance between butterfly and side of housing is 0.005 to 0.015 inch. After adjusting closed position and with no pressure in waste gate cylinder, adjust full open stop screw to provide 0.730 to 0.750 inch clearance between butterfly valve and side of housing with backlash taken up towards the open position.

NOTE

All adjustments to the wastegate valve must start from the closed position first and then to the open position.

8-42a. INSTALLATION OF EXHAUST WASTE GATE ASSEMBLY.

a. Install waste gate assembly with gasket between exhaust transition and tailpipe.
b. Secure waste gate with V band clamps and torque clamps to specifications given in Table VIII-II.
c. Connect oil lines and drain line to waste gate assembly.

NOTE

It is recommended that the waste gate valve be lubricated with a decarbonizing agent (Mouse Milk, WD-40 or equiv.) at the butterfly pivot points every 50 hours. Purchase Mouse Milk from: Worldwide Aircraft Filter Corp., 1685 Abram Ct., San Leandro, CA 94577.

8-42b. TURBOCHARGER DECOKING.

Mouse Milk, penetrating oil or equivalent may be used for decoking the turbine and compressor drive shaft by the following procedure:

a. Disconnect the oil inlet and outlet lines from the turbocharger and allow all oil to drain.
b. Cap the oil outlet port on the turbocharger.
c. Pour the Mouse Milk into the oil inlet port of the turbocharger and allow the unit to soak overnight.
d. Drain all Mouse Milk from the turbocharger and flush the unit with engine oil.
e. Prime the turbocharger in accordance with Paragraph 8-34a.

8-43. INSTALLATION OF EXHAUST WASTE GATE ASSEMBLY.

a. Install waste gate assembly with gaskets between exhaust transition and tail pipe.
b. Secure waste gate with V band clamps and torque clamps to specifications give in Table VIII-II.
c. Connect oil lines and drain line to waste gate assembly.

NOTE

All adjustments to the wastegate valve must start from the closed position first and then to the open position.

8-43a. TURBOCHARGER NOMENCLATURE. Many unfamiliar terms may appear on the following pages of this manual. An understanding of these will be helpful, if not necessary, in performing maintenance and troubleshooting. The following is a list of commonly used terms and names as applied to turbocharging.

TERM	MEANING
Supercharge	To increase the air pressure (density) above or higher than ambient conditions.
Supercharger	A device that accomplishes the increase in pressure.
Turbo-supercharger	More commonly referred to as a "Turbocharger". this device is driven by a turbine. The turbine is spun by energy extracted from the engine exhaust gas.
Compressor	The portion of a turbocharger that takes in ambient air and compresses it before discharging it to the engine.
Turbine	The exhaust driven end of the turbocharger unit.
Wastegate and Actuator	The wastegate is a butterfly type valve in the exhaust by-pass which, throughout its travel from open to closed, allows varied amounts of exhaust pressure to by-pass the turbine, controlling its speed, hence the output of the compression. The actuator is operated by a hydraulic piston and cylinder with the piston linked to an arm on the valve shaft.
Adjustable-Absolute Pressure Controller	An adjustable pressure controller that senses compressor discharge pressure on an on an aneroid bellows which is attached to a poppet valve. This poppet valve in turn controls the amount of engine oil pressure that is bled to the crankcase. Thereby modulating the wastegate as necessary to maintain the desired compressor discharge pressure selected by the pilot. Each time a new pressure is selected, that pressure will hold automatically.
Ground Boosted or Ground Turbocharged	These phrases indicate that the engine depends on a certain amount of turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.

Deck Pressure	The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.
Manifold Pressure	The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.
Normalizing	If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized".
Overboost	An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be detrimental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system.
Overshoot	Overshoot is a condition of the automatic controls not having the ability to respond quickly enough to check the inertia of the turbocharger speed increase with rapid engine throttle advance. Overshoot differs from overboost in that the high manifold pressures last only for a few seconds This condition can usually be overcome by smooth throttle advance.
Sonic Nozzle	Sonic nozzles are used in turbocharger systems where bleed air is used for cabin pressurization. They are a flow limiting device and work on the principle of controlling flow by passing the air through a smooth orifice, sized so that a sonic velocity, the maximum desired flow is achieved. The sonic nozzle prevents too much air going to the cabin and thereby starving the engine of its needed supply.
Bootstrapping	This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of that turbocharger, it would be called a bootstep system and if no losses were encountered, it would theoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbocharged engine above critical altitude (wastegate closed) is similar to the example mentioned above, except now there is an engine placed between the compressor discharge and turbine inlet. Slight system changes cause the exhaust gas to change slightly, which causes the turbine speed to change slightly, which causes the compressor air to the engine to change slightly, which in turn again affects the exhaust gas, etc.
Critical Altitude	A turbocharged engine's wastegate will be in a partially open position at sea level. As the aircraft is flown to higher altitudes (lower ambient pressures) the wastegate closes gradually to maintain the preselected manifold pressure. At the point where the wastegate reaches its full closed position, the preselected manifold pressure will start to drop and this is considered critical altitude.

8-44. INDUCTION SYSTEM AIR FILTER.

8-45. REMOVAL OF INDUCTION AIR FILTER.

a. Remove top engine cowl.
b. Remove screws from around air filter.
c. Remove air filter from induction air plenum.

8-46. CLEANING INDUCTION AIR FILTER.

a. Blow dry compressed air (100 PSI or less) thru element from clean side.
b. If necessary, wash element in warm water (120° or less) solution with household detergent. Rinse thoroughly. Examine pleated media carefully to determine that media has not been damaged.
c. Replace element for any of the following reasons:
   1. Pleated media is cut, torn, worn or uncleanable.
   2. Metal end caps are bent out of flat.
   3. Perforated metal bent into pleated media.
   4. Gasket is cut, deformed or damaged in any manner.

8-47. INSTALLATION OF INDUCTION AIR FILTER.

a. Install air filter in induction air plenum noting direction of airflow.
b. Secure air filter in induction air plenum with screws.
c. Install engine cowling.

8-48. ALTERNATE AIR DOOR. The alternate air door, located on the aft side of the firewall, provides a source of air to the turbocharger compressor should there be an air stoppage through the induction filter system. The following should be checked during inspection:

a. Door seals are tight and hinges are secure.
b. Actuate the door to determine that it is not sticking or binding.
c. Check that magnetic catch makes contact with door and allows if to seal completely.

8-49. FUEL INJECTOR.

8-50. FUEL INJECTOR MAINTENANCE.

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.
   1. Check tightness and lock of all nuts and screws which fasten-the injector to the engine.
   2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.
   3. Ascertain that fuel pressures are within the pressure range as given in Table IX-II of Section IX in this manual.
   4. Check throttle and mixture control rods and levers for tightness and lock.
   5. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer O-rings should be replaced. Torque strainer to 65-70 inch pounds.
   6. Check for correct torque of fuel injector nozzles per the latest revision of Lycoming Service Instruction No. 1231.
b. Tests prove that gasoline which becomes stale due to prolonged storage absorbs oxygen rapidly. This stale oxidized gasoline acquires a very distinctive odor similar to varnish, causes rapid deterioration of synthetic rubber parts, and also forms a gummy deposit on the internal metal parts. This condition, however, does not occur during normal operation of the injector where fresh fuel is being constantly circulated.

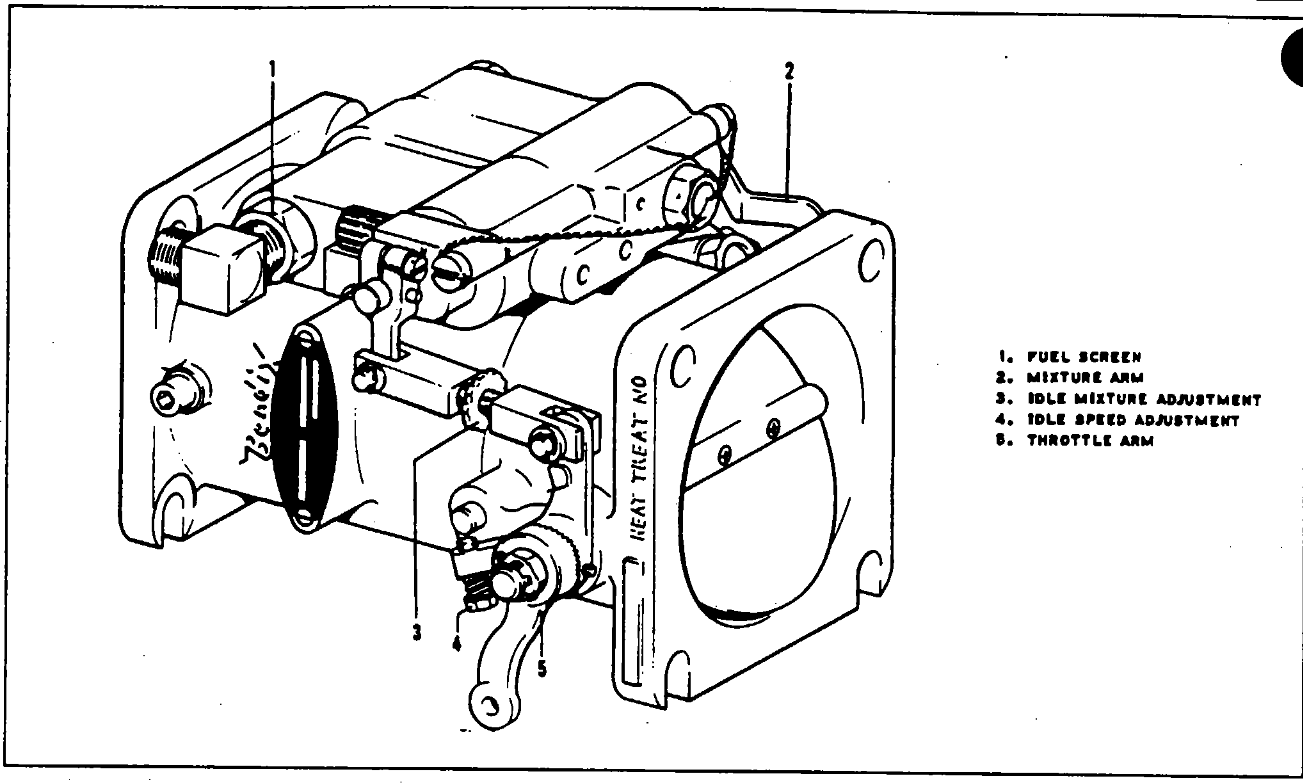


Figure 8-11. Fuel Injector

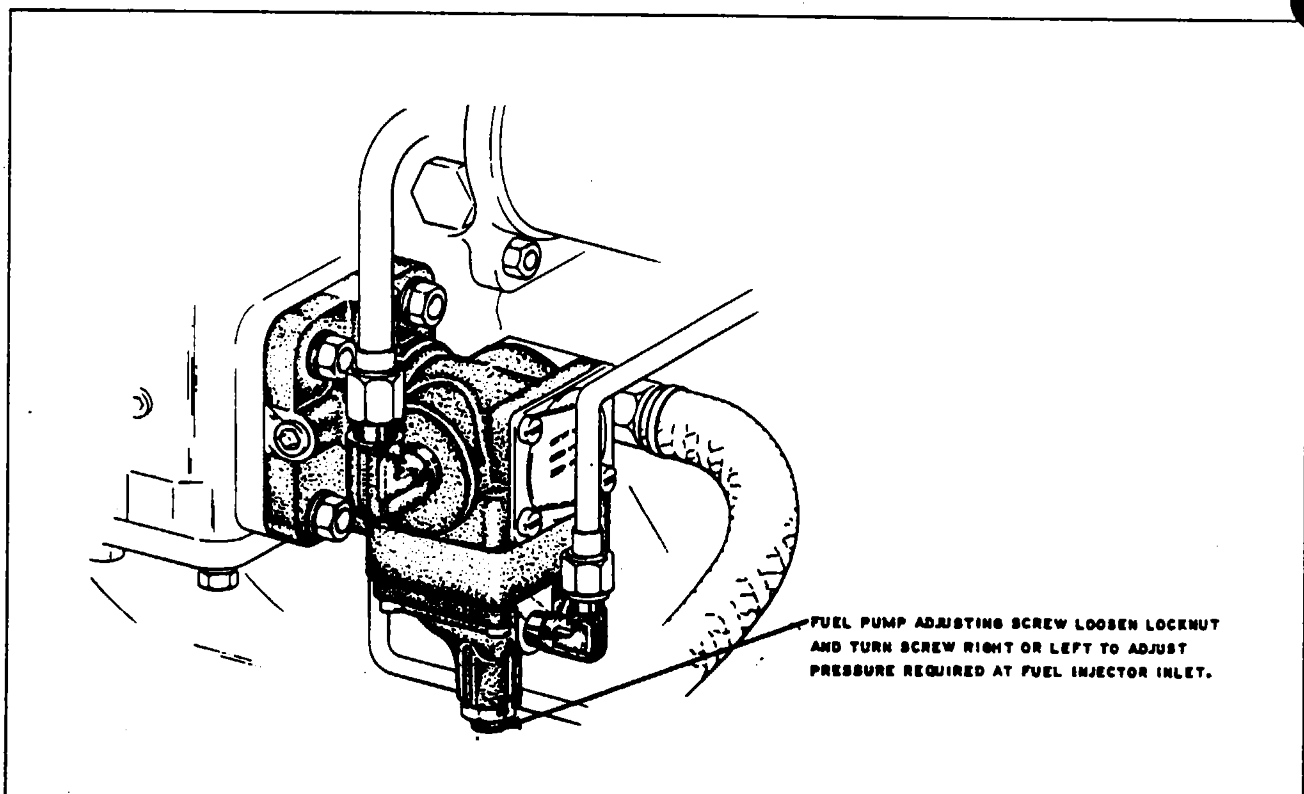


Figure 8-12: Fuel Pump (LEAR-ROMEC)

8-51. LUBRICATION OF FUEL INJECTOR.

a. There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary.
b. Place a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

8-52. REMOVAL OF FUEL INJECTOR.

a. Remove top engine cowling. (Refer to paragraph 8-5.)
b. Remove fuel flow pressure line and manifold pressure line at induction manifold.
c. Disconnect heater fuel line at injector unit.
d. Remove control rod from absolute pressure controller and linkage cross shaft.
e. Disconnect mixture control from injector unit and at cable attachment bracket.
f. Remove top center engine baffle.
g. Disconnect instrument deck pressure line at controller housing.
h. Disconnect fuel inlet line at injector unit and balance tube from controller housing.
i. Disconnect throttle linkage from injector unit.
j. Remove oil filler tube.
k. Disconnect fuel outlet line at injector unit.
l. Disconnect absolute pressure controller oil inlet line.
m. Disconnect absolute pressure controller drain line and remove ninety degree fitting.
n. Disconnect controller housing breather line.
o. Disconnect pressurization line from sonic nozzle.
p. Loosen compressor outlet hose clamps and slide hose forward on controller housing.
q. Loosen compressor inlet duct clamp.
r. Loosen clamp securing compressor housing to center housing.
s. Rotate compressor housing aft away from the controller housing.
t. Loosen cap screws securing controller housing to injector unit and remove the top and lower screws.
u. Remove cap screws securing injector unit to induction manifold.
v. Position injector unit and remove remaining cap screw securing controller housing to injector unit.
w. Remove injector unit and cap all lines and openings.

8-53. PREPARATION OF FUEL INJECTOR FOR SHIPPING. Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedures:

a. Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet until all fuel is discharged from the injector.
b. Replace plugs and apply flushing oil filtered through a 10-micron filter at 13-15 psi to the injector fuel inlet until oil is discharged from the outlet.
c. Replace fuel inlet shipping plug.

CAUTION

Do not exceed the above air pressure as internal damage to the injector may result.

d. After filling with preservative oil, the injector should be protected from dust and dirt and given such protection against moisture as climatic conditions at the point of storage require. In most cases, storing the unit in a dry area will be sufficient.

e. If the unit is to be stored near or shipped over salt water, the following precautions should be observed:
   1. Spray the exterior of the injector with an approved preservative oil.
   2. Pack in a dustproof container, wrap the container with moisture and vapor-proof material, and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bug of silica gel crystals in the dustproof container with injector. The bug must not touch the injector.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent oil or fuel from entering the air sections of the injector. As explained previously, damage to the air diaphragm will result. Fluid can easily enter the air section of the injector through the impact tubes or the annular groove around the venturi. For this reason, a protective plate should be installed on the scoop mounting flange when performing routine maintenance on the engine, such as washing down the engine and air scoop, servicing the air filter (surplus oil on the element), or when injecting preservative into the engine prior to storing or shipping.

8-54. PREPARATION OF FUEL INJECTOR FOR SERVICE. Fuel injectors that have been prepared for storage should undergo the following procedures before being placed in service.

a. Remove and clean the fuel inlet strainer assembly and reinstall.
b. Inject clean fuel into the fuel inlet connection with the fuel outlets uncapped until clean fuel flows from the outlets. Do not exceed 15 psi inlet pressure.

8-55. INSTALLATION OF FUEL INJECTOR.

a. Position injector unit with gasket to controller housing and attach with washer, lock washers and cap screws. Do not tighten screws at this time.
b. Mount injector unit with gasket to induction manifold and secure with washers, lock washers and cap screws.
c. Tighten cap screws securing controller housing to injector.
d. Rotate compressor housing forward and slide coupling hose aft onto compressor housing outlet, and secure with clamps.
e. Tighten clamp securing compressor housing to center housing to specification given in Table VIII-II.
f. Tighten compressor inlet duct clamp to specification given in Table VIII-II.
g. Connect pressurization line to sonic nozzle.
h. Connect controller housing breather line.
i. Install ninety-degree fitting in absolute pressure controller drain port and connect drain line.
j. Connect absolute pressure controller oil inlet line.
k. Connect fuel outlet line at injector unit.
l. Install oil filler tube and safety.
m. Connect throttle linkage to injector unit.
n. Connect fuel inlet line at injector unit and balance tube to controller housing.
o. Connect instrument deck pressure line at controller housing.
p. Install top center engine baffle.
q. Connect mixture control to bracket and control lever.

r. Install absolute pressure controller control rod.
s. Connect heater fuel line to injector unit.
t. Connect fuel flow pressure line and manifold pressure line to induction manifold.
u. Adjust throttle and mixture controls. (Refer to paragraph 8-56.)
v. Adjust idle speed and idle mixture. (Refer to paragraph 8-57.)
w. Install engine cowling. (Refer to paragraph 8-7.)

8-56. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. The throttle and mixture controls are adjusted so that when the throttle arm on the injector is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop, their respective cockpit control levers should be 0.062 to 0.125 inch in from their full forward stops, which are located in the control pedestal.

a. At the injector, disconnect the throttle and/or mixture control cable end from its control arm.
b. Loosen the jam nut securing the cable end.
c. Adjust the linkage by rotating the cable end to obtain the 0.062 to 0.125 inch spring back of the cockpit control lever when the throttle or mixture control arm contacts its stop.
d. Reconnect the cable end to its control arm and secure jam nut.
e. Pull the throttle and mixture control lever in the cockpit full aft to ascertain that the injector idle screw contacts its stop and the mixture control arm contacts its lean position.

8-57. ADJUSTMENT OF IDLE SPEED AND MIXTURE.

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.
b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.
c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON".

d. When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the "Idle Cut-Off" position and observe the tachometer for any change during the "leaning" process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.
e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

8-58. FUEL INJECTOR AND CONTROLLER LINKAGE.

8-59. ADJUSTMENT OF FUEL INJECTOR AND CONTROLLER LINKAGE. (Refer to Figures 8-13 to 8-13e.) The fuel injector and controller linkage must be set as described below to provide the proper amount of turbocharging and fuel metering to the engine.

a. Remove No. 2 and 4 intake pipes on TIO-541 engines and on TIGO-541 engines remove No. 2, 4 and 6 cylinder intake pipes and necessary baffling. Cover intake ports to prevent foreign objects from falling into cylinder. Disconnect aircraft throttle cable from cross shaft control lever. Remove injector connecting rod from both the cross shaft control lever and the throttle lever.
b. Position the cross shaft control lever using fixture ST-319 thus: Mount the fixture over No. 4 cylinder; hold down 3/8 inch studs and nuts. Secure with two (P/N 383-B) nuts. If unable to secure with nuts because of insufficient thread, hold the fixture by hand. The fixture in position is shown in Figure 13.
c. Back off idle stop adjusting screw until it just touches the injector stop pin when the throttle butterfly is fully closed. Check clearance with a piece of shim stock or an .0015 inch feeler gauge. See Figure 13a.
d. Place gauge (ST-318) over injector stop pin with side marked ".040" down and between pin and end of idle stop adjusting screw. Do not turn from full closed setting at this time. (See Figure 13b.)
e. Align hole in ball end of injector connecting rod, hole in cross shaft control lever and hole in fixture. Insert fixture pin through all three holes. (See Figure 13.) With throttle lever held firmly against gauge on injector, adjust the connecting rod length (maintaining approximately equal thread engagements on both ends) and attach to throttle lever. Remove fixture (ST-319) and attach injector connecting rod to the cross shaft control lever. Remove gauge (ST-318).
f. Replace gauge (ST-318) on injector stop pin with the side marked ".025" up. This is the desired clearance between the pad of the throttle arm and the injector stop pin with the throttle lever in full open position. Move cross shaft control lever forward to put injector throttle lever in full open position and maintain a constant pressure between the throttle arm pad and the gauge while completing the following step. (See Figure 13c.)
g. Remove the controller connecting rod at the controller end. Push the controller arm against the full boost stop pin (forward). (See Figure 13d.) With the controller arm in this position and the throttle lever in the position obtained in the preceding step, adjust the controller connecting rod (maintaining approximately equal thread engagement on both ends) to match hole locations in both the controller arm and the connecting rod. Attach the connecting rod to the controller arm and remove the gauge from the injector stop pin. (See Figure 13e.)
h. Check to make certain that all connecting rod jam nuts and linkage nuts are tight and safety the linkage nuts with cotter pins.
i. If throttle lever on the aircraft console is misaligned, adjustment may be made either at the ball end of the aircraft throttle cable or by moving the bracket which holds the throttle cable to the engine. Attach aircraft throttle cable to top hole of the cross shaft control lever.

Special Tools Available From:
Avco Lycoming
Williamsport, Pennsylvania 17701

Part Numbers	Nomenclature
ST-318	Gauge, Fuel Injector and Controller Linkage
ST-319	Fixture, Fuel Injector and Controller Linkage Adjusting

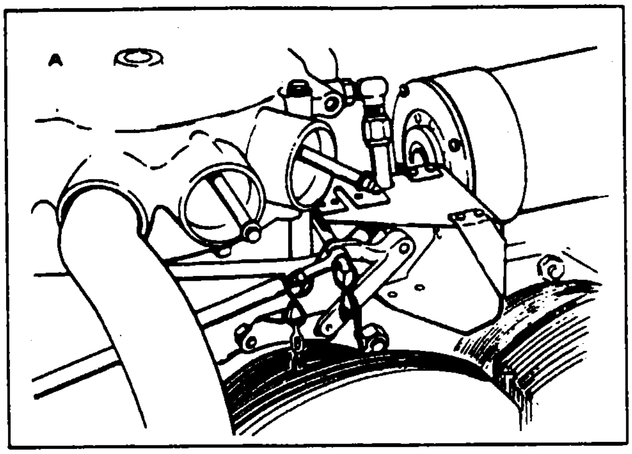


Figure 13. Fixture ST-319 installed and showing cross-shaft control lever in closed throttle position.

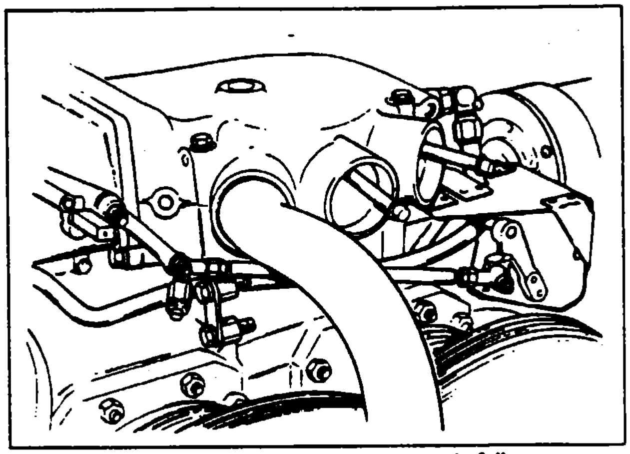


Figure 13c. Obtaining clearance of throttle lever in full open position.

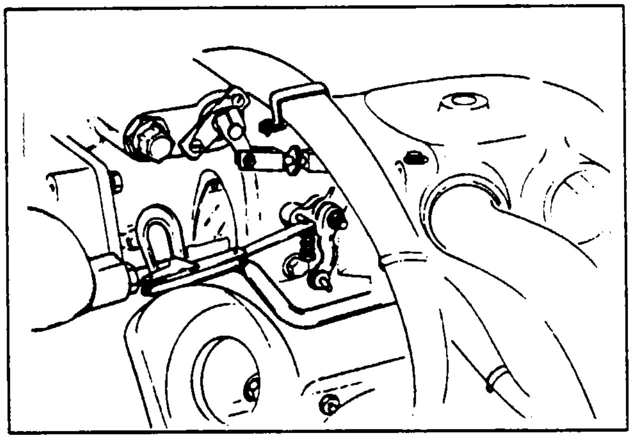


Figure 13a. Setting idle adjusting screw at injector stop pin.

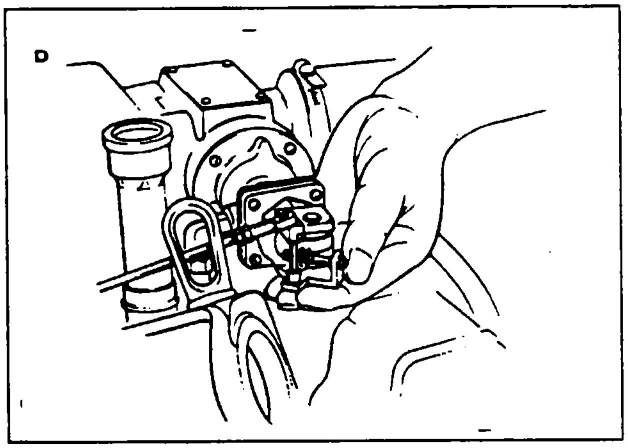


Figure 13d. Controller arm in full boost position.

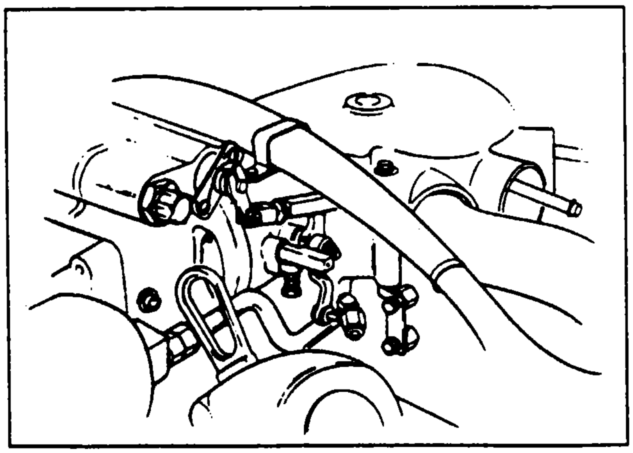


Figure 13b. Obtaining clearance of throttle lever closed position.

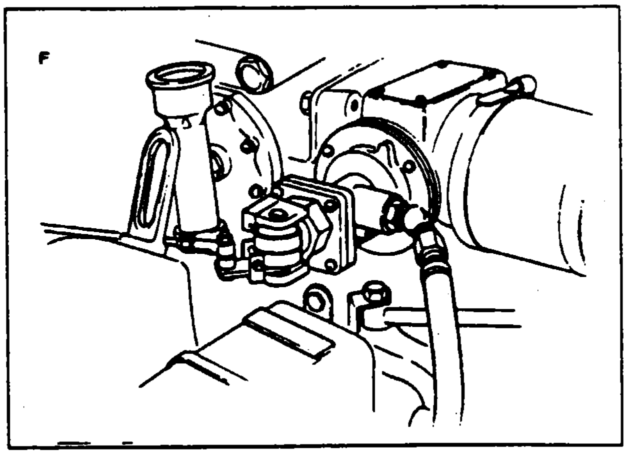


Figure 13e. Controller connecting rod secured to controller arm in full boost position.

NOTES

8-60. IGNITION SYSTEM MAINTENANCE.

8-61. MAGNETO.

CAUTION

Ascertain that the primary circuit of both magnetos is grounded before working on the engine.

8-62. INSPECTION OF MAGNETO.

a. After the first 25 hour and 50 hour periods, and periodically thereafter, the contact assemblies should be checked. Examine the points for excessive wear or burning. Points which have deep pits or excessively burned areas should be discarded. Examine the cam follower felt for proper lubrication. If necessary, points can be cleaned by using any hard finished paper. Clean breaker compartment with dry cloth.
b. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magnetos.
c. Should the trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for test and repair.
d. Should this not be possible, a visual inspection may disclose the source of trouble. Remove the harness outlet plate from the magneto. Inspect for the presence of moisture and foreign matter on the rubber grommet and high tension outlet side of the distributor block. Check height of block contact springs. Also check for broken leads or damaged insulation. If either is present, remove magneto and replace with one known to be in satisfactory condition.

e. Remove the breaker cover and harness screws and nuts. Then separate the cover from the magneto housing. Check the contact assemblies to see that the cam follower is securely riveted to its spring. Examine the contact points for excessive wear or burned condition. The desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area to each other, thereby providing the best possible electrical contact and highest efficiency of performance.

f. Minor irregularities or roughness of point surfaces are not harmful. Neither are small pits or mounds, if not too pronounced. If there is a possibility of a pit becoming deep enough to penetrate the pad, reject the contact assembly.

NOTE

No attempt should be made to stone or dress contact points. Should contact assembly have bad points or show excessive wear, the complete contact assembly should be replaced.

g. Check the condition of the cam follower felt. Squeeze felt tightly between thumb and forefinger. If fingers are not moistened with oil, re-oil using 2 or 3 drops of Bendix P/N 10-391200 lubricant. Allow approximately 30 minutes for felt to absorb the oil. Blot off the excess with a clean cloth. Too much oil may foul contact points and cause excessive burning.

h. Check the capacitor mounting bracket for cracks or looseness. Using the Scintilla 11-1767-1,-2 or -3 Condenser Tester or equivalent, check capacitor for capacitance, series resistance and leakage. Capacitance shall be at least 0.30 microfarads.

i. Check magneto to engine timing as follows:
   1. Connect Scintilla 11-851 Timing Light or equivalent across the main contact assembly.
   2. Slowly bring the engine up to number one cylinder advance firing position as instructed in paragraph 8-65. At this instant the timing light should go out. If it does, the magneto is properly timed to the engine. If the timing light does not go out, removal of the magneto for internal timing check and inspection is recommended.

NOTE

The magnetic service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magneto, it is recommended that the manufacturer's recommended service instructions be followed.

j. Refer to the latest revision of Lycoming Service Instruction No. 1400 for information regarding replacement of cam retaining screw.

8-63. REMOVAL OF MAGNETO. Before removing the magneto, make sure magneto switches are off.

a. Remove the harness assembly terminal plate from the magneto.

WARNING

The magneto is not internally grounded; when the ground lead is disconnected, the magneto is hot. Removing the harness assembly terminal plate first and installing them last minimizes the danger of starting the engine accidentally when the ground lead is removed from the magneto.

b. Disconnect the ground lead and the retard spark lead on the left magneto at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

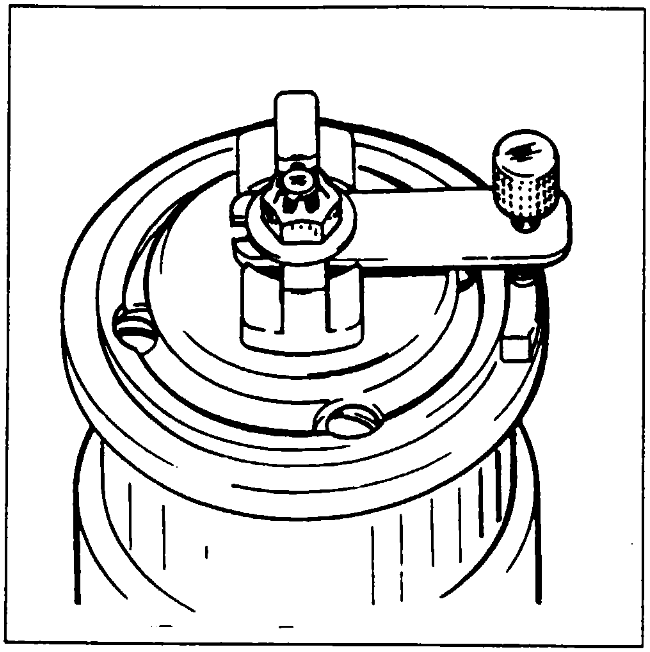


Figure 8-14. Rotor Holding Tool Installed

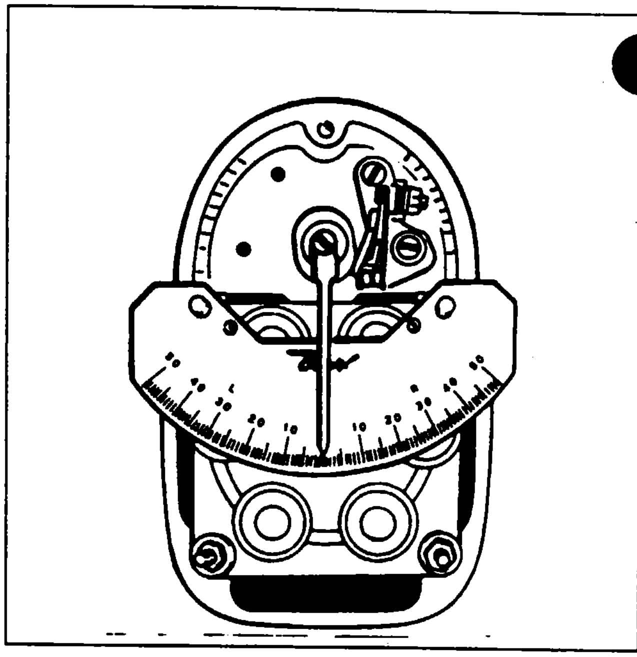


Figure 8-15. Timing Kit Installed

8-64 TIMING PROCEDURE. (Internal Timing).

a. Remove the cover to the contact(s), distributor block, etc.

b. To internally time the main contact assembly of either the dual-breaker magnetos or the single-breaker magnetos, proceed as follows:

1. Loosen the nut securing the drive plate to the magneto shaft sufficiently in order to install the Scintilla 11-8465 Rotor Holding Tool under the nut and flat washer as shown in Figure 8-14. Tighten the nut securely.
2. Remove the timing inspection plug from the top of the magneto. Turn rotating magnet to proper neutral position. This position is determined by locating keyways on drive end of magnet shaft at 12 o'clock with respect to name plate on housing. Tighten adjusting knob of 11-8465 Rotator Holding Tool until pressure is applied on housing flange preventing magnet from turning.
3. Loosen and rotate cam until cam follower of main contact assembly rests on highest point of cam lobe. Adjust main contact assembly to obtain the clearance of 0.016 inch. Tighten main contact assembly securing screws to 20-25 inch pounds.
4. Install the 11-8693 Timing Plate Assembly and the 11-8149 Pointer Assembly of the 11-8150 Scintilla Timing Kit to breaker compartment of magneto. (Refer to Figure 8-15.) Align pointer assembly with the 0° mark on timing plate. Loosen adjusting knob of 11-8465 Rotor Holding Tool and turn rotating magnet in normal direction of rotation until pointer indexes with the respective E gap mark (15° ± 2°). Tighten adjusting knob of 11-8465 Tool and remove the 11-8149 Pointer Assembly from magneto. Using a timing light, adjust main contact points to just open. This adjustment shall be made by rotating cam, in opposite direction of rotation, a few degrees beyond point where contacts close. Then rotate cam in normal direction of rotation until contacts just open. While holding cam in this exact position, push cam on magnet shaft as far as possible with the fingers. Extreme care must be exercised in this operation. If cam adjustment is changed in the slightest degree, the timing of the magneto will be thrown off. Do not drive cam on shaft with a mallet or other instrument. Tighten the securing screw thereby drawing the cam down, evenly and tightly. Torque non-self locking screw from 16-20 inch pounds. Refer to the latest revision of Lycoming Service Instruction No. 1400 for information regarding replacement of cam retaining screw.

Loosen the 11-8465 Rotor Holding Tool adjusting knob and return rotating magnet to neutral position. Reinstall the 11-8149 Pointer Assembly over 0° mark on timing plate. Rotate magnet shaft in normal direction of rotation and check for opening of main contact points at E gap setting (15° ± 2°).

c. The retard contact assembly of the dual-breaker magnetos may be timed as follows:
   1. The retard contact assembly is adjusted to open a predetermined number of degrees after the main contact assembly opens. The degree of retard for any particular magneto is stamped in the bottom of the breaker compartment.
   2. Locate the exact point of main contact assembly opening and set the 11-8149 Pointer Assembly over the 0 ° mark on the 11-8693 Timing Plate Assembly. Turn rotating magnet in the direction of normal rotation until pointer indexes with the degree of retard. Tighten adjusting knob of 11-8465 Holding Tool and set retard contact assembly to just open, within +2° -0°. Tighten securing screws to 20-25 inch pounds. Loosen adjusting knob of holding tool and turn rotating magnet until cam follower is on high point of cam lobe. Contact clearance shall be 0.016 ± 0.003 inch. If dimension is not within limits, readjust contact assembly and recheck to be sure that points will open within retard degree tolerance. Remove the 11-8150-1 Timing Kit and two studs from the magneto.

d. If the distributor block was not removed from the housing, the internal timing may be checked by turning the magneto in the normal rotation to number one firing position (keyway up and main points just opening). At this position, the reference line on the distributor block should line up between the L and LB marks on the gear. On single contact magnetos the line should favor the L mark and on the dual contact magnetos the line should favor the LB mark, if possible.

e. If the distributor block was removed from the housing, the distributor gear alignment and internal check may be accomplished as follows:
   1. Turn rotating magnet in direction of rotation until it is located in firing position (keyway up and main points just opening). Tighten adjusting knob of 11-8465 Rotor Holding Tool. Apply a light coating of Bendix Grease P/N 10-27165 to teeth of distributor gear, if needed. The large distributor gear incorporates four timing marks, L and LB for left hand rotation and R and RB for right hand rotation.
   2. With distributor gear assembled to block, turn gear until raised rib on block lines up between the L and LB marks. Assemble block and gear into housing, meshing the distributor gears together. For the dual contact assembly magneto, distributor block rib must align between painted marks. However, the rib should favor the LB mark, if possible. (Refer to Figure 8-16.) On the single contact magneto the rib should favor the L mark.
   3. Secure distributor block to housing with studs and washers. Tighten studs finger tight. Loosen the 11-8465 Rotor Holding Tool and turn rotating magnet in reverse direction of rotation until timing light indicates main contact assembly has just opened and check to make certain timing marks align within tolerance indicated above. Tighten block securing studs, first to 4-8 inch pounds torque and then final torque to 20 inch pounds.
   4. Insert the tip of your small finger through timing hole in housing and against large distributor gear teeth. Rock distributor gear back and forth slightly. There must be perceptible backlash between teeth of large and small gears. This check should be made at three different points, 120° apart on gear. If backlash is not evident, replace large distributor gear.
   5. Install the breaker cover and complete reassembly of the magneto. Refer to the manufacturer's publications for complete disassembly and reassembly procedures.

f. Install and time magneto, removed from engine, in accordance with paragraph 8-65.

g. Secure external switch and retard leads to the breaker cover terminals. Connect harness assembly to the magneto.

8-65. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine.)

a. Remove a spark plug from No. 1 cylinder and place a thumb over the spark plug hole. Rotate the crankshaft in direction of normal rotation until the compression stroke is reached; this will be indicated by a position pressure, inside the cylinder, tending to push the thumb off the spark plug hole.

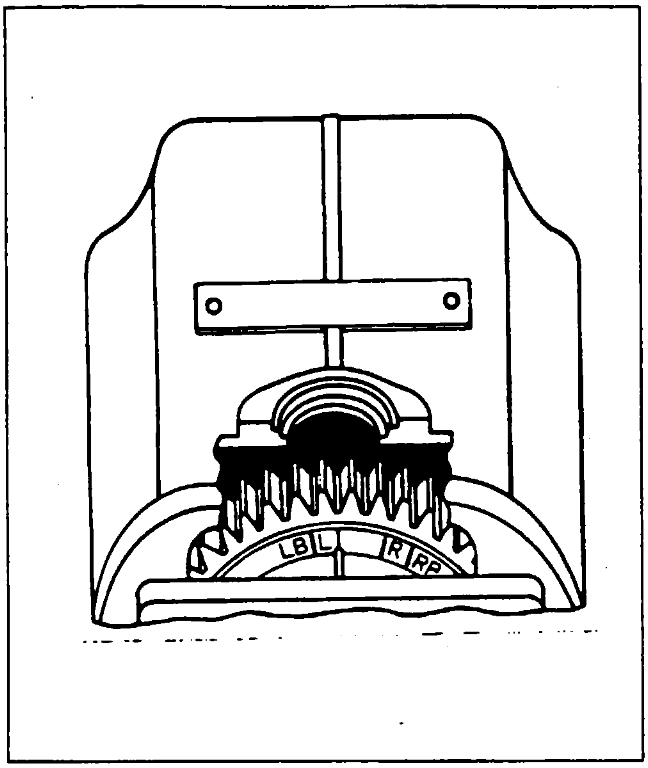


Figure 8-16. Aligning Timing Marks Single Contact Assembly Magneto

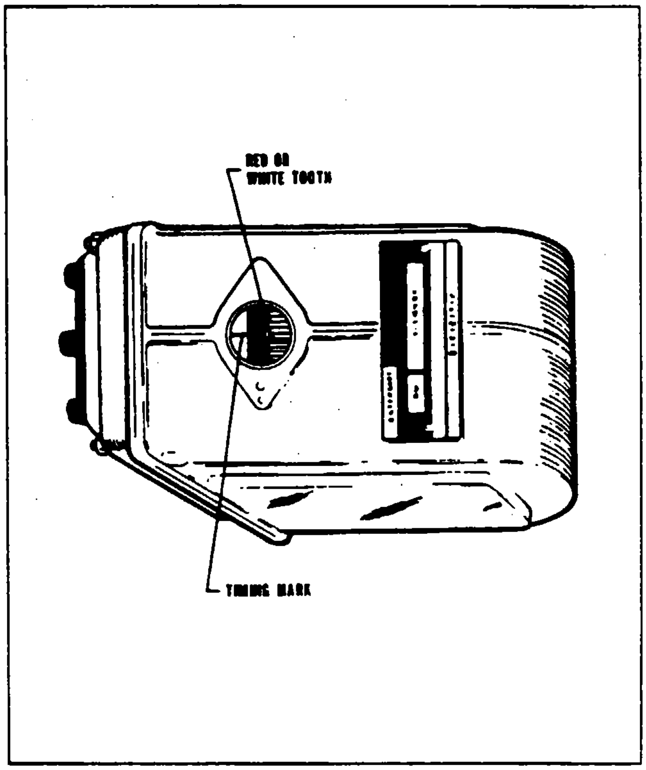


Figure 8-17. Magneto Timing Marks

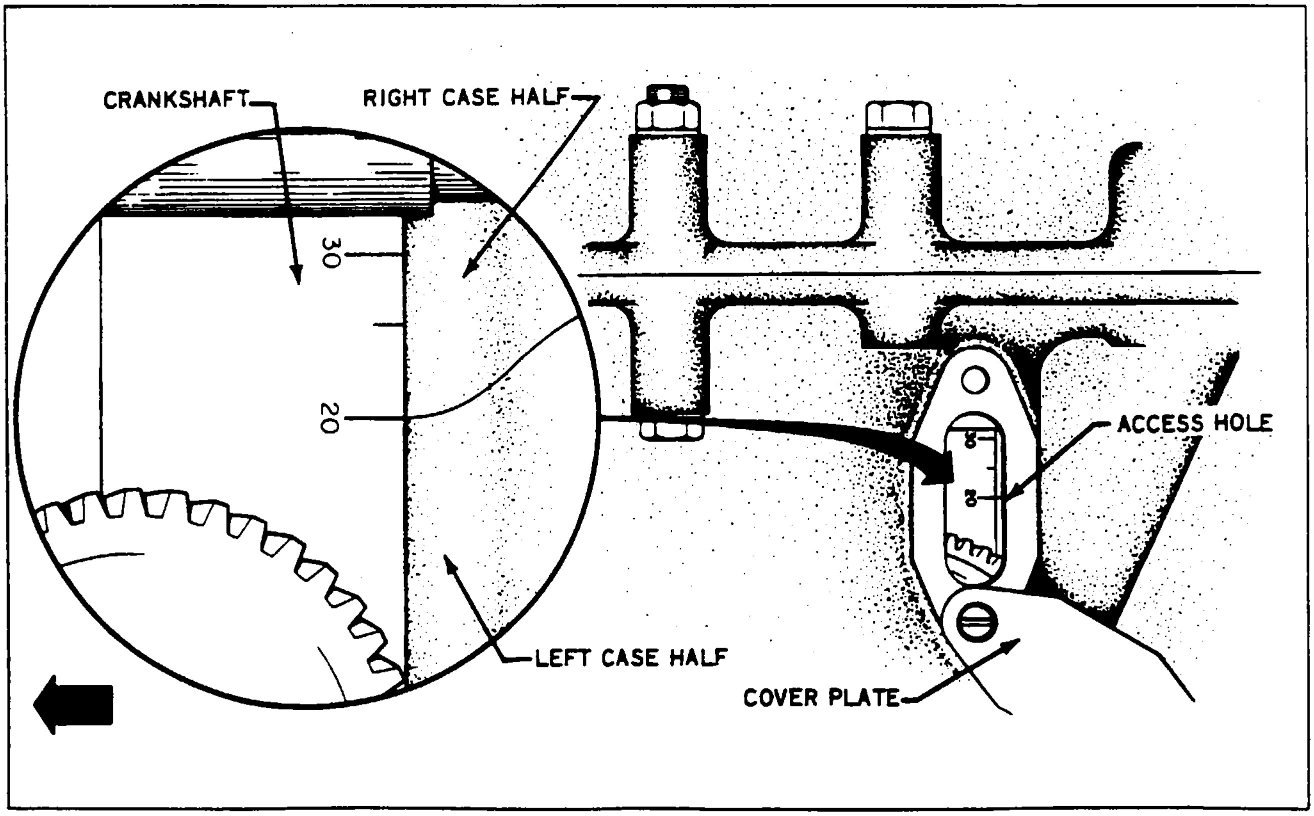


Figure 8-18. Engine Timing Marks

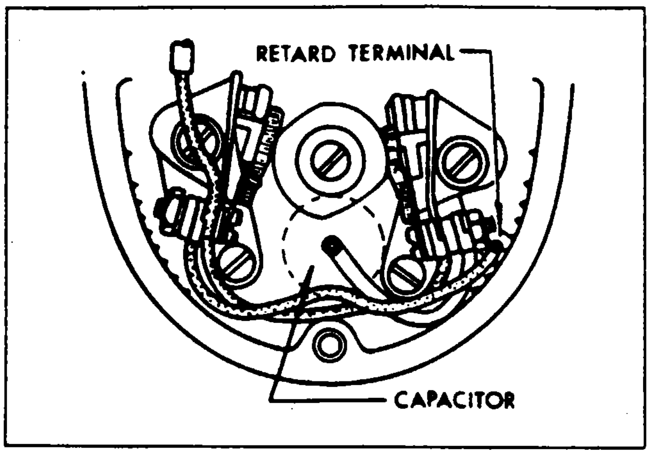


Figure 8-19. Forming Leads in Breaker Compartment

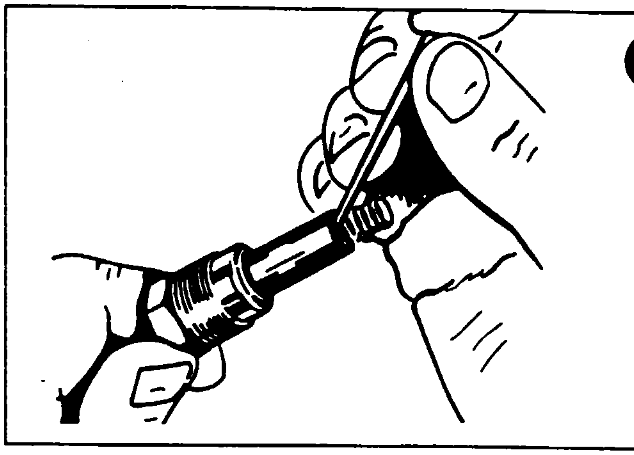


Figure 8-20. Removing Spring From Lead Assembly

b. Remove the timing hole cover, and sighting through the timing hole, continue to rotate crankshaft until the 20° timing mark on the crankshaft gear is in alignment with the parting surface of the crankcase. (Refer to Figure 8-18.)
c. Remove the inspection plug on the left magneto and turn the drive coupling in direction of normal rotation until the first painted chamfered tooth is aligned in the center of the inspection hole. (Refer to Figure 8-17.) Without allowing the gear to turn from this position, assemble gasket and magneto to the engine. Secure in place with clamps, washers and nuts: tighten only finger tight.

NOTE

The retard breaker magneto is installed on the left side of the engine.

d. Fasten ground wire of electric timing light to any unpainted portion of the engine, and one of the positive wires of the timing light to a suitable terminal connected to the ground terminal of the magneto. Then turn the engine crankshaft several degrees from the advance timing mark in direction opposite to that of normal rotation.
e. Turn on the switch of the timing light, which should be lit. Turn the crankshaft slowly in direction of normal rotation until the mark on the crankshaft gear aligns with the crankcase parting surfaces, at which point the light should go out. If not, turn the magneto in its mounting flange and repeat the procedure until the light goes out. Repeat the same procedures with the right magneto.

NOTE

Battery powered timing lights operate in the reverse manner from that described above; the light goes on when the marks align.

f. After both magnetos have been timed, leave the timing light wires connected and recheck magnetos as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go out simultaneously when the timing marks are in alignment. Tighten nuts to specified torque.
g. After magnetos have been properly timed, replace breaker cover and secure.
h. Install the ground lead and the retard spark lead on the left magneto.
i. Place the harness terminal plate on the magneto and tighten nut around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

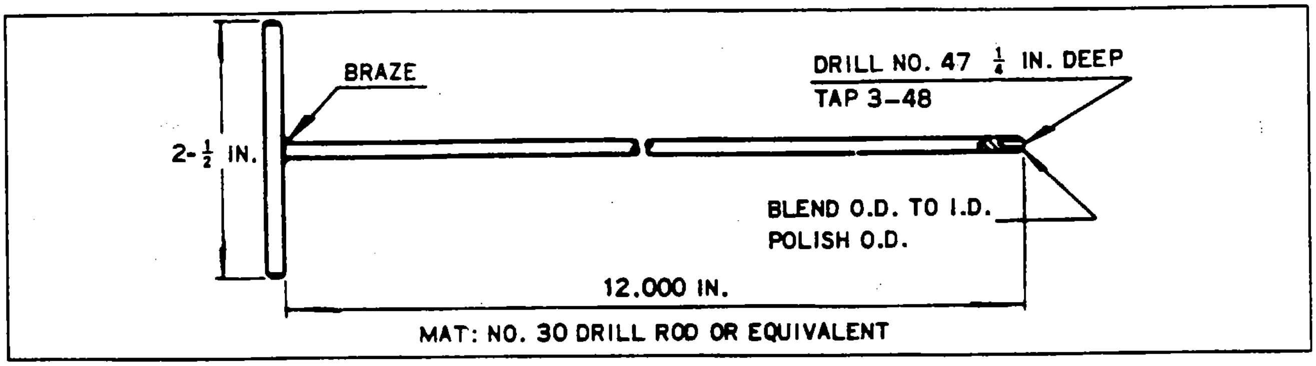


Figure 8-21. Assembly Tool

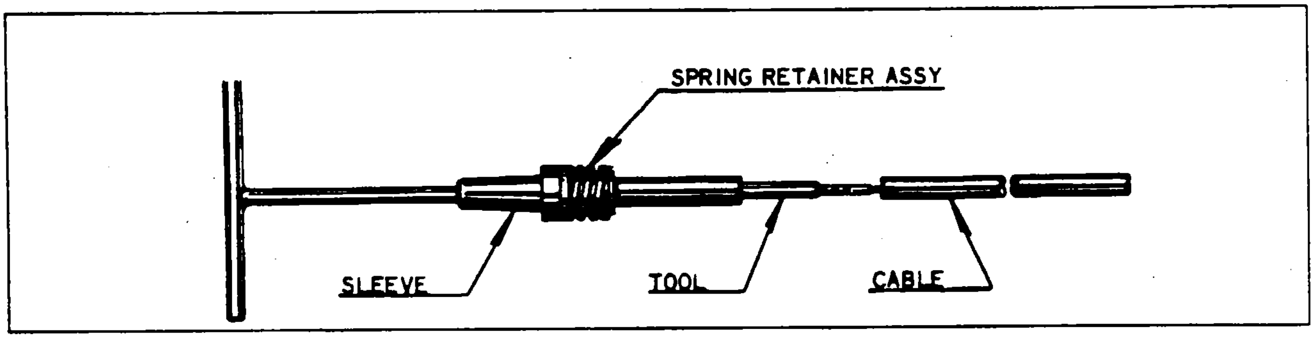


Figure 8-22. Using Assembly Tool

8-66. HARNESS ASSEMBLY.

8-67. INSPECTION OF HARNESS.

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.
b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.
c. For electrical test of harness assembly, use a high voltage, direct current tester such as the TAKK Model 86 or 86A or an equivalent direct current high voltage tester capable of delivering a test potential of 10,000 volts. Connect ground lead of high voltage tester to outer shielding braid of a single lead. Connect terminal. Turn tester "ON" and apply 10,000 volts. The insulation resistance should be 100 megohms minimum. Proceed to check other leads of harness in same manner.
d. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

8-68. REMOVAL OF HARNESS.

a. Disconnect the clamps that secure the wires to the engine and accessories.
b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.
c. Place a guard over the harness insulators.
d. Remove the harness assembly terminal plate from the magneto.
e. Remove the harness from the airplane.

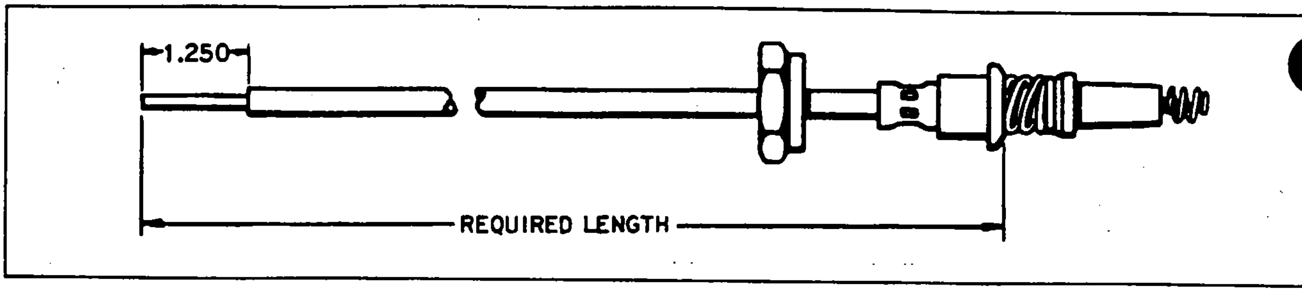


Figure 8-23. Measuring Lead Assembly Length

8-69. MAINTENANCE OF HARNESS.

a. To replace contact springs, spring retainer assemblies or insulating sleeves, proceed as follows:
   1. Using a Scintilla 11-7073 Needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 8-20.
   2. Using the needle or pencil, unscrew the spring.
   3. Slide insulating sleeve and spring retainer assembly off end of lead assembly.
   4. Replace defective component and reassemble as follows:
      (a) Fabricate a tool as shown in Figure 8-21 for installing the insulating sleeves over cable terminals.
      (b) Push the tool thru insulating sleeve and spring retainer assembly as shown in Figure 8-22. Screw the cable terminal into the tool.
      (c) Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

NOTE

It may be necessary to lubricate the cable and insulating sleeve with a thin film of MC 200 (200,000 centi-strokes) or commercial grade alcohol to facilitate assembly.

b. To replace one of the lead assemblies proceed as follows:
   1. Remove clamps and brackets from applicable lead assembly. Cut cable ties from assembly and discard.

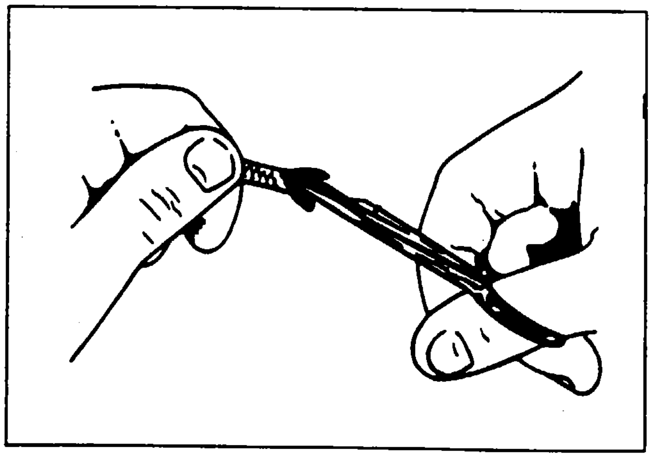


Figure 8-24. Cutting Metallic Braid From End of Lead

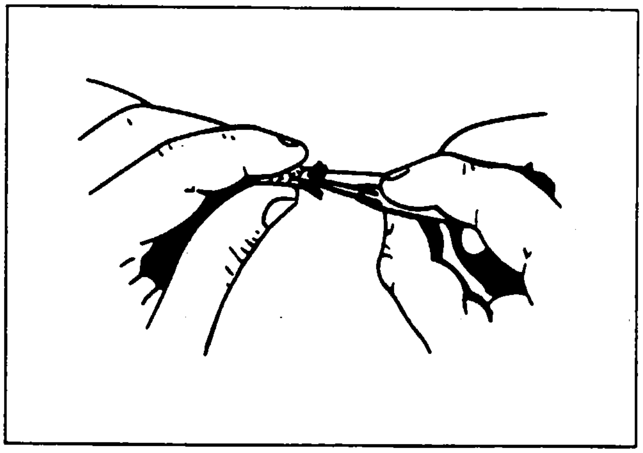


Figure 8-25. Unbrading Metallic Shielding

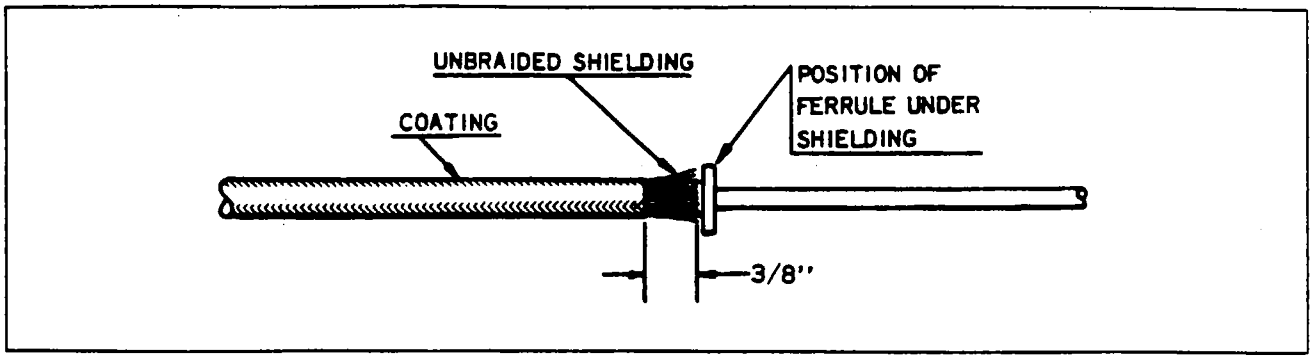


Figure 8-26. Forming Shielding Around Ferrule

2. Cut off condemned lead flush with outer surface of cable outlet plate.
3. Grip eyelet of lead with a pair of pliers and pull short length of conductor out of grommet and cable outlet plate.
4. Using a 3 inch long, 0.270 inch diameter drift, applied at outer surface of plate, drive out tapered ferrule and remaining pieces of insulation and shielding.
5. To determine what length the new lead assembly should be cut to, proceed as follows:
   (a) Measure the length of the condemned lead assembly. Move coupling nut back on lead assembly and measure from outer end of ferrule at spark plug end. See Figure 8-23.
   (b) To the length determined in step (a), add 1-3/4 inches.

NOTE

Spare part leads are supplied in various lengths. Use a lead which is longer than, but nearest to, the desired length.

6. Cut lead assembly to the length determined in step 5. Mark ferrule on spark plug end of lead with a metal stamp, scribe or rubber stamp to correspond with correct cylinder number.
7. Starting at spark plug location, thread new cable thru grommets and clamps as necessary for correct routing of cut end of cable to magneto location.
8. Using electrician's scissors, carefully remove 1.250 inch of outer braid from end of lead. Refer to Figure 8-24.

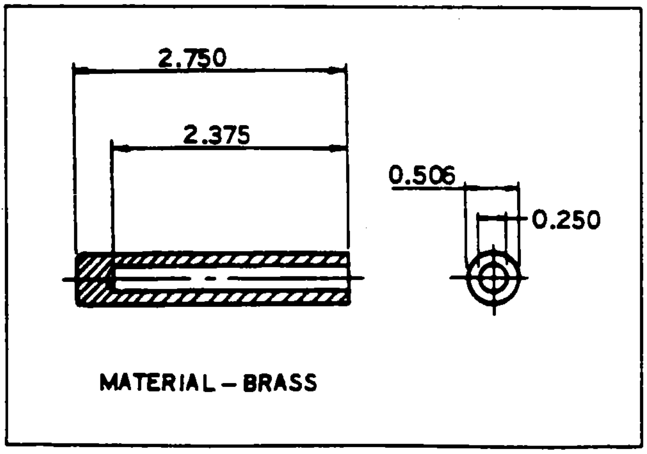


Figure 8-27. Ferrule Seating Tool

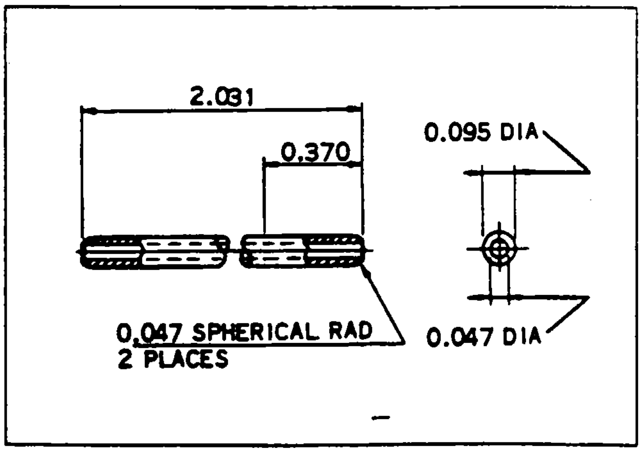


Figure 8-28. Needle

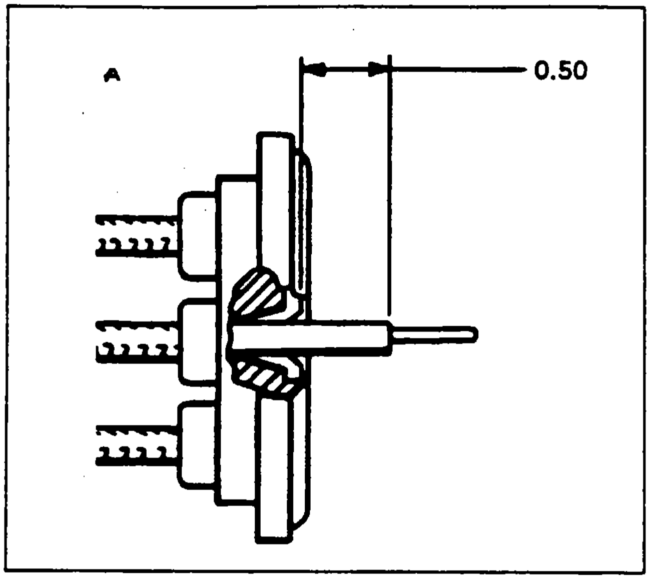


Figure 8-29. Measuring Wire From Top of Ferrule

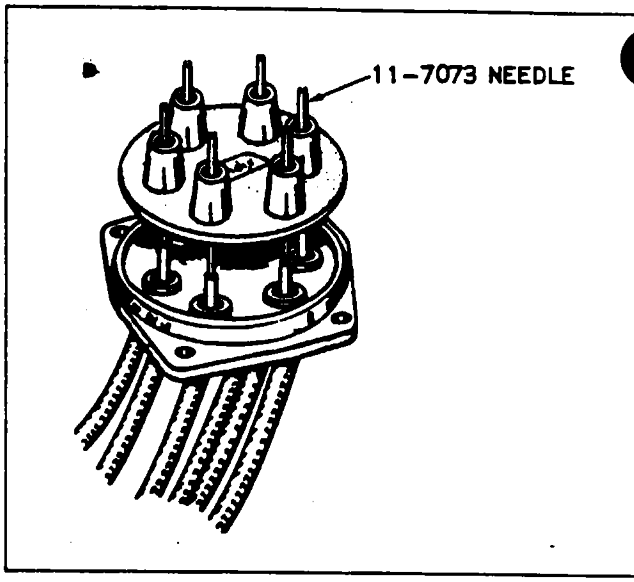


Figure 8-30. Installing Grommet Over Lead Assemblies

CAUTION

Use care not to nick or cut insulation when removing braid.

9. Using a scribe or similar pointed tool, unbraid 0.375 inch of braided shielding. (Refer to Figure 8-25.) Wrap a single thickness of electrical tape around unbraided strands to facilitate insertion of lead end thru hole in cable outlet plate.
10. Remove cable outlet plate from magneto. Support plate securely and, using suitable cutting pliers, split and remove eyelets from leads adjacent to lead being replaced. When splitting eyelet make certain that wire strands are not cut. Removal of eyelets on adjacent leads will allow grommet to be pulled away from outlet plate to facilitate insertion of new lead.
11. Pass the taped end of new lead through hole in outlet plate. Remove electrical tape from lead and install tapered end of ferrule under the unbraided strands of shielding. Form strands of shielding evenly around tapered ferrule as shown in Figure 8-26 and pull lead assembly back through cable outlet plate until ferrule binds in the outlet well. Position the Scintilla 11-7074 Ferrule Seating Tool (Figure 8-27) over the wire and firmly seat the ferrule by tapping the seating tool with a hammer or by using an arbor press.
12. Measure 0.50 inch from tapered ferrule and strip remaining insulation from wire. (Refer to Figure 8-29.)
13. Insert Scintilla 11-7073 Needle (Figure 8-28) thru small hole of grommet and over stripped end of wire. (Refer to Figure 8-30.) Slide grommet down needle until it seats tightly against the tapered ferrule.
14. Cut wire 0.375 inch from top of grommet outlet (See Figure 8-30.) Double wire over as shown in A of Figure 8-32. Slide eyelet over doubled wire until it is firmly seated in recess of grommet outlet.
15. Using the "AB" groove of Scintilla 11-4152 Crimping Tool, or equivalent, crimp eyelet to wire. Approximately 0.031 of wire should extend from end of eyelet after crimping. See B of Figure 8-32.

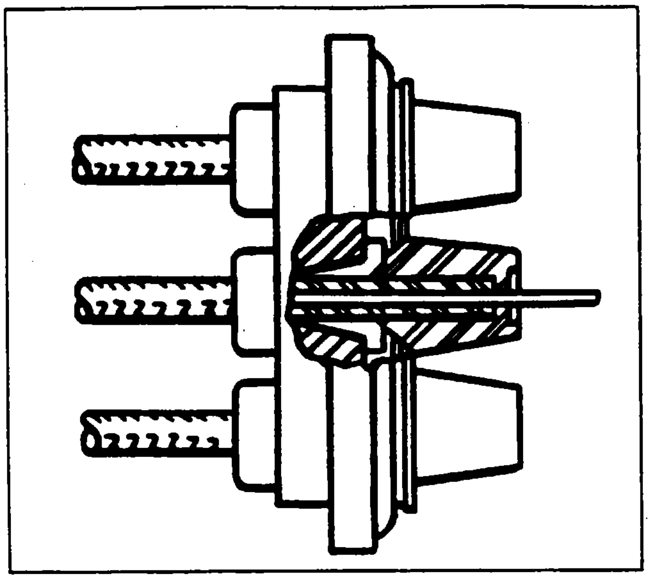


Figure 8-31. Lead Assembly Installed In Grommet

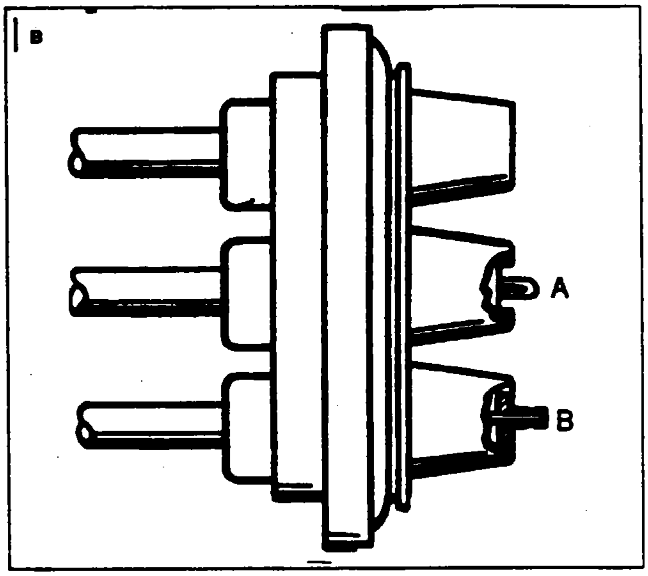


Figure 8-32. Wire Doubled Over for Installation of Eyelet

NOTE

If the crimping tool is not available, a satisfactory connection can be made by soldering with Kester Flux 709 or equivalent and a non-corrosive solder. After soldering, clean solder joints using denatured alcohol.

16. Install clamps and cable ties as necessary to secure lead to the engine.

8-70. INSTALLATION OF HARNESS. Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.
b. Route ignition wires to their respective cylinders as shown in Figure 8-33.
c. Clamp the harness assembly in position.
d. Connect the leads to the spark plugs.

8-71. SPARK PLUGS.

8-72. REMOVAL OF SPARK PLUGS.

a. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

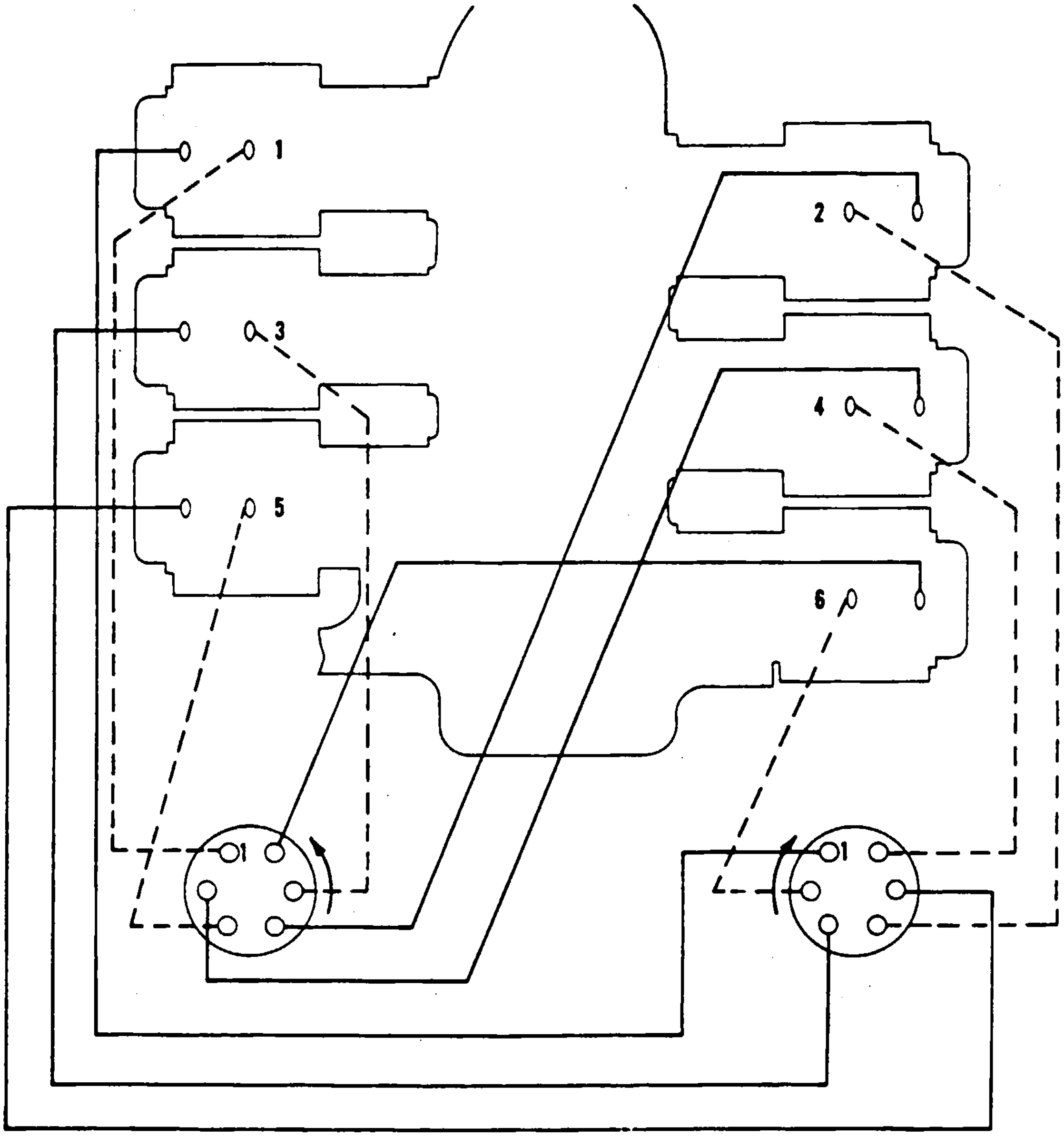


Figure 8-33. Ignition System Schematic

NOTE

When withdrawing the ignition cable lead connection from the plug, care must be taken to pull the lead straight out and in line with the center line of the plug barrel; otherwise a side load will be applied, which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

NOTE

Torque indicating handle should not be used for spark plug removal because of the greater torque requirement.

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed.

NOTE

Spark plugs should not be installed if they have been dropped.

d. Removal of seized spark plugs in the cylinder may be accomplished by application of liquid carbon dioxide by a Conical metal funnel adapter with a hole at the apex just large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8-34.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO_2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.
e. Do not allow foreign objects to enter the spark plug hole.

8-73 INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug for the following non-repairable defects:
   1. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.
   2. Badly battered or rounded shell hexagons.
   3. Out-of-round or damaged shielding barrel.
   4. Chipped, cracked or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.
b. Clean the spark plug as required, removing carbon and foreign deposits.
c. Set the electrode gap. (Refer to Table II-I of Section II.)
d. Test the spark plug both electrically and for resistance.

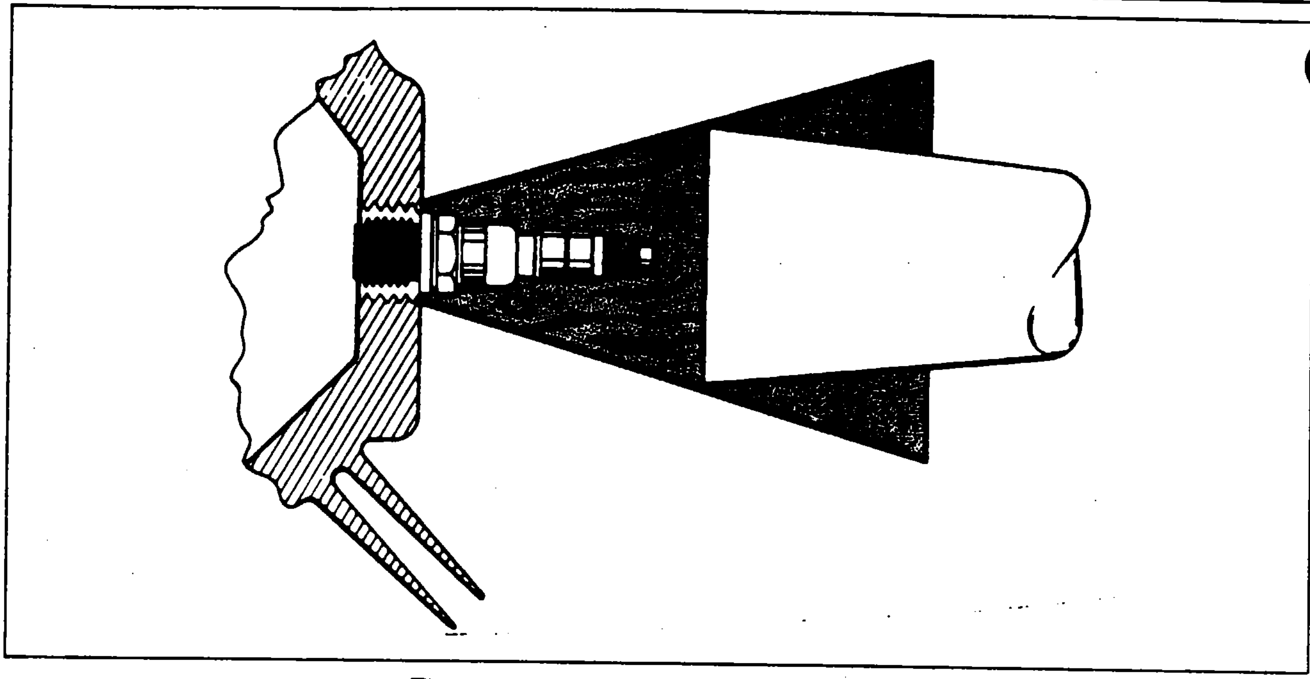


Figure 8-34. Removing Frozen Spark Plug

8-74. INSTALLATION OF SPARK PLUGS. Before installing spark plugs, ascertain that the threads within the cylinder are clean and not damaged.

a. Apply anti-seize compound sparingly on the threads and install gasket and spark plugs. Torque 360 to 420 inch pounds.

CAUTION

Make certain the deep socket is properly seated on the spark plug hexagon as damage to the plug could result if the wrench is cocked to one side when pressure is applied.

b. Carefully insert the terminal insulator in the spark plug and tighten the coupling nut.

8-75. STARTING VIBRATOR.

8-76. STARTING VIBRATOR CHECKING PROCEDURE.

a. Disconnect all spark plug leads from the left magneto at the spark plugs.

WARNING

Be sure all left magneto spark plug leads are removed, thus preventing cross-firing of the magneto and the possibility of hazardous conditions.

b. Rotate engine crankshaft until number one cylinder is in its retard firing position. Using the timing light, check to see that both magneto contact assemblies are open.
c. Remove battery terminal from starter switch or remove starter switch terminal from vibrator.

WARNING

It is necessary that the starter be electrically removed from the circuit before the vibrator is put into operation to eliminate possibility of starter being energized during the test.

d. Place left magneto switch in its "ON" position.
e. Connect a jumper lead from starter switch terminal on vibrator to ungrounded terminal on battery. This will energize the starting vibrator.
f. Holding the number one cylinder spark plug lead approximately 0.187 to 0.2 0 inch away from a good ground, a series of hot sparks should occur.

WARNING

Grasp the spark plug lead far enough away from the connection so as not to receive any dangerous electrical shock.

g. If the spark does not jump the gap, check the applied voltage to the starting vibrator. This voltage should be 24 volts.
h. If voltage is correct, check the contact points of the magneto. Both sets of contact points shall be opened.
i. Reject all units not complying with the preceding requirements or which show any visual defects.

8-77. REMOVAL OF STARTING VIBRATOR.

a. Remove the left access panel to the nose section aft of the baggage compartment.
b. The starter vibrator is attached to the forward electrical panel located above the radio shelf.
c. Disconnect the electrical lead from the vibrator.
d. Remove the vibrator from electrical panel by removing the attachment screws.

8-78. INSTALLATION OF STARTING VIBRATOR.

a. Position the vibrator on the electrical panel and secure with screws.
b. Connect the electrical leads to the vibrator.
c. Check operation per paragraph 8-76.
d. Install access panel.

8-79. LUBRICATION SYSTEM.

8-80. ADJUSTMENT OF OIL PRESSURE RELIEF VALVE. Engines are furnished with an adjustable oil pressure relief valve, which enables the operator to maintain engine oil pressure within the specified limits (60 to 90 psi). The valve is located at the rear right side of the engine below the oil filter. If the pressure under normal operating conditions should consistently exceed 90 psi or run less than 60 psi, adjust the valve as follows:

a. With the engine thoroughly warmed up and running at a maximum of 2000 RPM, observe the reading on the oil pressure gauge. If the pressure is above 90 psi, stop engine, loosen the adjusting locknut, and back off the adjusting screw one or two full turns. Tighten locknut and retest.

b. If pressure is too low, turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, tighten the locknut and lockwire the crown nut to the drilled ear projecting from the valve mounting boss.

8-81. OIL SCREEN. The suction screen located in the aft end of the engine sump should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. The suction screen is removed from the sump by removing the hex head plug at the lower aft end of the sump. Clean and inspect the screen and gasket and replace the gasket if over compressed or damaged.

8-82. OIL FILTER ELEMENT.

a. The oil filter element should be replaced after each 50 hours of engine operation; this is accomplished by removing the lockwire from the bolt-head at the end of the filter housing, loosening the bolt, and removing the filter assembly from the adapter.
b. Before discarding the filter element, remove the outer perforated paper cover, and using a sharp knife, cut through the folds of the element at both ends, close to the metal caps. Then, carefully unfold the pleated element and examine the material trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particle of metallic shavings might be found; these are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

NOTE

Refer to the latest revision of Lycoming Service Bulletin No. 337 for information concerning installation of new oil filter element.

c. After the element has been replaced, tighten the attaching bolt in accordance with placard. Lockwire the thermostatic bypass valve to the oil filter housing drain plug and the drain plug to the filter housing attaching bolt.

8-83. RECOMMENDATIONS FOR CHANGING OIL. (Refer to the latest revision of Lycoming Service Instruction No. 1014 and the latest revision of Lycoming Service Bulletin-No. 318.)

a. The only lubricants that are recommended for the TIGO-541 series engines are multi-viscosity ashless dispersant oils that essentially conform with MIL-L-22851 specifications.
b. Whenever the oil is changed, remove and check the oil section screen for metal particles. Clean and reinstall in accordance with paragraph 8-81.
c. For more detailed information on aircraft lubrication refer to Section II, paragraphs 2-47 thru 2-60.

TABLE VIII-III. TROUBLESHOOTING CHART (ENGINE)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel valves.
	Overpriming.	Unload engine by standard clearing procedure.
	Incorrect throttle setting.	Open throttle to 1/4 of its range.
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with tester and replace any defective wires.
	Improper operation of magneto	Clean points. Check timing.
	Internal failure.	Check oil screens for metal particles. If found, complete overhaul of engine is indicated.
Failure of engine to idle properly.	Incorrect idle mixture.	Adjust mixture control.
	Incorrect idle speed.	Adjust idle speed.
	Leak in induction system.	Tighten all connections and replace any defective parts.
	Uneven cylinder compression.	Check condition of piston ring and valve seats.

TABLE VIII-III. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Failure of engine to idle properly.(cont.)	Faulty ignition system.	Check ignition system.
Low power and uneven running.	Mixture too rich; indicated by sluggish engine, red exhaust flame. Extreme cases indicated by black smoke at exhaust.	Readjustment of fuel injector is indicated.
	Mixture too lean; indicated by overheating and back firing.	Check fuel lines for restrictions. Readjust mixture.
	Leak in induction system.	Tighten all connections, replace any defective parts.
	Defective spark plugs.	Clean and gap or replace spark plugs.
	Improper fuel.	Fill tank with recommended grade of fuel.
	Magneto breaker points not working properly.	Clean points, check timing.
Low power and uneven running. (cont.)	Defective ignition wire.	Check wires with tester, replace any defective wires.
	Defective spark plug terminal connectors.	Check and replace connectors if necessary.
Failure of engine to develop full power.	Leak in the induction system.	Tighten all connections, replace any defective parts.
	Throttle lever out of adjustment.	Check travel of throttle linkage.

TABLE VIII-III. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Failure of engine to develop full power. (cont.)	Improper fuel flow.	Check strainers and flow at fuel injector.
	Restriction in air scoop.	Examine air scoop and remove any obstructions.
	Improper fuel.	Drain and refill tank with fuel of recommended grade.
	Faulty ignition.	Check ignition system.
Rough engine.	Cracked engine mount.	Replace or repair mount.
	Defective mounting bushing.	Replace bushing.
	Uneven compression.	Check condition of piston rings and valve seats.
Low oil pressure.	Insufficient oil.	Fill sump with oil.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Dirty oil strainers.	Remove and clean oil strainers.
Low oil pressure. (cont.)	High oil temperatures.	"High Oil Temperatures" in "Trouble" column.
	Defective pressure gauge.	Replace gauge.
High oil temperature.	Insufficient oil supply.	Fill sump with oil of recommended grade.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
High Oil Temperature. (cont.)	Low grade of oil.	Drain and fill sump with oil conforming to specifications.
	Clogged oil lines or strainers.	Clean oil lines and strainers.
	Excessive blow-by.	Usually caused by worn or stuck rings.
	Failed or failing bearings.	Examine oil strainers for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gauge.	Replace gauge.
	Defective thermostat valve.	Replace valve.
Excessive oil consumption.	Low grade of oil.	Fill sump with oil conforming to specifications.
	Failing or failed bearings.	Examine oil strainers for metal particles. If found, overhaul of engine is indicated.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.

TABLE VIII-III. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Excessive oil consumption. (cont.)	Failure of rings to seat (new nitrided barrels).	Check quantity of oil in system, climb to cruise altitude at full power and operate at 75% cruise power setting for approximately one hour. Land aircraft and check oil consumption. Repeat flights until oil consumption stabilizes. Alternate procedure: Remove cylinder, hone lightly and replace piston rings.

TABLE VIII-IV. TROUBLESHOOTING CHART (TURBOCHARGER)

Trouble	Cause	Remedy
Excessive noise or vibration.	Improper bearing lubrication.	Supply required oil pressure. Clean or replace oil line. If trouble continues, overhaul turbo charger.
	Leak in engine intake or exhaust manifold.	Tighten loose connecttions, or replace manifold faucets as necessary.
Engine will not deliver rated power.	Clogged manifold system.	Clean all ducting.
	Foreign material lodged in compressor impeller or turbine.	Disassemble and clean.
	Excessive dirt build-up in compressor.	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.

TABLE VIII-IV. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine will not deliver rated power. (cont.)	Leak in engine intake or exhaust manifold.	Tighten loose connections, or replace manifold gaskets as necessary.
	Rotating assembly bearing seizure.	Overhaul turbocharger.
	Restriction in return lines from exhaust wastegate valve to variable pressure controller.	Remove and clean lines.
	Variable pressure controller out of adjustment.	Adjust controller.
	Oil pressure too low.	Tighten fittings, replace lines or hoses. Increase oil pressure.
	Oil inlet to exhaust bypass valve clogged.	Remove oil line at inlet and clean orifice.
	Variable pressure. controller malfunction.	Adjust controller. Install new controller if needed.
	Exhaust wastegate valve not closing because of low oil pressure or butterfly shaft binding.	Check for oil pressure difficulty. Examine shaft for evidence of binding.
	Impeller binding, frozen, or fouling housing.	Check bearings for evidence for failure. Overhaul turbocharger.

TABLE VIII-IV. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine will not deliver rated power. (cont.)	Piston seal in exhaust wastegate valve actuator. leaking.	Clean cylinder and replace piston seal.
Critical altitude lower than specified.	Controller not getting enough oil pressure to close wastegate valve.	Check pump outlet pressure, oil filters and lines for leaks or obstructions.
	Chips under metering valve in controller holding it open.	Replace controller.
	Metering jet in exhaust wastegate valve actuator plugged.	Remove exhaust bypass valve actuator and clean jet.
	Exhaust wastegate valve actuator piston seal leaking excessively.	Clean cylinder and replace piston seal.
	Wastegate valve sticking.	Clean and free action.
Engine surges or smokes.	Air in oil lines of exhaust wastegate valve actuator.	Bleed system
	Controller metering valve stem seal leaking oil into manifold.	Replace controller.
	Exhaust wastegate valve actuator to bypass valve linkage binding.	Correct cause of binding.

TABLE VIII-IV. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine surges or smokes. (cont.)	Clogged breather.	Check breather for restriction to air flow.
High Deck Pressure (Compressor Discharge Pressure).	Controller metering valve not opening.	Replace controller.
	Exhaust wastegate valve sticking closed.	Shut-off valve in return line inoperative.
	Controller return line restricted.	Clean or replace line.
	Oil pressure too high.	Reduce oil pressure.
	Exhaust wastegate valve actuator piston locked in closed position.	Disassemble actuator, check condition of piston and packing.
	Variable pressure controller malfunction.	Replace controller.

SECTION IX

FUEL SYSTEM

SECTION IX

FUEL SYSTEM

9-1. INTRODUCTION. This section contains instructions for repairing difficulties which may arise in the operation of the fuel system and its related parts. The instructions are organized so the mechanic can refer to: Description and Principle of Operation for a basic understanding of the system; Removal, Repair and Installation of the various components, and a Troubleshooting Chart to facilitate the location and repair of the different components of the fuel system.

9-2. DESCRIPTION. The fuel system is divided into two independent systems that allow each engine to have its own fuel supply. The systems are connected by a crossfeed valve that allows fuel to be drawn from one set of fuel cells to the engine on the opposite side, in the event of an emergency. The fuel cells are of the bladder type with the inboard cells containing internal baffles. Inboard and outboard cells are installed in the cavities of the wings. The inboard cells have a capacity of 56 U.S. gallons each, and the outboard cells have a capacity of 40 U.S. gallons each. There are two auxiliary fuel cells, one in each nacelle which have a capacity of 25 U.S. gallons each. This gives a total fuel load of 242 U.S. gallons.

Fuel is taken from each wing fuel cell through submerged fuel pumps and then on to the shutoff, selector valves. From the selector valves, fuel is drawn in a series configuration through the fuel filters, emergency electric fuel pumps, emergency shutoff valves and on to the engine driven pumps. These units, except for the engine driven pumps and submerged boost pumps are accessible through panels located between the underside of each wing and fuselage. The fuel filters, emergency electric and engine driven fuel pump incorporate a bypass valve that will open and allow fuel to pass in the event of fuel stoppage through the normal passage. The fuel in the nacelle fuel cells is transferred to the outboard wing fuel cell by electric transfer pumps. The fuel valves are operated through controls located in the fuel control panel, between the pilot's and copilot's seats ahead of the main spar. A series of warning lights are incorporated into the system to aid the pilot with fuel control management. Boost pump inoperative lights (left or right) come on whenever the submerged (boost) fuel pump pressure drops below 2-4 psi. These lights are located in the annunciator panel along the top of the instrument panel. On earlier model aircraft, the lights are in the overhead panel. Low fuel pressure of 29 psi or less at the engines is indicated by warning lights built into the emergency fuel pump switches located in the overhead panel and also on the annunciator panel. On earlier aircraft the lights were in the lower center portion of the instrument panel and in the switches. Low fuel warning lights indicate when less than four gallons of fuel is left in the outboard fuel cells. These lights are in the transfer pump switches in the overhead panel. These low fuel warning lights also let the pilot know when it is advisable to transfer the fuel from the auxiliary fuel cells to the outboard main cells. Each wing fuel cell has its own fuel quantity gauge, and the two nacelle fuel cells are read off of the respective outboard fuel gauge by depressing the button on the overhead panel adjacent to the outboard fuel gauges.

9-3. TROUBLESHOOTING. Troubles peculiar to the fuel system are listed in Table IX-II at the back of this section, along with their probable causes and suggested remedies. When troubleshooting, check from the fuel supply to the items affected. If no trouble is found by this method, the trouble probably exists inside individual pieces of equipment; they should be removed from the airplane and overhauled or replaced with identical units tested and known to be good. Troubleshooting the fuel quantity indicator may be found in Section X, Instruments. The electrical system diagram for the system may be found in Section XI, Electrical System.

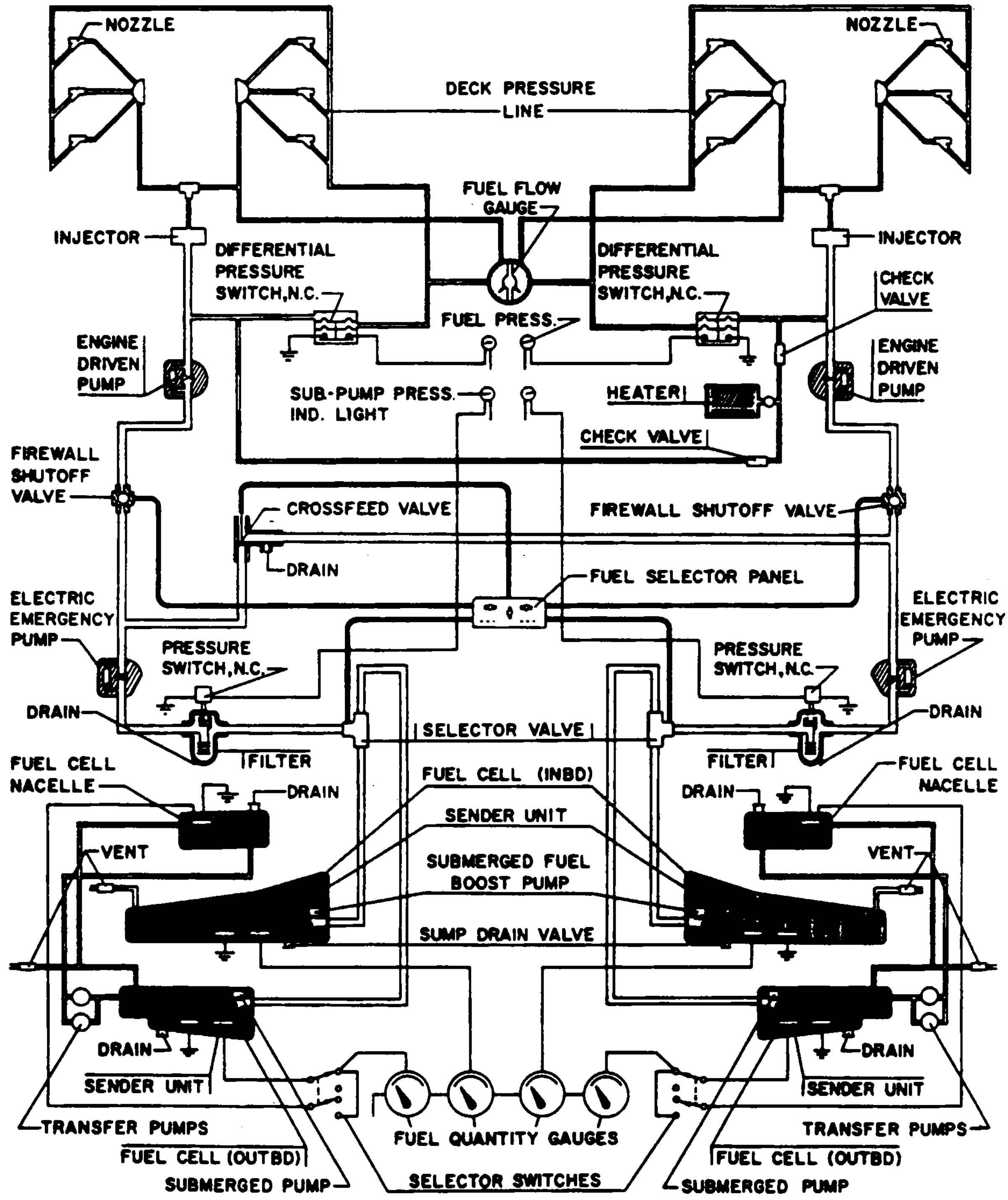


Figure 9-1. Fuel System

9-4. FUEL CELLS.

9-5. REMOVAL OF WING FUEL CELLS. (Refer to Figure 9-2 and 9-3.)

a. Turn the fuel selector to the off position and drain the fuel cell. (Refer to Draining Fuel System, Section II.)
b. From the underside of the wing, remove the access plates to the fuel cell outlet and vent.
c. Loosen the clamp and disconnect the fuel pump at the fuel outlet at the inboard end of the cell and vent line at the outboard end of the cell.
d. Remove the screws that secure the drain fitting plate, draw the drain down enough to disconnect the fitting clamp and remove the drain.
e. On top of the wing, remove the access plates to the fuel cell and senders.
f. Disconnect the wires from the sender units, remove the screws that secure the sender and carefully draw the sender with gasket from the cell. Note the installed position of the senders.
g. Remove the submerged fuel pump from the fuel cell by reaching through the access hole in the top of the cell.
h. Reach through the access hole and untie the nylon cord that secures the cell.
i. Remove the filler cap and machine screws that secure the cap adapter and gaskets.
j. Remove the cap bolts that secure the adapter bracket to the fuel cell and draw the adapter bracket out through the elongated access hole, being careful not to damage the cell.
k. Place tape or another protective material around the cell access opening to prevent damage to the cell when removing.
l. Push the cell down and work the nylon cord back through the cell hangers and rib bushing to the outboard ends of the cell compartment.
m. Fold the cell neatly within the wing and remove it gently through the opening in the top of the wing.

9-6. REMOVAL OF NACELLE FUEL CELL. (Refer to Figure 9-4.)

a. Turn the fuel selector to the off position and drain the fuel from the cell.
b. Remove the access plates to the fuel cell outlet, fuel sender unit and the tierope connection.
c. Loosen the clamps and disconnect the fuel outlet at the aft end of the cell, the vent line at the forward outboard end of the cell and the drain line from below the cell in the main landing gear wheel forward wells.
d. Disconnect the wires from the sender units, remove the screws that secure the sender and carefully draw the sender with gasket from the fuel cell. Note the installed position of the sender for proper reinstallation.
e. Reach through the access hole and untie the nylon cord that secures the fuel cell to the nacelle.
f. Remove the filler cap and machine screws that secure the cap adapter and gasket.
g. Place tape or another protective material around the cell access opening to prevent damage to the cell when removing it.
h. Push the cell down and work the nylon cord back through the cell hangers and bushing to the outboard ends of the cell compartment.
i. Fold the cell neatly within the nacelle and remove it gently through the opening at the top of the nacelle.

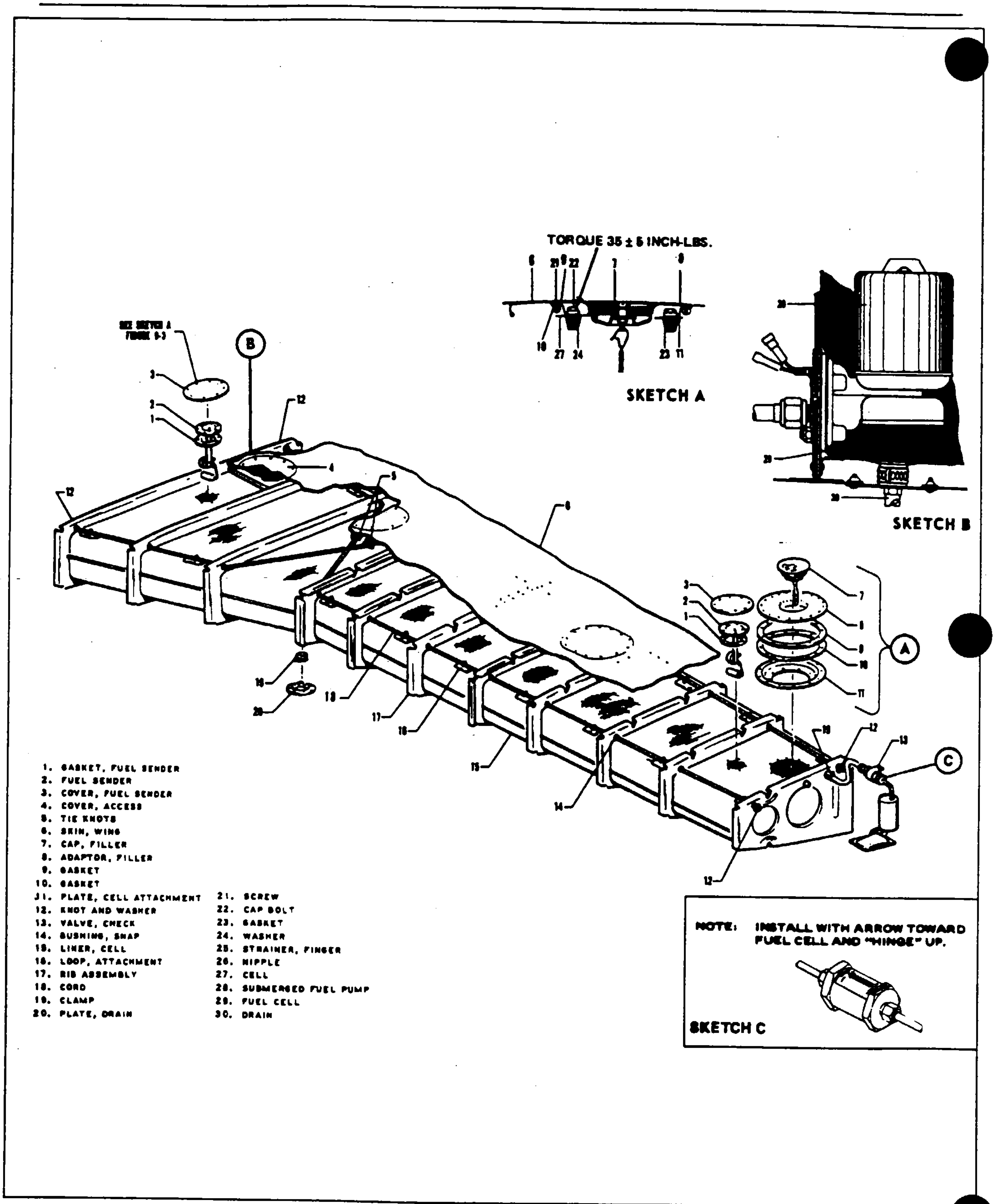


Figure 9-2. Fuel Cell Installation Inboard

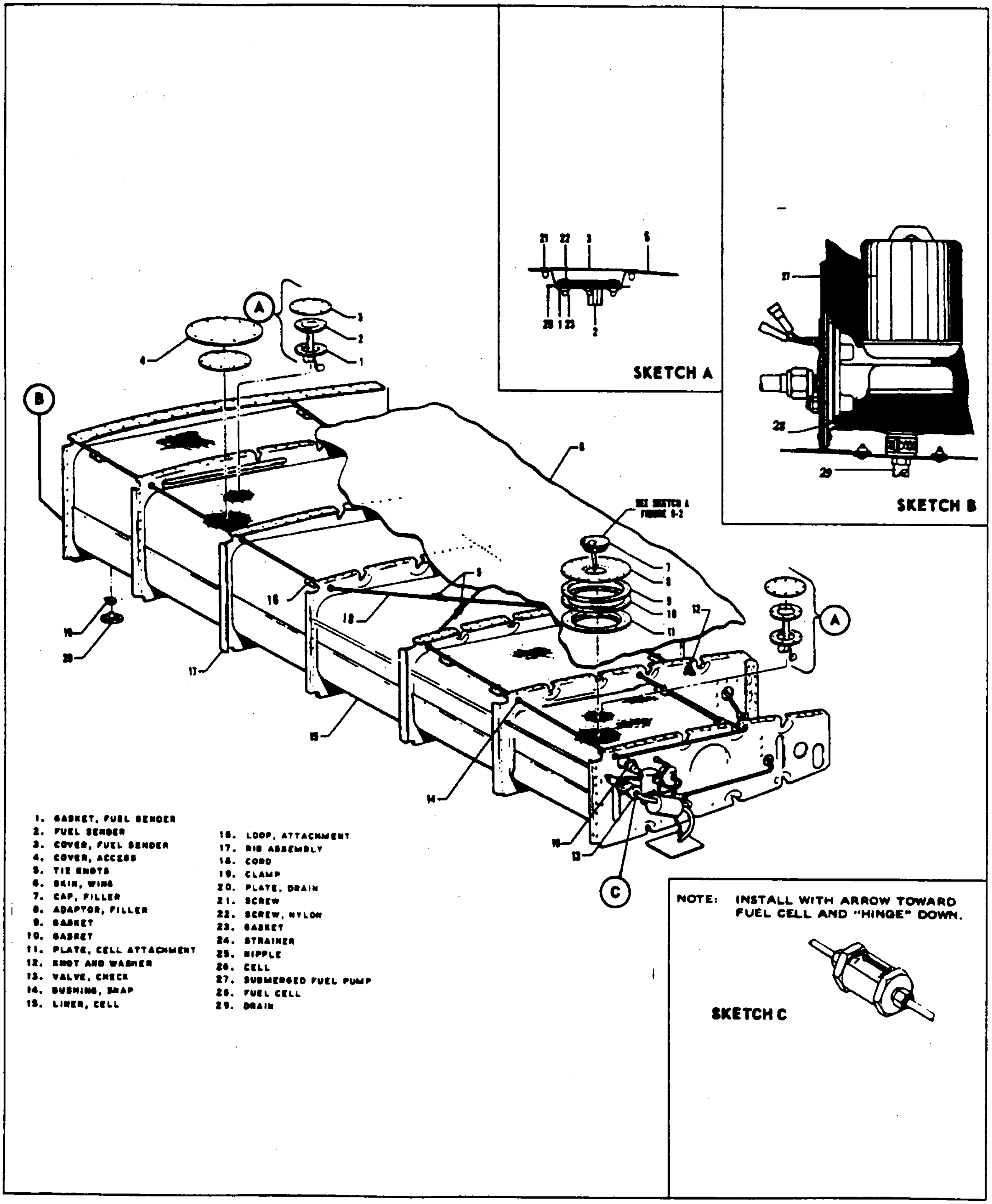


Figure 9-3. Fuel Cell Installation Outboard

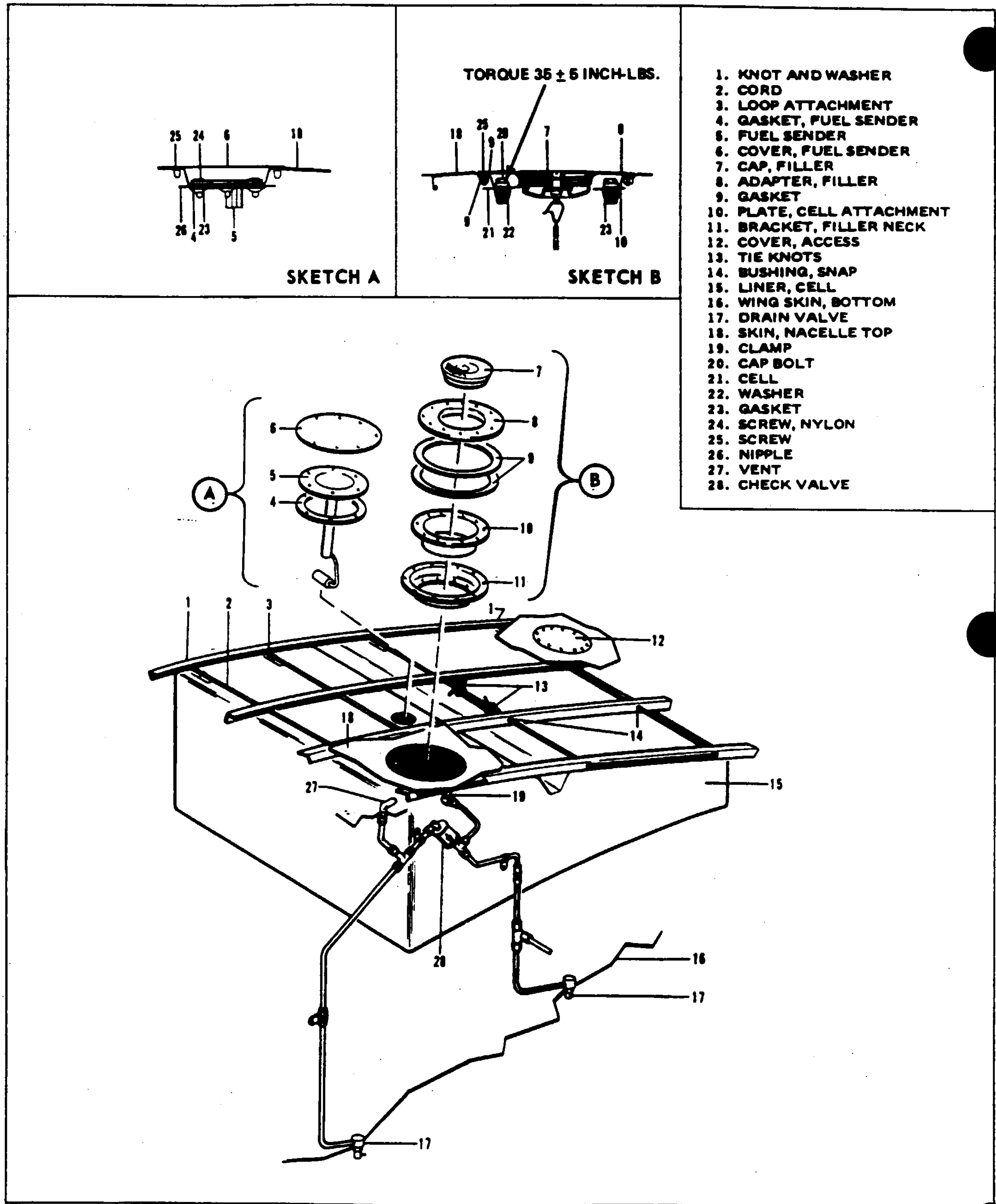


Figure 9-4. Fuel Cell Installation Nacelle

9-7. CLEANING, INSPECTION AND REPAIR OF FUEL CELLS.

a. Fuel cells may be cleaned by the following procedure:
   1. New Cells: It should not be necessary to clean new cells upon removing them from their containers, if they are installed in the airframe cavities promptly. If for any reason the cells are not installed immediately, and become dirty, they should be cleaned with soap and warm water to remove foreign material prior to installation in a clean cavity.
   2. Used Cells: Prior to removal, the cells are to be drained of fuel, purged with fresh air and swabbed out to remove all traces of fuel. Following removal, the cells are to be cleaned inside and out with soap and warm water.

WARNING

Use a vapor-proof light for inspection.

b. Fuel cells may be inspected by the following procedure:
   1. New Cells: Inspect the cell surface inside and outside for cuts, abraded (scuffed) areas and accessory damage. Also, inspect the fitting seals for nicks, scratches and foreign material.
   2. Used Cells: Cells removed from the airframe cavity for inspection and repair or cells being returned to service from storage, should be inspected as outlined above. Cells installed in the airframe cavity may be inspected for possible repairs by reaching through the fuel cell access plate and taking a section of cell between the thumb and forefinger. Wipe the ridge created by this action with MEK. If fine cracks are evident, the fuel cell is not repairable.
   3. Baffled Fuel Cells: Inspect every two years or after each 500 hours in service, whichever comes first, conduct the following inspection:
      (a) Defuel both main cells. (Refer to Section II.)
      (b) Remove the access plates located inboard of the nacelle. Remove both wing and fuel cell access plates.
      (c) Inspect fuel cell fittings for deterioration of the rubber used, using the fingernail to attempt to scrape the rubber off the metal or nipple fitting. If the rubber has not deteriorated, the fingernail will glide across the rubber. If a degraded condition exists the fingernail will dig into the rubber. Usually the deteriorated rubber will have changed from a light yellowish-tan to a dark reddish brown.
      (d) Check the tension and knots of the two nylon support cords.
      (e) Inspect the interior of the cell for security of baffle and the free operation of the flapper valve. Inspect both sides of the baffle.
      (f) Inspect the exterior of the cells to insure the Velco tape has not parted from the cell surface or liner surfaces.
      (g) Install all access plates on fuel cells and wings. Fill cells and check for leaks.

c. Due to the length of the fuel cell repair procedures, this information will be found in paragraph 9-15.

9-8. FUEL CELL COMPARTMENT.

a. Thoroughly clear the cell compartment of all fittings, trimmings, loose washers, bolts, or nuts.
b. Round off all sharp edges of the fuel cell compartment.
c. Inspect the fuel cell compartment just prior to fuel cell installation.
d. Tape over all sharp edges and all rough rivets.

9-9. MOLDED NIPPLE FITTINGS. The molded nipple fitting is a lightweight fitting developed for ease in installation in certain locations in the airplane. In order to get the best service from this type fitting, it is necessary to exercise certain precautions at the time of installation. The specific precautions other than the general care in handling are as follows:

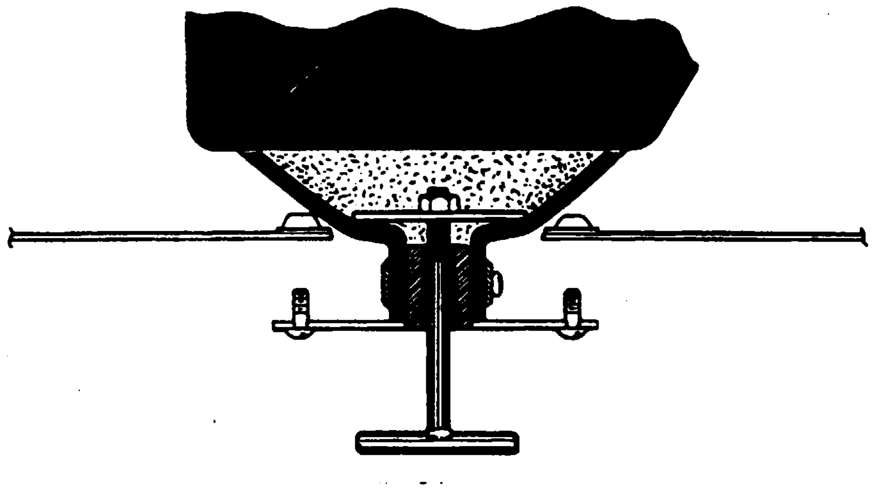


Figure 9-5. Installation Of Fuel Valve Drain Plate

a. Insert the fuel pump into the fuel cell as shown in Sketch "B", Figures 9-2 and 9-3.
b. Insert the vent tube into the fitting until the end is flush with the inside edge of the nipple.
c. The hose clamp must be clear of the end of the fitting by .25 inch where possible.
d. Locate the hose clamp on the fabric-reinforced area of the nipple.
e. Tighten the hose clamp snug. Do this once. Do not retighten unless the hose clamp is loosened completely and allowed to set for 15 minutes before retightening.
f. Do not use sealing paste or gasket compound.
g. Apply a thin film of Simonize Wax to metal flow tubes to facilitate installation and removal.

9-10. INSTALLATION OF FUEL CELL. (Refer to Figures 9-2 and 9-3.)

a. Inspect the cell compartment as explained in Paragraph 9-7.
b. Install two 4 inch strips (side by side) of Ludlow two-sided adhesive transfer tape No. 7322, Pipers part number 189 704, to the fuel liner at a point directly beneath the location of the fuel indicator sender unit float in "empty" position. Leave the backing on the tape to prevent adherence to the cell until the cell is properly positioned.
c. Should the cell be in its shipping container, do not remove until ready for installation.
d. Check to be sure that the cell is warm enough to flex. Do not use sharp tools such as screwdrivers, files, etc., for installed purposes.
e. Place tape or another protective material over the edges of the elongated access opening to prevent damage to the cell.
f. Roll the cell into the shape and size which can be inserted through the access opening of the cell compartment.
g. Unroll the cell and establish correct relationship of the cell to the compartment. Insure bottom of fuel cell is smoothed out and free of wrinkles.
h. Remove the backing from the tape installed in Step b. Press the cell to the exposed tape on the cell.

i. Lay out the nylon cord on the wing to determine the length of cord for each tie. The cords are routed as shown in Figures 9-2 or 9-3. Allow enough extra cord to work with.

NOTE

The nylon cord used to hold the fuel cells is .125 diameter with a minimum breaking strength of 550 pounds and conforming to MIL-C-5040C type III specifications. This can be obtained through Goodyear.

j. Double tie a washer (AN960-416) securely to the ends of each cord. Reach through the access openings and start the cord through the spar bushing at each end of the cell compartment.
k. From each end of the cell, feed the cord through the cell hangers and rib bushings until the cords can be joined at the access opening. Do not tie cords yet.
l. Connect the fuel drain valve plate by inserting the threaded end of bolt or rod not under three inches long, up through the plate and nipple fitting of the fuel cell. (Refer to Figure 9-5.) Reach through the fuel cell opening and install a two to two and one-half inch diameter washer on the bolt or rod and secure with a nut. Pull the nipple down through the opening in the wing panel enough to clamp the nipple fitting to the plate. Remove the bolt or rod, secure plate to wing panel and install drain valve.
m. Install the submergible fuel pump into the cell and secure in accordance with Figure 9-7.

NOTE

Install the vent line check valve with the "B" identification mark on the valve bottom.

n. Wipe the inside of the cell clean of all dirt and foreign material with a clean, soft, lint-free tack cloth and inspect for cleanliness.
o. Install the fuel cap adapter bracket by wrapping the bracket with a protective cover so as not to damage the cell; insert it through the elongated access opening and slide it in position. Install the gasket between the bracket and cell and start the cap bolts that attach the bracket to the cell. Align the holes in the adapter with the holes in the skin bracket and torque cap bolts to 35 ± 5 inch-pounds.
p. Position the cap adapter and gaskets; one gasket on each side of the skin bracket, with the attachment holes in the skin bracket and adapter bracket. Install machine screws and secure.
q. Install fuel senders, gaskets; one on each side of bracket and screws. Tighten nylon screws to 5 + 2, -0 inch-pounds.
r. Connect sender wires and ascertain that insulator sleeve is insulating to point where wire attaches sender. Install sender access plates.
s. Draw the nylon tie cords tight and hold. Ascertain the cell is in correct position in the cell compartment. Again draw the cord tight, hold with clamp or pliers and tie. A recommended tie is shown in Figure 9-17.
t. Install the remaining cell cover access plates on top of the wing. Torque cell cover cap bolts to 35 ± 5 inch-pounds.
u. Put enough fuel in cell to check for fitting leaks.
v. Install remaining access plates.

9-11. INSTALLATION OF NACELLE FUEL CELL. (Refer to Figure 9-4.)

a. Inspect the cell compartment as explained in Paragraph 9-7.
b. Install two 4 inch strips (side by side) of Ludlow two-sided adhesive transfer tape No. 7322, Piper part number 189 704, to the fuel liner at a point directly beneath the location of the fuel indicator sender unit float in "empty" position. Leave the backing on the tape to prevent adherence to the cell until the cell is properly positioned.
c. Should the cell be in its shipping container, do not remove until ready for installation.
d. Check to be sure the cell is warm enough to flex. Do not use sharp tools such as screwdrivers, files, etc., for installation purposes.
e. Place tape or another protective material over the edges of the access opening to prevent damage to the cell.
f. Roll the cell into the shape and size which can be inserted through the access opening of the cell compartment.
g. Unroll the cell and establish correct relationship of the cell to the compartment. Insure bottom of fuel cell is smoothed out and free of wrinkles.
h. Remove the backing from the tape installed in Step b. Press the cell to the exposed tape on the cell.
i. Lay out the nylon cord on the wing to determine the length of cord for each tie. The cords are routed as shown in Figure 9-4. Allow enough extra cord to work with.
j. Double tie a washer (AN960-416) securely to the ends of each cord. Reach through the access openings and start the cord through the bushing at each end of the cell compartment.
k. From each end of the cell, feed the cord through the cell hangers and rib bushings until the cords can be joined at the access opening. Do not tie cords yet.
l. Connect the fuel drain valve in the wheel well below the cell, the fuel outlet at the aft end of the cell and the vent line at the forward outboard end of the fuel cell.
m. Wipe the inside of the cell clean of all dirt and foreign material with a clean, soft, lint-free tack cloth and inspect for cleanliness.
n. Install the fuel cap adapter bracket by wrapping the bracket with a protective cover so as not to damage the cell; insert it through the access opening and slide it in position. Install the gasket between the bracket and cell and start the cap bolts that attach the bracket to the cell. Align the holes in the adapter with the holes in the skin bracket and torque cap bolts to 35 ± 5 inch-pounds.
o. Position the cap adapter and gaskets; one gasket on each side of the skin bracket, with the attachment holes in the skin bracket and adapter bracket. Install machine screws and secure.
p. Install fuel senders, gaskets; one on each side of bracket and screws. Tighten nylon screws to 5 +2,-0 inch-pounds.
q. Connect sender wires and ascertain that insulator sleeve is insulating to point where wire attaches sender. Install sender access plates.
r. Draw the nylon tie cords tight and hold. Ascertain the cell is in correct position in the cell compartment. Again draw the cord tight; hold with clamp or pliers and tie. A recommended tie is shown in Figure 9-17.
s. Install the remaining cell cover access plates on top of the nacelle. Torque cell cover cap bolts to 35 ±5 inch-pounds.
t. Put enough fuel in cell to check for fitting leaks.
u. Install remaining access plates.

9-12. CHECKING FUEL QUANTITY GAUGES.

a. Completely drain the nacelle, outboard or inboard fuel-cells, depending on which gauge is being checked. Checking inboard fuel cells also requires a complete draining of the unusable fuel in the system. (Refer to Draining Fuel System, Section II.)
b. Level the airplane longitudinally and laterally. (Refer to Leveling, Section II.)
c. Determine that the crossfeed and emergency shutoff valves are closed.

NOTE

The electrical system must supply 28 volts to the gauge to make this check.

d. Add 6.0 U.S. gallons of fuel to the inboard fuel cell. With the master switch ON, observe the fuel quantity gauge being checked. It should read empty with the respective fuel selector lever at the appropriate position.
e. Add fuel to the cell being checked in the amount of 6.25 U.S. gallons to the nacelle cell, 10.0 U.S. gallons to the outboard cell and 14.0 U.S. gallons to the inboard cell, to bring each cell to one-quarter its full capacity.
f. Observe the gauge. The quantity pointer should align with any part of the gauge index wire.
g. Continue to add fuel in increments of 6.25, 10.0 and 14.0 U.S. gallons to the nacelle, outboard or inboard cell respectively for each quarter capacity of the cells. Check that the quantity pointer aligns with any part of the index wire at each quarter increment, until the cell is full.
h. Should the gauge and the amount of fuel in the cell not correspond, the gauge may be calibrated per paragraph 9-13.

9-12a. CHECKING FUEL QUANTITY SENDERS.

a. Disconnect the sender unit and check for the ohm readings noted in Table IX-I.

TABLE IX-I. FUEL QUANTITY SENDER RESISTANCE LIMITS

Unit Location	Float Position	Ohm Reading
Main and Auxiliary Inboard	Empty	0 to 0.5
	Full	48 to 52
Main and Auxiliary Outboard	Empty	0 to 0.5
	Full	38 to 42
Nacelle	Empty	0 to 1.0
	Full	88 to 92

b. The sender unit must be replaced if the above tolerances are not maintained.

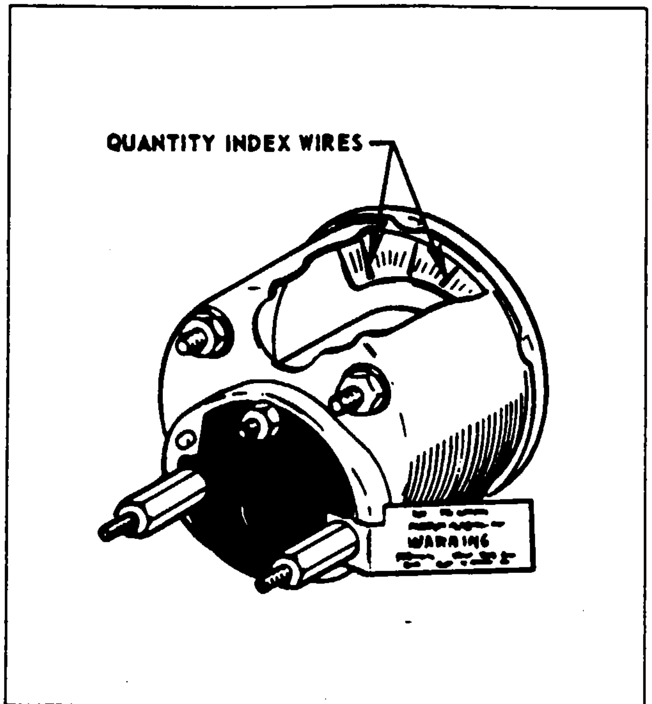


Figure 9-6. Fuel Gauge Adjustment Wires

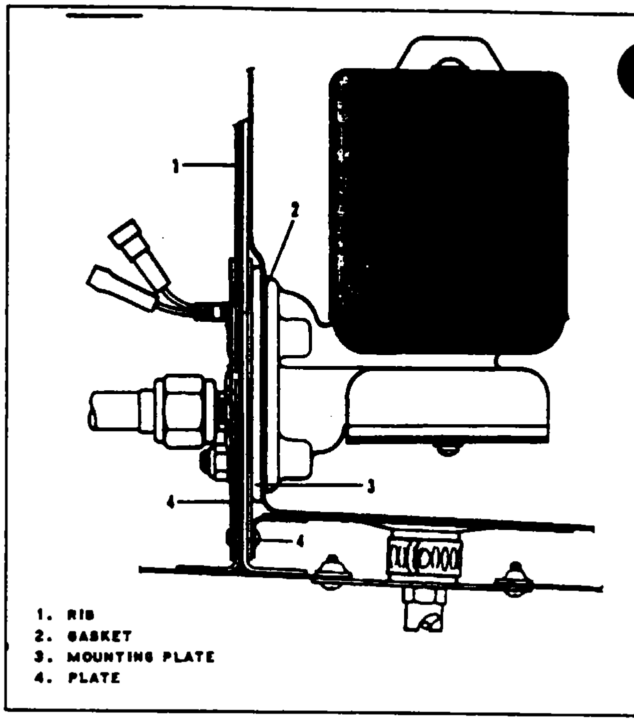


Figure 9-7. Installation Of Submerged Fuel Pump (Boost)

9-13. ADJUSTMENT OF FUEL GAUGES. The fuel gauges have been calibrated at time of installation at the factory and normally need not be recalibrated unless a gauge or cell sender unit has been replaced. Should it become necessary to calibrate a gauge, the following procedure may be used.

CAUTION

Adjust the quantity gauge; do not try to change adjustments of the sender units.

a. Accomplish the preparatory procedure as given in paragraph 9-12, steps a thru c and read note.
b. Lower the overhead panel that houses the fuel gauges. Do not disconnect the electrical wires.
c. Remove the light receptacle from the back of the fuel gauge. Note the quantity index wires in the gauge. (Refer to Figure 9-6.)
d. Add fuel to the cell in accordance with instructions given in paragraph 9-12 to bring the cell to one-quarter its full capacity.
e. With a small insulated screwdriver, reach through the light receptacle hole and move the index wire to align with the quantity pointer. Should the position of the pointer vary slightly when the fuel selector lever is moved from one cell to another, the wire may be adjusted to compensate for this difference by setting the wire at an average distance between the two selected positions of the needle. The wire should then align with part of the needle when the needle is in either position.
f. Continue to add fuel in quarterly increments. At each quarter increment adjust the wire with the pointer as outlined above until the cell is full.

9-14. HANDLING AND STORAGE OF FUEL CELLS.

a. Prevent needless damage by exercising common sense care in all handling of the cells. Folding or collapsing of cells is necessary to place them in containers for storage, install in airframe cavities and carrying from place to place. Protect fitting seal surface from contact with cavities during removal or installation. Use protective covers over fitting seal when practical. Protect cell from tools, hot lights, etc., when working around them. Avoid stepping on folds or creases in cells. Do not carry cells by fittings. Maintain original cell contours or folds when refolding for boxing, rolling to insert in airframe cavities or handling in the repair area. The cells to be repaired should be placed on a well-lighted table. Maintain natural contours, if possible, while repairing. Prevent contact with sharp edges, corners, dirty floors or other surfaces. Repair area must be well-ventilated. Do not stack cells. Inspect cavities and insure cleanliness prior to installing any cell.

WARNING

Do not permit smoking or open flame near repair area or cells.

b. When storing cells, observe the following rules.
   1. Fold cells smoothly and lightly as possible with a minimum number of folds. Place protective wadding between folds.
   2. Wrap cell in moisture-proof paper and place it in a suitable container. Do not crowd cell in container, use wadding to prevent movement.
   3. Stack boxed cells to allow access to oldest cells first. Do not allow stacks to crush bottom boxes. Leave cells in boxes until used.
   4. Storage area must be dry, 70°F, and free of exposure to sunlight, dirt and damaged.
   5. Used cells must be cleaned with soap and warm water prior to storage. Dry, and box as outlined above.

9-15. REPAIR OF GOODYEAR VITHANE FUEL CELLS. The following is the repair procedure recommended for field repair of fuel cells constructed of Goodyear Vithane material. There are two methods by which these repairs may be accomplished. One method is by heat cure, the other is air cure. The end result of either repair is a neat, permanent repair. The heat repair allows the cell to be cured and ready for reinstallation in two hours while the air cure method requires that the cell not be moved for 72 hours during the air cure period.

NOTE

Air cure repairs to be made at room temperature at approximately 75°F. For each 10° drop in temperature add 20 hours cure time. For instance if room temperature reads 65°F, air cure for 92 hours instead of 72 hours.

NOTE

The repair of Goodyear Vithane fuel cells is restricted to authorized personnel. Authorized personnel are those who have been certified and trained by Goodyear representatives, or those who have received their training from persons who have been certified and trained by Goodyear representatives.

NOTE

To determine if fuel cell is repairable, reach through the fuel cell access plate and take a section of cell between thumb and forefinger. Wipe the ridge created by this action with MEK. If fine cracks are evident, the fuel cell is not repairable.

9-16. HANDLING OF REPAIR MATERIALS.

a. All materials are to be protected from dirt contamination, sunlight, and excessive heat or cold while in storage. Containers are to be tightly capped and stored at a temperature of 70°F.
b. The repair cement code 80C27 referred to in this text is prepared immediately prior to use by mixing repair cement 80C27 (pint can with 320gms) with cross-linker 80C28 (4 oz. bottle with 81cc).

CAUTION

80C27 repair cement requires thorough mixing to obtain full adhesive values.

c. Repair cement has a pot life of 20 minutes after mixing. The unmixed 80C27 and 80C28 have a shelf life of six months from date of packaging.

CAUTION

All containers for cements and solvents should be properly identified.

9-17. DELETED.

9-18. REPAIR LIMITATIONS OF FUEL CELLS. Repair limitations are as follows:

a. FT-192 repair fabric is for repair of simple contours only. Patches referred to in this text are of this material.
b. Inside patches are to lap defect edges a minimum of 1.0 inch in each direction.
c. Outside patches are to lap defect edges .25 to .50 inches larger than inside patches.
d. Outside patches are to be applied and cured prior to applying an inside patch.
e. Blisters between inner liner and fabric, larger than .25 of an inch in diameter require an outside and an inside patch.
f. Separation between layers or plies larger than .50 inch in diameter require an outside and inside patch. Holes and punctures require an outside and inside patch.
g. Slits or tears up to 6.0 inches maximum length require an outside and inside patch.
h. External abraded or scuffed areas without fabric damage require an outside patch only.
i. A loose edge may be trimmed provided that a .50 inch minimum lap or seam is maintained.
j. Air cure repair patches are to remain clamped and undisturbed for 72 hours at room temperature of approximately 75°F.

CAUTION

For each 10° drop in temperature from 75°F, add 20 hours cure time. For example, at 65°F, cure for 92 hours.

k. All heat cured patches are ready for use when cool.
l. Fitting repairs are confined to loose flange edges, seal surface rework and coat stock.
m. The maximum number of heat cure repairs in the same area is four.

NOTE

Any damage not covered by the above should be returned to The Goodyear Tire & Rubber Company, Rockmart, Georgia 30153, for repair.

9-19. REPAIR PATCH (HEAT CURE METHOD).

a. Prepare exterior cell wall and exterior patch first. Cut repairs from FT-192 material to size required to insure proper lap over injury in all directions. (See Limitations). (Hold shears at an angle to produce a beveled edge (feather) on patch.) Round corners of patch. (Dull side or gum contact face of repair patch should be the largest surface after beveling.)
b. Wash one square foot of cell wall surrounding injury and repair patch contact side with a clean cloth soaked with Methyl Ethyl Ketone solvent.
c. Abrade cell wall surface about injury and contact side of patch with fine emery cloth to remove shine.
d. Repeat Methyl Ethyl Ketone washings two more times. A total of three washings each surface.
e. Tape an 8" x 8" piece of cellophane inside cell over injury.
f. When all the above preparatory work has been done and cell has been positioned for patch application on repair table, mix the 80C27 cement (320gms) with the crosslinker 80C28 (81cc), and stir mixture thoroughly for five minutes.
g. Brush one even coat of mixed repair cement on the cell wall around injury and on the contact side of repair patch. Allow to dry for fifteen minutes.
h. Repeat a second mixing of repair cement and brush a second coat.

CAUTION

Do not use the first mixture of repair cement for this coat.

NOTE

Cement must be at a minimum of 70°F before mixing. Keep away from water and excessive heat.

FUEL CELL REPAIR EQUIPMENT LISTS

Repair Kit, Goodyear Part No. 2F 1-3-37813

Group I Materials

80C27 Repair Cement	8	Pint cans 320gms in each
80C28 Cross-Linker	8	4 oz. bottle 81cc in each
Methyl Ethyl Ketone	2	Pint cans
FT-192 Repair Fabric	2	Sheet 12" x 12"
AP368 Manual	1	

Group II Materials

The following equipment is necessary to perform the repair.

Group II equipment will be furnished at additional cost, if ordered by customer.

Foam Rubber Cloth Back Sheet, 1/4" x 12" x 12"	2
Paint Brush, 1 inch wide	2
Aluminum Plates, 1/4" x 6" x 6"	4
Measuring Cup (250 ml)	1
Cellophane (Sheet 12" x 24")	2

NOTES

Accessories - order per individual cell requirements.

Phenol plates, phenol plate assemblies and phenol test equipment can be ordered as required from cell manufacturer.

Cure Iron (Set 240°F) Optional.

i. Allow cement to dry approximately five minutes and then center patch over injury. Lay repair patch by rolling down on surface from center to edge without trapping air. Hold the unrolled portion of repair patch off the cemented surface until roller contact insures an air-free union. At this time repair patch may be moved by hand on wet surface to improve lap. Do not lift repair patch, slide it.

CAUTION

Make sure cellophane inside cell over injury remains in place as any cement will stick cell walls together without it as a separator.

j. Cover one smooth surface each of two aluminum plates (plates must be larger than patch), with fabric-backed airfoam fabric side out. Tape airfoam in place. Foam must cover edges of plate for protection. Use a cellophane separator to prevent the cement from sticking in the wrong place.
k. Fold cell adjacent to patch and place prepared plates one over repair patch and one on opposite side.
l. Center a repair iron 2F1-3-25721-1 on the plate over the repair patch. Secure the assembly with a "C" clamp. Tighten by hand. Check cement flow to determine pressure.

CAUTION

Make sure that cell fold is not clamped between plates. This would cause a hard permanent crease. Also make sure that patch does not move when clamp is tightened.

m. Connect repair iron into 110 volt electrical outlet and cure repair for two hours. After two hours cure, unplug electric and allow repair iron to cool to touch. Then remove "C" clamp. Wet cellophane to remove from repair.
n. Inside patch is applied same as above procedure except for size of repair patch (see Limitations) after outside patch has been cured.

CAUTION

Success of applying both an outside and inside repair patch simultaneously is doubtful and not recommended.

9-20. REPAIR PATCH (AIR CURE METHOD). Follow procedure for heat cure method, except omit repair iron and cure each patch per air limitations (minimum 72 hours), undisturbed at 75°F.

9-21. METAL FITTING - SEALING SURFACES.

a. Rub off roughness of affected area with a fine file or fine emery cloth. Treat reworked area.
b. Clean metal surface using a clean cloth dipped in Methyl Ethyl Ketone. Moisten cleaned surface with clean cloth dipped in water. Apply alodine 1200 solution, undiluted, to the affected area with a small nylon brush. Allow solution to dry until a light golden color appears. When coating has been formed, remove excess solution by wiping with a clean water-moistened cloth. Allow coating to dry.

WARNING

Do not allow solution to come in contact with hands, eyes or clothing.

9-22. ACCESSORY REPLACEMENT.

a. Obtain cured repair accessory from cell manufacturer.
b. Mark location of old accessory and preserve markings for guide lines to locate new part.
c. Remove old accessory by gradually loosening an edge with a blunt probe-like instrument.
d. When a loose edge is created, grasp accessory by loose edge with pliers and gently pull accessory of cell wall. Be careful not to pull cell lap open while peeling accessory off. Pull from blind side of a cell lap toward the exposed edge.
e. Buff the cell surface under accessory with emery cloth to smooth roughness and prepare for cement.

NOTE

Removal of old accessory will probably leave an uneven cavity and surface.

f. Prepare replacement accessory by buffing and washing contact surface. Also wash cell surface (see repair patch).
g. Apply mixed 80C27 repair cement to both surfaces being sure to level cavity left by removal of old accessory.
h. Roll new accessory into place as with a repair patch and place suitable padded plates in position to insure adequate pressure when clamped. Use cellophane separator to prevent cement sticking in the wrong place.
i. Cure as with repair patch either cure method.

9-23. DEFECT REPAIRS OF FUEL CELL.

a. Blisters: Remove loose material by trimming. Apply an outside and inside repair patch.
b. Holes, Punctures, Cuts, Tears and Deep Abraded Areas: Trim away any ragged material and apply an outside and inside repair patch.
c. Loose Seams: Buff loose edge and contact surface with emery cloth. Wash three times with Methyl Ethyl Ketone. Apply 80C27 mixed cement two coats as with repair patch. Clamp and cure. Either method may be used. See repair patch. Loose seams may be trimmed if minimum lap remains.
d. Loose Fitting Flange - Inside: Buff edge of flange and contact surface under flange. Apply 80C27 mixed repair cement, cellophane, padded plates and clamp. Follow procedure as outlined for repair patch, except for patch itself.
e. Looseness Against Metal: Prepare metal as per metal fitting - sealing surfaces. Apply 80C27 mixed cement and cure.

9-24. TESTING FUEL CELLS. Either of the following procedures may be used to detect leaks in the bladder cells.

a. Soap Suds Test.
   1. Attach test plates to all fittings.
   2. Inflate the cell with air to a pressure of 1/4 psi maximum.
   3. Apply a soap and water solution to all repaired areas and any areas suspected of leakage. Bubbles will appear at any point where leakage occurs.
   4. After test, remove all plates and wipe soap residue from the exterior of the cell.
b. Chemical Test.
   1. Attach test plates to all fitting openings except one.
   2. Make up a phenolphthalein solution as follows: Add 40 grams phenolphthalein crystals in 1/2 gallon of ethyl alcohol mix, then add 1/2 gallon of water.
   3. Pour ammonia on an absorbent cloth in the ratio of a 3 ml per cubic foot of cell capacity. Place the saturated cloth inside the cell and install remaining test plate

4. Inflate the cell with air to a pressure of 1/4 psi maximum, cap and maintain pressure for fifteen minutes.
5. Soak a large white cloth in the phenolphthalein solution, wring it out thoroughly, and spread it smoothly on the outer surface of the cell. Press the cloth down to insure detection of minute leaks.
6. Check the cloth for red spots which will indicate a leak. Mark any leaks found and move the cloth to a new location. Repeat this procedure until the entire exterior surface of the cell has been covered. If red spots appear on the cloth, they may be removed by resoaking the cloth in the solution.
7. The solution and test cloth are satisfactory only as long as they remain clean. Indicator solution that is not in immediate use should be stored in a closed rust proof container to prevent evaporation and deterioration.

After the test, remove all plates and test equipment. Allow the cell to air out.

In conducting either test outlined above, the cell need not be confined by a cage or jig providing the 1/4 psi pressure is not exceeded.

NOTE

The chemical test is the more sensitive and preferred test.

9-25. FUEL VALVES.

9-26. REMOVAL OF FUEL VALVES. (Refer to Figure 9-8.) The selector valve, cross-feed valve and emergency shut-off valve, all of which are located between the wing and fuselage, are removed by the following procedure.

a. Remove the access plate located forward of the main spar on the underside of the wing, between the wing and fuselage.
b. If the selector valve is to be removed, drain the appropriate fuel cell. (Refer to Draining the Fuel Cell, Section II.) If the cross-feed valve or emergency shut-off valve is to be removed, ascertain that the selector valve is off.
c. Disconnect the control cable from the valve handle.
d. Disconnect the lines from the valve and cover the ends to prevent contamination.
e. Remove the valve from its attachment fitting.

NOTE

It is recommended that for overhaul or repair of the three-way fuel selector valve or cross-feed valve, they be returned to Scott Aviation Corporation, Lancaster, New York 14086, U.S.A. If, however, this cannot be achieved, the valve "O" ring packings may be replaced by instructions given in paragraphs 9-27 thru 9-34. Recommended overhaul for these valves is 200 hours.

9-27. DISASSEMBLY OF SELECTOR VALVE (SCOTT). (Refer to Figure 9-8.)

a. Remove the four screws (14) and washers (15) that attach the cap assembly (9) to the valve body (2).
b. Pull the cap assembly straight from the valve body (2).
c. Push the spool (12) from the valve body.
d. To disassemble the cap assembly (9), remove the roll pin (3) that secures the gear (21) on its shaft (4) by driving the pin with a 3/32 straight drift punch.
e. Remove the gear and spacer (8) from the shaft.

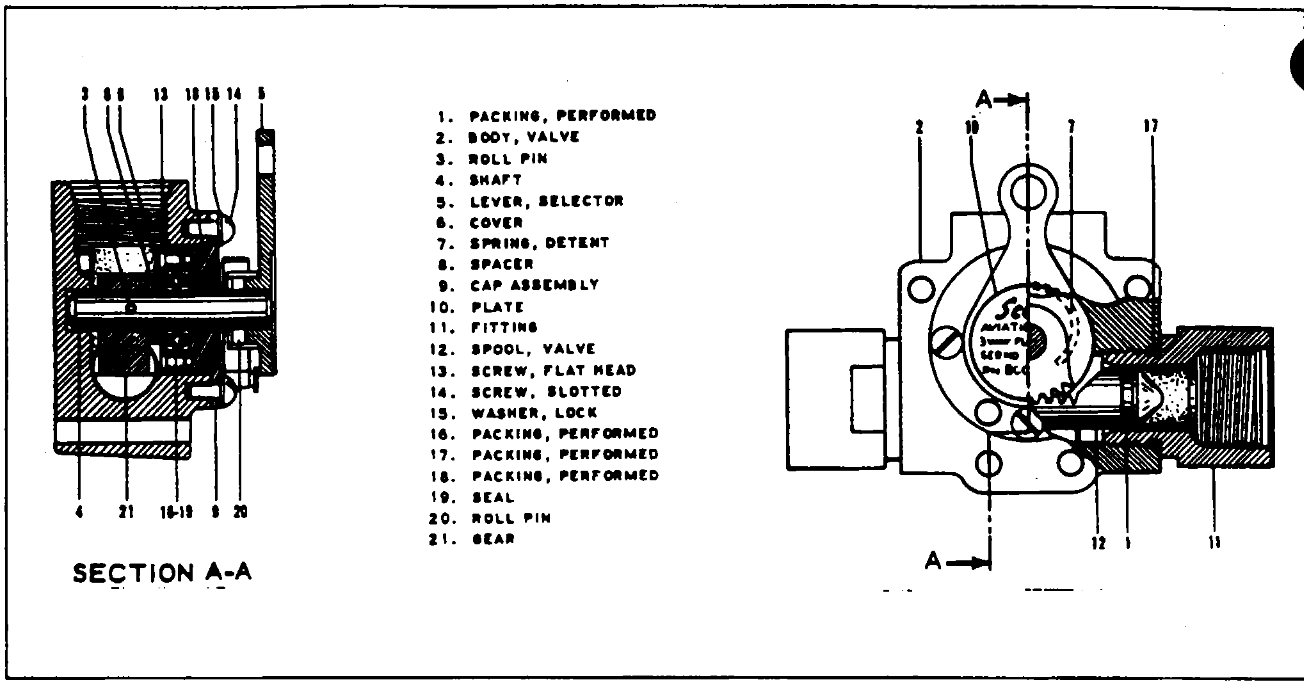


Figure 9-8. Fuel Selector Valve

f. Remove the four screws (13) that secure the packing and seal cover (6). Remove the cover.
g. Remove old "O" rings and seal.
h. If fitting (11) is removed, replace "O" ring packing (17).

9-28. CLEANING, INSPECTION AND REPAIR OF SELECTOR VALVE (SCOTT).

a. Clean the valve components in a dry cleaning solvent.
b. Inspect the valve for the following:
    1. Check that the friction surfaces of the valve are free from nicks, dents and burrs.
    2. Check that the teeth of the gear and spool are not damaged.
    3. Check that the threaded surfaces are not stripped or cross-threaded.
    4. Check that the selector detent mechanism is operating properly.
c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and the replacing of "O" ring packings and seal.

NOTE

Fittings (11) in valve are special. Do Not use AN fittings.

9-29. ASSEMBLY OF SELECTOR VALVE (SCOTT). (Refer to Figure 9-8.)

a. If either fitting (11) was removed, install the "O" ring packing (17) and assemble the fitting on the valve body (2).
b. Lubricate the "O" ring packings (17) with a thin coat of Stop-Lock Grease, Dow Corning Corp., Midland, Michigan, and install on the valve spool (12).
c. Insert and center the spool in the valve body.
d. Lubricate the seal (19) and "O" ring (16), and install in the cap assembly (9).
e. Ascertain that the shaft (4) is in place and install cover (6). Secure with screws (13).

f. Slide the spacer (8) and gear (21) on the shaft, with the pin holes aligned so that the gear teeth are opposite the selector lever (5). Secure the gear with roll pin (3).
g. Install the "O" ring packing (18) on the cap assembly.
h. Place the selector handle in neutral in relation to the cap and install the cap assembly in the valve body. Secure the cap assembly with screws (14) and washers (15).
i. Lubricate external parts of fuel selector valve sprocket with ESSO "Beacon 325" grease or equivalent (MIL-G-3278), and check valve operation.

9-30. LEAK TEST OF SELECTOR VALVE (SCOTT).

a. Connect the inlet port of the valve assembly to a 25 psi air source.
b. Plug the right hand port and close the left hand port by placing the control lever to the right.
c. Apply pressure to 25 psi. There shall be no evidence of leakage either through the port or around the fitting and lever when submerged in kerosene or a similar petroleum-base fluid for 30 seconds.
d. Depressurize, remove the plug from the right hand port, place on left hand port and close right hand port by placing the lever to left.
e. Repeat step c.
f. Disconnect and wipe fluid from exterior.

9-31. DISASSEMBLY OF CROSS-FEED VALVE. (Refer to Figure 9- 9.)

a. Disconnect the control arm (10) from the valve stem(2) by removing nut (9) from the pin (8).
b. Push the stem out of the valve body (3).
c. Remove seal(s) requiring replacement.
d. If seat valve (4) is removed, replace "O" ring packing (6).

9-32. CLEANING, INSPECTION AND REPAIR OF CROSS-FEED VALVE.

a. Clean the valve components in a suitable cleaning solvent.
b. Inspect the valve for the following:
   1. Check that the friction surfaces of the valve body and stem are free from nicks, dents and burrs.
   2. Check that the inner and outer seals are not worn so much as to allow the valve stem to misalign in the valve seat. (For replacement of inner and outer seal, return to Scott.)
   3. Check that the threaded surfaces of the seat fitting are not stripped or cross-threaded.
c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and the replacing of "O" ring packings.

NOTE

Fitting (4) in valve is special. Do not use AN fittings.

9-33. ASSEMBLY OF CROSS-FEED VALVE. (Refer to Figure 9-9.)

a. If seat valve (4) was removed, install the "O" ring packing (6) and assemble the seat fitting on the valve body (3).
b. Lubricate the "O" ring packings with a thin coat of Stop-Lock Grease, Dow Corning Corp., Midland, Michigan, and install.
c. Push the stem (2) into the valve.
d. Connect the control arm (10) with the stem and secure with pin (8) and nut (9).
e. Check valve operation.

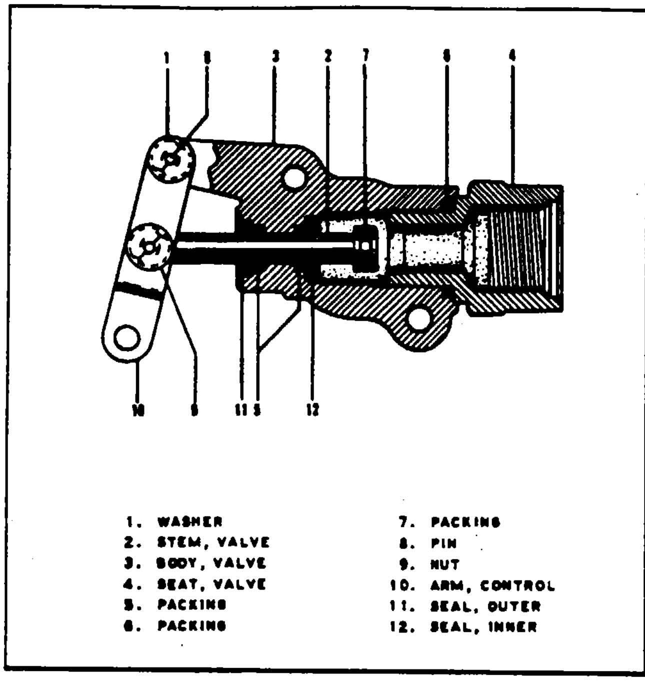
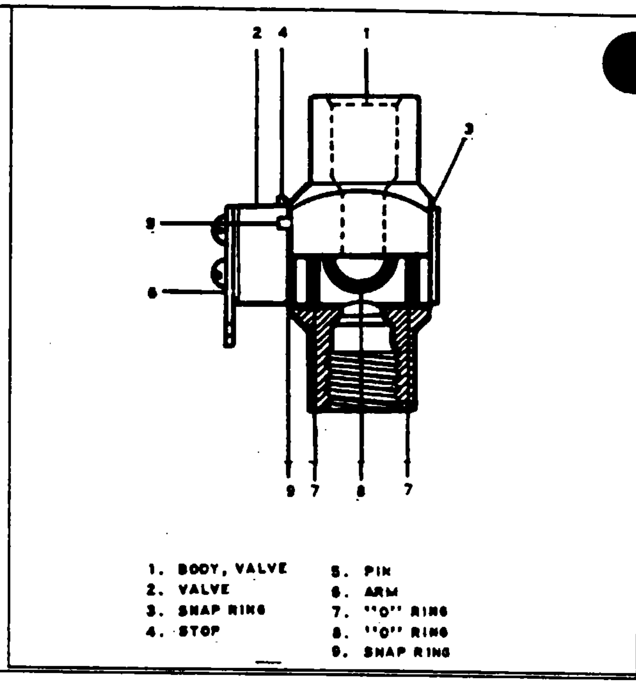


Figure 9-9. Crossfeed Valve



9-10. Emergency Shutoff Valve

9-34. LEAK TEST OF CROSS-FEED VALVE.

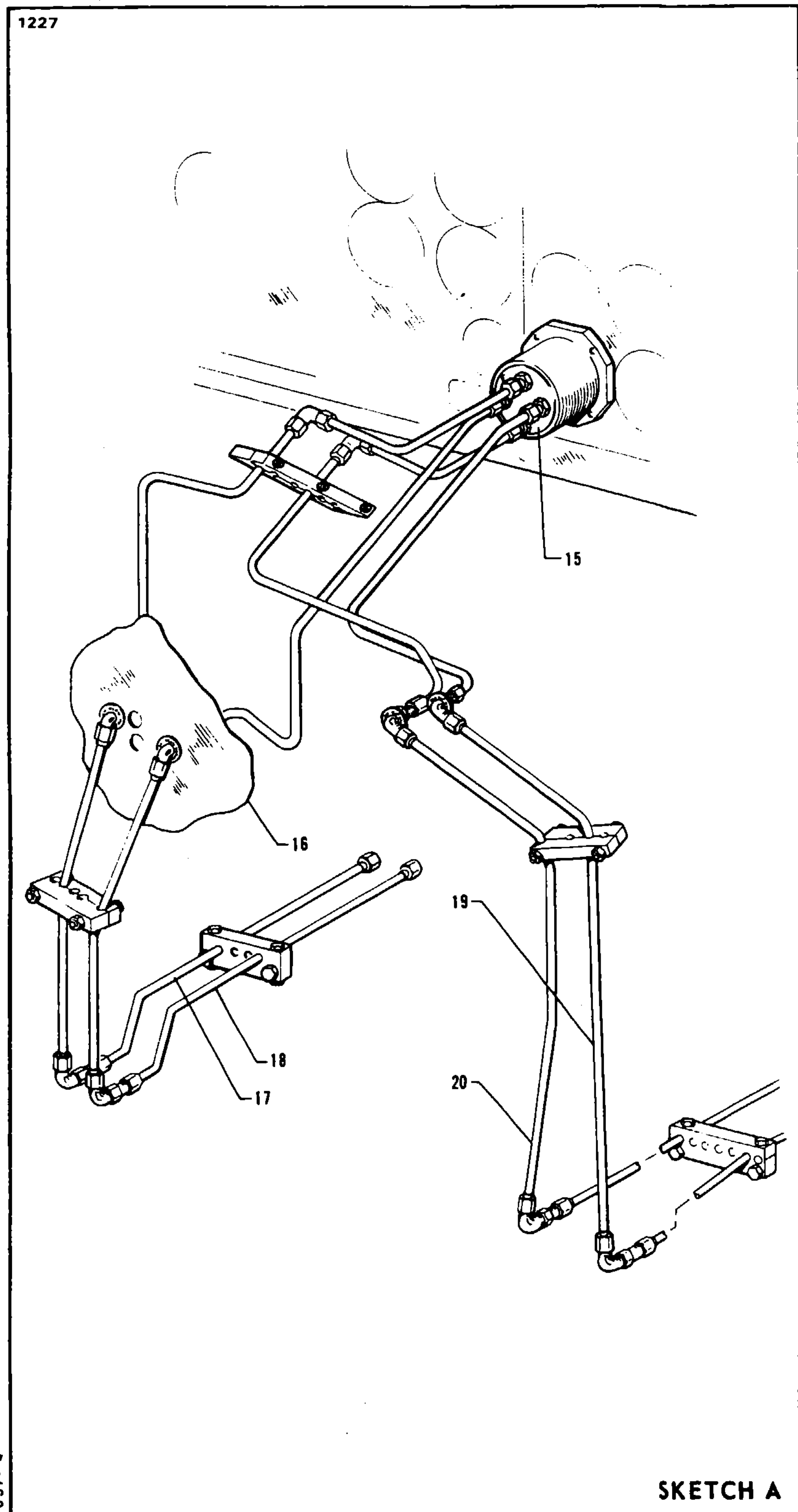
a. Connect one port of the valve to a 50 psi air source.
b. Close valve, apply pressure to 50 psi and submerge in kerosene or a similar petroleum base fluid f two minutes.
c. Depressurize and connect the air source to the other port of the valve.
d. Repeat step b.
e. There shall be no evidence of leaking through the valve seat or around the valve stem.
f. Disconnect and wipe fluid from exterior.

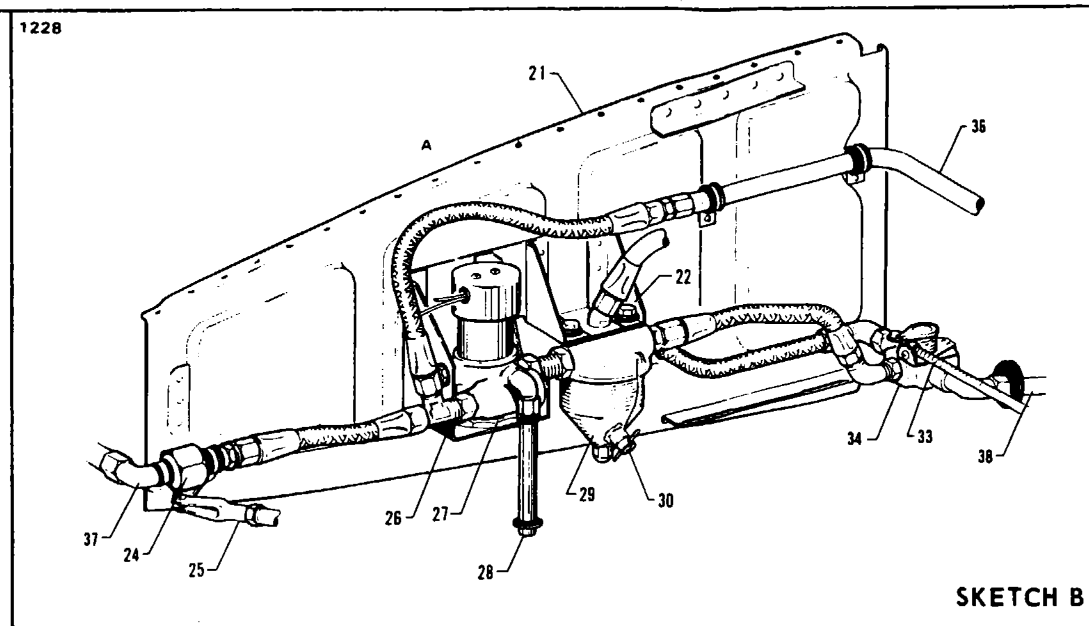
9-35. DISASSEMBLY OF EMERGENCY SHUT-OFF VALVE. (Refer to Figure 9-10).

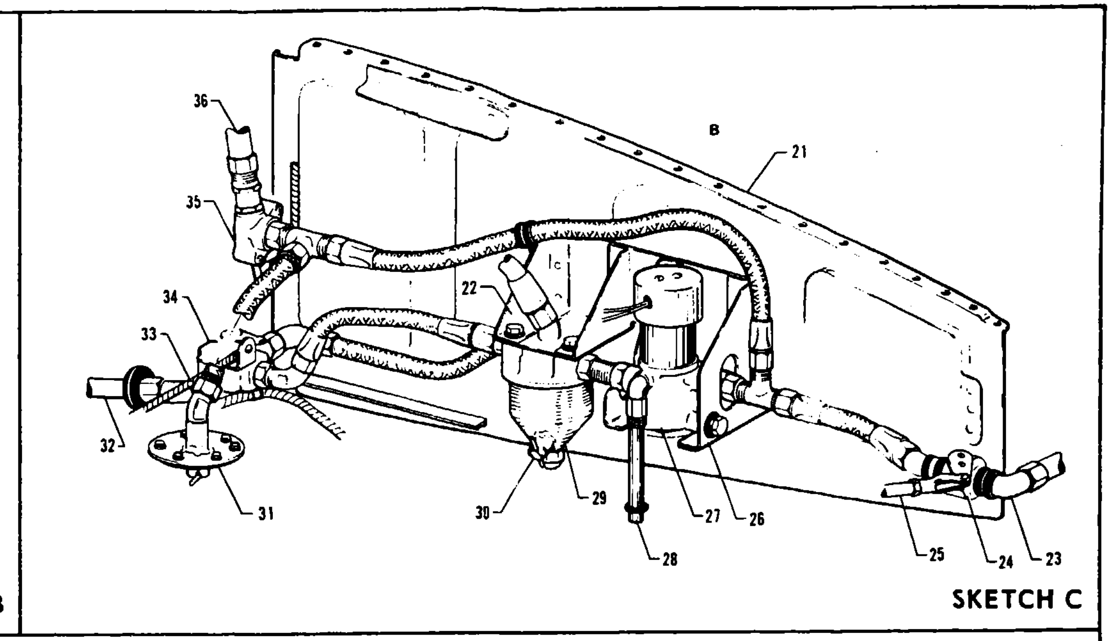
a. Remove the snap ring (3) on the bottom of the valve.
b. Push the valve (2) from the valve body (1).
c. Remove and discard the "O" rings (7 and 8.)

9-36. CLEANING, INSPECTION AND REPAIR OF EMERGENCY SHUT-OFF VALVE.

a. Clean the valve components in a suitable cleaning solvent.
b. Inspect the valve for the following:
   1. Check that the valve and valve body stop pins are not bent, broken or missing.
   2. Check that the handle is not loose on the valve.
   3. Check that the valve and inside of the valve body is free of scratches, burrs, etc., that may damage the "O" rings.
c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and replacing of "O" rings







1. VALVE, CHECK
2. TRANSFER PUMP
3. FUEL CELL, OUTBOARD
4. SUBMERGED FUEL PUMP
5. FUEL CELL, NACELLE
6. FUEL CELL, INBOARD
7. SUBMERGED FUEL PUMP
8. VENT ASSY.
9. VALVE, CHECK
10. PANEL, FUEL SELECTOR
11. FUEL PUMP, RIGHT
12. INJECTOR, RIGHT
13. FUEL PUMP, LEFT
14. INJECTOR, LEFT
15. GAUGE, FUEL FLOW
16. BULKHEAD
17. LINE, R. DECK PRESSURE
18. LINE, R. FUEL PRESSURE
19. LINE, L. DECK PRESSURE
20. LINE, L. FUEL FLOW PRESSURE
21. RIG ASSY.
22. SHOCK, "O" RING
23. LINE TO L. ENGINE
24. VALVE, EMERGENCY SHUT-OFF
25. CONTROL, EMERGENCY SHUT-OFF
26. BRACKET, MOUNTING
27. FUEL PUMP
28. DRAIN, FUEL PUMP
29. FILTER
30. DRAIN, FILTER
31. DRAIN, CROSSFEED
32. LINE FROM L. OUTER CELL
33. CONTROL, SELECTOR VALVE
34. VALVE, FUEL SELECTOR
35. VALVE, CROSSFEED
36. LINE, CROSSFEED
37. LINE TO R. ENGINE
38. LINE FROM R. OUTER CELL

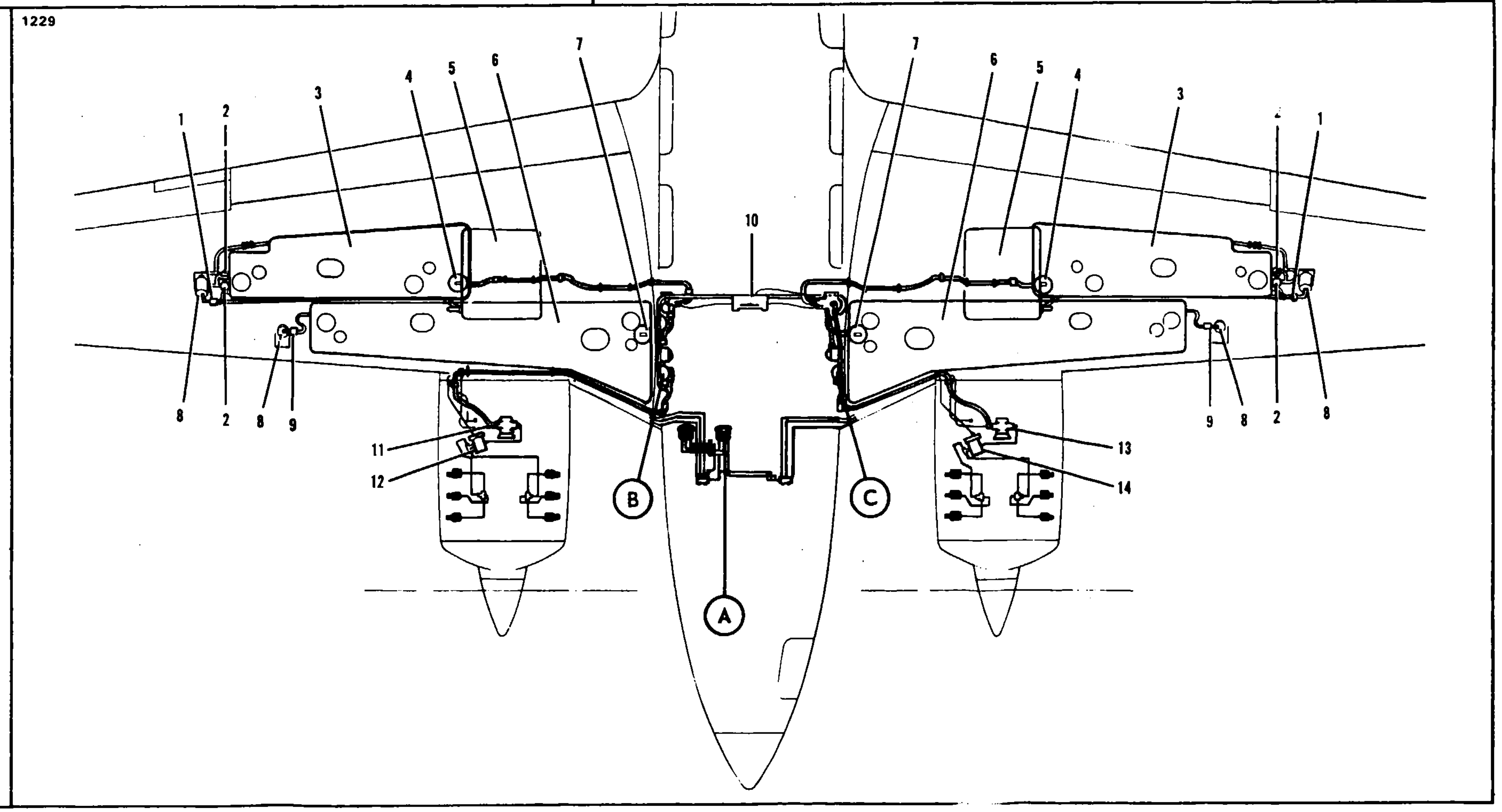


Figure 9-11. Fuel System Installation

9-37. ASSEMBLY OF EMERGENCY SHUT-OFF VALVE. (Refer to Figure 9-10.)

a. Ascertain that the snap ring (9) is installed on the upper portion of the valve (2).
b. Place new "O" rings (7 and 8) on the valve.
c. Lubricate the "O" rings with DC-55 (MIL-G-4343) and insert the valve (2) in the valve body (1). Place the valve in the valve body so that the valve is allowed only 90° travel between stops.
d. Lock the valve in the valve body by installing the snap ring (3) on the valve.

9-38. LEAK TEST OF EMERGENCY SHUT-OFF VALVE.

a. Connect the inlet port of the valve to a 50 psi air source.
b. Close valve, apply pressure to 50 psi and submerge in kerosene or similar petroleum base fluid for two minutes.
c. There should be no evidence of leakage through the valve port or around seat.
d. Disconnect and wipe fluid from exterior.

9-39. INSTALLATION OF FUEL VALVES. (Refer to Figure 9-11.)

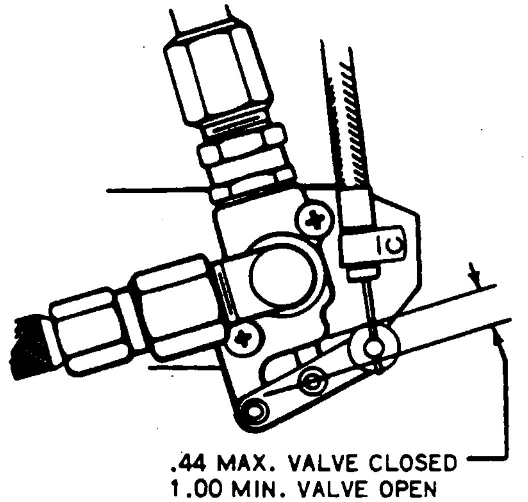
a. Place the valve in position and secure.
b. Connect the lines to the valve.
c. Connect the control cable to the valve and check for proper adjustment. Refer to paragraph 9-40, 9-42 or 9-43, and lubricate control cable swivel fittings with ESSO "Beacon 325" grease or equivalent (MIL-G-3278).
d. Allow fuel to flow to valve and check for leaks.
e. Install access plates.

9-40. ADJUSTMENT OF SELECTOR CONTROL VALVE.

a. Remove the access cover located on the underside of the fuselage, below the fuel selector panel just ahead of the main spar and the access panels between the fuselage and the underside of the wings.
b. Ascertain that the control cable wire is connected to the selector valve handle in the cockpit and that the valve is in neutral or OFF position. The wire on the valve handle should be free to rotate.
c. Place the fuel selector handle in the cockpit in neutral or OFF position.
d. Assemble the swivel assembly with the control cable wire on the arm of the selector handle. Apply a slight pressure on the swivel stud toward the end of the wire so that as the stud and wire are being drawn into the swivel, through tightening of the nut, the stud will center itself. Tighten the stud nut, allow the swivel to be free to rotate and safety.
e. Actuate the selector to ascertain that the valve moves into its detents, and lubricate control cable swivel fittings with ESSO "Beacon 325" grease or equivalent (MIL-G-3278).
f. Reinstall the access and selector panels.

9-41. ADJUSTMENT OF BOOST PUMP SWITCHES. There are six micro switches mounted in the fuel selector control panel which are used to operate the submerged boost pumps in the wing fuel cells; and also the Low fuel warning lights for the outboard fuel cells. The switches are activated as the pilot selects a particular fuel cell and the appropriate circuit is completed. The following steps should be used to adjust these switches.

a. Remove the access panel from the bottom of the fuselage below the fuel selector panel.
b. Position the selector levers in each position and check the operation of the micro switches.
c. Should any of the switches need adjustment, loosen the screws securing the switch to the mounting bracket and move the switch till it activates.
d. Leave enough play between the switch and the selector lever, so as not to damage the switches when operating the levers.
e. Secure the switch to the mounting bracket and replace the access panel at the bottom of the fuselage.



9-12. Adjacent Of Cross-feed Valve

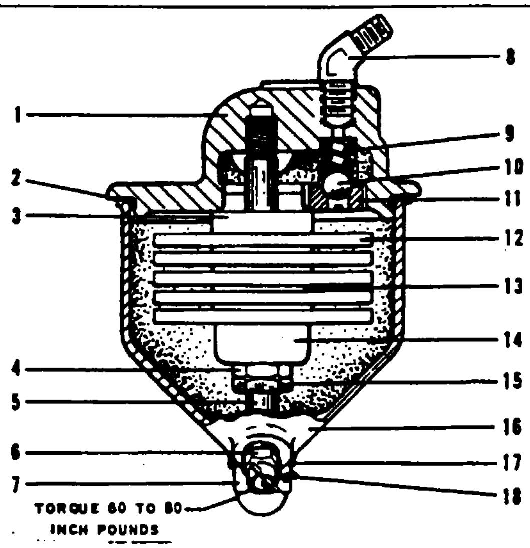


Figure 9-13. Fuel Filter

9-42. ADJUSTMENT OF CROSS-FEED VALVE.

a. Remove the access cover located on the underside of the fuselage, below the fuel selector panel just ahead of the main spar and the access panels between the fuselage and the underside of the wings.
b. Ascertain that the control cable wire is connected to the cross-feed valve handle in the cockpit. The wire on the valve handle should be free to rotate.
c. Place the cross-feed handle in the cockpit in the OFF position.
d. Assemble the swivel assembly with the control cable wire on the arm of the cross-feed handle. Adjust and secure the swivel fitting to obtain a maximum of seven-sixteenth of an inch between the center of the pin that goes through valve and valve body. (Refer to Figure 9-12.)
e. Move the cross-feed handle to the ON position and ascertain that there is a minimum of one inch between the center of the shaft pin and the valve body.
f. Actuate the selector to ascertain proper operation and maximum and minimum travel of the valve shaft.
g. Reinstall the access and selector panels.

9-43. ADJUSTMENT OF EMERGENCY SHUT-OFF VALVE.

a. Remove the fuel selector panel cover in the cockpit and the access panel to the control valve located just ahead of the main spar between the fuselage and the underside of the wing.
b. Ascertain that the control cable clevis ends are connected to the arm of the shut-off lever in the cockpit and the arm of the shut-off valve. Allow the jam nuts of the devises to remain loose.
c. Rotate the control cable from under the wing so that the valve will contact its stops before the lever in the cockpit contacts its stops.
d. Reinstall the access and selector panels.

9-44. FUEL FILTER.

9-45. REMOVAL OF FUEL FILTER. (Refer to Figure 9-13.) The instructions given are for the removal of the complete filter from the airplane. For cleaning and servicing purposes only, steps a and b of this paragraph are necessary; then proceed to paragraph 9-46.

a. Turn the fuel selector valve to the OFF position.
b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.
c. Disconnect the electrical leads to the fuel pump.
d. Disconnect the line to the sender unit.
e. Disconnect the fuel lines to the filter and fuel pump. Cover the line ends to prevent contamination.
f. Remove the bolts that secure the filter and pump to their mounting brackets.
g. Separate the filter from the fuel pump.

9-46. DISASSEMBLY OF FUEL FILTER. (Refer to Figure 9-13.)

a. Cut safety wire (18) and remove the cap nut (7) from the bottom of the filter bowl (16).
b. Take the bowl from the filter housing (1).
c. The bowl gasket (2) may be removed from the housing.
d. Loosen and remove both the check nut (15) and the nut (4) from the stud (5) that holds the filter cartridge subassembly.
e. Slide the filter cartridge from the stud. The filter discs (12) and washers (13) need not be separated from the element outlet tube (3) for normal cleaning.
f. If it is necessary to disassemble the filter cartridge, remove the retainer cup (14) from the outlet tube (3) and slide the discs (12) and washers (13) from the outlet tube. Do not use a screwdriver or sharp tool that may damage the discs.
g. The filter bypass assembly may be removed by using the proper size screwdriver and turning out the relief valve seat (11). Then remove the relief ball (10) and spring (9).
h. The fuel pressure switch fitting (8) may be removed by unscrewing it from the top of the filter body (1).

9-47. CLEANING, INSPECTION AND REPAIR OF THE FUEL FILTER.

a. Wash the element in oil solvent such as mineral spirits. (It is not necessary to remove discs from element outlet tube for normal cleaning.) Plug open ends of element outlet tube while washing to keep out dirt.
b. Inspect filter discs for damage and broken screens.
c. Check condition of bowl gaskets (2 and 17.)
d. Check condition of bowl drain and drain "O" ring.
e. Check for corrosion of filter parts.
f. Check movement of bypass valve.
g. Check condition of filter rubber shock mounts.
h. Normal repairs necessary for the filter are replacement of bowl gaskets and damaged filter discs.

9-48. ASSEMBLY OF FUEL FILTER. (Refer to Figure 9-13.)

a. If removed install bypass valve spring (9), relief ball (10) and seat (11).
b. Place the filter cartridge (assembled) on the housing stud (5). Ascertain that the end of the outlet tube (3) has positioned itself in the filter body.
c. Secure the filter cartridge with nut (4). Torque nut 10 to 15 inch pounds. Torque check nut (15) against nut (4) 40 to 60 inch pounds.

d. Place bowl gasket (2) on housing and install bowl (16), gasket (17) and cap nut (7). Torque nut 60 to 80 inch pounds and safety.
e. Install the filter. If the filter was not removed, proceed to step c of paragraph 9-49.
f. Install the fitting (8) on top of filter.

9-49. INSTALLATION OF FUEL FILTER. (Refer to Figure 9-11.)

a. Connect the filter and electric fuel pump. Tighten the jam nut on the fitting between the pump and filter to allow the "O" ring to seat on the non-threaded portion of the fitting.
b. Position the filter and pump on the mounting brackets and secure.
c. Connect the lines to the filter and pump tee.
d. Connect the line from the pressure switch to the fitting on the filter.
e. Connect the electrical leads to the fuel pump.
f. Turn on the fuel valve and check for fuel leaks.
g. Install the access plate.

9-50. CLEANING FUEL SYSTEM.

a. To flush fuel tanks and selector valve, disconnect fuel line at the injector.
b. Select a fuel tank, turn on the electric fuel pump and flush fuel through the system until it is determined that there is no dirt and foreign matter in the fuel valve, lines or tank. During this operation, agitation of the fuel within the tank will help pick up and remove any dirt. Repeat this procedure for each tank.
c. When all tanks are flushed, clean the filter assembly.

9-51. ELECTRIC FUEL PUMPS.

9-52. ELECTRIC FUEL PUMP (PULSATING TYPE). These pumps are mounted in pairs and are used to transfer fuel from the nacelle tanks to the outboard fuel cells. The pumps are located in the wing just outboard of the outboard fuel cells, and are accessible through access panels on the lower surface of the wing.

9-53. REMOVAL OF PULSATING PUMP.

a. Remove the access panels on the lower wing surface. (Refer to Figure 2-5, Section II.)
b. Ascertain that the nacelle tanks and outboard fuel cells are empty before removing the pumps from the airplane.
c. Place a suitable container below the pumps to catch the fuel that is in the fuel lines.
d. Disconnect the electrical leads from the pumps.
e. Disconnect the inlet and outlet lines from the pumps. Cap all lines to avoid contamination.
f. Remove the pumps by removing the pump attachment bolts.
g. The two pumps can be separated from each other for further servicing.

9-54. DISASSEMBLY OF PULSATING PUMP. (Refer to Figure 9-14.)

a. Remove the safety wire that secures the bottom cover to the pump.
b. Using a 5/8 inch wrench, release the bottom cover (12) from the bayonet fittings. Twist the cover by hand to remove it from the pump body
c. Remove the filter (3) magnet (10) and cover gasket (11) .
d. Remove the retainer spring (9) from the plunger tube (2) using thin nose pliers to spread and remove ends of retainer from tube.
e. Remove washer (8) "O" ring seal (7) cup valve (6) plunger spring (5) and plunger (4) from the tube (2).

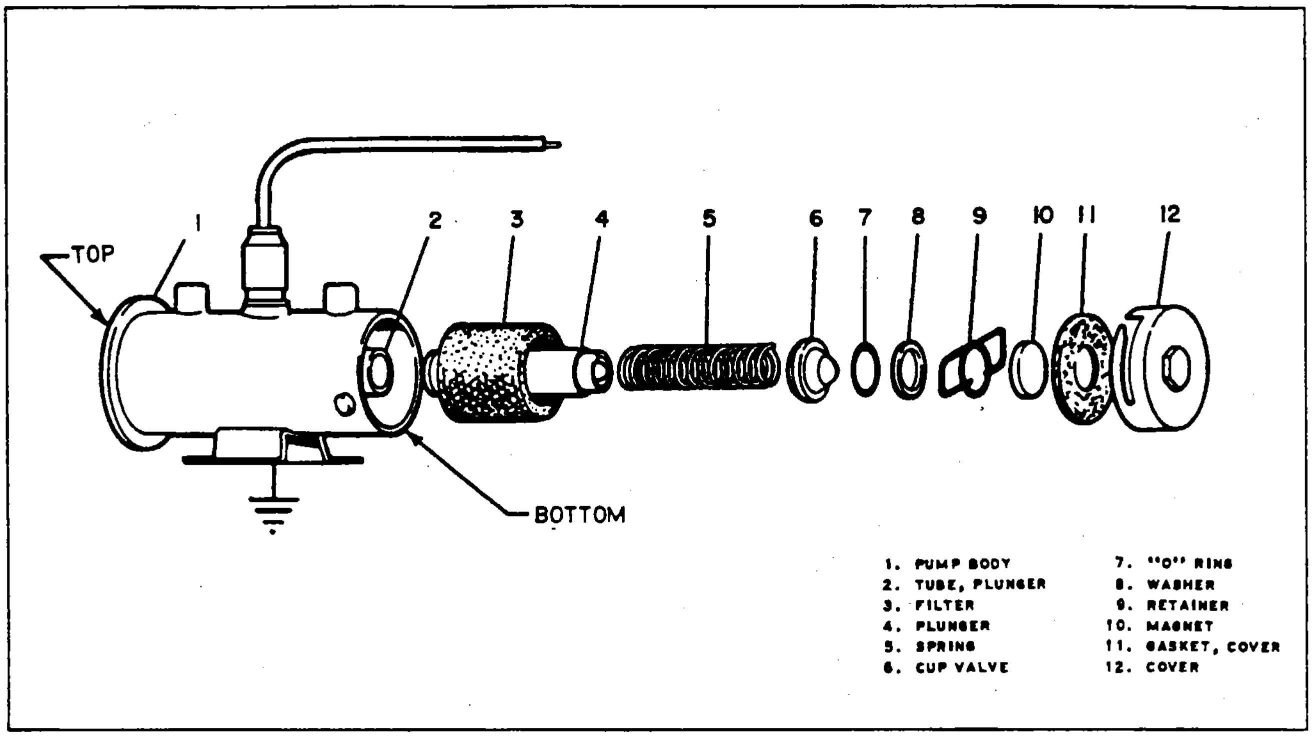


Figure 9-14. Electric Fuel Pump (Transfer)

9-55. CLEANING OF PULSATING PUMP.

a. Wash all parts in cleaning solvent and blow out with air pressure.
b. If plunger does not wash clean or if there are any rough spots, gently clean surface with crocus cloth.
c. Slosh the pump assembly in cleaning solvent and blow out with air pressure
d. Swab the inside of the tube with a cloth wrapped around a stick.

9-56. INSPECTION AND REPAIR OF PULSATING PUMP. The inspection and repair of this type of fuel pump is very limited, consisting of mainly replacing parts that are worn or broken. To disassemble and check these parts, proceed as follows:

a. Disassemble the pump according to paragraph 9-54.
b. The filter usually comes off with the cover; it may stick inside the fuel pump. Carefully remove the filter and replace if distorted.
c. Check cover gasket and replace if deteriorated.
d. Check the "O" ring seal and plunger spring and replace if worn.

9-57. ASSEMBLY OF PULSATING PUMP. (Refer to Figure 9-14.)

a. Insert the plunger (4) into the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger in the tube. It should move fully without any tendency to stick. If a click cannot be heard, the interrupter assembly is not functioning properly in which case the pump should be replaced.
b. Install the plunger spring (5), cup valve (6) "O" ring seal (7) and washer (8).
c. Compress spring (5) and assemble retainer (9) with ends of retainer in side holes of tube (4).
d. Place the cover gasket (11) and magnet (10) in the bottom cover (12) and assemble the filter (3) and cover assembly.
e. Twist the cover by hand to hold in position on pump housing. Using a 5/8 inch wrench, securely tighten the bottom cover with the bayonet fittings on the pump body and install the safety wire.

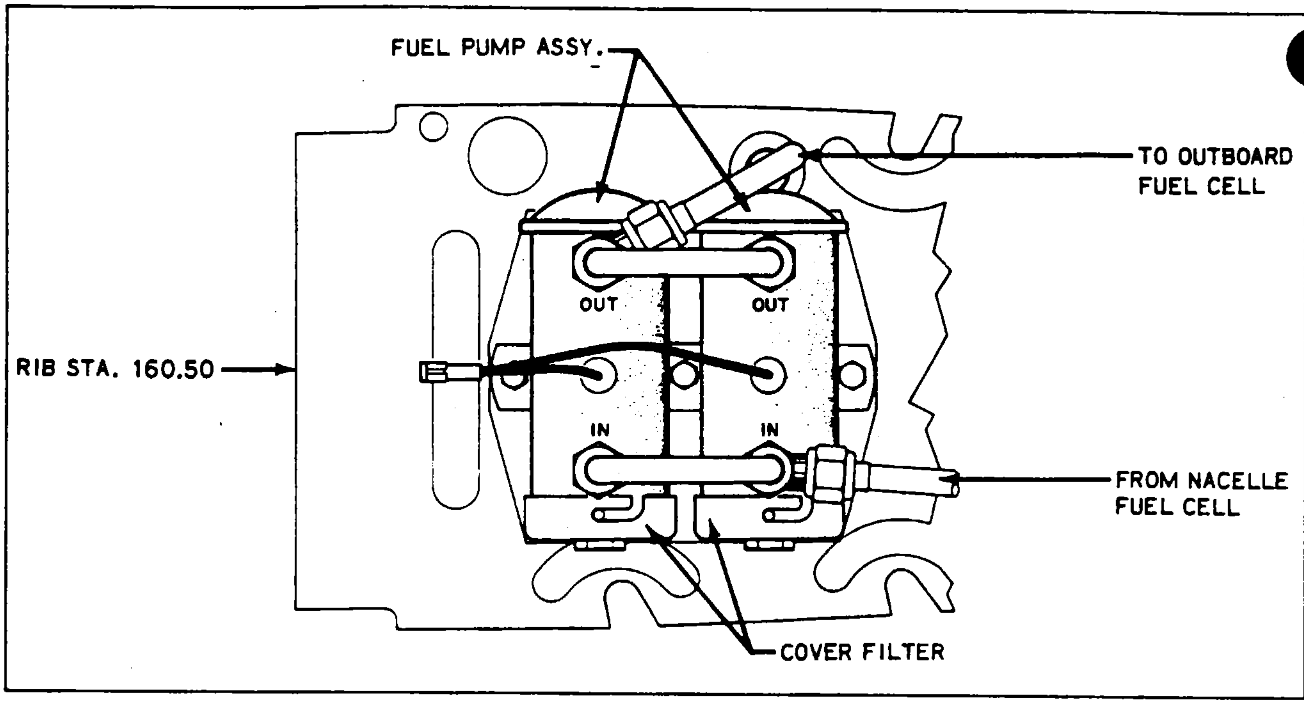


Figure 9-15. Installation Of Transfer Pumps

9-58. INSTALLATION OF PULSATING PUMP.

a. Connect the two fuel pumps according to Figure 9-15.
b. Install the pumps into the wing and secure with attachment bolts.
c. Connect the inlet and outlet lines to the pumps.
d. Connect the electrical leads to the pumps.
e. Replace the fuel into the system and run the pumps to check for leaks and proper operation.
f. Replace the access panel to the lower wing surface.

9-59. ELECTRIC FUEL PUMP (ROTARY VANE TYPE).

9-60. REMOVAL OF ROTARY VANE PUMP. (Refer to Figure 9-16.) Instructions given are for the removal of the electric fuel pumps from the airplane for the purpose of cleaning, inspection, replacement or repair and adjustment.

a. Turn the fuel selector to the OFF position.
b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.
c. Disconnect the electrical leads to the fuel pump.
d. Disconnect the fuel lines from the fuel pump and filter assembly. Cover the line ends to prevent contamination.
e. Remove the bolts that secure the pump and filter to their mounting brackets and remove from the airplane.
f. Separate the fuel pump from the filter.

9-61. DISASSEMBLY OF ROTARY VANE PUMP. (Refer to Figure 9-16.) The motor of the A10007-B pump assembly may be separated from the pump body by removing the two screws (1) which hold the cover (2) on top of the motor (4). Remove the two motor thru bolts (3) at the commutator end of the motor. The B10007-C pump assembly may be separated from the pump by removing the four motor attachment screws (30). Care should be taken when separating the pump from the motor to insure that the shaft end bearing, which is a press fit on the armature shaft, slips out of the pump body housing. After separation of the pump and motor, disassembly of the pump can proceed as follows:

a. Remove the seal spring (8), seal washer (9) and seal cage (11) containing seal "O" ring (10) from the pump shaft. Long thin nose pliers may be used to facilitate removal of seal cage.
b. Unscrew the insert plug (19) with "O" ring seal (20) from the pump body (5). The wear plate (17) and wear plate spring (18) can be removed at this time.
c. Insert number 5-40 screws into tapped holes on face of insert (13) and pull insert assembly from pump body. If necessary, pry the insert loose from the pump body by using a lever arm between the pump body and screw heads.
d. Remove the rotor (16) from the insert by pushing on the end of the rotor shaft. Remove the blade retainer spring (15) and blades (14). Also the "O" ring seals (12) from the insert.
e. Using a light arbor press, apply pressure to the valve adjusting screw (25) to release tension against the Tru-Arc retaining spring (27) and remove the spring with Tru-Arc pliers. Pull out adjustment guide (24) containing "O" ring seal (23), adjusting screw (25) and locknut (26).
f. Remove the valve spring (22) and piston assembly (21).

NOTE

The piston assembly should not be disassembled. If found defective, it should be replaced with a new assembly. (Refer to PA-31P Parts Manual.)

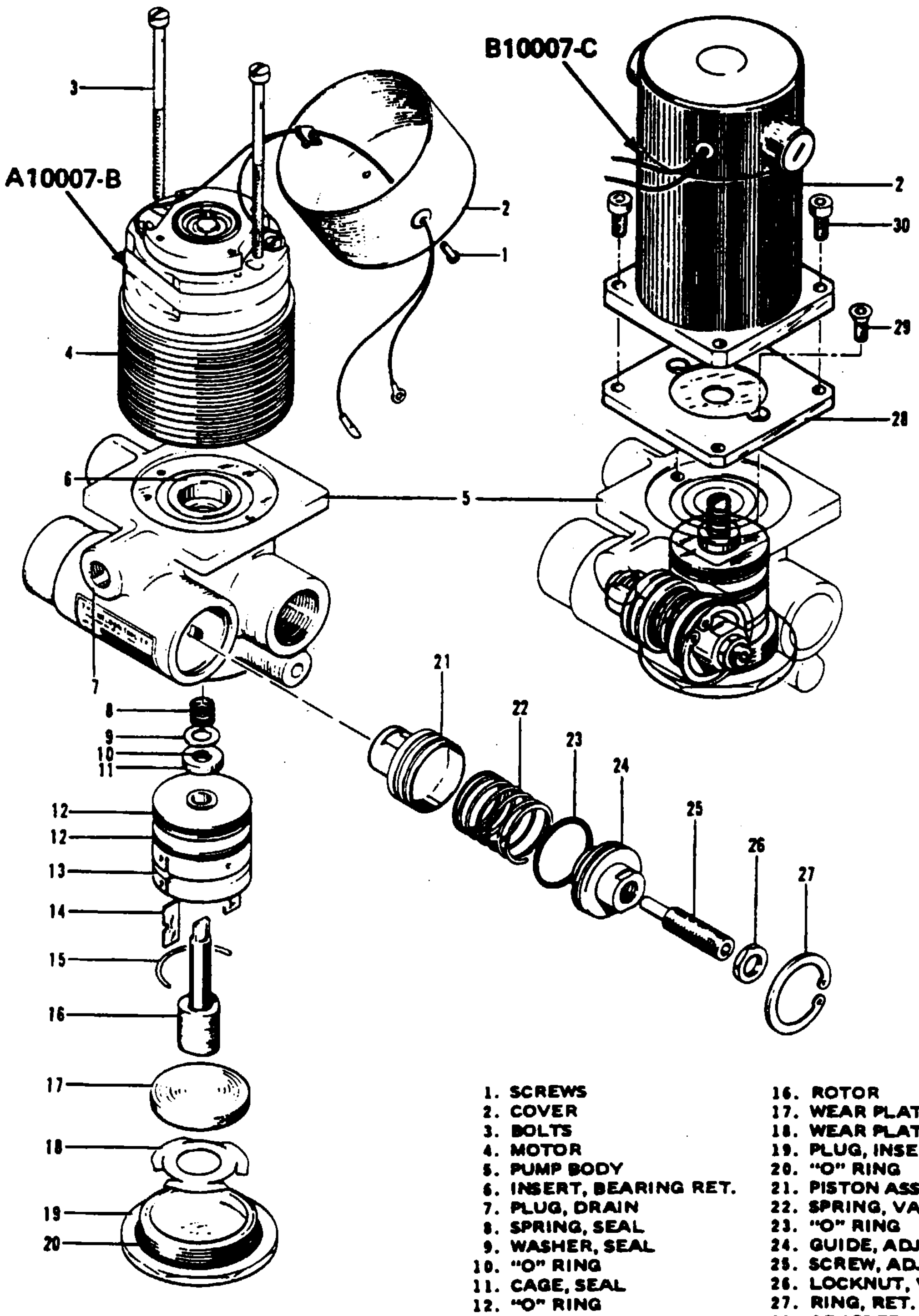
g. Remove the bearing retainer insert (6) from the pump body, when required, by means of an arbor press.

9-62. CLEANING, INSPECTION AND REPAIR OF ROTARY VANE PUMP.

a. Clean all parts in oil solvent such as mineral spirits.
b. Inspect all parts for wear, with special attention to the insert, rotor and blades. (Check wear limits per Table IX-Ia.)
c. Repair is limited to replacing parts that are defective or worn.

9-63. ASSEMBLY OF ROTARY VANE PUMP. (Refer to Figure 9-16.)

a. Replace the bearing insert retainer (6) and press it flush with the pump body housing (5).
b. Lubricate "O" ring seals with Parker "O" Lube or equivalent to facilitate reassembly.
c. Replace the piston assembly (21) and valve spring (22) into the pump body.
d. Install adjustment guide (24) with a new "O" ring (23), adjustment screw (25) and locknut (26) into the pump body. Refer to Figure 9-16 for proper reassembly of component parts and secure in place with the Tru-Arc retainer (27).

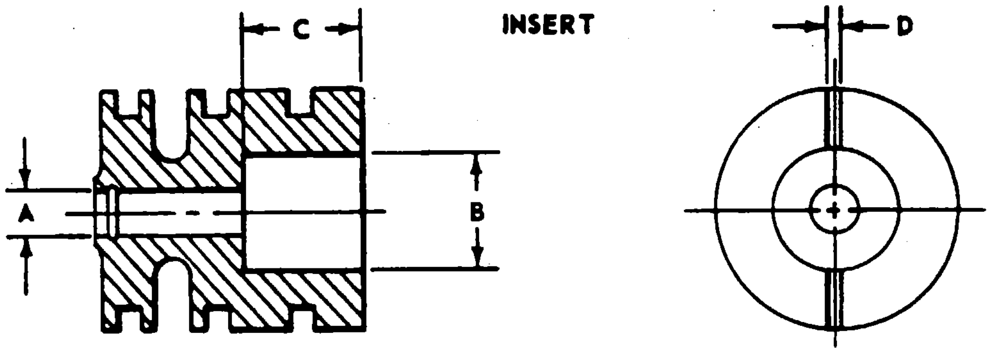


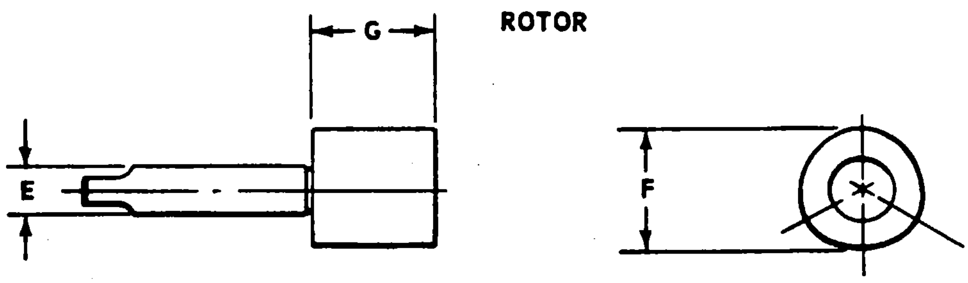
1. SCREWS
2. COVER
3. BOLTS
4. MOTOR
5. PUMP BODY
6. INSERT, BEARING RET.
7. PLUG, DRAIN
8. SPRING, SEAL
9. WASHER, SEAL
10. "O" RING
11. CAGE, SEAL
12. "O" RING
13. INSERT
14. BLADE
15. RING, BLADE RET.
16. ROTOR
17. WEAR PLATE
18. WEAR PLATE SPRING
19. PLUG, INSERT
20. "O" RING
21. PISTON ASSEMBLY
22. SPRING, VALVE
23. "O" RING
24. GUIDE, ADJUSTMENT
25. SCREW, ADJUSTMENT
26. LOCKNUT, VALVE
27. RING, RET. (TRU-ARC)
28. ADAPTER
29. SCREWS
30. SCREWS

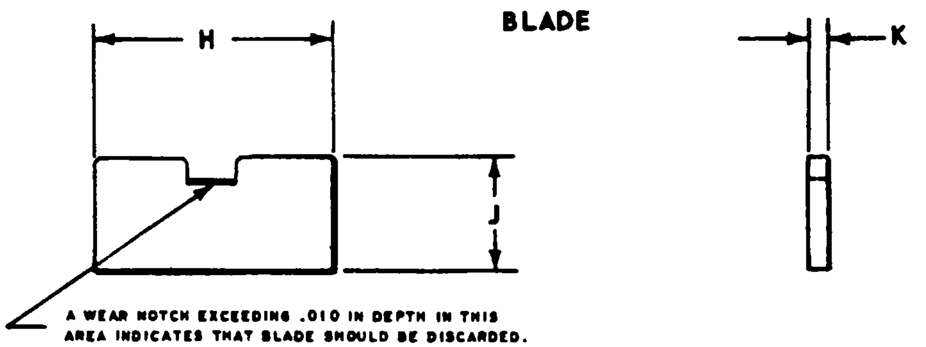
Figure 9-16. Electric Fuel Pump (Emergency)

TABLE IX-Ia. WEAR LIMITS FOR ELECTRIC FUEL PUMP

DIM.	WORN PART LIMIT	DIM.	WORN PART LIMIT
A	.2502 MAX.	F	.6245 MIN.
B	.6252 MAX.	G	.6244 MIN.
C	.6252 MAX.	H	.6246 MIN.
D	.0455 MAX.	J	.298 MIN.
E	.2493 MIN.	K	.0448 MIN.







e. Install the rotor (16) into the insert (13) and the rotor blades (14) into the slots with the notches toward the outer edge of the insert. Secure the blades with the blade retainer spring (15). Clearance across the top of the rotor and blades should measure a nominal .0005 after reassembly.
f. Replace the two "O" ring seals (12) on the insert (13).
g. Install the insert and rotor assembly into the pump body (5).
h. Install the "O" ring seal (20) on the insert plug (19).
i. Install the wear plate spring (18) into the plug and be sure the wear plate (17) is installed into the pump body before installing the plug and spring into the pump body.
j. Replace the seal cage (11), seal washer (9) and seal spring (8) on the rotor shaft before installing the motor to the pump body.
k. Replace the motor (4) on the pump body (5) being sure the female end of the motor shaft fits over the male end of the rotor shaft. Secure the motor with the two motor thru bolts (3).
l. Replace the cover (2) on the end of the motor housing and securing with two screws (1).
m. Adjust the pump in accordance with paragraph 9-64.

9-64. ADJUSTMENT OF ROTARY VANE PUMP (BENCH TEST).

a. Ascertain that the pump is sufficiently lubricated to prevent damage if run dry for a period greater than five minutes.
b. Connect the electric leads to a 28-volt d.c. power source. (The black lead is the negative lead.)
c. Using a suitable container with the proper octane fuel, connect a fuel line from a container to the inlet side of the pump.
d. Connect another line from the outlet side of the pump to a pressure gauge and bypass valve and back to the container.
e. Run the pump with the bypass valve open until a steady flow of fuel is obtained. Then close the bypass valve and check the pressure gauge for the proper reading of 40 ± 2 psi maximum, no flow. Do not keep the bypass valve closed for more than one minute during pump operation and adjustment.
f. Loosen the locknut and turn the adjusting screw until there is a reading of 40 ± 2 psi maximum, no flow, on the gauge. Repeat steps e and f until the proper pressure is obtained.
g. Disconnect the power source from the pump and lock the adjustment screw with the locknut. Remove the fuel lines from the pump.

9-65. ADJUSTMENT OF ROTARY VANE PUMP (IN THE AIRPLANE).

a. With the access panels removed and the fuel selector in the OFF position, remove the fuel line from the outlet end of the pump.
b. Connect a test line with a bypass valve and pressure gauge to the outlet end of the pump.
c. Place a container below the pump to catch any fuel from the test line during the adjustment of the pump.
d. Turn the fuel selector on, open the bypass valve on the test line and start the pump.
e. When a steady flow of fuel is obtained, close the bypass valve and check the reading on the pressure gauge. It should read 40 ± 2 psi maximum, no flow. Do not keep bypass valve closed for more than one minute during pump operation and adjustment.
f. Loosen locknut on adjusting screw and turn screw to obtain the proper pressure of 40 ± 2 psi maximum, no flow. Repeat steps e and f until adjustment is complete. Lock adjusting screw with locknut.
g. Turn off fuel pump and close fuel selector. Remove the test line from the pump.
h. Reconnect the original fuel line to the pump. Open fuel selector and run the pump to check for any fuel leaks.
i. Shut off the pump, close the fuel selector and replace and secure the access panels.

9-66. INSTALLATION OF ROTARY VANE PUMP. (Refer to Figure 9-16.)

a. Connect the fuel pump and fuel filter. Tighten the jam nut on the fitting between the pump and filter to allow the "O" ring to seat on the non-threaded portion of the fitting.
b. Position the fuel pump and filter on the mounting brackets and secure with bolts.
c. Connect the fuel lines to the pump and filter.
d. Connect the electrical wires to the pump motor. (Black wire is ground wire.)
e. Turn on the fuel valve and check for fuel leaks.
f. Install the access plate and secure it.

9-67. SUBMERGED FUEL (BOOST) PUMPS.

9-68. INSPECTION OF SUBMERGED FUEL PUMPS. Inspection of the submerged fuel pumps is limited to unit operation and fuel leakage.

a. Remove the access panels forward of the main gear door opening to view the outboard pump and open the fuel filter access door to view the inboard pump.
b. Operate the pumps and look for any indication of fuel leakage. Inspect the area around the pump wiring harness and where the harness extends from the protective sheet.
c. If evidence of fuel leakage is not found, the inspection is completed.
d. If fuel leakage is evident, the defective pump must be replaced. Refer to Paragraph 9-69 for removal and installation.
e. Install the access panels and make the appropriate logbook entry.

9-69. REMOVAL AND INSTALLATION OF SUBMERGED FUEL PUMPS.

a. Drain either the entire system or make sure the crossfeed is in the OFF position so that either wing may be drained separately without fuel from the opposite side draining also. (Refer to Draining Fuel System, Section II.)
b. Remove the lower wing root fairing or access panels from the underside of the wing of which the pump is to be removed.
c. Remove the access plates on top of the wing over the location of the particular fuel pump. This exposes the fuel cell cover plate which must be removed also to obtain access to the fuel pump. (Refer to Figures 9-2 and 9-3.)
d. In the wing cavity disconnect the electrical connections and fuel lines from the pump.
e. While holding the pump through the cell access opening in the top of the wing, have an assistant remove the four pump mounting bolts in the wing cavity, then remove the pump up and out of the fuel cell.
f. Installation of the pump is accomplished by first installing a new gasket on the fuel pump mounting boss, then insert the pump into the fuel cell and hold it in position while an assistant attaches it to the wing butt rib with four mounting bolts. (Refer to Figure 9-7.)
g. Reconnect the electrical connections and fuel lines to their respective positions.
h. Install fuel cell cover plates and cell access plate on top of the wing and fill the cell just enough to check for leaks in accordance with instructions given in Paragraph 9-68.
i. Install the lower wing root fairing and access panels.

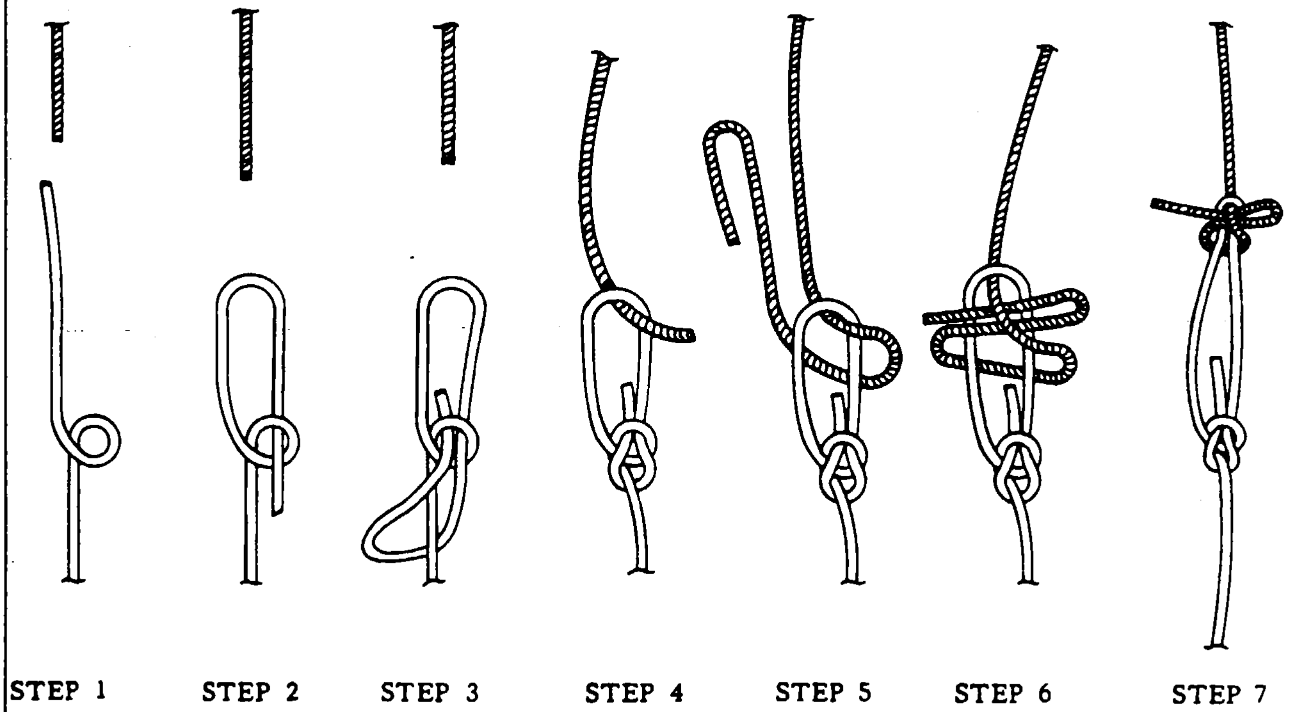


Figure 9-17. Fuel Cell Tie Detail

TABLE IX-II. FUEL PUMP PRESSURE CHECKS

Inboard or Outboard Submerged Pump	Submerged and Emergency Pump	Emergency Pump Only	Engine Pump Only	All three Pumps
13 psi max.	48 psi min. 53 ± 2 psi max.	40 ± 2 psi max.	35 ± 2 psi max.	55 psi max.

9-70. FUEL PUMP PRESSURE CHECKS. The following checks should be done at each 100 hour inspection or whenever the problem of excessive fuel pressure is suspected. To properly perform these checks, a calibrated differential pressure gauge with a range of 0 to 60 psi is necessary.

a. Remove the engine cowls and connect the high pressure side of the calibrated differential pressure gauge to the heater fuel line at the fire wall by teeing into the line.
b. Connect the low pressure or reference port of the gauge to the deck pressure line at the fire wall by teeing into the line.
c. Secure the gauge to the engine nacelle facing the cockpit. Ascertain that the area around the engines are clear and the propwash will not damage any objects in back of the airplane.
d. Operate the opposite engine to supply proper voltage to check the no flow pressure of the inboard and outboard submerged pumps. (Refer to Table IX-II.)
e. Turn on the emergency pump and check the combined no flow pressures with either submerged pump on, or pull the circuit breaker to shut off the submerged pump. These pump pressures are additive and subtracting submerged pump pressure will give emergency pump pressure. (Refer to Table IX-II.)
f. Start the engine that the gauge is connected to. Ascertain that the emergency pump is off and that the circuit breaker for the submerged pump is pulled. Operate the engine at maximum power and check engine driven pump pressure. (Refer to Table IX-II.)
g. With engine still operating, activate the electric fuel pumps and check fuel pressures throughout the full RPM range and note the maximum pressure. (Refer to Table IX-II.)
h. Repeat the above steps on the opposite engine.

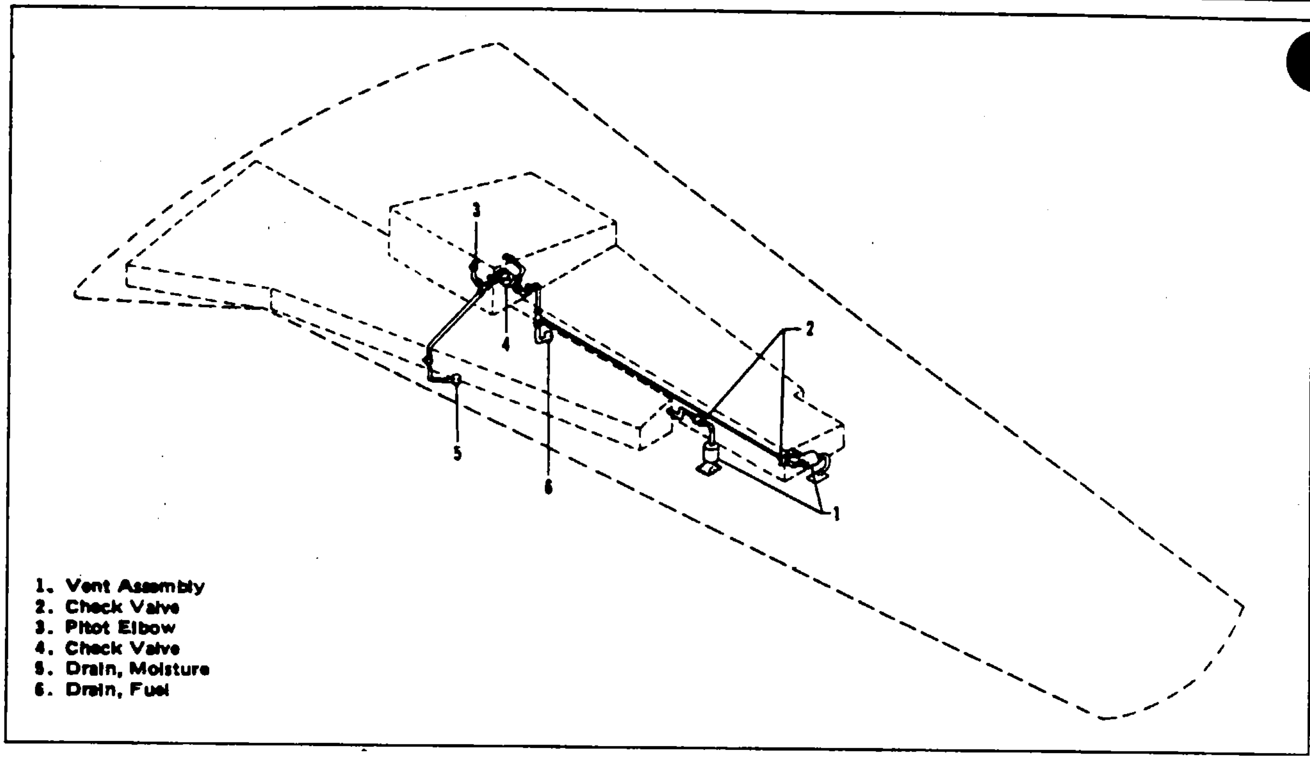


Figure 9-18. Fuel Vent System

9-71. FUEL VENT SYSTEM. (Refer to Figure 9-18.)

The vent system includes two NACA non-icing type vent assemblies, these are non-siphoning type which incorporate flame arrestors. The nacelle and auxiliary fuel tanks are vented through the aft vent and the main fuel tank is vented through the forward vent. The nacelle and auxiliary fuel vent system includes a source of pitot air to evacuate fuel from the system in flight. A drain is provided to remove moisture that might enter through the pitot. Another drain is provided to drain fuel from the line. These drains are opened during the pre-flight inspection. A check valve is provided in the nacelle and auxiliary fuel vent system to prevent fuel and fumes from exiting the pitot. Near each vent assembly is a check valve to aid in the retension of fuel during maneuvers and taxi turns with full tanks.

When troubleshooting the system ascertain that the checks valves are installed per Figures 9-2, 9-3 and 9-4. The valves may be removed and checked if vent problems are encountered. Lines may also be checked for air flow during troubleshooting. Excess fuel because of fuel expansion will also escape through the vent assembly and should be considered normal.

TABLE IX-III TROUBLESHOOTING CHART(FUEL SYSTEM)

Trouble	Cause	Remedy
Fuel gauge fails to indicate proper tank level. NOTE: With current off, gauges will indicate fuel level as existed when current was shut-off or failed.	Circuit breaker out.	Reset and check.
	Broken wire.	Check and repair.
	Gauge inoperative.	Replace.
	Tank selector switch inoperative.	Repair or replace.
	Incomplete ground.	Check ground connections at fuel transmitters in wings and at gauge.
	Float and arm assembly of fuel transmitter(s) in wing sticking.	Check fuel transmitters in wings and repair or replace.
Fuel gauge indicating approximately 1/2 tank when tank is full but will function normally on other tank.	Inboard fuel transmitter assembly grounded.	Check inboard fuel transmitter installation and repair.
	Float and arm assembly of fuel transmitter(s) in wing sticking.	Check fuel transmitters in wings and repair or replace.
	Emergency shut-off valve off.	Turn on.
Low fuel pressure indicator light stays on.	Fuel valve stuck.	Checks valve.
	No fuel in tanks.	Check fuel, fill.
	Filters dirty.	Clean filters.
Excessive fuel pressures suspected.	All pumps operating, and low engine RPM.	Turn off emergency pump.
		Increase engine RPM.
		Move mixture control towards the lean position.

TABLE IX-III TROUBLESHOOTING CHART(FUEL SYSTEM)(cont.)

Trouble	Cause	Remedy
Excessive fuel pressures suspected. (cont.)	Fuel pump or pumps out of adjustment	Check pressures in accordance with paragraph 9-67.
Pressure low or pressure surges.	Obstruction in inlet side of pump. Faulty pump.	Trace lines and locate obstruction. Replace.
Unidentified leak.	Fuel lines damaged or improperly installed. "O" rings improperly installed.	Locate and repair Locate and repair or tighten.
Fuel valve leaks.	Worn "O" rings.	Replace "O" rings or valve.
Pump (pulsating type) operates, but fails to deliver fuel.	Air leak in lines or fittings. Kinked or clogged lines restricting flow.	Replace lines and/or tighten fittings. Replace and/or clean lines.
Pump (pulsating type) runs erratically.	Not enough voltage. Wrong polarity. Poor ground connection. Loose electrical connection.	Check voltage. Check polarity. Check ground connection. Check electrical connection.
Pump does not Operate (pulsating type).	Circuit breaker out. Defective wiring. Defective ground. Defective pump.	Reset circuit breaker. Check wiring. Check ground. Replace pump.

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PIPER
Customer Services

PA-31P **PRESSURIZED NAVAJO**

Service Manual

CARD 3 OF 4

PIPER AIRCRAFT CORPORATION

753 770

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AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material:

Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing. physical location of material or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 770 issued July, 1972 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG720700	July 1972	-
PR730223	February 23, 1973	-
PR74 1122	November 22, 1974	-
PR 7S0926	September 26, 1975	-
PR760715	July 15, 1976	1, 2, 3 and 4
PR76 1130	November 30, 1976	1, 2, 3, 4 and 5
PR77 1130	November 30, 1977	1, 2, 3, 4 and 5
PR790131	January 31, 1979	1, 2, 3 and 4
PR790907	September 7, 1979	1, 2 and 3
PR810320	March 20, 1981	1, 2, 3 and 4
PR821110	November 10, 1982	1, 2, 3 and 4
IR860430	April 30, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March 13, 1990	1

INTERIM REVISION

Revisions appear in Section V of card 1. Please dispose of your current card 1 and replace it with the revised card. DO NOT DISPOSE OF CARDS 2, 3, 4, or 5.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

Revised: November 10, 1982
Interim Revision: March 13, 1990

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

NOTE

Electrical schematics see Grid No. 3E17.

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LIST OF TABLES

SECTION X

INSTRUMENTS

SECTION X

INSTRUMENTS

10-1. INTRODUCTION. The purpose of this section is to provide instructions for remedying difficulties which may arise in the operation of the various instruments and the pneumatic system. The instructions are organized so that the mechanic can refer to Description, for a basic understanding of the instruments and pneumatic system; Troubleshooting, for a methodical approach in locating the difficulty, corrective maintenance, for the removal, repair and installation of components and Adjustments and Tests, for the operation of the repaired system.

10-2. DESCRIPTION. The instrumentation of the PA-31P provides for all conditions of flight. The instruments are designed to give a quick and actual indication of attitude, performance and condition of the airplane. They are divided into four groups: Pressure Gyro, Pitot-Static, Electrical, Pressurization and Miscellaneous. Some of the instruments are components of indicating systems that indicate conditions at remote parts of the airplane. A few of the instruments are self-contained and merely have to be correctly installed to give an indication. Warning lights are installed to indicate unsatisfactory or dangerous conditions in some of the systems. Instruments requiring power from the electrical system are provided with circuit protectors to isolate the individual instruments in the event of trouble. Each instrument is either individually lighted by shielded post lights or a light incorporated as part of the instrument.

The panel has been arranged to accommodate flight instruments on the left side, in front of the pilot, electronic equipment and some engine instruments in the center, and the remaining engine and miscellaneous instruments to the right. A second set of electrically operated flight instruments may be installed in the right instrument panel for use by the co-pilot. Additional instruments are mounted in the overhead panel located above the windshield. All the flight instrument panels are shock mounted to minimize vibration and shock transmitted to the instruments.

10-3. INSTRUMENTS.

10-4. PRESSURE-GYRO INSTRUMENTS. The directional gyro incorporates an air-driven gyro stabilized in the vertical plane. The gyro is rotated at a high rate of speed by allowing regulated pneumatic air pressure to enter the instrument against the gyro buckets. Air from the instrument is vented through lines to the unpressurized portion of the fuselage and atmosphere.

The attitude gyro is essentially an air-driven gyroscope rotating in a horizontal plane and is operated by the same principle as the directional gyro.

The gyro pressure gauge indicates the amount of pneumatic air pressure going to the gyros after it passes through the regulator. This gauge is located on the extreme left side of the pilot's instrument panel. Also incorporated in the pneumatic system are two warning lights mounted at the top of the pilot's instrument panel to indicate a pneumatic pump failure.

10-5. PITOT-STATIC INSTRUMENTS. The airspeed indicator provides a means of indicating the speed of the airplane passing through the air. The airspeed indication is the differential pressure reading between pitot air pressure and static air pressure.

The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and dial scale. The long pointer is read in hundreds of feet. The middle pointer is read in thousands of feet and the short pointer in ten thousand feet. A field pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument.

The rate of climb indicator measures the rate of change in static pressure when the airplane is climbing or descending, by means of a pointer and dial. This instrument will indicate the rate of ascent or descent of the airplane in feet per minute.

10-6. ELECTRICAL INSTRUMENTS. The turn and bank indicator is an electrical instrument used for making coordinated controlled turns. The turn portion of the indicator is an electrically driven gyroscope, while the bank portion is a ball sealed in a curved glass tube filled with damping fluid. The indicator is connected directly to the main distributor bus through its own circuit breaker.

There are three ammeters mounted on the overhead switch panel. The center ammeter indicates the battery charging current. Each alternator's output is monitored by its own ammeter. Left alternator, left ammeter. Right alternator, right ammeter.

There are four fuel quantity gauges also mounted on the overhead switch panel. These gauges are calibrated in fractional divisions of one-fourth, one-half, three-fourths and full. The two center gauges monitor the inboard main fuel cells and the two end gauges monitor the outboard main fuel cells. The two outboard fuel gauges will also monitor the nacelle fuel cells by depressing the buttons on the panel adjacent to the outboard fuel quantity gauges. Dual transmitter units are installed in series in each fuel cell. These units contain a resistance strip and a movable control arm. The position of this arm is controlled by a float in the fuel cell and the position is transmitted electrically to the indicator gauge to show the amount of fuel in the cell.

The dual exhaust temperature gauge indicates, in degrees Fahrenheit, the temperature of the exhaust gases as they pass through the exhaust manifold of each engine. The sender unit for this instrument is a thermocouple type probe installed in each manifold.

The oil pressure, oil temperature and cylinder head temperature is a combination gauge, each a complete unit within itself. The oil pressure unit (non-electrical) is connected to the pressurized oil passage of its respective engine. The oil temperature and cylinder head temperatures utilize ratiometer to control each unit, both of which are connected with the airplanes electrical system.

The engine hour recorder operates in conjunction with a pressure switch installed on the right engine. Engine oil pressure actuates the switch, thus recording actual running time regardless of engine RPM.

The cowl flap and wing flap position indicators are separate instruments, each with their respective rheostat type sender units. Each sender unit is further described and their adjustment procedures given in their related sections in this manual.

10-7. MISCELLANEOUS INSTRUMENTS. The magnetic compass is a self-contained instrument and is mounted above the instrument panel on the windshield centerstrip. This instrument has an individual light which is connected to the instrument lighting circuit. A compass correction card is located in the card holder mounted above the compass.

The clock is a hand wound 8 day timepiece. It incorporates a stem wind with the knob at the lower left-hand side of the dial. This knob, when pulled and turned, also adjusts the hands.

The dual tachometer provides an indication of crankshaft speed in revolutions per minute for each engine. A tachometer generator is connected to each engine accessory housing. The tachometer generator supplies alternating current which drives a synchronous motor in the indicator.

The dual manifold pressure gauge is a direct reading pressure instrument that indicates manifold pressure graduated in inches of mercury. As the pressure in the intake manifolds increases or decreases, the evacuated diaphragms contract or expand, moving the respective pointers through a mechanical linkage. The dual minimum fuel press indicator lights operate off two differential pressure switches, located between each engine driven fuel pump and injector. The lights will come on whenever the fuel pressure drops to the minimum fuel pressure needed to operate the engines.

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1. WARNING LIGHT, CABIN DIFFERENTIAL PRESSURE HIGH OR CABIN ALTITUDE OVER 10,000 FEET
2. WARNING LIGHT, BAGGAGE DOOR, NOSE CONE, UNSAFE
3. WARNING LIGHT, LEFT PNEUMATIC SOURCE, MALFUNCTION
4. WARNING LIGHT, RIGHT PNEUMATIC SOURCE, MALFUNCTION
5. WARNING LIGHT, CABIN DOOR UNSAFE
6. SWITCH PANEL, AUDIO SELECTOR
7. WINDSHIELD WIPER CONTROL
8. GYRO PRESSURE GAUGE ASSY.
9. PNEUMATIC PRESSURE GAUGE ASSY.
10. CABIN ALTITUDE CONTROL ASSY.

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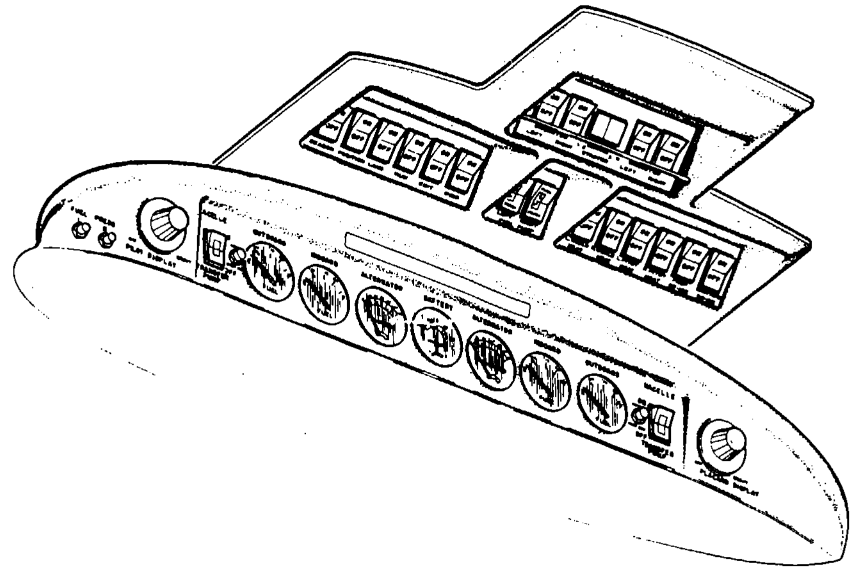
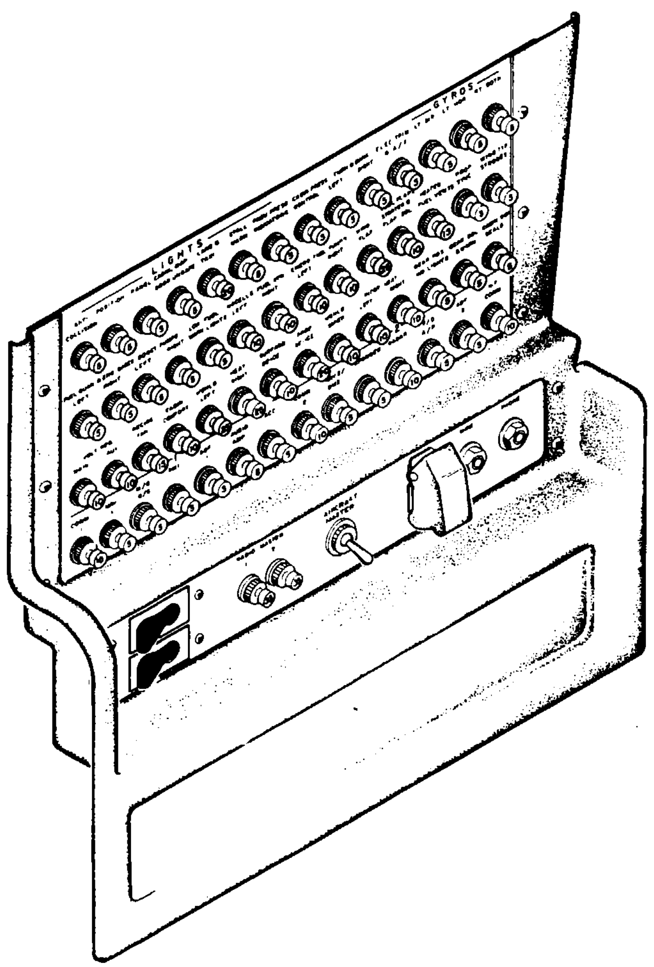


11. SELECTOR VALVE, CABIN AIR
12. LANDING GEAR SELECTOR
13. COWL FLAP ACTUATING SWITCHES
14. WARNING LIGHT, LEFT FUEL BOOST PUMP, INOPERATIVE
15. WARNING LIGHT, RIGHT FUEL BOOST PUMP INOPERATIVE
16. MANUAL ALTERNATE AIR CONTROLS
17. WING FLAP CONTROLS
18. CABIN COMFORT CONTROL ASSY.
19. OXYGEN SUPPLY PRESSURE GAUGE
20. ALTERNATE STATIC AIR SELECTOR AND ALTERNATOR FIELD SWITCHES
21. COWL FLAP INDICATOR

1285



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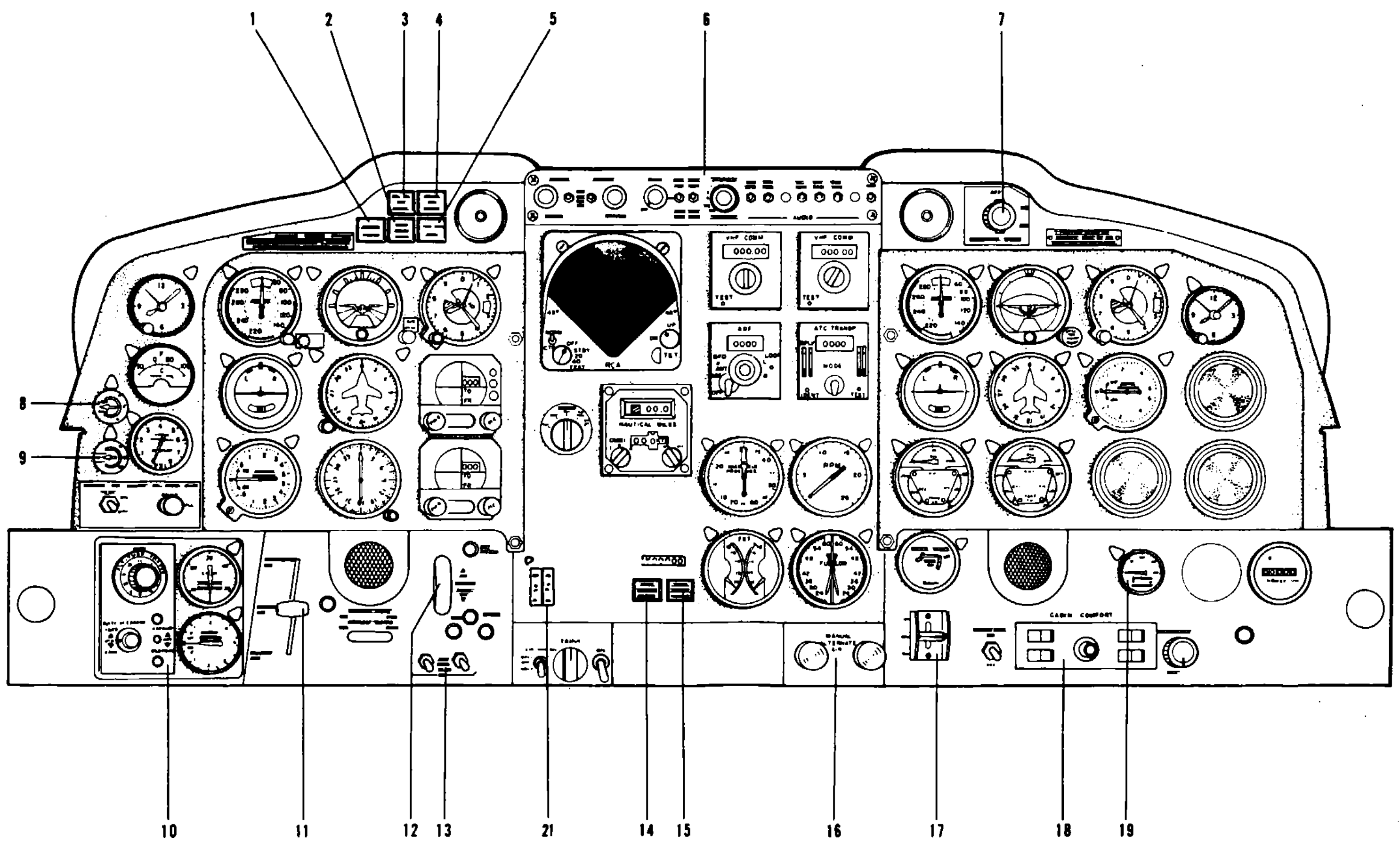

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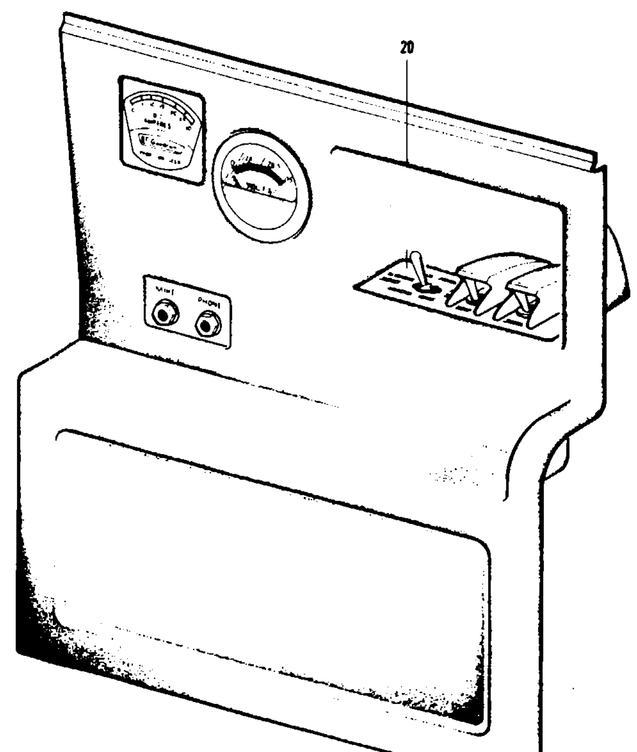

Figure 10-1. Instrument Panel Installation (S/N 31P-1 to 31P-83 incl.)

1. WARNING LIGHT, CABIN DIFFERENTIAL PRESSURE HIGH OR CABIN ALTITUDE OVER 10,000 FEET
2. WARNING LIGHT, BAGGAGE DOOR, NOSE CONE, UNSAFE
3. WARNING LIGHT, LEFT PNEUMATIC SOURCE, MALFUNCTION
4. WARNING LIGHT, RIGHT PNEUMATIC SOURCE, MALFUNCTION
5. WARNING LIGHT, CABIN DOOR UNSAFE
6. SWITCH PANEL, AUDIO SELECTOR
7. WINDSHIELD WIPER CONTROL
8. GYRO PRESSURE GAUGE ASSY.
9. PNEUMATIC PRESSURE GAUGE
10. CABIN ALTITUDE CONTROL ASSY.

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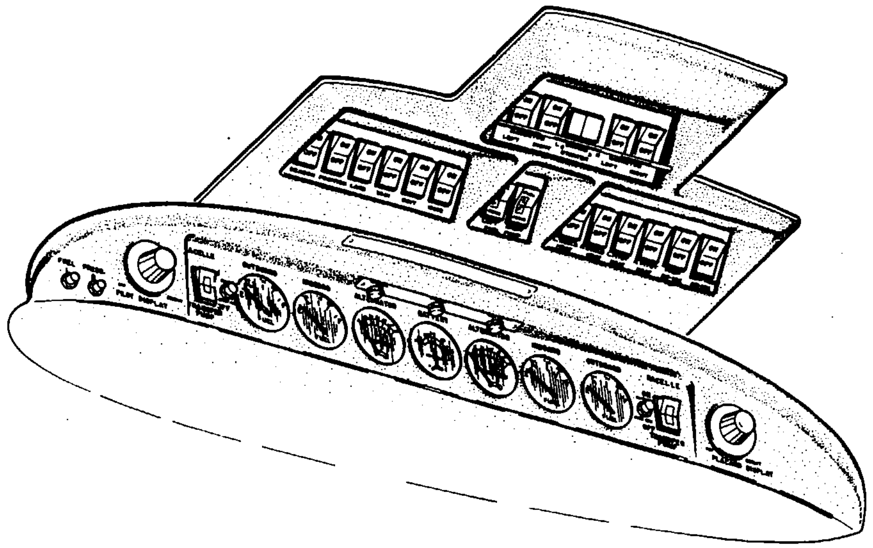
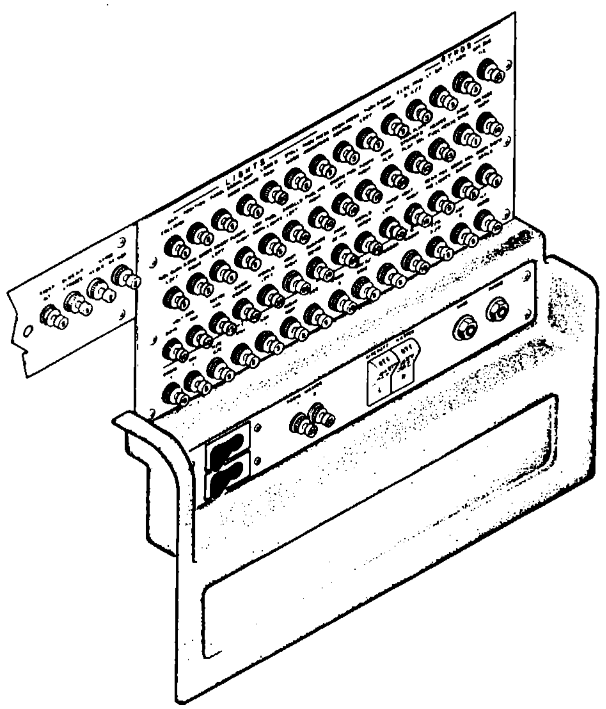
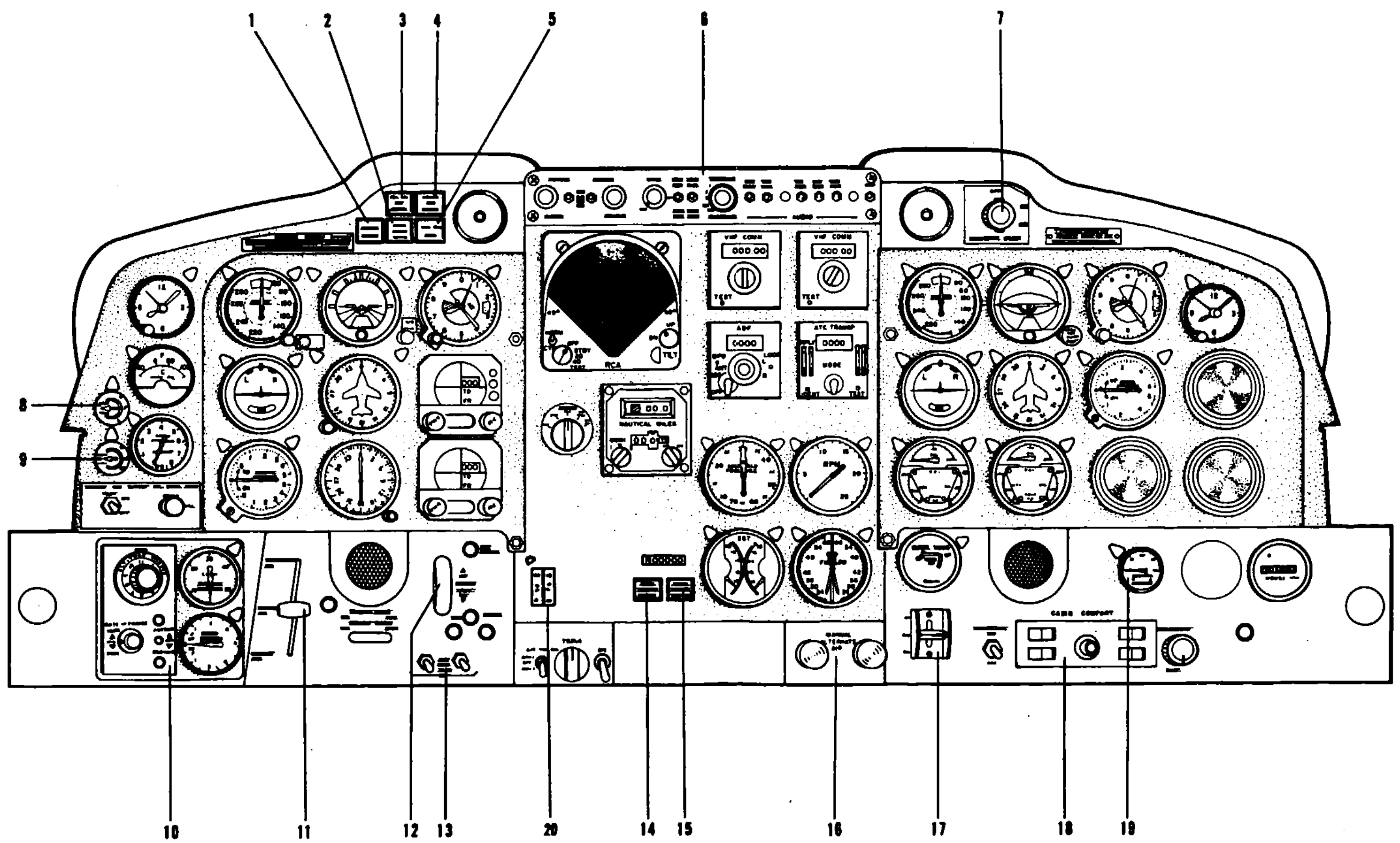


11. SELECTOR VALVE, CABIN AIR
12. LANDING GEAR SELECTOR
13. COWL FLAP ACTUATING SWITCHES
14. WARNING LIGHT, LEFT FUEL BOOST PUMP, INOPERATIVE
15. WARNING LIGHT, RIGHT FUEL BOOST PUMP, INOPERATIVE
16. MANUAL ALTERNATE AIR CONTROLS
17. WING FLAP CONTROL
18. CABIN COMFORT CONTROL ASSY.
19. OXYGEN SUPPLY PRESSURE GAUGE
20. COWL FLAP INDICATOR

1289





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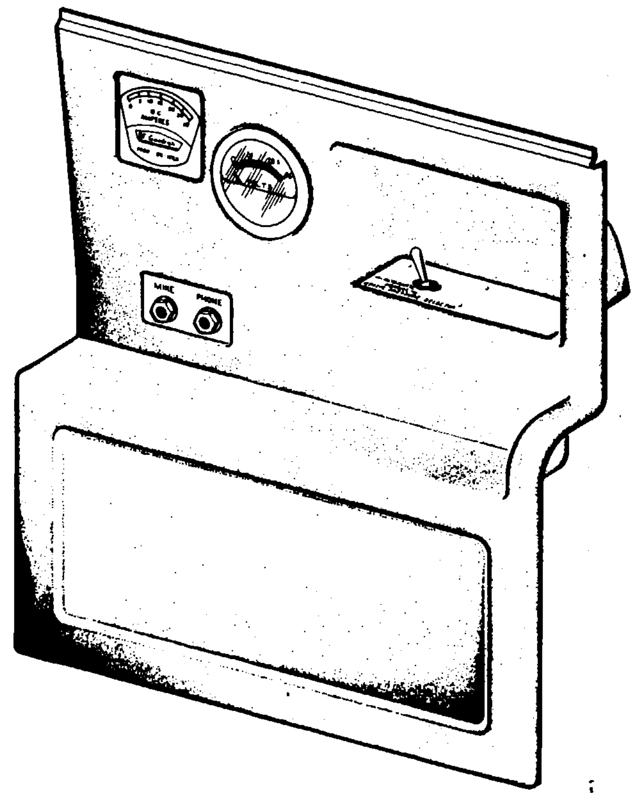
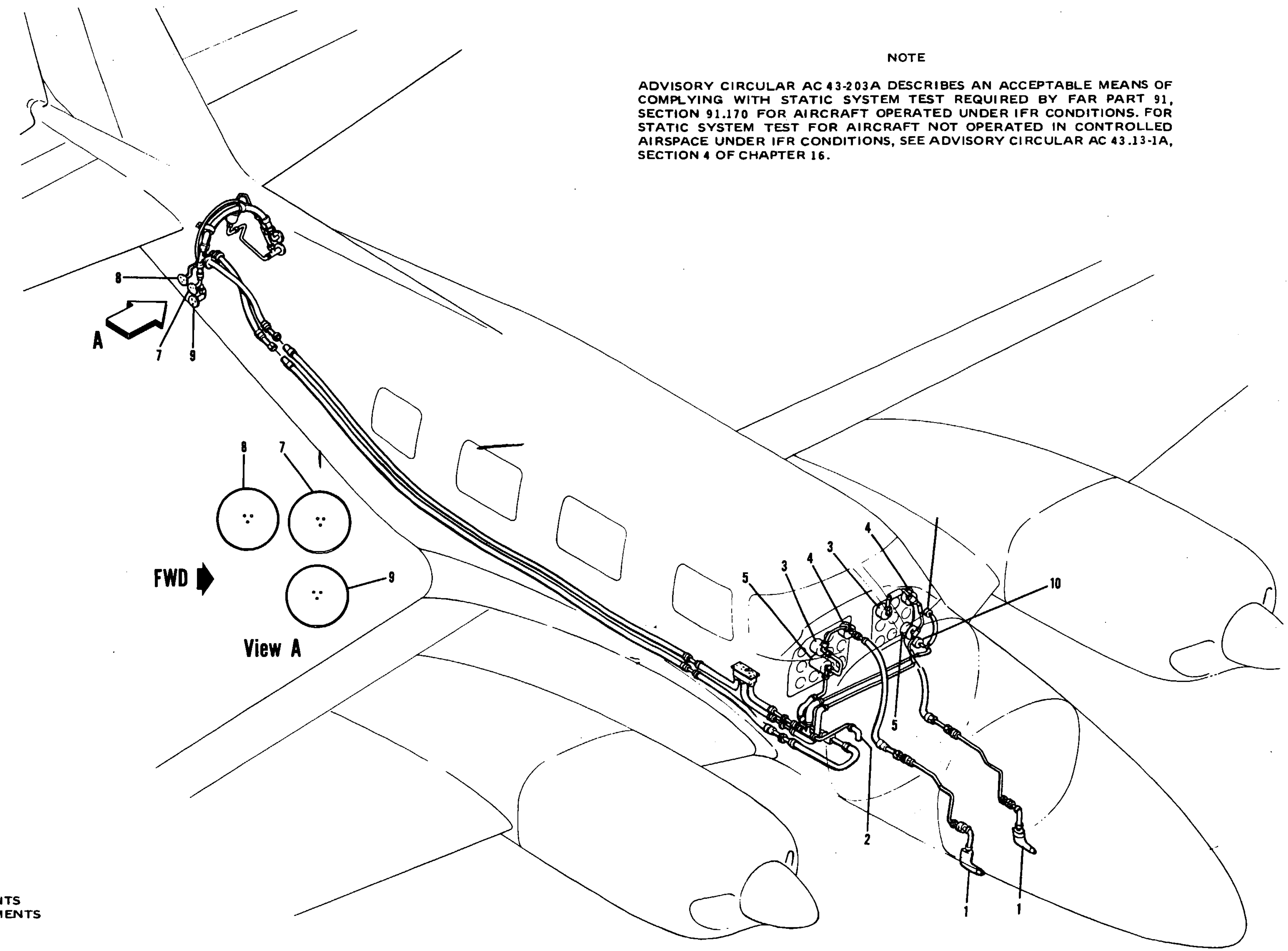


Figure 10-2. Instrument Panel Installation (S/N 31P-84-132)

1293

NOTE

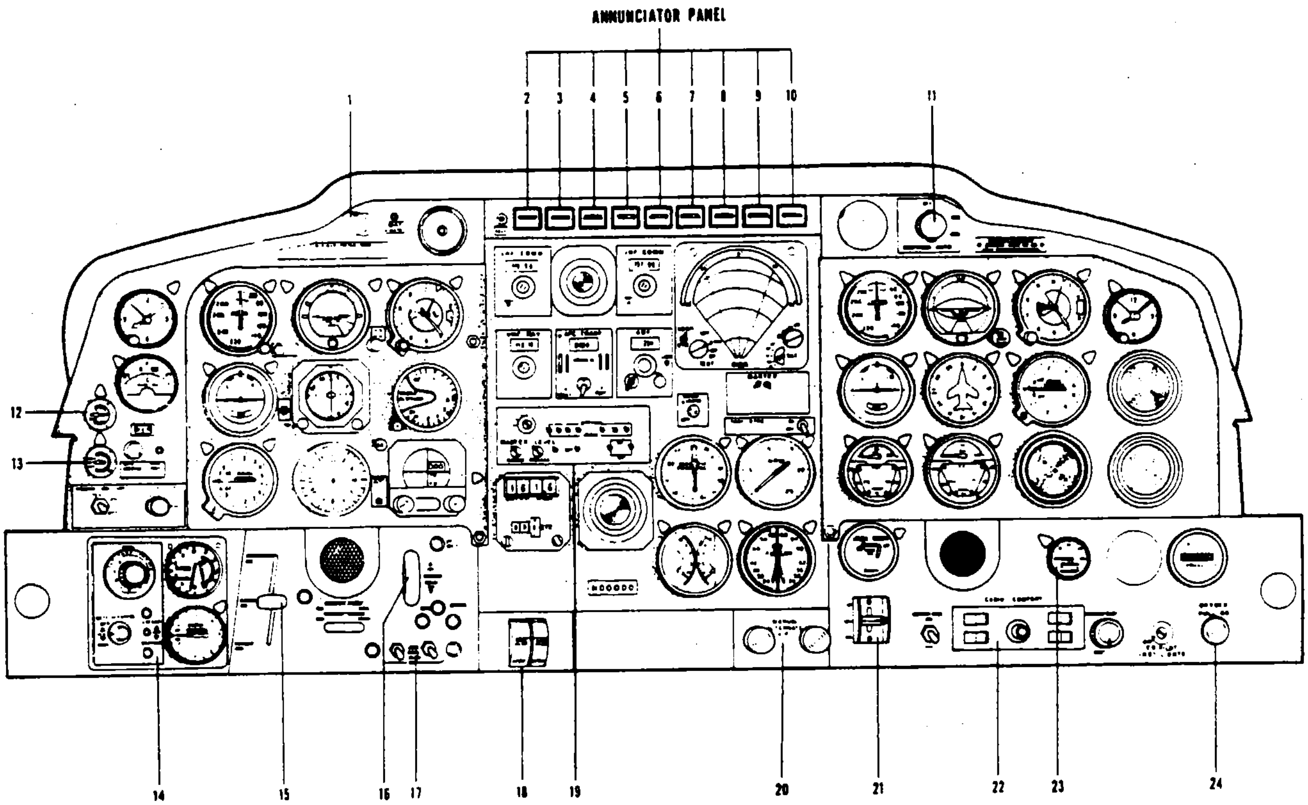
ADVISORY CIRCULAR AC 43-203A DESCRIBES AN ACCEPTABLE MEANS OF COMPLYING WITH STATIC SYSTEM TEST REQUIRED BY FAR PART 91, SECTION 91.170 FOR AIRCRAFT OPERATED UNDER IFR CONDITIONS. FOR STATIC SYSTEM TEST FOR AIRCRAFT NOT OPERATED IN CONTROLLED AIRSPACE UNDER IFR CONDITIONS, SEE ADVISORY CIRCULAR AC 43.13-1A, SECTION 4 OF CHAPTER 16.



1. PITOT HEAD
2. ALTERNATE STATIC SOURCE
3. ALTIMETER
4. AIRSPEED INDICATOR
5. RATE OF CLIMB INDICATOR
6. PNEUMATIC PRESSURE GAUGE
7. STATIC SOURCE FOR PILOT'S INSTRUMENTS
8. STATIC SOURCE FOR COPILOT'S INSTRUMENTS
9. STATIC SOURCE FOR ALTIMATIC V SERIES ALTITUDE CONTROLLER
10. CABIN DIFF PRESSURE AND ALTITUDE

Figure 10-2b. Instrument Air System Installation

1292



1. MAP LIGHT
2. LEFT FUEL SUPPLY WARNING
3. RIGHT FUEL SUPPLY WARNING
4. LEFT PNEUMATIC SOURCE MALFUNCTION
5. RIGHT PNEUMATIC SOURCE MALFUNCTION
6. CABIN PRESSURE WARNING
7. LEFT FUEL PRESSURE LOW
8. RIGHT FUEL PRESSURE LOW
9. CABIN DOOR UNSAFE
10. BAGGAGE DOOR NOSE CONE UNSAFE
11. WINDSHIELD WIPER CONTROL
12. GYRO PRESSURE GAUGE
13. PNEUMATIC PRESSURE GAUGE
14. CABIN ALTITUDE CONTROL
15. SELECTOR VALVE, CABIN AIR
16. LANDING GEAR SELECTOR
17. COWL FLAP ACTUATING SWITCHES
18. COWL FLAP INDICATORS
19. SWITCH PANEL, AUDIO SELECTOR
20. MANUAL ALTERNATE AIR CONTROLS
21. WING FLAP CONTROL
22. CABIN COMFORT CONTROL ASSY.
23. OXYGEN SUPPLY PRESSURE GAUGE
24. OXYGEN CONTROL KNOB

Figure 10-2a. Instrument Panel Installation (S/N 31P-7300133 and up)

There are also dual indicator lights to indicate whenever the fuel pressure from the fuel cell is low. The lights are connected to two pressure switches connected to the top of the two fuel filters, between the electric fuel pumps and the fuel cell boost pumps.

The dual fuel flow instrument incorporates a differential diaphragm movement and indicates fuel flow in gallons per hour by measuring differential pressure between the injector outlet and deck pressure.

Refer to Section XIII for Service Information on cabin altitude controller.

10-8. TROUBLESHOOTING. For troubleshooting of the various instruments, refer to Table X-II of this section.

10-9. REMOVAL OF INSTRUMENTS.

a. The non-shock-mounted instruments located in the center and along the bottom of the instrument panel may be removed by the following procedure:

1. At the back of the panel, unscrew the electrical connector from the post light(s).
2. Disconnect the plumbing and/or electrical connector from the back of the instrument. Where two or more lines connect to an instrument, identify each line to facilitate reinstallation. Attach a dust cap or plug to each fitting.
3. Remove the post light(s) by turning off nut.
4. Remove the screws that secure the instrument in the panel cutout.
5. Remove the instrument from the panel.

b. The shock-mounted instruments may be removed by the following procedure:

1. Unsnap the forward side of the instrument panel cover and slide forward enough to allow it to move from its attachment slot. Remove the cover from over the panel.
2. Pull the control wheel that is at the opposite side of the instrument panel from where the shock-mounted panel is to be removed, to its aftmost position, and secure with a cord tied between the wheel and around the seat back.
3. Pad the control wheel tube with foam rubber or similar material.
4. Remove the four self-locking nuts that secure the floating panel to its shock mounts. There is one nut located on the panel at each side of the control wheel tube, and one nut located at each side of the panel, near the top. With an open end wrench held next to the back side of the panel, hold the rubber mounts to eliminate twisting as the nuts are being removed.
5. Pull the panel back and allow it to rest on the padded control wheel tube.
6. Unscrew the electrical connector from the post light(s).
7. Disconnect the plumbing and/or electrical connector from the back of the instrument and identify each line to facilitate reinstallation. Attach a dust cap or plug to each fitting.
8. Remove the post light(s) by turning off nut.
9. Remove the screws that secure the instrument in the panel cutout.
10. Remove the instrument from the panel and secure the panel from rolling off the control tube.
11. Check the general condition of the rubber shock mounts and replace if necessary.

10-10. INSTALLATION OF INSTRUMENTS.

a. The non-shock-mounted instruments may be installed by the following procedure:

1. Place the instrument in its proper panel cutout and secure with screws.
2. Install the post light(s) and secure. Do not over tighten nut.
3. Connect the plumbing and/or electrical connector to back of instrument.
4. Connect the electrical connector of the post light(s). Tighten connector finger tight.
5. Check instrument and post light(s) operation.

b. The shock-mounted instruments may be installed by the following procedure:
1. Place the instrument in its proper panel cutout and secure with screws.
2. Install the post light(s) and secure. Do not overtighten nut.
3. Connect the plumbing and/or electrical connector to back of instrument.
4. Connect the electrical connector of the post light(s). Tighten connector finger tight.
5. Ascertain that one end of the ground straps is placed over the panel side of the shock mount stud.
6. Place the floating panel in position and allow the shock-mount attachment studs to protrude through the panel. Install and tighten attachment nuts.
7. Remove the padding and release the control wheel.
8. Check the instrument and post light operation.

10-10a. INSPECTION AND CHECKS OF INSTRUMENTS AND SYSTEM. During the regular inspection of the airplane or whenever an instrument or instruments is changed or serviced, the following inspection and checks should be made to the complete system:

a. Inspect the pitot-static system for cleanliness, condition, security and operation per Advisory Circular No. AC43-203A for aircraft operated in controlled airspace under IFR conditions. Aircraft not operated in controlled airspace should be tested per Advisory Circular AC43.13-1A, Section 4 of Chapter 16.

b. Inspect the instruments for poor condition, mounting, markings, broken or loose and/or missing knobs, bent or missing pointers, and improper operation (where applicable).

c. Check power-off indications of instrument pointers and warning flags for proper indication.

d. Apply power and check for excessive mechanical noise, erratic or intermittent operation, failure to indicate, sluggishness or indication of excessive friction. Note if the erection or warm-up time is excessive, caging functions are normal, and warning flags and indicating lights and test circuits are operable.

e. Note operation of instruments during engine runup. Check for intermittent or improper operation of any instrument.

f. Inspect the complete system for general condition, apparent and obvious defects, insecurity of attachments, tubing connections and pneumatic tubing for security, leaks, corrosion, cracks, bends and pinching and any evidence of chafing.

g. Check electrical connections and circuit breakers for proper size, security and condition. Check instrument lighting system for range of illumination, burned out bulbs and defective controls. Check wiring for chafing, excessive tension, improper support or broken lacing and ties.

h. Check instruments for evidence of overheating or contamination of equipment by foreign matter or water. Dust, dirt and lint contribute to overheating of equipment, poor ventilation and malfunctioning. Special attention should be given that ventilation openings in equipment housings are open and free from obstructing lint and dust.

10-11. GYRO SERVICE PROCEDURE.

10-12. GYRO INSTALLATION INSPECTION. The following inspections should be made before removing a suspected gyro instrument from the airplane:

Visual Examination:

a. Has the instrument been modified?

b. Has the instrument been damaged?

c. Does the instrument show any signs of abuse?

Installation Inspection:

a. Are all pressure and static lines free from bends, restrictions or leaks? (Ref. to paragraph 10-14a - Pneumatic Filters.)

b. Is the instrument properly mounted in the panel?

c. Does the instrument physically touch other instruments, tubing or airframe members when the engines are started or stopped?

d. Are unused ports correctly sealed against air leaks?

e. Is the system pressure correct, and does the pressure gauge give an accurate reading?

f. Is the pressure regulator adjusted correctly and functioning properly?

CAUTION

Do not bump, or place a gyro instrument abruptly on any hard surface to avoid ball-denting the rotor bearings. Gyros shall be in shipping containers, mounted in aircraft, or only temporarily placed on at least 1" thick foam blankets.

10-12a. INSTALLATION OF AIR GYRO PORT FITTINGS.

CAUTION

Make absolutely sure no oil, grease, pipe compound or any foreign material enters the ports prior to installation of any fittings. Make certain all air lines are clean and free of foreign particles and/or residue before connecting lines to gyro. DO NOT use thread lube on fittings or in ports. The use of thread lube can readily cause contamination which shortens the life expectancy of the gyro and can cure premature failures. Any evidence of thread lube will create a *warranty void condition.*

a. Select the proper fitting and teflon tape.

b. Carefully lay teflon tape on threads such that one thread is visible from the end of the fitting.

c. Hold tape in place and wrap in the direction of the thread so tape will remain tight when installed. Make sure to use sufficient tension while winding, to assure the tape forms into the thread grooves. One full wrap plus a 1/2 inch overlap is sufficient.

NOTE

Make sure to separate the tape as follows because if it is sheared or cut the tape may loosen.

d. After wrapping the threads maintain tension on the tape and *tear* tape by pulling in direction of wrap. The resulting ragged end is the key to the tape staying in place.

e. Press tape well into threads.

f. Screw fitting into port being careful not to exceed torque requirements as indicated on cover of gyro.

NOTE

Refer to Table II-IV Consumable Materials for tape availability and supplier.

10-13. GYRO HANDLING AND SHIPPING. The following information applies to all three inch directional gyros and attitude horizon instruments installed by the factory or a Piper field service facility.

Gyro instruments being returned to the factory are to be placed in approved containers with all ports properly sealed immediately after removal from the aircraft instrument panel. The instrument must also be accompanied by factory copies of the warranty and credit claim forms. These forms and the special containers should be available at any Piper Dealer and/or Distributor. Should any gyro instrument be received by the factory in an unapproved container or if the ports are not sealed, the warranty will be immediately voided and the instrument returned to the sender. The instrument must be returned immediately after removal from the aircraft (not to exceed 15 days following discovery of defect).

10-14. PNEUMATIC AND PRESSURE GYRO SYSTEM. The two engine driven, dry type, pneumatic pumps supply air pressure to operate the gyro instruments, the optional deicer system, and the main entrance door seal. The pneumatic pumps also provide a source of pressurized air for cabin pressurization along with the main pressurization source from the turbochargers. If pressure is lost on either side, a check valve closes automatically and pressure is supplied by the remaining side. Pneumatic pressure is also used in conjunction with a venturi ejector to obtain vacuum used in the deicer system to resist the aerodynamic forces and maintain the tubes in a flat or deflated condition. A pneumatic system pressure gauge is installed in the left side of the instrument panel to provide a constant indication of pressure which should normally remain at 5.5 psig. During deicer operation or whenever the main entrance door seal accumulator requires repressurization, the pneumatic system pressure would automatically increase to 18 psig. Certain malfunctions of the pneumatic system electrical components may result in continuous high pressure readings (above the green arc) on the pneumatic pressure gauge. This condition will result in very rapid pneumatic pump wear.

The gyro pressure gauge is also located on the left side of the instrument panel and provides a constant indication of gyro instrument pressure which is normally 4.25 to 6.25 inches of mercury.

10-14a. PNEUMATIC SYSTEM FILTER REPLACEMENT. (Refer to Figure 10-3.) There are two pneumatic system inline filters located in each half of the pneumatic system; items (11) and (14) in the referenced figure. There is one filter (11) located in each engine nacelle and another filter (14) located in each wheel well. Both filters are the throw away type and should be replaced at every 150 to 200 hours of aircraft operation or whenever a pneumatic pump is replaced. It is highly recommended that both filters be serviced as stated to insure proper pump operation and service life. The filters are marked with arrows to insure being installed in the system properly (arrow points in the direction of air flow).

WARNING

If filters are not replaced as stated, there is a restriction of air flow thus reducing existing or new pneumatic pump service life.

NOTE

Refer to Section XIII, Paragraph 13-136 for additional filter service information.

10-14b. PNEUMATIC PUMP REMOVAL AND REPLACEMENT. The pneumatic instrument air pump can be removed by the following procedure:

a. Remove the engine cowling.
b. Disconnect shroud assembly and remove the hoses from pump fittings.
c. Remove the pump by removal of the four retaining nuts.

d. Reinstall the pump in reverse order of removal, noting the following:
   1. Place gasket in proper position.

CAUTION

The only dry air pump mounting gasket authorized and approved for use on the Airborne dry air pump is the Airborne gasket B3-1-2, Piper part number 751 859. Use of any other gasket may result in oil seepage or leakage at the mounting surface.

2. Torque the four mounting nuts to 48-50 inch-pounds. (Tool is available from Airborne to facilitate installation.)

Airborne Mfg. Co.
711 Taylor St.
Elyria, Ohio 44035

10-14c. REPLACING PNEUMATIC PUMP FITTINGS. (On 832 CW pump only.)

a. The handling procedure for securing the pump while installing or removing fittings are as follows:
   1. Use two soft wood blocks in a vise to protect pump from vise jaws.
   2. The pump square mounting flange must be held between the wood blocks at right angles to the vise jaws.
   3. Use only enough vise pressure to hold pump firmly.

CAUTION

Do not apply vise pressure to outside diameter or overall length of the pump.

b. Thread lubricant, if required, should be applied sparingly to the external threads of the fitting only. Use a powdered moly sulfide or graphite in dry form or in an evaporating vehicle, or employ a silicone spray.

CAUTION

Do not use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate pump and cause malfunction. The fittings in the 842 CW, aluminum pump, are installed by Airborne and should be serviced by Airborne.

c. Use the following steps for fitting installation:
   1. Secure pump as noted above.
   2. Insert fittings in pump ports and hand tighten firmly.
   3. Using a wrench, tighten each fitting from one-half to two additional turns.

10-15. PNEUMATIC SYSTEM SET-UP PROCEDURE. The pneumatic system set-up procedure given in these instructions cover all combinations of instrument and accessory installations.

NOTE

Insure engines are up to operating temperature prior to checking or adjusting the pneumatic system.

WARNING

Do not make adjustments of the regulators that are within the engine nacelles while the engines are operating.

a. Remove the access panel on the inboard side of both engine nacelles to gain access to the pressure control valve. (Refer to Figure 10-3.)

NOTE

It will be necessary to block the pneumatic air line on the opposite side of the system being checked, to obtain an accurate pressure reading. This is accomplished by disconnecting the pneumatic air line at the connection to the regulator in the nacelle and plugging the end of the line.

b. With the left engine operating at 1650 propeller RPM, actuate the pneumatic deicers and check that the pressure gauge in the extreme left instrument panel is indicating 18 ± 1.0 psig.

c. If the pressure regulator must be adjusted, adjust only to correct the boot inflation pressure (18 ± 1.0 psig). Shutdown the engine and loosen the jam nut of the regulator adjustment screw; turn the adjustment screw clockwise to increase the pressure and counterclockwise to decrease the pressure.

d. Restart the engine and recheck the boot inflation pressure, if satisfactory turn off the pneumatic deicers and check the low side pressure to be 5 + 1.5-.5 psig.

e. If the low side pressure does not fall within the stated range, the regulator is not adjustable and must be replaced.

f. Repeat the procedure for the right engine.

g. Tighten both regulator adjustment screw jam nuts; ascertain that the pneumatic air lines are reconnected to the regulators, and check the pressure reading throughout the entire multi-engine range.

h. Reinstall the access plates.

10-16. ATTITUDE AND DIRECTIONAL GYRO SETUP. The required reading at the gyro pressure gauge located in the left side of the instrument panel should indicate 4.25 to 6.25 inches of mercury during single and multi-engine operation. Each engine should be operated separately at about 1650 propeller RPM to determine if each pneumatic pump is operating properly. There is one regulator located below the instrument panel, mounted on the upper left portion of the nose wheel well. (Refer to Figure 10-2.) Adjustment procedure for the gyro pressure regulator is as follows:

a. The gyro pressure gauge in the airplane can be used to set up the required pressure for the gyro instruments.

b. Ascertain that the two pressure control valves are functioning by operating each engine separately, and observing the reading on the pneumatic pressure gauge located below the gyro pressure gauge on the extreme left instrument panel. (Refer to Paragraph 10-21.)

c. Operate one engine at 1650 propeller RPM to ascertain that the gyro pressure gauge indicated 4.25 to 6.25 inches of mercury.

d. If the indication on the gyro pressure gauge is not 4.25 to 6.25 inches of mercury, loosen the jam nut on the regulator below the instrument panel and turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.

e. Perform Step c and d with the opposite engine.

f. Operate each engine separately and then both through their entire range to determine that the reading is correct.

g. Tighten the regulator jam nut after completion of adjustment.

NOTE

The installation of deicer equipment should not effect the gyro instruments.

NOTE

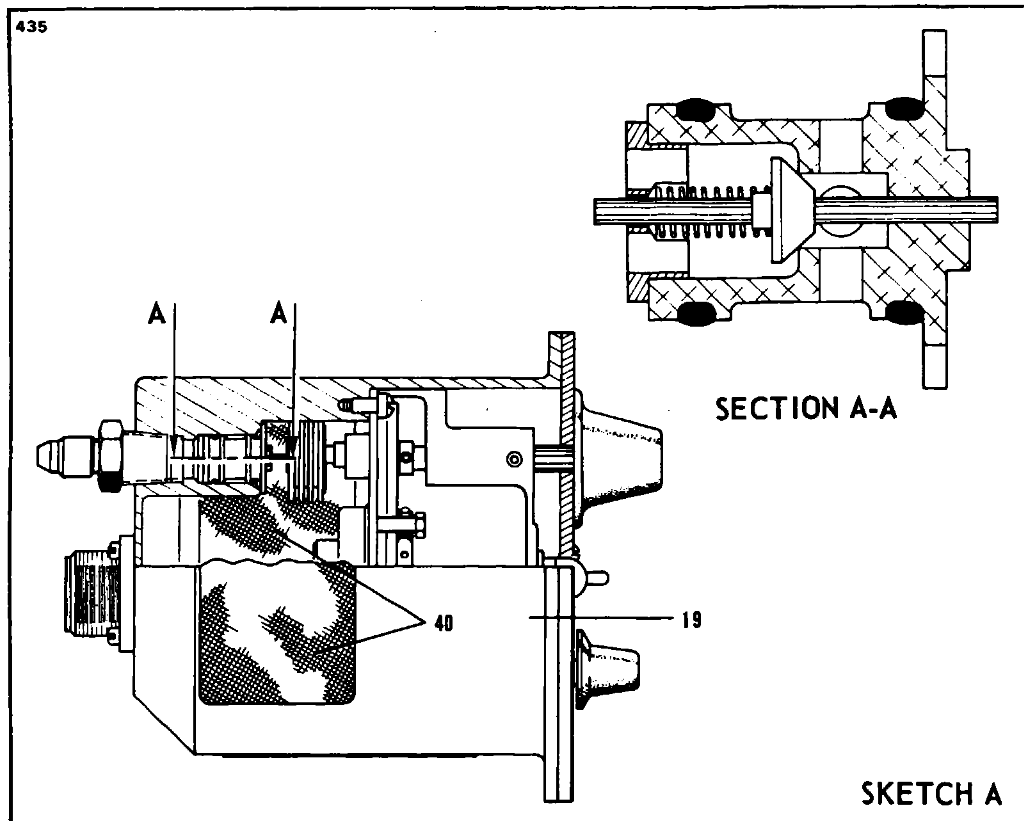
There is no other adjustment required on the pneumatic system even when deicer equipment is installed. The system is designed to handle all optional equipment without further adjustments.

10-17. STALL WARNING INDICATOR AND LIFT DETECTOR. The stall warning light is a red light mounted on the top left instrument panel. The stall warning transmitter is mounted in the leading edge of the right wing and activates the light when the airplane approaches a stall.

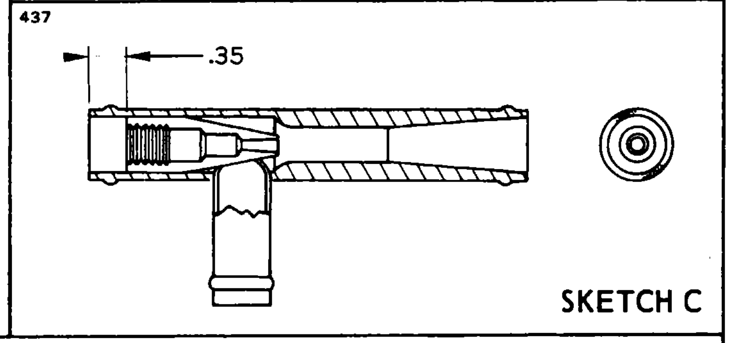
10-18. REMOVAL OF LIFT DETECTOR. Remove four screws at corners of lift detector mounting plate. Carefully pull detector from wing and disconnect wires.

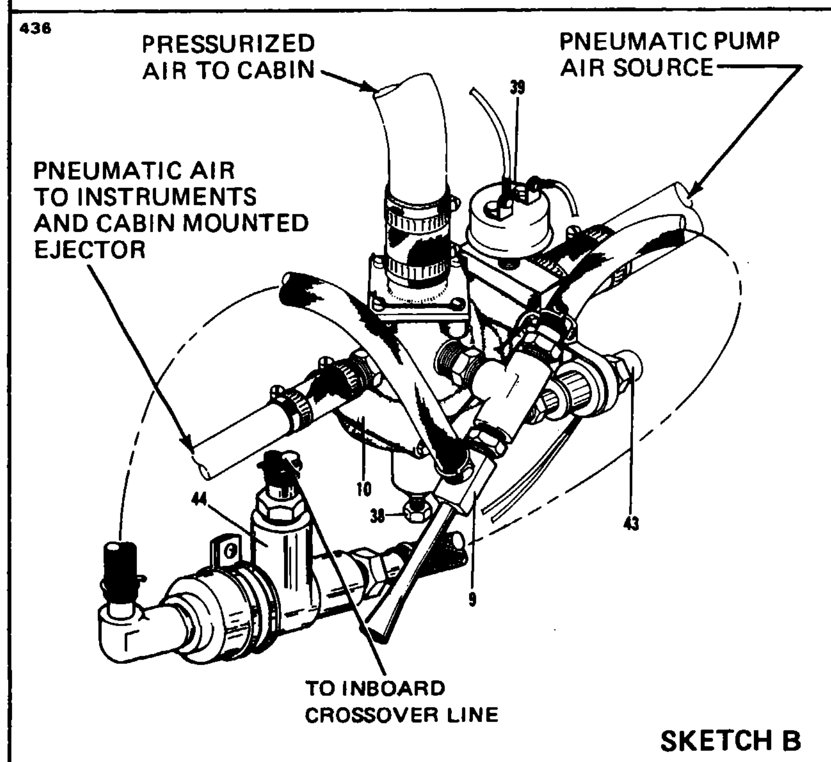
10-19. INSTALLATION OF LIFT DETECTOR. To install lift detector, locate wires through mounting hole and connect to lift detector. Insert lift detector in mounting hole and secure mounting plate to wing panel using four screws.

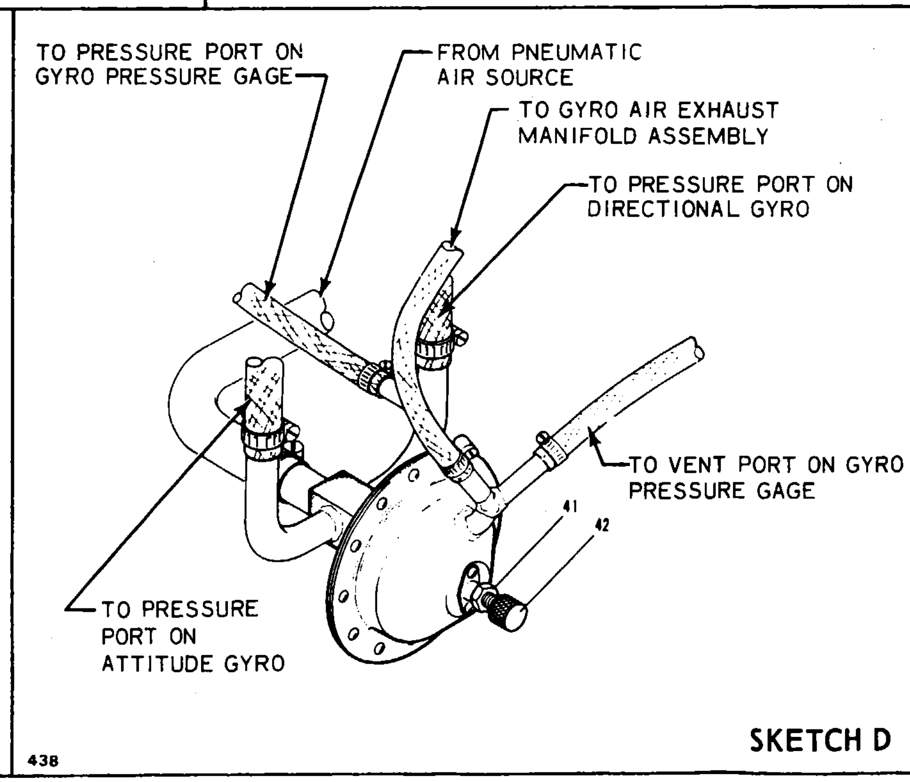
10-20. ADJUSTMENT OF LIFT DETECTOR. The lift detector is adjustable to increase or decrease the speed at which a stall indication is observed. To adjust the detector, loosen two screws adjacent to the vane and move vane forward or backward. Forward will decrease the stall warning speed while backward will increase the stall warning speed.



1. DEICER BOOT
2. PNEUMATIC PUMP
3. TURBOCHARGER
4. SONIC NOZZLE
5. CHECK VALVE
6. INDUCTION AIR FILTER
7. ALTERNATE AIR SOURCE
8. DEICER SOLENOID VALVE
9. BOOT EJECTOR
10. REGULATOR
11. FILTER
12. INSTRUMENT LINE
13. DEICER LINE
14. FILTER
15. TO ENVIRONMENTAL CONTROL SYSTEM
16. PRESSURIZATION DUMP VALVE
17. REGULATOR
18. EJECTOR
19. PRESSURIZATION CONTROLLER
20. GYROS
21. SOLENOID VALVE
22. PRESSURIZED AIR CONTROL BOX
23. PRESSURIZATION LINE
24. PRESSURIZATION CONTROL LINE
25. PRESSURE SWITCH
26. ALTERNATE AIR DOOR
27. PRESSURE TANK
28. DOOR SEAL
29. TO EMPENNAGE DEICER BOOTS
30. BLEED SETTING ADJUSTMENT
31. SAFETY VALVE
32. CABIN DIFFERENTIAL PRESSURE AND ALTITUDE WARNING SWITCH
33. RUPTURE DIAPHRAGM
34. STATIC SOURCE
35. STATIC SOURCE
36. BLEED LINE
37. ISOBARIC VALVE
38. ADJUSTMENT SCREW
39. PRESSURE SWITCH
40. FILTER SCREENS
41. LOCKNUT
42. ADJUSTMENT KNOB
43. REGULATOR SOLENOID
44. SOLENOID VALVE
45. SOLENOID VALVE







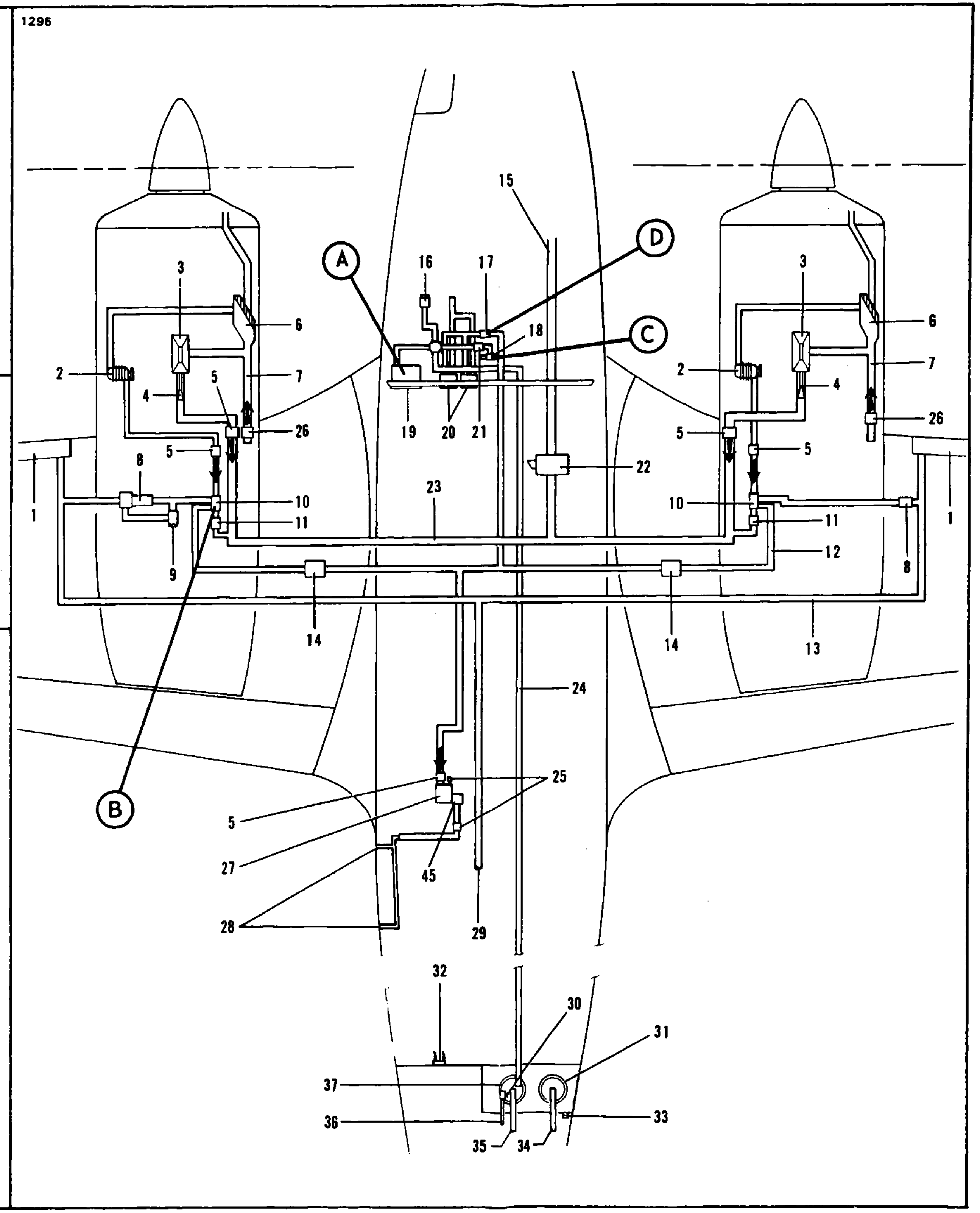


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Figure 10-3. Pneumatic System Installation.

10-21. MANIFOLD PRESSURE GAUGE FILTERS. The manifold pressure gauge has two filter assemblies secured to the rear of the gauge. The removal of the top instrument access panel is necessary to gain access to the filter assemblies. Remove the two filter assemblies and replace the filter elements during the 500 hour inspection of the airplane, or sooner if conditions indicate a restricted filter element.

10-22. EXHAUST GAS TEMPERATURE GAUGE. This instrument, which is commonly referred to as EGT, is used to aid the pilot in selecting the economical fuel-air mixture for cruising flight at a power setting of 75% or less. It is a sensing device to monitor the fuel-air mixture entering the engine cylinders. This gauge is not adjustable. If it is found defective after checking with the troubleshooting chart, it should be replaced.

CAUTION

When replacing leads, it is very important to use the same type and length of thermocouple wire, as the resistance of the leads is critical for the proper operation of this gauge.

10-23. REMOVAL OF EGT PROBE AND GAUGE.

a. Disconnect wires from the EGT gauge at the instrument panel.

b. Remove four bolts which secure the gauge to the instrument panel and remove the gauge.

c. Remove wires from the wire harness going to the engine.

d. Loosen the nut which secures the EGT probe to the exhaust transition area of the exhaust system and remove the probe.

10-24. CLEANING AND INSPECTION. Unless mechanical damage is evident, broken glass, bent or broken pointers, or broken case, the following checks should be performed before removing the instrument.

a. Remove the probe from the exhaust transition area and check for broken weld (at tip end) or burnt off end.

b. Disconnect the lead wires at the instrument and check for poor electrical connections.

c. With leads connected to the instrument, heat the probe with a propane torch to a dull red. The meter should show a reading. If the pointer does not move, replace the meter.

CAUTION

Do not connect an ohmmeter across the meter. It will burn out the movement of the meter.

10-25. INSTALLATION OF EGT PROBE AND GAUGE.

a. Install the probe into the hole in the transition area of the exhaust system and secure with locknut.

b. Route the thermocouple wires along with the existing wire harness to the instrument panel.

c. Install the EGT gauge into the instrument panel and secure with four bolts.

d. Connect the thermocouple wires to the rear of the EGT gauge.

TABLE X-I. INSTRUMENT MARKINGS (PA-31P)

Exhaust Gas Temperature	
Green Arc (Normal Operating Range)	750°F to 1650°F
Radial Red Line (Never Exceed)	1650°F
Fuel Flow	
Green Arc (Normal Operating Range)	0 to 60 GPH
Red Line	61 GPH
Manifold Pressure	
Radial Red Line	45.5 in. HG
Tachometer	
Green Arc (Normal Operating Range)	335 RPM to 2133 RPM
Radial Red Line (Maximum)	2133 RPM
Cylinder Head Temperature	
Green Arc (Normal Operating Range)	100°F to 475°F
Radial Red Line (Never Exceed)	475°F
Oil Pressure	
Green Arc (Normal Operating Range)	55 PSI to 90 PSI
Yellow Arc (Caution Range)	10 PSI to 55 PSI
Yellow Arc (Caution Range)	90 PSI to 100 PSI
Radial Red Line:	
Minimum	10 PSI
Maximum	100 PSI
Oil Temperature	
Green Arc (Normal Operating Range)	120°F to 245°F
Yellow Arc (Caution Range)	50°F to 120°F
Radial Red Line (Never Exceed)	245°F
Flap Indicator	
White Arc (Range of Flap Permitted for Take-Off)	0-15°
Airspeed Indicator	
Green Arc (Normal Operating Range)	90 MPH to 230 MPH
Yellow Arc (Caution Range)	230 MPH to 283 MPH
White Arc (Flaps Extended Range)	82 MPH to 150 MPH
Radial Red Line (Never Exceed - Smooth Air)	283 MPH
Radial Red Line (Minimum Control Speed)	95 MPH
Radial Blue Line (Best Single Engine Rate of Climb Speed)	125 MPH

TABLE X-I. INSTRUMENT MARKINGS (PA-31P) (cont.)

Gyro Pressure	
Green Arc (Normal Operating Range)	4.25 to 6.25 in. HG
Pneumatic Pressure	
Green Arc (Normal Operating Range)	5 PSI to 10 PSI
Yellow Arc (Caution Range)	10 PSI to 21 PSI
Cabin Differential Pressure	
Green Arc (Normal Operating Range)	0.0 PSI to 5.5 PSI
Yellow Arc (Caution Range)	5.5 PSI to 5.7 PSI
Radial Red Line (Maximum)	5.7 PSI
Cabin Pressure Altitude	
Yellow Arc (Use Supplemental oxygen - All Occupants)	10,000 ft. to 29,000 ft.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS)

Trouble	Cause	Remedy
	ATTITUDE GYRO INDICATOR	
Bar fails to respond.	Insufficient pressure.	Pressure line kinked or leaking. Check pump, filters, tubing and regulator adjustment.
Bar does not settle.	Excessive vibration.	Check shock mounts. Replace if necessary.
	Insufficient pressure.	Check line and pump. Adjust valve.
	Defective instrument.	Replace instrument.
Bar oscillates or shimmies continuously.	Excessive vibration.	Check shock mounts. Replace if necessary.
	Pressure too high.	Adjust valve.
	Defective mechanism.	Replace instrument.
	DIRECTIONAL GYRO INDICATOR	
Excess drift in either direction.	Excessive vibration.	Check shock mounts.
	Insufficient pressure. If pressure is below 4.15 inches of mercury, check for the following:	
	a. Relief valve(s) improperly adjusted.	a. Adjust.
	b. Incorrect gauge reading.	b. Recalibrate.
	c. Pump failure.	c. Repair or replace.
	d. Pressure line kinked or leaking.	d. Check and repair.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	DIRECTIONAL GYRO INDICATOR (cont.)	
Excess drift in either direction.	Defective instrument.	Replace instrument.
Dial spins continuously.	Defective mechanism.	Replace instrument.
	ALTIMETER	
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
High reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of airspeed tube.
Setting knob is hard to turn.	Wrong lubrication or lack of lubrication.	Replace instrument.
Inner reference marker fails to move when setting knob is rotated.	Out of engagement.	Replace instrument.
Setting knob set screw loose or missing.	Excessive vibration.	Tighten instrument screw, if loose. Replace instrument if screw is missing.
Cracked or loose cover glass.	Excessive vibration.	Replace instrument.
Barometric scale and reference markers out of synchronism.	Slippage of mating parts.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	ALTIMETER (cont.)	
Barometric scale and reference markers out of synchronism with pointers.	Drift in mechanism.	Reset pointers. Refer to latest revision of A.C. 43.13-1A.
	AIRSPEED TUBES AND INDICATOR	
Tube does not heat or clear itself of ice with switch "ON".	Circuit breaker popped.	Reset.
	Open circuit.	Repair.
	Excessive voltage drop between battery at pitot head.	Check voltage at pitot head.
	Heating element burned out.	Replace pitot head.
Pointers of static instruments do not indicate properly.	Leak in instrument. case or in pitot lines.	Check for leak and seal.
Pointer of instrument oscillates.	Leak in instrument case or in pitot lines.	Check for leak and seal.
	RATE OF CLIMB INDICATOR	
Pointer does not set on zero.	Aging of diaphragm.	Reset pointer to zero by means of setting screw tap instrument while resetting.
Pointer fails to respond.	Obstruction in static line.	Disconnect all instruments connected to the static line. Check individual instruments for obstruction in lines.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	AIRSPEED TUBES AND INDICATOR (cont.)	
Pointer oscillates.	Leaks in static line.	Disconnect all instruments connected to the static line. Check individual instruments for leaks. Reconnect instruments to static line and test instalation for leaks.
	Defective mechanism.	Replace instrument.
	TURN AND BANK INDICATOR	
Turn indicator fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
	No electrical circuit.	Check for voltage at instrument.
Incorrect sensitivity.	Misadjustment of sensitivity spring.	Adjust by means of sensitivity spring screw. If this pulls the pointer from zero, replace instrument.
Turn indicator does not set on zero.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pointer incorrectly set on its staff.	Replace instrument.
	Sensitivity adjustment pulls pointer off zero.	Replace instrument.
Vibrating turn indicator.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pitted or worn pivots or bearings.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	TURN AND BANK INDICATOR (cont.)	
In low temperature, turn indicator fails to respond or does so sluggishly and with insufficient deflection.	Oil has become too thick.	Replace instrument.
	Insufficient bearing clearance.	Replace instrument.
Turn indicator sluggish in returning to zero and does not set on zero when stationary.	Oil or dirt between damping pistons and cylinder.	Replace instrument.
	Excessive clearance between rotor and rotor pivots.	Replace instrument.
Ball in inclinometer does not center.	Instrument out of alignment of panel.	Correct alignment. Check for sagging shock mounts.
Sluggish or jerky pointer movement.	Improper damping adjustment.	Adjust damping screw.
Broken or loose cover glass.	Vibration or excessive pressure.	Replace glass and reseat case.
Incorrect reading. (Air driven type only.)	Moisture or oil in line.	Disconnect lines and blow out.
	Restricted filter element.	Replace filter element.
	MANIFOLD PRESSURE INDICATOR	
Excessive error at existing barometric pressure.	Pointer shifted.	Replace instrument.
Excessive error when engine is running.	Line leaking.	Tighten line connections.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	OIL TEMPERATURE INDICATORS	
Instrument fails to show any reading.	Broken or damaged capillary. Wiring open.	Check engine unit and wiring to instrument.
Excessive scale error.	Improper calibration adjustment.	Repair or replace.
Pointer fails to move as engine is warmed.	Broken or damaged capillary or open wiring.	Check engine unit and wiring.
	ENGINE OIL PRESSURE GAUGE	
Excessive error at zero.	Pointer loose on shaft. Overpressure or seasoning of bourdon tube.	Replace instrument.
Excessive scale.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Improper damping or rough engine relief valve.	Disconnect line and drain. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation or pointer or pressure fails to build up.	Engine relief valve open.	Check and clean.
	TACHOMETER	
Tachometer inoperative or erratic.	Defective indicator or tachometer generator.	Replace indicator or tachometer generator.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	TACHOMETER (cont.)	
Cont'd - Tachometer inoperative or erratic.	Loose connection, open or grounded circuit.	Check continuity of wires. wires. Replace defective wires.
	Defective tachometer generator drive mechanism.	Replace drive mechanism.
	MAGNETIC COMPASS	
Excessive card error.	Compass not properly compensated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Improper mounting on instrument panel.	Align instrument.
	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet.	Replace instrument.
	Excessive pivot friction or broken jewel.	Replace instrument.
	Instrument too heavily compensated.	Remove excess compensation.
Liquid leakage.	Loose bezel screws.	Replace instrument.
	Broken cover glass.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	MAGNETIC COMPASS (cont.)	
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity of wiring.
	EXHAUST GAS TEMPERATURE	
Gauge Inoperative.	Defective gauge, probe or wiring.	Isolate defective circuit, replace defective probe or gauge.
Fluctuating Reading.	Loose, frayed or broken electrical lead.	Tighten connections, and repair or replace defective leads.
	PNEUMATIC SYSTEM	
Pressure drops extremely low with single pump operation. (Note position of indication on pressure gauge.)	Leaking check valve.	Check operation of valve and replace if necessary.
During single engine operation, pressure indication light remains off on inoperative engine.	Leaking check valve.	Check operation of valve and replace if necessary.
No pressure gauge indication at instrument.	Pump inoperative. Disconnected, broken or restricted lines.	Replace pump. Locate trouble and correct.
No pressure gauge indication at instrument.	Hose from instrument to gauge leaking or restricted.	Check all lines and connections.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	PNEUMATIC SYSTEM (cont.)	
No pressure gauge indication at the instrument of source.	Faulty gauge. Malfunctioning regulator valve or pump.	Check operation of instrument. If operation is faulty, replace gauge. If instrument is not faulty, check operation of pump and regulator valve.
Low system pressure.	Regulator valves incorrectly adjusted. Leaking of the system lines or fittings.	Adjust regulator valves in accordance with adjustments of this section. Check all lines and fittings.
High system pressure.	Regulator valve incorrectly adjusted.	Adjust in accordance with Adjustments of this section.
	Cabin door seal switch failed in closed position.	Replace cabin door seal switch.
	Door seal switch pressure setting too high.	Replace switch.
	Leak in door seal system.	Repair system.
	Regulator solenoid malfunction.	Replace solenoid.
	Deicer solenoid malfunction.	Replace solenoid.
	Deicer timer malfunction.	Replace timer.
	Deicer boots selector switch stuck in ON position.	Replace switch.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
	CYLINDER HEAD TEMPERATURE	
Erratic reading.	Probe loose.	Tighten.
	Probe insulated from cylinder head by foreign matter.	Clean probe socket in cylinder head.
	Gauge error between left and right gauges.	Calibrate or replace.
	Wiring loose or broken.	Repair or replace.

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SECTION XI

ELECTRICAL SYSTEM

Paragraph			Aerofiche Grid No.
	11-30.	Operation	3C21
	11-31.	Maintenance	3C21
	11-32.	Overhaul	3C22
	11-33.	Removal	3C22
	11-34.	Disassembly	3C22
	11-35.	Brushes	3C23
	11-36.	Armature	3C23
	11-37.	Field Coils	3C24
	11-38.	Brush Holders	3C24
	11-39.	Gear Housing	3C24
	11-40.	Bendix Drive	3C24
	11-41.	Assembly	3D1
	11-42.	Bench Tests	3D1
	11-43.	Starting Motor Control Circuit	3D2
	11-44.	Starting Motor Service Test Specifications	3D2
11-45.	Battery (Lead Acid)		3D3
	11-46.	Servicing Battery	3D3
	11-47.	Removal of Battery	3D3
	11-48.	Installation of Battery	3D3
	11-49.	Battery Box Corrosion Prevention	3D3
	11-50.	Hydrometer Reading and Battery Charge	3D4
	11-51.	Charging Battery	3D4
	11-51a.	Battery Discharge	3D6
	11-51b.	High and Low Temperatures	3D6
	11-51c.	Battery Repairs, Storage and Service Tips	3D6
	11-52.	Starting Through External Power Receptacle	3D7
11-53.	Battery (Nickel Cadmium)		3D8
	11-54.	Removal of Battery	3D8
	11-55.	Installation of Battery	3D8
	11-56.	Battery Cleaning	3D8
	11-57.	Periodic Battery Check	3D9
	11-58.	Adjustment of Electrolyte Level	3D9
	11-59.	Battery Cell Replacement	3D10
	11-60.	Charging Battery	3D11
	11-61.	Constant Current Charging	3D11
	11-62.	Constant Potential Charging	3D12
11-63.	Electrical Switches and Circuit Breakers		3D13
	11-64.	Removal of Overhead Switches	3D13
	11-65.	Removal of Overhead Switches	3D13
	11-66.	Installation of Overhead Switches	3D13
	11-67.	Circuit Protector Panel	3D13
	11-68.	Removal of Master Switch Panel	3D14
	11-69.	Installation of Master Switch Panel	3D14
	11-70.	Installation of Circuit Protector Panel	3D14

REFER TO GRID 3E18
FOR ELECTRICAL SYSTEMS SCHEMATICS

SECTION XI

ELECTRICAL SYSTEM

11-1. INTRODUCTION.

This section contains instructions and schematics for correcting difficulties which may arise in the operation of the electrical system.

The instructions are organized so the mechanic can refer to: Description and Principles of Operation for a basic understanding of the various electrical systems; Troubleshooting for a methodical approach in locating the difficulty; Corrective Maintenance for the removal, repair and installation of components; and Adjustments and Tests for the operation of the repaired systems. Schematics for the individual systems are located at the end of this section. For information concerning electronic equipment refer to Section XII, Electronics.

11-2. DESCRIPTION.

Electrical power is supplied by a 28-volt, direct current negative ground electrical system. A 24-volt battery is incorporated in the system to furnish power for starting, and as a reserve power source in case of alternator failure. An external power receptacle is also provided in the nose of the airplane for use of external power during cold weather operation or whenever external power is needed to start the engines on the airplane.

The electrical generating system consists of two engine driven 100 ampere alternators. They are paralleled by the use of one voltage regulator to control field voltage of both units. Also incorporated in the system is an overvoltage relay. Its function is to open and remove field voltage to the unregulated alternator in the event of a failure of the voltage regulator. An auxiliary voltage regulator and overvoltage relay is also furnished in the system.

The electrical switches are located in an overhead panel just above the windshield and in a panel on the left side of the cockpit next to the pilot's knee. All circuit breakers are located on the left side panel next to the pilot.

Lighting consists of standard navigation lights, a landing and taxi light located on the nose gear strut housing. Models PA-31P-1 thru 6 have two rotating beacons, PA-31P-7 thru 12 have two strobe lights, PA-31P-12 - 146 have one anti-collision light (strobe type) mounted on the vertical fin and the other rotating beacon is mounted on the bottom center of the fuselage. Models 147 and up have three white strobes, one on each wing tip and one on the tail cone. Lighting inside the cabin area includes front and rear dome lights, five reading lights, a map light located on each side of the overhead panel, fuel selector panel lights, and cabin, baggage door, and nose cone ajar indicator lights. The instrument panel lighting consists of two post lights over each instrument. Placard lighting is accomplished through electroluminescent panels. There is also a light in the nose baggage compartment. Included as optional equipment, one 50 watt wing inspection light is located outboard in the left engine nacelle, and white wing tip strobe lights.

11-3. TROUBLESHOOTING.

Troubles peculiar to the electrical system are listed in Table XI-VI along with their probable causes and suggested remedies. The wiring diagrams included in the manual will give a physical breakdown of the different electrical circuits used in the airplane. Refer to Electrical Diagrams in the rear of this section.

After the trouble has been corrected, check entire electrical system for security and operation of its components.

11-4. ALTERNATOR SYSTEM.

11-5. DESCRIPTION OF ALTERNATOR SYSTEM. For each alternator, the alternator output circuit is connected by means of a 125-ampere circuit breaker, and a shunt to monitor alternator output.

The field circuit consists of a 10-ampere thermal circuit breaker, a voltage regulator, selector switch, overvoltage relay, and special switch ganged to the 125-ampere circuit breaker to remove field voltage from the alternator should the circuit breaker open. Separate alternator field control switches are included in the system to completely isolate a defective alternator from the rest of the electrical system.

The field and output circuits of both alternators are joined by a bus bar which directs current to the battery. A shunt and ammeter connected in each alternator feed line monitors the output of each alternator. A shunt and ammeter are incorporated in the battery feed line to measure the current flow to and from the battery. A voltmeter is also provided to show the bus voltage. The field circuit is combined with the master switch to turn off each alternator when the master switch is turned off.

A second set of components is installed in the field circuit should a failure of the main regulating system occur.

The 125-ampere alternator circuit breakers should not be switched on and off under load for testing or any other reason.

WARNING

The alternator circuit breaker switches should be in the OFF position whenever the master switch is ON for service of other components. This will prevent alternator fields from overheating.

11-6. ALTERNATOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for the 28-volt alternators installed as standard equipment on PA-31P series airplanes are as follows:

TABLE XI-II. ALTERNATOR TEST SPECIFICATIONS

Alternator Model	ALV-9401	
Voltage	28-volts	
Rated Output	100 Amperes	
Ground Polarity	Negative	
Rotation	Bi-Directional	
Rotor:		
Current Draw (77°F)	2.0 to 2.2 amps @24.0-volts	
Resistance (77°F)	10.7 to 11.6 ohms	
Output Test (77°F)		
Volts	25.8	28.4
Amperes Output	10.0	100
Field Amperes	2.1	2.25
Alternator RPM	2000 min.	5000 min.

NOTE

If ohmmeter is used to test for shorts or open circuits. remember to test for shorts on lowest resistance scale and test for opens using the highest resistance scale of the ohmmeter.

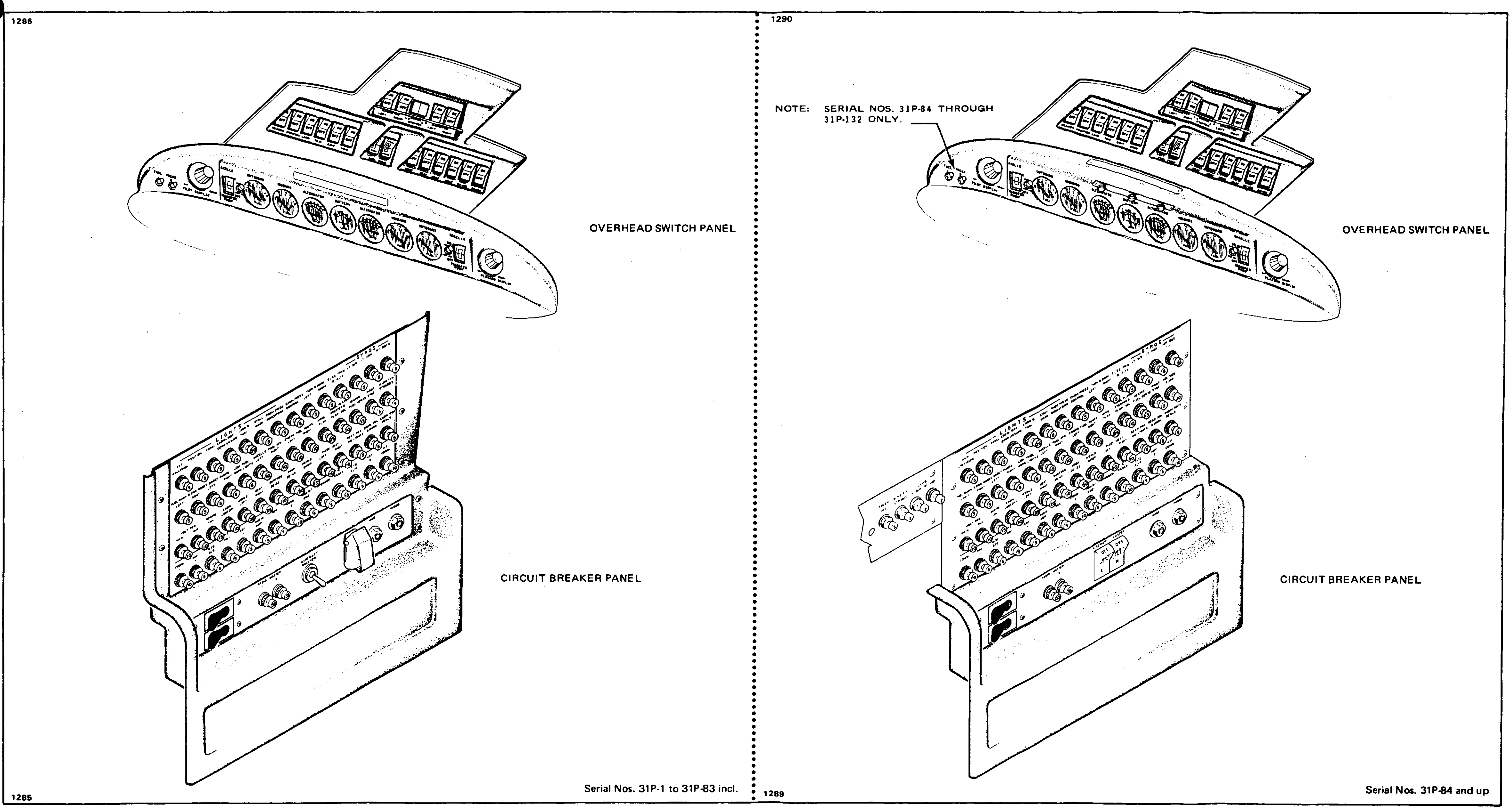

Figure 11-1. Switch and Circuit Breaker Panels

11-7. ALTERNATOR AND COMPONENTS.

11-8. DESCRIPTION OF ALTERNATOR. (Refer to Figure 11-3.) The principal components of the alternator are the slip ring head (1), the heat sink and rectifier assemblies (2), the stator (3), the rotor (4), and the drive end head assembly (5).

a. The slip ring end head provides the mounting for the rectifier heat sink assemblies, the output, auxiliary and ground terminal studs, brush holder and brush assemblies and the slip ring end bearing.

b. The rectifier and heat sink assemblies used in these alternators are different in construction from those used in any other alternator used on Piper aircraft. Each heat sink has six (6) rectifiers of one polarity attached to it. Each stator lead connects to four rectifiers (two positive and two negative). This can best be illustrated with an internal wiring diagram. (See Figure 11-4.) Each rectifier is rated at 150 P.I.V. (Peak Inverse Volts) minimum for transient voltage protection. All soldered connections are made with high temperature solder. The stator and rectifier leads are anchored to the heat sink with epoxy cement to provide vibration protection. Because of this construction, special service procedures must be followed. Refer to Paragraph 11-13b, Inspection and Testing of Components.

c. The stator contains a center tap lead which is connected to the center of the three phase windings and is used to activate low voltage warning systems or relays. The stator has been treated with a special epoxy varnish for high temperature resistance and vibration protection.

d. The rotor winding and winding leads have been specially treated with a high temperature varnish and epoxy cement to provide vibration and temperature resistant characteristics. High temperature solder is used to secure the winding leads to the slip rings.

e. The drive end head, contains a pre-lubricated bearing, oil seal, collar and shaft seal and a suction tube connection for cooling.

11-9. CHECKING ALTERNATOR SYSTEM. Three ammeters are installed which enable an independent output check of each alternator, as well as the electrical output-input of the battery. Should either alternator show no output on its ammeter, check the appropriate circuit breaker. If a further check of the ammeter shows no output from either alternators, switch to the auxiliary voltage regulator and overvoltage relay. If switching to the auxiliary system indicates no electrical output, further check the alternator system. (Refer to Figure 11-2.)

a. Ascertain that the ammeters are operating properly.
b. Disconnect the battery (+) lead at the alternator.
c. Disconnect fields (F1 and F2) leads at the alternator.
d. Ascertain that all electrical units are off and battery is fully charged.
e. Turn on the master switch.
f. To check the alternator output circuit, connect a voltmeter or 28-volt test light to the battery lead and to ground. If a reading of approximately 28-volts registers on the voltmeter or the test light lights, the battery circuit is operational.
g. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 11-2.) A component that allows no voltage to pass through it should be replaced.
h. Check each field circuit by the following procedures:
   1. On lead connected to (F1) terminal, connect a voltmeter to the field lead and to ground. If voltmeter indicates any voltage the circuit is operational.
   2. On lead connected to (F2) terminal, connect a voltmeter or 28-volt test light to field lead and to ground. If a reading of approximately 28-volts registers on the voltmeter or the test light lights, the circuit is operational.
   3. Both the main and auxiliary field systems may be checked in a like manner.
i. If voltage is indicated at both the battery lead and field lead, the alternator should be checked for possible malfunction. (Refer to paragraph 11-16.)

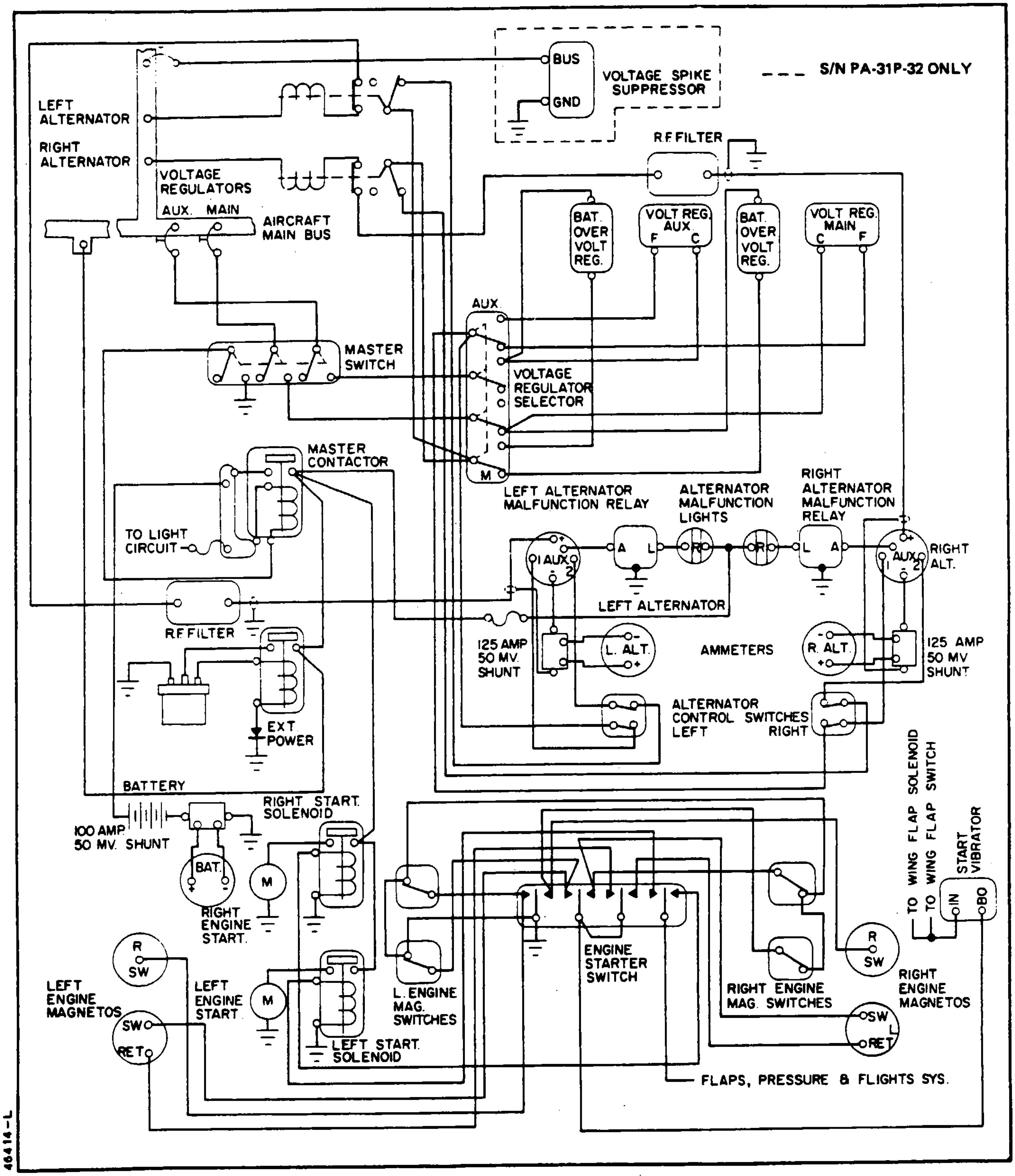

Figure 11-2. Alternators and External Power Diagram
(For Later Installations Refer to Figure 11-24a)

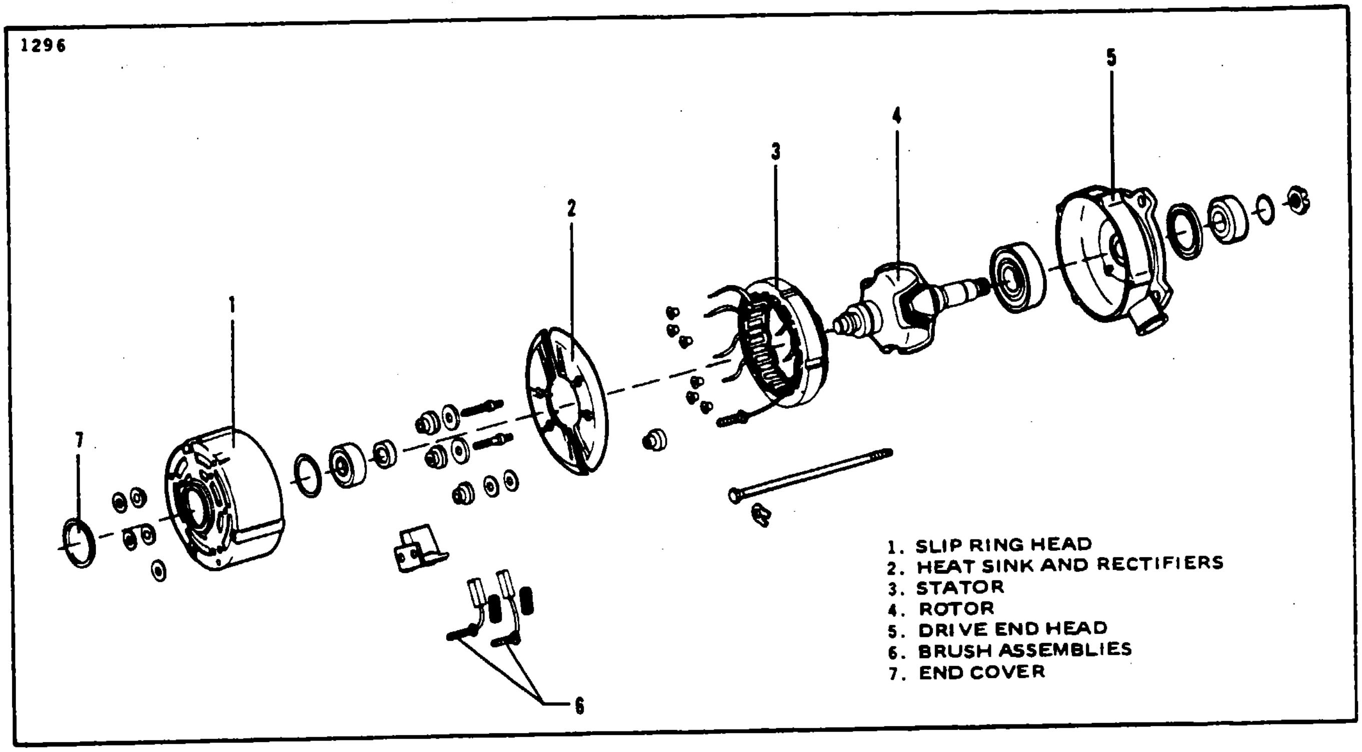

Figure 11-3. Exploded View of Alternator

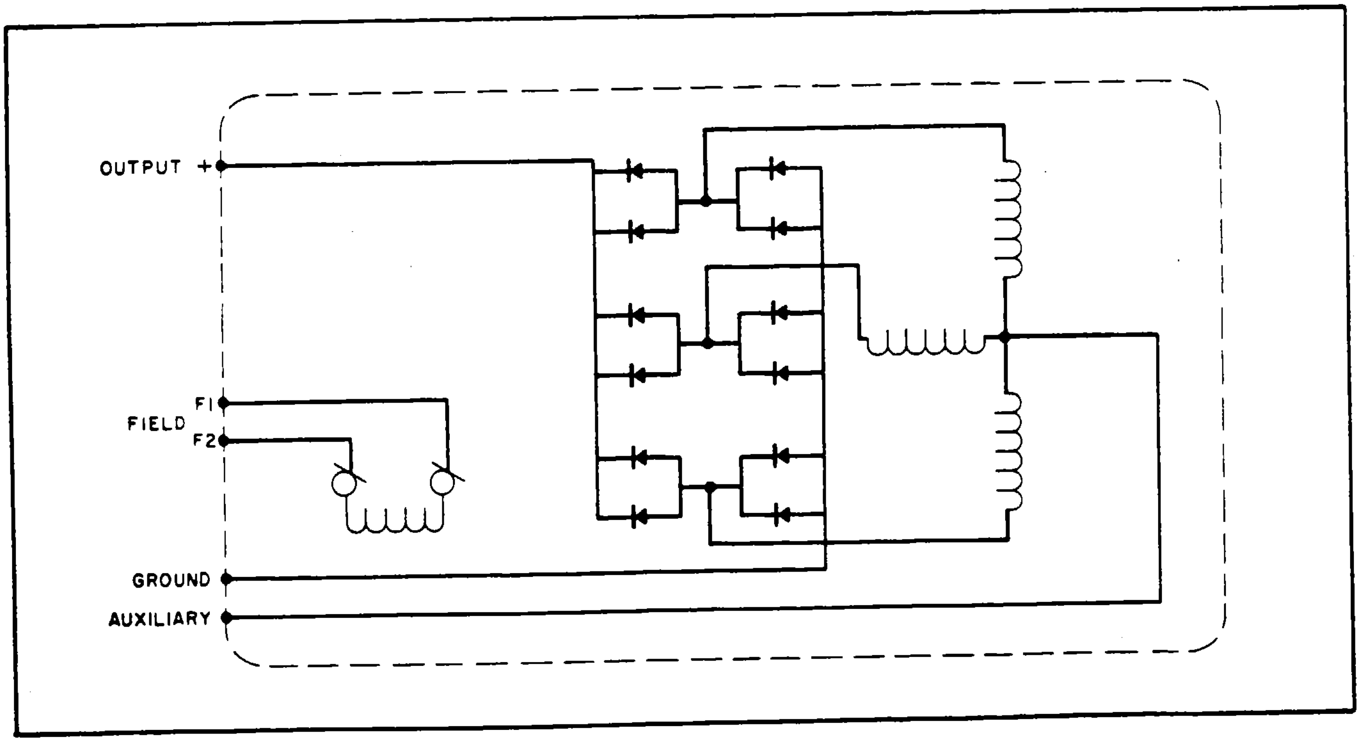

Figure 11-4. Internal Wiring of Alternator

11-10. ADJUSTMENTS. The only adjustment necessary to maintain the alternator system is the adjustment of the voltage control on the voltage regulator. A voltage of 28.5 volts is maintained. All other control adjustments are made at time of installation and need not be reset.

IMPORTANT

Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.
b. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.
c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.
d. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.
e. Do not short across or ground any of the terminals on the alternator or regulator.
f. Do not attempt to polarize the alternator.

11-11. OVERHAUL OF ALTERNATOR. When repairing the alternator, complete disassembly may not be required. In some cases it will only be necessary to perform those operations which are required to effect the repair. However, in this section, the complete overhaul is covered step-by-step to provide detailed information on each operation. In actual service practice, these operations may be used as required.

11-12. DISASSEMBLY OF ALTERNATOR.

a. Straighten the ears on the lock tab washers and remove the six through bolts.

b. Remove the slip ring end bearing cover. This can be accomplished by wedging a small, sharp object, such as a small, sharp chisel or knife blade, between the cover and the slip ring end head.

c. Use a puller, as shown in Figure 11-6 , to press the rotor shaft out of the slip ring end bearing. Separate the drive end head and rotor, as a unit, from the stator and slip ring end head, being careful not to lose the brush springs while separating the units.

d. Remove the nuts, lock washers, flat washers and insulators from the output, ground and auxiliary terminal studs. The end head can now be separated from the stator and heat sink assemblies. The slip ring end bearing can be pushed out from the inside of the end head.

e. Each brush is connected to a terminal stud that is insulated and mounted through the slip ring end head. Service brushes come attached to terminal studs. The brush holder is attached to the slip ring end head with two screws and can be easily serviced once the alternator is disassembled.

f. Clamp the rotor in a vise, being careful not to distort the rotor poles, and remove the drive components from the rotor shaft.

NOTE

The drive assemblies, used on these alternators are not manufactured or serviced by the vendor, but are available from the engine manufacturer.

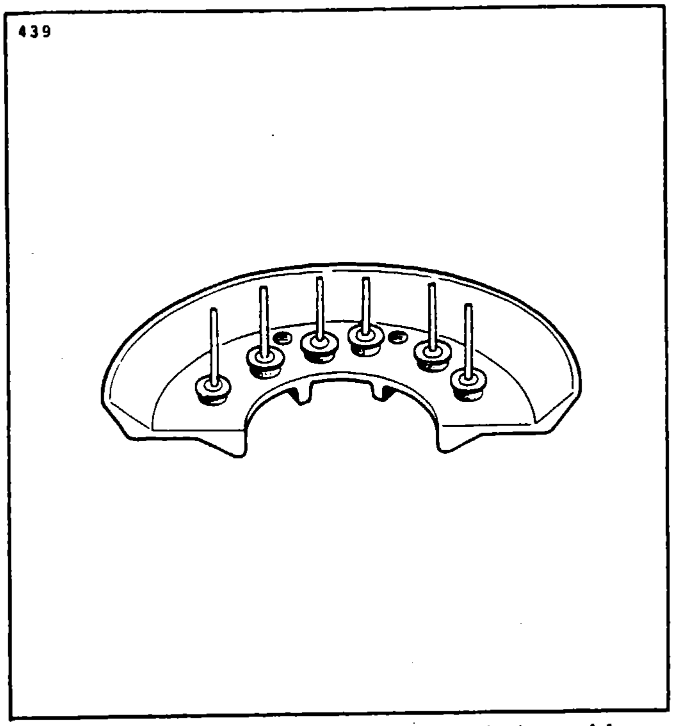

Figure 11-5. Rectifier and Heatsink Assembly

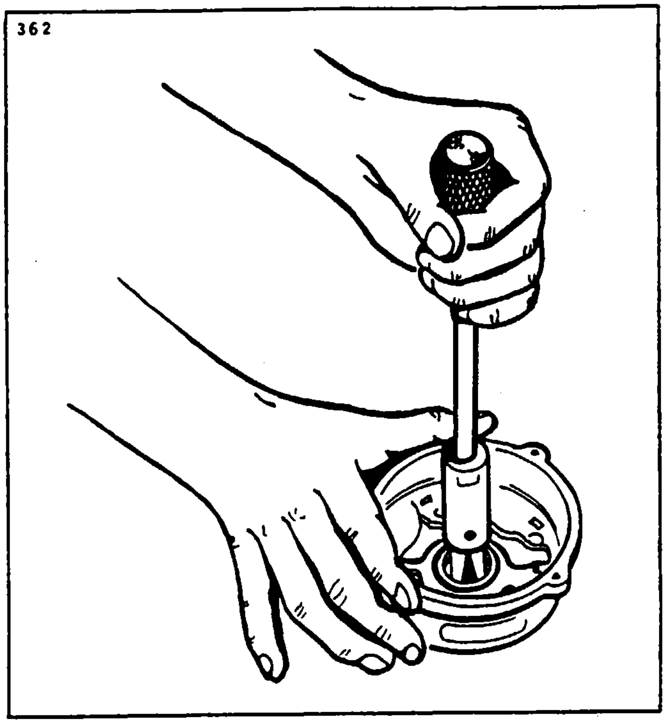

Figure 11-6. Removal of Slip Ring End Bearing

g. The drive end head and rotor can be separated by supporting the end head and pressing out the rotor. Remove the bearing retainer plate screws and retainer. Support the end head and carefully press out the bearing. The oil seal, can be knocked or pressed out from the inside of the end head.

11-13. INSPECTION AND TESTING OF COMPONENTS. Upon completion of disassembly all parts should be thoroughly cleaned and visually inspected for cracks, wear, or distortion, and any signs of overheating or mechanical interference.

a. Rotor: The rotor should be tested for a grounded, shorted, or open winding. The ground test can be made with a 110 volt test lamp, an ohmmeter, or any type of continuity tester. (Refer to Figure 11-7 .) There must not be any continuity from the slip rings to the rotor shaft or poles. To test for shorted turns in the rotor winding, connect an accurate voltmeter, ammeter and rheostat as shown in Figure 11- 8 , or use an accurate ohmmeter. Rotor current draw and resistance are listed in Table XI-II Alternator Specifications. Excessive current draw or a low ohmmeter reading would indicate shorted windings. No current draw or an infinite ohmmeter reading would indicate an open winding.

b. Rectifiers: A rectifier tester can be used to detect shorted rectifiers and open pairs of rectifiers. The construction of the alternator (two rectifiers connected to one stator lead) makes it impossible to check for single open rectifiers without going through the operation of unsoldering and separating the rectifier leads. When soldering and unsoldering the rectifier connections, use pliers as a heat dam on the rectifier leads, between the solder joint and rectifier. Too much heat will damage the rectifiers. If a shorted or open rectifier is located, the heat sink assembly containing that rectifier must be replaced. The individual rectifiers are not replaceable and no attempt should be made to unsolder them from the heat sink.

c. Stator: The stator can be tested for open or grounded windings with test probes and a No. 57 bulb connected in series with a 12 volt battery, an ohmmeter, or any type continuity tester except 110 volt test bulb. To test for grounded windings, connect one test probe to the auxiliary terminal stud or any stator lead. Connect the other test probe to the stator frame. If the test bulb lights or any continuity is indicated,

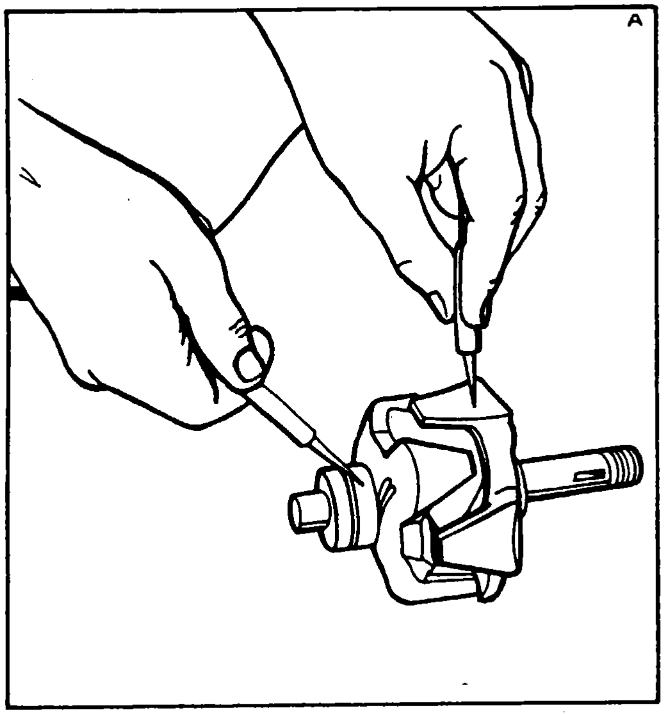

Figure 11-7. Testing Rotor for Ground

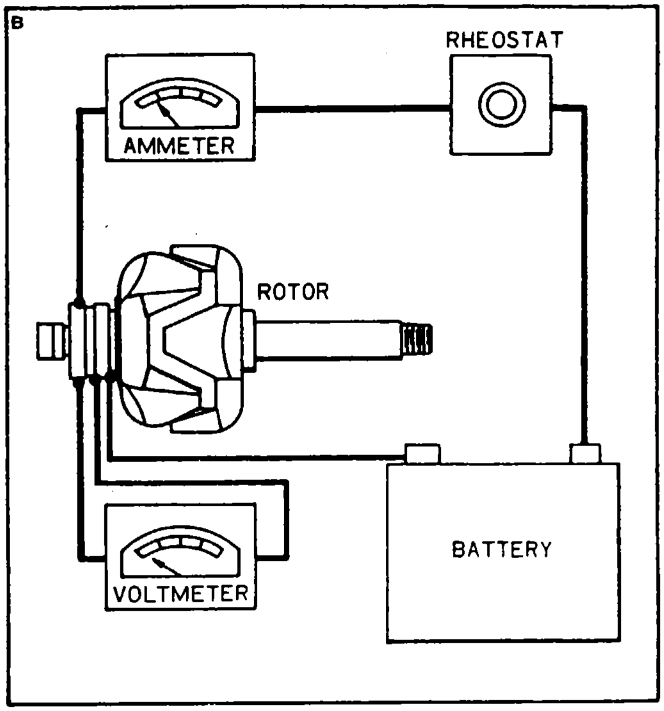

Figure 11-8. Testing Rotor for Shorts

the stator is grounded and must be replaced. To test for open windings, connect one test probe to the auxiliary terminal stud and touch each stator connection with the other test probe. The test bulb must light or continuity must be indicated between all connections. If the stator is open, it must be replaced. Check flexible leads for possible open's before replacing the stator. Due to low resistance of the stator windings, shorted windings are almost impossible to locate. However, shorted stator windings will usually cause the alternator to be noisy or "growl" during operation and will usually show signs of overheating. If all other electrical checks are normal and the alternator fails to supply its rated output, the stator should be replaced to determine whether or not it is the faulty component.

d. Stator and/or Rectifier Heat Sink Replacement: When soldering or unsoldering the rectifier connections, pliers should be used as a heat dam between the solder joint and the rectifier. Too much heat will damage the rectifiers.

e. Miscellaneous Components: Whenever the alternator is overhauled, the following components should be replaced, even though they appear to be in good condition. The brushes, drive end bearing, slip ring end bearing, oil seal, shaft seal, shaft seal "O" ring and the lock tab washers. Any one of the above components can cause an alternator to fail within a very short period of time.

11-14. ASSEMBLY OF ALTERNATOR. After thoroughly cleaning, inspecting, testing, and replacing any faulty components, reassemble and test the unit. Reassembly is, basically, the reverse of disassembly. However, the following assembly procedures must be observed to obtain a properly assembled unit.

a. Drive End Head: Install the oil seal with the lip toward the outside of the end head. Press the oil seal in approximately .062" below the outside edge of the casting. Install the bearing with the sealed side toward the rotor. Lubricate the bearing on reassembly with Chevron BRB No. 2, Chevron SRI No. 2 or AeroSheel No. 5. When installing the bearing, press only on the outer race. Install the bearing retainer and screws. Support the rotor shaft and press the end head assembly onto the shaft, being careful not to damage the oil seal. Reassemble the oil seal collar, being careful not to fold the oil seal lip under. A small amount of oil on the collar will make installation easier. Install the "O" ring seal, being careful not to cut the "O" ring on the shaft keyway. Use a small, blunt instrument to push the "O" ring seal into the shaft collar. A small

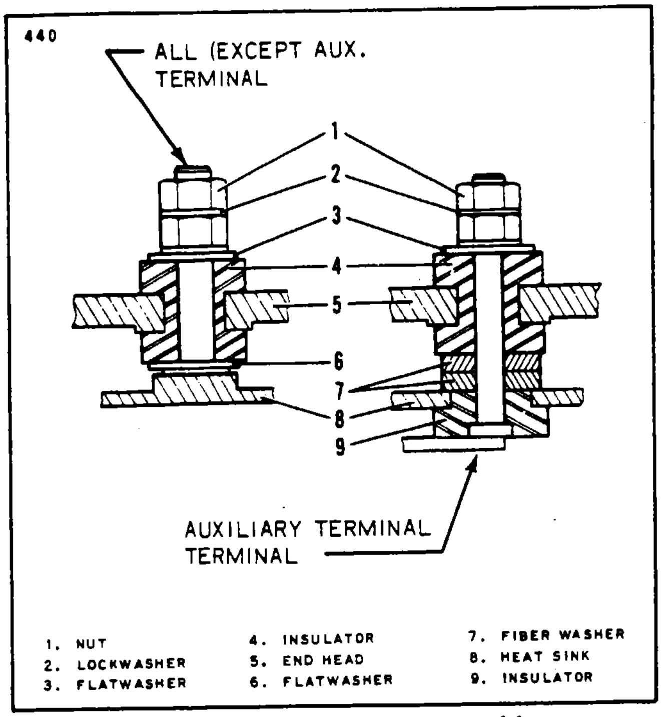

Figure 11-9. Terminal Assembly

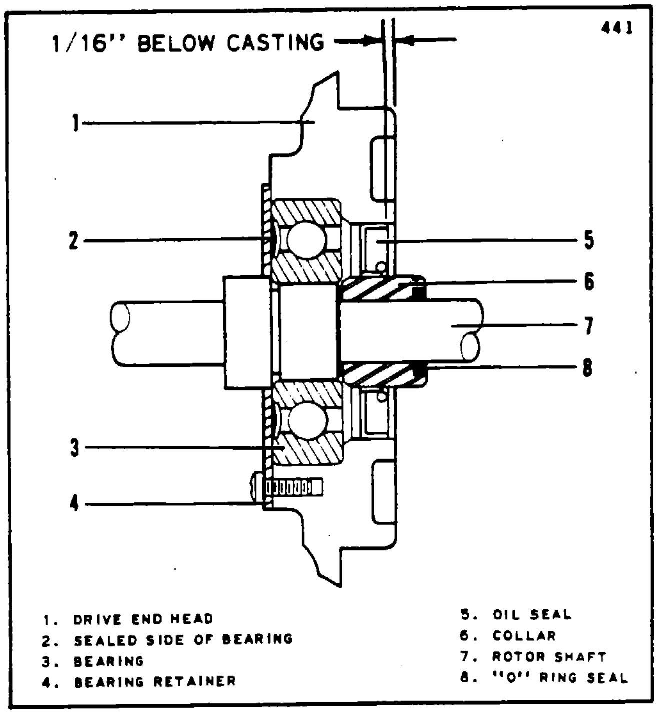

Figure 11-10. Bearing and Seal Assembly

amount of oil on the "O" ring seal will make installation easier. Make certain the "O" ring seal is fully installed before assembling the remainder of the drive assembly. Figure 11-10 shows the correct assembly of the drive end head components. Torque the drive retaining nut to 37 to 42 foot-pounds.

b. Slip Ring End Assembly: Assemble the brush and terminal stud assemblies in the end head prior to assembling the heat sinks and stator. Make sure brush holder retaining screws are tight. A small amount of Lock-Tite on the retaining screw threads, prior to assembly, will provide additional vibration protection. Assemble the stator and rectifier heat sink assemblies in the end head, making certain the insulators are correctly assembled as shown in Figures 11-9. Position the stator leads so they will not interfere with the rotor.

NOTE

If it was necessary to replace the stator or either rectifier heat sink, position the stator leads so they will not interfere with the rotor and secure the leads to the heat sinks with epoxy cement.

Position the snap ring, in the end head, so that one of the holes is directly inline with the brushes. Install the brush springs and brushes in the brush holder. Insert a small drill or metal rod through the snap ring hole to hold the brushes in place. Assemble the alternator and install a couple of through bolts to hold the unit together. Remove the brush holding tool and make sure the brushes are contacting the slip rings. Visually check to make sure the brush leads are free and cannot bind against anything. Make sure the shaft snap ring retainer is in place and install the slip ring end bearing. The bearing must be installed with the sealed side toward the rotor. Lubricate the bearing on reassembly with one of the following bearing greases; Chevron BRB No. 2, Chevron SRI No. 2 or AeroShell No. 5. Also after assembly the end cover should be removed every 100 hours and an inspection conducted for the proper amount of the lubricant. Use a tool that fits against the bearing inner race and press the bearing onto the rotor shaft while supporting the drive end of the shaft. Install the remaining through bolts. Do not install the blast tube assembly on the 8000 Series Units, or secure the lock tab washers until the unit has been tested.

11-15. TORQUING SPECIFICATIONS. After the alternator is fully assembled, the components should be torqued to the specifications given in Table XI-II.

TABLE XI-III. ALTERNATOR TORQUES

Through Bolts	30-35 In. Lbs.
1/4 Inch Term. Stud Nuts	70-85 In. Lbs.
#10-32 Term. Stud Nuts	30-35 In. Lbs.
Coupling Retaining Nut	37-42 Ft. Lbs.

11-16. TESTING ALTERNATOR. Upon completion of assembly, the alternator should be tested to determine if the unit is capable of delivering its full rated output.

CAUTION

These alternators require a source of ventilation. Do Not test these units at full rated output for more than 20 seconds unless adequate air pressure for cooling is supplied.

Wiring connections for bench testing the alternator are shown in Figure 13-11. The alternator must meet or exceed the specifications given in Table XI-III. Adjust carbon pile, if necessary, to obtain the specified voltage.

After bench testing the alternator, install the alternator on the engine, making sure all mounting surfaces are free of corrosion or foreign materials. Torque the alternator retaining bolts to the specifications listed in the engine manufacturer's manual.

11-17. PRECAUTIONS. The following precautions are to be observed when testing or servicing the electrical system.

a. Disconnect the battery, before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter, or accessories, will cause severe damage to the units and/or wiring.

b. The alternator output lead must not be removed from the alternator with the field circuit energized and the alternator operating.

c. Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so may result in damage to the alternator, regulator or circuits.

d. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.

e. Reversed battery connections may damage the rectifiers, aircraft wiring, or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. The Pressurized Navajo has a negative ground.

f. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

g. When using an auxiliary power unit, make sure the voltage and polarity are set to correspond with the aircraft system voltage and polarity.

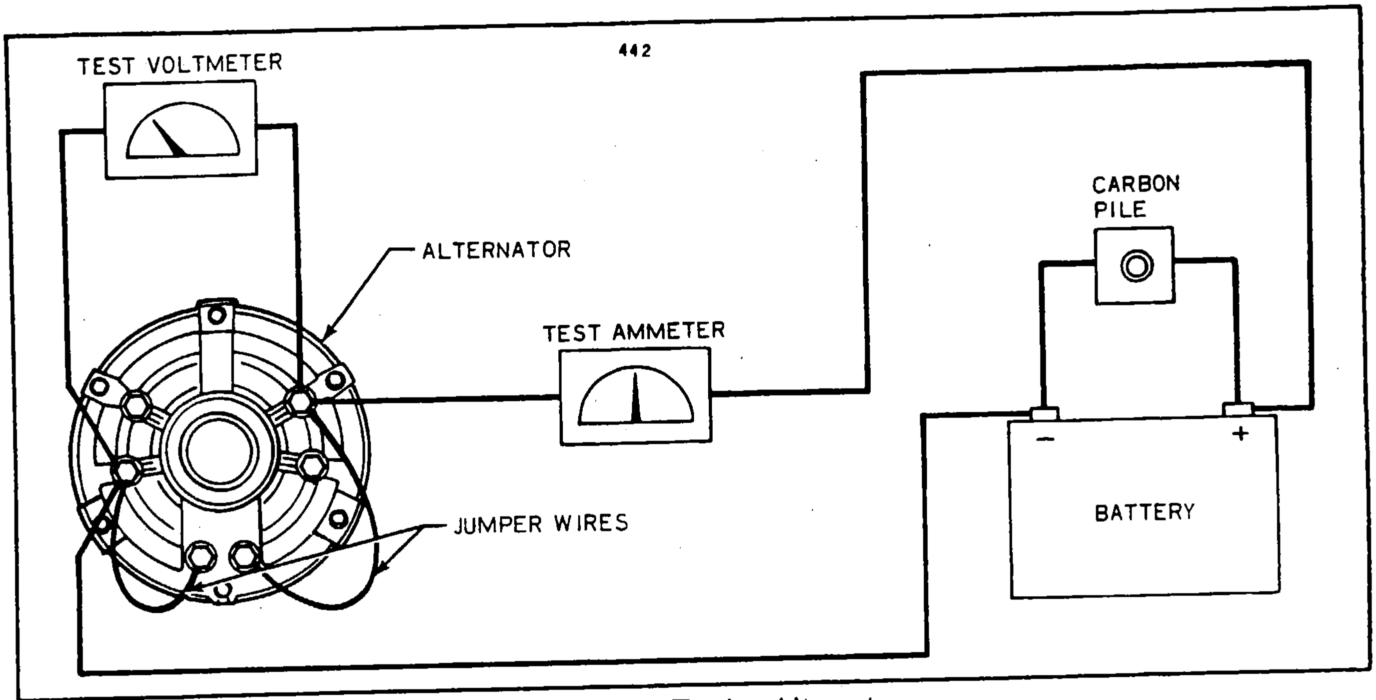

Figure 11-11. Testing Alternator

TABLE XI-IV. TEST VOLTAGE

Volts	Output	RPM
25.8	10.0 Amps. Min.	2000
28.4	100.0 Amps. Min.	5000

11-18. ALTERNATOR NOMENCLATURE.

a. Bearings: These units have ball bearings at both ends. Both bearings are sealed on one side only. Install bearings with sealed side toward the inside of the alternator.

b. Lubrication: New bearings are recommended at overhaul. Bearing should be packed 1/2 full with Shell Alvania #2 or an equivalent bearing lubricant. A light film of lubricant on the O-ring seals will facilitate assembly and prevent damage to the seals.

c. Brushes: The brushes in these units are mounted internally. When assembling the alternator, position the snap ring, in the slip ring end head, so that one of the holes is directly in line with the brushes. Install the brush springs and brushes and insert a small drill or metal rod through the snap ring hole to hold the brushes in place.

d. Ventilation: These units have a drive end head cover which incorporate a blast tube connection for air pressure ventilation. Do not test these units at full rated output for more than 20 seconds unless adequate air pressure for cooling is supplied.

11-18a. ALTERNATOR PARALLELING SYSTEM.

11-18b. DESCRIPTION OF ALTERNATOR PARALLELING SYSTEM. The positive output terminal of each alternator is connected to the aircraft electrical bus through separate 125 ampere circuit breaker switches. Each alternator has a shunt installed between airframe ground and its negative output terminal in order to monitor output current on an ammeter.

The field circuit for each alternator is wired through a section of a Dual Master Switch (L or R as appropriate), an auxiliary switch which is ganged to the circuit breaker switch, an overvoltage relay and a voltage regulator. Field voltage can be manually disconnected from either alternator by turning off the appropriate section (L or R) of the Dual Master Switch. Turning both sections of the Master Switch off completely disconnects all electrical power from the aircraft Bus Bar. Field voltage will be automatically removed from an alternator whenever its overvoltage relay actuates or its circuit breaker switch trips.

The system has separate ammeters installed to measure system currents. One ammeter is provided for each alternator to measure its output current, as previously described. A shunt is installed between airframe ground and the negative terminal of the battery to allow measuring of the battery charge and discharge current with its ammeter. A voltmeter is also provided to indicate aircraft electrical bus voltage.

An alternator inoperative ("INOP") warning light is provided for each alternator. The appropriate light will illuminate whenever its respective alternator fails to provide output voltage.

The 125 ampere circuit breaker switches should not be turned off when their associated alternator is operating normally. Turning "OFF" one of these switches while it is carrying current could cause a high voltage transient to occur on the electrical bus with possible subsequent damage to the semiconductor equipment attached to it.

11-18c. DESCRIPTION OF ALTERNATOR. For a complete description of the alternator, refer to Paragraph 11-8.

11-18d. CHECKING ALTERNATOR PARALLELING SYSTEM. The alternator paralleling system incorporates three (3) ammeters which provide for an independent check of each alternator, as well as the charge/discharge current of the battery. In the event either ALTERNATOR INOPERATIVE light begins to glow or the ammeter check for either alternator fails to indicate an output, check the appropriate alternator circuit breaker switch, also the voltage regulator circuit breaker. If the circuit breakers are in their normal operating position a further check of the alternator system should be accomplished. (Refer to Figure 11-11a.)

a. Verify that the ammeters are operating properly.
b. Disconnect the output (+) lead at the alternator.
c. Disconnect the field F-2 lead at the alternator.

CAUTION

DO NOT ALLOW THE FIELD LEAD TO COME IN CONTACT WITH AIRFRAME GROUND WHEN THE MASTER SWITCH IS ON AS THE VOLTAGE REGULATOR WILL BE DAMAGED.

d. Verify that all electrical units are off and the battery is fully charged.
e. Turn ON the section of the master switch for the alternator being tested. (L or R.)
f. To check the alternator output circuit, connect a voltmeter or 28 volt test light to the previously disconnected output (+) lead. Check that the circuit breaker switch for the alternator under test is turned on. If a reading of approximately 28 volts is obtained on the voltmeter, or the test light glows, the output circuit is operational.
g. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 11-11a.) A component that does not indicate voltage at both its input and output terminals should be replaced.
h. Check the field circuit by connecting a voltmeter to previously disconnected field (F-2) lead. If a reading of approximately 28 volts is obtained on the voltmeter, the field circuit is operative.
i. If voltage is present at both the output and field leads, the alternator should be checked for a possible malfunction. (Refer to Paragraph 11-16.)

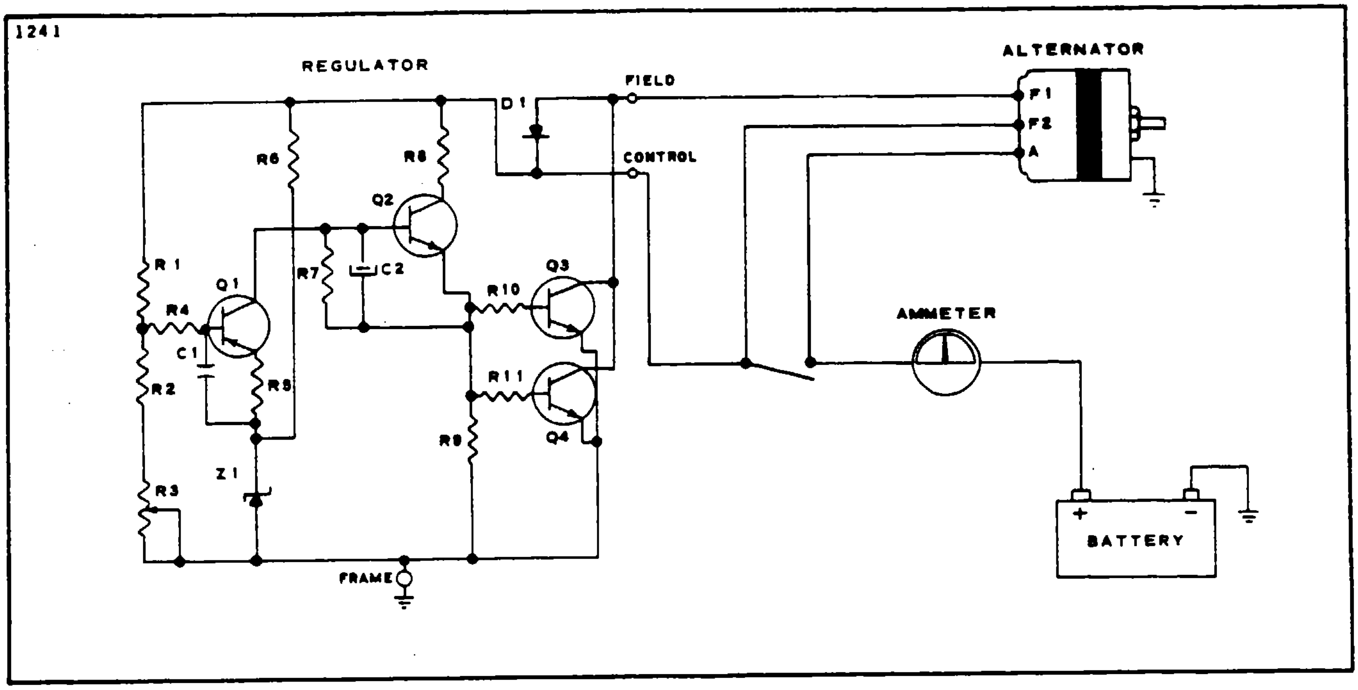

Figure 11-12. Regulator Diagram

11-19. REGULATOR.

11-20. REGULATOR COMPONENTS. Alternator output voltage can, within the limits of the design capability of the alternator, be controlled by properly varying the average level of current flow in the rotor winding. The LAMAR solid state electronic regulator is well suited for this purpose. The alternator, due to its design, has self-limiting current characteristics and therefore needs no current-limiting element in the regulator.

a. Transistor: The transistor (Symbol "Q") is an electronic device which can control the flow of current in an electric circuit. It has no mechanical or moving parts to wear out.

b. Rectifier Diode: The rectifier diode (Symbol "D") will pass current in one direction only (forward direction); and in this respect it may be compared to a check valve.

c. Zener Diode: The Zener diode (Symbol "Z") in addition to passing current in the forward direction, will also pass current in the reverse direction when a particular value of reverse voltage is applied. This property makes it useful as a voltage reference device in the regulator.

d. Capacitor: The capacitor (Symbol "C") is a device which will store electrical energy for short periods of time. This property makes it useful as a filter element to smooth variations of voltage.

e. Resistor: The resistor (Symbol "R") is a device which is used to limit current flow.

11-21. OPERATION OF REGULATOR (Refer to Figure 11-12.)

a. When the alternator switch is turned on, battery voltage is applied to the "Control" terminal of the regulator and also to "F2" on the alternator.

b. Current flow through R6 and Z1 establishes a reference voltage across Z1.

c. Resistor R1 and R2/R3 comprise a voltage divider which is adjustable by means of variable portion R3. Voltage at the junction of R1 and R2 and the reference voltage across Z1 are applied to comparison transistor Q1. R3 is adjusted so that these voltages are balanced when the desired alternator output voltage is present on the "Control" terminal of the regulator.

d. Thereafter, whenever alternator output voltage (applied to the "Control" terminal) falls below the desired regulation value, the comparison transistor Q1 will supply increased current to driver transistor Q2, which in turn will drive power transistors Q3/Q4 to a higher value of field current. This will result in alternator output voltage increasing to a value which will restóre balance between the two voltages applied to Q1.

e. Conversely, if alternator output voltage increases due to a greater engine speed or reduced loading of the electrical system, the comparison transistor will act to reduce current flow to driver transistor Q2, and thus reduce the drive to power transistors Q3/Q4. This will result in a reduction of alternator field current and automatically restore balance between the two voltages applied to comparison transistor Q1.

f. Capacitors C1 and C2 function together with their related resistors to smooth alternator output ripple and voltage spikes so that the alternator field current is a steady value.

g. The LAMAR solid state regulator controls alternator field current to a steady value as required by the load conditions and engine speed. It does not continuously switch field current between high and low values as do mechanical regulators or switching type electronic regulators.

h. The design of this unit is such as to provide an alternator output voltage that does not vary with temperature.

11-21a. OPERATION OF REGULATOR (PARALLELING SYSTEM). (Refer to Figure 11-12a.)

a. When the alternator is turned on, battery voltage is applied to the "BUS" terminal of the regulator and via Q4 through the "FIELD" terminal of the regulator to the alternator field terminal F2. The amount of voltage applied to the field of the alternator is controlled automatically by action of the regulator in response to alternator output as described below.

b. Current flow through R6 and Z1 establishes a reference voltage across Z1.

c. Resistors R1 and R2/R3 comprise a voltage divider which is adjustable by means of the variable portion R3. Voltage at the junction of R1 and R2 and the reference voltage across Z1 are applied to comparison transistor Q1. R3 is adjusted so that these voltages are balanced with the desired alternator output voltage present on the "BUS" terminal of the regulator.

d. Thereafter, whenever alternator output voltage (as applied to the "BUS" terminal) falls below the desired regulation value, the comparison transistor Q1 will supply increased current to driver transistors Q2/Q3, which in turn will drive power transistor Q4 to a higher value of field current. This will result in alternator output voltage increasing to a value which will restore balance between the two voltages applied to Q1.

e. Conversely, if alternator output voltage (as applied to the "BUS" terminal) increases because of a greater engine speed or reduced loading of the electrical system, the comparison transistor Q1 will act to reduce current flow to the driver transistors Q2/Q3, and thus reduce the drive to power transistor Q4. This will result in a reduction of alternator field current and automatically restore balance between the two voltages applied to comparison transistor Q1.

f. Capacitors C1 and C2 function, together with their related transistors, in a way to smooth alternator output ripple and voltage spikes so that the alternator field current is controlled at a steady value.

g. The LAMAR solid state regulator controls alternator field current to a steady value as required by the electrical load conditions and engine speed. It does not continuously switch field current between high and low values as do mechanical regulators and the switching type of electronic regulators.

h. The design of this unit is such as to provide an alternator output voltage that does not vary with ambient temperature.

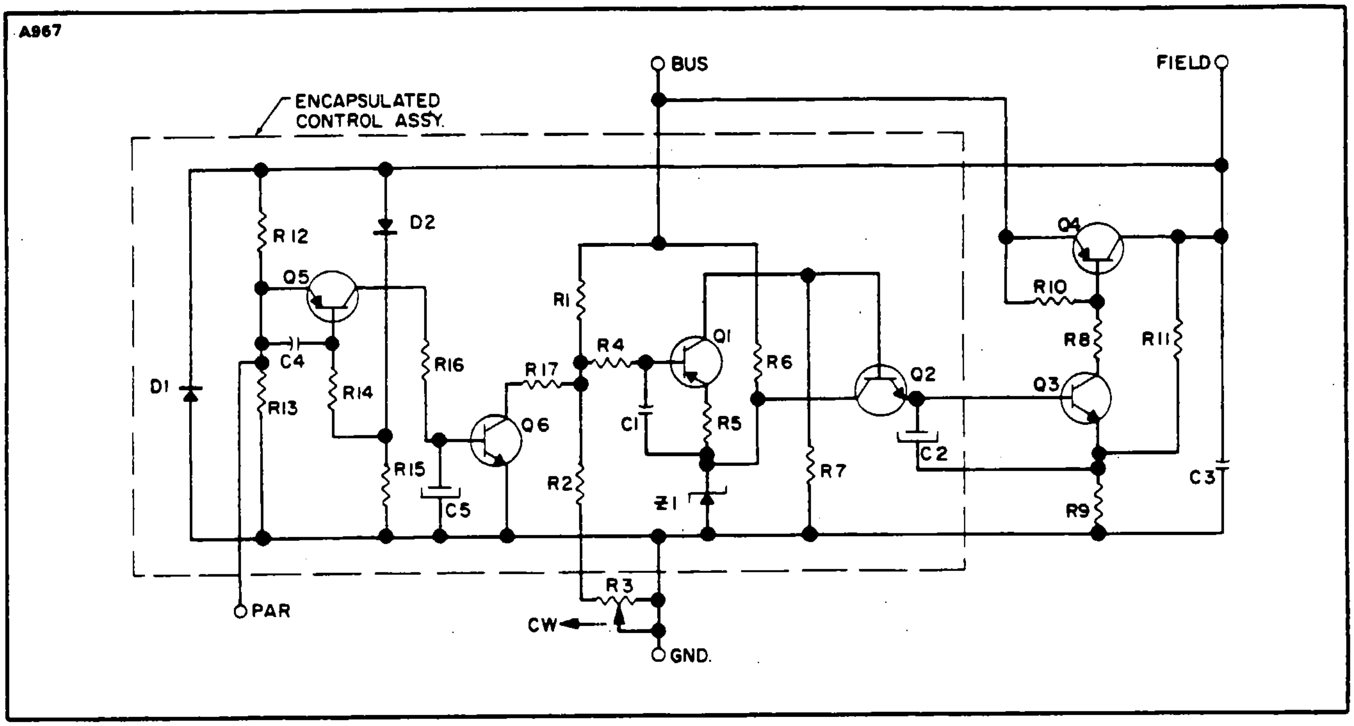

Figure 11-12a. Regulator Diagram (Paralleling System)

11-21b. BALANCING CIRCUIT OPERATION (PARALLELING SYSTEM). (Considering two identical alternators and regulators having the "PAR" terminals of the regulators connected.)

a. Balancing circuit operation is initiated within one regulator whenever individual field voltages delivered by the regulator units to their related alternators are not equal.

b. When a difference in individual field voltages occurs, one-half the difference is impressed across R12 within each regulator and is thus applied to the input of Q5.

c. In that regulator which is delivering the lower field voltage, the polarity of R12 voltage drop causes Q5 collector current flow.

d. Q5 collector current flow results in conduction occurring in the collector circuit of Q6.

e. Q6 collector current flows from regulator divider R1/R2+R3 through limiting resistor R17 to ground.

f. Conduction through R17 effectively alters the ratio of the regulator divider R1/R2+R3 in the direction to increase Q1 collector current flow.

g. As described above under REGULATING CIRCUIT OPERATION, increased Q1 current results in increased output from the regulator to the field of its related alternator.

h. Feedback action results in Q6 collector current stabilizing at a value that results in nearly equal field voltage being delivered by the two regulators to their respective alternator fields.

i. The balancing circuit will thus automatically maintain, at a low value, the difference voltage applied to the alternator fields. In a parallel system having identical alternators operating at the same RPM, the output currents of the alternators will thus be maintained nearly equal.

j. In whichever regulator of a pair is set to deliver the highest voltage, the balancing circuits are inactive. Thus system voltage is determined by the regulator of a pair which is set to higher voltage. The lower set regulator will adjust itself automatically, as described above, to deliver the same field voltage as the one which is set higher, within the limits of its design capability.

k. The balancing regulator system as described provides for automatic load balancing of parallel operated alternators having independent field excitation circuits. The pilot can, while in flight, remove either alternator system completely from the aircraft system and maintain operation of the other system.

11-22. PREPARATION FOR TESTING. (Regulators may be tested using the aircraft's alternator or an alternator test stand.)

CAUTION

Do not interchange regulator leads. This will destroy regulator and void warranty.

a. The aircraft technician or other electrical systems specialist, must disconnect the battery ground cable at the battery before connecting or disconnecting a test ammeter or other test equipment or before making wiring changes in the electrical system.

b. Voltmeters with test probes or clips are not recommended. Fully insulated bolted terminal connections are best, and these should be attached when all power is removed as described above.

c. When installing a battery in an aircraft, be sure that the battery negative terminal is in a position so that this terminal can be connected to the battery ground cable for negative ground systems.

d. The regulator under test is to be mounted on a grounded metallic surface using three No. 8 screws pulled up tight. For extended test periods the heat transfer from regulator to the mounting surface is significant.

e. A ground wire between the regulator "GND" terminal and the aircraft or test stand structure is essential for proper operation. The alternator frame must also be solidly bonded to the system ground.

f. The alternator does not need to be polarized; therefore, never connect ground, even momentarily, to either the regulator field terminal or to the alternator field terminals. Do not interchange I and F leads to regulator as this will destroy the regulator.

g. The LAMAR regulator is intended for use with alternator systems having one field terminal grounded at the alternator. The other field terminal F2 of the alternator is connected to the "FIELD" terminal of the regulator. NEVER UNDER ANY CIRCUMSTANCE PERMIT A GROUND TO CONTACT THIS CIRCUIT EVEN FOR AN INSTANT WHILE POWER IS APPLIED TO THE SYSTEM. Due to this precaution, the mechanic should not use tools near these circuits while power is applied.

h. The alternator should be in good condition and capable of producing full output, and the alternator drive belt must be adjusted tight enough to prevent slippage.

i. The battery must be in good condition and should be fully charged.

j. The voltmeter and ammeter should be of the best quality and should be accurate.

k. A carbon-pile connected across the battery may be used to load the charging circuit while testing the regulator.

11-23. TESTING REGULATOR.

a. The procedure for testing the regulator, whether on the airplane or on the test bench, remains the same. Connect test meters as shown in Figure 11-13.

b. All circuit connections should be clean and tight. This includes the test instrument connections which must not come loose or open the charging circuit at any time while the system is operating.

c. The voltmeter will not indicate the true regulator setting until the regulator has been operating in the charging system or on the test bench for at least one minute, at a charge rate of 10 to 15 amperes.

d. Connect the voltmeter and the ammeter as shown in Figure 11-13. Start the engine and adjust its speed to obtain 3,000 to 4,000 alternator RPM (714 to 952 prop RPM). Turn on accessories as needed to establish 10 to 15 ampere electrical load, or use a carbon-pile across the battery to obtain this charge rate.

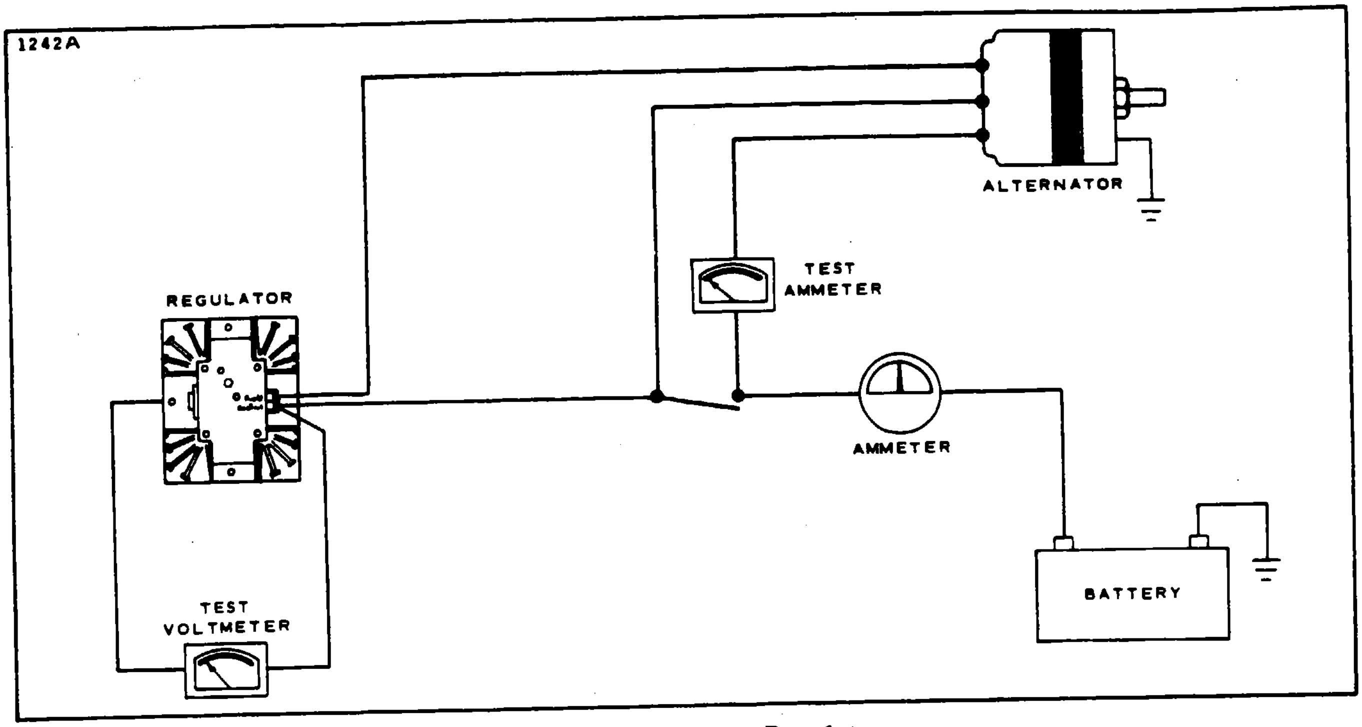

Figure 11-13. Testing Regulator

e. After five minutes operating time, check the regulator operating voltage as indicated by the voltmeter. Refer to Table XI-I Alternator Test Specifications, for the correct operating voltage. The operating voltage is shown for the ambient temperature in which the regulator is operating.

f. If the voltmeter reading indicates that the operating voltage is not within limits, carefully insert a small screwdriver (Phillips # O) in the voltage adjustment access hole on top of the regulator and adjust voltage slowly to the desired value. Before condemning the regulator, recheck the alternator and the battery; making sure that they are in good condition. Recheck all circuit connections and all wiring for unwanted resistance (voltage drop test). Recheck the voltmeter for accuracy and repeat the entire operating test.

11-23a. TESTING REGULATOR (PARALLELING SYSTEM).

a. The procedure for testing the regulator, whether on the airplane or on the test bench, remains the same. Connect the test meters and regulator wiring as shown in Figure 11-13a.

b. All circuit connections should be clean and tight. This includes the test instrument connections which must not come loose or open the charging circuit at any time while the system is operating.

c. The voltmeter will not indicate the true regulator setting until the regulator has been operating in the charging system or on the test bench for at least five minutes, at a charge rate of from 10 to 15 amperes.

d. With the connections made as shown in Figure 11-13a, start the engine and adjust speed to obtain alternator RPM of 3,000 to 4,000 (714 to 952 prop RPM). Adjust the carbon pile or accessory load to establish the 10 to 15 ampere load value. Note that the battery charge current is indicated by the ammeter. Therefore, the current value may change downward at the beginning of a test run. This will be especially true if the battery was used for engine starting.

e. After five minutes operating time, check the regulator operating voltage as indicated by the voltmeter. Refer to Table XI-II Alternator Test Specifications, for the correct operating voltage. The

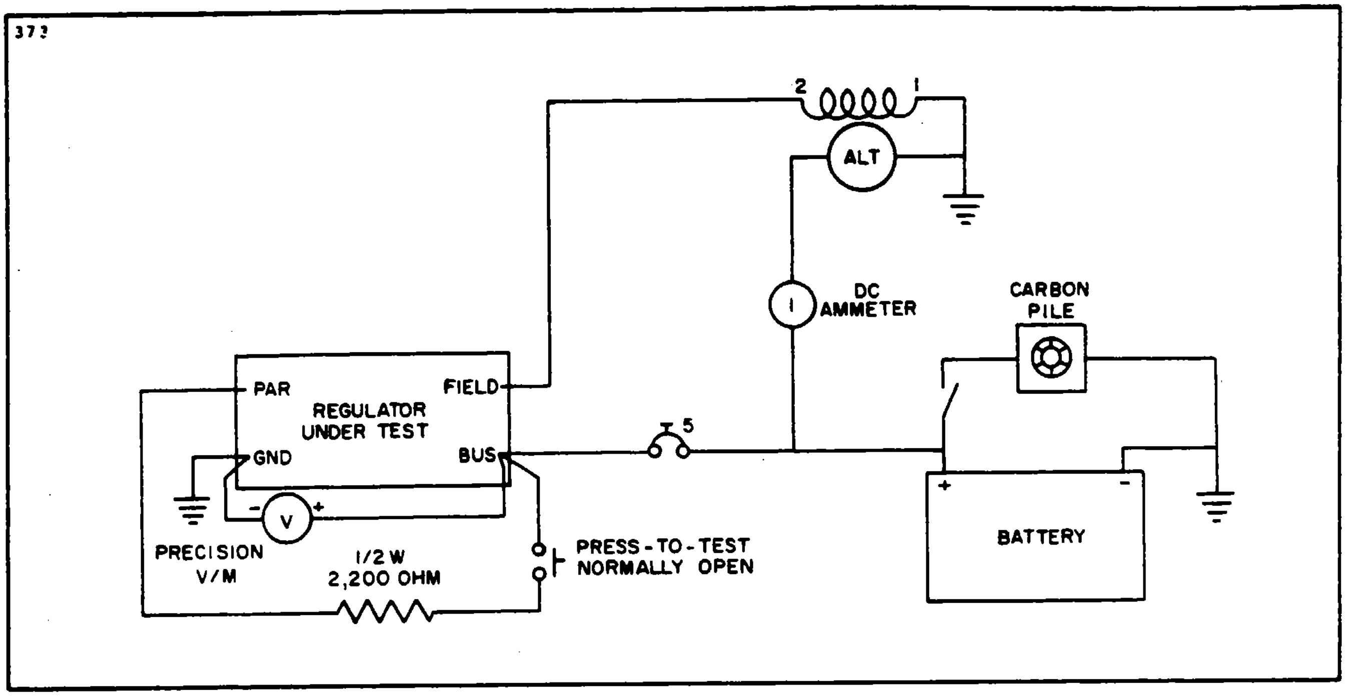

Figure 11-13a. Testing Regulator (Paralleling System)

operating voltage is shown for the ambient temperature in which the regulator is operating.

f. If the voltmeter reading indicates that the operating voltage is not within limits, carefully insert a small screwdriver (Phillips #0) in the voltage adjustment access hole on top of the regulator and adjust voltage adjustment slowly to obtain desired value. Before condemning the regulator, recheck the alternator and the battery; making sure that they are in good condition. Recheck all circuit connections and all wiring for unwanted resistance (voltage drop test). Recheck the voltmeter for accuracy and repeat the entire operating test.

g. Balance circuit operation is confirmed by closing the press-to-test switch momentarily and observing that the alternator output current increases abruptly to a higher level. Upon release of this switch, the alternator output will be restored to its previous level, except that minor differences may be noted which are due to battery charge conditions.

11-24. ADJUSTING REGULATOR.

a. Adjustment: These units have a voltage adjustment access hole on their top surface with the direction shown for voltage increase. The regulator has an adjustment range of 25.0 to 30.0 volts.

b. Operating Voltage: The regulator should be adjusted to 28.4 volts when controlling a load of 10 to 15 amperes after five minutes of operation for initial warm up. The regulator unit is not affected by ambient temperatures. The voltmeter must be connected from the "Control" terminal or the alternator switch terminal to ground.

c. Caution Note:

1. This regulator is to be used only with insulated (ungrounded) field alternators.
2. Regulator base must have a good solid ground electrical connection.
3. Do not (even momentarily) connect the two voltage regulator terminals together.
4. Do not connect battery into system with polarity reversed.
5. Do not force the voltage adjustment screw.
6. Field repair of the regulator should not be attempted. Unit repairable only by manufacturer.

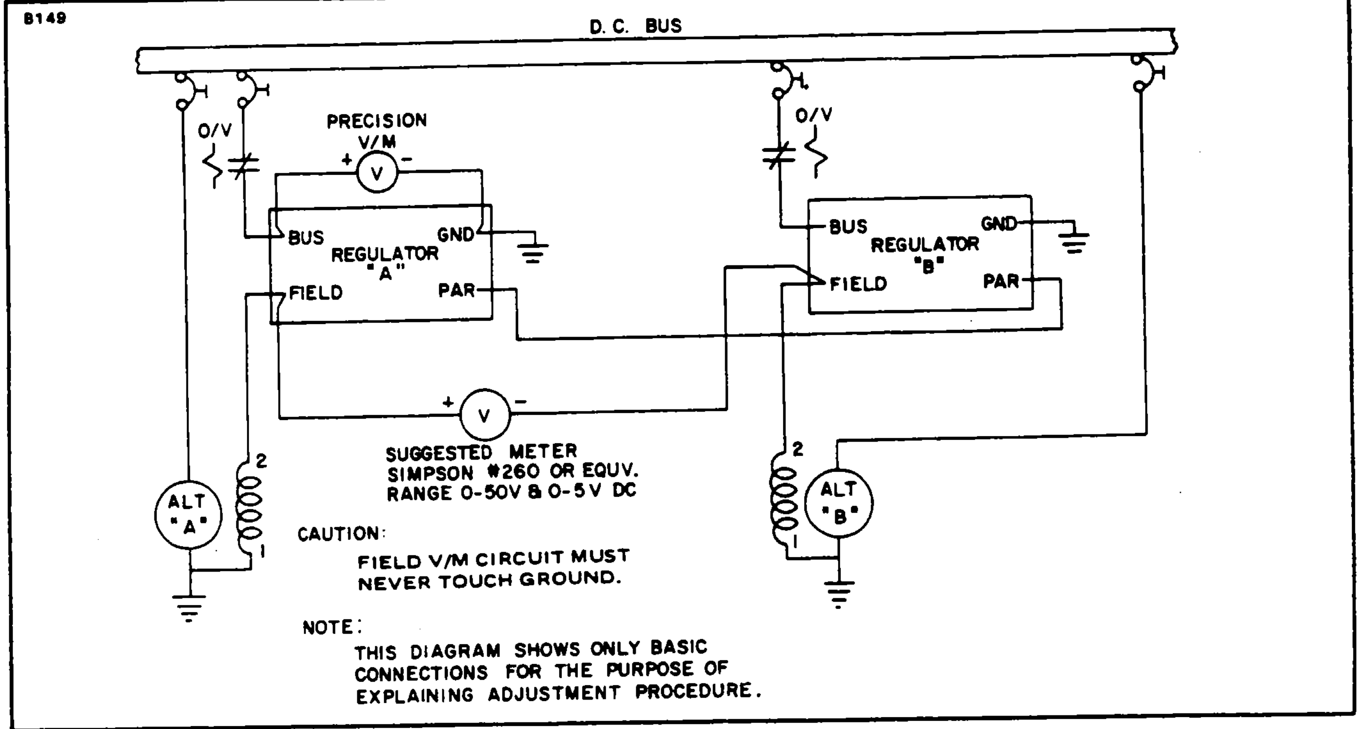

Figure 11-13b. Adjusting Regulator (Paralleling System)

11-24a. ADJUSTING REGULATOR (PARALLELING SYSTEM).

a. These regulators are normally used in parallel alternator systems of multi-engine aircraft. Their final adjustment should be made in actual operation in the aircraft system with test equipment connected as shown in Figure 11-13b. The balance adjustment is made while operating only one engine, either left or right. The engine to be operated must be selected so as to permit the technician a completely safe access to both of the regulators, so that they may be adjusted without danger while the engine is operating. We shall designate the engine selected to be operated as "RIGHT" and the inoperative engine as "LEFT."

b. Lift the wire from the "PAR" terminal of either regulator and insulate the free end so it will not contact other circuits or ground during the adjustment procedure. Breaking this circuit disables the balancing circuits in both regulators.

c. Turn off the "LEFT" alternator field switch. All the "RIGHT" alternator switches are to be on.

d. Operate the "RIGHT" engine and alternator with a load of at least 15 to 30 amperes, and alternator RPM of 3000 to 4000 (714 to 952 prop RPM) for at least 5 to 10 minutes. If required, carefully set the "RIGHT" regulator voltage adjustment to the correct voltage value as measured with the precision voltmeter connected to the regulator terminals. Replace the snap plug in the "RIGHT" regulator adjustment access hole.

CAUTION

Do not make any further adjustment of the "RIGHT" regulator.

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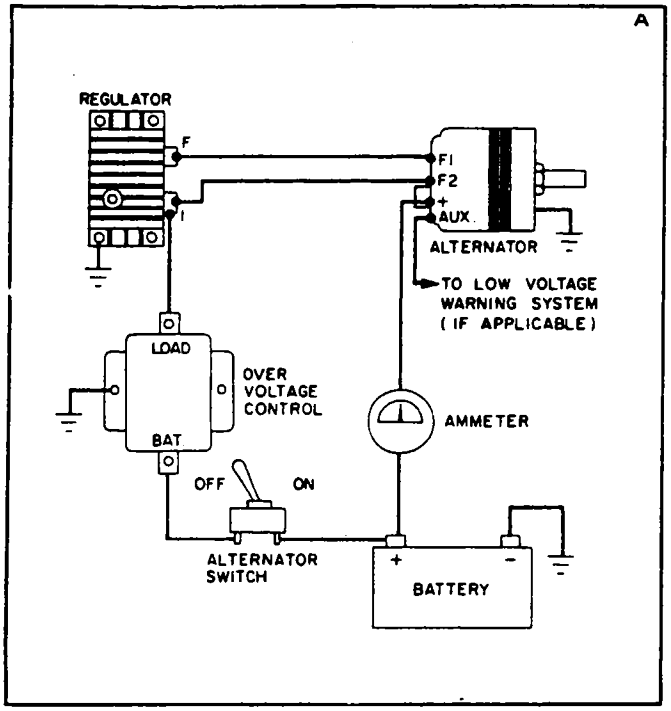


Figure 11-14. Application of Overvoltage Control

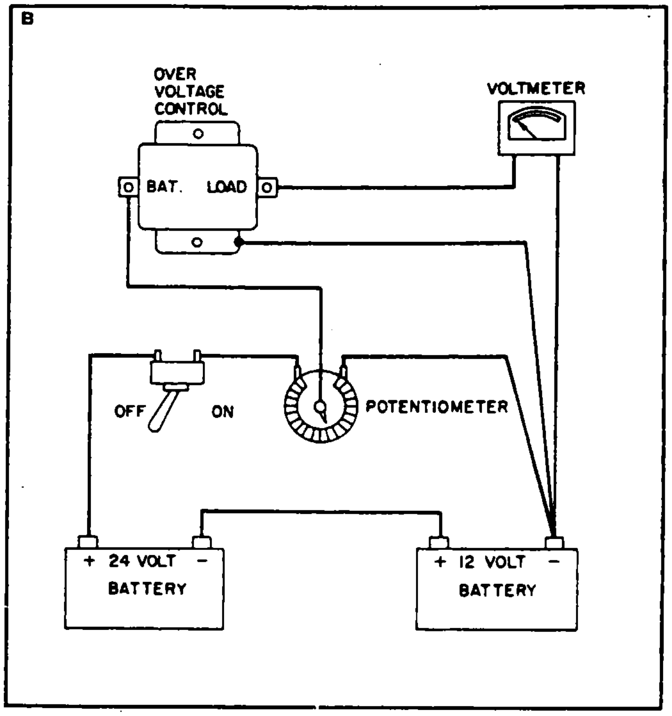


Figure 11-15. Testing Overvoltage Control

NOTE

Several operations of connecting and disconnecting the "PAR" circuit wire are required by the following steps. For convenience, a switch or a dependable clip connection may be used to accomplish this. No danger of damage exists if this circuit touches any other circuit or ground, however, erroneous results will be obtained if such occurs.

e. Shutdown the system, including the master electrical switch. Connect a portable voltmeter (non-precision) such as Simpson 260 or equivalent between the "FIELD" terminals of the left and right regulators in addition to the aircraft system wires already on these terminals. The positive terminal of the meter is to be on the "RIGHT" regulator terminal. Use a 30V or 50V meter range initially.

f. Restore operation of the "RIGHT" engine and alternator system using load and RPM as in Step d) above, and turn on the "LEFT" alternator system switches. (HOWEVER, THE LEFT ENGINE IS NOT OPERATING.)

g. Now slowly rotate the "LEFT" regulator voltage adjustment while observing the voltmeter connected between the field terminals. If a reverse (downscale) reading is obtained with meter polarity as specified, turning the "LEFT" regulator adjustment counterclockwise will bring the meter up scale. Then slowly set the "LEFT" adjustment to a point where the voltmeter will read a low value. Any reading from 0 to .8-volts is acceptable. A stable reading should not be expected. A lower meter range such as 10V may be used for this adjustment. Now reconnect the wire to join the "PAR" terminals of the two regulators and observe that the voltmeter drops to a very low value (0.2 to 0.5-volt) and it will be stable. Continue operation in this manner for 5 to 10 minutes to establish initial warmup of the "LEFT" regulator and alternator system. After the warmup period make a final adjustment of the balance. This is done by again briefly opening the "PAR" circuit between regulators and touching up the "LEFT" adjustment for a low reading of the voltmeter between field terminals. Again any value from 0 to .8-volts is acceptable; and again it will not be stable while the "PAR" circuit is open. Remove the adjustment screwdriver and replace the snap plug in the "LEFT" regulator adjustment hole. Shutdown the "RIGHT" engine and master switch. Remove all voltmeter leads. Reconnect the "PAR" circuit wire removed in Step b and check all terminal screws for security.

11-25. OVERVOLTAGE CONTROL.

11-26. PURPOSE AND OPERATION.

a. The overvoltage control is used to protect electrical circuits and electronic equipment from excessive voltage in the event of a charging circuit malfunction.

b. The overvoltage control consists of a mechanical relay and a solid state triggering device. The solid state triggering device activates the mechanical relay, when the voltage reaches a preset value, thereby opening the relay contacts and disconnecting the field circuit of the alternator.

c. The relay contacts will remain open until the alternator switch is turned off. Figure 11-14 illustrates the overvoltage control connected in a typical Prestolite insulated field alternator.

11-27. TEST PROCEDURE. Connect the relay as shown in Figure 11-15. Use a 100 ohm potentiometer of 15 watt rating, or more, to adjust the voltage. The voltmeter is used to read the voltage until the relay opens, at which time the voltmeter reading will drop to zero. See tabulation for voltage reading. Test figures are at 75 degrees Fahrenheit. Relay contacts open between 31.50 and 32.50 volts. Use 36 volts to test.

NOTE

These units are not adjustable. Replace the overvoltage control if it does not test to specifications.

11-27a. OVERVOLTAGE RELAY OPERATIONAL CHECK. This check should be made at each 500 hour inspections, per the following instructions:

a. Determine that aircraft master switch is OFF.
b. Pull out (OFF) all circuit breakers except the main and auxiliary voltage regulators (10 amp).
c. Turn off the right and left alternator output circuit breaker switches (125 amp).
d. Set the voltage regulator switch to MAIN.
e. Obtain a variable D.C. voltage power supply and set it to zero output.
f. Disconnect battery at master contactor.

NOTE

On aircraft with optional alternator warning lights, remove the 5 amp fuse at master contactor.

g. Connect the power supply to the aircraft through the external power receptacle.

NOTE

Connections must be positive to positive and negative to negative.

h. Obtain a volt/ohmmeter and set it to 60 volts D.C. Connect the meter VOM lead to the (REG.) output terminal of the MAIN overvoltage relay. Connect the meter COM lead to the airframe ground.

i. Turn the aircraft master switch ON.

j. Increase the output voltage of the variable D.C. power supply until the MAIN overvoltage relay trips out. When the relay operates, the VOM needle should drop to zero volts. Record the power supply voltmeter reading which was indicated just prior to the overvoltage relay operating. Voltage limits are: Min. 31.50 volts - Max. 32.50 volts.

CAUTION

Limit overvoltage operation to two minutes maximum.

k. Reduce the power supply voltage to zero. Turn the master switch OFF.

l. Set the VOM to resistance scale and determine continuity between battery terminal (BAT) and regulator terminal (REG.) on the overvoltage relay, to insure that the relay is reset.

m. Change the voltage regulator selector switch from MAIN to AUX. Reconnect the volt/ohmmeter to the AUX. overvoltage relay and repeat steps i thru l.

n. Reset circuit breakers, turn on alternator output circuit breakers, reset voltage regulator selector to MAIN, disconnect VOM, and reconnect the battery cables.

11-27b. OVERVOLTAGE RELAY OPERATIONAL CHECK (PARALLELING SYSTEM). This check should be accomplished at each 500 hour inspection, per the following instructions:

a. Pull all circuit breakers to the out (OFF) position except the left and right voltage regulator (5 amp) circuit breakers.

b. Obtain a variable D.C. voltage power supply and set it to zero output.

c. Connect the power supply to the aircraft through the external power receptacle.

d. Turn ON the left alternator section of the Dual Master Switch.

e. Obtain a volt/ohmmeter and set it to 60 volts D.C. Connect the positive lead of the VOM to the output (LOAD) terminal of the LEFT overvoltage relay. Connect the negative lead of the VOM to airframe ground.

f. Increase the output voltage of the variable D.C. power supply until the LEFT overvoltage relay trips out. (An audible click will be heard when the relay operates and the VOM needle must drop to zero volts.) Record the power supply voltmeter reading which was indicated just prior to the overvoltage relay operating. Voltage limits are: Min. 31.50 volts - Max. 32.50 volts.

g. Reduce the power supply to zero. Turn OFF the left alternator section of the Dual Master Switch. Another click will be heard when the overvoltage relay resets itself for normal operation.

h. Turn ON the right alternator section of the Dual Master Switch. Reconnect the volt/ohmmeter to the right overvoltage relay and repeat steps f and g.

NOTE

These units are not adjustable. Replace the overvoltage control if it does not test to specifications.

11-27c. VOLTAGE SPIKE SUPPRESSOR. The Voltage Spike Suppressor is connected to the aircraft electrical bus through a 10 ampere circuit breaker. (Refer to Figure 11-2.) The purpose of this unit is to provide a cut-off of voltage spikes above a given amplitude caused by voltage surges on the electrical bus during normal operation. Should the amplitude of the voltage spikes exceed the cut-off limit of the suppressor, they will be bypassed to ground. This will eliminate any possible subsequent damage to the semiconductor equipment attached to the electrical bus of the aircraft.

11-28. STARTING MOTORS.

11-29. DESCRIPTION. The gear reduction starting motor consists of six major components. The Commutator End Head Assembly, The Armature, The Frame and Field Assembly, The Gear Housing, and The Bendix Drive Assembly. Refer to Figure 11-16.

11-30. OPERATION. When the starting circuit is energized, battery current is applied to the starting motor terminal. Current flows through the field coils, creating a strong magnetic field. At the same time, current flows through the brushes to the commutator, through the armature windings to ground. The magnetic force created in the armature combined with that created in the field windings begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, where it is supported by a roller bearing. The gear mates with the teeth of the reduction gear that drives the Bendix shaft. The shaft is keyed to the reduction gear. The Bendix drive is held in position on the shaft by a "spirol" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the starter drive housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the starter drive gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the starter drive gear.

11-31. MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and the conditions under which the aircraft is operated. It is recommended that such inspection be made at least twice a year and include the following:

a. The battery should be checked with a hydrometer to be sure it is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

b. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

1. Voltage loss from insulated battery post to starting motor terminal - 0.3-volt maximum.
2. Voltage loss from battery ground post to starter frame - 0.1-volt maximum.

NOTE

If voltage loss is greater than the above limits, additional tests should be made over each part of the circuit to locate the high-resistance connections.

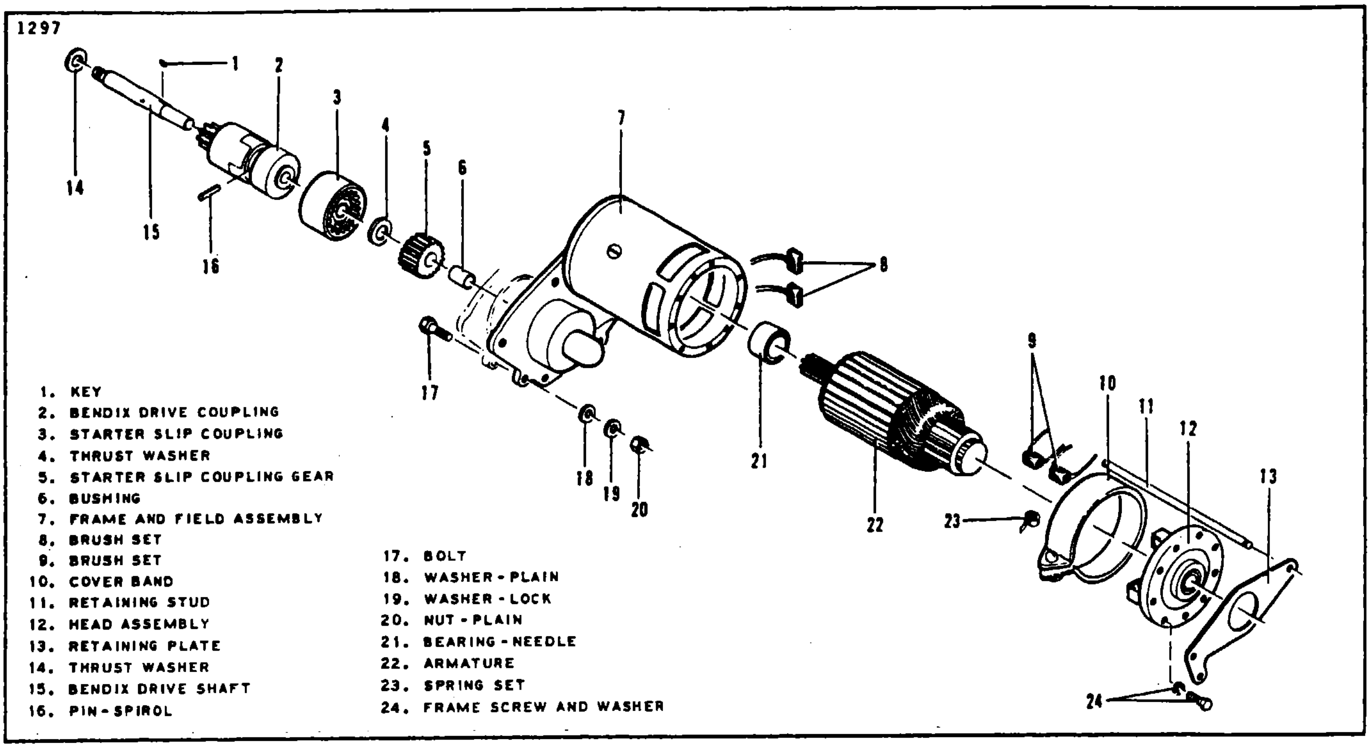


Figure 11-16. Exploded View of Starting Motor

c. No lubrication is required on the starting motor except at the time of overhaul. Then lubricate the entire shaft under Bendix Drive, fill grooves in armature shaft at drive end and pack gear box with 1.3 to 2.0 ounces of Lithium Soap Base Grease # 1925 Molytex "O" or equivalent.

d. The starting motor should be operated for a few seconds with the ignition switch off to make sure that the pinion engages properly and that it turns freely without binding or excessive noise. Then the engine should be started two or three times to see that the pinion disengages properly when the starter switch is released.

11-32. OVERHAUL. If during the above inspection any indication of starting motor difficulty is noted, the starting motor should be removed from the engine for cleaning and repair.

11-33. REMOVAL. To remove the starting motor from the engine, first disconnect the ground cable from the battery post to prevent short circuiting. Disconnect the lead from the starting motor terminal, then take out the mounting bolts. The motor can then be lifted off and taken to the bench for overhaul.

11-34. DISASSEMBLY.

a. Remove the frame screws from the commutator end head and pull end head and armature from frame. Lift the brushes and lock in elevated position with brush springs. Use a puller to remove the end head from the armature. Use a special bearing puller to remove the sealed ball bearing from the armature shaft.

b. Remove the frame screws that secure the gear housing to the frame. Pull Bendix shaft from pinion housing. Do not lose the steel spacer that is located on the pinion end of the shaft. Remove reduction gear, woodruff key and steel spacer from shaft.

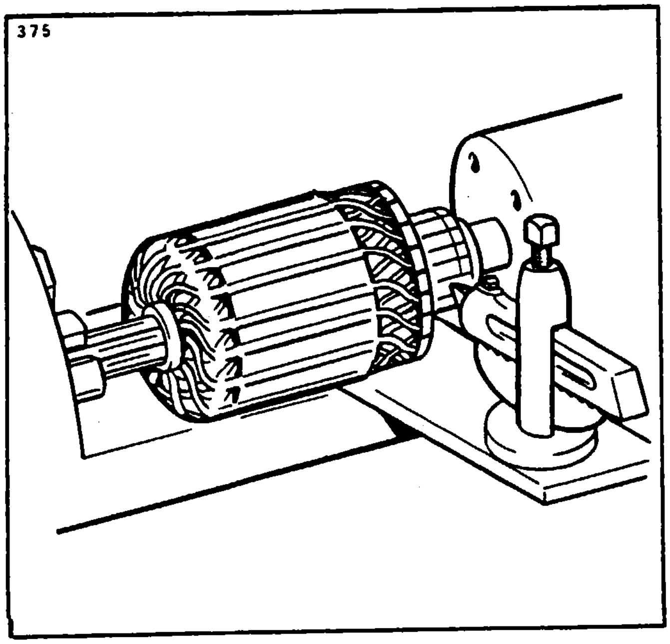


Figure 11-17. Turning Starting Motor Commutator

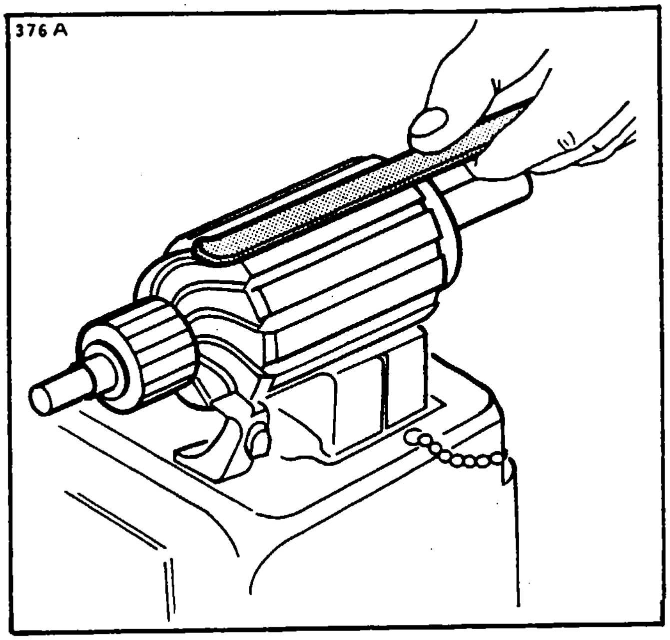


Figure 11-18. Testing Motor Armature for Shorts

c. Turn the Bendix pinion until it locks in the extended position. Locate "spirol" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

d. To remove the roller bearings from the gear housing, use an arbor press and the correct bearing arbor. DO NOT HAMMER OUT. Each part should be cleaned and inspected for excessive wear or damage. Bearings should be checked for proper clearance and evidence of roughness or galling. Oil and dirt should be removed from insulation and the condition of the insulation checked.

11-35. BRUSHES. Check the brushes to see that they slide freely in their holders and make full contact on the commutator. If worn to half their original length or less, they should be replaced.

11-36. ARMATURE.

a. Check the commutator for uneven wear, excessive glazing or evidence of excessive arcing. If only slightly dirty, glazed or discolored, the commutator can be cleaned with 00 or 000 sandpaper. If the commutator is rough or worn, it should be turned in a lathe. Refer to Figure 11-17. The armature shaft should be inspected for rough bearing surfaces and rough or damaged splines.

b. To test the armature for grounds, a set of test probes connected in series with a 110-volt light should be used. Touch one probe to a commutator segment and the other to the armature core. If the test lamp lights, the armature is grounded and should be replaced.

c. To test for shorted armature coils, a growler is used. (Refer to Figure 11-18.) The armature is placed on the growler and slowly rotated by hand while a steel strip is held over the core so that it passes over each armature core slot. If a coil is shorted, the steel strip will vibrate.

d. A quick check for opens can be made by inspecting the trailing edge (in direction of rotation) of the commutator segments for excessive discoloration. This condition indicates an open circuit.

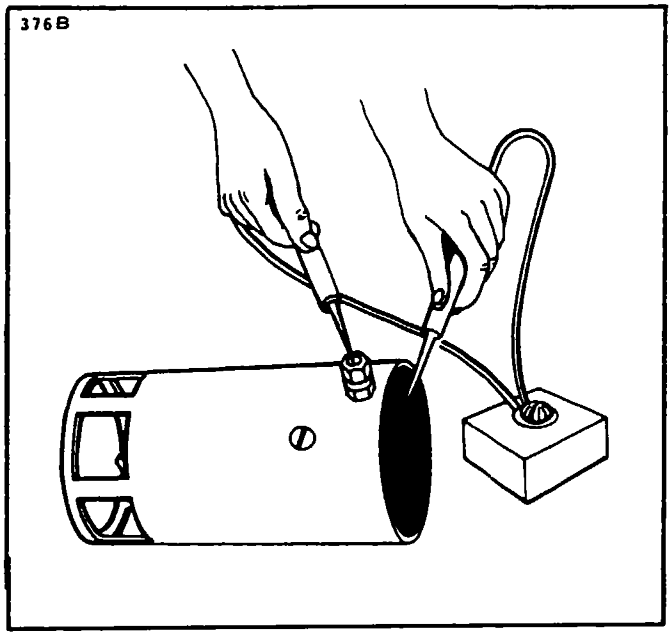


Figure 11-19. Testing Motor Fields for Grounds

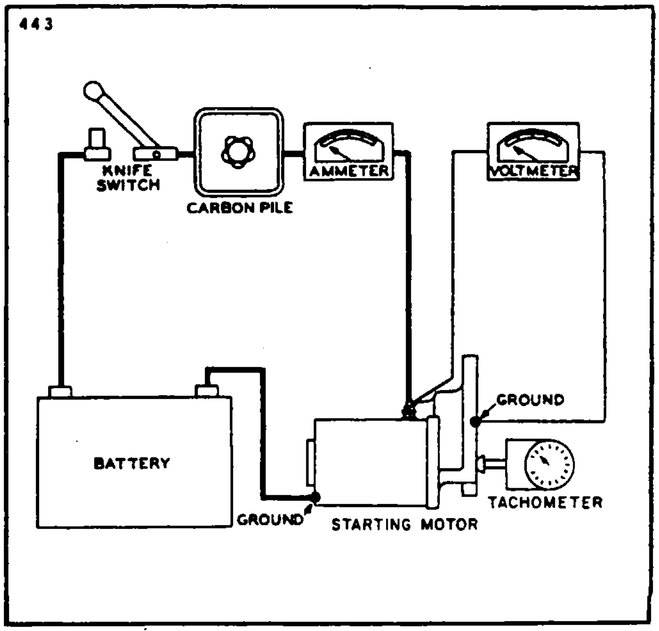


Figure 11-20. No-Load Test Hook-Up

11-37. FIELD COILS.

a. Check the field coils for grounded windings. Disconnect the shunt field coil ground connection and make sure the brushes are not accidentally touching the frame. Using a test lamp and probes (Refer to Figure 11-19) touch one test probe to the motor terminal and the other test probe to the motor frame. If the test lamp lights, the field coils are grounded. Repair or replace field coils.

b. Check the shunt field current draw to the specifications contained in Table XI-IV, Starting Motor Test Specifications.

c. Inspect all connections to make sure they are clean and tight and inspect insulation for deterioration.

11-38. BRUSH HOLDERS.

a. To test brush holders, touch one test probe to the brush plate and the other to each brush holder.

b. The test lamp should light when the grounded brush holders are touched and should not light when the insulated brush holders are touched.

11-39. GEAR HOUSING. Inspect bearings for excessive wear, and housing for cracks.

11-40. BENDIX DRIVE. The Bendix Drive should be wiped clean with a dry cloth. The pinion should turn smoothly in one direction and should lock in the other direction. Replace drive if it fails to check as above or if the pinion teeth are excessively worn or damaged.

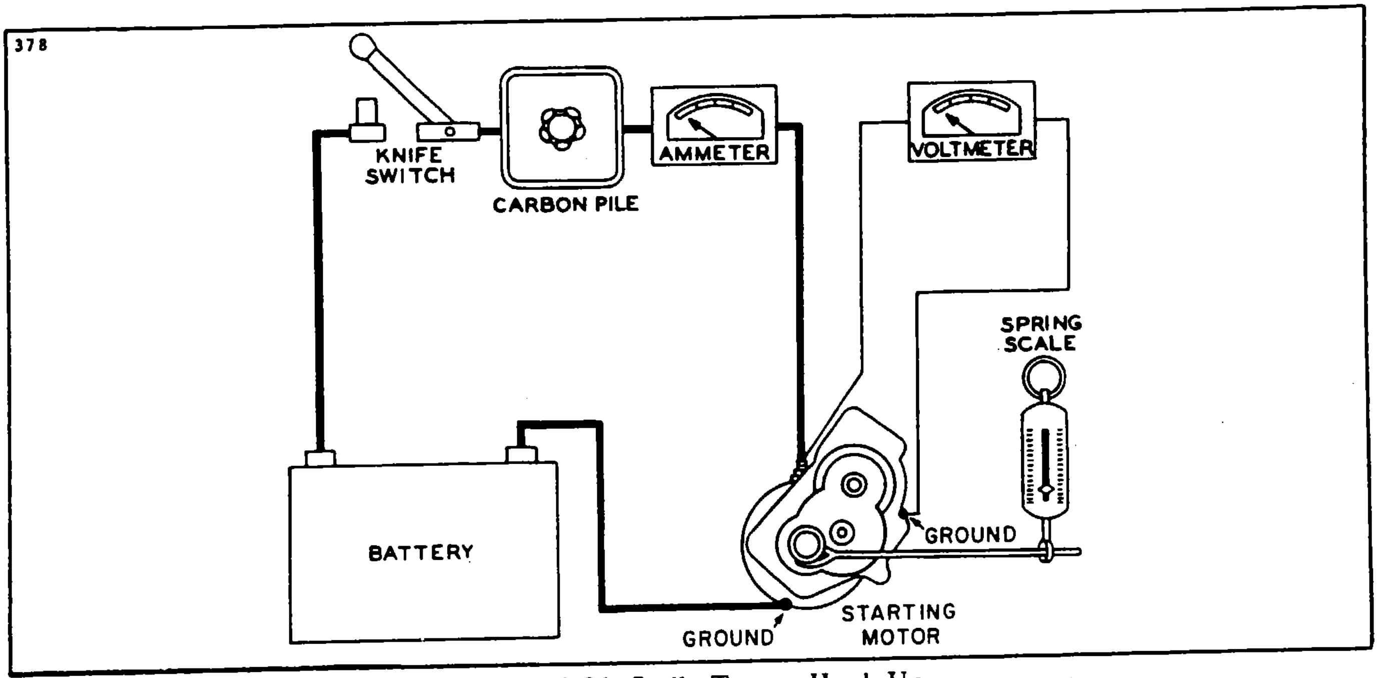


Figure 11-21. Stall - Torque Hook-Up

11-41. ASSEMBLY.

a. When assembling the starting motor, always use an arbor press and the proper bearing arbor for installing bearings. The Bendix shaft should have a thin film of Lubriplate # 777 or equivalent on the Bendix portion of the shaft. End play should be .005 to .050 of an inch.

b. New brushes should be properly seated when installing by wrapping a strip of 00 sandpaper around the commutator (with the sanding side out) 1-1/4 to 1-1/2 times maximum. Drop brushes on sandpaper covered commutator and turn the armature slowly in the direction of rotation. Dust should be blown out of the motor after sanding.

c. When installing the end head on the motor frame, ascertain that the letter "L" on the end head is directly in line with the motor terminal stud.

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with the scale hooked under the brush spring near the brush and the reading is taken at right angles to the line of force exerted by the brush spring.

d. Check the position of the pinion to be sure the unit will mesh properly with the starter drive gear. See specifications for unit for correct dimensions. Refer to paragraph 11-44.

11-42. BENCH TESTS.

a. After the starting motor is reassembled, it should be tested to see that the no-load current at a certain voltage is within specifications as given in paragraph 11-44. To make this test, connect as shown in Figure 11-20. If current is too high, check the bearing alignment and end play to make sure there is no binding or interference. Two or three sharp raps on the frame with a rawhide hammer will often help to align the bearings and free the armature.

b. If no difficulty is indicated in the above test, a stall torque test may be made to see if the starting motor is producing its rated cranking power. Make test connections as shown in Figure 11-21.

c. If torque and current are not within specifications, check the seating of the brushes and internal connections for high resistance. If these checks are made and found to be in good order, replace frame and field assembly and retest starter.

11-43. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect the control circuit wiring between the battery solenoid and manual starting switches for breaks, poor connections and faulty insulation. Tighten all connections and make sure solenoid is firmly mounted and makes a good ground connection.

b. Check the voltage loss across the switch contacts during normal starting. If loss is in excess of 0.2 volts per 100 amperes, the solenoid should be replaced.

c. If solenoid fails to operate when the manual switch is turned on or if it fails to release when the manual switch is released, it should be removed and tested to specifications. If either opening or closing voltages are not to specifications, replace the solenoid.

11-44. STARTING MOTOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for 24-volt starting motors installed as standard equipment on the PA-31P are as follows:

TABLE XI-V. STARTING MOTOR SPECIFICATIONS

Motor Model	MHB-4005
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.
Shunt Field Coil Current Draw at 24.0 Volts (77°F) Min. Amps. Max. Amps.	 8.7 10.4
No-Load Test (77°F) Volt Max. Amps. Min. R.P.M.	 20 35 4600 (1)
Stall Torque Amps. Min. Torque, Ft. Lbs. Approx. Volts	 330 10.7 16.0
(1) Make test as brief as possible to avoid possible armature damage.	

11-45. BATTERY. (LEAD ACID)

11-46. SERVICING BATTERY. The battery is located in the nose section of the airplane, aft of the nose cone. Access to the battery is through the nose cone access door. The battery should be checked for fluid level, but must not be filled above the horizontal baffles. A hydrometer check should be made to determine the percent of charge present in the battery. Ascertain that all connections are clean and tight. These services should be done at intervals of 50 hours or 30 days whichever comes first. The battery should be removed from the battery box at each 100 hour inspection or every 90 days, and any traces of corrosion cleaned from both the battery and battery box.

11-47. REMOVAL OF BATTERY.

a. Open the small access door on the left side of the nose section and unlatch the nose cone latching mechanism, then swing open the nose cone.

b. Remove the two wing nuts at the top of the battery box, and remove the cover by lifting and pulling it towards the front of the airplane.

c. Disconnect the battery cables.

NOTE

Always remove the ground cable first and install it last to prevent accidental short circuiting or arcing.

d. Lift the battery out of the battery box.

11-48. INSTALLATION OF BATTERY.

a. Ascertain that the battery and battery box are free of any corrosion. (Refer to paragraph 11-49.)

b. Install the battery into the box with the terminals towards the left side.

c. Apply a light coating of petroleum jelly to the battery terminals.

d. Connect the positive terminal to the battery.

CAUTION

A polarity check of the battery should be made with a voltmeter before completing the cable hookup. A reverse polarity would destroy diodes in the electrical system.

e. Connect the ground cable and install the battery box cover over the battery and secure in place with two wing nuts.

f. Ascertain that the combination vent and drain tube on the lower left side of the battery box is not clogged or kinked.

g. Close the nose cone and secure with the latching mechanism on the left side of nose section and close small access door.

11-49. BATTERY BOX CORROSION PREVENTION. The following check against corrosion within the battery box should be performed at least every 30 days or 50 hours.

a. Open the battery box cover and check for any indication of electrolyte that may have overflowed into the box.

b. Check terminals and connections for corrosion. Corrosion effects may be neutralized by applying a solution of baking soda and water mixed to the consistency of thin cream.

CAUTION

Do not allow soda solution to enter battery.

c. Repeat application until all bubbling action has ceased.
d. Wash battery and box thoroughly with clean water and dry.
e. Paint the battery box with an acid resistant paint if necessary.
f. Close battery box cover and secure with two wing nuts.

11-50. HYDROMETER READING AND BATTERY CHARGE. Whenever checking the battery, ascertain that all connections are clean and tight and the fluid level is above the baffle plates. If it is necessary to add fluid, fill cell with distilled water to a maximum of 3/8 of an inch above the baffle plates. After adding water, charge the battery until gassing before taking a hydrometer reading. Otherwise, the water and electrolyte will not be mixed, giving a false reading. Temperatures different from the established norm will also effect the hydrometer readings. Refer to Table XI-VB for the temperature corrections. Specific gravity values for a fully charged battery are as follows:

Electrolyte Temperature	Specific Gravity
47°F 77°F 107°F	1.290 to 1.310 1.280 to 1.300 1.270 to 1.290
Temperature change of 30°F changes the reading 0.010.	

TABLE XI-VA. ELECTROLYTE TEMPERATURE

To adjust low specific gravity, charge the battery (see Charging Battery) until it is gassing and until the specific gravity rises no higher over a 3 hour period. Then remove some electrolyte and replace with 1.300 specific gravity electrolyte. Repeat this step if after one hour of charging the specific gravity is still too low. DO NOT ADJUST A CELL THAT DOES NOT GAS.

To adjust high specific gravity, charge the battery (see Charging Battery) until it is gassing and until the specific gravity rises no higher over a 3 hour period. Remove some electrolyte and replace with distilled water. Repeat this step if after one hour of charging the specific gravity is still too high.

11-51. CHARGING BATTERY. Remove the battery from the airplane before charging. (Refer to Paragraph 11-47.)

a. Remove caps and check fluid level.

b. The battery may be charged at any rate in amperes that will not produce gassing or bubbling of the electrolyte or a cell temperature in excess of 115°F as soon as gassing starts, or before. If the temperature reaches this limit, the rate should be reduced and the charge completed at 1-1/2 amperes or lower; do not charge at a higher rate while cells are gassing. If charging at constant current is more convenient, the entire charge may begin at or below 3 amperes and finished at or below 1-1/2 amperes.

c. If the cells flood or sputter electrolyte, the level is too high and should be lowered by withdrawing electrolyte down to the specified level. Clean exterior of battery per Paragraph 11-49.

TABLE XI-VB. SPECIFIC GRAVITY TEMPERATURE CORRECTION

Electrolyte Temperature		
°C	°F	Correction
60	140	+.024
55	130	+.020
49	120	+.016
43	110	+.012
38	100	+.008
33	90	+.004
27	80	.000
23	70	-.004
15	60	-.008
10	50	-.012
5	40	-.016
-2	30	-.020
-7	20	-.024
-13	10	-.028
-18	0	-.032
-23	-10	-.036
-28	-20	-.040
-35	-30	-.044

CAUTION

In the operation of the battery, gases are formed which may be explosive if ignited. Never create sparks of any kind or bring an open flame near the battery. Ventilate the battery compartment when charging to dispose of the gas generated by the battery.

d. A sulfated battery requires a different charging procedure. Charge the battery at the normal rate until the specific gravity does not rise for 2 hours. Then overcharge for 60 hours at 10% of the normal charging rate. If battery capacity is still low, the battery is unfit for service and needs to be replaced.

e. Reinstall the battery when completely charged.

11-51a. BATTERY DISCHARGE. The capacity of a storage battery is measured in units of ampere hours, which is the product of the electrical current in amperes multiplied by the time in hours. Although current may be obtained after the end of the time, the voltage of the battery has dropped to a point beyond which it is not very useful. The ampere hours which may be obtained from a battery are greater for a long low-rate or intermittent rate discharge than for a short high-rate discharge because the voltage will drop faster at the higher discharge rate. The maximum permissible rate of discharge is limited only by the current-carrying ability of the wiring, motor, or other apparatus to which the battery is connected or by the current-carrying ability of the cell terminals and connectors and not by the plates themselves. Listed below are recommended discharge rates:

TABLE XI-VC. ELECTRICAL DISCHARGE RATES

Battery Type	Plates per Cell	Volts	5 Hours Ampere Hours	20 Min. 80°F Amps	5 Min. 80°F Amps	3 Min. 0°F Amps
12-GCAB-24	9	24	25	44	117	117

11-51b. HIGH AND LOW TEMPERATURES. Operation of storage batteries beyond their ambient temperature or charging voltage limits will result in excessive cell temperatures leading to electrolyte boiling, rapid deterioration of the cell, and finally battery failure. The relationship between the maximum charging voltage and the number of cells in the battery is also significant, since this will determine (for a given ambient temperature and state of charge) the rate at which energy is absorbed as heat within the battery. The maximum voltage per cell should not exceed 2.35-volts, and the maximum temperature should not exceed 115°F.

Low electrolyte temperatures temporarily reduce the battery capacity and the freezing point depends on the specific gravity. To prevent freeze damage, maintain the specific gravity at a reasonably high level as indicated by Table XI-VD.

NOTE

Lead-acid batteries are subject to a constant discharge due to the internal chemical action.

11-51c. BATTERY REPAIRS, STORAGE AND SERVICE TIPS. The internal parts of the battery have been designed to wear at approximately the same rate, making it uneconomical to replace any of the parts with new ones. Replacing the entire battery is simpler and cheaper.

Before storing the battery, it should be properly charged, the vent plugs put tightly in place, and the leads disconnected to prevent use during idle periods. The battery should be charged at intervals during the idle period. Before returning the battery to service, it should be thoroughly charged. The battery will be sufficiently charged when, after a 3 hour period, the specific gravity does not rise any higher with the electrolyte gassing and a charging rate of 1-1/2 amperes.

Long battery life and trouble-free service is obtained from the battery if the following simple tips are observed:

a. Keep it clean.
b. Keep it charged.
c. Maintain proper electrolyte levels.
d. Keep specific gravity equal among all cells.

TABLE XI-VD. ELECTROLYTE FREEZING POINTS

Specific Gravity	Freezing Point	
	°C	°F
1.300	-70	-95
1.275	-62	-80
1.250	-52	-62
1.225	-37	-35
1.200	-26	-16
1.175	-20	-4
1.150	-15	+5
1.125	-10	+13
1.100	-8	+19

11-52. STARTING THROUGH EXTERNAL POWER RECEPTACLE. When using external power from such sources as a 24-volt generator or battery carts, etc., to start or service the airplane, the master switch should be OFF.

The master switch should be OFF when operating any equipment from external power, and whenever inserting or removing the plug from the external power receptacle.

Do not connect the power carts to a low battery.

If a six-volt battery is available, it can be connected in series with the 24-volt external battery to supply 30-volts for starting. In this case, use the same starting procedure as used with a power cart.

CAUTION

In the event it becomes necessary to start the engines through the external power receptacle, due to a low battery condition, ascertain that aircraft battery is on the charging line by monitoring the battery ammeter (charging current will be high). Do not take off until charging current falls below 20 amperes.

NEVER use a 12 or 24-volt battery in place of the six-volt battery, since electrical damage may result.

11-53. BATTERY (Nickel Cadmium). The 24-volt vented nickel-cadmium storage battery requires little service which is normally limited to checking electrolyte level during each periodic inspection, cleaning the battery box and components when necessary, equalizing the cells when required and occasionally recharging the battery.

CAUTION

Do not use tools, hydrometers, or water that have been contaminated by contact with lead-acid batteries or acid of any kind.

Electrolyte (Potassium Hydroxide) is very caustic and will burn the eyes, fabric, skin, etc. Neutralize with 3% boric acid and wash with water.

Be very careful when working with tools around the battery terminals. This battery can deliver very high currents when started and a cell may sometimes be exploded by spark. It is advisable to remove finger rings when working on a battery since a ring may fuse to the intercell straps and cause loss of the finger.

NOTE

Keep vent plugs in place at all times except when inspecting and adjusting electrolyte level. Carbon dioxide absorbed from the air forms potassium carbonate which could effectively dilute the electrolyte.

11-54. REMOVAL OF BATTERY.

a. Open the small access door on the left side of the nose section and unlatch the nose cone latching mechanism, then swing open the nose cone.
b. Disconnect electrical cables from battery.

NOTE

Always remove the ground cable first and install it last to prevent accidental short circuiting or arcing.

c. Remove attaching bolts from battery mounting lugs.
d. Disconnect battery vent lines and remove battery.

11-55. INSTALLATION OF BATTERY.

a. Slide battery into position and secure with attaching bolts.
b. Connect battery vent lines and electrical cables.
c. Position and secure nose cone.

11-56. BATTERY CLEANING. The nickel-cadmium batteries must be kept clean and dry to maintain peak performance. Foreign materials in sufficient quantities may form conductive paths that will permit a rapid self-discharge of the cells in the battery. To prevent this condition, the battery should be cleaned every 30 days or 100 hours of service, whichever occurs first.

a. Remove the battery and clean off the case and cover.

b. Clean the top of the cells, filler cap vent plugs and terminal links with a soft bristle brush or compressed air. Do not use a wire brush as it will damage the battery.

c. Remove vent plugs and wash under running water while removing deposits. Avoid contact with any portion of the plug that has electrolyte on it.

d. If intercell connectors become hot or show signs of overheating, disassemble, clean and reassemble. Torque the connections properly as specified in Table XI-V.

11-57. PERIODIC BATTERY CHECK. The condition of the battery should be determined annually if the temperatures are 100 degrees Fahrenheit or below. If the temperatures are above 100 degrees Fahrenheit the battery should be checked more frequently. This check will also equalize the cell voltages.

a. Discharge the battery at a rate of 20 amperes until the cutoff voltage of 20.0 volts.

b. Adjust the resistive load to 3 amperes for an additional 12 hours. The battery voltage will decay essentially to zero.

NOTE

Some cells may reverse during this final discharge. This is not abnormal. At the low current and relatively short time involved, this is not harmful.

c. When battery cools to room temperature, completely recharge it. Let the battery stand idle after recharge for four to eight hours and then adjust electrolyte level in accordance with paragraph

11-58. ADJUSTMENT OF ELECTROLYTE LEVEL. The liquid level in this battery varies with the state of charge. It should be visible above the bottom of the baffle when the battery is fully charged.

a. The level must be adjusted after the battery is fully charged and has been at rest for two to four hours on an open circuit.

b. Remove the vent plug from each cell one at a time to adjust electrolyte level.

c. Use a transparent tube open at both ends, about six inches long and 0.0250 of an inch in diameter. Insert it perpendicular into the filler well until the end rests lightly on the cell baffle. Then place the index finger over the top end and withdraw the tube.

CAUTION

Do not spill any electrolyte on the airplane structure.

d. The liquid level in the tube should be between 0.375 to 0.500 of an inch. If the liquid level is above 0.500 of an inch, remove the excess with a syringe or squeeze bottle. If the level is below 0.375 of an inch add distilled water only.

e. The battery should be recharged after the addition of distilled water to prevent damage from freezing during cold weather.

CAUTION

The electrolyte used in nickel-cadmium batteries is potassium hydroxide which is highly caustic and will burn skin or clothing. Spilled electrolyte should be neutralized with a mild boric acid solution or vinegar. If neither is available, wash the contaminated area thoroughly with water. If any electrolyte comes in contact with eyes, immediate medical attention should be obtained.

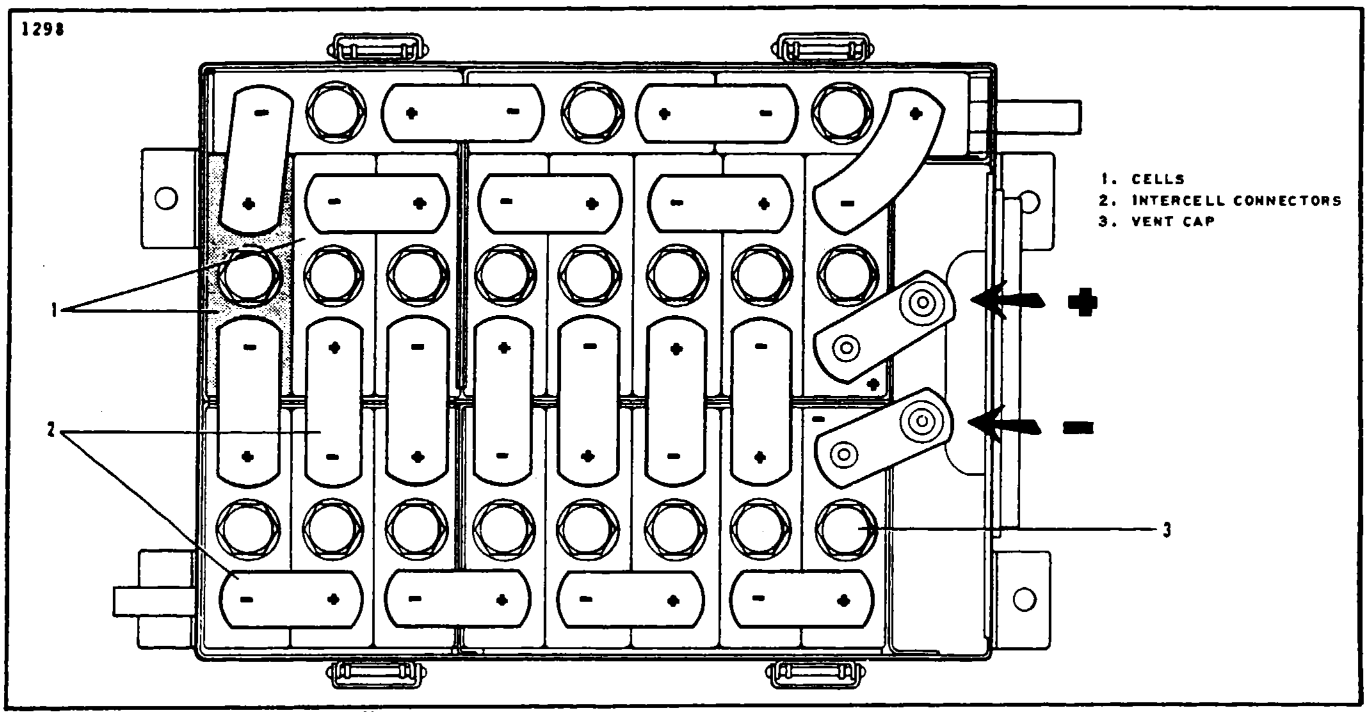


Figure 11-22. Cell Layout - Nickle Cadium Battery

11-59. BATTERY CELL REPLACEMENT. To avoid personal injury or battery damage, do not remove a cell or terminal lugs from a charged battery. If the battery has not been discharged through normal use, discharge it in accordance with instructions below:

NOTE

Never use acid or tools contaminated with acid during any service on this battery. Even small traces of acid can damage this battery. Use only equipment reserved for nickel-cadmium batteries.

a. Discharge the battery at the one hour rate or slower. Using appropriate clip leads, short circuit each cell as its voltage goes below one volt.

b. After all cells have been shorted, remove the clip lead and connecting straps from the defective cell.

c. Lift cell from battery case by lifting at the terminals. For large cells, lift by two terminals to avoid bending of studs.

CAUTION

Safety mask or goggles should be worn to protect the eyes from any electrolyte spray which might be squeezed from the replacement cell when it is pushed into place.

NOTE

Do not remove the defective cell from the battery case until a replacement cell is immediately available.

d. Install the new cell being sure it is discharged and the polarity symbols are in the right direction.

e. If the cell is difficult to install, apply a little vaseline or Shell Dorina # 2 on the sides of the replacement cell.

f. Reassemble the attaching hardware. These parts are specifically designed to provide an adequate electrical connection. Never use homemade hardware.

g. Tighten the link screws to a torque to specifications given in Table

h. Recharge the battery in accordance with paragraph 11-60 charging battery.

i. Allow the battery to stand for two to four hours, then adjust the liquid level in accordance with paragraph 11-58 Adjustment of Electrolyte Level.

11-60. CHARGING BATTERY. A battery's capacity is measured in "ampere hours", abbreviated A.H. This term in the product of the number of amperes flowing from the battery multiplied by the number of hours this current flows. The charge required is also measured in ampere hours and is always somewhat larger than the discharge obtainable. The amount of recharge required at normal rates and temperatures may range from 115% to 140% of the discharge obtainable.

For values of all voltages, currents, etc. referred to Table XI-VC. Charging is most efficient when performed at battery temperatures between +40° F and +80° F. Charge should not be started except when necessary, if the battery temperature is above 100° F.

Do not charge a nickel-cadmium battery in the proximity of lead-acid batteries. There may be enough fumes or acid spillage to contaminate the nickel-cadmium battery. If the same equipment is used to charge both types of batteries it should be thoroughly cleaned with a solium bicarbonate solution before using it on nickel-cadmium batteries. There are several methods used to charge this type of battery, the preferred method and an alternate method AIC given below.

11-61. CONSTANT CURRENT CHARGING. This method is preferred over all other methods.

If the state of charge of the battery is unknown, completely discharge the battery before proceeding with the charging .

a. Charge the battery at 5 to 11 amperes until the battery voltage reaches the "control point" value while the battery is connected and charging. Then charge the battery at the finishing rate which is 1/3 of the ampere hours already put into the battery at the starting rate.

NOTE

When the battery voltage reaches the "Control Point" the amount of charge received by the battery is approximately equal to that previously removed by actual or self-discharge. Additional charging at the finished rate equal to 1/3 of the initial charge will assure a fully charged battery.

b. When the initial charge at the starting rate has been completed, the time required for finishing charge may be computed as follows:

$$T_f = \frac{I_S \times T_S}{3 \times I_f}$$

T_f = Time, in hours, required for finishing charge.
I_s = Starting charge rate, in amperes
T_s = Time, in hours, of charge at the starting rate until "Contact Point" voltage was reached.
I_f = Rate, in amperes, of finishing charge.

11-62. CONSTANT POTENTIAL CHARGING. This is an alternate method of charging a nickel-cadmium battery.

a. Charge the battery for four hours at 28.5 volts. The charger should be able to deliver a minimum of 23 amperes.

b. A nearly full charged (90%) battery may be restored in one hour at 28.5-volts if the charger is capable of delivering at least 43 amperes.

c. A battery in a discharged state will accept very high currents, for a few minutes at the beginning of the charge. 230 amperes is the maximum in rush current at 28.5-volts. This current does not damage the battery, but the charger should have inherent current limiting or be otherwise protected against overload.

TABLE XI-VI. NICKEL CADMIUM BATTERY SPECIFICATIONS

Battery Type: AKO 1923

Capacity: 23 AH @ the 1 hour rate. Venting Pressure 2 - 10 psig.

Number of series connected cells –19–Nominal Voltage –24

OCV: Fully charged–25–volts or more.
Fully discharged–22–volts or less.

Constant Current Charging:
Starting rate (I_s) - 5 to 11 amperes – Control Point 29.5 volts.
Finishing rate (I_f) - 2 to 7 amperes – Trickle rate 115 to 230 MA.

Constant Potential Charging:
Voltage (E_c) 28.5 V. Charger Capability: 23 amperes min.
Inrush current at above voltage: 230 amperes max.
Floating Voltages:

0°F	27.5	to	29.5	volts
75°F	26.6	to	28.5	volts
100°F	26.0	to	28.0	volts

Discharge Rates:	Cutoff Voltage:
Max. Continuous:	565 amps.
Max. Peak (1 sec.)	10000 amps.
1 hour rate: 23 amperes	19.0
5 hour rate: 5 amperes	20.0
20 hour rate: 1.25 amperes	20.9

(Cell) Terminal Type: Screw - Thread Size 10/32 – Torque: 34-38 in. lbs.

Electrolyte Level:	Depth in Baffle:
Charged State, 2 to 24 hours after charge:	3/8" - 1/2"
During last 20 minutes of charge:	5/8" - 7/8"
On float or trickle, charged condition:	1/2" - 3/4"

11-63. ELECTRICAL SWITCHES AND CIRCUIT BREAKERS.

11-64. REMOVAL OF OVERHEAD SWITCHES. These switches are located on electro-luminescent panels mounted in a single royolite trim panel above the overhead instrument panel, located centrally above the windshield.

11-65. REMOVAL OF OVERHEAD SWITCHES.

a. Ascertain that the airplane master switch is off.

b. Remove the screws securing the particular electro-luminescent panel containing the switch to be serviced.

c. With the electro-luminescent panel unfastened from the royolite trim panel, it is now possible to gain access to the switch mounting clip at the back of the panel.

d. Working from the rear of the switch, insert a narrow, thin bladed screwdriver between the top of the switch and the mounting clip, then disengage the clip from the switch. Also, do the same at the bottom of the switch and mounting clip.

CAUTION

Use caution when working on these switches and panels that other parts and wiring are not damaged.

e. If the switch must be changed, mark the wires before disconnecting them, for ease of reassembly.

11-66. INSTALLATION OF OVERHEAD SWITCHES.

a. Install the new switch into the electro-luminescent panel from the back end of the panel by inserting a narrow, thin bladed screwdriver between the top of the switch and the mounting clip to help engage the prongs on the switch body into the clip. Do the same at the bottom of the switch.

NOTE

The mounting clip has two positions built into it for positioning the switch. Be sure to get both the upper and lower prongs on the switch body into the same positions on either end of the clip.

b. Connect the wires to the proper switch terminals.

c. Install the particular switch panel into the royolite trim panel and secure it in place with screws.

d. Check the operation of the new switch to determine the proper function of the particular system it controls.

11-67. CIRCUIT PROTECTOR PANEL. This is an electro-luminescent panel which is located on the left side of the pilot's seat below the side window, and incorporates all the circuit protectors for the various electrical systems used in the airplane. There is another panel below the circuit protector panel which has the left and right alternator switches, radio master, airplane master and voltage regulator switches along with the mike and phone jacks for the pilot. (Refer to paragraph 11-68.) The circuit protector panel can be removed and serviced in accordance with the following procedure:

a. Disconnect the airplane's battery before doing any work on the circuit protector panel.

b. Remove the six mounting screws securing the panel in place and pull the panel out slightly to gain access to the machine screw and nut which connect the wire from the electro-luminiscent panel at the top of the cover.

CAUTION

Use caution when working on these circuit protectors so that other parts and wiring are not damaged.

c. Before removing any wires from the particular circuit protector being serviced, mark the wires for ease of reassembly.

d. Remove the wires from the circuit protector and also remove the bus bar linking the circuit protectors to other units.

e. Remove the knurled ring nut and nylomatic washer from the face of the circuit protector panel and remove the unit from the rear of the panel.

11-68. REMOVAL OF MASTER SWITCH PANEL. This switch panel is located below the circuit protector panel on the left side of the pilot's seat and incorporates the alternator, aircraft master, radio master and voltage regulator switches along with jacks for the pilot's mike and earphones. The panel is removed by the following procedure:

a. Disconnect the airplane's battery before doing any work on these electrical switches.

b. Remove the six screws securing the electro-luminescent panel in place and pull the panel out of the trim cover.

CAUTION

Use caution when working on these switches so that other parts and wiring are not damaged.

c. Mark any wires before disconnecting them from the switches to facilitate reconnection.

d. The alternator switch is removed by removing the nut from the stud extending out the rear of the switch through the bus bar. Also remove the jumper wire between the switches.

e. The radio master switch is removed by removing the knurled ring nut and washer from the front of the switch panel and taking the switch out of the panel from the back.

f. The airplane master and voltage regulator switches are removed in the same procedure as the radio master switches.

11-69. INSTALLATION OF MASTER SWITCH PANEL.

a. Replace or install any switches needed into the electro-luminescent panel and secure them in place before installing the panel.

b. Check the electrical connections thoroughly to ascertain the proper connection to the new or replaced switches.

c. Install the electro-luminescent panel into the switch panel and secure it in place with the six screws.

d. Reconnect the airplane's battery and check the operation of the new or replaced switch.

11-70. INSTALLATION OF CIRCUIT PROTECTOR PANEL.

a. Replace or install any circuit protector required into the electro-luminescent panel and secure in place with the knurled ring nut.

b. Check the electrical connections thoroughly to ascertain all the wires are connected to the proper terminals, making sure the ¼" thick phenolic spacers are in place, between the C.B. panel and the two bulkheads.

c. Install the electro-luminescent panel into the switch panel cover and secure it in place with six mounting screws.

d. Reconnect the airplane's battery and make an operational check of the new or replaced circuit protectors.

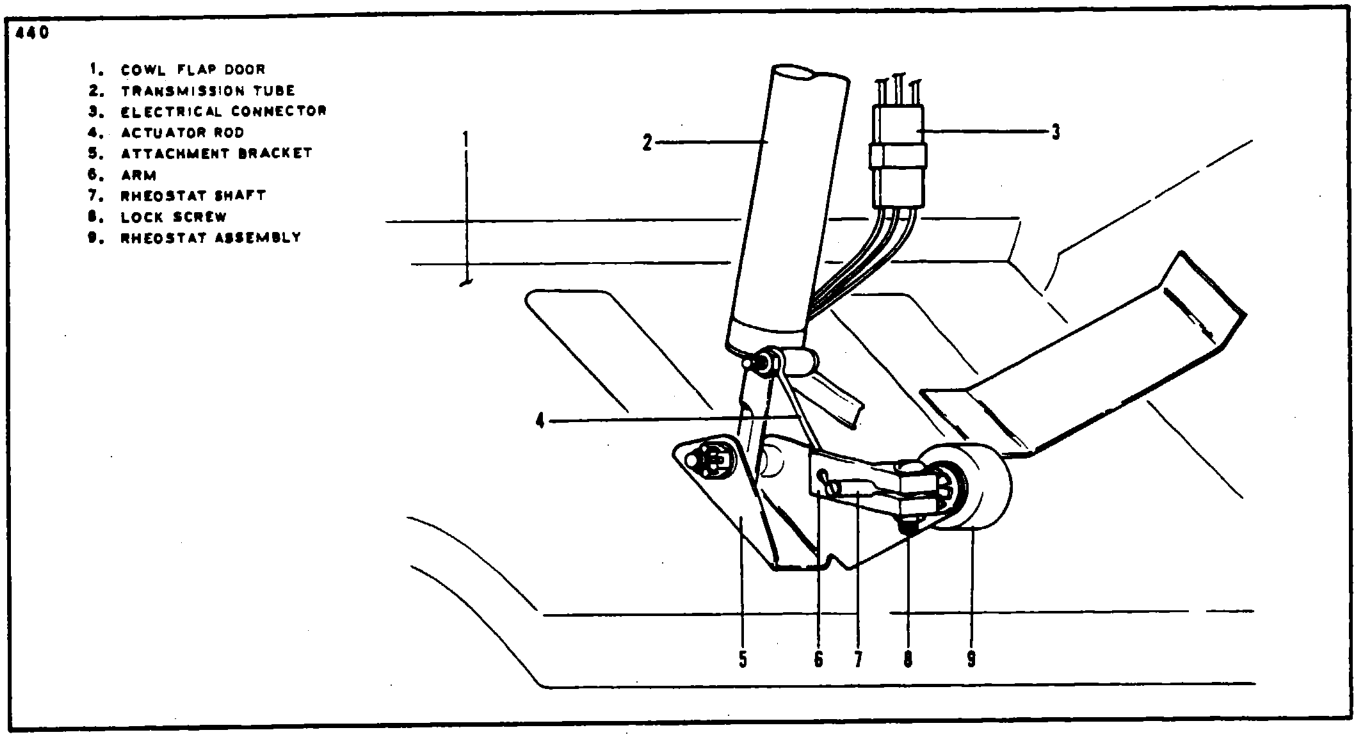


Figure 11-22a. Cowl Flap Indicator Sending Unit, Serial Nos. PA-31P - 54 and up

11-71. COWL FLAP INDICATORS.

11-72. REPLACEMENT OF COWL FLAP INDICATOR LIGHTS. (Serial Nos. PA-31P - 1 to 53 incl.) The cowl flap indicator lights are located beneath the landing gear selector and to the outboard sides of the cowl flap actuating switches. The light bulbs may be replaced by unscrewing the top off the post light assembly and replace the little bulb.

11-72a. ADJUSTMENT OF COWL FLAP INDICATORS. (Refer to Figure 11-22a.) (Serial Nos. PA-31P - 54 and up.) The cowl flap indicators are located in the lower left corner of the center instrument panel. The sending unit is a rheostat assembly (9) mounted on the inside of the cowl flap door. Movement of the flap turns the rheostat shaft (7) by means of an arm (6) and actuator rod (4) connected to the transmission tube (2). Adjust each side as follows:

a. Ascertain cowl flap is properly adjusted per Paragraph 8-12.

b. Turn master switch on and move cowl flaps to the down position by actuating the switch in the cockpit. With a voltmeter check the voltage to the rheostat by disconnecting the three pin connector (3) and check wire R1J on the right side of the aircraft and E4D on the left side for 20-volts with the master switch on and cowl flap switch in either up or down position. If there is more or less than 20-volts the indicators cannot be adjusted properly. Reconnect the plug and move the cowl flaps to the up position by actuating the switch in the cockpit.

c. Loosen lockscrew (8) and turn shaft (7) with a screwdriver until the indicator needle on the instrument panel just reaches the up position and tighten the lockscrew.

d. Adjust the indicator on the other side so the two indicator needles are opposite each other in the up position. During movement, and in the down position the indicators may not read exactly opposite each other. This is to be considered normal.

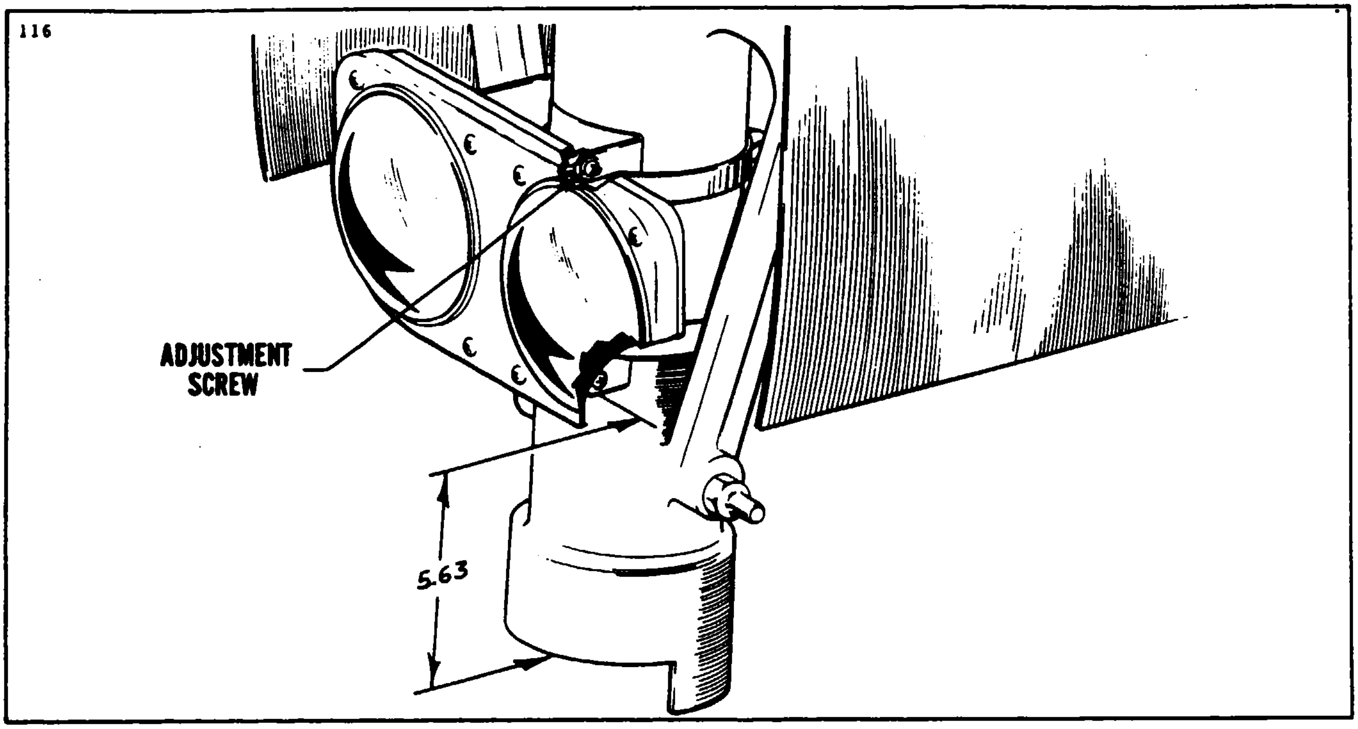


Figure 11-23. Landing and Taxi Lights

11-73. LANDING AND TAXI LIGHTS. These lights consist of two 250 watt lamps which are located on a mounting fixture secured to the nose gear oleo strut housing. Both lamps are used for landing and one lamp is used while taxiing. Each lamp is controlled by a separate switch mounted on the overhead switch panel. (Refer to Figure 11-23.) Both lamps are wired to the same 20 amp circuit protector mounted in the circuit protector panel. There is a safety switch mounted on the nose gear strut which will break the circuit to the lights when the nose gear is retracted in case the pilot forgets to shut the switches.

11-74. REMOVAL OF LANDING AND TAXI LIGHTS. (Refer to Figure 11-23.)

a. Ascertain the circuit protector is off before doing any work on the landing lights.

b. To remove either lamp from the landing light mounting fixture, remove the screws from the front of lamp attachment plate and remove the attachment plate from the mounting fixture.

CAUTION

When removing the attachment plate, use caution not to drop the lamps.

c. Disconnect the electrical leads from the desired lamp being serviced.

d. To remove the complete assembly from the gear strut, disconnect the electrical leads from both lamps and release the clamps that secure the assembly to the strut housing.

11-75. INSTALLATION OF LANDING AND TAXI LIGHTS. (Refer to Figure 11-23.)

a. To install the landing light lamps, attach the electrical leads to the lamp or lamps.

b. Place the lamp or lamps against the mounting pad and position the attachment plate and secure it in place with screws.

NOTE

Tighten the screws just enough to allow the lamps to fit snug in the mounting fixture.

c. To install the landing light assembly to the strut, position the assembly against the strut housing with the bottom of the mounting fixture 5.63 inches up from the bottom of the strut housing. (Refer to Figure 11-23.)

d. Align the bracket longitudinally and secure in place with clamps.

e. The light beam angle may be adjusted by the adjustment screws at the sides of the bracket and tilting the mounting fixture as desired.

11-76. STALL WARNING INDICATOR AND LIFT DETECTOR. This system consists of a stall warning light mounted on the instrument panel in front of the pilot and a lift detector unit mounted in the leading edge of right wing. The electrical circuit for this system is protected by a five amp circuit protector mounted in the circuit protector panel.

11-77. REMOVAL OF LIFT DETECTOR.

a. Ascertain that the circuit protector for this system is open.

b. Mark the relative position of the detector unit to the wing to facilitate reinstallation.

c. Remove the lift detector from the wing by removing the four screws holding the unit in place.

d. Pull the detector unit from the wing and disconnect the wires. It may be helpful to mark the wires before disconnecting them from the unit to facilitate reinstallation.

11-78. INSTALLATION OF LIFT DETECTOR.

a. Connect the wires to the detector unit.

b. Position the unit into the wing; ascertain that the sensor blade of the unit drops down.

c. Secure the detector unit in place with four screws.

11-78a. ADJUSTMENT OF LIFT DETECTOR. The lift detector is adjustable to increase or decrease the speed at which a stall indication is observed. To adjust the detector, loosen the two screws adjacent to the vane and move the vane forward or backward. Movement forward will decrease the stall warning speed, while backward movement will increase the stall warning speed.

11-79. WING NAVIGATION LIGHT.

11-80. REMOVAL OF WING NAVIGATION LIGHT.

a. To remove bulb, remove the screws securing the clear window.
b. Remove screws securing the lens retainer.
c. Remove lens and bulb.

NOTE

To remove the complete lamp assembly, the wing tip must be removed.

11-81. INSTALLATION OF WING NAVIGATION LIGHT.

a. Install bulb, lens gasket and secure retainer.
b. Put clear window in position and secure.

11-82. REMOVAL OF LAMP IN ANTI-COLLISION WING TIP STROBE LIGHT. The lights are located in both wing tips next to the navigational lights.

a. Remove the screws securing the plexiglas window to the wing tip and remove window.
b. Remove the screw securing the navigational light cover and remove cover.
c. Remove the three screws securing navigational light bracket assembly and remove light assembly.
d. Remove the strobe lamp by cutting the wires on the lamp beneath the mounting bracket.
e. Remove the defective lamp.
f. Remove and discard the plug with the cut wires from the electrical socket.

11-83. INSTALLATION OF LAMP IN ANTI-COLLISION WING TIP STROBE LIGHT.

a. Route the wires from the new lamp down through the hole in the navigational light bracket.
b. Insert the wire terminals in the plastic plug supplied with the new lamp. Wire according to the schematic diagram located at the back of this section.
c. Position strobe lamp on navigational light bracket.
d. Secure navigation light assembly and bracket with appropriate screws.
e. Replace navigational light cover and secure with appropriate screws.
f. Replace plexiglas window on wing tips and secure with appropriate screws.

11-84. REMOVAL OF LAMP IN ANTI-COLLISION LIGHT. There are two anti-collision lights; one is located under the fuselage at sta. 207.12 and one is located on the upper section of the vertical fin. Depending on the serial number of the aircraft, there are two types; the rotating beacon and the strobe type anti-collision lights. Some early models had two rotating beacons and some had two strobe type lights. The later models have a rotating beacon and a strobe light. Remove the lamp as follows:

a. Loosen the screw in the clamp securing the light cover.

b. Remove the light cover.

c. If the light is a rotating beacon, remove the bulb and if the light is a strobe type, unplug the lamp assembly by pulling from the socket.

11-85. TROUBLESHOOTING PROCEDURE FOR ANTI-COLLISION AND WING TIP STROBE LIGHT SYSTEMS. The strobe light assembly functions as a condenser discharge system. A condenser in the power supply is charged to approximately 450-volts D.C.; then discharged across the xenon flash tube at intervals approximately 45 flashes per minute. The condenser is parallel across the xenon flash tube which is designed to hold off the 450-volt D.C. applied until the flash tube is triggered by an external pulse. This pulse is generated by a solid state timing circuit in the power supply.

When troubleshooting the strobe light system, it must first be determined if the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm if the tube is defective. A normal operating power supply will emit an audible tone of 1 to 1.5 KHz. If there is no sound emitted, check the system according to the following instructions. When troubleshooting the system, utilize the appropriate schematic in this manual.

a. Ascertain the input voltage at the power supply is 28-volts.

CAUTION

When disconnecting and connecting the power supply input connections, do not get the connection reversed. Reversed polarity of the input voltage for just an instant will permanently damage the power supply. The reversed polarity destroys a protective diode in the power supply, causing self-destruction from overheating of the power supply. This damage is sometimes not immediately apparent, but will cause failure of the system in time.

b. Check for malfunction in interconnecting cables.

1. Ascertain pins 1 and 3 of interconnecting cable are not reversed.

2. Using an ohmmeter, check continuity between pin 1 and 3 of interconnecting cable. If you obtain a reading on the meter, the cable is shorted and should be replaced.

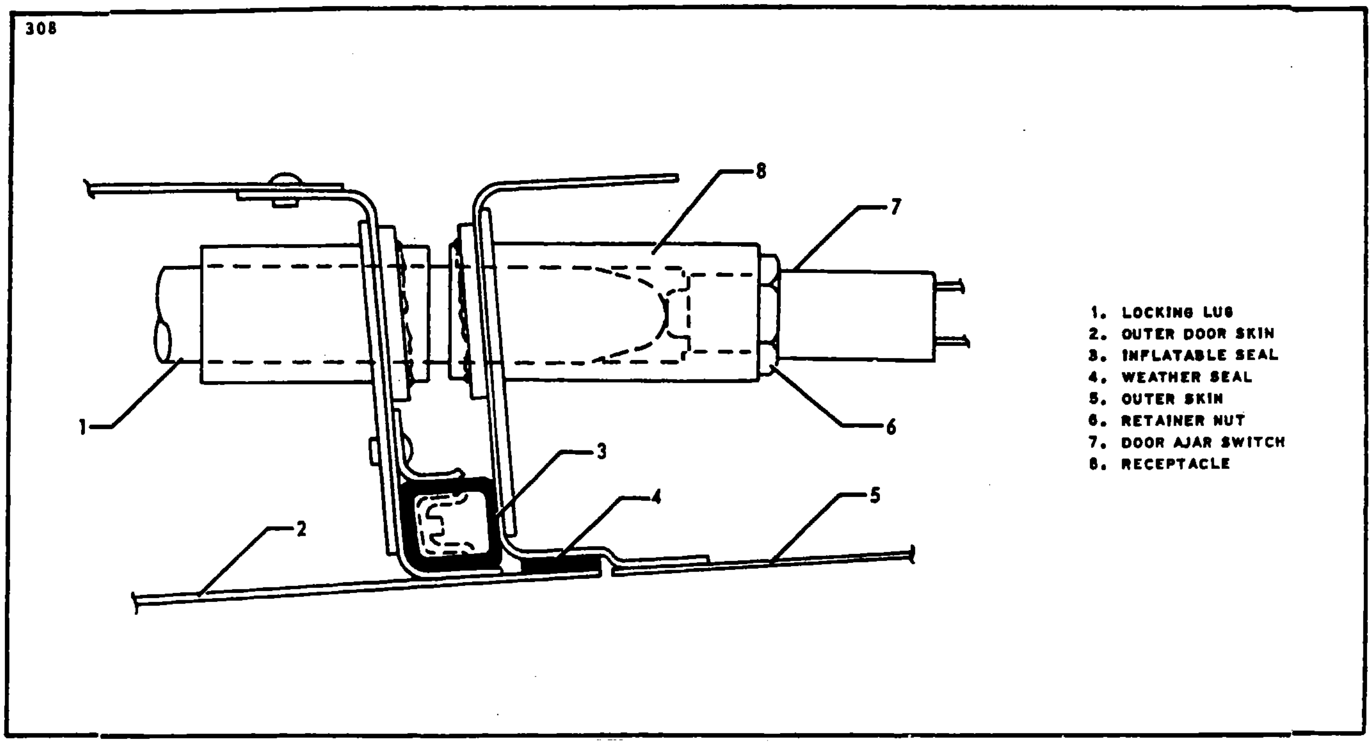


Figure 11-24. Door Ajar Switch

NOTE

A short of the type described in steps 1 and 2 will not cause permanent damage to the power supply but the system will be inoperative if such a short exists. Avoid any connection between pin 1 and 3 of interconnecting cable as this will discharge the condenser in the power supply and destroy the trigger circuit.

CAUTION

When disconnecting the power supply allow five minutes of bleed down time before handling the unit.

c. Check interconnecting cables for shorts.
   1. Disconnect the output cables from the power supply outlets.
   2. The following continuity checks can be made with an ohmmeter.
   3. Check for continuity between the connectors of each interconnecting cable by checking from pin 1 to pin 1, pin 2 to pin 2 and pin 3 to pin 3. When making these checks if no continuity exists the cable is shorted and should be replaced.
   4. Check continuity between pins 1 and 2, 1 and 3 and 2 and 3 of the interconnecting cable. If continuity exist between any of these connections the cable is shorted and should be replaced.
   5. Check for continuity from pins 1, 2 and 3 to airplane ground. If continuity exists the cable is shorted and should be replaced.
d. Check tube socket assembly for shorts.
   1. Disconnect the tube socket assembly of the anti-collision light from the interconnecting cables.

2. The following continuity checks can be made with an ohmmeter.

3. Check for continuity between pin 1 of AMP connector to pin 1 of tube socket, pin 2 of AMP connector to pin 6 and 7 of tube socket and pin 3 of AMP connector to pin 4 of tube socket. When making these tests if no continuity exists the tube socket assembly is shorted and should be replaced.

11-86. INSTALLATION OF LAMP IN ANTI-COLLISION LIGHT.

a. Plug a new bulb of the proper number into the socket of the rotating beacon and plug a lamp of the proper number into the socket of the strobe type light making sure to align the keyway on the lamp and socket.

b. Replace light cover.

c. Tighten screw in clamp to secure light cover.

11-87. DOOR AJAR SWITCHES. (Figure 11-24.) There are seven switches wired in parallel located in the cabin door channel, three on each side and one on top. These switches are adjusted to sense the insertion of the door plungers in their receptacles in the locked position. If any one of the switches is out of adjustment and the circuit is not completed the cabin door ajar light will stay on. The lower forward switch is a two pole switch. The purpose of these switches is to independently provide ground to the warning light assembly should any one of the locking pins not engage properly. In addition to these mechanically operated switches, there is also a pressure operated switch located in the line leading to the door seal from the accumulator tank. This is the cabin door ajar light, which will come on anytime the pressure in the door seal falls below 12 psig. (Refer to paragraph 13-138.)

11-88. REMOVAL OF DOOR AJAR SWITCHES.

a. Remove the interior trim panel from around the door frame.

b. Remove the wires and mark them for positive identification when switches are reinstalled.

c. Loosen the retainer nut and unscrew the switch from the receptacle.

11-89. INSTALLATION OF DOOR AJAR SWITCHES.

a. Install new switch into latch receptacle located behind the door frame.

b. With the door closed and locked, screw the switch into the receptacle until the switch actuates.

NOTE

An ohmmeter or continuity tester can be used to indicate switch actuation.

c. Secure the switch in this position with the retainer nut.

d. Reinstall the wires and interior trim panel around the door frame.

11-90. ADJUSTMENT OF DOOR AJAR SWITCHES.

Due to the presence of seven switches wired in parallel, each one will have to be checked and adjusted separately. This can be accomplished by jumping the wires at the switches not being adjusted.

a. Before adjusting the switches ascertain that all the locking pins are adjusted in accordance with paragraph 4-63, Adjustment of Latching Mechanism.

b. With the door closed and locked screw the switch into the receptacle until the switch actuates.

NOTE

An ohmmeter or continuity tester can be used to indicate switch actuation.

c. When adjustment is satisfactory, tighten the retainer nut on the switch. If several switches are being adjusted, follow the same procedure for each switch.

11-91. INTERIOR LIGHTS.

11-92. REMOVAL OF DOME LIGHT IN SPEAKER PANEL ASSEMBLIES. The lamp is located in the forward section of the overhead speaker panel. It is necessary to remove the complete panel assembly from the headliner before the lamp can be changed.

a. Remove the attachment screws and lower the speaker panel assembly from the headliner.
b. Remove the screws holding the light assembly to the panel and remove light assembly.
c. The lamp can now be replaced using proper lamp number.

11-93. INSTALLATION OF DOME LIGHT IN SPEAKER PANEL ASSEMBLIES.

a. Replace the light assembly and secure to panel with screws.
b. Install the speaker panel assembly into the headliner.
c. Secure the speaker panel assembly to the headliner with attachment screws.

11-94. REMOVAL OF LAMP IN OVERHEAD ENTRANCE LIGHT. The removal of the headliner panel is necessary to replace the lamp.

a. Remove the machine screws holding the trim plate around light assembly, and remove the trim panel.
b. Using a flat tool, carefully pry out the headliner panel from the trim extrusions.
c. Remove the screws holding light assembly in place and remove assembly.
d. Remove the snap cover over the lamp on the assembly and replace the lamp.

11-95. INSTALLATION OF LAMP IN OVERHEAD ENTRANCE LIGHT.

a. Replace the snap cover over the lamp on the light assembly.
b. Replace light assembly and secure with screws.
c. Carefully replace the headliner panel into the trim extrusions.
d. Replace trim plate and secure with screws.

11-96. REMOVAL OF LAMP IN OVERHEAD READING LIGHTS. The lamp is located above each passenger window.

a. Placing a flat tool between the trim molding and plate at the center of the unit, pry the plate out, being careful not to bend it.
b. Remove the ground wire from the light assembly and remove the cover over the lamp.
c. Replace the lamp using the proper number.

11-97. INSTALLATION OF LAMP IN OVERHEAD READING LIGHTS.

a. Replace the cover over the lamp and connect the ground wire to the light assembly.
b. Install the plate into the trim molding.
c. Press the plate into position to secure it in place.

11-98. REMOVAL OF TABLE LIGHT.

a. Remove ring from around the light lens by prying between ring and lens.
b. Remove light assembly by removing attachment screws.

11-99. INSTALLATION OF TABLE LIGHT.

a. Position light assembly and secure with attaching screws.
b. Insert ring over light lens and press into place.

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	ALTERNATOR	
No output from alternator.	Malfunction of alternator, alternator output circuit or field circuit.	Check alternator output and field circuits. Refer to Para. 11-5. Check alternator. Refer to Paragraph 11-9.
Reduced output from alternator.	Open diode.	Check alternator. Refer to Paragraph 11-9.
	STARTER	
Motor fails to operate.	Low battery charge.	Check and recharge if necessary.
	Defective or improper wiring or loose connections.	Refer to wiring diagram and check all wiring.
	Defective starter solenoid or control switch.	Replace faulty unit.
	Binding, worn, or improperly seated brush, or brushes with excessive side play.	Brushes should be a free fit in the brush boxes without excessive side play. Binding brushes and brush boxes should be wiped clean with a gasoline (undoped) moistened cloth. A new brush should be run in until at least 50% seated; however, if facilities are not available for running in brushes, then the brush should be properly seated by inserting a strip of No. 0000 sandpaper between the brush and commutator, with the sanded side next to

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	STARTER (cont)	
Motor fails to operate. (cont)		the brush. Pull sand-paper in the direction of rotation, being careful to keep it in the same contour as commutator. CAUTION Do not use coarse sand-paper or emery cloth. After seating, clean thoroughly to remove all sand and metal particles to prevent excessive wear. Keep motor bearing free from sand or metal particles.
	Dirty commutator.	If commutator is rough or dirty, smooth and polish with No. 000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles.
	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test and then replace with new part.
Motor operates at proper speed but fails to crank engine.	Faulty Bendix drive.	Remove Bendix drive assembly. Clean and check, replace.
Slow motor and cranking speed	Worn, rough, or impro-perly lubricated motor or starter gearing.	Disassemble, clean, in-spect and relubricate, replacing ball bearings if worn.

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	STARTER (cont.)	
Slow motor and cranking speed (cont.)	Same electrical causes listed under "Motor fails to operate."	Same remedies listed for these troubles.
Excessive arcing of motor brushes.	Binding, worn, or improperly seated brush or brushes, with excessive side play.	See information above dealing with this trouble.
	Dirty, rough, pitted or scored commutator.	Clean as outlined above.
	Grounded or open field circuit.	Test and replace defective parts.
Excessive wear and arcing of motor brushes.	Rough or scored commutator.	Remove and turn commutator down on a lathe.
	Armature assembly not concentric.	Reface commutator.
	BATTERY 24 VOLT LEAD ACID	
Battery will not hold charge.	Battery worn out.	Replace battery.
	Charging rate not set right.	Reset.
	Discharge too great to replace.	Reduce use of starter on the ground; use external power wherever possible.
	Standing too long.	Remove and recharge battery if left in unused airplane one week or more.
	Equipment left "ON" accidentally.	Remove and recharge. (See Paragraph 11-51.)

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	BATTERY 24-VOLT LEAD ACID (cont.)	
Battery will not hold charge. (cont.)	Impurities in electrolyte.	Replace electrolyte.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Replace battery.
Battery life is short.	Overcharge due to level of electrolyte being below tops of plates.	Maintain electrolyte level.
	Heavy discharge.	Reduce use of equipment while on ground.
	Sulfation due to disuse.	Replace.
	Impurities in electrolyte.	Replace battery.
Cracked cell.	Hold down loose.	Replace battery and tighten.
	Frozen battery.	Replace.
Compound on top of battery melts.	Charging rate too high.	Reduce.
Electrolyte runs out of vent plugs.	Too much water added to battery.	Drain and keep at proper level.
	Excessive charging rate.	Check and correct.

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	BATTERY 24-VOLT LEAD ACID (cont.)	
Excessive corrosion inside battery box.	Spillage from over-fillings.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
Battery freezes.	Discharged battery.	Replace.
	Water added and battery not charged immediately.	Always recharge battery at least 1/2 hour when adding water in freezing weather.
	Leaking jar.	Replace.
Battery polarity reversed.	Connected backwards on airplane or charger.	Battery should be slowly discharged completely and then charged correctly and tested.
Battery consumes excessive water.	Charging rate too high (if in all cells).	Correct charging rate.
	Cracked jar (one cell only).	Replace battery.
Battery will not come up to charge.	Battery worn out.	Give capacity test and replace if capacity is too low.
	Plates badly sulfated.	Charge as for sulfated.

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	BATTERY-DISCONNECT SOLENOID	
Does not operate.	Open circuit.	Repair wiring.
	Dirty contacts on connector plug.	Clean contacts.
	Open-circuited solenoid coil.	Replace unit.
	Plunger binding.	Remove and wash plunger and housing thoroughly with carbon tetrachloride. Change spring compression only as a last resort.
Intermittent operation.	Short-circuited coil. Loose electrical connection.	Replace coil. Clean and tighten electrical connections.
	Plunger binding.	See remedy pertaining to "Plunger binding" under "Does not operate."
	Badly burned points.	If points cannot be dressed down, replace the unit.
	STROBE LIGHT	
Flash tubes do not fire.	Flash tube exposed to very high temperature.	Replace flash tube.
	Leak around seal of the wire to the glass.	Replace flash tube.
Flash tubes continuously glow as does a light bulb.	Flash tubes are self-ionized.	Replace flash tube.

TABLE XI-VII. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	DOOR SEAL CIRCUIT	
Cabin door unsafe light will not go out.	Latching relay sticking in the open position.	Lubricate the mechanical parts (sparingly) with "Glide Air" or equivalent.
	Switch or switches in door frame out of adjustment.	Adjust per Paragraph 11-90.
	Defective pressure switch.	Replace switch.
	Short to ground.	Check wiring and repair.
Cabin door unsafe light will not come on.	Circuit breaker open.	Reset circuit breaker.
	Broken wire or loose connection.	Check and repair wiring.

TABLE XI-VIII. CIRCUIT LOAD CHART

CIRCUIT	CIRCUIT PRO-TECTOR RAT-ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN-EOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT	
				24.0 V.	28.5 V.
ANTI-COL LIGHTS RED	5	POWER SUPPLY *2 RED STROBE TUBES	1	1.90	2.30
WING TIP STROBES WHITE	5	POWER SUPPLY * 2 WHITE STROBE TUBES	1	1.90	2.30
POSITION LIGHTS	5	WING LIGHTS	2	.76	0.90
		TAIL LIGHT	1	.88	1.04
PANEL & MAP LIGHTS	5	POST LIGHTS - (STANDARD)	51	.03	.04
		POST LIGHTS - (OPTIONAL)	13	.03	.04
		PEDESTAL LIGHTING	6	.03	.04
		OVERHEAD INSTRUMENT LIGHTS	7	.14	.17
		ELECTROLUMINESCENT PLACARDS W/POWER SUPPLY	1 SET	.61	.72
		MAP LIGHTS	2	.11	.13
CABIN DOOR UNSAFE LIGHTS	5	DOME LIGHT	1	.76	.90
		FUEL PANEL LIGHT	1	.11	.13
		PASSENGER READING LIGHTS	5	.43	.51
		NO SMOKING/FASTEN SEAT BELT	1 SET	.54	.64
		DOOR AJAR LIGHTS	2	.07	.08
LANDING & TAXI LIGHTS	20	LANDING/TAXI LIGHTS (250 WATT)	2	7.50	8.90
		LIGHT SOLENOIDS	2	.42	.50
		WING INSPECTION LIGHT (5C WATT)	1	1.52	1.80
STALL WARNING	5	WARNING LIGHT	1	.03	.04
		WARNING HORN	1	.08	.10
		FLASHER UNIT	1	.01	.01
PRESSURE INDICATORS	5	LEFT PNEUMATIC PRESSURE SOURCE	1	.07	.08
		RIGHT PNEUMATIC PRESSURE SOURCE	1	.07	.08
		CABIN DIFFERENTIAL PRESSURE	1	.06	.08
PRESSURE CONTROL (CABIN)	5	VACUUM CONTROL SOLENOID (GROUND)	1	.76	.90
		CABIN ALTITUDE CONTROL SELECTOR (FLIGHT)	1	.42	.50
LEFT SIDE T & B	5	TURN & BANK INDICATOR ELECTRIC GYRO	1	.69	.82
RIGHT SIDE T & B	5	TURN & BANK INDICATOR ELECTRIC GYRO	1	.69	.82
ELECTRIC GYROS (RIGHT)	5	DIRECTIONAL GYRO	1	.42	.50
		ARTIFICIAL HORIZON GYRO	1	.42	.50
LEFT FUEL QUANTITY AND ENGINE GAGES	5	LEFT OUTBOARD & NACELLE TANK IND.	1	.20	.24
		LEFT INBOARD INDICATOR	1	.20	.24
		LEFT SUBMERGED PUMP INDICATOR	1	.03	.04
		LEFT FUEL PRESSURE INDICATOR	1	.03	.04
		LEFT OIL TEMP. INDICATOR	1	.16	.19
		LEFT CYL. HEAD TEMP. INDICATOR	1	.16	.19
		HOUR METER	1	.01	.01
RIGHT FUEL QUANTITY AND ENGINE GAGES	5	RIGHT OUTBOARD & NACELLE TANK IND.	1	.20	.24
		RIGHT INBOARD INDICATOR	1	.20	.24
		RIGHT SUBMERGED PUMP INDICATOR	1	.03	.04
		RIGHT FUEL PRESSURE INDICATOR	1	.03	.04
		RIGHT OIL TEMP. INDICATOR	1	.16	.19
		RIGHT CYLINDER HEAD TEMP. INDICATOR	1	.16	.19

TABLE XI-VIII. CIRCUIT LOAD CHART (cont.)

CIRCUIT	CIRCUIT PROTECTOR RATING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTANEOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 24.0 V.	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 28.5 V.
ELECTRIC GYROS (LEFT)	5	DIRECTIONAL GYRO	1	.42	.50
		ARTIFICIAL HORIZON GYRO	1	.42	.50
ELECTRIC TRIM AND AUTOFLITE	5	PITCH TRIM SERVO (MANUAL OPERATION)	1	.58	.60
		AUTOCONTROL (IDLE)	1	.45	.54
BOOST PUMPS - LEFT	5	LEFT INBOARD SUBMERGED FUEL PUMP 1	1	2.53	3.00
		LEFT OUTBOARD SUBMERGED FUEL PUMP 1		2.53	3.00
BOOST PUMPS - RIGHT	5	RIGHT INBOARD SUBMERGED FUEL PUMP 1	1	2.53	3.00
		RIGHT OUTBOARD SUBMERGED FUEL PUMP 1		2.53	3.00
LOW FUEL WARNING LIGHTS	5	LEFT OUTBOARD INDICATOR	1	.07	.08
		RIGHT OUTBOARD INDICATOR	1	.07	.08
LEFT NACELLE FUEL TRANSFER PUMPS	5	LEFT PUMPS	1 PAIR	.85	1.00
RIGHT NACELLE FUEL TRANSFER PUMPS	5	RIGHT PUMPS	1 PAIR	.85	1.00
LEFT EMERGENCY FUEL PUMP	5	LEFT PUMP	1	3.04	3.60
RIGHT EMERGENCY FUEL PUMP	5	RIGHT PUMP	1	3.04	3.60
WING FLAPS	25	FLAP MOTOR	1	10.10	12.00
COWL FLAPS STARTER & FLAP SOLENOID	10	LEFT STARTER SOLENOID	1	3.88	4.60
		RIGHT STARTER SOLENOID		3.88	4.60
		LEFT COWL FLAP MOTOR	1	3.46	4.10
		LEFT COWL FLAP INDICATOR	1	.03	.04
		RIGHT COWL FLAP MOTOR	1	3.46	4.10
		RIGHT COWL FLAP INDICATOR	1	.03	.04
		WING FLAP SOLENOID	1	.42	.50
		WING FLAP INDICATOR	1	.08	.09
		WING FLAP BRAKE RELAY	1	.85	.10
HEATER FUEL VENTS	10	HEATER ELEMENTS	2	2.10	2.50
PROP SYNC.	3	PROPELLER SYNC. SYSTEM (WOODWARD)	1	.84	1.00
VOLTAGE REG. - LEFT	10	OVERVOLTAGE RELAY	1	.07	.08
		LEFT ALTERNATOR FIELD	1	1.43	1.70
		RIGHT ALTERNATOR FIELD	1	1.43	1.70
VOLTAGE REG. - RIGHT	10	OVERVOLTAGE RELAY	1	.07	.08
		LEFT ALTERNATOR FIELD	1	1.43	1.70
		RIGHT ALTERNATOR FIELD	1	1.43	1.70
RECIRCULATING FAN	15	FAN MOTOR	1	9.75	11.60
CABIN COMFORT	10	CONTROL HEAD & THERMOSTAT	1	.42	.50
		RECIRCULATING FAN RELAY	1	.08	.10
		HEATER	1	3.20	3.80
		AIR CONDITIONER COMPRESSOR CLUTCH	1	1.52	1.80
WINDSHIELD HEATER LEFT	25	LEFT HEATING ELEMENT	1	19.40	23.00
		LEFT TIMER	1	.01	.01
		LEFT CONTROL SOLENOID	2	.42	.50
WINDSHIELD HEATER RIGHT	25	RIGHT HEATING ELEMENT	1	19.40	23.00
		RIGHT TIMER	1	.01	.01
		RIGHT CONTROL SOLENOID	2	.42	.50

TABLE XI-VIII. CIRCUIT LOAD CHART (cont.)

CIRCUIT	CIRCUIT PRO-TECTOR RAT-ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN-EOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 24.0 V.	28.5 V.
SURFACE DEICE	10	TIMER	1	.03	.04
		RELAY	2	.08	.10
		DEICER BOOT CONTROL SOLENOID	2	1.09	1.30
		EJECTOR SOLENOID	1	1.09	1.30
		RELIEF SOLENOID	2	.76	.90
		PRESSURE INDICATOR	1	.03	.04
PROP DEICE	20	LEFT & RIGHT PROP DEICE BOOTS	1 SET	15.80	18.00
WINDSHIELD WIPER	10	WINDSHIELD WIPER MOTOR	1	3.88	4.60
PITOT HEAT - LEFT	10	LEFT PITOT HEATER ELEMENT	1	5.99	7.10
PITOT HEAT - RIGHT	10	RIGHT PITOT HEATER ELEMENT	1	5.99	7.10
GEAR POSITION INDICATOR LIGHTS	5	INDICATOR LIGHTS	3	.03	.04
GEAR SOLENOIDS & WARNING	5	GEAR DOOR SOLENOID	1	2.14	2.54
		ANTI-RETRACT SOLENOID	1	.96	1.14
		ANTI-RETRACT RELAY	1	.08	.10
		GEAR IN MOTION/WARNING LIGHT	1	.03	.04
		GEAR WARNING HORN	1	.08	.10
		LANDING LIGHT SOLENOID	1	.42	.50
CABIN DOOR SEAL	5	ACCUMULATOR RELIEF VALVE	1	.85	1.00
MASTER SWITCH	NONE	MASTER CONTACTOR SOLENOID	1	.30	.35
STARTER MOTORS	NONE	L & R STARTER MOTORS	1	175 AMPS R.M.S./7 SEC	
COM 1	10	NARCO MK-16 NAV COM	XMITT.	4.07	4.83
		(MP16 POWER CONVERTER)	RCV.	0.49	0.58
		KING KTR-900 W/KNI-500L	XMITT.	5.23	6.20
			RCV.	0.52	0.62
NAV 1	5	NARCO MK-16 NAV COM.		–	–
		KING KNR-600 OR KNR-660 (RMI)*		0.62	0.73
		VOA-8 INDICATOR		0.15	0.18
		VOA-9 INDICATOR		0.15	0.18
M/B (MARKER BEACON) G/S (GLIDE SLOPE)	5	NARCO UGR-2		0.20	0.24
		NARCO MBT-24		0.21	0.25
		PIPER PM-1		0.21	0.25
		KING KGM-690 W/ KNI-500L		0.33	0.39
RMI	5	*RMI-KNR-660 (CURRENT IN ADDITION TO NAV 1)		0.09	0.10
		R. C. ALLEN - RMI		3.93	4.65
ADF - 1	5	BENDIX T12C & INDICATOR		0.44	0.52
		KDF-800		1.14	1.35
		KR-85		0.87	1.04
		ARC		1.84	2.18
AUDIO AMP	3	KING KAA-445 (✡1 POWER INPUT SPEAKER)	AT 20 WATT OUTPUT	1.84	2.18
ACC.	5	KING KAA-445 (✡2 POWER INPUT PHONES)	IDLE	0.13	0.16
		RADIO PANEL LAMPS (SOLID STATE DIMMER)	MAX.	2.95	3.50
COM 2	10	SIMILAR TO COM 1			

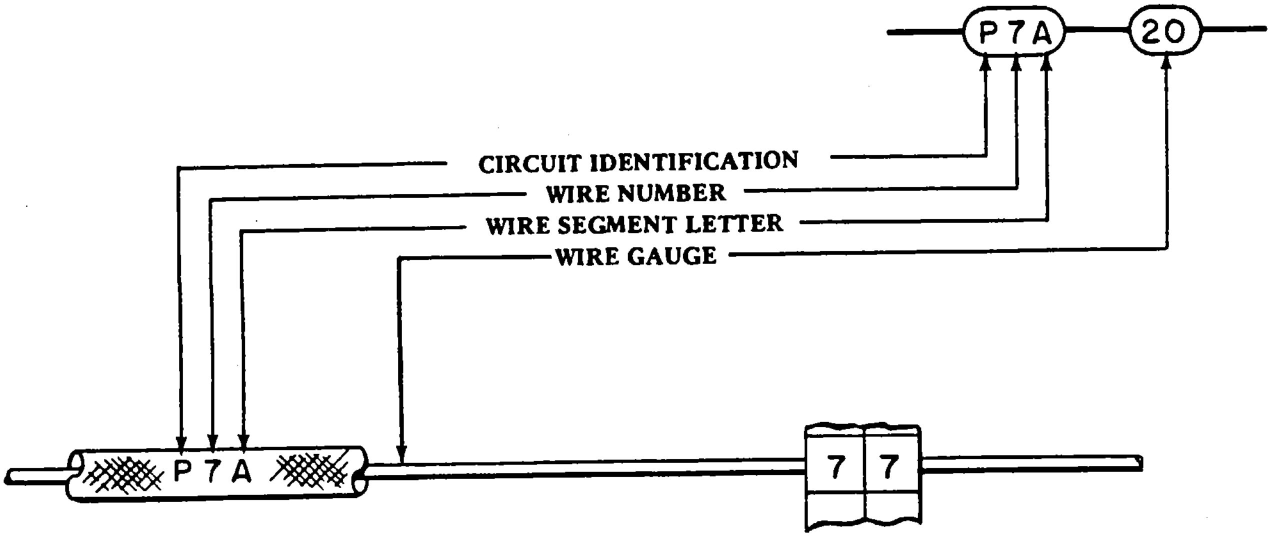
TABLE XI-VIII. CIRCUIT LOAD CHART (cont.)

CIRCUIT	CIRCUIT PRO-TECTOR RAT-ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN-EOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 24.0 V.	28.5 V.
NAV 2/DME	5	NAV 2 SIMILAR TO NAV 1			
		DME KING KDM-700	TRACK MODE	2.40	2.85
		DME NARCO UDI-4		2.86	3.39
XPONDER	5	KING KXP-750 TRANSPONDER	MAX. REPLY	0.96	1.14
RADAR	10	BENDIX RDR-110 W/BASLER 400 CYCLE INVERTER		7.75	9.17
		RCA AVQ-46 OR AVQ-47		4.28	5.09
F/D	5	ALTIMATIC IIIB AUTOPILOT (MITCHELL)		3.50	4.15
A/P	OR	ALTIMATIC V AUTOPILOT (BENDIX)		5.75	6.80
	10	BENDIX FD/AP FLIGHT DIRECTOR A/P		5.75	6.80
ADF 2	5	SIMILAR TO ADF *1			
HF COM	15	SUNAIR SA-14RA	XMITT.	8.05	9.55
			RCV.	2.40	2.85
		SUNAIR ASB-60	XMITT.	6.43	7.62
			RCV.	2.15	2.55
		SUNAIR ASB-125	XMITT.	6.43	7.62
			RCV.	2.15	2.55

TABLE XI-IX. LAMP REPLACEMENT GUIDE

Location	Piper Part No.	Lamp No.
Wing Tips	753 478	A-7512-24
Taillight	753 477	1683
Wing Inspection Light	472 049	4593
Landing Light	472 769	4596 (250W)
Reading Light	758 152	MS35478-305
Fuel Selector Panel	472 028	327
Trim Indicator Light Assemblies	472 784	7033-29B-P7
Fuel Gauges	453 792	1828
Ammeter Lights	453 792	1828
Alternator Warning	472 815	10-251-R-FB38
Voltmeter	453 791	356
Instrument Bolt Lights	472 028	327
Compass Light	472 028	327
No Smoking - Fasten Seat Belt	472 789	10-0246-7
Forward Baggage	472 057	313
Gear Down Warning	472 028	327
Gear Unlocked, Red	472 028	327
Stall Warning	472 028	327
Dome Light	758 151	MS15584-15
Refreshment Table	472 057	313
Warning Lights	472 058	387
Strobe Lights - Wing Tips	761 157	A428
Strobe Light - Fuselage - Fin	757 635	A406
Map Lights	472 052	304
Overhead Light Assemblies	46815	
Flap Indicator	453 791	356

TABLE XI-X. ELECTRICAL WIRE CODING



CIRCUIT IDENTIFICATION	CIRCUITS	HARNESS CONNECTOR NUMBERS AND LOCATIONS
E	ENGINE INSTRUMENT	E 100 Series = Left Wing and Nacelle.
F	FLIGHT INSTRUMENT	
G	LANDING GEAR	
H	HEATER, VENTILATING	E 200 Series = Right Wing and Nacelle.
J	IGNITION SYSTEM	
L	LIGHTING SYSTEM	
ML	ELECTRICAL GAUGES	
P	PRIMARY POWER	E 300 Series = From Fuselage Station 81.00 Aft.
PD	PROPELLER DEICER	
PF	ALTERNATOR FIELD	
PR	PRESSURIZATION SYSTEM	
Q	FUEL AND OIL	E 400 Series = From Fuselage Station 81.00 Forward.
SD	SURFACE DEICER	
WH	WINDSHIELD HEAT	
WW	WINDSHIELD WIPER	

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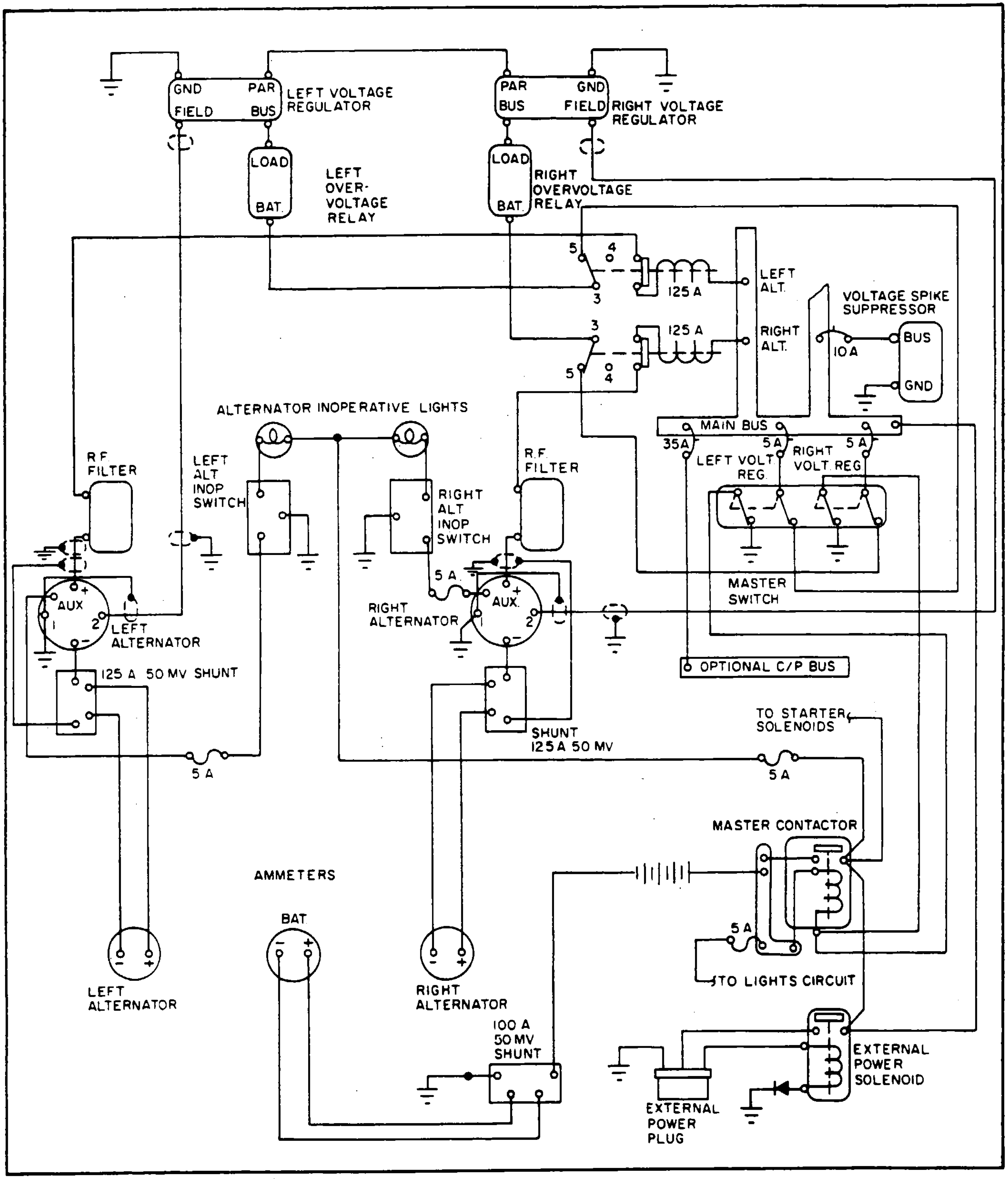

Figure 11-24a. Alternators and External Power Diagram
(For Earlier Installations Refer to Figure 11-2)

11-100. COCKPIT LIGHTING. The lighting in the cockpit area of the Pressurized Navajo is controlled by several types of electrical power connections. The pedestal lights are wired directly to the circuit protector panel. The overhead map lights are controlled by on/off switches. Finally the electro-luminescent panel lights and instrument bolt lights have a potentiometer type of control. This potentiometer operates with the Lamar solid state dimmer assembly. For a description of the Lamar solid state dimmer assembly see Paragraph 11-102.

The electrical power supply for the cockpit lighting system is a 28 volt DC aircraft power supply.

NOTE

If the optional radio lights dimmer needs servicing, refer to the appropriate Avionics Wiring Diagram Service Manual for wiring information.

11-101. SOLID STATE DIMMER ASSEMBLY.

11-102. DESCRIPTION OF OPERATION FOR THE SOLID STATE DIMMER ASSEMBLY. The Lamar Solid State Dimmer Assembly is attached to the aircraft electrical supply through the potentiometer. This supply is switched on and off simultaneously with the low voltage control circuit. A switch inside the potentiometer controls this on/off function. When the potentiometer's control knob is turned on, the lighting intensity is very dim. Lighting intensity increases with a clockwise rotation of the potentiometer's control knob. The Lamar Solid State Dimmer serves as a release for extra heat generated when the lights are dimmed. The solid state dimmer has a unit ground that connects to the forward overhead bulkhead aircraft ground. A wire leading to the Electro-Luminescent Power Supply of the panel lighting system and a wire leading to the various instrument bolt-lights complete the circuits for both standard solid state dimmer assemblies.

11-103. TROUBLESHOOTING PROCEDURE FOR THE SOLID STATE DIMMER ASSEMBLY. When troubleshooting the solid state dimmer assembly, it must first be determined if the trouble is a defective dimmer assembly, or a shorted or open connection in the wiring for the unit. Verify that the proper voltage exists at the dimmer assembly by turning on the map light. If the map light for the appropriate side is working, then the harness wiring is not shorted or opened as far as the bombtail connection near the map light. (See appropriate "Panel Lights Schematic" for wiring details.) If the map light is working, gain access to the dimmer assembly wiring per the instructions in Paragraph 11-105, Removal of Solid State Dimmer. Locate the red wire on the potentiometer and check for 28-volts DC. If voltage is present, then the dimmer assembly may be defective. Prior to replacing the solid state dimmer assembly with another unit, ring out the entire wiring for the system for a possible short. If the wiring is not shorted or open, replace the solid state dimmer assembly.

NOTE

If the optional radio lights dimmer needs servicing, refer to the Avionics Wiring Diagram Service Manual for the appropriate wiring information. (See Section XII.)

11-104. LOCATION OF THE SOLID STATE DIMMER ASSEMBLY. There are two Lamar solid state dimmer assemblies installed in this aircraft. The dimmer assemblies are located above the overhead switch panels. The Lamar solid state dimmers are attached to the forward overhead bulkhead and the potentiometers project through the royalite panel. The dimmer assembly located to the left side above the royalite panel controls the panel lighting. The dimmer assembly located on the right side above the royalite panel controls the electro-luminescent lighting.

11-105. REMOVAL OF SOLID STATE DIMMERS. The following procedures apply to both dimmers, the dimmer for the electro-luminescent panels and the dimmer for the instrument lights.

a. Remove the screws securing the royalite trim panel containing the overhead switch panel and let hang.

b. Remove the knob from the potentiometer which controls the dimmer that is being removed.

c. Remove the nut securing the potentiometer to the front of the panel.

d. Pull the potentiometer out of the overhead instrument panel.

e. Disconnect the red wire from the potentiometer at plug connection.

f. Disconnect white wire from dimmer assembly at plug connection.

NOTE

Make note of the placement of the wires and plugs to facilitate reinstallation.

g. Remove the screws mounting the dimmer assembly to the aircraft. Remove the dimmer assembly and potentiometer from the airplane.

11-106. INSTALLATION OF SOLID STATE DIMMERS.

a. Position the solid state dimmer in place behind the overhead switch panel and secure with the appropriate screws.

b. Connect the white and red wires to the plug connections from which the old assembly was previously removed.

c. Solder the main harness from the dimmer to the potentiometer. Solder the wires in the same position as the old assembly.

d. Insert the potentiometer into its proper place on the overhead trim panel.

e. Install nut on the potentiometer securing it to the front of the panel.

f. Install the knob on the potentiometer.

g. Position the overhead trim panel and secure with the appropriate screws.

11-107. REMOVAL OF POWER SUPPLY FOR ELECTRO-LUMINESCENT PANELS. The power supply is located behind the overhead switch panel.

a. Remove the screws securing the royalite trim panel containing the overhead switch panel and let hang.

b. The power supply is mounted to the panel. Disconnect the red wire from the plug connection and the white wire from the bombtail.

c. Disconnect the screws securing the power supply to the panel. Make note of the ground wire attached to one of the screws. Remove the power supply.

11-108. INSTALLATION OF POWER SUPPLY FOR ELECTRO-LUMINESCENT PANELS.

a. Position the power supply and secure with the appropriate screws. Be sure ground wire is connected to its proper screw.

b. Connect the red wire at the plug connection from which it was previously removed and secure.

c. Position the royalite trim panel and secure with the appropriate screws.

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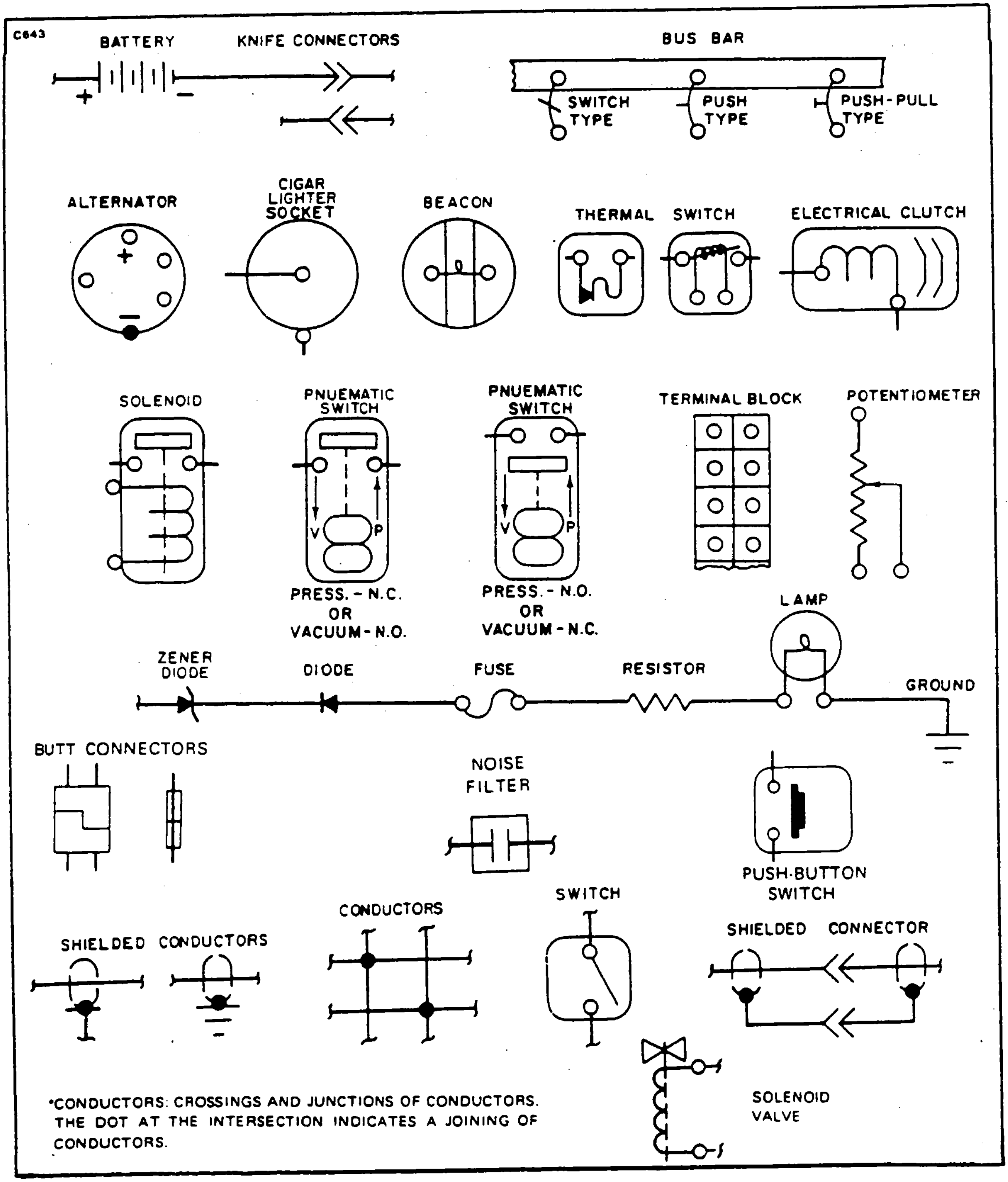
TABLE XI-I. INDEX - ELECTRICAL SYSTEMS SCHEMATICS

TABLE XI-I. INDEX - ELECTRICAL SYSTEMS SCHEMATICS (cont.)

TABLE XI-I. INDEX - ELECTRICAL SYSTEMS SCHEMATICS (cont.)


C643
BATTERY
KNIFE CONNECTORS
BUS BAR
SWITCH TYPE
PUSH TYPE
PUSH-PULL TYPE
ALTERNATOR
CIGAR LIGHTER SOCKET
BEACON
THERMAL SWITCH
ELECTRICAL CLUTCH
SOLENOID
PNUEMATIC SWITCH
PRESS. - N.C. OR VACUUM - N.O.
PNUEMATIC SWITCH
PRESS. - N.O. OR VACUUM - N.C.
TERMINAL BLOCK
POTENTIOMETER
LAMP
ZENER DIODE
DIODE
FUSE
RESISTOR
GROUND
BUTT CONNECTORS
NOISE FILTER
PUSH-BUTTON SWITCH
SHIELDED CONDUCTORS
CONDUCTORS
SWITCH
SHIELDED CONNECTOR
SOLENOID VALVE
*CONDUCTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

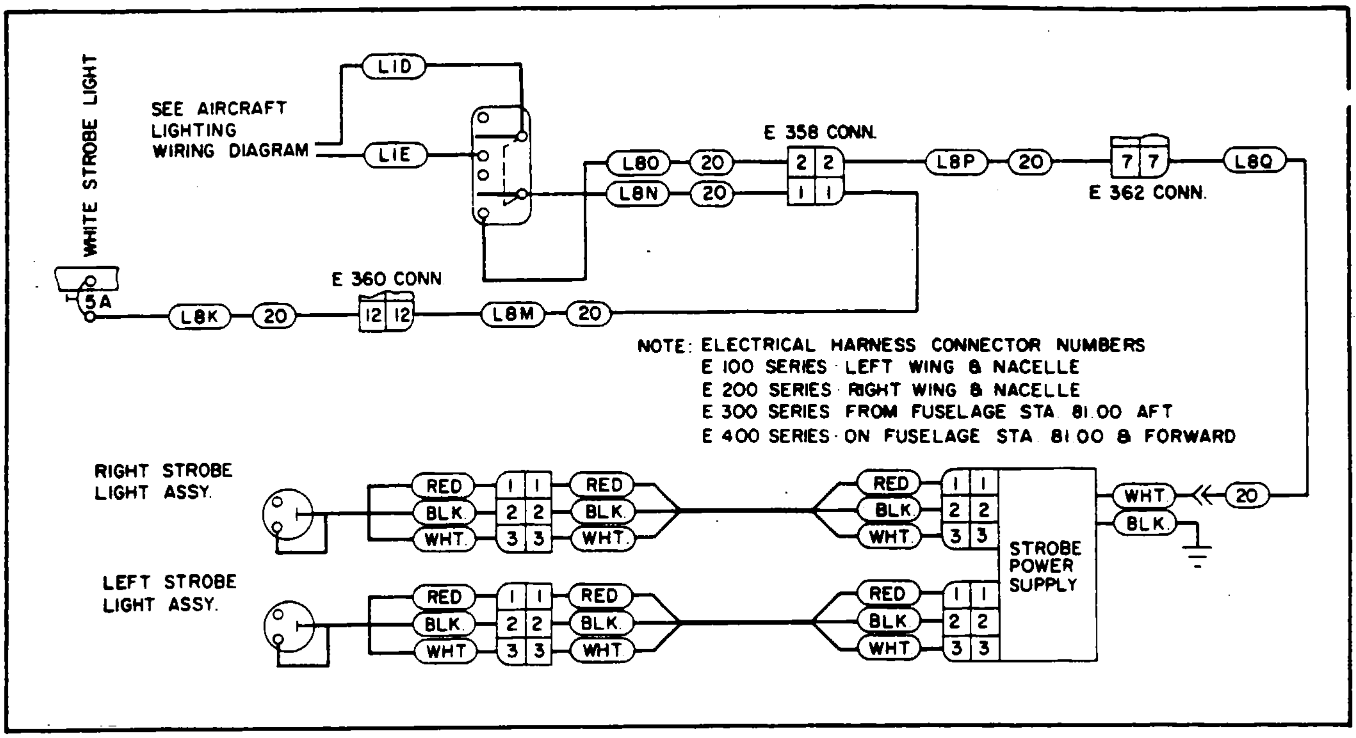


Figure 11-25. Optional Strobe Light (Wing) - Schematic

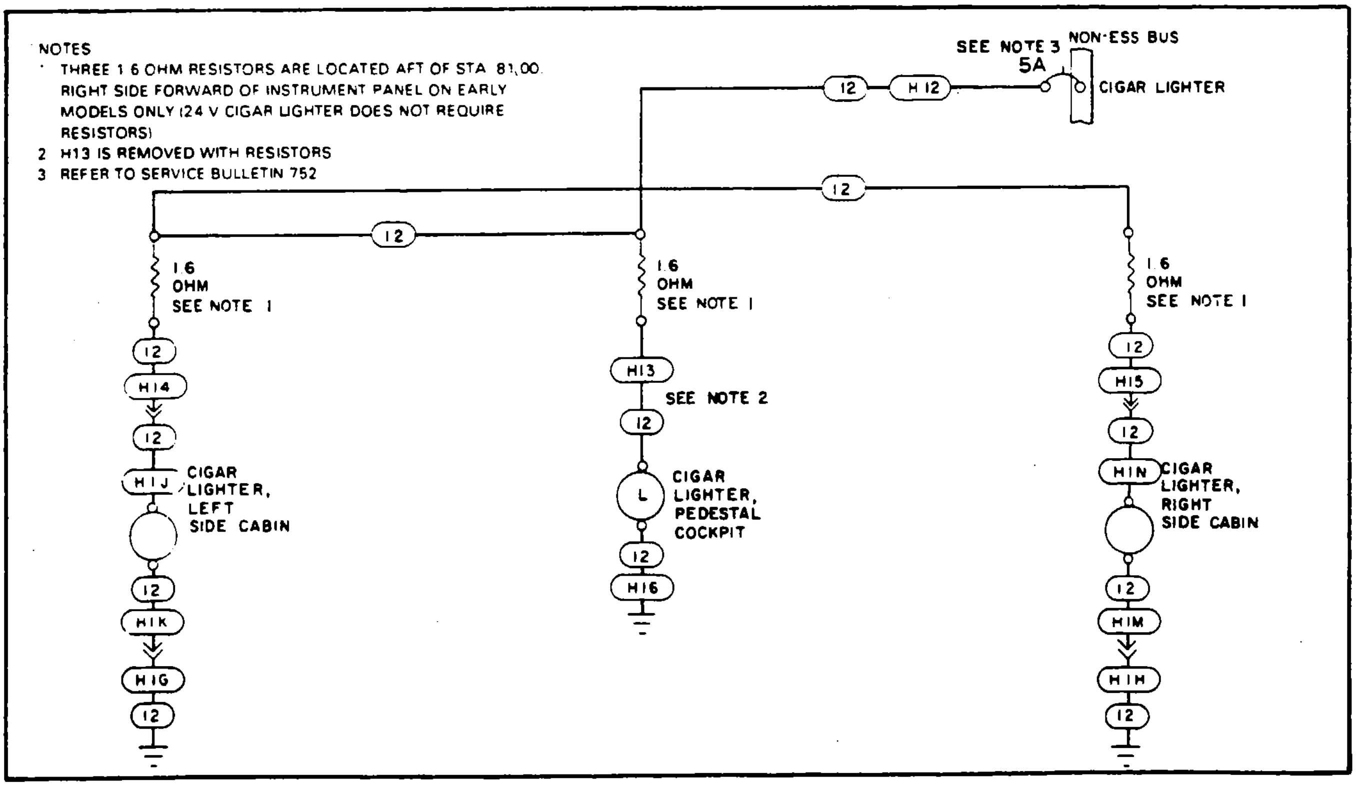


Figure 11-26. Cigar Lighter (12v), S/N PA-31P-7300153 to PA-31P-7630005

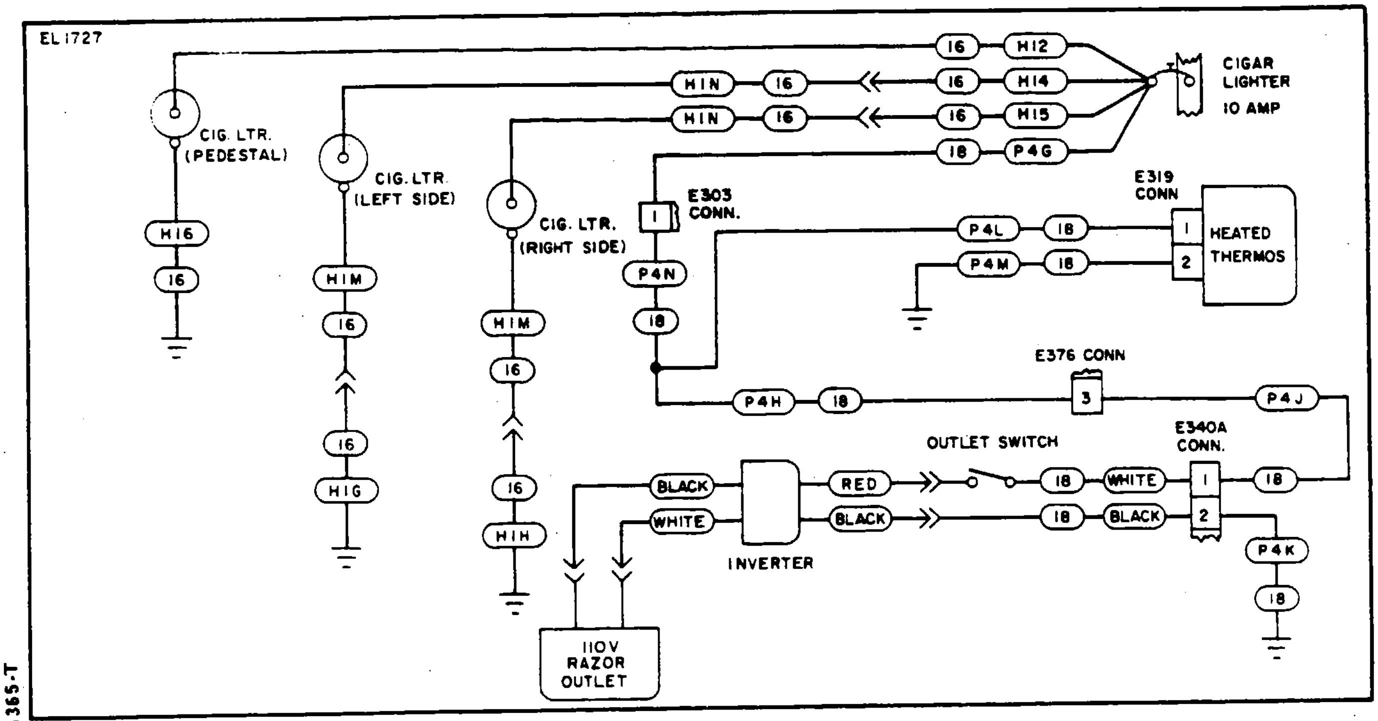


Figure 11-27. Cigar Lighter (24v), Heated Thermos and Razor Outlet. S/N PA-31P-7630006 and up

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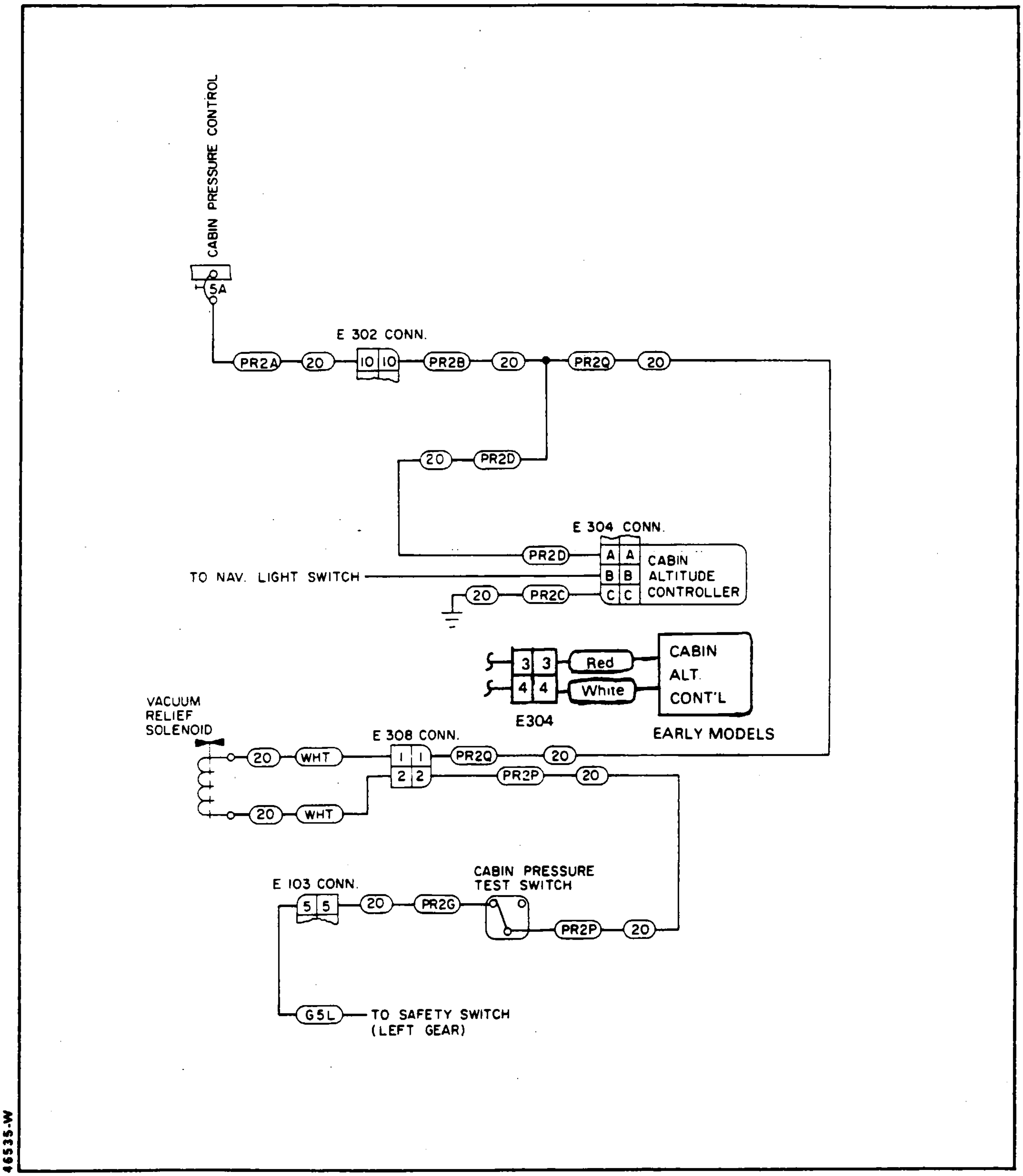

Figure 11-28. Cabin Pressure Control - Schematic

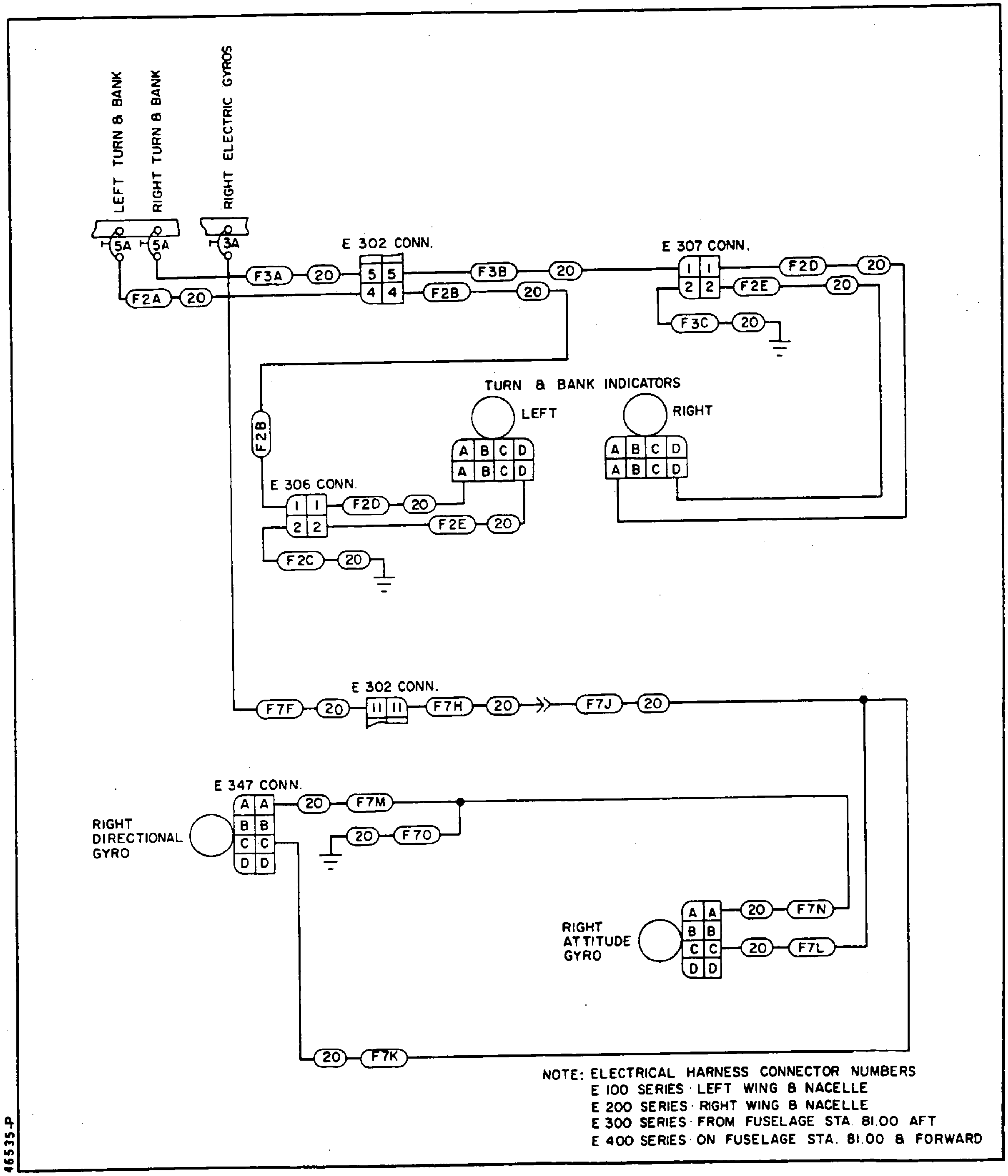

Figure 11-29. Attitude Horizon, Directional Gyro, Turn and Bank
S/N 31P-7300001 to 7300127

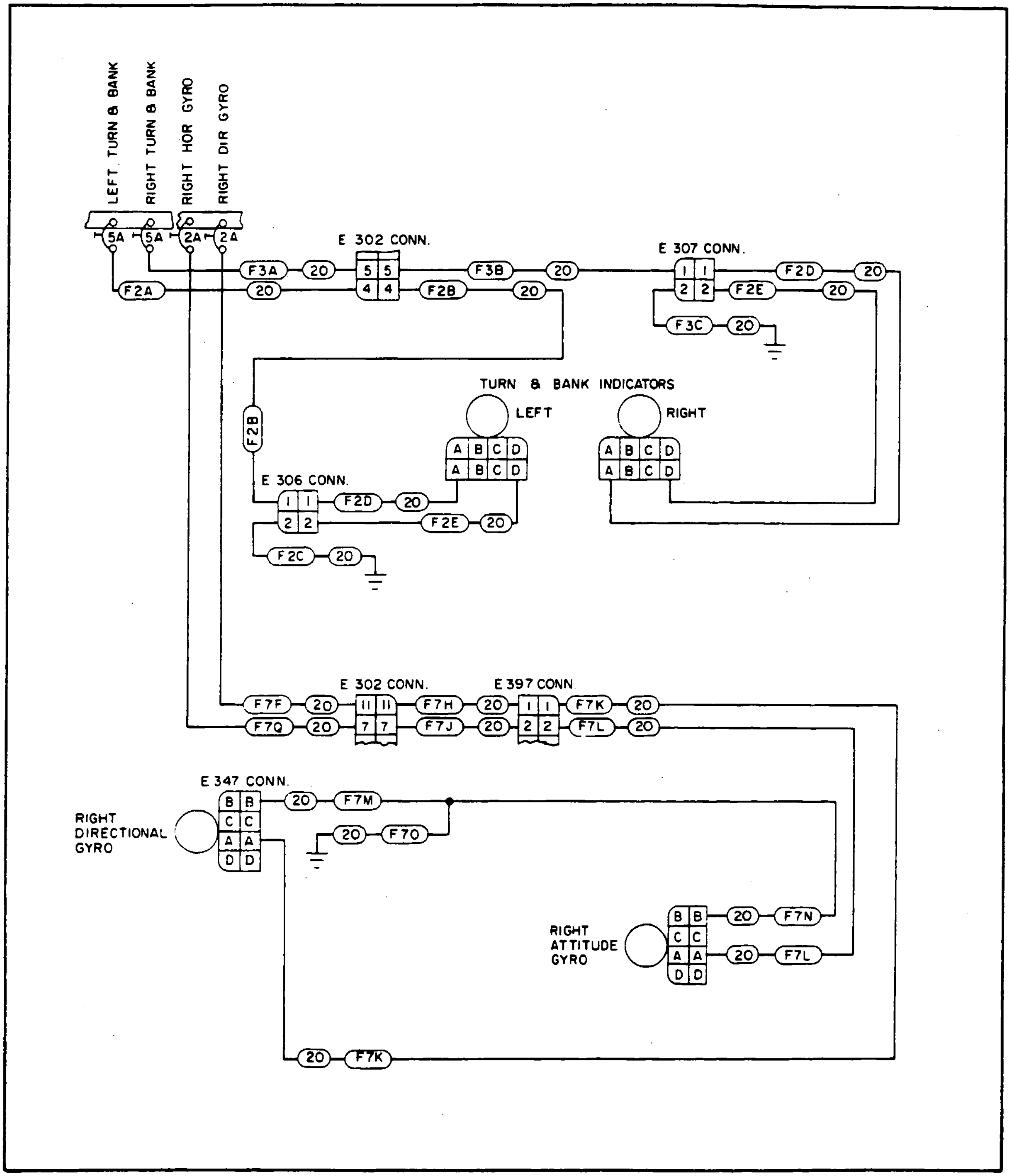

Figure 11-30. Attitude Horizon, Directional Gyro, Turn and Bank
S/N 31P-7630008 and up

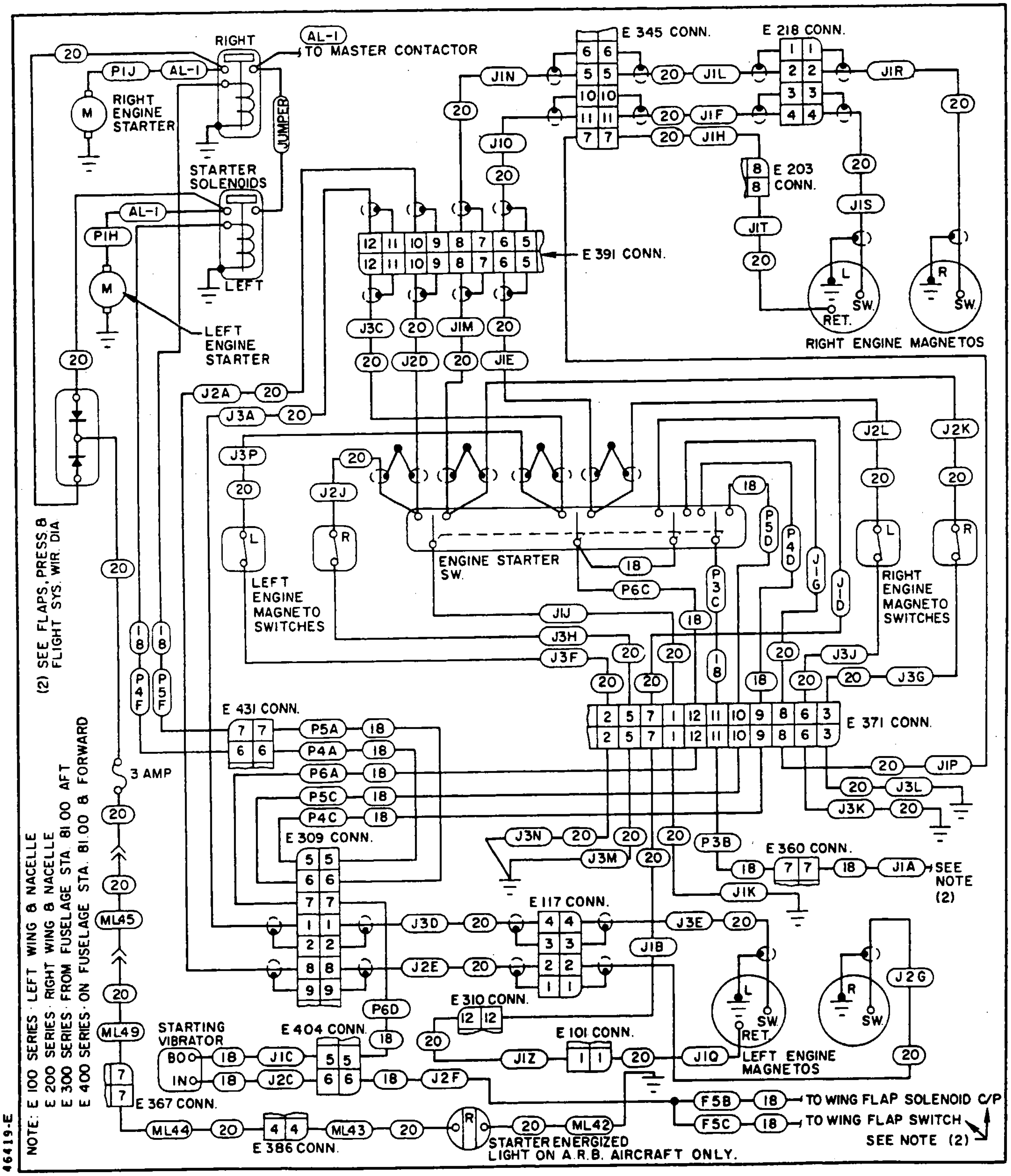

Figure 11-31. Magnetos/Starter Systems

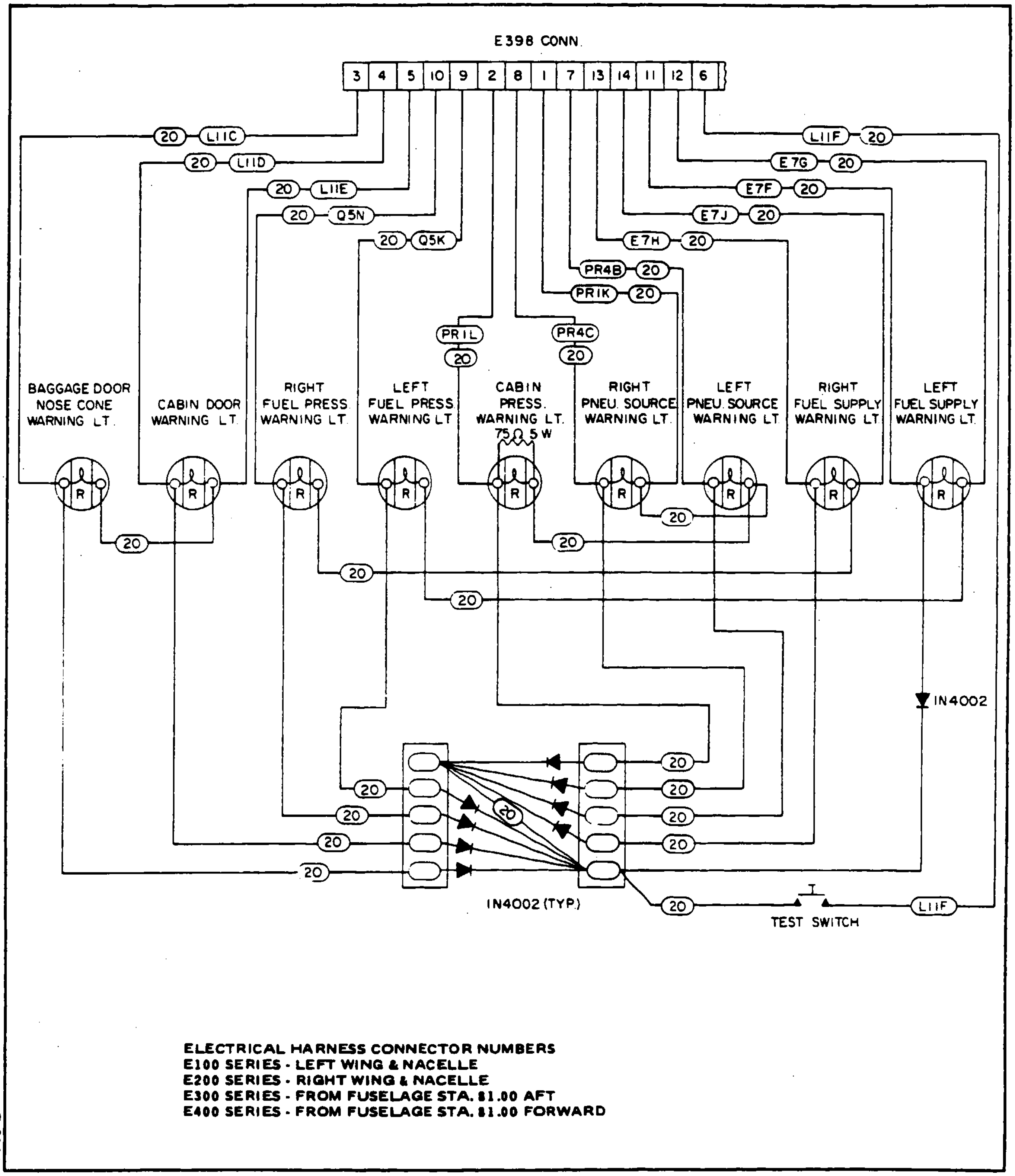

Figure 11-32. Annunciator Panel - Schematic, S/N 31P-7300128 and up

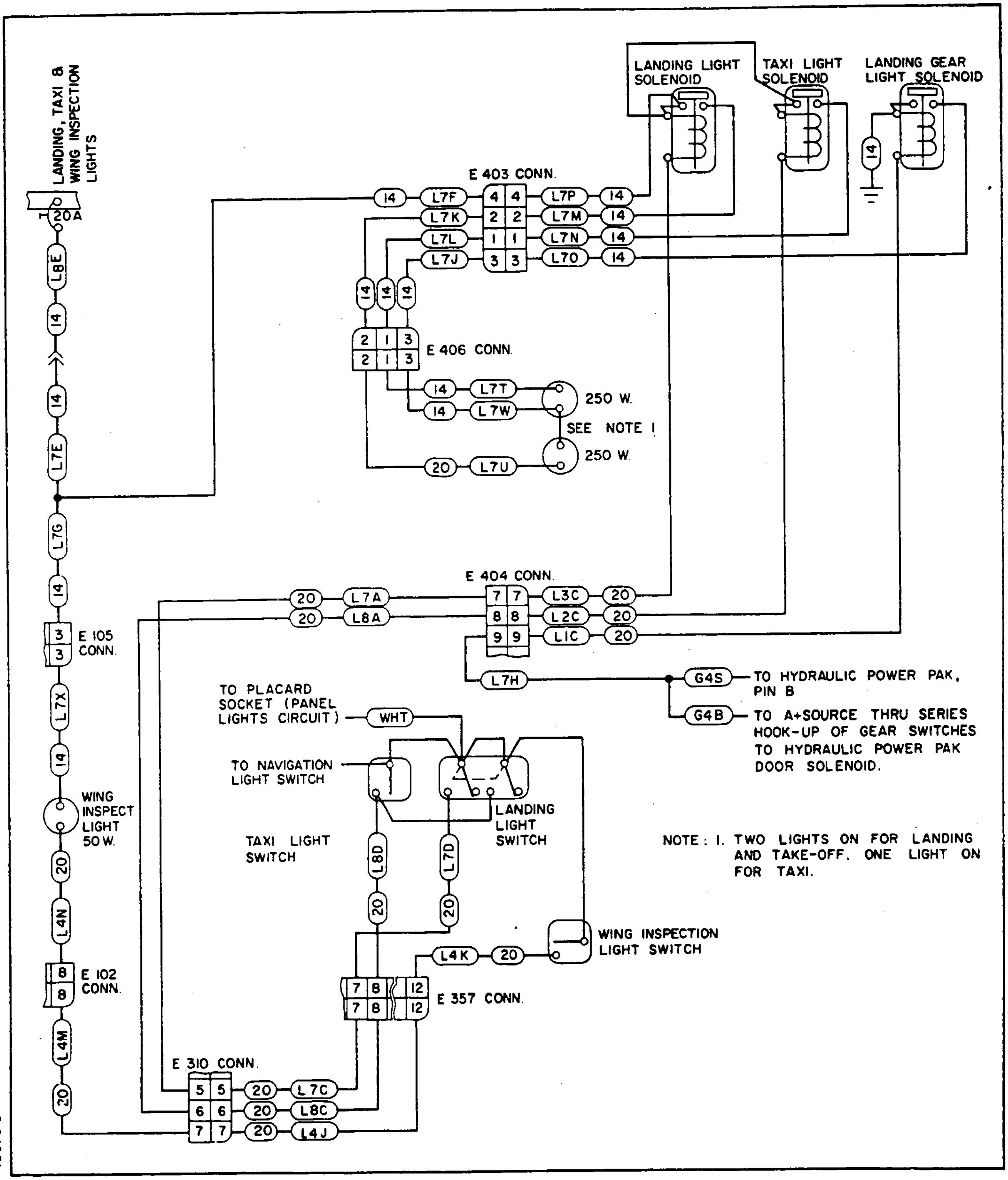

Figure 11-33. Landing and Taxi Light - Schematic

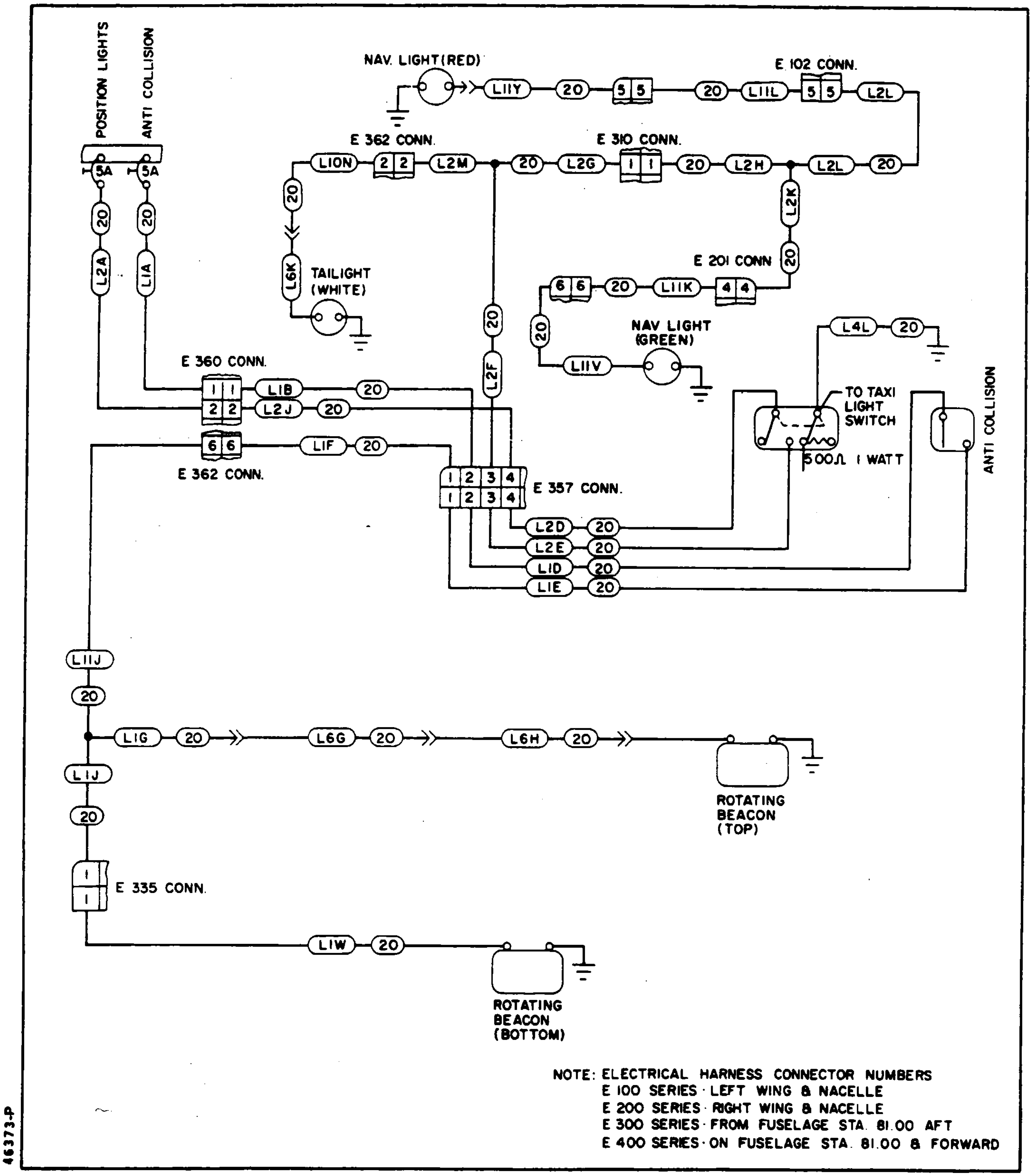

Figure 11-34. Position Lights and Anti-Collision - Schematic, S/N 31P-7300001 to 7300146

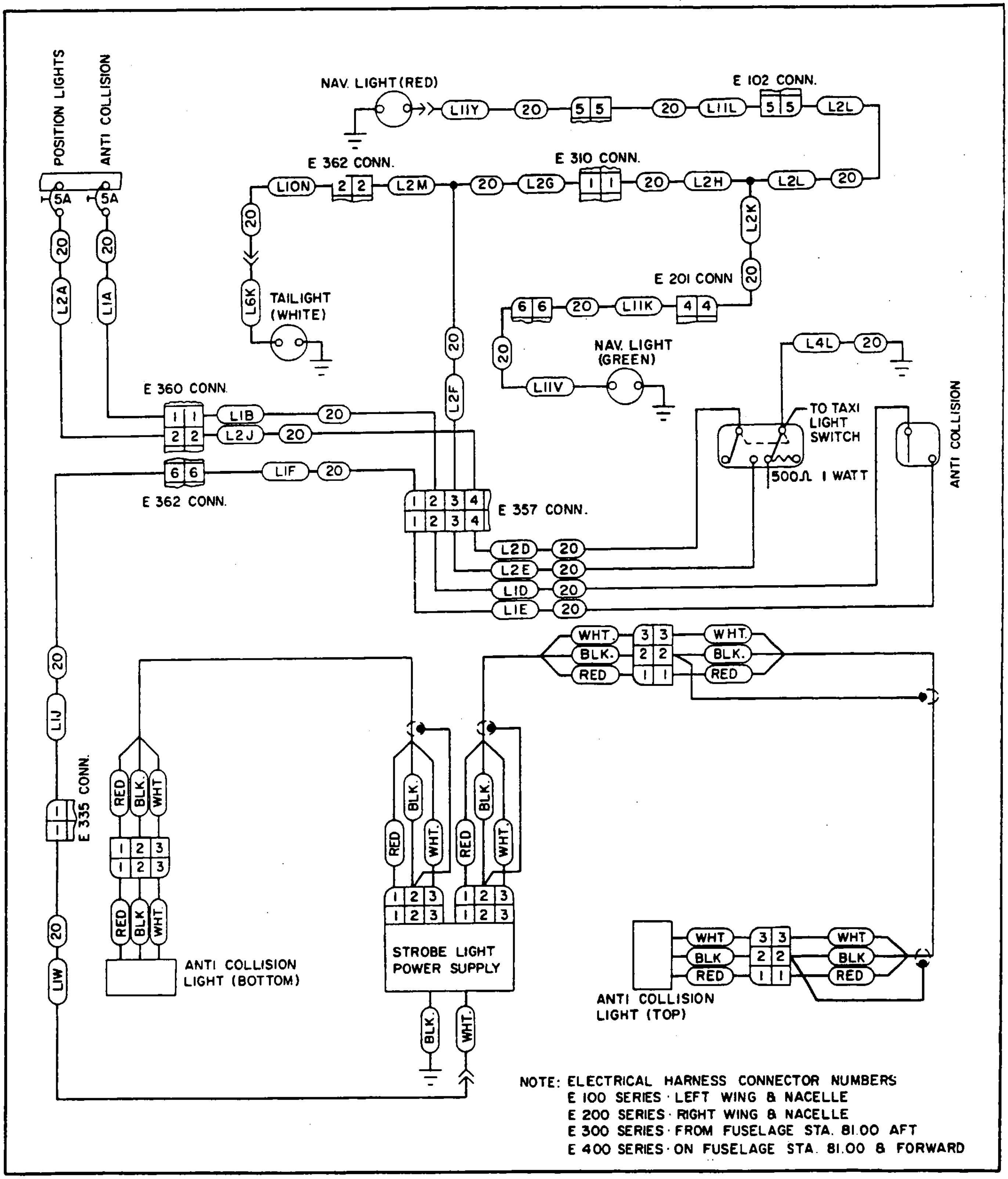

Figure 11-35. Position Lights and Anti-Collision - Schematic, S/N 31P-7300007 to 7300012

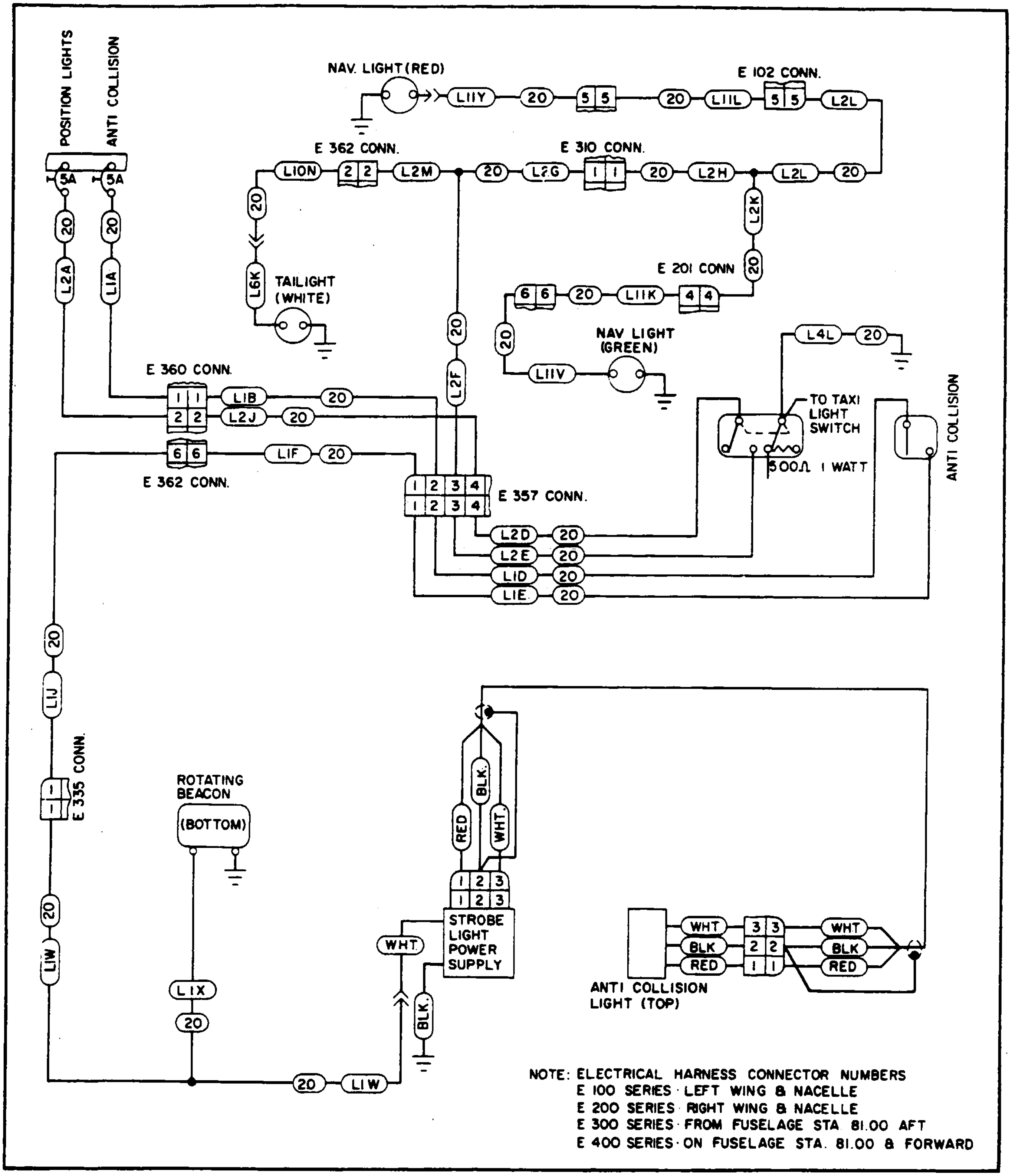

Figure 11-36. Position Lights and Anti-Collision - Schematic, S/N 31P-7300013 to 7300146

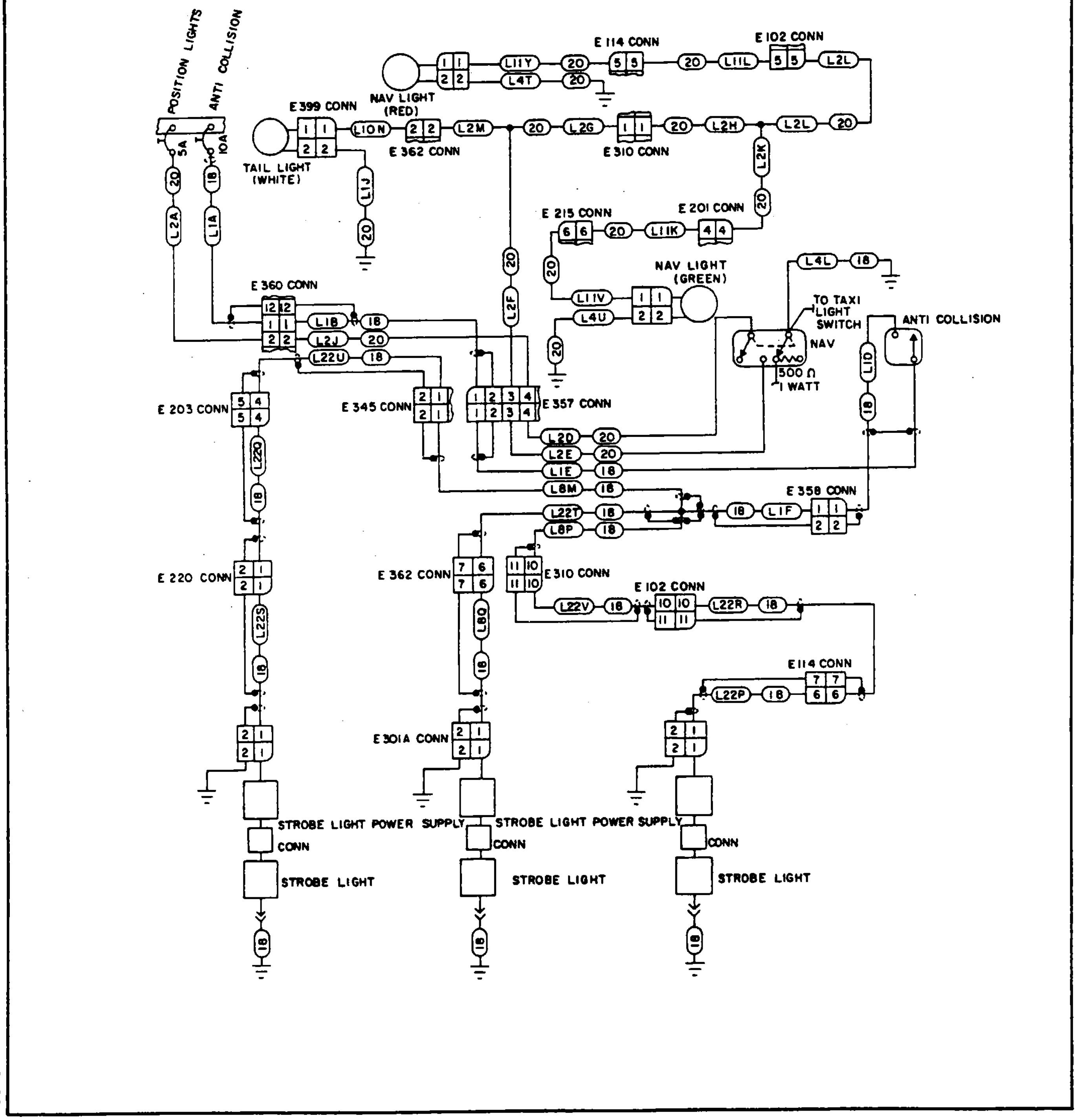

Figure 11-37. Position Lights and Anti-Collision - Schematic, S/N 31P-7300147 and up

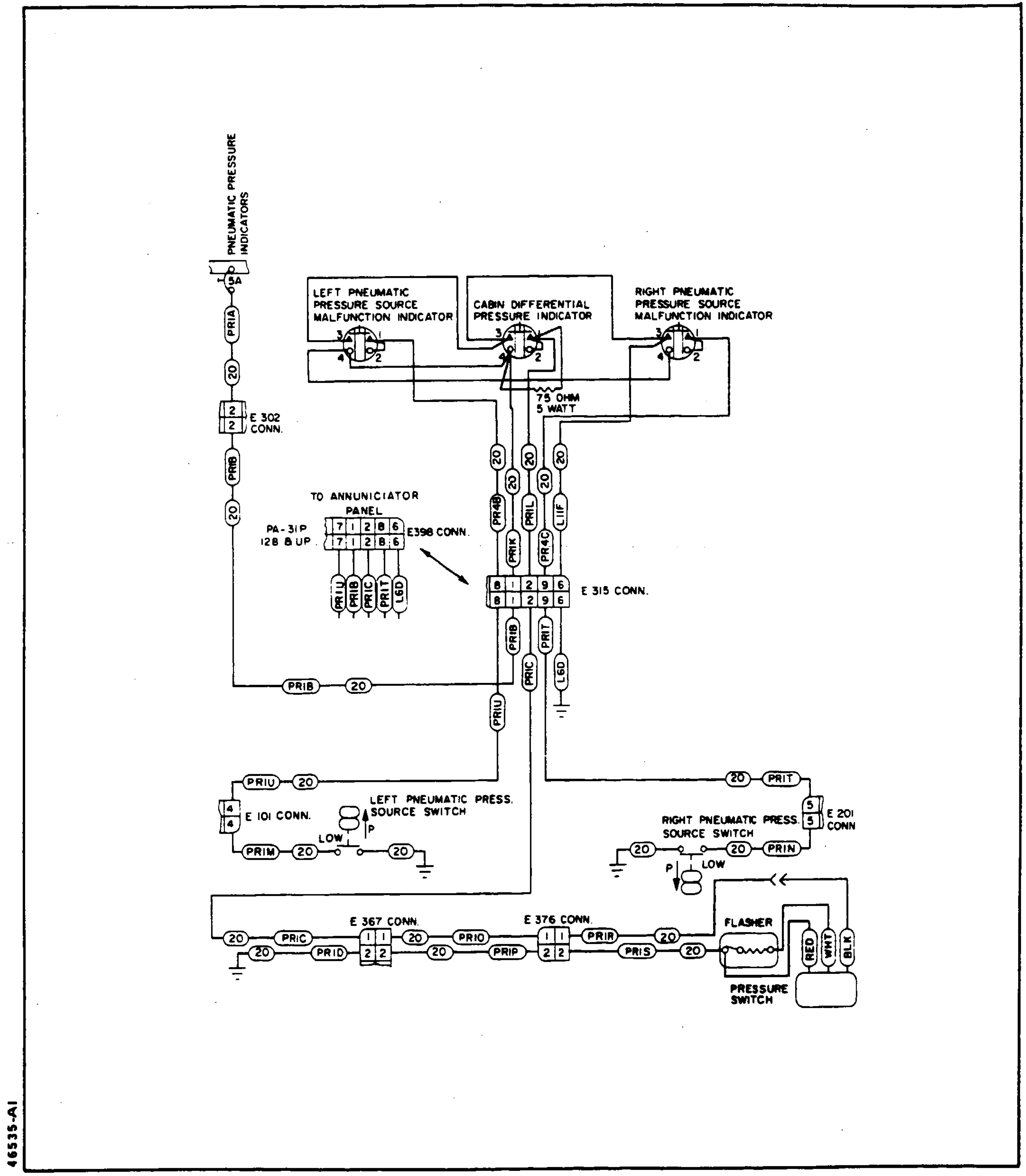

Figure 11-38. Pneumatic Pressure Indicators - Schematic

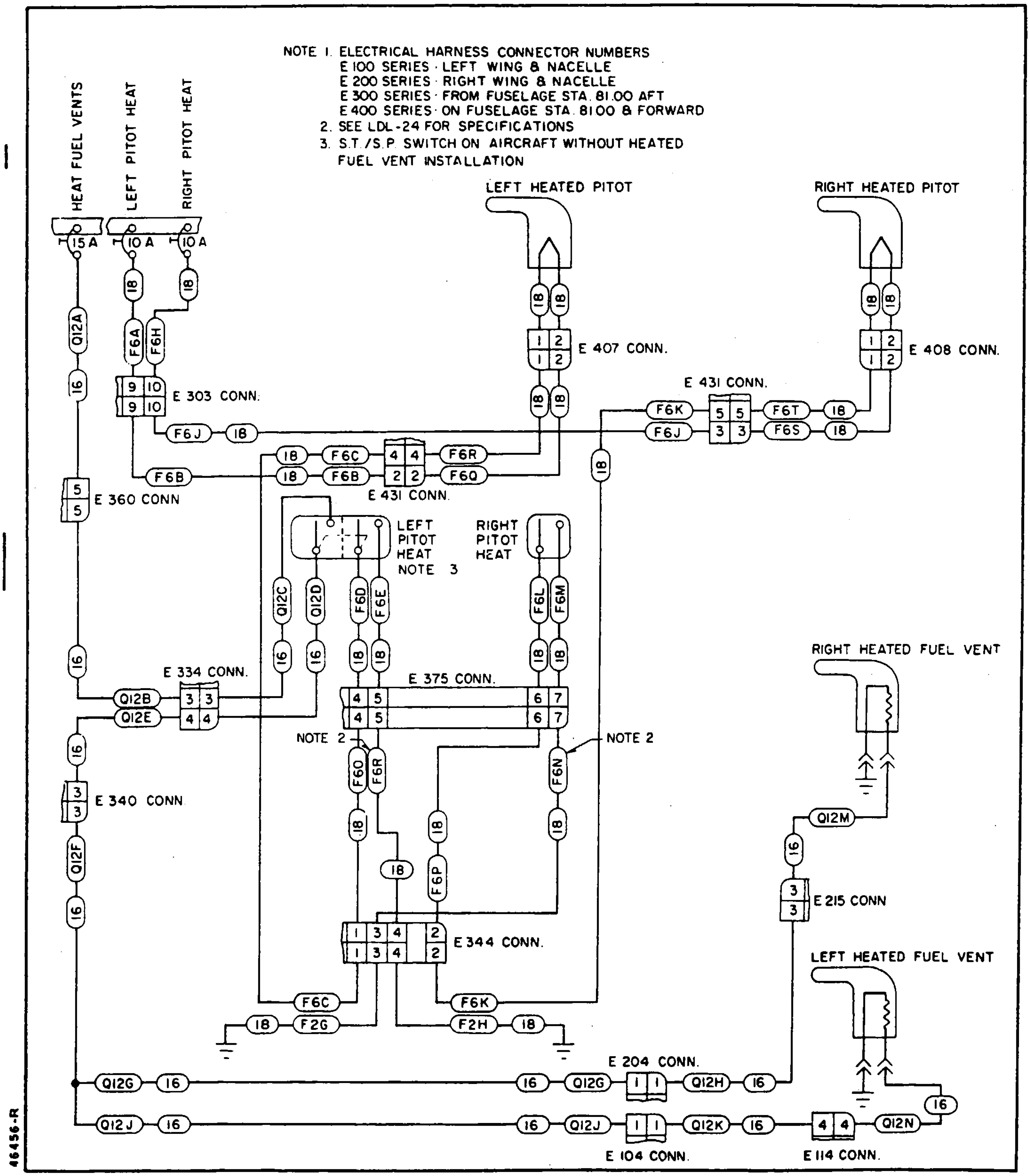

Figure 11-39. Pitot Heat and Heated Fuel Vents, Right and Left - Schematic

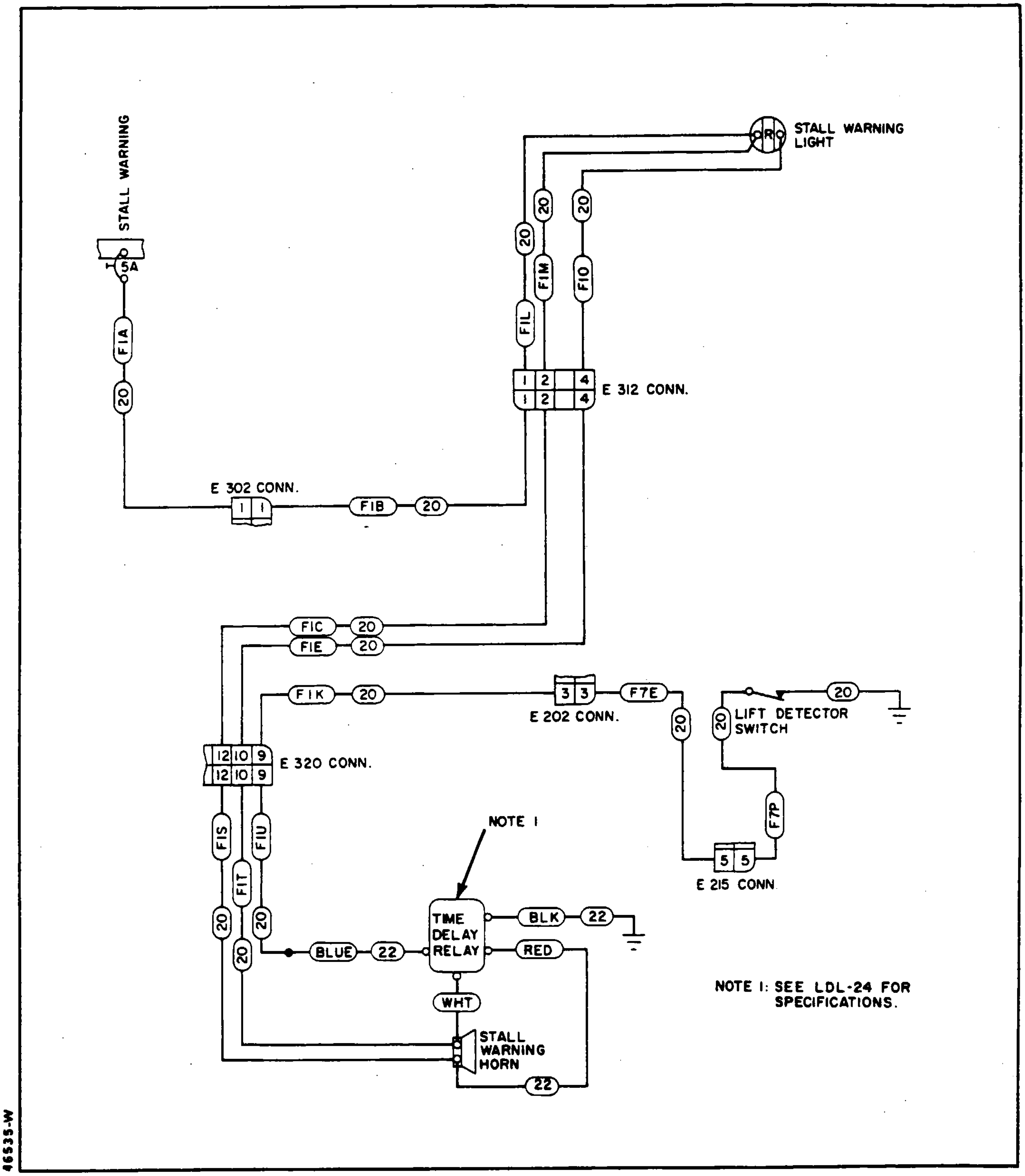

Figure 11-40. Stall Warning - Schematic, S/N 31P-7300003 to 7530022
PA-31P-7530022

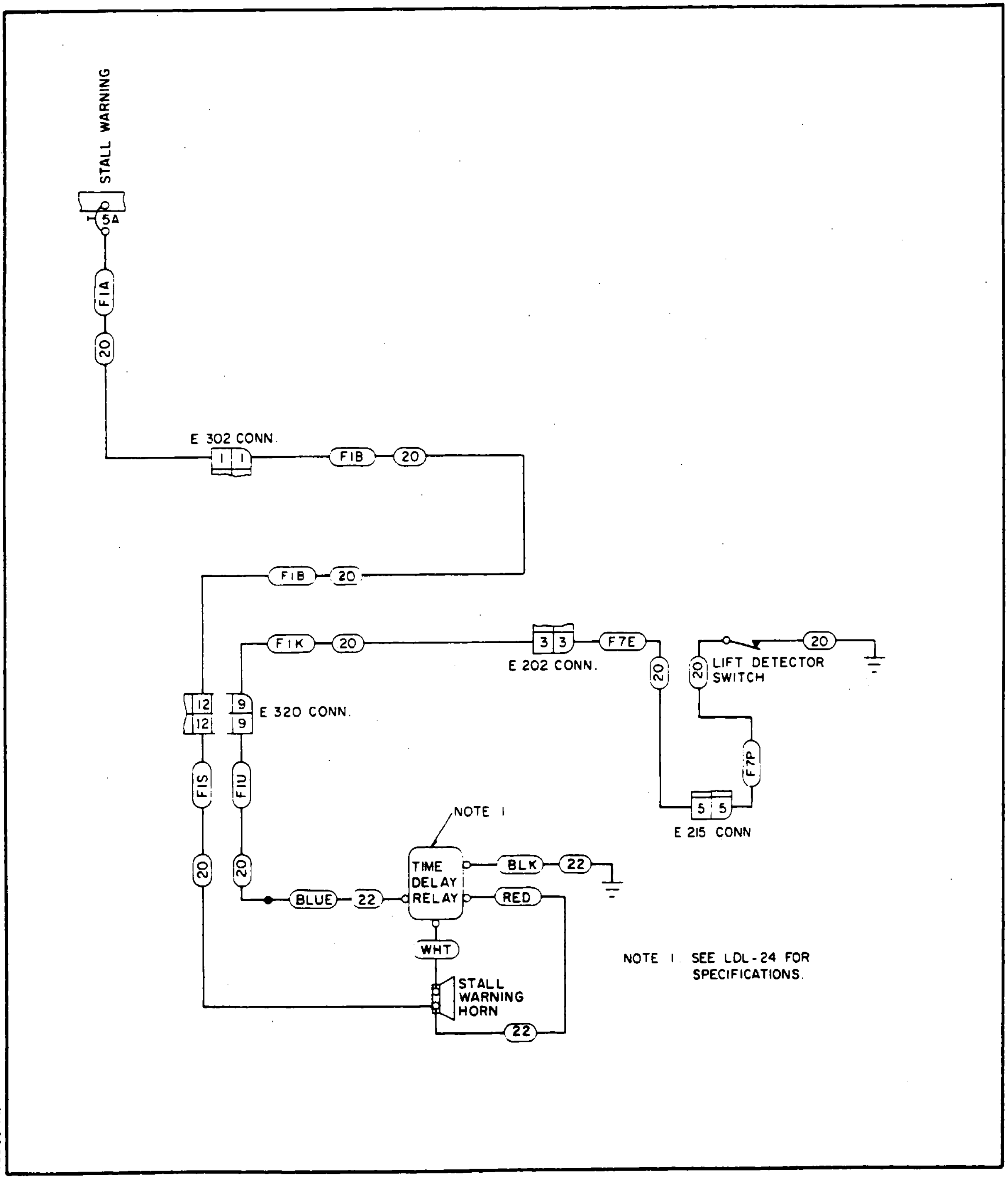

Figure 11-41. Stall Warning - Schematic, S/N PA-31P-7530023 and up

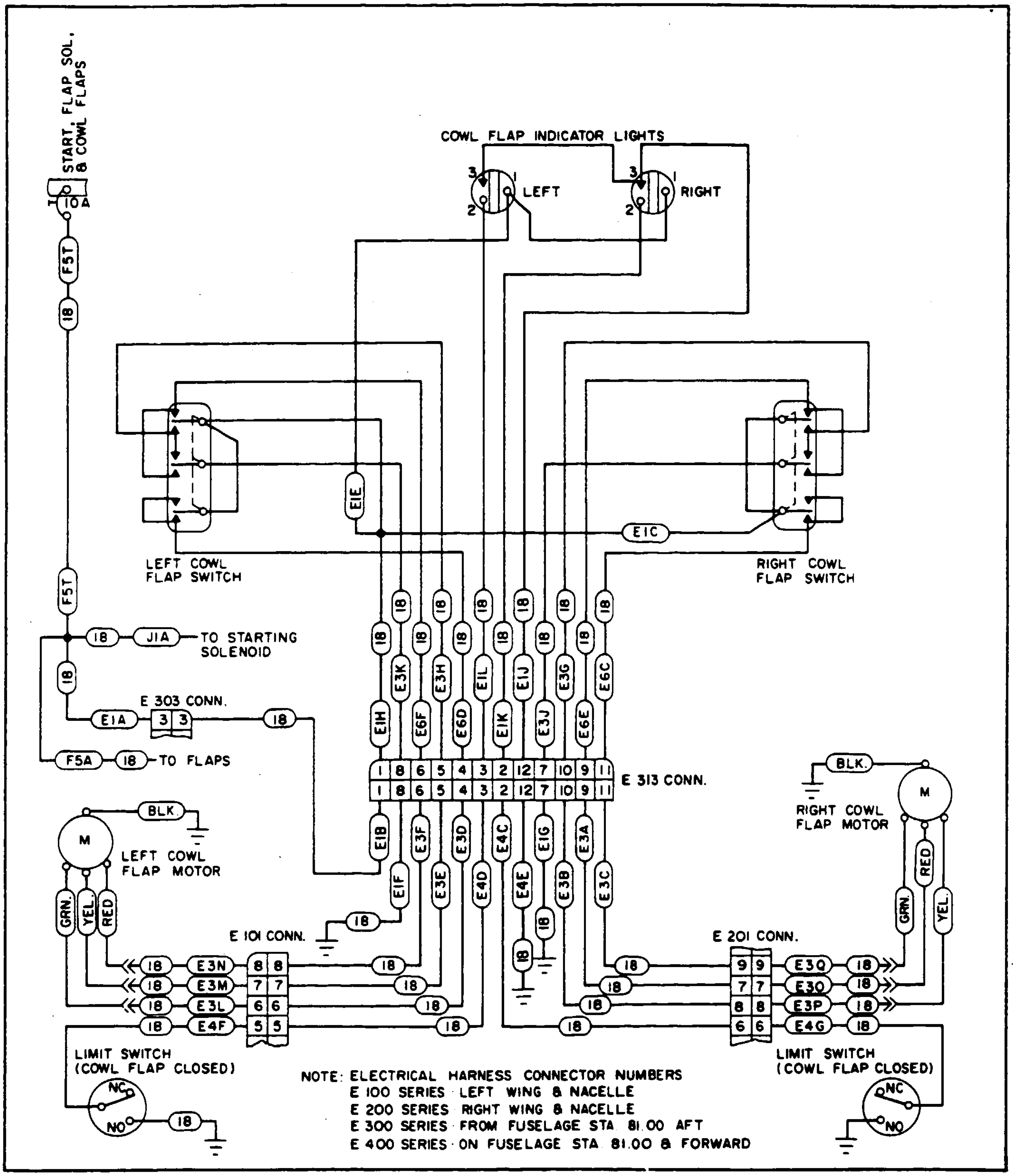

Figure 11-42. Cowl Flaps - Schematic, S/N 31P-7300001 to 7300053

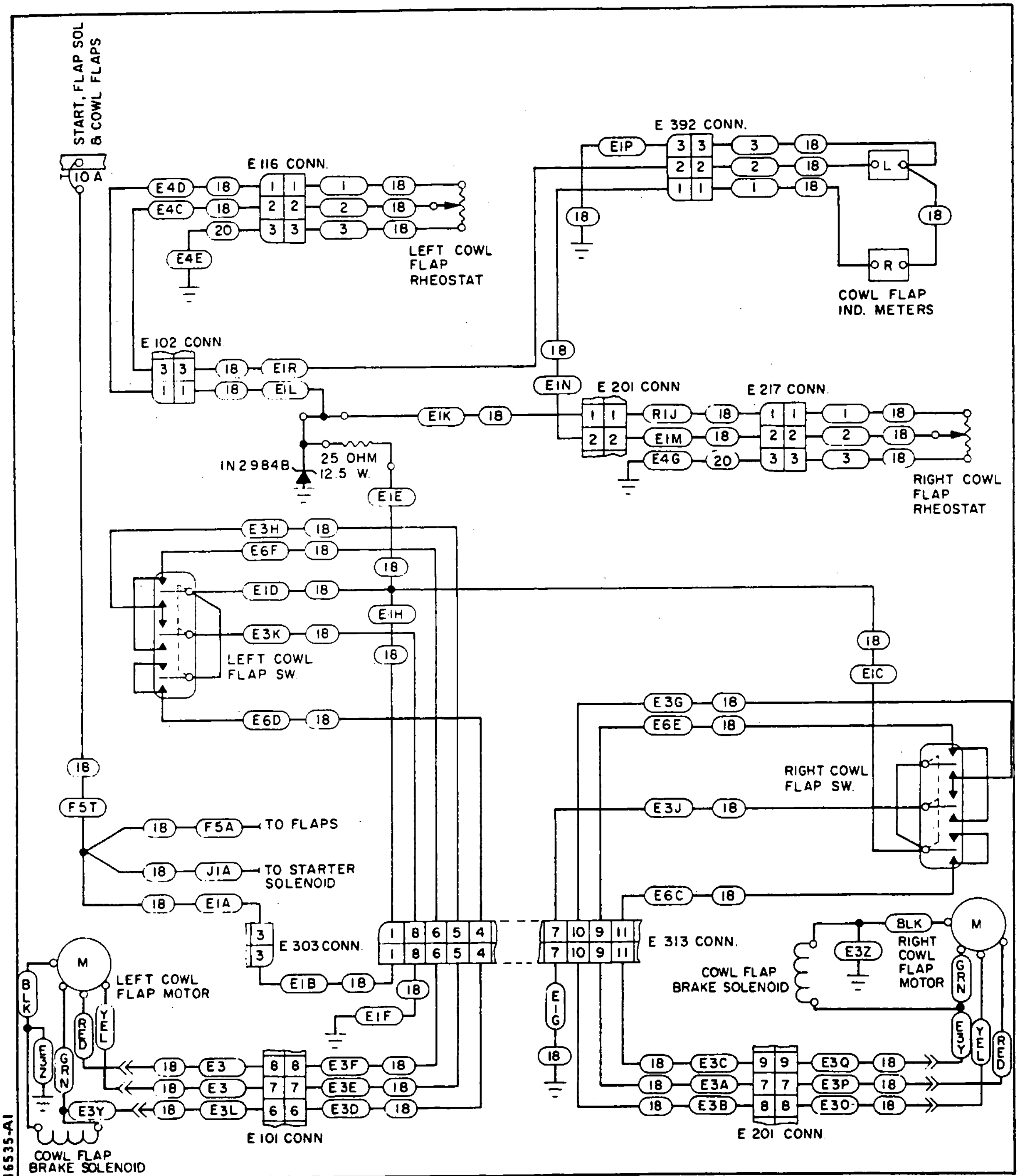

Figure 11-43. Cowl Flaps - Schematic, S/N 31P-7300054 and up

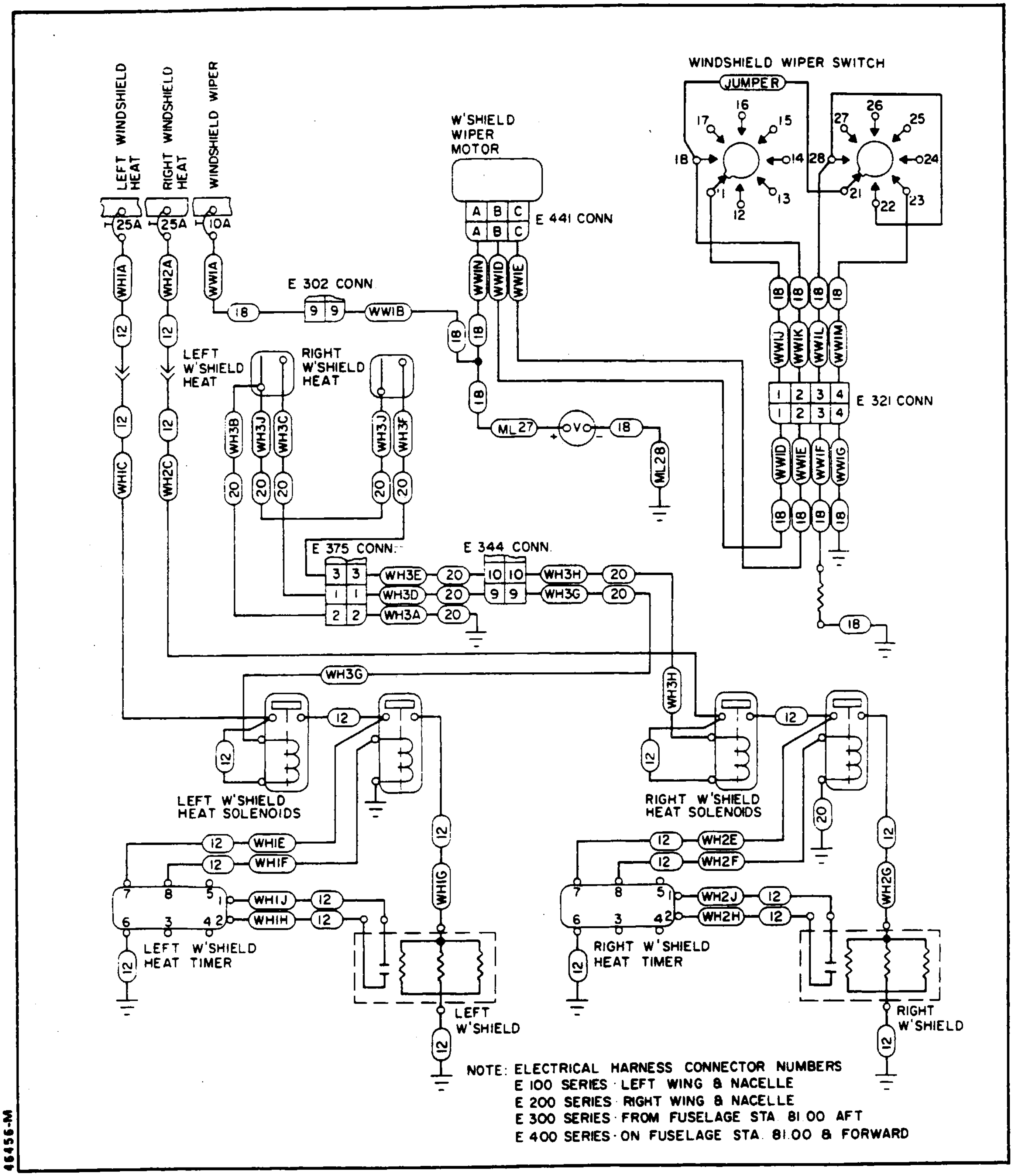

Figure 11-44. Windshield Wiper and Heater - Schematic

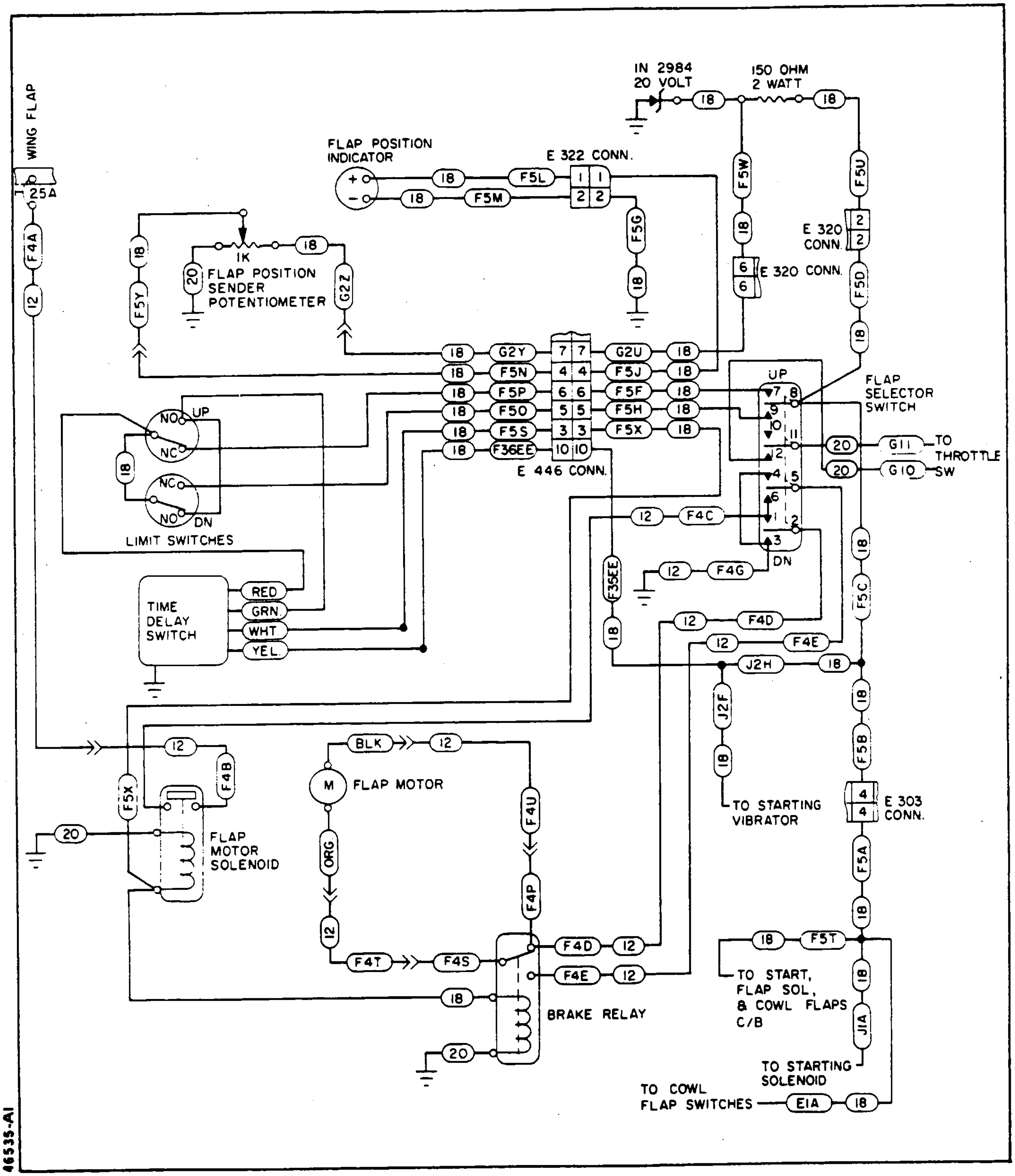

Figure 11-45. Wing Flap - Schematic

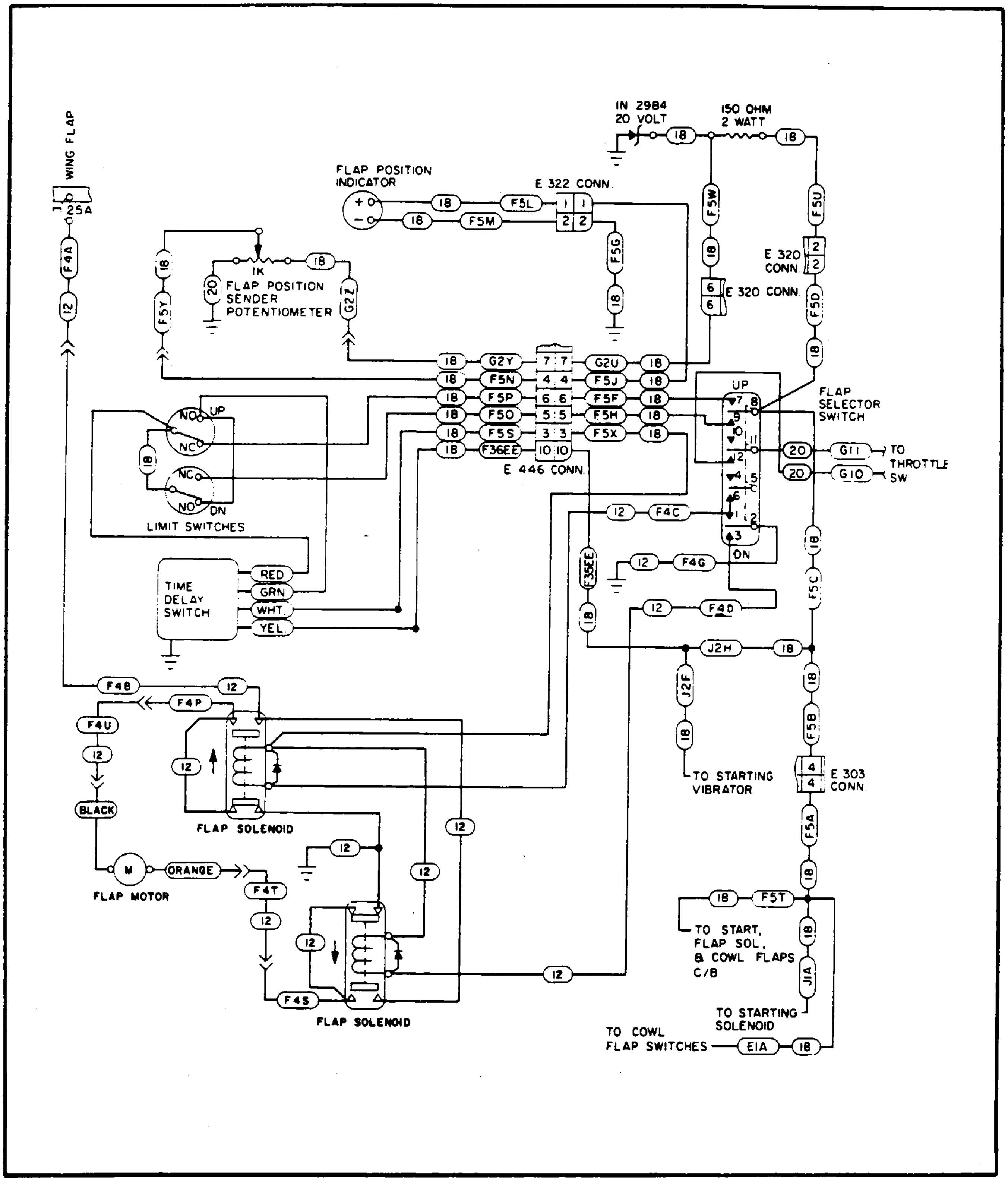

Figure 11-45a. Wing Flap - Schematic, S/N 31P-7730012 and up

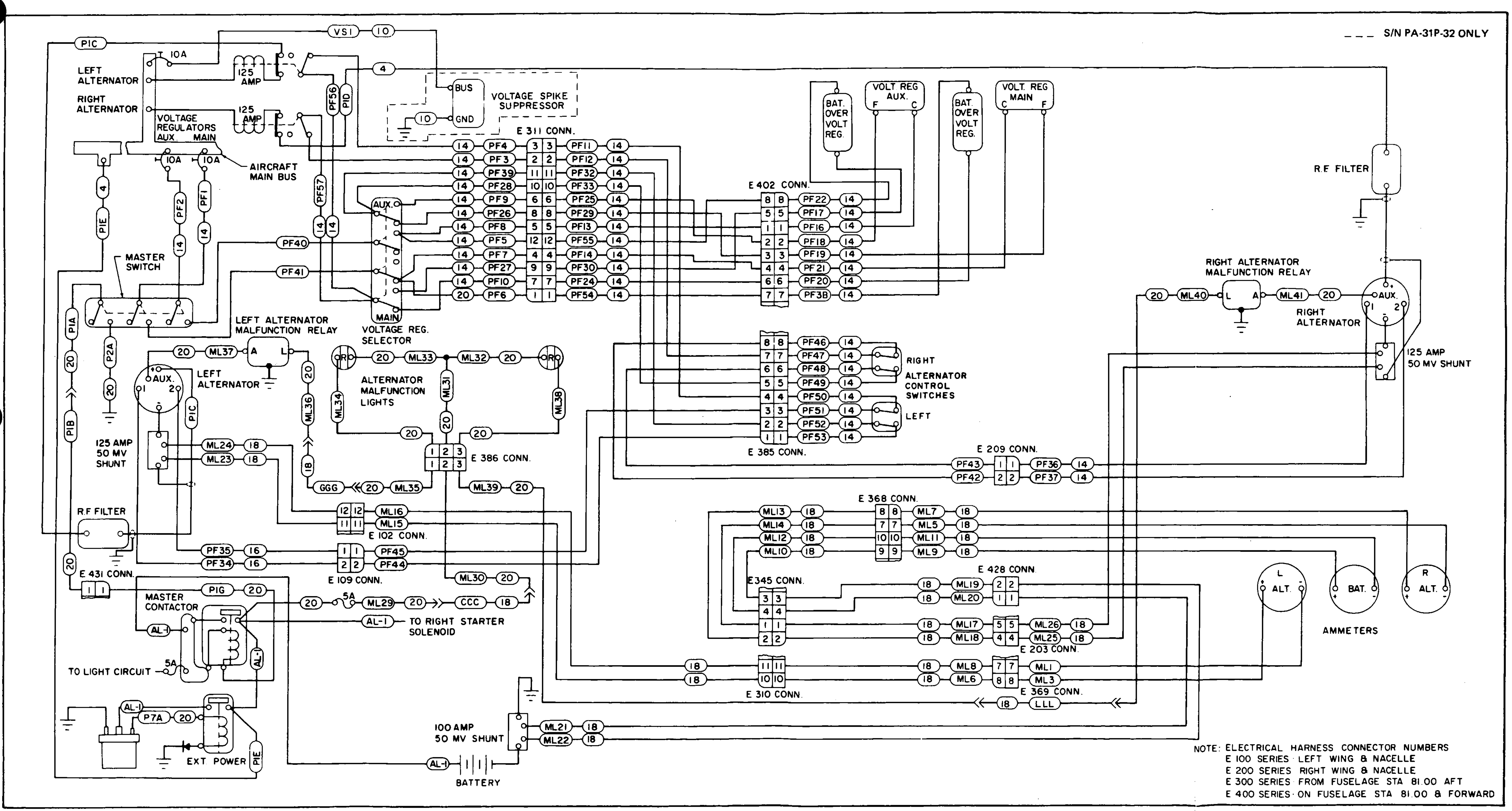

Figure 11-46. Alternator and Battery - Schematic, S/N PA-31P-7300001 to 7300109

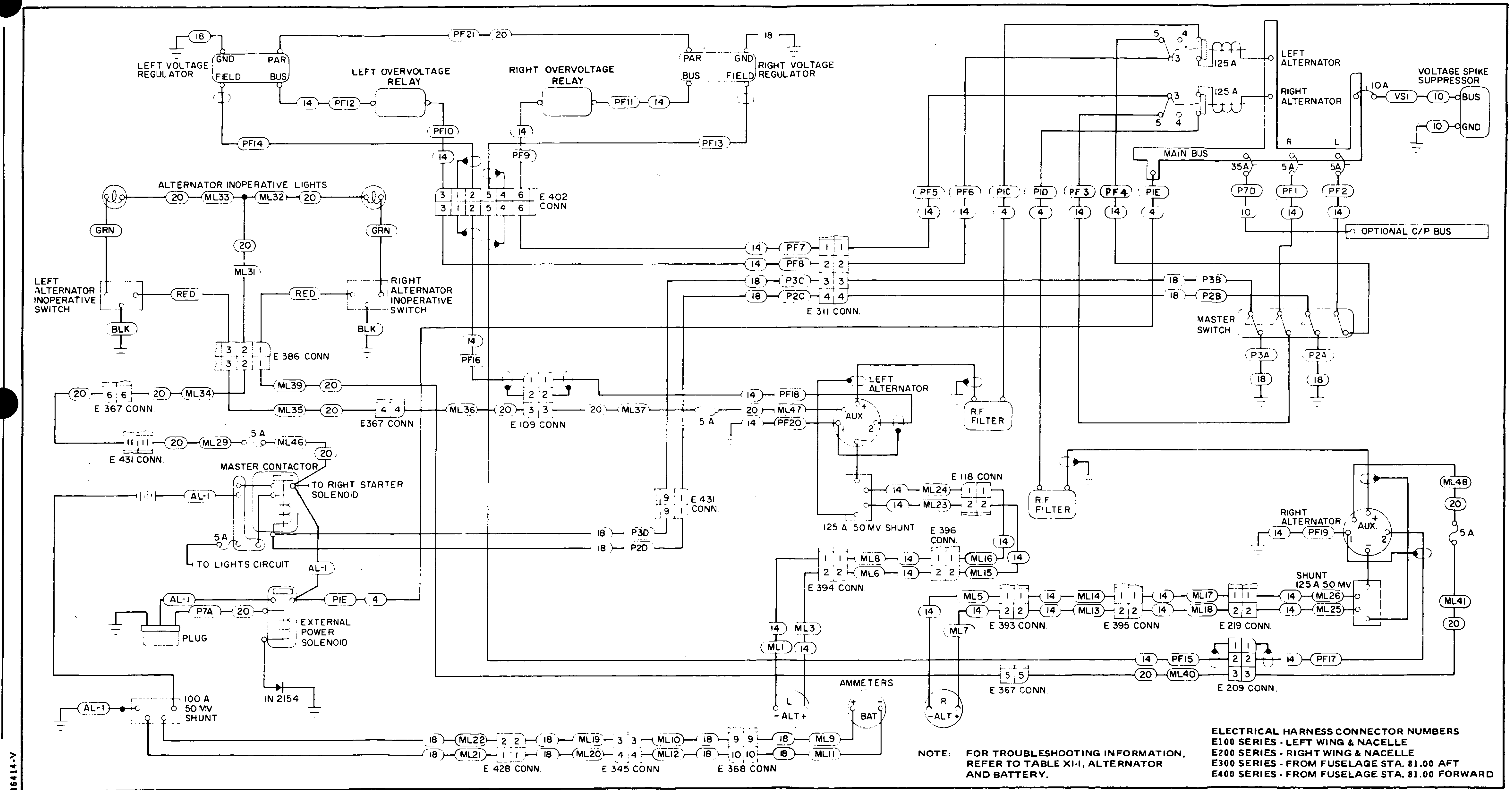

Figure 11-47. Alternator Paralleling System, S/N PA-31P-7300110 and up

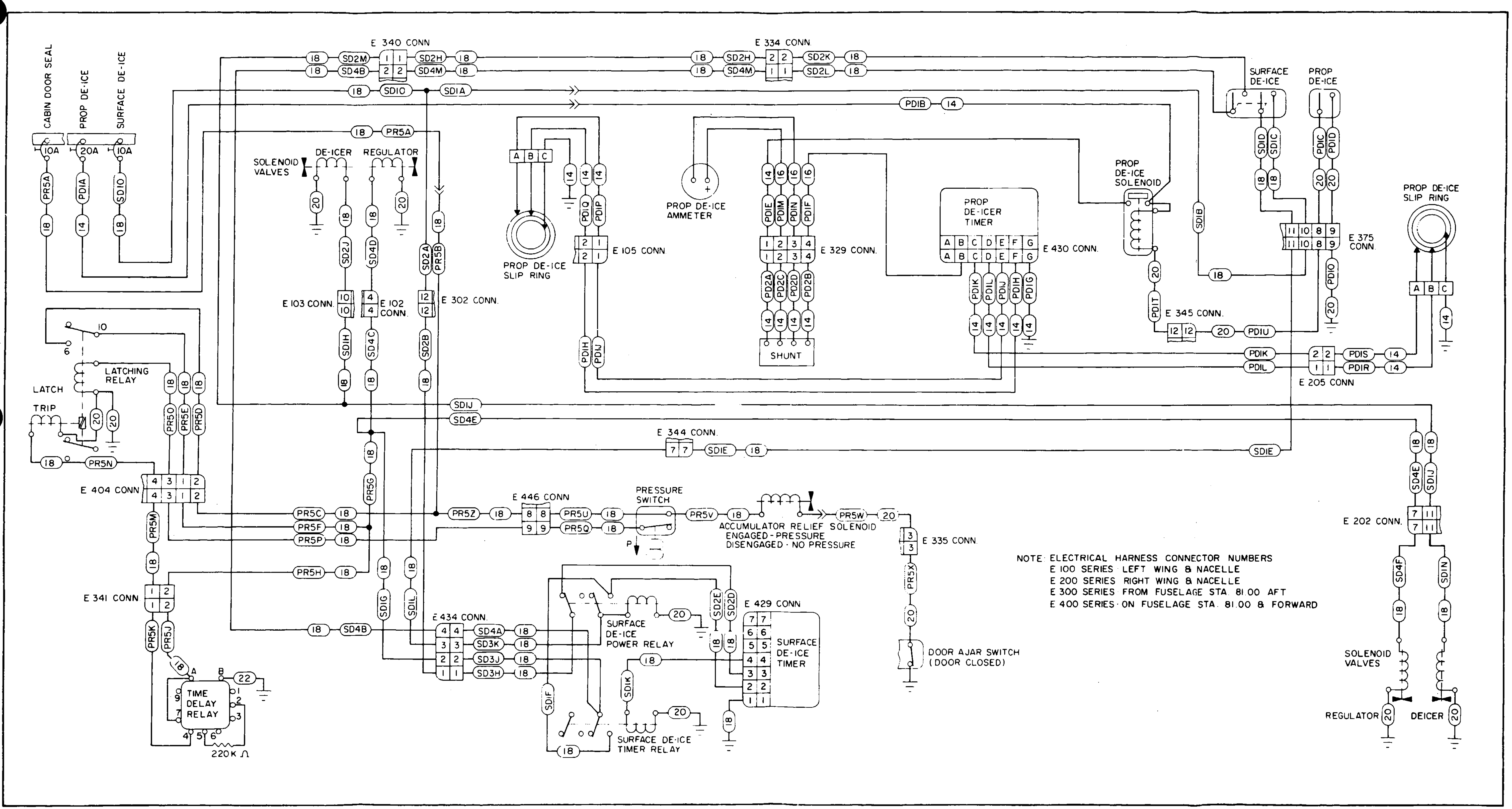

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Figure 11-48. Cabin Door Seal - Prop Deice - Surface Deice - Schematic,
S/N 31P-7300003 to 7530027

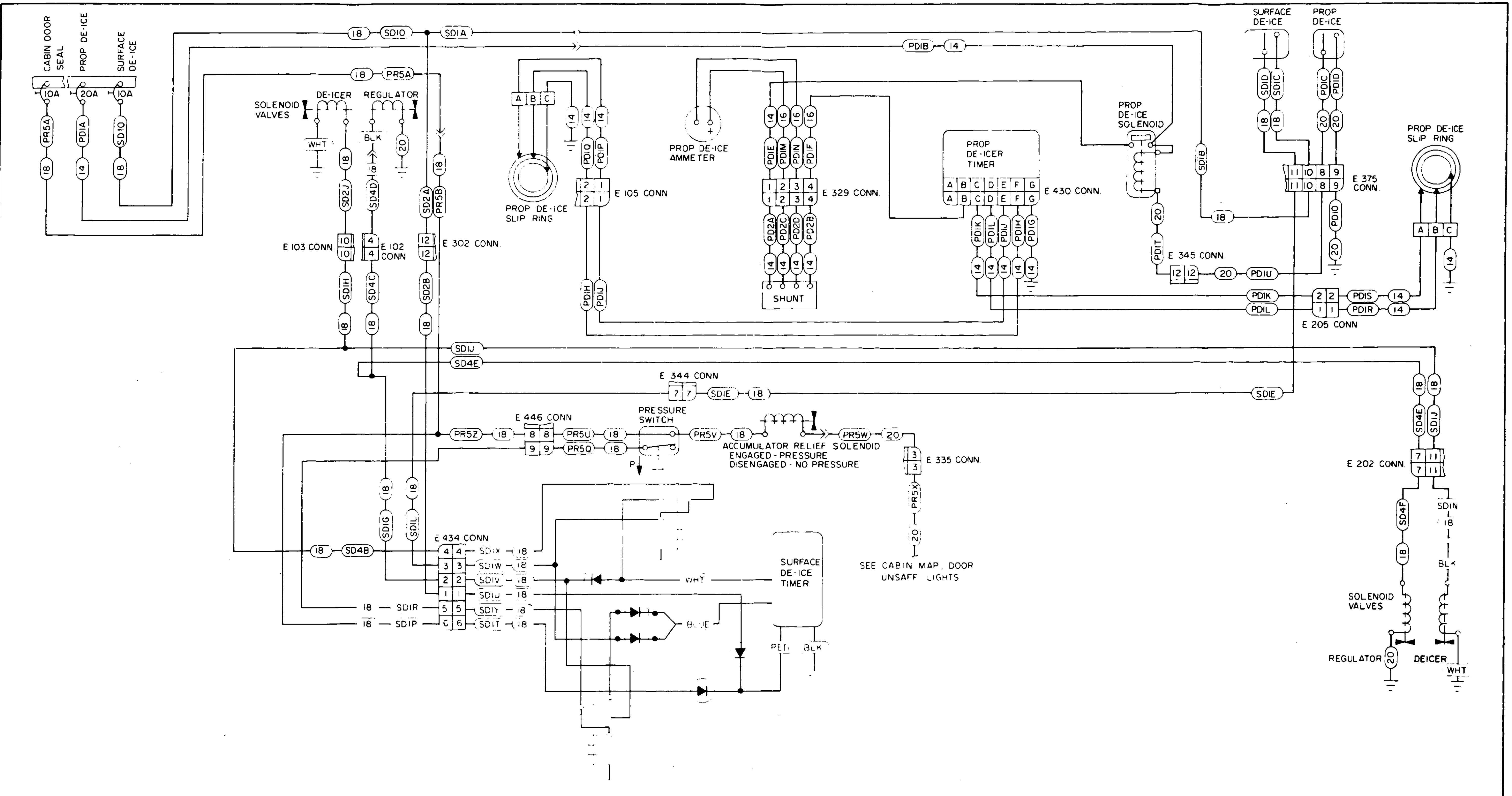


Figure 11-49. Cabin Door Seal - Prop Deice - Surface Deice - Schematic,
S/N PA-31P-7530028 and up

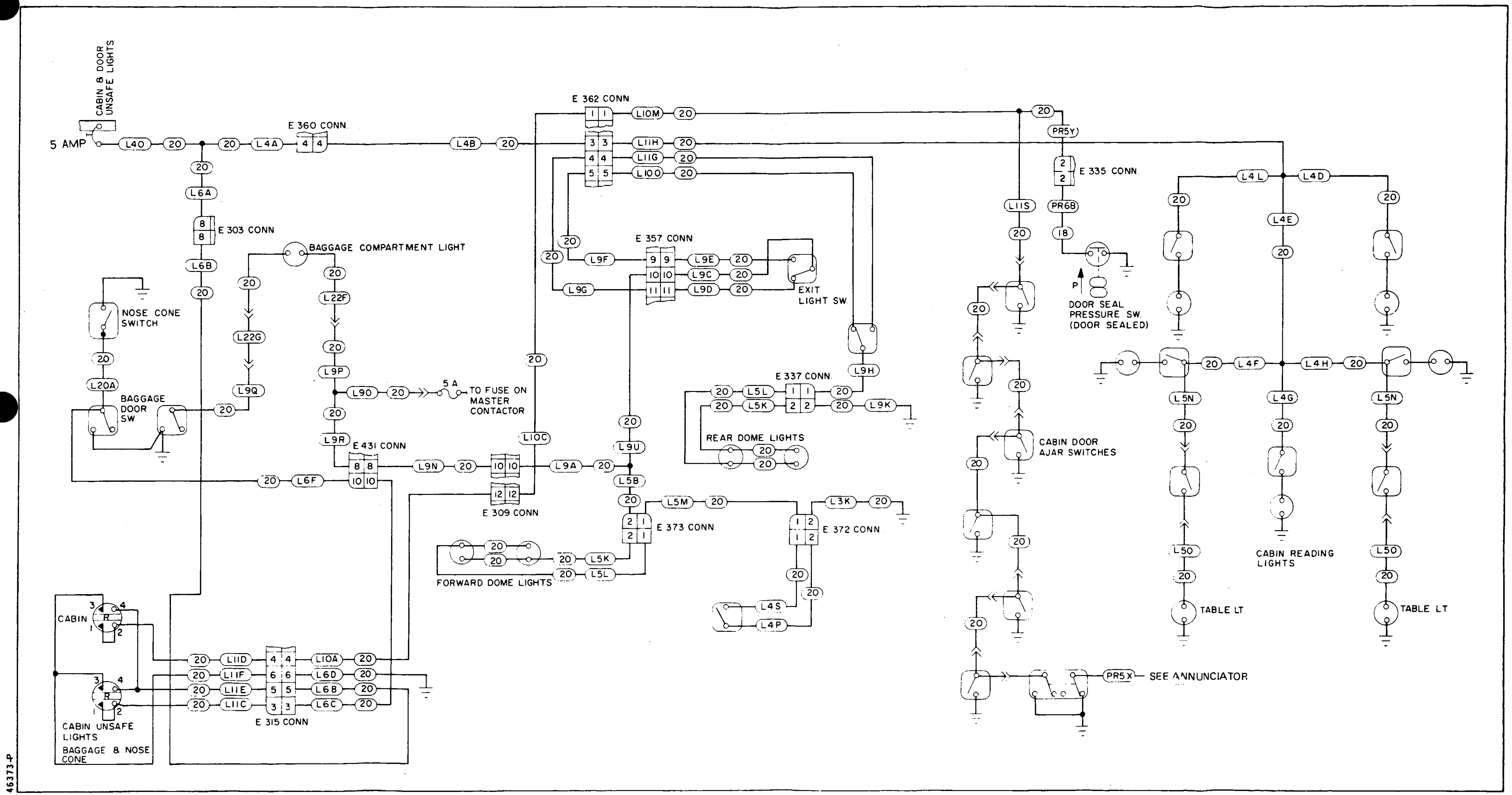


Figure 11-50. Baggage, Dome, Reading, Door Ajar, S/N 31P-7300001 to 7300127

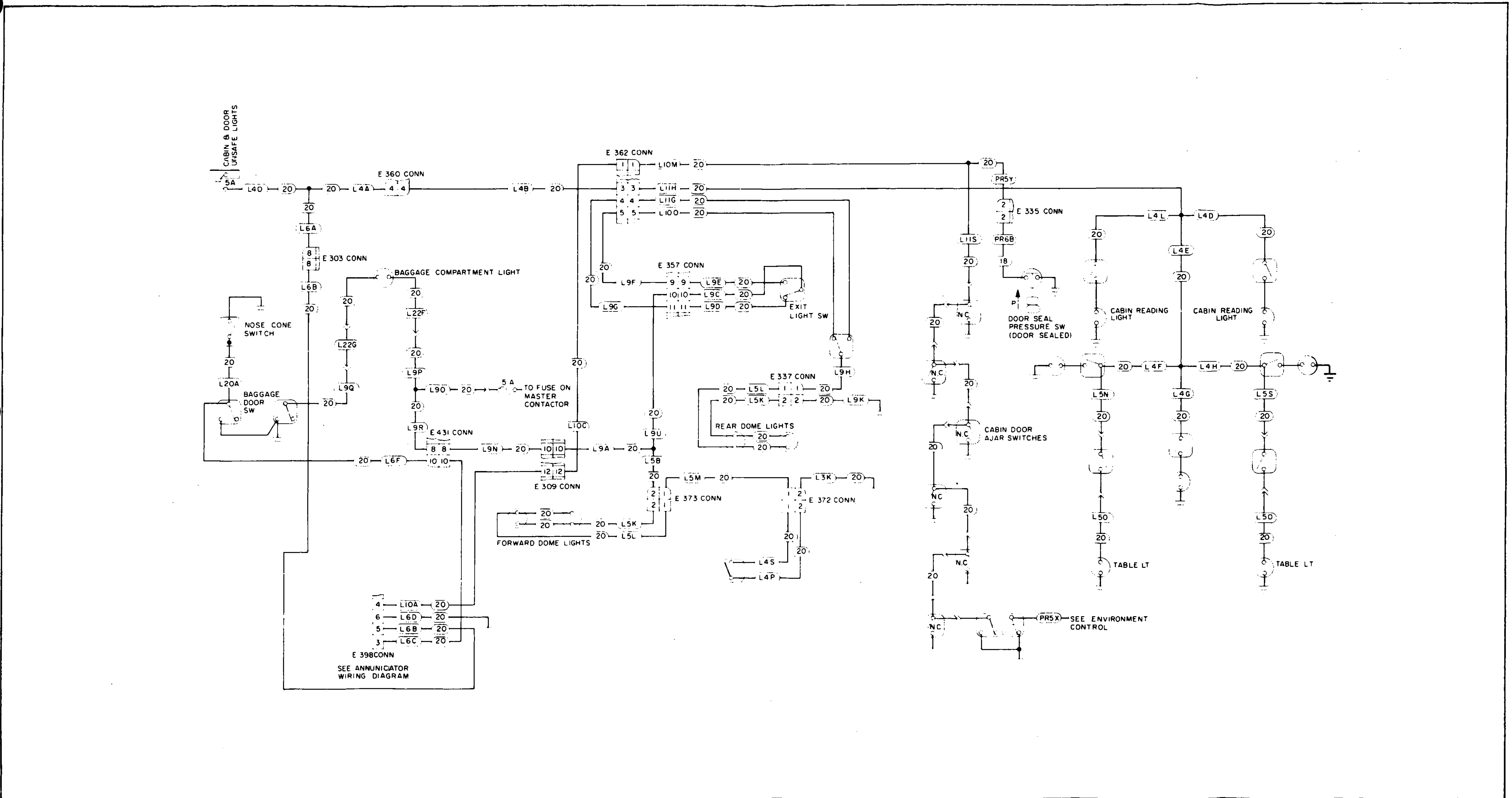


Figure 11-51. Baggage, Dome, Reading, Door Ajar, S/N 31P-7300128 to 7630005

46373-U

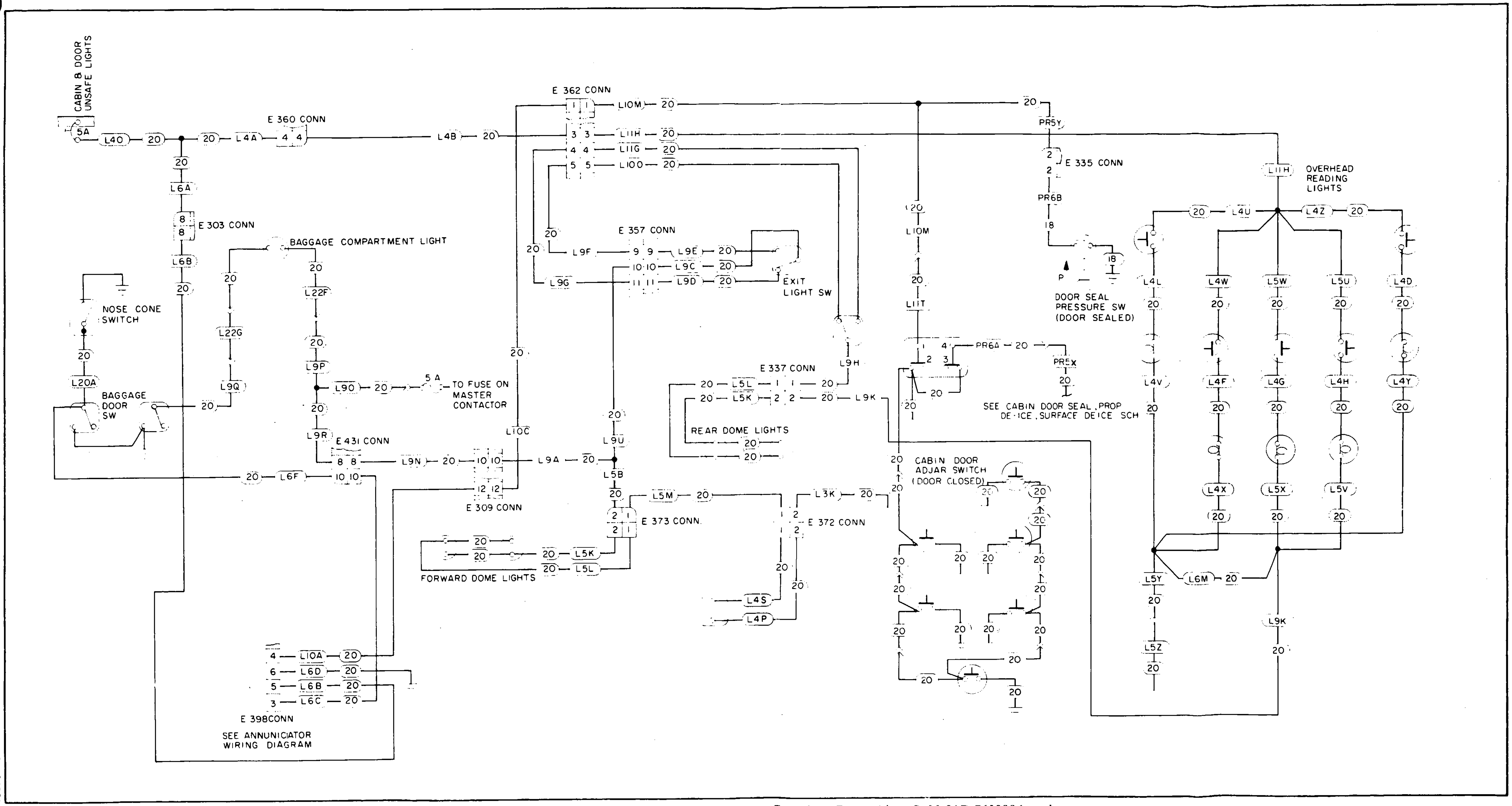


Figure 11-52. Baggage, Dome, Reading, Door Ajar, S/N 31P-7630006 and up

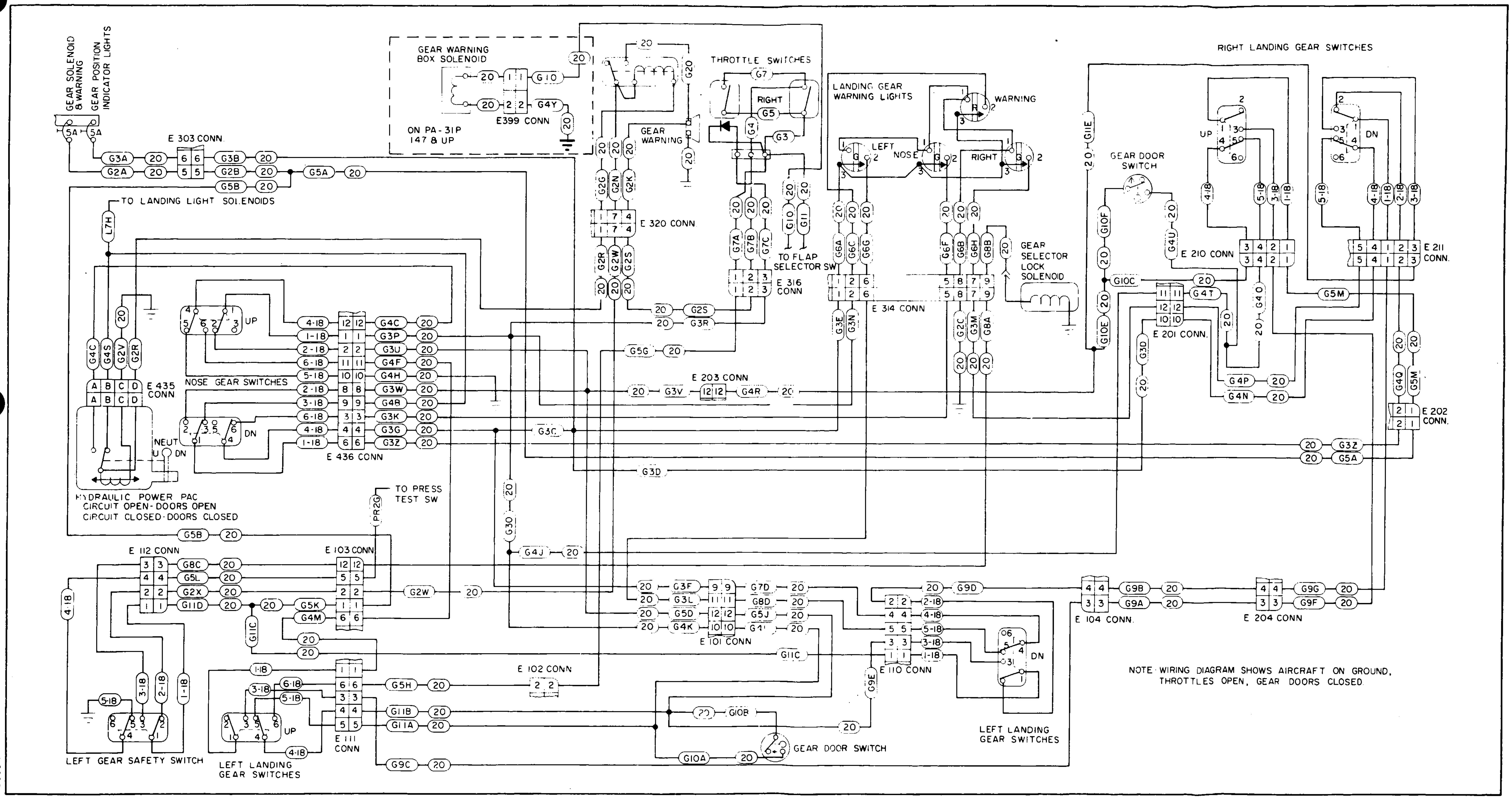


Figure 11-53. Landing Gear - Schematic

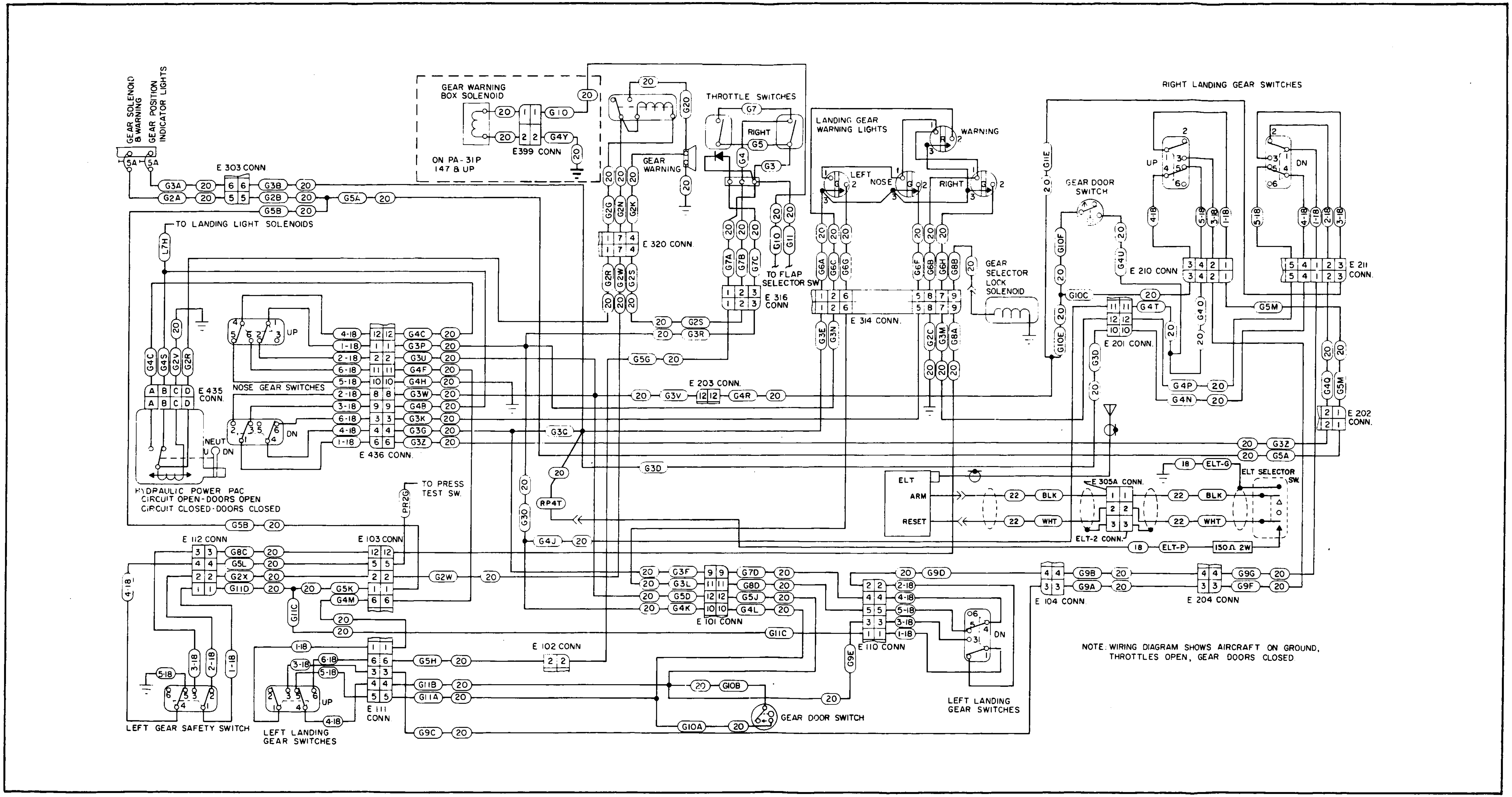
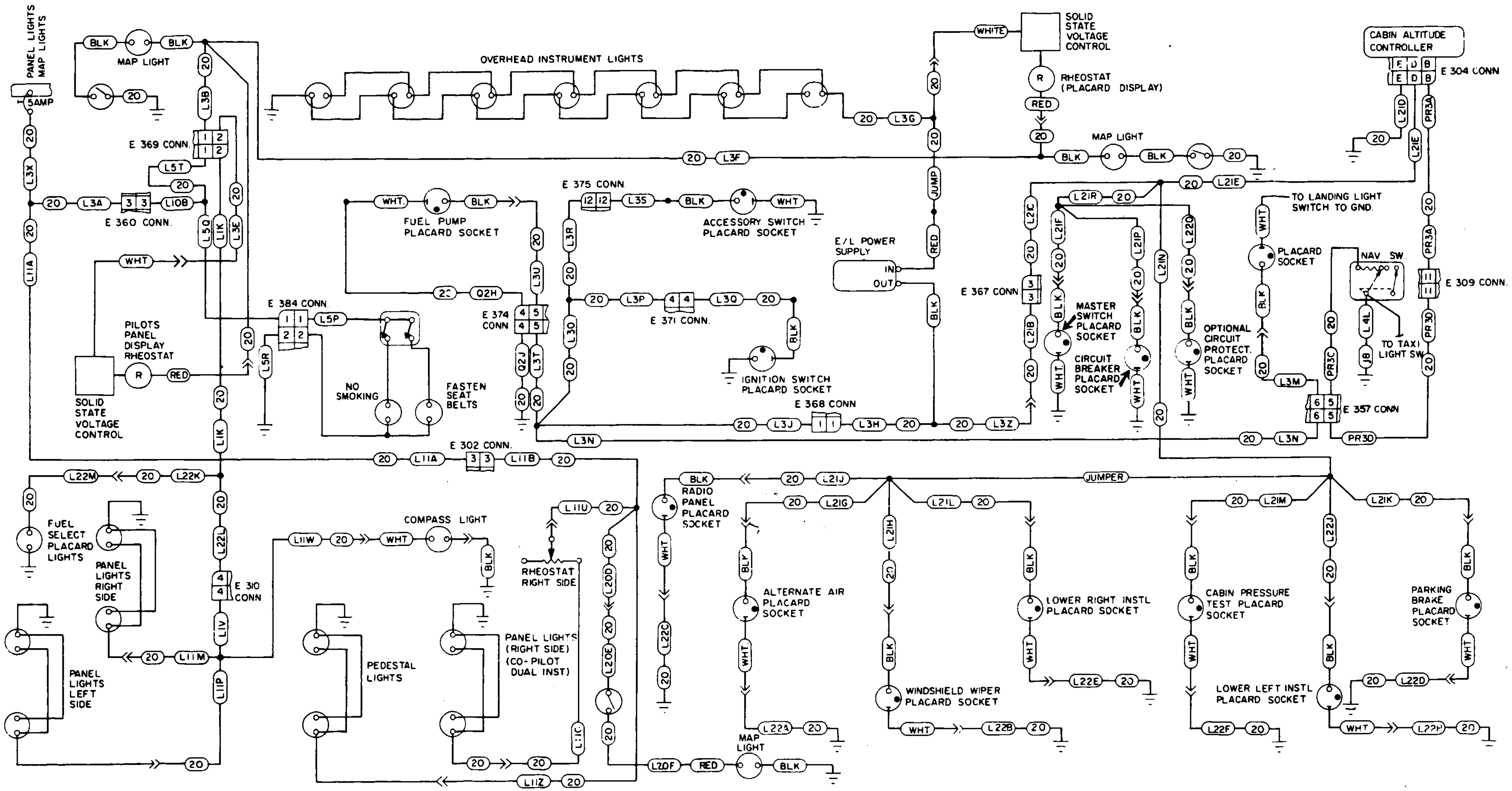


Figure 11-53a. Landing Gear. S/N 31P-7730004 and up



46373-U

Figure 11-54. Panel Lights - Schematic, S/N 31P-7300001 to 7630005

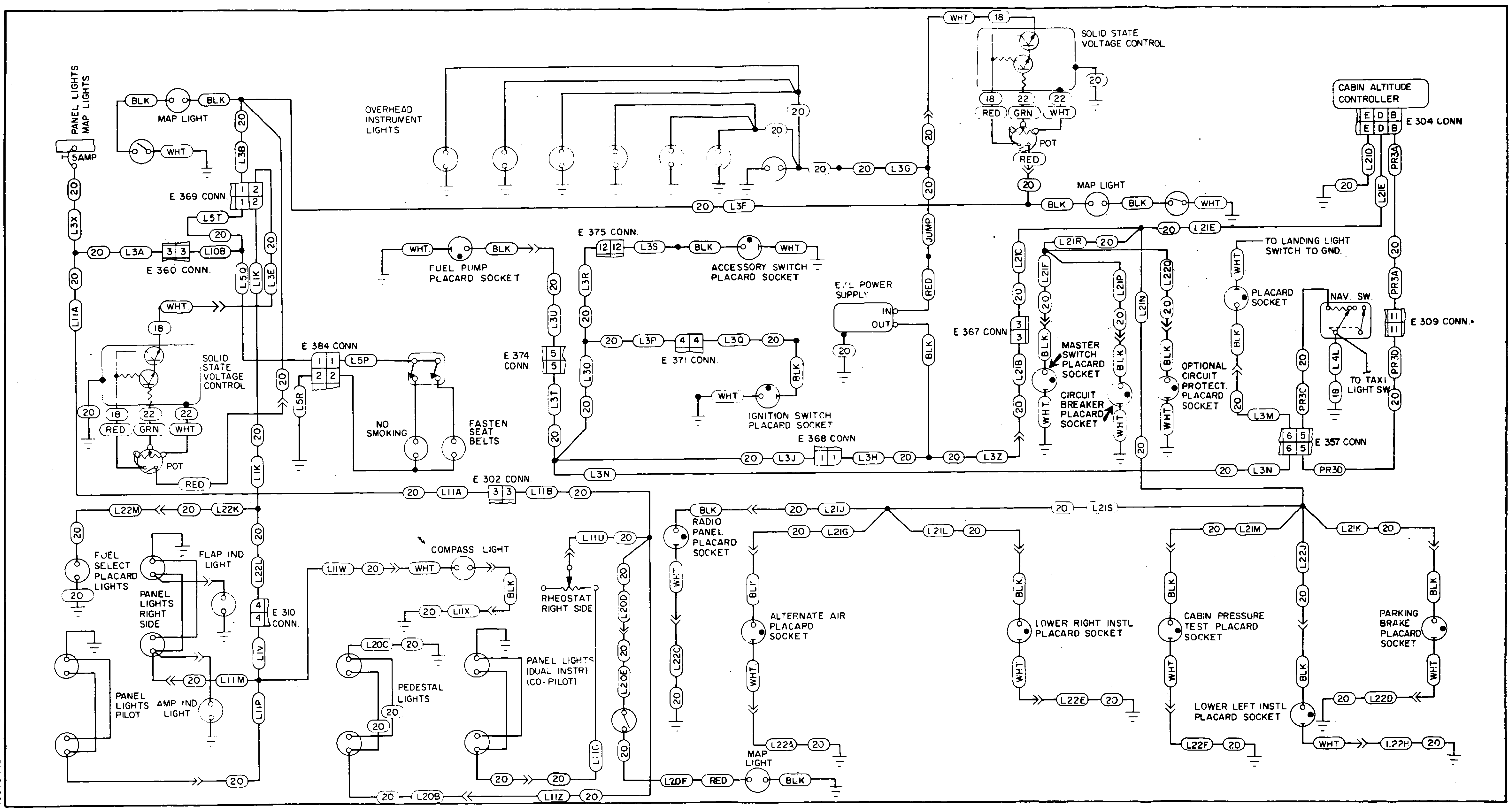


Figure 11-55. Panel Lights - Schematic, S/N PA-31P-7630006 and up

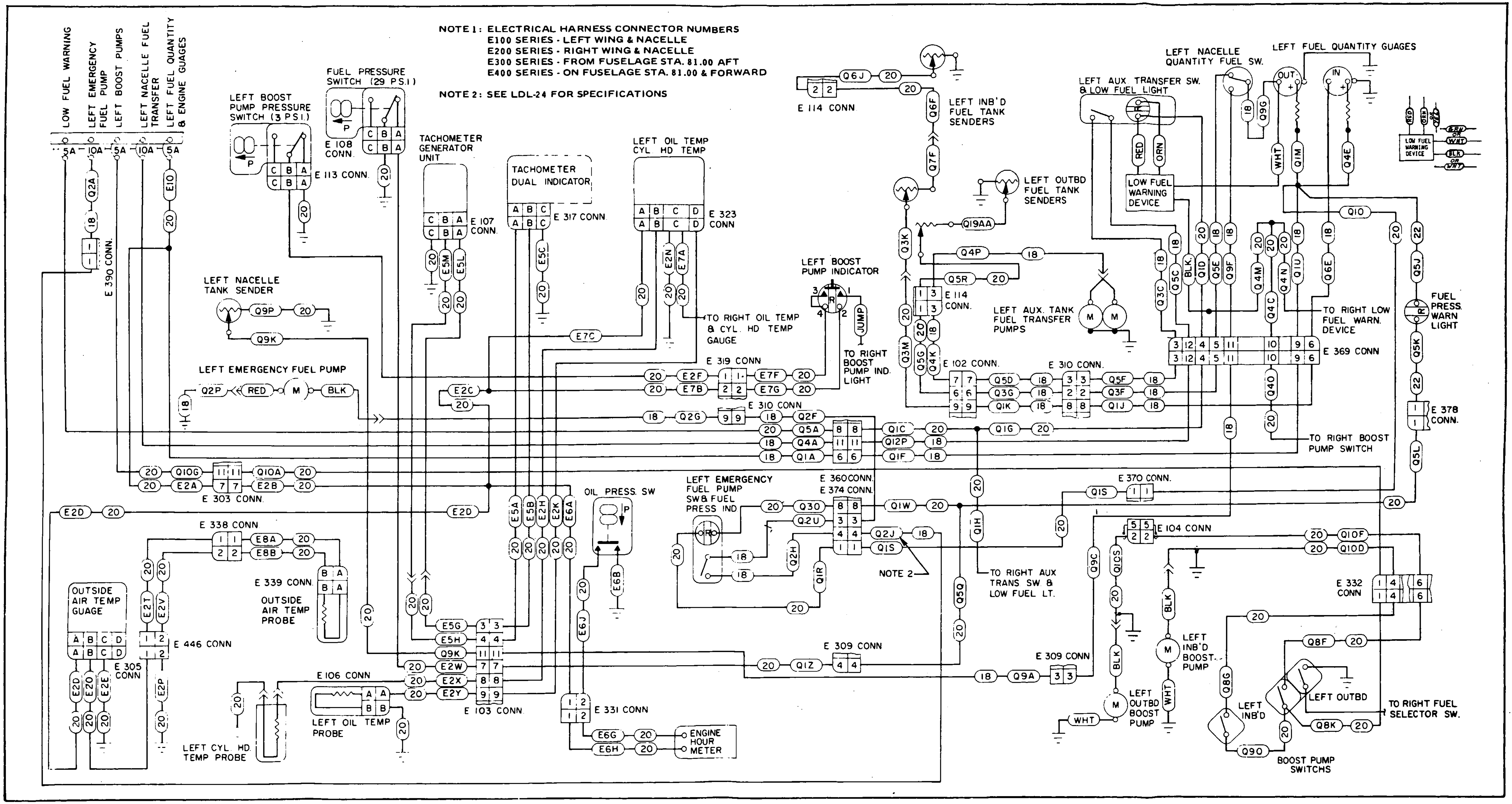


Figure 11-56. Fuel System; Left - Schematic, S/N 31P-7300001 to 7300127

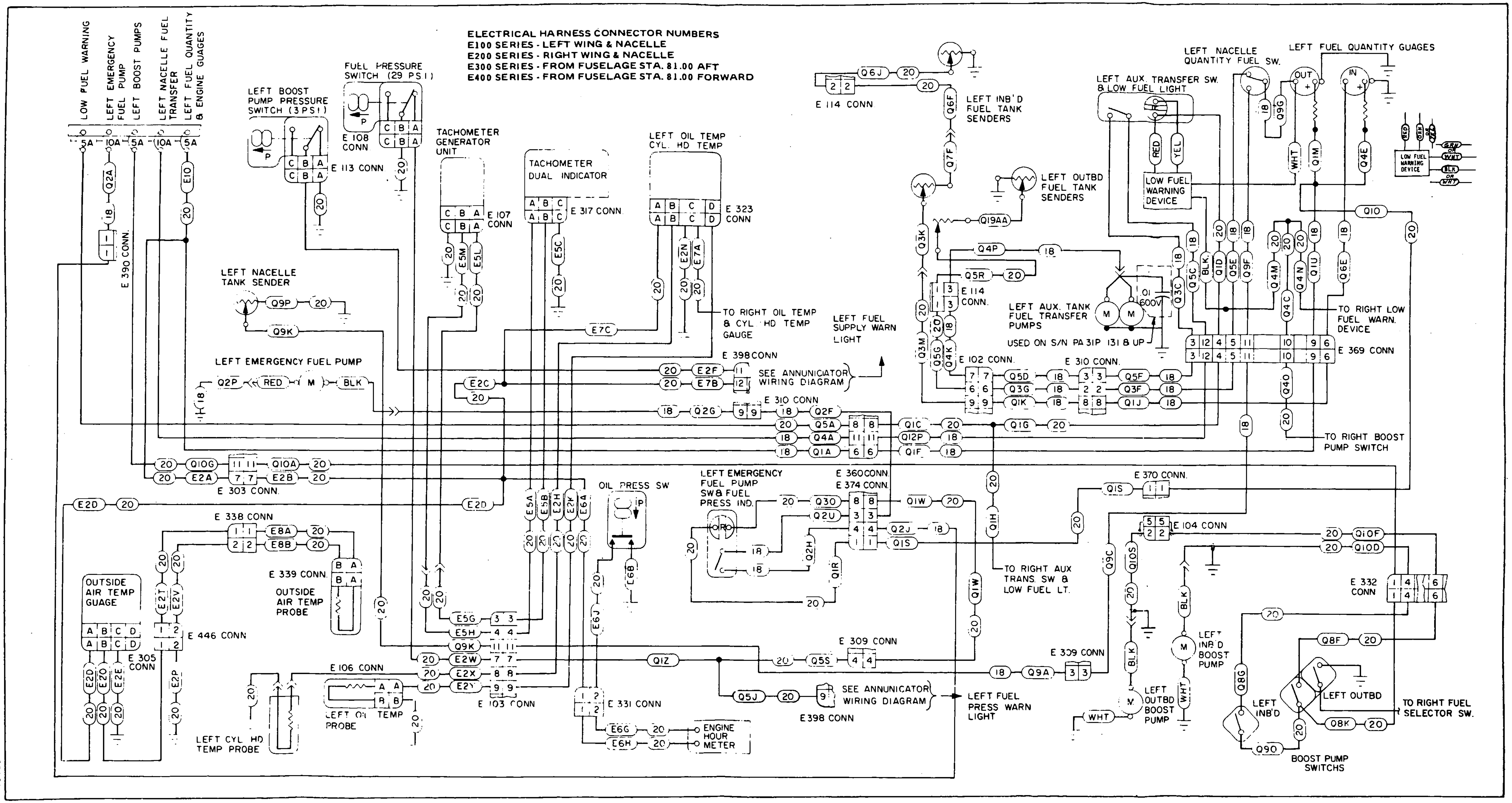


Figure 11-57. Fuel System; Left - Schematic, S/N 31P-7300128 to 7630007

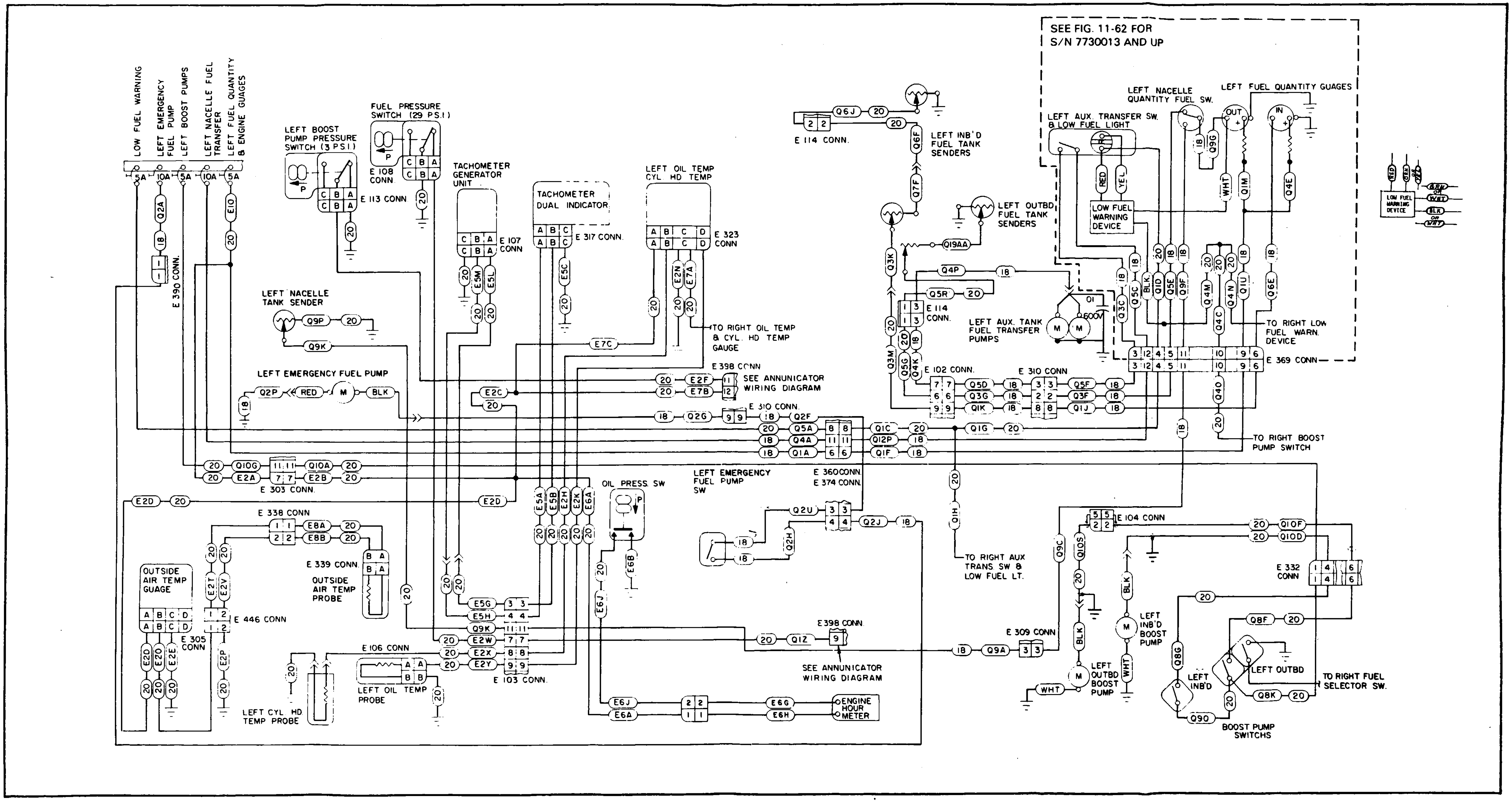


Figure 11-58. Fuel System; Left - Schematic, S/N PA-31P-7630008 and up

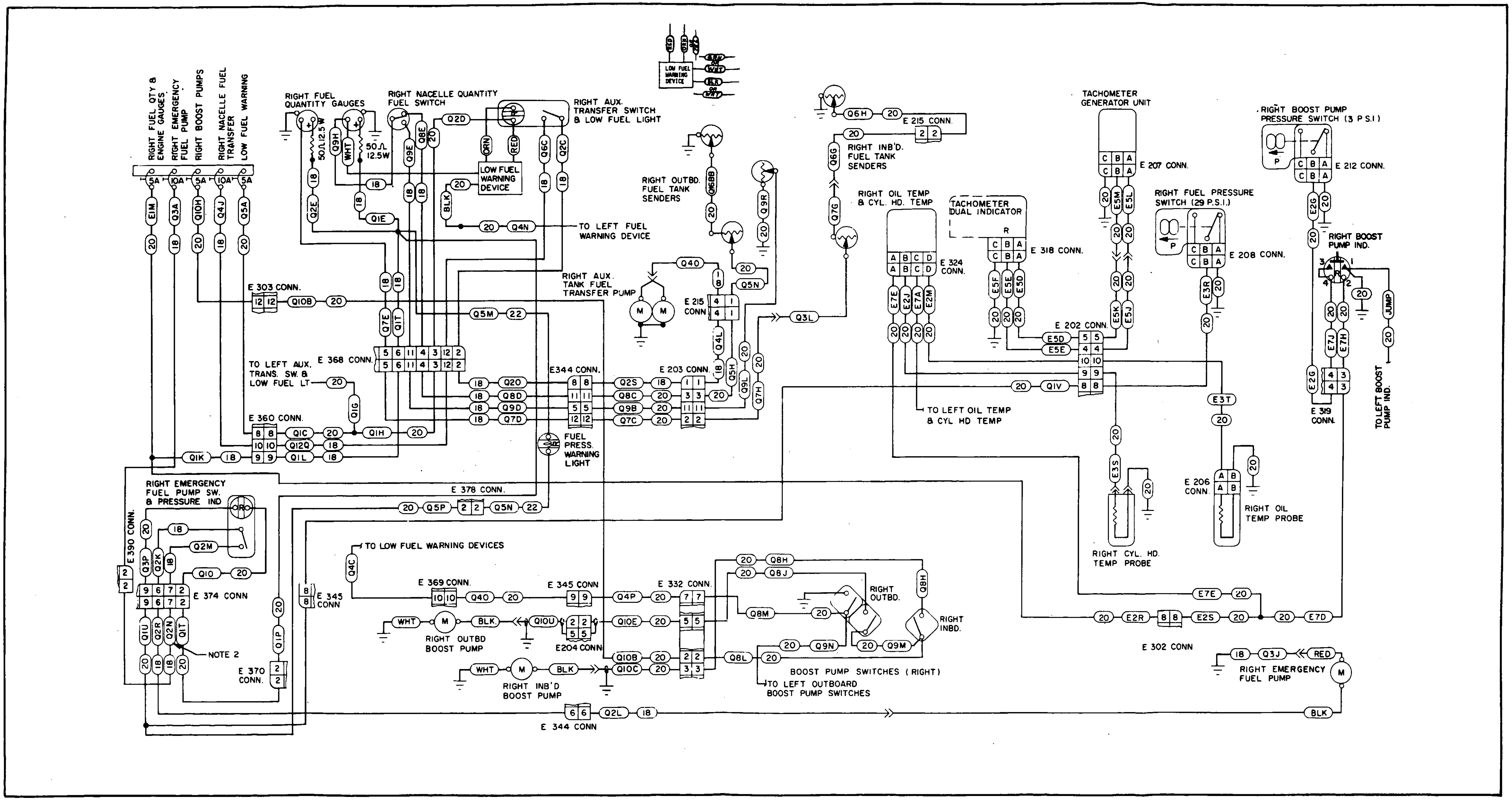


Figure 11-59. Fuel System; Right - Schematic, S/N 31P-7300001 to 7300127

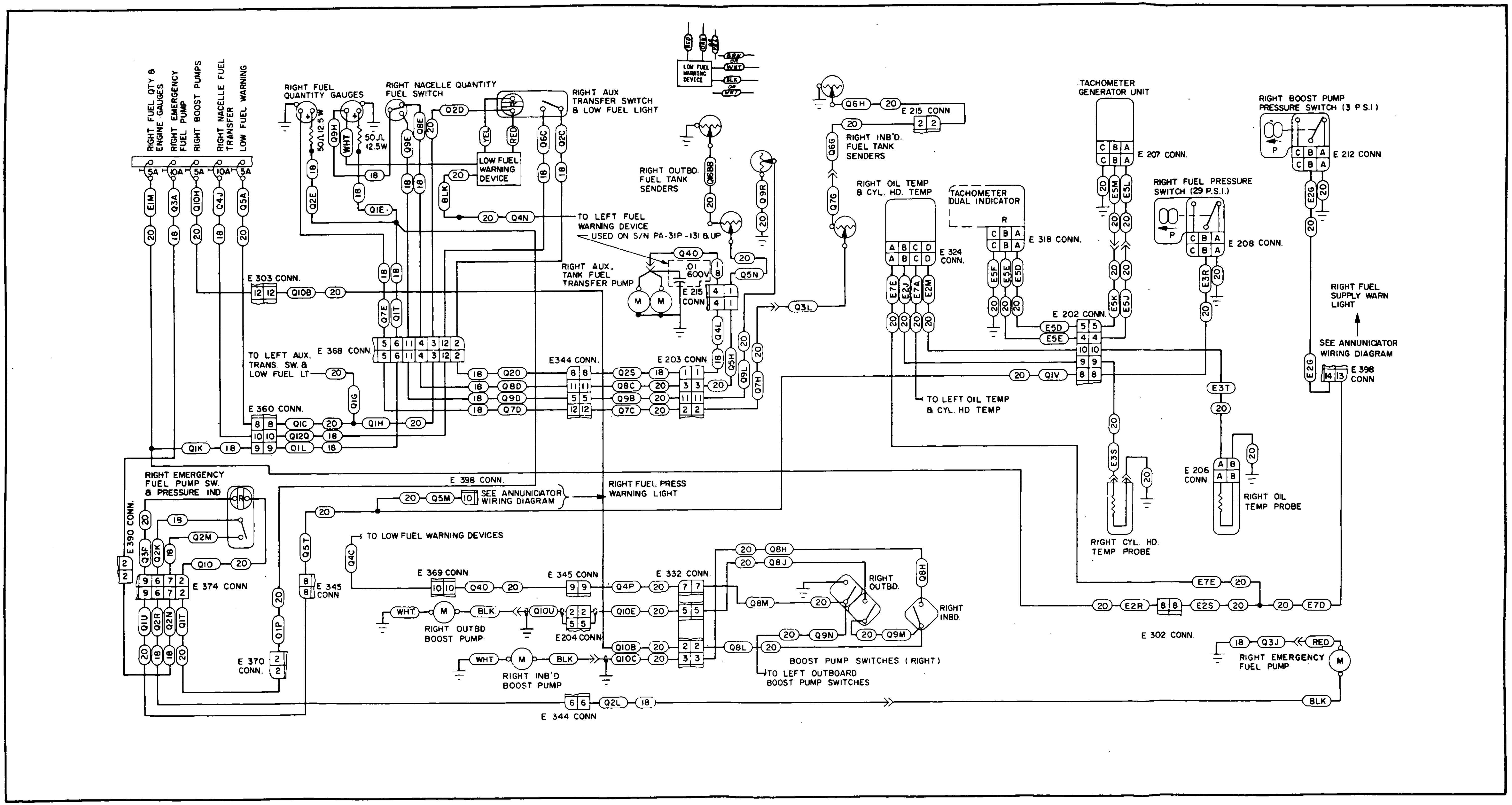


Figure 11-60. Fuel System; Right - Schematic, S/N 31P-7300128 to 7630007

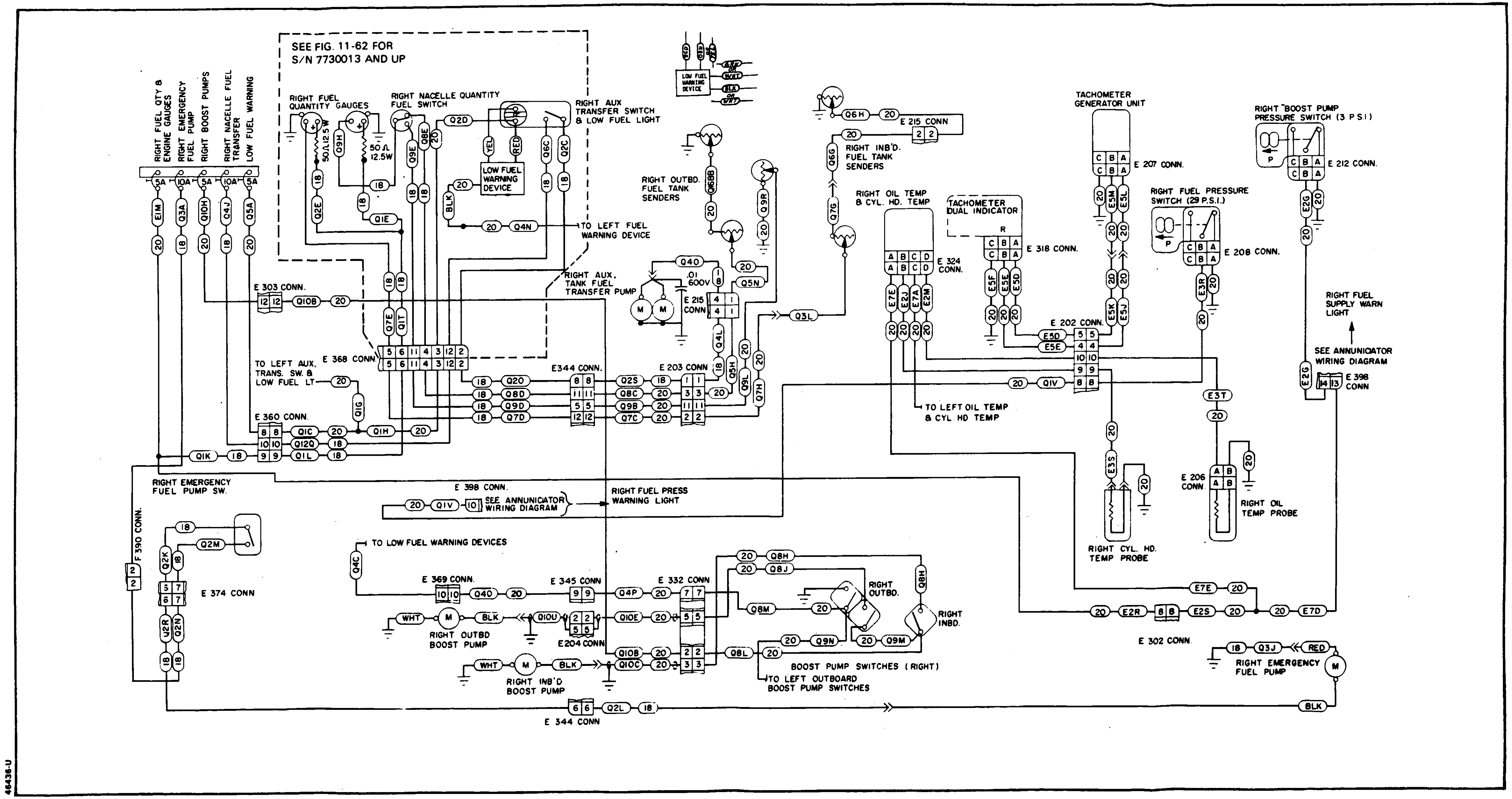


Figure 11-61. Fuel System; Right - Schematic, S/N PA-31P-7630008 and up

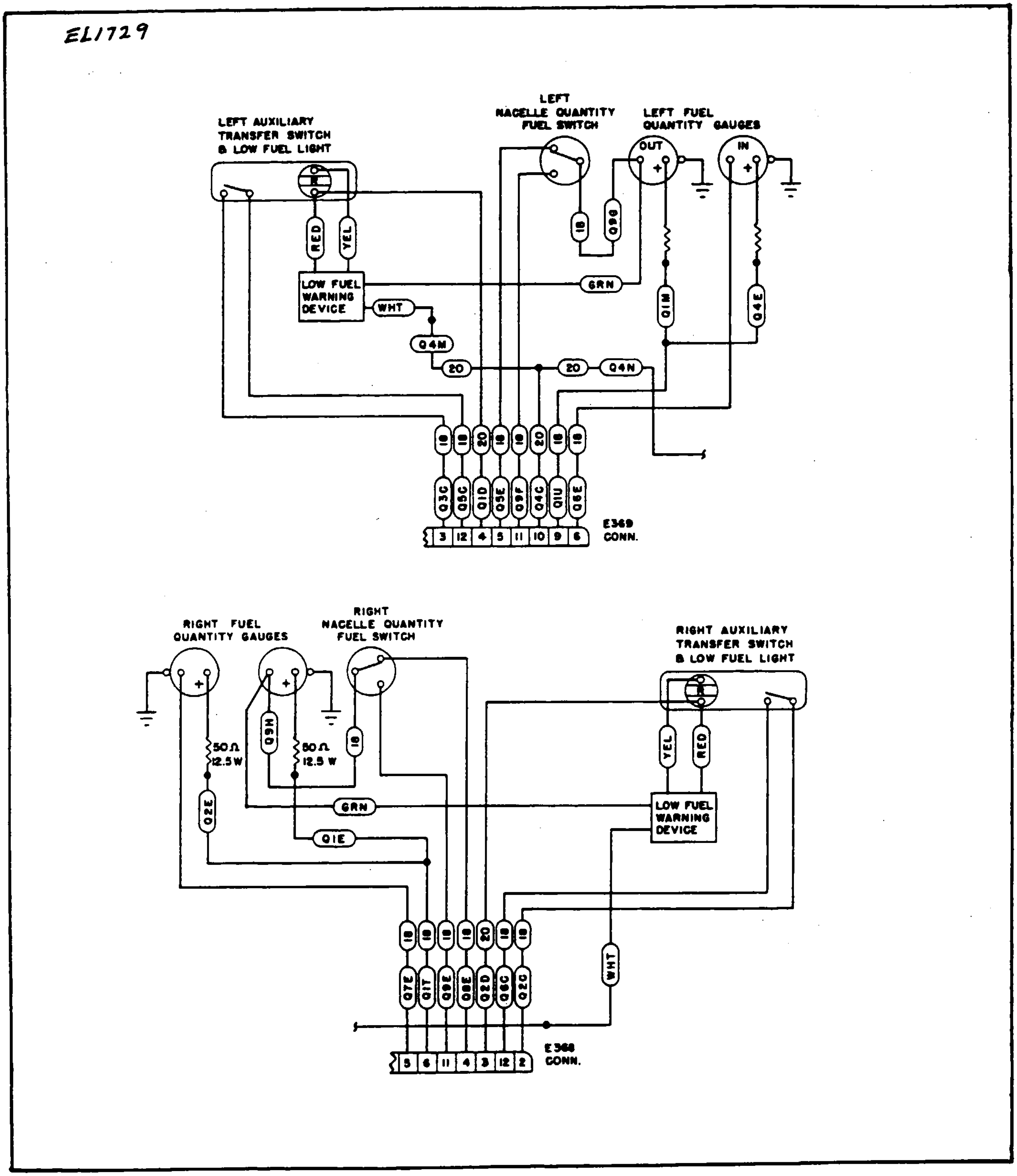


Figure 11-62. Fuel Quantity Warning, PA-31P S/N 7730013 and up

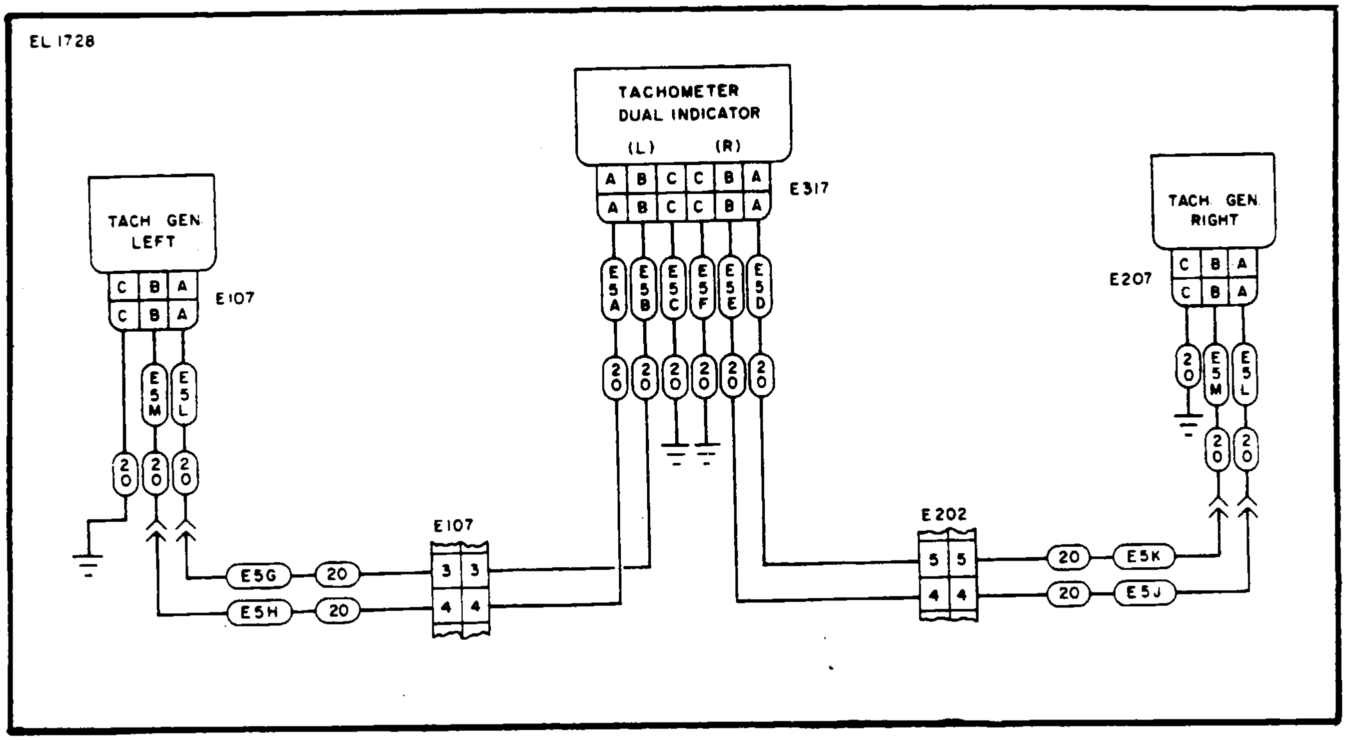


Figure 11-63. Tachometer Generators

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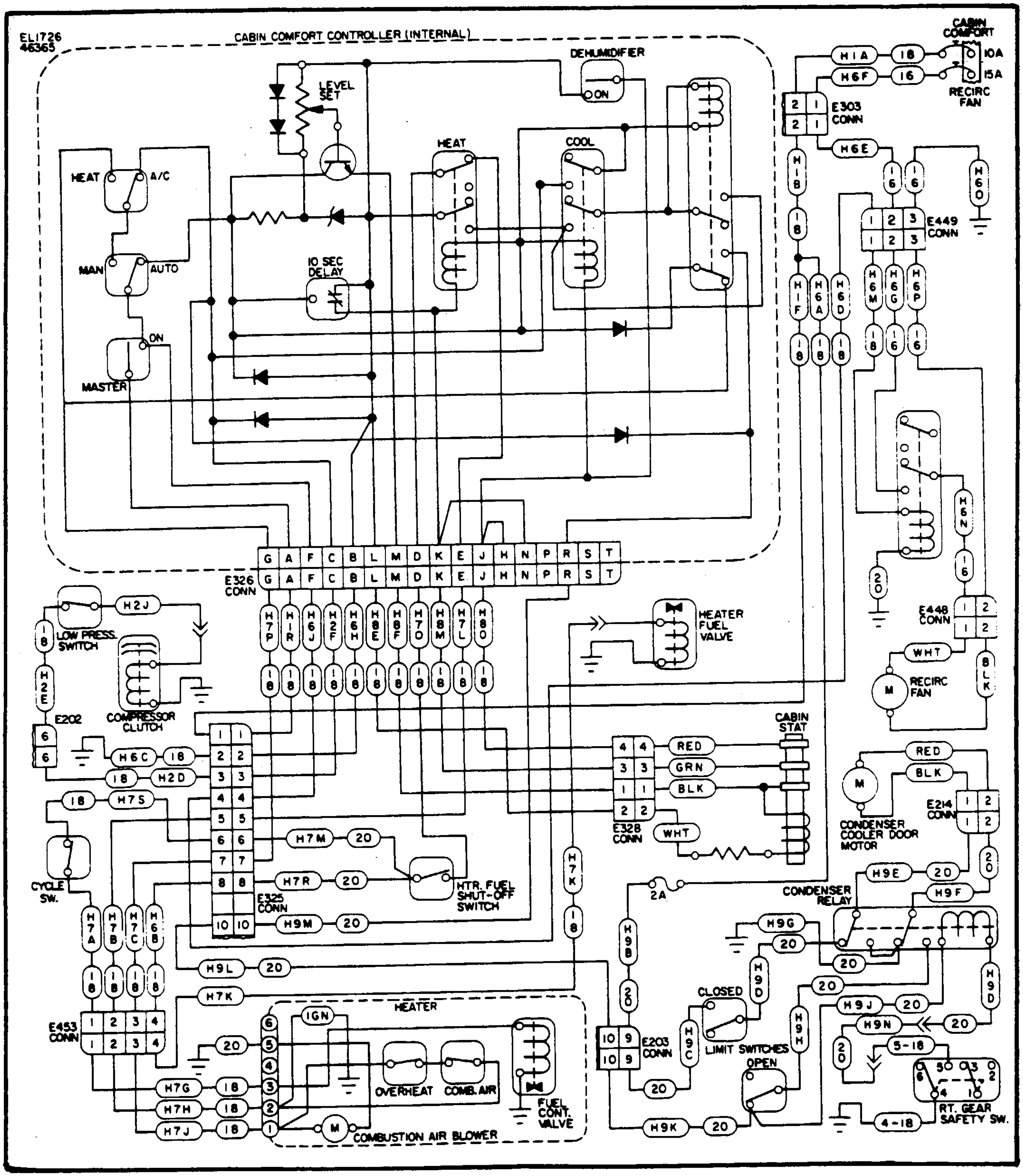

Figure 11-64. Cabin Comfort Control

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PIPER
Customer Services

PA-31P **PRESSURIZED NAVAJO**
Service Manual

CARD 4 OF 4

PIPER AIRCRAFT CORPORATION

753 770 4 A1

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material:
Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 770 issued July, 1972 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG720700	July 1972	—
PR730223	February 23, 1973	—
PR741122	November 22, 1974	—
PR750926	September 26, 1975	—
PR760715	July 15, 1976	1, 2, 3 and 4
PR761130	November 30, 1976	1, 2, 3, 4 and 5
PR771130	November 30, 1977	1, 2, 3, 4 and 5
PR790131	January 31, 1979	1, 2, 3 and 4
PR790907	September 7, 1979	1, 2 and 3
PR810320	March 20, 1981	1, 2, 3 and 4
PR821110	November 10, 1982	1, 2, 3 and 4
IR860430	April 30, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March 13, 1990	1
IR980715	July 15, 1998	1 and 4

INTERIM REVISION

Revisions appear in Sections III and IV of card 1, and Section XIV of card 4. Please dispose of your current cards 1 and 4 and replace them with the revised cards. DO NOT DISPOSE OF CARDS 2 and 3.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

LIST OF ILLUSTRATIONS (cont.)

LIST OF TABLES

SECTION XII
ELECTRONICS

For radio service and maintenance, refer to the appropriate manufacturer's service manual.

Subject Manual	Part Number
Avionics Service Manual (1975 & 1976)	761 643
Avionics Wiring Diagram Service Manual (Prior to 1975)	761 682
Avionics Wiring Diagram Service Manual (1975 thru 1976)	761 647

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SECTION XIII - ELECTRONICS

AUTO FLITE

12-1. GENERAL. Due to the wide variety of A.F.C.S. (Automated Flight Control System) options, it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as; adjusting bridle cable tension, servo removal & installation, servo clutch adjustments, etc.

12-2. NON-PIPER A.F.C.S. EQUIPMENT CONTACTS. Refer to the following list of Autopilot/Flight Director manufacturers to obtain service direction, parts support, and service literature.

Bendix Avionics Division
2100 N.W. 62nd. Street
Fort Lauderdale, Fla. 33310
(305) 776-4100/TWX 5109559884

Collins General Aviation Division
Rockwell International
Cedar Rapids, Iowa 52406
(319) 395-3625 Telex: 464-421

Edo Corporation - Avionics Division
Box 610
Municipal Airport
Mineral Wells, Texas 76067
(817) 325-2517 Telex: 76067

King Radio Corporation
400 North Rodgers Road
Olathe, Kansas 66061
(913) 782-0400 Telex: 4-2299-Kingrad

Sperry Flight Systems/Avionics Division
8500 Balboa Boulevard
P.O. Box 9028
VanNuys, CA 91409
(213) 894-8111 Telex: 65-1367

Global Navigation
2144 Michelson Drive
Irvine, CA 92715
(714) 851-0119

12-3. PIPER A.F.C.S. EQUIPMENT. In the case of Piper Autopilot equipment bearing the Piper name, the appropriate Piper Autopilot/Flight Director Service Manual shall be used.

NOTE

If a Roll Axis-only Autopilot is installed, or if no Autopilot is installed, consult the Piper Pitch Trim Service Manual - 753 771 for manual electric pitch trim service information.

The following is a listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the Autopilot system by "faceplate" model name, in order to consult the appropriate service manual. Each manual identifies the revision label and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the aircrafts parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl III and AltiMatic III and IIIB	753 723
AutoControl IIIB and AltiMatic IIIB-1	761 502
AltiMatic IIIC	761 602
AltiMatic V and V-1	761 525
AltiMatic V F/D and V F/D-1	761 526
Piper Pitch Trim (Manual-Electric)	757 771

SECTION XII

ELECTRONICS

12-4. INTRODUCTION. This part contains information necessary to perform operational checks of the Emergency Locator Transmitter (ELT) and Pilot's Remote Switch used with the ELT. Included are the appropriate removal and installation instructions to facilitate battery replacement.

12-5. EMERGENCY LOCATOR TRANSMITTER (GARRETT MFG. LTD.).

12-6. DESCRIPTION. The electrical power for the ELT is totally supplied by its own self-contained battery. The magnesium batteries used on early models have a service life of four years. The lithium batteries used on later models have a service life of ten years. However, to comply with FAA regulations, magnesium batteries must be replaced every 2 years and lithium batteries must be replaced at 5 year intervals. If the transmitter has been used in an emergency situation during this 2 or 5 year period or it has more than one hour of accumulated test time, the battery must be replaced according to FAA regulations. To replace the battery pack in the transmitter, it is necessary to remove the transmitter from the aircraft. (Refer to paragraph 12-7 or 12-8.)

12-7. BATTERY REMOVAL AND INSTALLATION. (2 year, magnesium battery, refer to Figure 12-1.) The ELT is located underneath the dorsal fin between sta. 304.75 and sta. 317.00.

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Set the ON/ARM/OFF switch on the transmitter to the OFF position.

c. Disconnect the antenna coax from the transmitter.

d. If installation includes pilot's remote switch, disconnect the harness to the pilot's remote switch from the transmitter.

e. Remove the rear mounting bracket by pulling the plastic knob out. Remove the transmitter from the airplane.

f. Remove the two long or four short screws securing the transmitter plain end cap. Remove the plain end cap.

g. Disconnect the battery connector from the board terminals.

h. Withdraw the battery pack from the transmitter case.

i. Before installing the new battery pack, check the replacement date printed on the battery. Transfer this date onto the outside of the ELT.

j. Slide the new battery pack, plain end first, into transmitter. It may be necessary to rotate the battery slightly to get it seated properly in the transmitter case and to achieve correct orientation of the battery connector.

k. Connect the battery connector to board terminals.

l. Insure O-ring is fitted in plain end cap and correctly seated.

NOTE

Red ELT's have no O-ring; replace end cap using fresh RTV silicone rubber compound.

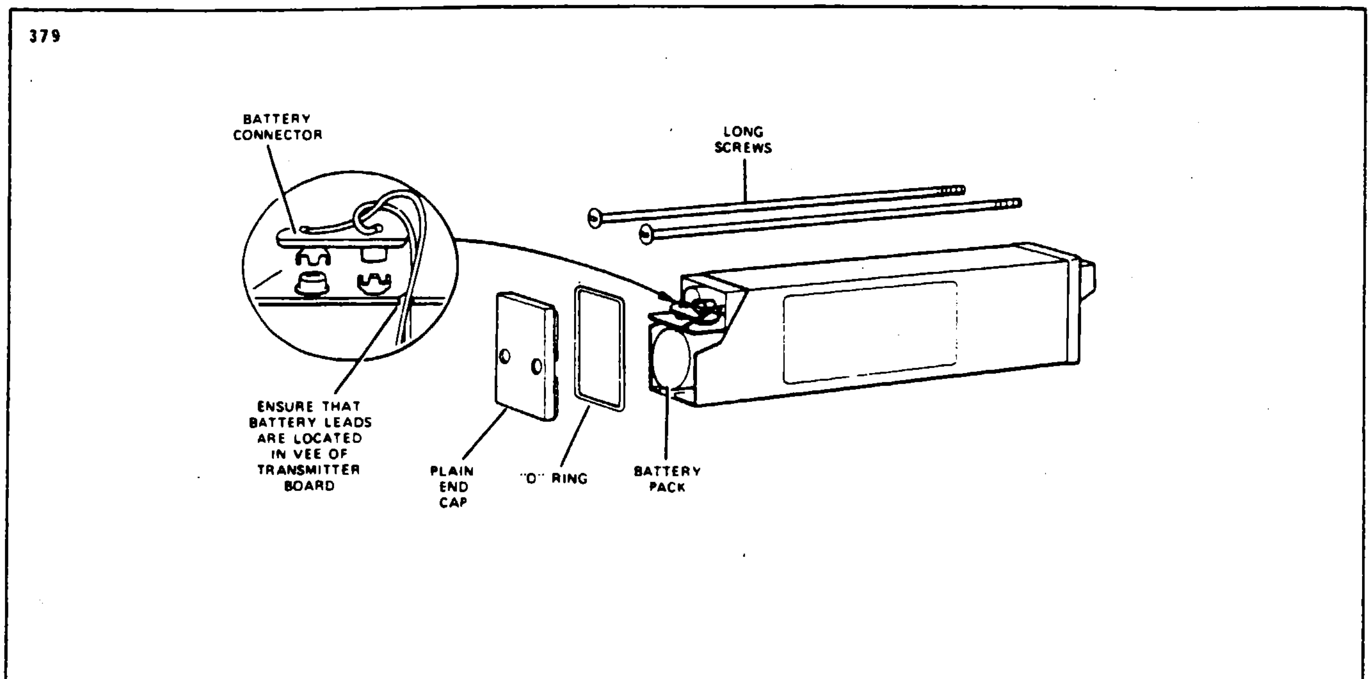


Figure 12-1. Two Year, Magnesium Battery Connections

m. Refit end cap and secure with the screws previously removed.

NOTE

Do not overtighten the end cap screws.

n. Place transmitter into its mounting bracket; replace rear mounting bracket by pushing plastic knob into place.

o. If installation includes pilot's remote switch, connect the harness to the transmitter.

p. Connect the antenna coax to the transmitter.

q. Install the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 and secure with appropriate screws. Make an entry in the aircraft logbook, including the new battery run out date.

NOTE

Before installing access panel move transmitter switch to the ARM position. It may also be advisable to test the unit operation before installing the access panel. (Refer to paragraph 12-6.)

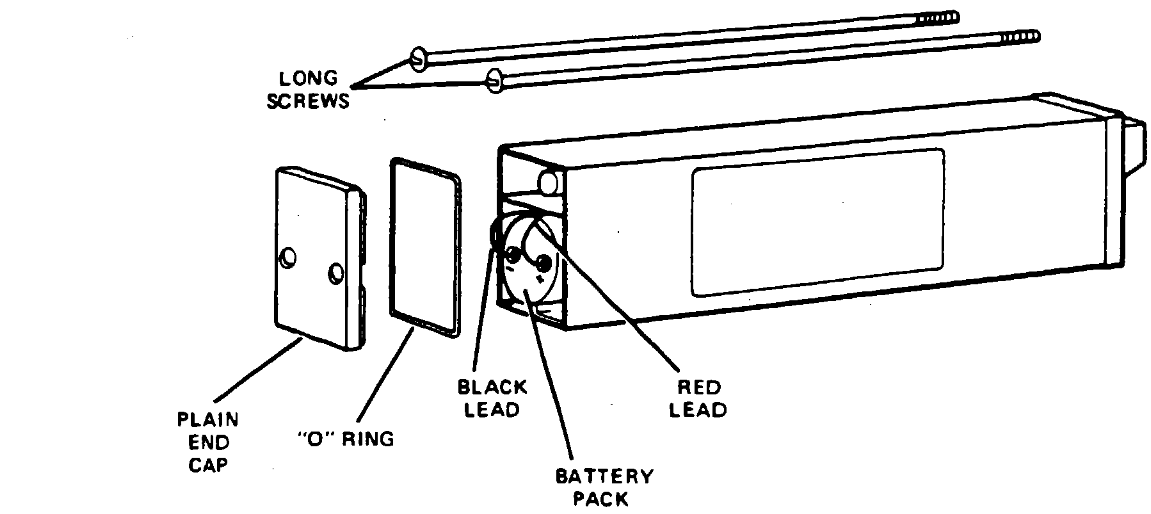


Figure 12-1a. Five Year, Lithium Battery Connections

12-8. BATTERY REMOVAL AND INSTALLATION. (5 year, lithium battery, refer to Figure 12-1a.) The ELT is located underneath the dorsal fin between sta. 304.75 and sta. 317.00 (Refer to the latest revision of Piper Service Letter No. 820, regarding replacement of battery and/or transmitter.)

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Set the ON/ARM/OFF switch on the transmitter to the OFF position.

c. Disconnect the antenna coax from the transmitter.

d. Disconnect the harness to the pilot's remote switch from the transmitter.

e. Remove the rear mounting bracket by pulling the plastic knob out. Remove the transmitter from the airplane.

f. Remove the two long screws securing the transmitter plain end cap. Remove the plain end cap.

WARNING

ENSURE THAT NO SHORT CIRCUIT OF BATTERY TERMINALS CAN OCCUR.

g. Unsolder red and black leads from terminals of battery pack.

h. Withdraw battery pack from transmitter case.

i. Discard battery pack.

WARNING

DO NOT RECHARGE, SHORT CIRCUIT OR EXPOSE TO HIGH TEMPERATURES.

j. Before installing the new battery pack, note the replacement date stamped on the battery. Transfer this date onto the ELT label.

k. Remove protective cap from terminal end of new battery pack.

WARNING

ENSURE THAT NO SHORT CIRCUIT OF BATTERY TERMINALS CAN OCCUR.

l. Slide new battery pack, plain end first, into transmitter. If necessary, partially rotate battery pack until correct seating and desired orientation of battery terminals is achieved.

m. Solder red lead to plus (+) terminal and black lead to minus (-) terminal of battery pack.

n. Ensure O-ring is fitted and correctly seated in plain end cap.

o. Refit end cap and secure with the two long screws previously removed.

NOTE

Do not overtighten the two long screws.

p. Place transmitter into its mounting bracket; replace rear mounting bracket by pushing plastic knob into place.

q. Connect the pilot's remote switch harness to the transmitter.

r. Connect the antenna coax to the transmitter.

s. Install the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 and secure with appropriate screws. Make an entry in the aircraft logbook, including the next battery replacement date.

NOTE

Before installing access panel move transmitter switch to the ARM position. It may also be advisable to test the unit operation before installing the access panel. (Refer to Paragraph 12-9.)

12-9. TESTING EMERGENCY LOCATOR TRANSMITTER. The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Before performing any operational test of the ELT, the following precautions should be observed:

CAUTION

Testing of an ELT should be conducted in a screen room or metal enclosure to ensure that electromagnetic energy is not radiated during testing. If a shielded enclosure is not available, testing may be performed in accordance with the following procedures:

1. Test should be no longer than three audio sweeps.
2. If the antenna is removed, a dummy load should be substituted during the test.
3. Test should be conducted only within the time period made up of the first five minutes after any hour.
4. If the operational tests must be made at a time not included within the first five minutes after the hour, the test should be coordinated with the closest FAA Tower or Flight Service Station.

Consult FAA Advisory Circular AC 20-81 for detailed information concerning the above caution.

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON; deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

c. On the transmitter, set the ON/ARM/OFF switch to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather, there may be a slight delay before transmission occurs.

d. A transmitter which is functioning properly should emit a characteristic downward swept tone.

e. When the test is completed, ascertain the transmitter ON/ARM/OFF switch is in the ARM position.

f. Place the access panel on the dorsal fin between sta. 296.00 and sta. 317.00 and secure with the appropriate screws.

WARNING

Whenever the unit is checked by moving the transmitter ON/ARM/OFF switch from the ARM to the ON position, it must then be moved to the OFF position before reverting to the ARM position again.

CAUTION

Under normal conditions, the transmitter switch must be set to ARM.

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip inflight.

12-10. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the right side panel, is provided to allow the transmitter to be controlled from inside the cabin. The switch is locked into each position. To move the switch, the toggle must be pulled out and moved to the new desired position. On early models the pilot's remote switch is placarded "ON," "ARM," "OFF/RESET." If the pilot's remote switch has been placed in the "ON" position for any reason, the "OFF/RESET" position must be selected for one second before the switch is placed in the "ARM" position. On later models the pilot's remote switch is placarded "ON/RESET" and "ARM (NORMAL POSITION)." The switch is normally left in the down or "ARM" position. To turn the transmitter off, move the switch to the "ON/RESET" position for one second then return it to the "ARM" position. To actuate the transmitter for tests or other reasons, move the switch upward to the "ON/RESET" position and leave it in that position as long as transmission is desired.

CAUTION

Under normal conditions, the remote switch must be set to ARM.

12-11. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the following precautions should be observed:

CAUTION

The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Permission should be obtained from the FAA/FCC Representative (or other applicable Authority) prior to testing. Keep your test transmission to a minimal duration.

a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON; deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

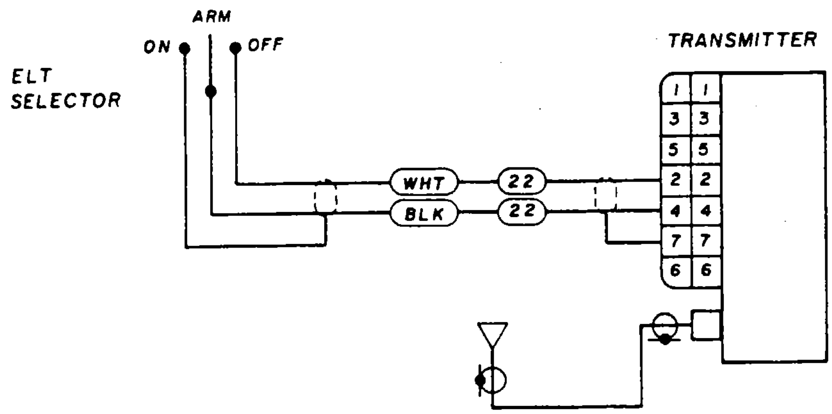
If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

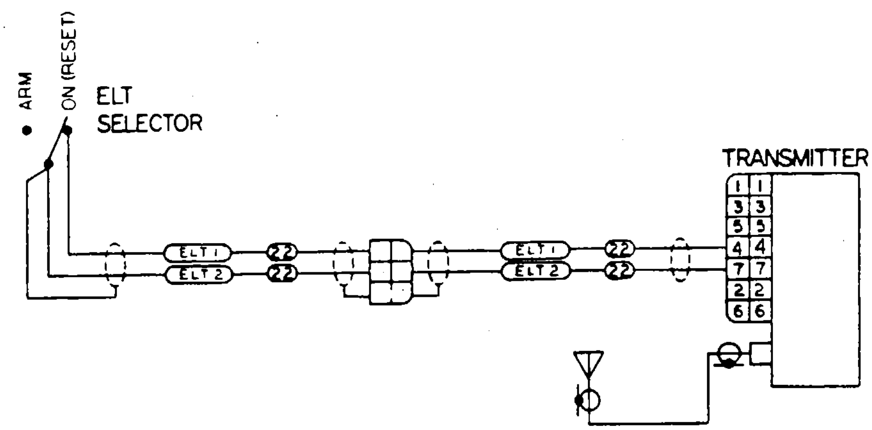
NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the RESET position for one second; then select the ARM position.



YELLOW CASE
3 POSITION SWITCH, 2 YEAR MAGNESIUM BATTERY



YELLOW OR WHITE (CANADA) CASE
2 POSITION SWITCH, 5 YEAR LITHIUM BATTERY

33544, 51417

Figure 12-1b. Pilot's Remote Switch Schematic

12-12. INADVERTENT ACTIVATION.

a. In the event the ELT is inadvertently activated in aircraft without a pilot's remote switch, the ELT will have to be reset by gaining access to the ELT. (Refer to Paragraphs 12-7 or 12-8.) Put the ON/ARM/OFF switch in the OFF position. To reset for automatic operation, return switch to the ARM position. (See Note.)

b. In aircraft with a pilot's remote switch, if the ELT is inadvertently activated, set the pilot's remote switch to the RESET position; then return it to the ARM position. (See Note.)

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with paragraph 12-9. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

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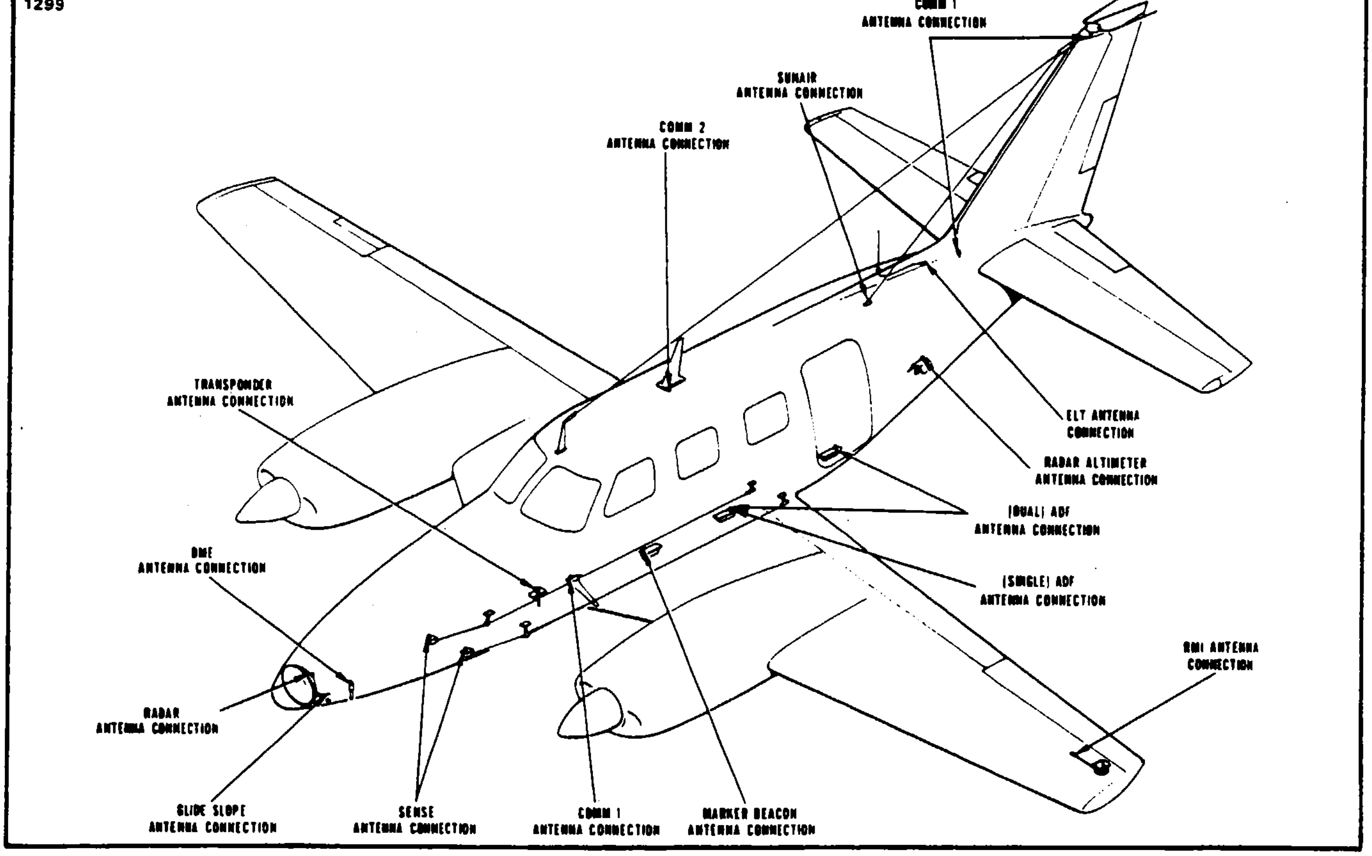

Figure 12-2. Avionic Antenna Locations

12-13. EMERGENCY LOCATOR TRANSMITTER (COMMUNICATIONS COMPONENTS CORP.).

12-14. DESCRIPTION. The electrical power for the ELT transmissions is totally supplied by its own self-contained battery. However, aircraft power is required to shut off transmitter with the remote switch. For portable use, the ELT can be easily removed from its mounting in the aircraft. To comply with FAA regulations, the battery must be replaced after 5 years of shelf life. The battery must also be replaced if the transmitter has been used in an emergency situation or if accumulated test time exceeds one hour. The replacement date is marked on the transmitter label.

12-15. BATTERY REMOVAL AND INSTALLATION. (5 YEAR LITHIUM.) The ELT is located underneath the dorsal fin between sta. 304.75 and sta. 317.00. (Refer to the latest revision of Piper Service Letter No. 820, regarding replacement of battery and/or transmitter.)

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Rotate the ON/ARM/OFF switch to the OFF position.

c. Disconnect the antenna coax cable (twist left, then pull outward).

d. Disconnect the harness to the pilot's remote switch.

e. Remove the forward mounting bracket by pulling the black plastic knob out. Remove the transmitter from the airplane.

f. Remove the six Phillips-head screws securing the transmitter cover. Remove the cover.

g. Lift out the old battery pack.

h. Copy the expiration date on the battery into the space provided on the external ELT name and date plate.

i. Disconnect and replace with a new battery pack. The nylon battery connector is a friction fit and is easily removed by pulling on the exposed end.

j. Insert transmitter into airplane and fit into place. Reinstall mounting bracket by pushing the black plastic knob into place.

k. Reconnect the pilot's remote switch harness and the antenna coax cable to the transmitter.

l. Set the ON/ARM/OFF switch to the ARM position.

m. Reinstall the access plate previously removed.

NOTE

It may be advisable to test the unit operation before installing the access panel. (See paragraph 12-9.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-16. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the right side panel, is provided to allow the transmitter to be controlled from inside the cabin. The pilot's remote switch is placarded ON, AUTO/ARM and OFF/RESET. The switch is normally left in the AUTO/ARM position. To turn the transmitter off, move the switch momentarily to the OFF/RESET position. The aircraft master switch must be ON to turn the transmitter OFF. To actuate the transmitter for tests or in the event the automatic feature was not triggered by impact, move the switch upward to the ON position and leave it in that position as long as transmission is desired.

12-17. TESTING EMERGENCY LOCATOR TRANSMITTER. (Testing done the same as noted in paragraph 12-9.)

12-18. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the same precautions noted in paragraph 12-9 must be observed.

a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON, deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the momentary OFF/RESET position. The switch is spring loaded to automatically return to the ARM position.

12-19. INADVERTENT ACTIVATION. The remote switch allows the pilot to turn off the transmitter inadvertently activated by impact or improper switch selection. The pilot simply selects the momentary OFF, RESET position. The transmitter shuts off and the spring loaded switch automatically returns to the ARM position. The aircraft master switch must be ON to turn transmitter OFF with the remote switch. Stopping inadvertent activation at the transmitter itself is accomplished in the following manner:

a. Improper switch selection is corrected by rotating the switch to the OFF position and then to the ARM position.

b. If the transmitter is inadvertently activated through impact, deactivate by pushing in on the OFF/ARM/ON switch.

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with paragraph 12-9. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

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SECTION XIII

ENVIRONMENTAL CONTROL SYSTEM

Par.		Aerofiche Grid No.
	13-90. Adjustment of Drive Belt	4E2
13-91.	Magnetic Clutch	4E2
	13-92. Magnetic Clutch Removal	4E2
	13-93. Magnetic Clutch Installation	4E3
13-94.	Condenser	4E3
	13-95. Condenser Removal	4E3
	13-96. Condenser Installation	4E4
	13-97. Adjustment of Condenser Air Scoop	4E4
13-98.	Receiver Dryer	4E4
	13-99. Receiver Dryer Removal	4E4
	13-100. Receiver Dryer Installation	4E5
13-101.	Expansion Valve	4E5
	13-102. Expansion Valve Removal	4E5
	13-103. Expansion Valve Installation	4E5
13-104.	Evaporator Control Valve	4E5
	13-105. Evaporator Control Valve Removal	4E5
	13-106. Evaporator Control Valve Installation	4E7
13-107.	Evaporator	4E7
	13-108. Evaporator Removal	4E7
	13-109. Evaporator Installation	4E7
13-110.	Pressurization System	4E17
13-111.	Description and Principles of Operation	4E17
13-112.	Pressurization Controls	4E17
	13-113. Operating Instructions	4E18
	13-114. Cabin Pressurization Check	4E18
	13-115. Pressurization Check with Test Unit	4E23
	13-116. Isobaric Valve Function	4F6
	13-117. Safety Valve Function	4F6
	13-118. Isobaric and Safety Valves Combined Function	4F6
	13-119. Dump Valve Function	4F6
	13-120. Rupture Disc	4F6
	13-121. Isobaric Valve Removal	4F7
	13-122. Isobaric Valve Installation	4F7
	13-123. Safety Valve Removal	4F7
	13-124. Safety Valve Installation	4F7
	13-125. Isobaric and Safety Valve Cleaning	4F8
	13-126. Isobaric and Safety Valve Setup	4F8
	13-127. Safety Precautions	4F8
	13-128. System Setup Procedure	4F8
	13-129. Isobaric and Safety Valve Adjustment	4F9
	13-130. In Flight Adjustments	4F9
	13-131. Take-Off and Climb Procedure	4F9
	13-132. Adjustment of Diaphragm Spring	4F11
13-133.	Cabin Altitude Selector	4F12
	13-134. Removal of Selector	4F12
	13-135. Installation of Selector	4F13
	13-136. Filter Replacement	4F13
	13-137. Pressurization Controller Cleaning	4F14

Paragraph		Aerofiche Grid No.

SECTION XIII

ENVIRONMENTAL CONTROL SYSTEM

13-1. INTRODUCTION. This section provides instructions for remedying difficulties which may arise in the operation of the environmental control system. The instructions are organized so that the mechanic can refer to: principles of operation, for a basic understanding of the systems, troubleshooting, for a methodical approach in locating the difficulty; corrective maintenance, for the removal, repair and installation of components; and adjustments and tests, for the operation of the repaired system.

13-2. DESCRIPTION. The cabin comfort control panel located at the lower right corner of the instrument panel contains all the controls needed to operate the heating, cooling and dehumidification system. A master switch on the panel controls the heater, air conditioner and cabin recirculating air blower. A mode switch is normally used in the automatic position and the pilot need only select the proper temperature level with the control marked TEMP. A manual position of the mode switch is furnished as a standby in case of an automatic mode malfunction. The switch marked MANUAL controls the heater or air conditioner when the mode switch is in the manual position. The dehumidify switch provides a means to decrease cabin humidity when the mode switch is in the automatic position. The heater fuel on-off switch controls the heater fuel at the heater fuel regulator. It must be on for heater operation. On models prior to S/N 31P-730149, the defroster control, to the right of the cabin comfort panel, controls the flow of air to the inside surface of the windshield. On models S/N 31P-730149 and up, the defroster is in constant operation. Control of the cabin temperature is through cycling of the heater or air conditioner. Both units are controlled by an electronic controller which receives its signal from a controllable thermostat. When the thermostat calls for heat, the controller turns on the heater system. The heater will operate at full capacity until the desired temperature is obtained at the thermostat. The thermostat has a dead band between the heating and cooling cycles. Under all normal operations, the cabin thermostat will control the heater and air-conditioner operations. The air-conditioning system utilizes an engine mounted, belt driven compressor which is driven from a power takeoff on the rear of the right engine. The cabin humidity is controlled by the arrangement of the heater and air conditioner. For dehumidification, the heater and air conditioner are operated at the same time, with the air conditioner operating continuously and the heater cycling to maintain a desired temperature level. This is very helpful in preventing cabin condensation during letdown from a high cold soak altitude to warm humid conditions near airport levels.

13-3. TROUBLESHOOTING. Troubles pertaining to the environmental control system are listed in Table XIII-III at the end of this section, along with their probable cause and suggested remedies.

13-4. JANITROL HEATER. This part of Section XIII contains information for operation, service and overhaul of the combustion heater, Part No. 47D65 or 47D65-1 and combustion air blower, Part No. 57D77 or 89D23-1 (used with the heater). (See Figure 13-3.)

13-5. CABIN HEATER SYSTEM DESCRIPTION. The flow of primary air for heating, ventilating, and defrosting is taken through the main pressurization airline or from an outside ram air duct in the lower right side of the nose section. During cabin pressurization, the ram air duct is closed, and primary air is taken from the engine sources together with secondary air taken from the cabin by means of a recirculation blower and is delivered to the cabin air conditioning and heater system. Air from the heater is directed to

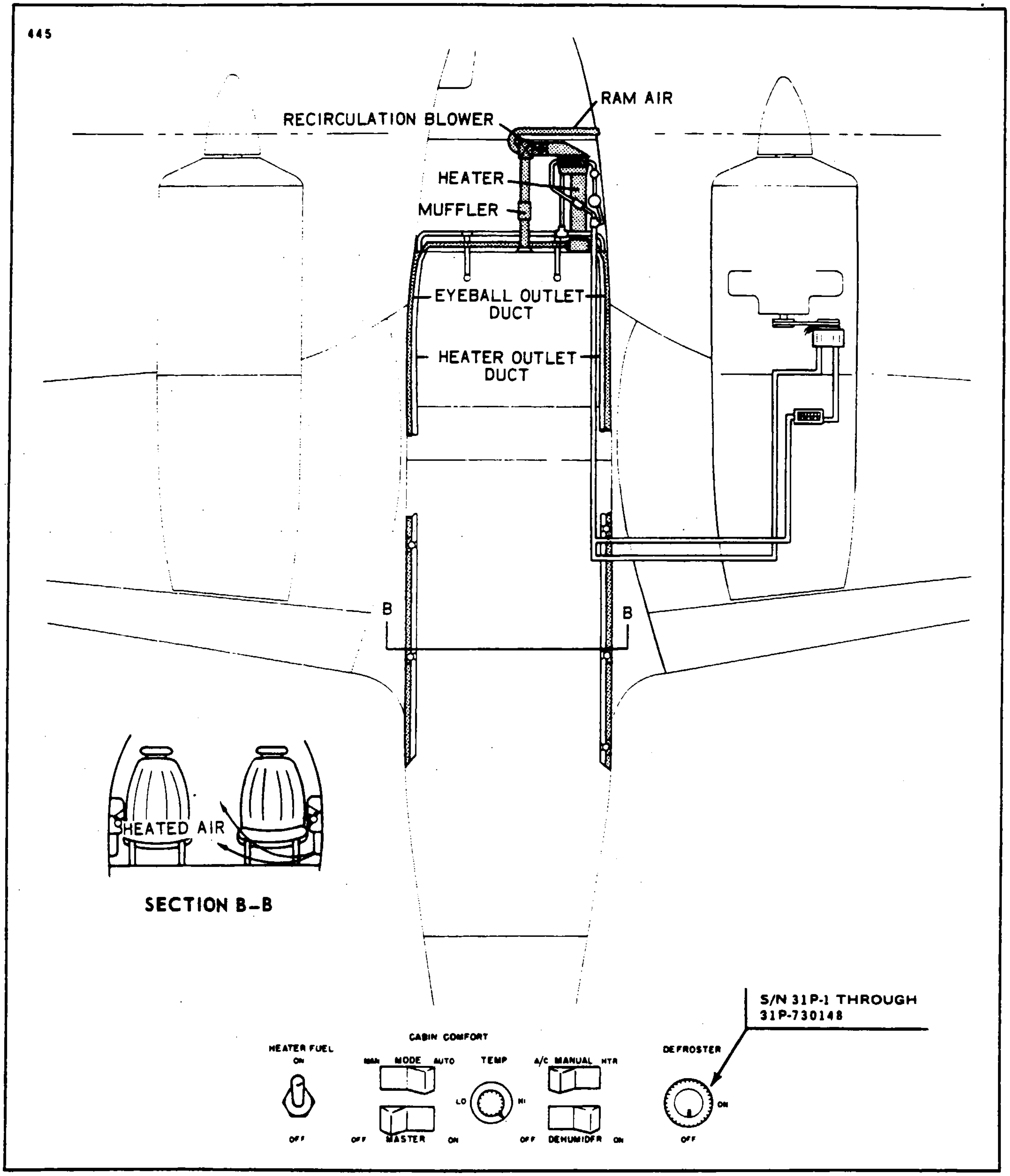


Figure 13-1. Heating System Flow Diagram

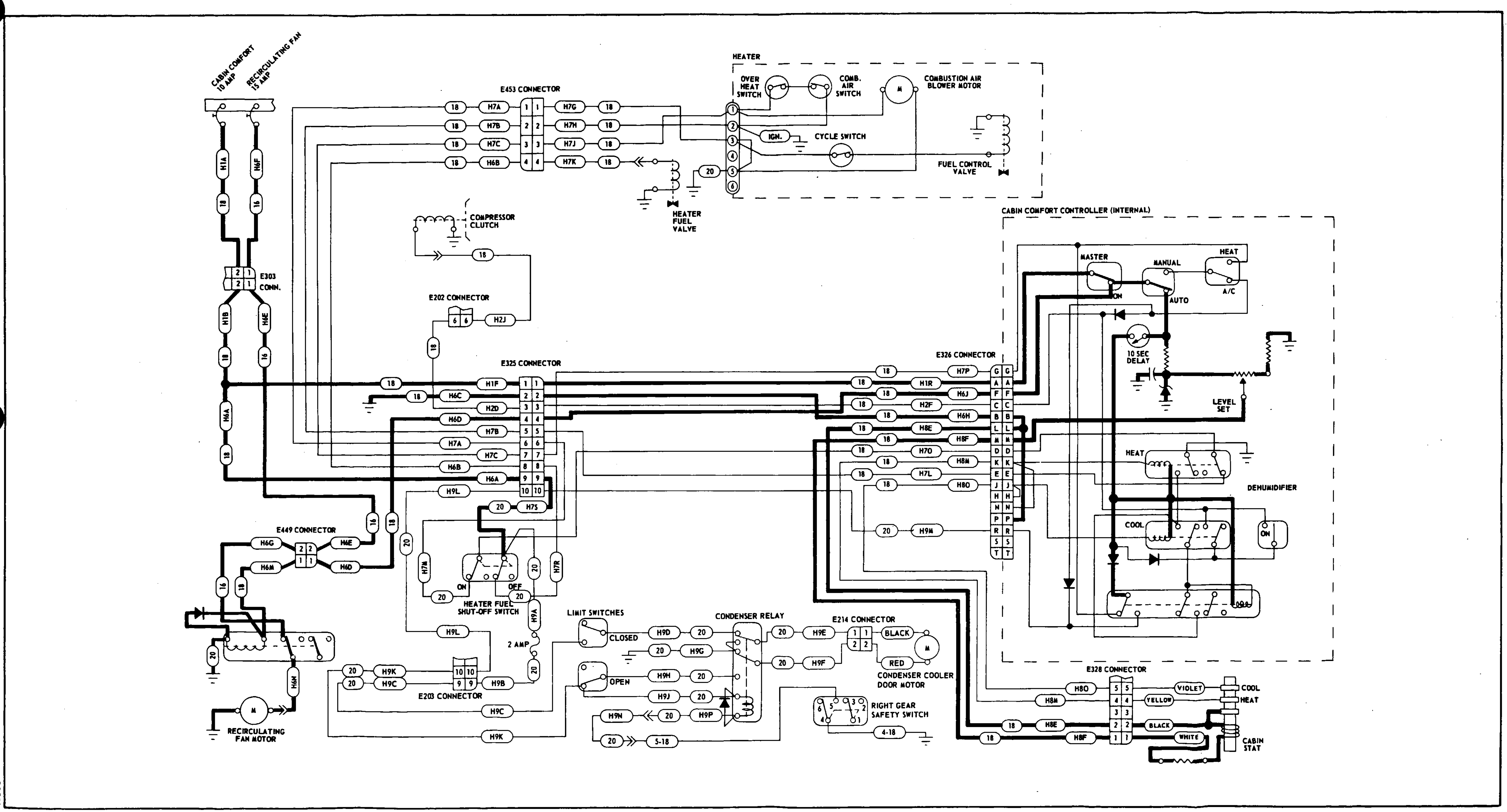
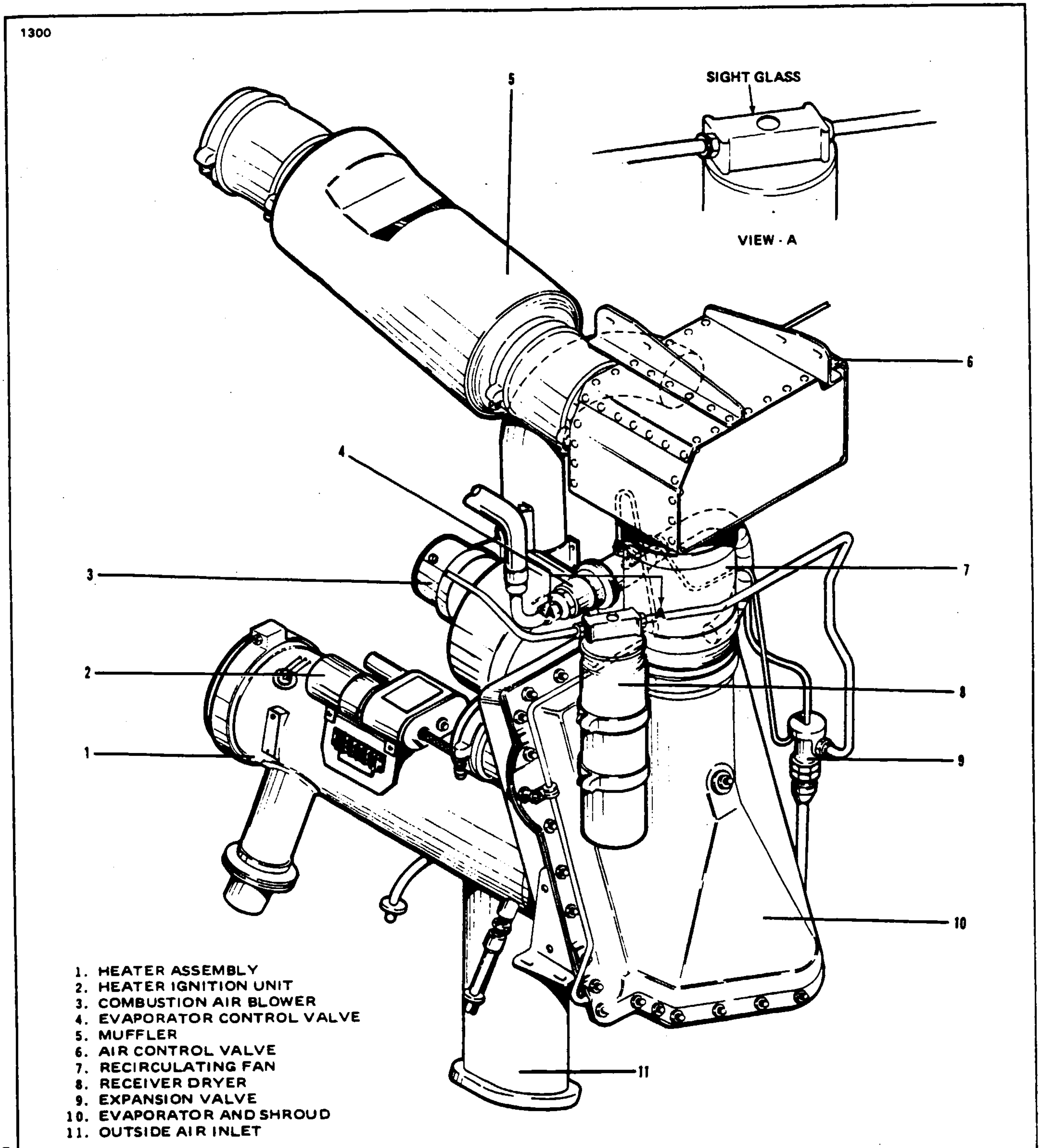


Figure 13-2. Environmental Control - Schematic - (Control System)



1. HEATER ASSEMBLY
2. HEATER IGNITION UNIT
3. COMBUSTION AIR BLOWER
4. EVAPORATOR CONTROL VALVE
5. MUFFLER
6. AIR CONTROL VALVE
7. RECIRCULATING FAN
8. RECEIVER DRYER
9. EXPANSION VALVE
10. EVAPORATOR AND SHROUD
11. OUTSIDE AIR INLET

Figure 13-3. Environmental Components

outlets along both sides of the cabin. Air from the heater can also be routed to the windshield defroster outlets along both sides of the windshield center post. Air for ventilating is routed through ducts along both sides of the cabin and exits out of individually controlled eyeball outlets next to each passenger seat and in front of the pilot and copilot. The recirculation blower operates whenever the cabin comfort control master switch is on. All controls for the heater are mounted on the lower right instrument panel.

13-6. HEATER OPERATION. The 35,000 B.T.U. gasoline combustion heater is controlled by an electronic controller located on the lower right instrument panel. A master switch turns the system ON or OFF. To the left of the controller is the heater fuel switch and to the right is the defroster control. The controller has a mode switch for operating the heater in an automatic or manual selection. A temperature control is used to select the desired temperature through the use of a controllable mercury bulb thermostat. The system is normally operated in the AUTO mode position and when the thermostat calls for heat, the controller turns the heater on. The heater operates at maximum efficiency until the desired temperature is obtained.

13-7. DESCRIPTION OF HEATER COMPONENTS.

13-8. SPARK-SPRAY IGNITION. (Refer to Figure 13-4.) The controlled atomized spray from a specially designed spray nozzle, coupled with high-voltage spark plug ignition, insures instant firing and continuous burning under all flight conditions.

Heat is produced by burning a fuel-air mixture in the combustion chamber of the heater. Aviation gasoline is injected into the combustion chamber through the spray nozzle. The resulting cone-shaped fuel spray mixes with combustion air and is ignited by a spark from the spark plug. Electric current for ignition is supplied by an ignition unit which converts 24-volts d.c. to high-voltage oscillating current to provide a continuous spark across the spark plug gap. A shielded, high-voltage lead connects the ignition unit to the spark plug. Combustion air enters the combustion chamber, tangent to its surface and imparts a whirling or spinning action to the air. This produces a whirling flame that is stable and sustains combustion under the most adverse conditions because it is whirled around itself many times. Therefore, ignition is continuous and the combustion process is self-piloting. The burning gases travel the length of the inner combustion chamber, then double back along the inside wall of the heat exchanger to the three cross-overs, through which they pass into the outer heat exchanger compartment. After traveling the length of the heat exchanger, they then pass out the exhaust outlet.

Ventilating, pressurized or dehumidified air passes through the heater between the jacket and the outer surface of the combustion tube, and through a passage between the outer and inner portions of the combustion chamber. In this manner the air comes in contact with the heated cylinder surfaces.

13-9. COMBUSTION AIR BLOWER. This centrifugal-type blower supplies combustion air to the combustion chamber of the heater. Performance of the combustion air blower is assisted by the use of ram air during flight.

13-10. FUEL REGULATOR AND SHUT-OFF VALVE. (See Figure 13-5.) This unit provides preset, regulated fuel pressure as well as remote shut-off to the heater, regardless of fuel inlet pressure variations. It is set at 7.5 psi, with inlet pressures up to 50 psi. The shut-off valve is operated by a solenoid and the regulator is adjustable, but not repairable.

13-11. HEATER LIMIT SWITCH. Located on the heater is an overheat or limit switch, which acts as a safety device to render the heater system inoperative if a malfunction should occur causing excessively high temperatures (275 ° Fahrenheit). This switch is located on the down-stream end of the vent jacket, with the reset button on the switch. The reset button is reached only through the access panel on the right side of the nose section to insure that the malfunction causing the overheat condition is corrected prior to future heater operation.

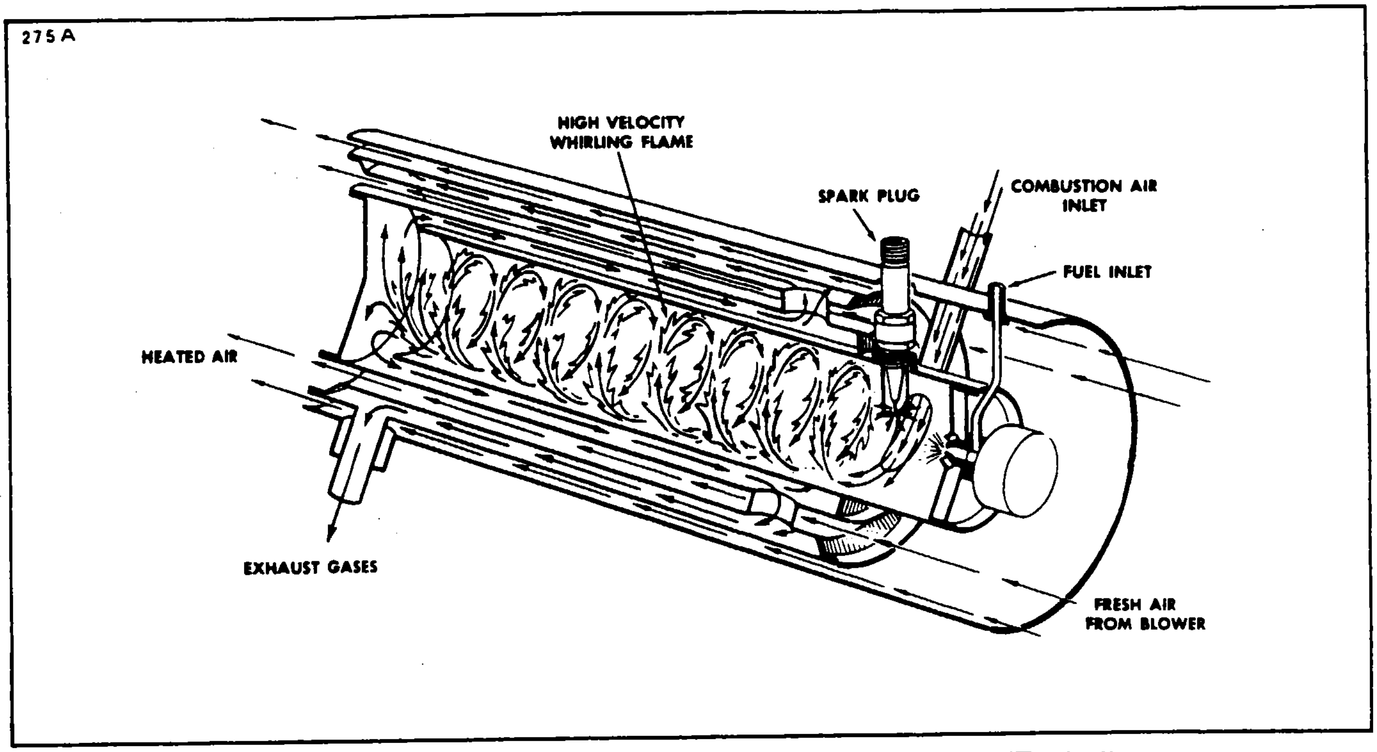


Figure 13-4. Cutaway of Heater, Showing Whirling Flame (Typical)

13-12. HEATER CYCLING SWITCH. The cycling switch, located on the upper surface of the left cabin heat duct, just opposite the left rudder pedal, operates to control the outlet air temperature from the heater at approximately 160° to 180° Fahrenheit. This switch cycles the heater on and off to maintain the set temperature and is adjustable. (See Figure 13-4a.)

13-13. COMBUSTION AIR PRESSURE SWITCH. This is a differential pressure switch which cuts off the heater operation whenever the fuel-air mixture is not appropriate for efficient heater operation.

13-14. INSPECTION OF HEATER AND HEATER COMPONENTS.

a. Inspect all fuel lines and fittings for fuel stains, indicating leakage, and replace lines or tighten fittings as necessary.

b. Check heater for loose bolts, screws and wiring.

c. Inspect all electrical connections for corrosion. If corrosion is evident, clean affected components, and wipe clean with a lightly oiled cloth.

d. Inspection of the heater combustion chamber is limited because the outer jacket is not removable. Minor cracks or pin holes will be detected in the leakage test outlined in Paragraph 13-55.

13-15. 100 HOUR INSPECTION. Perform the following inspections at the end of 100 hours of heater operation:

a. Inspect the sensing tube between the pressure switch and heater exhaust for clogging. Disconnect tube at pressure switch and blow air through the tube. If combustion product residue has collected in the exhaust end of the tube, it may be necessary to clean the tube with a wire.

b. Inspect air inlets and exhaust outlets for restrictions, damage of any kind, and security at the aircraft skinline.

c. Check for abnormal stains, discoloration, and excessive carbon formation that would indicate poor heater operation.

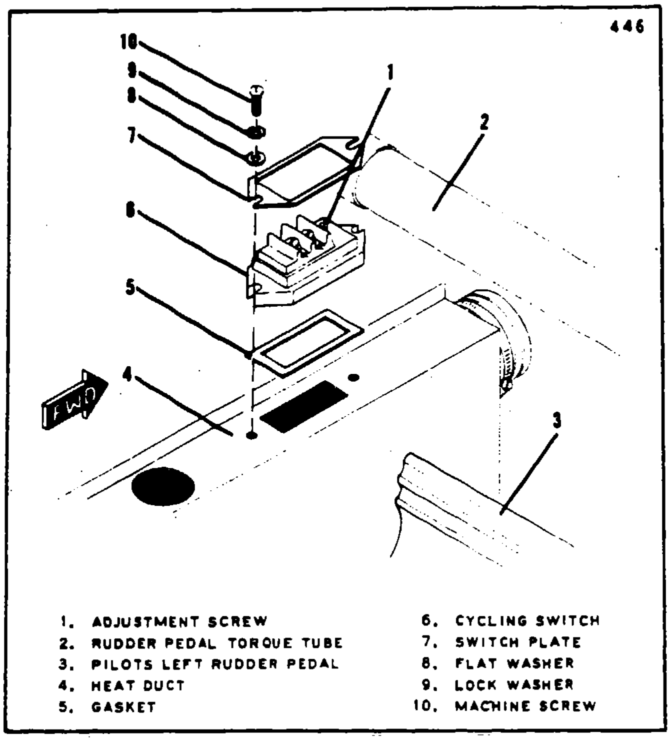


Figure 13-4a. Heater Cycling Switch

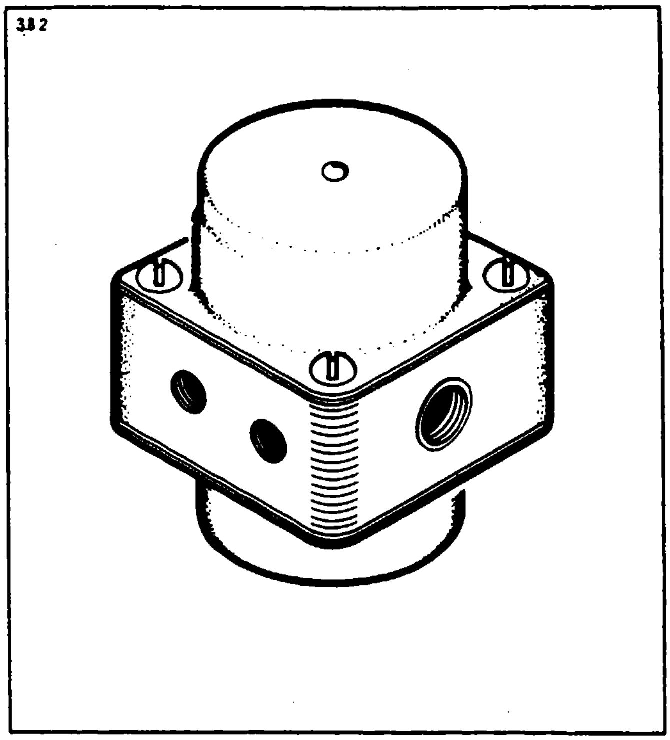


Figure 13-5. Fuel Regulator and Shutoff Valve

d. Check the full length of all lines to be sure all joints and shrouds are secure, and that there is no evidence of leaks. Be sure the fuel lines are secure at the points of attachment to the aircraft and be sure the fuel drainlines are undamaged and free of obstructions.

e. Inspect all heater and control wiring for loose connections, conditon of insulation and security of attachment points.

f. Make sure the high voltage cable is tight at the spark plug. Inspect it for burning or discoloration of sheath, which would indicate arcing.

g. Perform inspections as required and operational check to insure the mechanical and electrical integrity of the heater and its accessories.

13-16. 500 HOUR INSPECTION. At the end of 500 hours of heater operation or after each heating season, whichever comes first, remove the heater from the airplane for complete inspection of heater parts and any necessary repairs and replacements made prior to reassembly.

13-17. MAINTENANCE SERVICE. Instruction contained in the following paragraphs consist of removal and installation of the heater assembly from the airplane.

13-18. REMOVAL OF HEATER.

a. Ascertain that the heater switches are off.
b. Remove the access panel located on the right side of the airplanes nose section.
c. Remove the air-conditioning duct which extends over the heater from the evaporator shroud.
d. Disconnect the wires from the harness to the heater terminal strip.

NOTE

For ease of installation, the wires should be marked before removal.

e. Disconnect the combustion air blower intake and exit tubes and electrical leads. Then remove the blower assembly from its mounting bracket.

f. Remove the shroud cover at the fuel line fitting at the heater and disconnect the fuel and drain lines. Also disconnect the electrical lead from the terminal on the heater which goes to the solenoid valve assembly.

g. Disconnect the fuel drain fitting below the heater and let it rest against the skin.

h. Disconnect and remove the two air ducts from the air distribution box assembly.

i. Loosen and remove the two V-band clamps which secure the heater to the air distribution and evaporator shroud.

j. Loosen the four screws which hold the evaporator shroud in place and move the shroud forward, as far as it will go, to obtain added clearance for heater removal.

k. Remove the heater assembly from the airplane by raising the aft end of the heater to clear the air distribution box assembly, then moving the heater aft to clear the evaporator shroud.

13-19. INSTALLATION OF HEATER.

a. Install the forward end of the heater below the outlet on the evaporator shroud and move it forward till the aft end of the heater clears the air distribution box.

b. Align the heater exhaust pipe into the hole in the fuselage skin.

c. Move the evaporator shroud aft till it butts against the heater; then install the V-band clamps at the ends of the heater. To improve pressurization system sealing, wrap 3M 69EGS tape one overlapped turn around joint before installing V-band coupling.

NOTE

Do not tighten the clamps at this time, as it may be necessary to move the heater or evaporator assembly to make other hookups.

d. Install the four screws which hold the evaporator shroud in place and secure the shroud.

e. Connect the fuel drain fitting below the heater.

f. Connect the fuel line and fuel shroud drain line at the heater and install the fuel shroud cover.

g. The V-band clamps can be tightened at this time.

h. Mount the combustion air blower to the intake and exit air tubes and secure the connections at the tubes. Now secure the blower to the mounting bracket.

i. Connect the electrical lead to the solenoid valve terminal on the heater jacket.

j. Connect the rest of the electrical leads to the heater terminal strip.

NOTE

A wiring schematic of the heater hookup may be found in the Heater Electrical System Checks.

k. Install and secure the two air ducts from the air distribution box assembly.

l. Install and secure the air-conditioning duct extending over the heater from the evaporator shroud.

m. Make a complete inspection of the system installation; then install the access panel and secure it.

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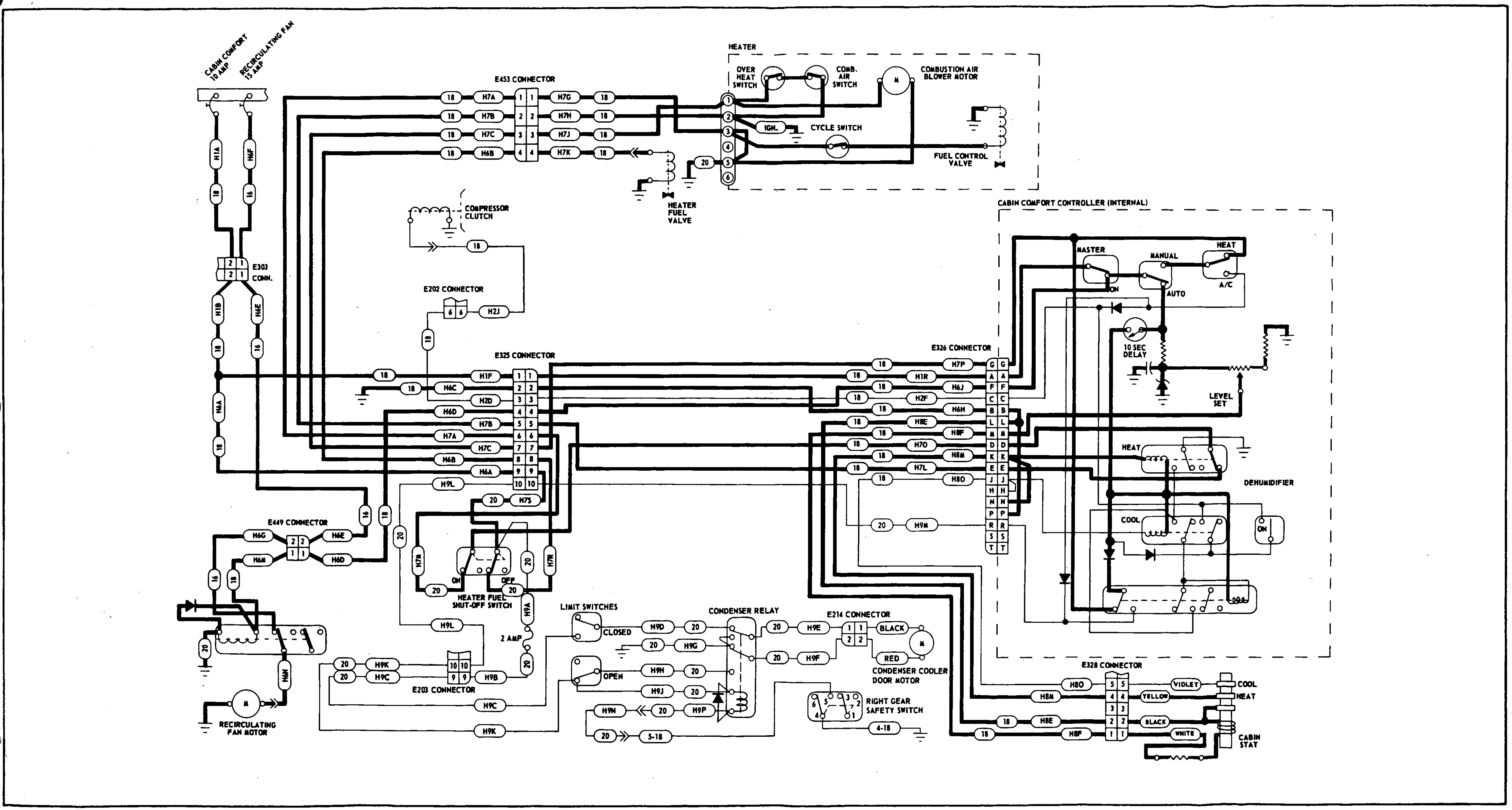


Figure 13-6. Environmental Control - Schematic - (Heating System)

13-20. HEATER ELECTRICAL SYSTEM CHECKS.

13-21. ELECTRICAL CONTINUITY CHECK. (Refer to Figure 13- 6.) These tests are listed as an aid in isolating open-circuited or inoperative components.

NOTE

The schematic wiring diagram (Figure 13- 6) shows, in addition to the heater circuitry, the airplane environmental control circuit. For the purposes of this manual, the circuitry shown in these illustrations will be utilized to describe electrical continuity checks.

It must be assumed that power, which is furnished through the cabin comfort circuit breaker, is present at the "MASTER" switch at all times. Always check the circuit breaker before performing electrical continuity checks.

a. To operate the "RECIRCULATING FAN" turn the cabin comfort controller "MASTER" switch "ON". The fan will operate as long as the switch is "ON".

b. To operate the heater set up the cabin comfort controller as follows:

1. Position the "SELECTOR" switch in the "HEAT" position.
2. Position the "MODE" switch in the "MANUAL" position.
3. Position the "HEATER FUEL" switch "ON".
4. Turn the "MASTER" switch "ON" and check at combustion air outlet for ignition.

c. To check the "TEMP" control, reset the controller as follows:

1. Operate the heater as outlined in step b, and reset the "MODE" switch to "AUTO" position.
2. Rotate the "TEMP" control to the "HI" position and check for heater ignition after 10 second delay.

NOTE

With the controller set up in this configuration, the "SELECTOR" switch is cut out of the circuit, and the heater will operate only if the "TEMP" control is set high enough to call for heat. The outside air temperature must be below 80°F or the cabin thermostat must be artificially cooled.

3. Rotate the "TEMP" control to the "LO" position. The heater should shut off.

13-22. RECIRCULATING FAN POWER CIRCUIT CHECK. With the cabin comfort controller "MASTER" switch in the "ON" position, electrical continuity (24 volts nominal) should be present at the recirculating fan motor.

13-23. HEATER POWER CIRCUIT CHECK. With the cabin comfort controller "MASTER" switch in the "ON" position, the "SELECTOR" switch in the "HEAT" position and the "MODE" switch in the "MAN" position, electrical continuity should be present at the following locations:

NOTE

The recirculating fan will operate as long as the master switch is on.

a. Terminal No. 1 of the heater terminal strip to ground.

b. Terminal No. 1 of heater terminal strip, through the radio noise filter to the combustion air blower motor to terminal No. 5 of the heater terminal strip.

c. From terminal No. 1 of the heater terminal strip to the overheat switch through the combustion air pressure switch to terminal No. 2 of the heater terminal strip.

d. From terminal No. 2 of the heater terminal strip to the ignition unit.

e. From terminal No. 3 of the heater terminal strip through the cycling switch to the fuel solenoid valve.

In the event that electrical continuity is not present at one or more of the above, listed points, the wiring must be tracked back to the power source. If components are still inoperative after the wiring inspection, check the individual inoperative components for continuity and, if necessary, replace them.

13-24. MAINTENANCE AND REPAIRS. Instructions in this paragraph pertain to maintenance of the basic heater and components. Instructions for removal of components are included, provided the installation permits accessibility.

NOTE

No special tools are required for normal periodic maintenance.

13-25. COMBUSTION AIR BLOWER.

a. Removal.

1. Disconnect wire at quick-disconnect terminal.

2. Disconnect the inlet tubing from the inlet air adapter.

3. Loosen the clamps that hold the combustion air blower assembly in the support bracket and slide the motor out of the bracket.

b. Installation.

1. Prior to installing the combustion air blower, inspect all parts of the assembly for loose screws, loose nuts and poor ground connection on the blower housing. Make sure the blower wheel is tight on the shaft and properly located in the housing. It should have just enough clearance to rotate at full speed without binding. Blower performance is based upon this close-tolerance clearance. It is recommended that correct voltage be applied for this clearance check.

2. Install the blower inlet adapter in the same orientation as before removal.

3. Place the combustion air blower assembly in position in the attaching clamp so the air tubing can be connected, and slide the tubing into position at the point where it was disconnected during removal. Tighten the motor in the attaching strap.

4. Secure the air tubing by installing the bolt and locknut removed during disassembly.

5. Connect the wire lead to No. 1 terminal on terminal strip.

6. Check motor operation by setting the selector switch to the heat position, the mode switch to the manual position and leaving the heater fuel switch in the off position. Now turn on the comfort control master switch.

NOTE

It may be desirable to disconnect the lead wire to the recirculating fan, as it will also operate whenever the cabin comfort master switch is in the ON position.

13-26. DISASSEMBLY OF COMBUSTION AIR BLOWER ASSEMBLY. (See Figure 13-7.)

a. Disassembly of the combustion air blower used on the 47D65 heaters as follows:

1. Remove the combustion air blower inlet adapter (2) by removing three screws, lock washers, cover plate and gasket.

2. Remove the outlet adapter (5) by removing the two screws (18) and lock washers (17).

3. Remove the inlet flange (6) by removing the three screws (18) and lock washers (17).

4. Remove screws (18) and lock washers (17), then separate the back plate (11), with motor (13) attached, from the blower housing (8) and free the motor leads and capacitor (7) from the back plate (11).

5. Loosen the set screw in the blower wheel (10) and slide it off the motor shaft.

6. Remove the two hex nuts (23), lock washers (24) and flat washers (25), and slide the back plate (11) off the motor through bolts. The spacer (12) will drop out.

b. Disassembly of the combustion air blower used on the 47D65-1 heater as follows:

1. Remove the combustion air blower inlet adapter (2) by removing the screw (29).

2. Remove the outer housing (31) by removing the four screws.

3. Loosen the set screw (28) in the blower wheel (10) and slide it off the motor shaft.

4. Remove the two hex nuts (23), lock washers (24) and flat washers (25), and slide the inner housing (32) off the motor through bolts. The spacer (12) will drop out.

c. Install new motor brushes as described in Paragraph 13-29. If the motor commutator is badly worn, or if the motor is defective in any respect, it must be replaced.

13-27. REASSEMBLY OF COMBUSTION AIR BLOWER ASSEMBLY. (Refer to Figure 13-7.)

a. Reassembly of the combustion air blower used on the 47D65 heaters as follows:

1. Place the spacer (12) over the end of the motor shaft and attach the motor assembly (13) to the back plate (11) with the two self-locking nuts (23), flat washers (25) and lock washers (24).

2. Slide the blower wheel (10) on the motor shaft and tighten the set screw lightly against the flat portion of the motor shaft.

3. Place the blower housing (8) in position on the back plate (11) and install screws (18) and lock washers (17).

4. Attach the capacitor (7) at the point shown with the screw (18) and lock washer (17). The motor ground lead terminal (16) can be grounded to the motor support bracket (3).

5. Attach the inlet flange (6) and blower inlet adapter (2) to blower housing (8) with three screws (18) and lock washers (17).

6. Loosen the Allen set screw in the blower wheel (10) and shift the wheel on the motor shaft until it is near the inlet in the blower housing. Tighten the set screw securely. The blower wheel should just clear the inlet flange when rotated at full RPM. Spin the blower wheel by hand for clearance check; then apply proper voltage to run motor and recheck for proper clearance.

7. Slide the blower outlet adapter (5) on the blower housing outlet (8) and install the two screws (18) and lock washers (17).

b. Reassembly of the combustion air blower used on the 47D65-1 heater as follows:

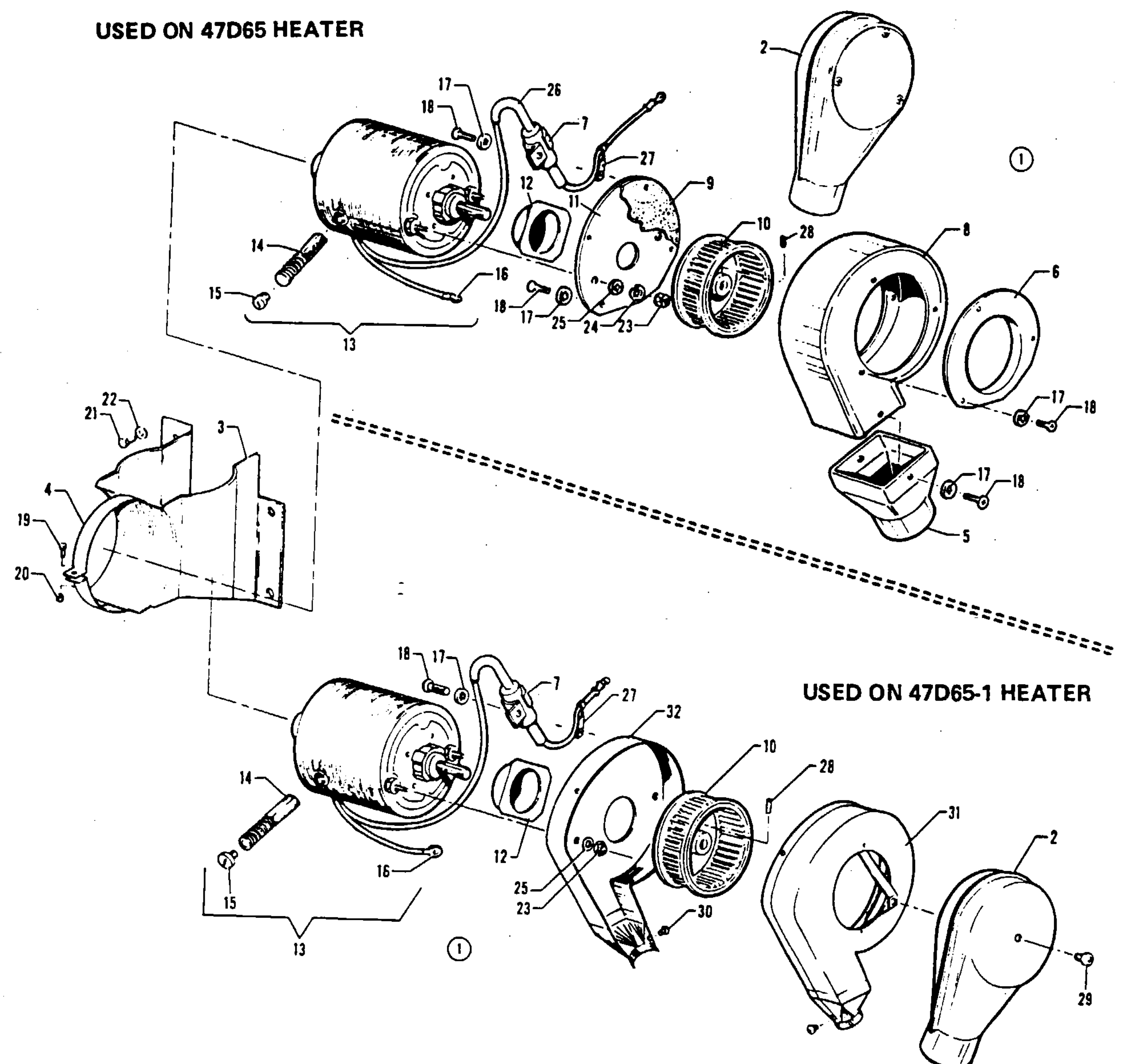
1. Place the spacer (12) over the end of the motor shaft and attach the motor assembly (13) to the inner housing (32) with the two self-locking nuts (23), flat washer (25) and lock washer (24).

2. Slide the blower wheel (10) on the motor shaft and tighten the set screw (28) lightly against the flat portion of the motor shaft.

3. Place the blower outer housing (31) in position on the inner housing (32) and install screws (30).

4. Attached the capacitor (7) at the point shown with the screw (18). The motor ground lead terminal (16) can be grounded to the motor support bracket (3).

5. Loosen the Allen set screw in the blower wheel (10) and shift the wheel on the motor shaft until it is near the inlet in the blower housing. Tighten the set screw securely. The blower wheel should just clear the inlet flange when rotated at full RPM. Spin the blower wheel by hand for clearance check; then apply proper voltage to run motor and recheck for proper clearance.



1. COMBUSTION AIR BLOWER AND MOTOR ASSEMBLY
2. ADAPTER ASSEMBLY - BLOWER INLET
3. BRACKET - MOTOR SUPPORT
4. CLAMP - MOTOR SUPPORT
5. ADAPTER - OUTLET
6. FLANGE - INLET
7. CAPACITOR
8. HOUSING - BLOWER
9. GASKET BACK PLATE
10. FAN - COMBUSTION AIR BLOWER
11. PLATE - BACK
12. SPACER
13. MOTOR ASSEMBLY
14. BRUSH ASSEMBLY
15. CAP - BRUSH ASSEMBLY
16. TERMINAL - PREINSULATED
17. WASHER - LOCK
18. SCREW
19. SCREW
20. NUT
21. SCREW
22. WASHER - LOCK
23. NUT
24. WASHER - LOCK
25. WASHER
26. SLEEVE - HIGH TEMPERATURE
27. STRAP - CABLE
28. SET SCREW
29. SCREW
30. SCREW
31. HOUSING - BLOWER, OUTER
32. HOUSING - BLOWER, INNER

Figure 13-7. Combustion Air Blower And Motor Assembly

13-28. CLEANING OF COMBUSTION AIR BLOWER.

a. Clean individual metal parts (except the combustion tube and jacket assembly and those part which contain switches or electrical wiring) by immersing them in dry-solvent such as Stoddard Solven (Federal Specification P-D-680). Use a bristle brush to assist the cleaning process if foreign accumulation are stubborn to remove.

b. Allow the parts to air-dry. If speed is necessary, the parts may be dried with compressed air or lintless cloth.

c. Wipe electrical components with a clean, dry cloth. If foreign material is difficult to remove moisten the cloth in carbon tetrachloride or electrical contact cleaner, and clean all exterior surfaces of th parts thoroughly.

d. Dust, etc., should be removed from switches by wiping or blowing it off.

13-29. INSPECTION AND REPAIR OF COMBUSTION AIR BLOWER.

Remove the brush cap at one of the brush locations. Note position of brush inside the guide an carefully lift the brush and brush spring out of the guide. Be sure to hold the brush so that it can b reinstalled in precisely the same position if no brush replacement is required.

Inspect the brush for wear. A new brush is .531 inch long. If brushes are worn to a length of .187 inc they must be replaced.

Looking through the brush guide, inspect the commutator, which should be smooth and mediur brown to dark brown in color. Remove all dust from commutator with compressed air. If the commutato is grooved in the brush track, gouged, scored or shows signs of having burned spots, replace the complet motor assembly. If the commutator is in good condition, install new motor brushes and tighten brush cap into place. Make sure each brush is oriented so that the curved end fits the curvature of the commutator.

After installing new brushes, it is advisable to run-in the brushes as follows: Connect the motor to controlled voltage supply (rheostat in a 24-volt line). Operate the motor at approximately 1/2 its norma speed for the first hour, then gradually increase the speed until it is rotating at approximately normal speed Continue the run-in operation for at least two hours to properly seat the brushes before installing th blower in the airplane.

13-30. RECIRCULATING FAN. (Refer to Figure 13-8.)

a. Removal.

1. Remove the access panel on the right side of the nose section.

2. Loosen and remove the four clamps securing the fan to the flexible rubber cuffs and the ai control box and evaporator shroud.

3. Disconnect the electrical leads to the fan motor.

4. Slide the lower cuff down onto the evaporator shroud until the end of the fan housing i exposed, then remove lower cuff.

5. Move the fan down to disconnect the upper cuff from the air control box and remove.

6. Rotate the fan's upper end out towards the access opening and remove the fan from th airplane.

b. Installation.

1. If the cuffs were removed when taking the fan out of the airplane, replace them onto the ai control box and evaporator shroud.

2. Install the fan into the space between the air control box and evaporator shroud with th motor end of the fan extending into the shroud.

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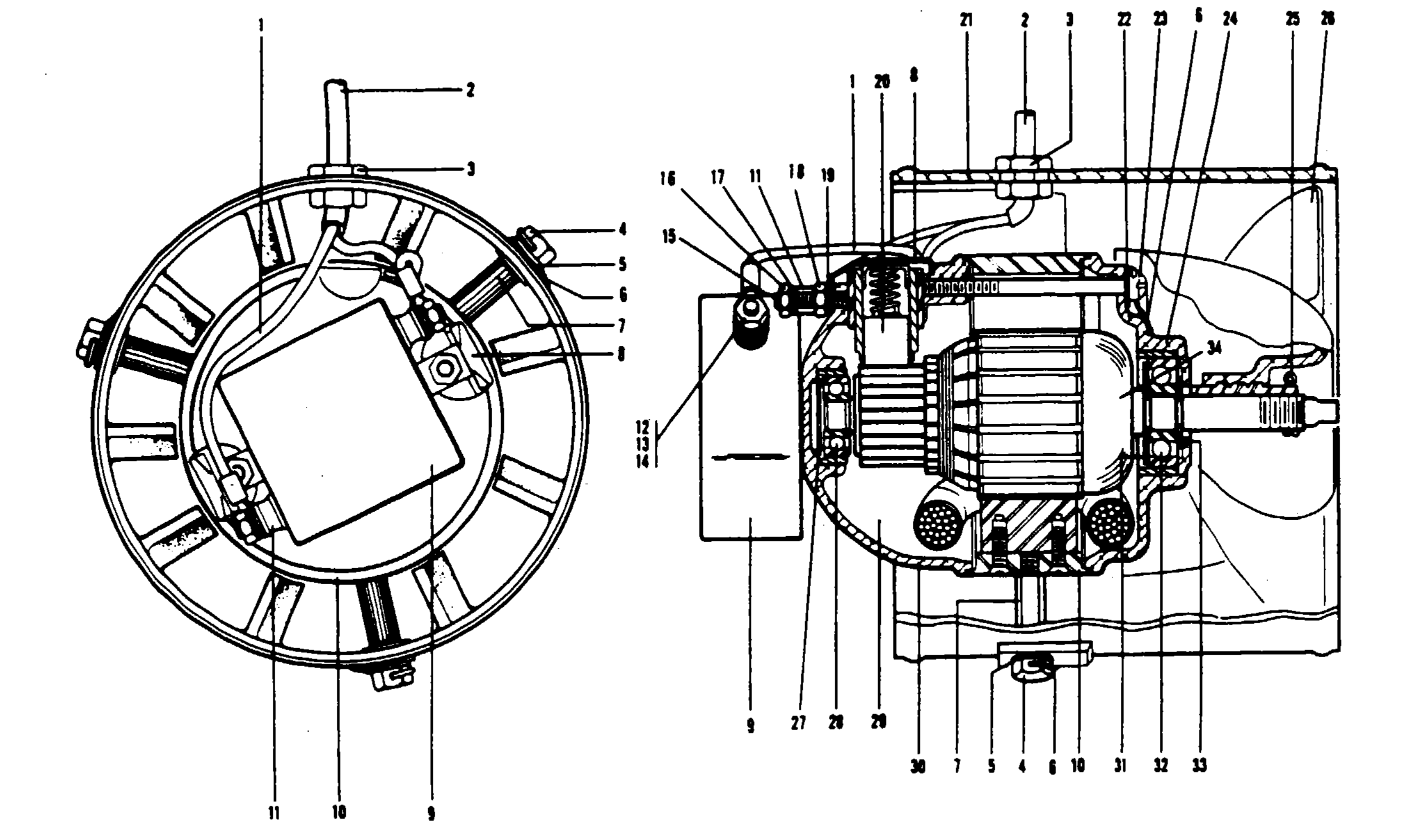


1. ELECTRICAL LEAD
2. SLEEVE (INSULATING)
3. GROMMET
4. BOLTS
5. WASHERS
6. SAFETY WIRE
7. SPACERS
8. CAP
9. NOISE FILTER (RADIO)
10. STATOR
11. SLEEVE (SPACER)
12. NUT
13. LOCK WASHER
14. PLAIN WASHER
15. TERMINAL LUG
16. NUT
17. WASHER
18. NUT
19. WASHER
20. BRUSHES
21. FAN HOUSING
22. WASHERS (FLAT)
23. MACHINE SCREWS
24. END BELL
25. COTTER PIN
26. PROPELLER
27. FLAT SPRING
28. BEARING
29. MOTOR ASSEMBLY
30. END BELL
31. BEARING SHIELD
32. BEARING
33. SLINGER
34. ARMATURE

Figure 13-8. Recirculation Fan And Motor Assembly

3. Turn the fan upright between the air box and shroud and slide the upper edge of the fan housing into the cuff on the air box.

4. Secure the fan, cuff and air control box together with two clamps.

5. Slide the lower cuff over the lower end of the fan and secure it to the shroud and fan housing with the two other clamps.

NOTE

Ascertain that the fan does not come in contact with any part of the air control box or evaporator shroud. The cuffs act to shock mount the fan.

6. Connect the electrical leads to the fan and replace the access panel on the nose section.

13-31. DISASSEMBLY OF RECIRCULATING FAN. (Refer to Figure 13-8.)

a. Remove the cotter pin (25) from the shaft end of the motor armature (34) and remove the propeller (26) by unscrewing it from the shaft end.

b. Remove the plastic grommet (3) and insulating sleeve (2) from the electrical leads extending out from the fan housing (21).

c. Cut the safety wire and remove the three bolts (4) and washer (5) which secure the motor assembly (29) in the fan housing (21) along with the spacers (7).

d. Disconnect the electrical lead (1) from the radio filter (9) by removing the nut (12), lock washer (13) and plain washer (14).

e. Disconnect and remove the nut (16) and washer (17) from the terminal lug (15) and remove the radio noise filter (9) and the sleeve spacer (11).

f. Remove the nut (18) and washer (19) on the terminal lug (15) and remove the cap (8) from over the brush holders.

g. Remove the brushes (20) from the motor assembly (29).

h. Cut the safety wire and remove the machine screws (23) and flat washers (22) from the motor assembly (29).

NOTE

Make some type of reference marks along both bell ends and stator to facilitate reassembly.

i. Remove the end bell (24) being careful not to drop the bearing (32) slinger (33) and bearing shield (31).

j. Remove the end bell (30) also being careful not to drop the bearing (28) and flat spring (27) behind the bearing.

k. Remove the motor armature (34) from the stator (10).

l. Remove the bearings (32) and (28) from their respective end bells along with the related parts. (Refer to Figure 13-8.)

13-32. ASSEMBLY OF RECIRCULATING FAN. (Refer to Figure 13-8.)

a. Install the flat spring (27) into the end bell (30) with the tabs toward the bearing, then install the bearing (28).

b. Install the slinger (33) into the end bell (24), then install the bearing (32) and bearing shield (31) with the tapered center hole towards the bearing.

c. Install the motor armature (34) into the stator (10) and position the end bell (30) to the stator, aligning the reference marks made before disassembly.

d. Install the forward end bell (24) onto the armature shaft and align the reference marks.

e. Secure the end bells (30) and (24) to the stator (10) with the two machine screws (23) and washers (22). Install safety wire MS20995-C32 to both screws (23).

f. Install brushes (20) into the brush holders of the motor assembly (29).

g. Install the cap (8) onto the terminal lug (15) and secure with washer (19) and nut (18).

h. Install the sleeve spacer (11) over the terminal lugs (15) and position the radio noise filter (9) onto the lugs and secure in place with washer (17) and nut (16).

i. Connect the electrical leads (1) to the terminals on the filter (9) and secure with plain washer (14), lock washer (13) and nut (12).

j. Install the motor assembly (29) into the fan housing (21) and route the electrical leads through the hole in the housing.

k. Align the three mounting holes in the motor assembly (29) with the mating holes in the housing (21) then install the spacers (7) and secure the motor and housing with the three bolts (4) and washers (5) to secure the assembly and safety the three bolts with MS20995-C32 safety wire.

l. Install the insulating sleeve (2) over the electrical leads extending out of the fan housing (21) and install the plastic grommet (3) over the wires and sleeve into the housing.

m. Install the propeller (26) onto the armature (34) shaft by screwing it in place and align the hole in the propeller bushing with the mating hole in the shaft and secure the propeller to the shelf with a new cotter pin (25).

13-33. CLEANING OF RECIRCULATING FAN MOTOR. No solvents should be used on the electrical leads or motor parts. Lint-free cloths and compressed air should be used for cleaning. Parts other than electrical may be washed in solvent (Federal Specification P-D-680) and dried with compressed air.

13-34. INSPECTION OF RECIRCULATING FAN MOTOR.

a. Check the housing and propeller for any damage.

b. Check the electrical leads and radio noise filter for damage and broken insulation.

c. Check brushes for amount of wear which should not exceed 20 percent of the useful length, or 0.125 of an inch.

NOTE

When brushes are removed for inspection only, each brush and corresponding holder should be marked to identify exact original positioning in the motor.

d. Check bearings and bearing seats for any damage of rotating bearings.

e. Check armature for commutator wear and eccentricity. Evidence of wear requires finish and undercutting.

f. If further electrical tests are required on the motor, it should be done in an electrical shop familiar with maintenance and overhaul of rotating electro-mechanical devices such as starters, generators, etc. (Refer to Table XIII-I, Leading Particulars.)

13-35. REPAIR OF RECIRCULATING FAN MOTOR.

a. Replace damaged leads and insulation on all parts.

b. If commutator or armature is worn, it should be turned down enough to eliminate evidence of wear and the mica between the bars undercut approximately 0.031 of an inch deep and 0.030 of an inch wide. Remove all particles of mica and polish the commutator with 3/0 sandpaper and remove all particles of copper between the bars. Coat the commutator with "long life" manufactured by Magnus Chemical Company, Inc., Garwood, New Jersey.

c. Replace all rejected parts. Refer to Table XIII-I, Leading Particulars for tolerances of parts.

d. Replace bearings if unit has 500 hours service or at any time the brushes are replaced.

NOTE

Bearings used in this unit are critic l parts. Great care should be taken to protect bearings in handling and assembly to prevent damage to fits.

e. If holder and lead or holder has to be replaced, extreme care must be exercised to get them positioned to clear the commutator by 0.031 of an inch and to align the rectangular portion exactly parallel with the center line of the shaft.

f. If finish on any parts is damaged, touch-up and refinish it.

13-36. TESTS OF RECIRCULATING FAN MOTOR.

a. Electrical: The following should be done by an electrical shop.

CAUTION

Before making dielectric tests, be sure all carbon dust has been removed with compressed air.

1. Perform a dielectric test between the commutator and shaft at operating temperature. The commutator and shaft must pass a hi-potential test of 500 RMS volts at 60 cycles AC for one minute and insulation resistance shall measure 200 megohms or more. If test cannot be met, replace the armature.

2. Make a dielectric test of the stator between the leads at operating temperature. It must pass a hi-potential test of 500 RMS volts at 60 cycles AC for one minute and insulation resistance shall measure 200 megohms or more. If the test cannot be met, replace the stator.

b. Prior to Reassembly:

WARNING

Before energizing fan or motor on bench test, strap it down and provide some type of wire guard around propeller to protect personnel. The fan has high suction and can draw a persons' hand into the intake end.

TABLE XIII-I. LEADING PARTICULARS (AXIAL FLOW FAN)

Electrical Current	27 Volts D.C.
Service	Continuous, sea level to 40,000 feet
R-F Interference	Filtered per Spec. MIL-I-6181
Operating Temperature	-54°C to + 121°C; -65°F to + 250°F
Motor Brushes	Body Length, New, 0.56 inch Useful Length 0.44 inch
Minimum Useful Diameter of Commutator	0.935 inch
Bearing Insert Seat, Shaft End, Inside Diameter	Min. 1.1811 inch; Max. 1.1814 inch
Bearing Insert Seat, Comm. End, Inside Diameter	Min. 0.8661 inch; Max. 0.8664 inch
Weight	5.25 lbs.
Requirements	300 cfm at 3.0" H_20 static pressure with standard air density of 0.0765 lbs./cu./ft.

1. The motor should be run on a low voltage of 8 to 14 volts until the brushes are 75 to 90 percent seated before full voltage is used. During this process, the motor can be loaded by installing the propeller on the shaft.
2. Check performance of motor with propeller installed on shaft. After operating at full voltage for 20 minutes, the maximum current input should not exceed 12.5 amperes and minimum speed should be 11,300 RPM.

13-37. SPARK PLUG.

a. Removal.

1. Remove the access panel on the right side of the nose section to expose the heater and gain access to the spark plug.

NOTE

Insure that the heater electrical circuits are de-energized.

2. Unscrew and remove the high-voltage lead connector at the spark plug. Exercise care to avoid fouling or damaging the connector.
3. Using a 7/8 inch deep hex socket, unscrew and remove the spark plug. Make sure the spark plug gasket is removed with the spark plug. It will normally stick on the spark plug threads.

b. Inspection and Servicing.

1. If the spark plug appears to be in good condition, except for a mild coating of oxide on the porcelain and electrode, it may be cleaned and reused. Cleaning is accomplished on a conventional airplane-type spark plug cleaner, except that it will be necessary to use two or more adapters in order to raise the long extension of the plug far enough out of the cleaner nozzle opening to perform an effective job. Plug the ceramic insert cavity at the terminal end of the plug with a piece of paper or cloth to keep out

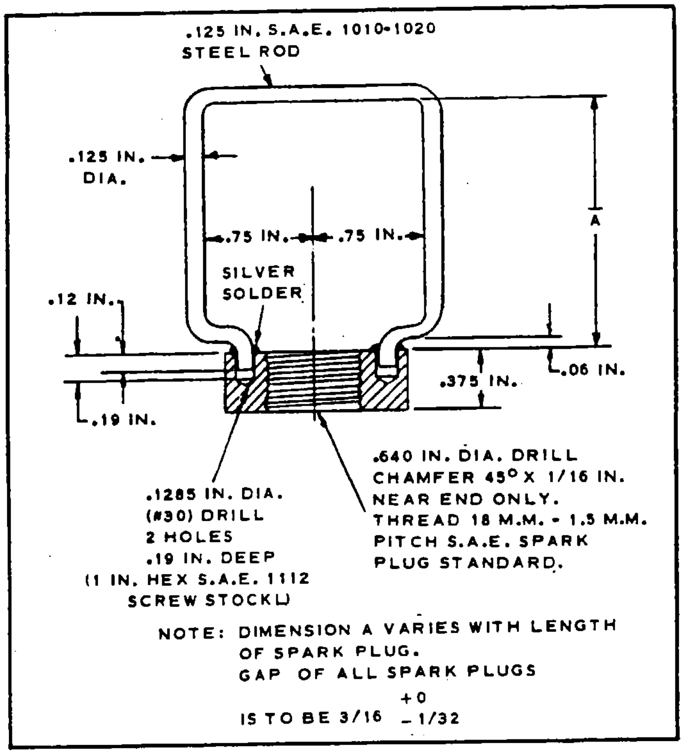


Figure 13-9. Spark Plug Fixture

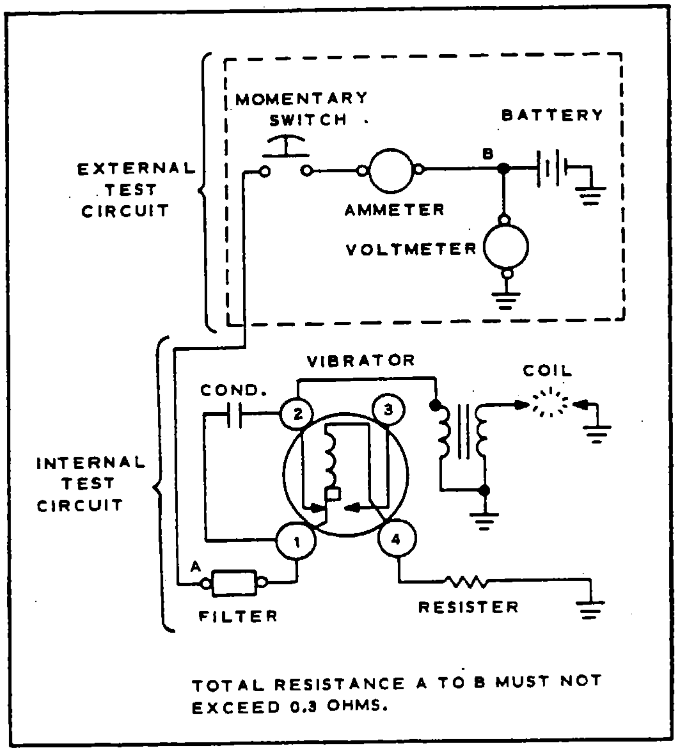


Figure 13-10. Wiring - Test Setup

any of the cleaning sand. Wipe this cavity out thoroughly with a cloth wet with carbon tetrachloride. If after cleaning, the spark plug porcelain is white, and the electrode is not eroded, proceed to check the ground electrode in the heater and adjust the spark gap in accordance with Paragraph 13-37, Step c, and Figure 13-11.

NOTE

If the spark plug fails to cleanup properly and/or the electrode is badly eroded, it should be replaced.

c. Spark Gap Check and Adjustment: (See Figure 13-11.)

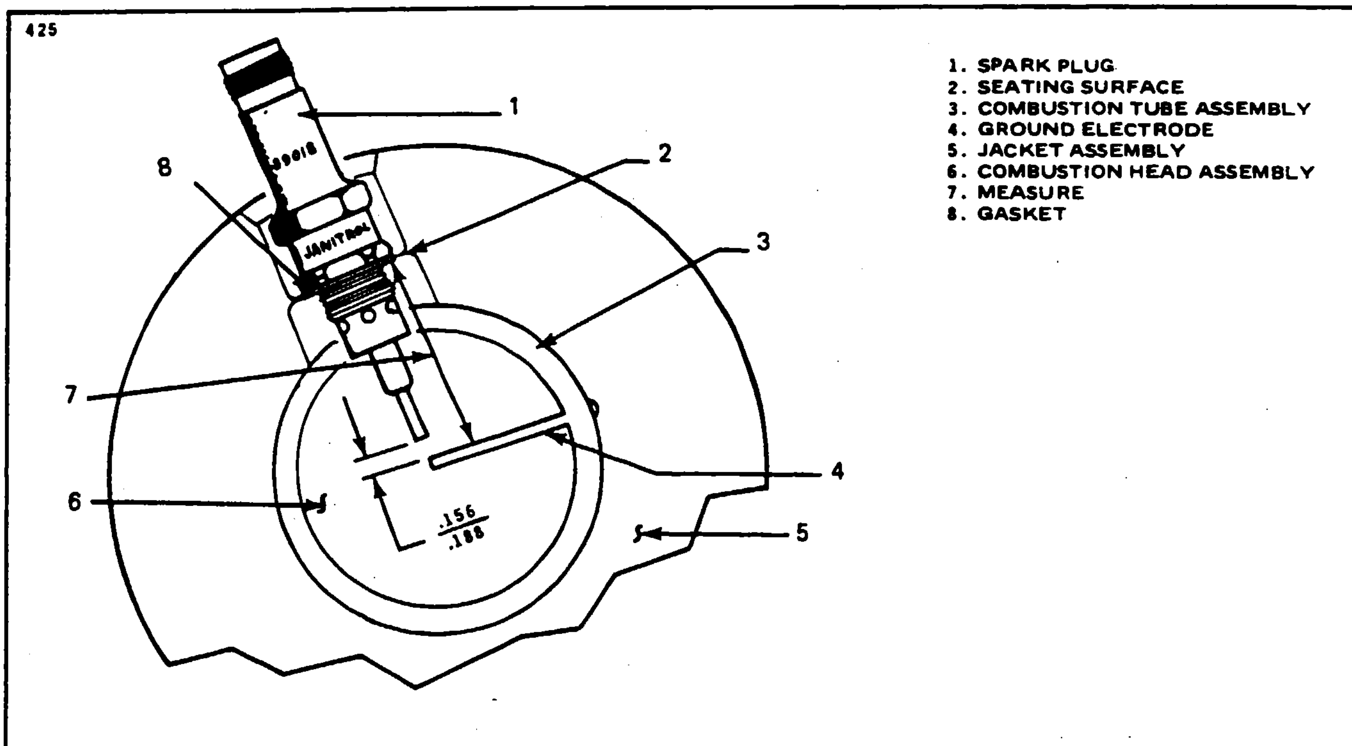
A spark gap of 0.156 to 0.188 of an inch must be maintained on the P/N 39D18 spark plug. This gap should be checked any time a plug is replaced or at the time of heater overhaul. A spark gap greater than that specified can shorten the life of the ignition assembly. There are several methods in which the spark gap of this heater may be checked. Method I is recommended when the heater is being overhauled and before the installation of the fuel nozzle. Methods II and III are suitable for checking the gap through the spark plug well when the heater is not disassembled.

Method I:

1. Using a 5/32 inch drill (0.156) or a piece of 5/32 rod, reach down through the small opening in the combustion head and find the ground electrode. (It is welded inside the head.)

2. Move the drill along the side of the electrode on the spark plug side. (Movement should be from the outer edge towards the center.) The drill should just pass through the spark plug gap opening. Should the drill fail to pass through this opening, the gap is too narrow. If it passes through too freely, the gap is too wide. In either case, it will be necessary to bend the ground electrode in the direction required. This may be done by removing the spark plug and reaching through the opening.

3. Recheck the gap after repositioning of the ground electrode.



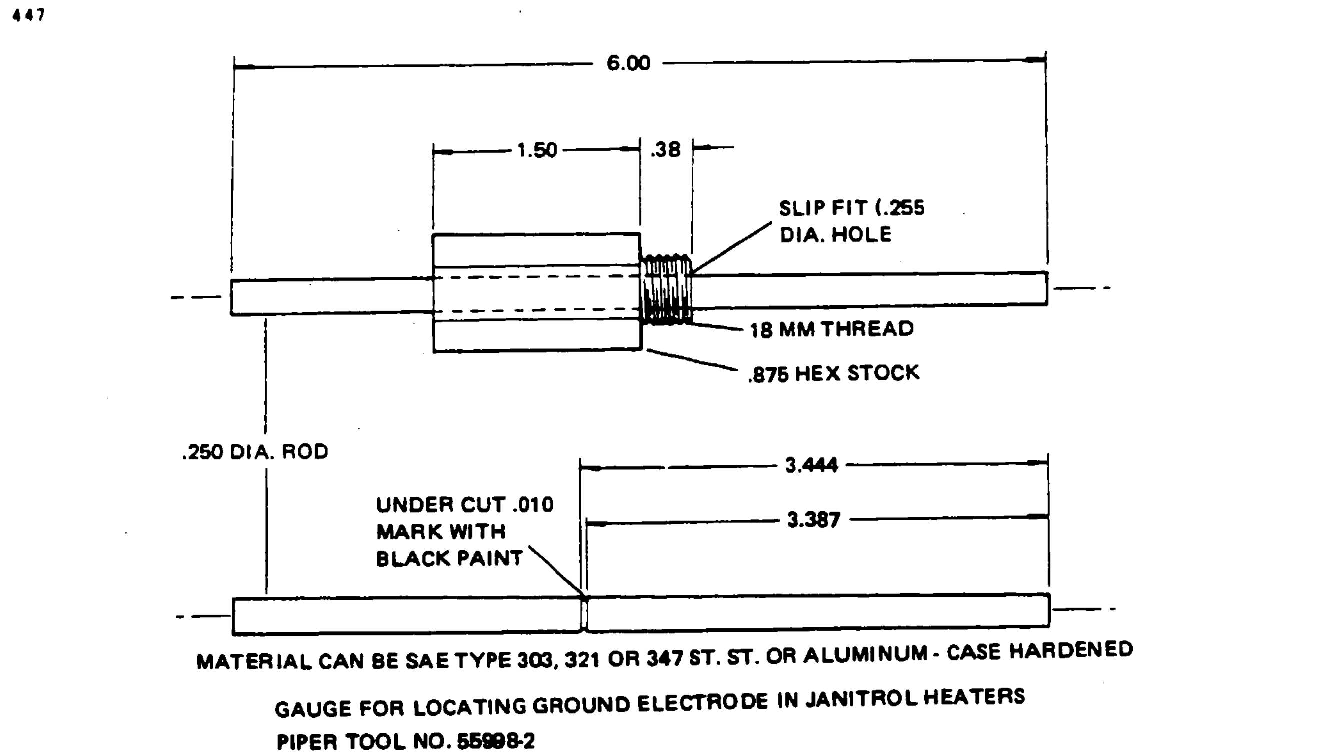


Figure 13-11. Spark Plug Gap Adjustment and Tool

Method II:

1. Measure the distance between the seating surface of the spark plug with a new gasket installed to the end of the plug electrode.

2. Using a depth gauge, measure the distance between the ground electrode in the heater to the spark plug seating surface in the heater jacket and check this measurement against the measurement obtained in Step 1. The difference should be between 0.156 to 0.188 of an inch.

3. The ground electrode can be bent to obtain the required gap.

Method III:

1. Fabricate or purchase from Piper the special tool from dimensions given in Figure 13-11.
2. Install the threaded end of the tool into the spark plug hole.
3. Slide the rod of the tool into the combustion head until it contacts the ground electrode.
4. Check that the indicator ring on the rod lines up with the end of the tool. The ground electrode may be bent to obtain the required gap.

NOTE

Inspect the ground electrode for erosion. If it is eroded to approximately half of its original 1/8 inch diameter, it should be replaced. This can be done as follows:

(a) Grind off the head of the rivet where it projects through the combustion head and remove the electrode.
(b) Install a new CRES rivet AN125452 which is 1.500 inches in length.
(c) Heliarc tack weld the rivet head to hold it in place.
(d) Check spark gap as noted in Methods I, II or III.

d. Installation:

1. If a new spark plug is being installed, be sure to adjust the spark gap as outlined in Paragraph 13-37, Step c.

2. Place a new spark plug gasket on the threads. A small drop of Aviation Permatex, or similar material may be used on the gasket to help hold it to the spark plug shell during installation.

3. Screw the spark plug into the heater with a deep socket wrench. Tighten to a torque of 28 foot-pounds. Install the grommet in heater jacket opening.

4. Carefully insert the spring connector on the high voltage lead into the spark plug shell; press down gently and start the nut on the threads. Tighten the nut to 20 foot-pounds.

5. Operate the heater to check dependability and replace the access panels.

13-38. IGNITION UNIT. This unit converts 28 volt dc to high voltage, oscillating current capable of producing a continuous spark gap in the combustion chamber of the heater. This unit remains energized and produces a continuous spark during heater operation. It contains a condenser, resistor, radio noise filter and vibrator socket. It also has an externally mounted vibrator and ignition coil.

13-39. IGNITION UNIT REMOVAL AND INSTALLATION.

a. Removal. (Refer to Figure 13-14.)

NOTE

Make sure the heater electrical circuits are de-energized.

1. Disconnect the primary wire from the primary terminal of the ignition assembly.
2. Carefully unscrew and disconnect the high-voltage ignition cable at the spark plug. Exercise care to avoid fouling or damaging the connector.
3. Remove the four attaching screws and lift the ignition assembly off the heater jacket.

b. Installation. (Refer to Figure 13-14.)

1. Place the ignition assembly in position on the heater jacket, with the high-voltage cable facing the spark plug end of the heater.
2. Install the four screws. Tighten the screws securely.
3. Carefully connect the high-voltage lead to the spark plug. (Refer to Paragraph 13-37 d.)
4. Connect the primary lead to the primary terminal on the ignition assembly and tighten the nut securely.
5. Check for proper heater operation.

13-40. TESTING IGNITION UNIT. The ignition unit does not require complete overhaul. The following test will indicate whether or not the unit is operational and whether the vibrator should be replaced before reinstallation in the aircraft. The following equipment is required to test the components.

a. A battery that will supply power at approximately 28 volts dc.

b. A voltmeter with a range of 0-30 volts.

c. A lead from the battery to the test fixture in which is included an ammeter with a range of 0-3 amperes and a normally open, momentary-closed switch. The total resistance of the lead, including the ammeter and switch must not exceed 0.3 ohms.

d. A spark gap of 0.187 inch. A convenient means of arranging the correct spark gap is to install a spark plug, P/N 39D18 in a test fixture arranged to provide a ground electrode and a .187 inch spark gap. (Refer to Figure 13-9 for information on fabricating this fixture.

NOTE

Any one of several spark plugs may be used with the spark plug fixture detailed in Figure 13-9.. However, the "A" dimension in that sketch must be varied with the length of spark plug electrode to provide a gap of .187 inch for all spark plugs.

CAUTION

When testing an ignition unit, do not use a screwdriver as a substitute for a spark plug and spark plug fixture.

e. The high tension shielded ignition lead between the ignition unit and the spark plug is a part of the cover assembly.

f. Arrange the test equipment as shown in Figure 13-10.

13-41. OPERATIONAL TEST OF IGNITION UNIT

a. Close the momentary switch and read the voltmeter and ammeter. Release the momentary switch immediately.

b. The amperage reading at 28 volts dc must be 1.25 ± 0.25 amperes.

13-42. VIBRATOR. The vibrators should be replaced after 250 hours of operation. This schedule applies equally to vibrators installed in new units as well as new vibrators installed in ignition units that have been in service.

13-43. VIBRATOR REMOVAL AND INSTALLATION. (Refer to Figure 13-12.)

a. Remove safety wire on the clamp assembly (6) and loosen clamp assembly thumb screw. On models without clamp assembly (6) simply remove the hose type clamp (18).

b. Remove the vibrator (7) from the ignition unit, it may require a slight back-and-forth movement to remove it from the unit. A piece of masking or friction tape around the exposed portion of the vibrator will help to grip the vibrator for removal.

c. Install the new vibrator with the index marks aligned. The connector pins on the vibrator can be felt entering the pin sockets in the vibrator socket, then press the vibrator fully and firmly into position.

d. Replace the clamp assembly (6) and tighten the thumb screw and install safety wire. On models without clamp assembly (6) simply install hose type clamp (18).

NOTE

If replacement of vibrator fails to correct operational failure, further disassembly and inspection may be required.

13-44. DISASSEMBLY OF IGNITION UNIT. (Refer to Figure 13-12.)

a. Remove cover assembly by removing screws.

b. Remove ignition cable terminal from ignition coil.

c. All replaceable items are now accessible for checking without further disassembly from the ignition box.

13-45. INSPECTION. Inspect components as directed in Table XIII-II below; and Figure 13-12.

13-46. ASSEMBLY OF IGNITION UNIT. Replace any component that fails to meet tests listed in Table XIII-II.

CAUTION

When installing cover assembly (1), the ignition cable terminal must seat into the opening of the ignition coil (11).

Replace cover assembly (1) to ignition box (15) and secure with screws (2).

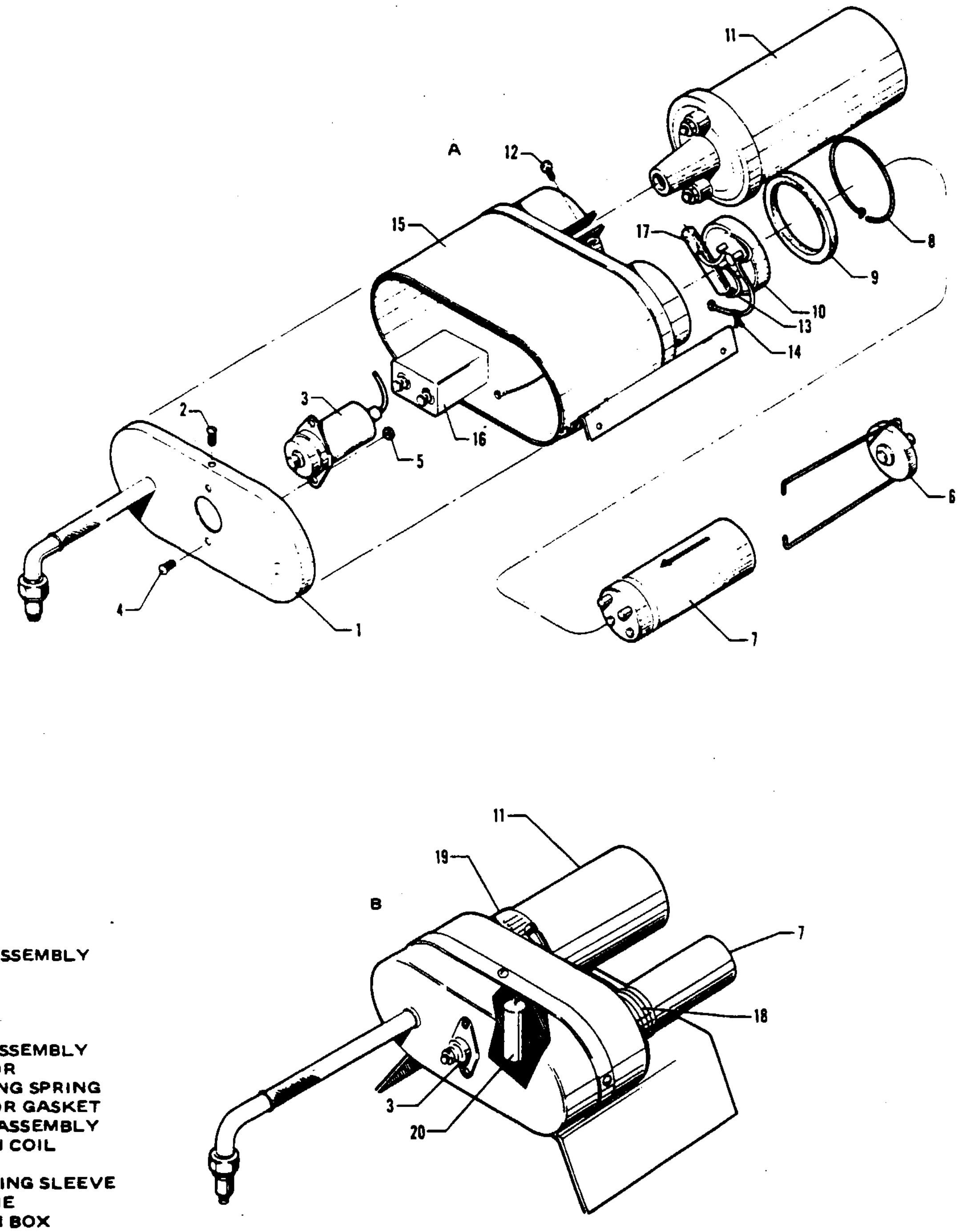
13-47. LIMIT (OVERHEAT SAFETY) SWITCH. (Refer to Figure 13-14 or 13-14a.)

a. Removal.

1. If the limit switch (item 7 in Figure 13-14 or item 5 in Figure 13-14a) is damaged or defective, disconnect the two electrical leads from the switch terminals. Be sure to mark the leads for proper reassembly. (The switch terminals are identified by numbers "1," "2," and "3.")

2. Remove the attaching hardware and lift the limit switch and gasket from the jacket opening.

1303



1. COVER ASSEMBLY
2. SCREW
3. FILTER
4. SCREW
5. NUT
6. CLAMP ASSEMBLY
7. VIBRATOR
8. RETAINING SPRING
9. VIBRATOR GASKET
10. SOCKET ASSEMBLY
11. IGNITION COIL
12. SCREW
13. INSULATING SLEEVE
14. CABLE TIE
15. IGNITION BOX
16. CONDENSER
17. RESISTOR
18. CLAMP
19. CLAMP
20. CONDENSER

Figure 13-12. Ignition Unit Assembly

TABLE XIII-II. INSPECTION (See Figure 13-12)

Index No.	Nomenclature	Inspection
1	Cover Assembly	Inspect for security of lead assembly to cover. Ignition cable, grommet. terminal and connector for carbon tracks, cracks or distortion. Repair or replace for any of above conditions.
3	Filter	Inspect terminal for thread damage, and lead for breakage. Check filter for open or short circuit conditions. Capacity of filter should be 2.0 MFD ± 10%. Replace filter, if it fails to meet any one of the above conditions.
17	Resistor	Inspect resistor (component of socket assembly) for broken leads and open circuit. Replace for either condition.
11	Ignition Coil	Inspect for broken bakelite, carbon tracks, oil leaks, and dents in coil cover. Replace for any of the above conditions.
16	Condenser	Inspect for oil leakage or broken terminals. Check condenser for open or shorted condition. Capacity of condenser should be 0.5 MFD. Replace if condenser fails to meet above conditions.

b. Installation.

1. Install the limit switch and gasket. Gasket is installed one or two each per existing installation and secured with attachment hardware.

2. Tighten screws securely; then reconnect the electrical leads in accordance with markings made during disassembly. (If in doubt about electrical connections, refer to the wiring diagram, Figure 13-6.)

13-47a. CYCLING SWITCH. (Refer to Figure 13-4a.)

a. Removal.

If the switch is damaged or defective, disconnect the electrical leads, being sure to mark them for proper reassembly. Remove the two screws (10), lock washers (9), and plain washers (8) and lift the cycling switch (6), gasket (5), and switch plate (7) from the top of the duct (4).

b. Installation.

Install the cycling switch (6), gasket (5), and switch plate (7) by placing in position on the heat duct opening and securing with the two screws (10), lock washers (9) and plain washers (8). Tighten screws securely then reconnect the electrical leads to their respective terminals as marked during disassembly.

NOTE

No attempt should be made to repair either the limit switch or the cycling switch. If they do not operate properly, they should be replaced. (Refer to Paragraph 13-66 test instructions.)

13-48. COMBUSTION AIR PRESSURE SWITCH. (Refer to Figure 13-14 or 13-14a.)

a. Removal.

1. Disconnect electrical leads from the terminals of the combustion air pressure switch (item 20 in Figure 13-14 or item 17 in Figure 13-14a), being sure to mark them for proper reassembly. Disconnect the tube from the switch cap. Exercise caution not to exert excessive bending of the tube. (It is "tacked" to the combustion chamber inside the jacket.)

2. Unscrew and remove the combustion air pressure switch from the fitting on the combustion air inlet tube.

b. Installation.

1. Install the combustion air pressure switch (item 20 in Figure 13-14 or item 17 in Figure 13-14a) by rotating it on the threaded fitting of the combustion air inlet tube and tighten it securely. Exercise caution not to over-torque the switch as this could change the setting.

2. Connect electrical leads to their respective terminals in accordance with markings made during removal. If in doubt regarding proper connections, refer to wiring diagram, Figure 13-6. Connect the tube to the switch cap.

3. Check for proper heater operation.

13-49. FUEL REGULATOR AND SHUTOFF VALVE. (Refer to Figure 13-5.)

a. Removal.

1. Disconnect the electrical lead from the valve.

2. Disconnect the fuel lines from the inlet openings. Make note of these connections for correct installation.

3. Remove the two attaching screws to free the unit from its mounting.

b. Adjustment. The fuel regulator and shutoff valve used in this system are adjustable but not repairable. The following steps cover the proper adjustment of this unit.

1. Install the regulator in a test stand similar to that shown in Figure 13-13.

2. Install a 2.5 gph nozzle (Janitrol Part No. D08D09). Stoddard solvent can be used for testing. Do not use gasoline due to explosion and fire hazard.

3. Apply a fluid pressure of 20 to 30 psi and energize the solenoid.

4. Using a screwdriver, break the adjustment seal and adjust the regulated outlet pressure as close to 7.5 psi as possible. (Turn clockwise to increase pressure; counterclockwise to decrease pressure.)

5. Slowly vary the inlet pressure from 10 to 50 psi. The outlet pressure should remain between 7.0 and 8.0 psi.

6. With the inlet pressure of 50 ± 3 psi de-energize and energize the solenoid at least twice. The outlet pressure should be 7.0 to 8.0 psi with solenoid energized and when the solenoid is de-energized the pressure should drop to zero and the fuel flow from the nozzle should stop.

7. With solenoid energized, slowly reduce inlet pressure from 50 to 10 psi. Outlet pressure should remain between 7.0 and 8.0 psi.

8. During the above tests, observe for signs of external leakage. Any leakage is cause for rejection of the regulator. After satisfactory adjustment has been made, apply Glyptol around threads of the adjustment screw and in the slot.

c. Installation.

1. Attach the fuel regulator and shutoff valve to its mounting with the two attaching screws.

2. Place the fuel regulator and shutoff valve into position between the fuel line connections and tighten all connections securely.

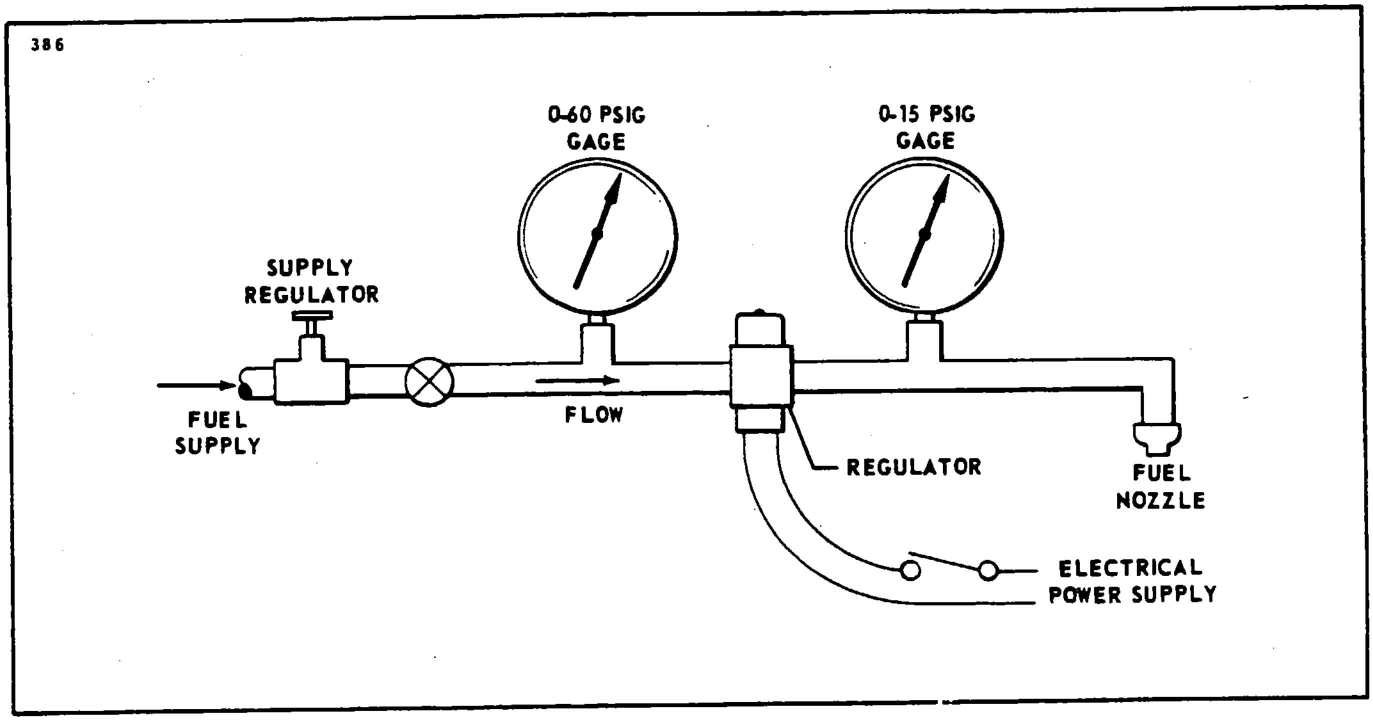


Figure 13-13. Test Setup - Fuel Regulator

3. Connect the electrical lead. Be sure to slide an insulating sleeve (or tape) over the connection to avoid a short circuit and secure the sleeve in place.

4. Operate the heater to make sure the unit is functioning properly.

13-50. OVERHAUL INSTRUCTIONS. After 500 heater hours or after each heating season, whichever comes first, the heater should be removed from the airplane, disassembled and all parts thoroughly inspected and any necessary repairs and replacements made prior to reassembly. Detailed step by step instructions are provided for a complete heater overhaul. In some instances, however, inspection may reveal that it is unnecessary to remove certain parts, and, if so, those portions of the overhaul procedures may be eliminated.

NOTE

For disassembly and reassembly operations, refer to the exploded-view drawings and parts list.

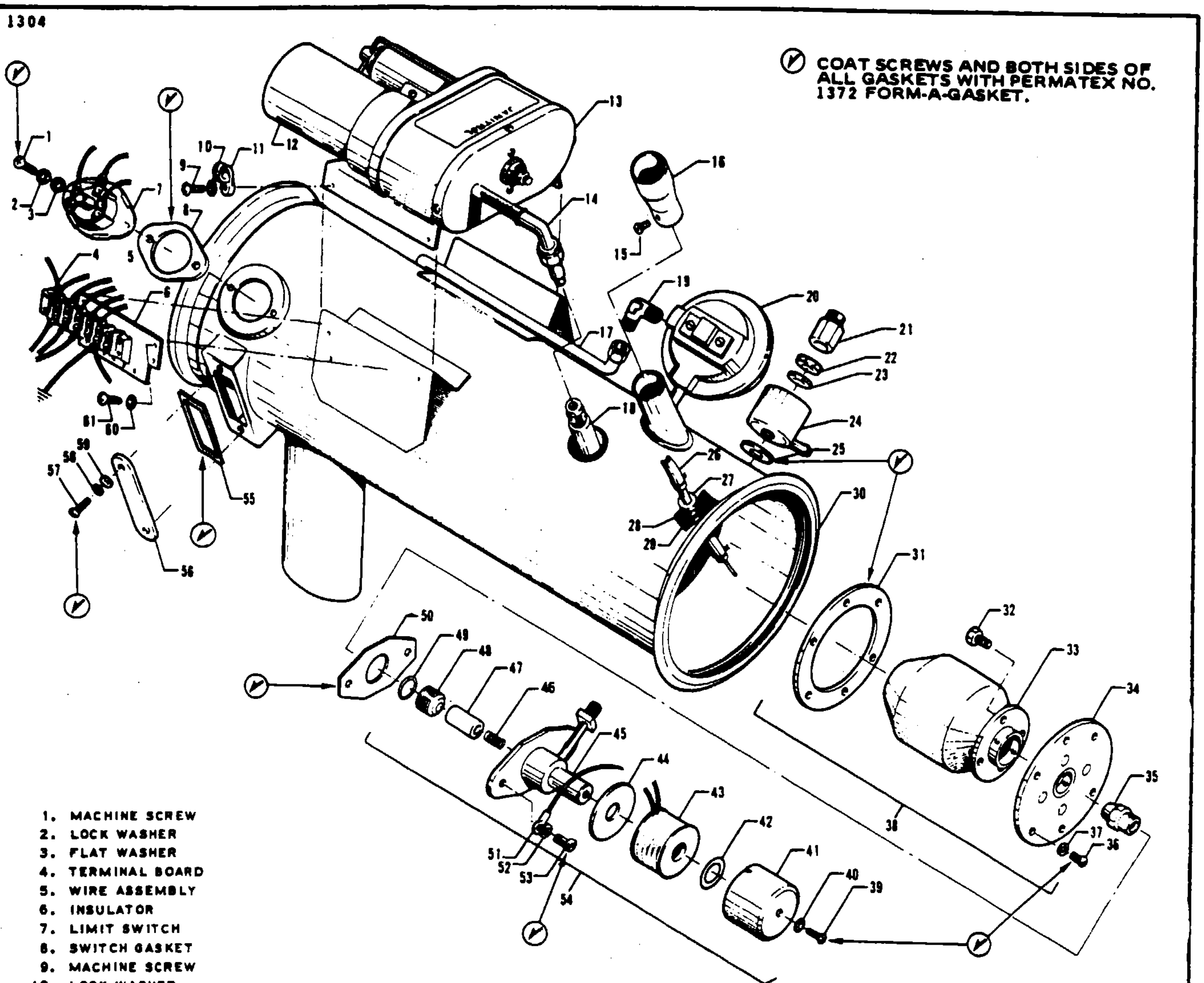
13-51. DISASSEMBLY OF HEATER. (Refer to Figure 13-14 or 13-14a.)

a. Disassemble the 47D65 heater in the general sequence of the index numbers in Figure 13-14. Pay special attention to the following instructions:

NOTE

Label all wires prior to removal, so they can be replaced properly at reassembly.

1. Remove the two screws (1), lock washers (2), flat washers (3), and lift out the limit switch (7) and gasket (8).



1. MACHINE SCREW
2. LOCK WASHER
3. FLAT WASHER
4. TERMINAL BOARD
5. WIRE ASSEMBLY
6. INSULATOR
7. LIMIT SWITCH
8. SWITCH GASKET
9. MACHINE SCREW
10. LOCK WASHER
11. CABLE STRAP
12. COIL (IGNITION)
13. IGNITION ASSEMBLY
14. HIGH TENSION LEAD
15. MACHINE SCREW
16. ADAPTER
17. TUBE (COMBUSTION AIR SWITCH)
18. SPARK PLUG
19. ELBOW
20. COMBUSTION AIR SWITCH
21. FITTING
22. NUT
23. GASKET
24. SHROUD
25. GASKET
26. SLEEVE
27. TERMINAL
28. LOCK WASHER
29. NUT
30. COMBUSTION TUBE AND JACKET ASSEMBLY
31. HEAD GASKET
32. MACHINE SCREW
33. HEAD ASSEMBLY
34. HEAD PLATE ASSEMBLY
35. SPRAY NOZZLE
36. MACHINE SCREW
37. LOCK WASHER
38. COMBUSTION HEAD ASSEMBLY
39. MACHINE SCREW
40. LOCK WASHER
41. SHELL COVER
42. PREFORMED PACKING
43. SOLENOID COIL ASSEMBLY
44. BASE PLATE
45. VALVE ASSEMBLY
46. SPRING
47. PLUNGER
48. SEAT
49. PREFORMED PACKING
50. GASKET
51. WIRE ASSEMBLY
52. LOCK WASHER
53. MACHINE SCREW
54. FUEL FEED, NOZZLE HOLDER AND SOLENOID VALVE ASSEMBLY
55. GASKET
56. COVER PLATE
57. MACHINE SCREW
58. LOCK WASHER
59. FLAT WASHER
60. LOCK WASHER
61. MACHINE SCREW

Figure 13-14. Heater Assembly (47D65) Exploded View

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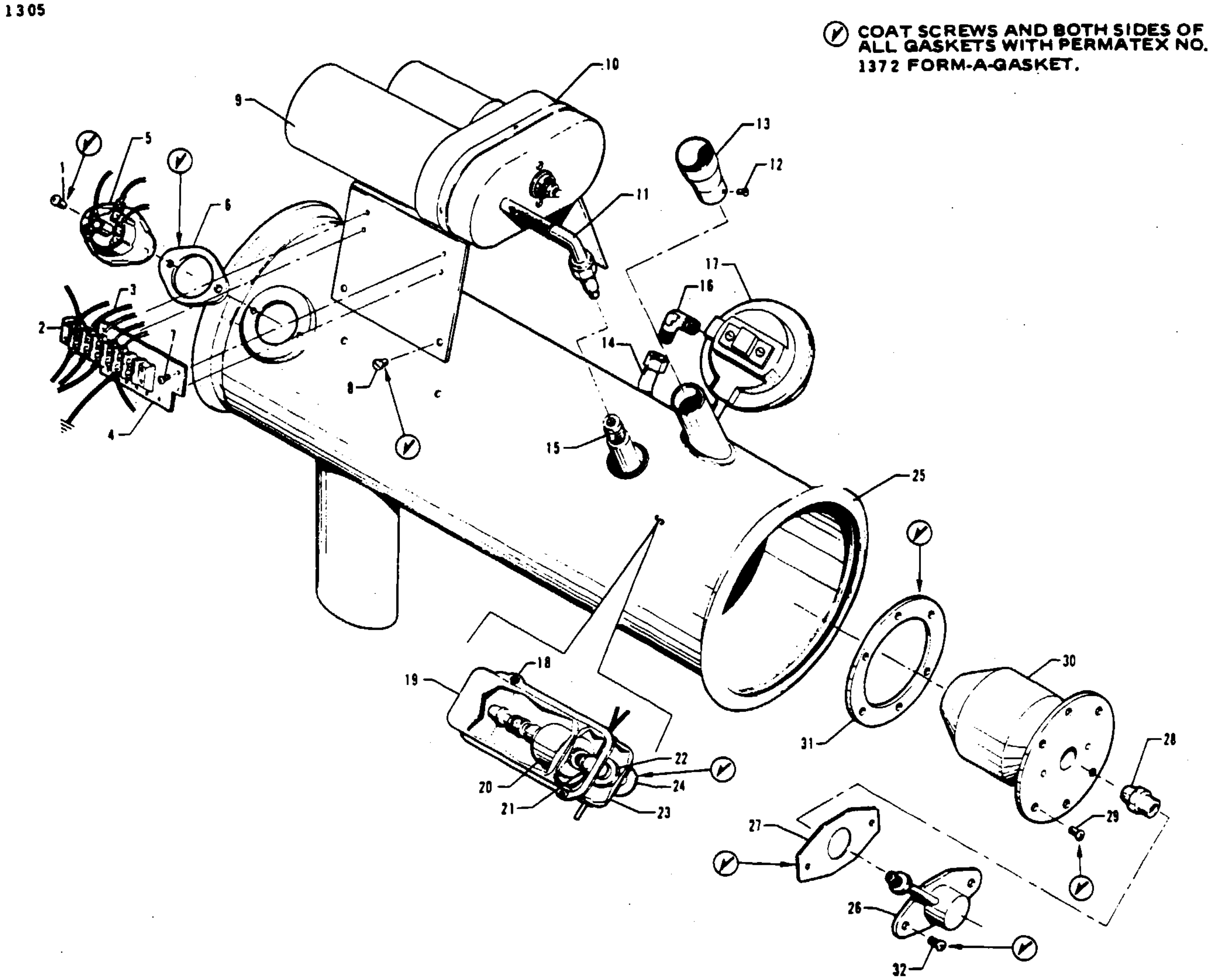


1. SCREW
2. TERMINAL BOARD
3. WIRE ASSEMBLY
4. INSULATOR
5. LIMIT SWITCH
6. SWITCH GASKET
7. SCREW
8. MACHINE SCREW
9. COIL (IGNITION)
10. IGNITION ASSEMBLY
11. HIGH TENSION LEAD
12. MACHINE SCREW
13. ADAPTER
14. TUBE (COMBUSTION AIR SWITCH)
15. SPARK PLUG
16. ELBOW
17. COMBUSTION AIR SWITCH
18. SCREW
19. COVER, UPPER
20. SOLENOID
21. ELBOW
22. NUT
23. COVER, LOWER
24. GASKET AND WASHER
25. COMBUSTION TUBE AND JACKET ASSEMBLY
26. FUEL FEED AND NOZZLE HOLDER ASSEMBLY
27. GASKET
28. SPRAY NOZZLE
29. MACHINE SCREW
30. COMBUSTION HEAD ASSEMBLY
31. HEAD GASKET
32. MACHINE SCREW

Figure 13-14a. Heater Assembly (47D65-1) Exploded View

2. To remove the terminal board (4) and insulator (6) from the combustion tube and jacket assembly (30), remove the four screws (61) and lock washers (60).

3. Disconnect and remove electrical wiring and individual wires from the various components on the heater. It is advisable to remove wire harness assembly intact.

4. Remove the four screws (9), lock washers (10) and cable straps (11) to free the ignition assembly (13) from the combustion tube and jacket assembly (30). (Refer to Paragraph 13-46 for ignition unit overhaul.)

5. Carefully disconnect the high-voltage ignition lead at the spark plug. Handle the spring connector on the end of this lead with care to prevent fouling or damage.

6. Remove the machine screw (15) and slide the adapter (16) off the combustion air inlet tube.

7. Remove the spark plug (18) using a 7/8 inch deep socket. Make sure the spark plug gasket is removed.

8. Disconnect the combustion air switch tube (17) from the elbow (19) on the combustion air switch (20) and remove the combustion air switch from the combustion air inlet tube.

9. Remove the fitting (21) and nut (22) with a 3/4 inch deep socket. This will free the shroud (24) and gasket (25).

10. Remove the two screws (53) and lock washers (52) and disconnect the electrical wire to terminal (27). Carefully take the fuel feed, nozzle holder and solenoid valve assembly (54) out of the combustion head. Handle this assembly carefully to avoid damaging the nozzle (35). Also remove the gasket (50).

11. Carefully unscrew and remove the spray nozzle (35) from the fuel feed, nozzle holder and solenoid valve assembly (54). Remove the O-ring (49). Do not disassemble the valve assembly (45) unless it requires cleaning.

CAUTION

Handle the nozzle with care to avoid damage to the tip. The material around the orifice is very thin, and any blow on the face of the nozzle can distort the spray pattern or effect the burning rate. This, in turn can cause malignition or improper combustion.

12. Remove six screws (36) with lock washers (37) that attach the combustion head assembly (38) to the combustion tube and jacket assembly (30) and lift out of combustion tube. Do not disassemble the head plate (34) from the head (33) unless there is damage to one of the parts.

13. Remove the screw (39), lock washer (40), cover (41) and preformed packing (42). Then carefully slide the solenoid coil (43) off the valve assembly (45). It is not necessary to remove the base plate (44) unless it is warped.

b. Disassemble the 47D65-1 heater in the general sequence of the index numbers in Figure 13-14a. Special attention should be given to the following instructions:

NOTE

Label all wires prior to removal, so they can be replaced properly at reassembly.

1. Remove the two screws (1), lift out the limit switch (5) and gaskets (6).

2. To remove the terminal board (2) and insulator (4) from the ignition bracket, remove the two screws (7).

3. Disconnect and remove electrical wiring and individual wires from the various components on the heater. It is advisable to remove wire harness assembly intact.

4. Remove the four screws (8) to free the ignition assembly (10) from the combustion tube and jacket assembly (25). Refer to Paragraph 13-46 for ignition unit overhaul.

5. Carefully disconnect the high-voltage ignition lead at the spark plug. Handle the spring connector on the end of this lead with care to prevent fouling or damage.

6. Remove the machine screw (12) to remove the adapter (13) from the combustion air inlet tube.

7. Disconnect the combustion air switch tube (14) from the elbow (16) on the combustion air switch (17) and remove the combustion air switch from the combustion air inlet tube.

8. Remove the spark plug (15) using a 7/8 inch deep socket. Make sure the spark plug gasket is removed.

9. Remove the cover screws (18) and upper cover (19).

10. Disconnect solenoid (20), elbow (21) and nut (22). This will free the lower cover (23) gasket and washer (24).

11. Carefully take the fuel feed and nozzle holder assembly (26) off the combustion head. Handle this assembly carefully to avoid damaging the nozzle (28). Also remove the gasket (27).

12. Carefully unscrew and remove the spray nozzle (28) from the fuel feed and nozzle holder assembly (26).

CAUTION

Handle the nozzle with care to avoid damage to the tip. The material around the orifice is very thin, and any blow on the face of the nozzle can distort the spray pattern or effect the burning rate. This, in turn can cause malignition or improper combustion.

13. Remove six screws (29) that attach the combustion head assembly (30) to the combustion tube and jacket assembly (25) and remove the combustion head assembly.

13-52. CLEANING OF COMBUSTION TUBE AND JACKET ASSEMBLY.

a. The inside of the combustion chamber and radiator can be cleaned by filling it with Oakite M-3 Stripper Solution and allowing it to soak overnight. This will require closing the combustion air, exhaust and drain openings with tight-fitting metal caps to retain the Oakite Solution. The solution is made by mixing one pound of Oakite with each gallon of water used; and should be maintained at 190 degrees Fahrenheit to 210 degrees Fahrenheit during the soaking period. Be sure to rinse the heater thoroughly with water after soaking.

CAUTION

Do not submerge the combustion chamber, radiator and jacket assembly in the Oakite solution, as this will destroy the non-removable gasket at the exhaust outlet opening in the jacket.

b. A sandblast cleaner or a stainless steel brush may also be used to clean the inside of the combustion chamber. After sandblasting or brushing, be sure to remove all sand or loosened foreign material.

CAUTION

Do not use an ordinary steel brush, as it may cause corrosion.

c. Wipe the outside of the jacket with a cloth dampened in dry-cleaning solvent and follow up with a clean, dry cloth.

13-53. INSPECTION OF COMBUSTION CHAMBER AND JACKET.

a. Since the outer jacket is not removable, inspection of the combustion chamber is limited. Minor cracks or pin holes can be detected in the leakage test outlined in Paragraph 13-56. The following information should be useful in attempting to evaluate a damaged combustion chamber.

b. Damage to the combustion chamber and radiator can be classified as soft and spongy metal as a result of overheating, deformation as a result of overheating or backfiring, fatigue cracks, and pin holes.

NOTE

A heater showing damage due to overheating has been operating in a system where some control is not functioning correctly. Be sure to check all components of the heating system before placing the heater back into service.

c. Soft and spongy metal can be detected by tapping lightly with a ball-peen hammer on the downstream end of the combustion tube. Soft spots will produce a dull sound in contrast to the solid ringing response obtained when tapping on live metal. If soft spots are found, the combustion chamber and jacket assembly should be replaced.

d. Deformation as a result of backfiring usually will distort the wall of the radiator near the crossover passages. This will be accompanied by evidence of extreme oxidation and is sufficient reason for replacement of the assembly.

13-54. INSPECTION OF REMAINING COMPONENTS.

a. Discard all rubber parts such as grommets, gaskets, and "O" rings. Always replace these items at overhaul.

b. Inspect all wires for damaged terminals, and for chafed, cracked or otherwise damaged insulation. Individual wires can be replaced by making them up from No. 16 AWG stock, cut to correct length, with terminals installed by means of an acceptable crimping tool. Do not use solder for heater wiring connections.

c. If heater controls were operating correctly prior to overhaul, reinstall them.

d. Inspect all hardware parts such as bolts, screws, nuts, washers, and lock washers. Replace damaged parts.

e. Inspect the terminal board for signs of damage, such as distortion or cracks. Replace if either exists.

f. Inspect the spray nozzle with a magnifying glass. The nozzle can be disassembled for cleaning. Remove the screen and wash in cleaning solvent if dirt is found on the screen. Look for any obstructions in the nozzle orifice and any sign of damage to the slight conical protrusion at the nozzle tip. There should be no evidence of any metal object having come into contact with it. Use compressed air to remove obstructions and re-examine to be sure the orifice is open. Do not under any circumstances press or rap on the tip face. After cleaning, store the nozzle in a polyethylene bag until ready for reassembly. If there is any sign of damage or distortion, replace the nozzle.

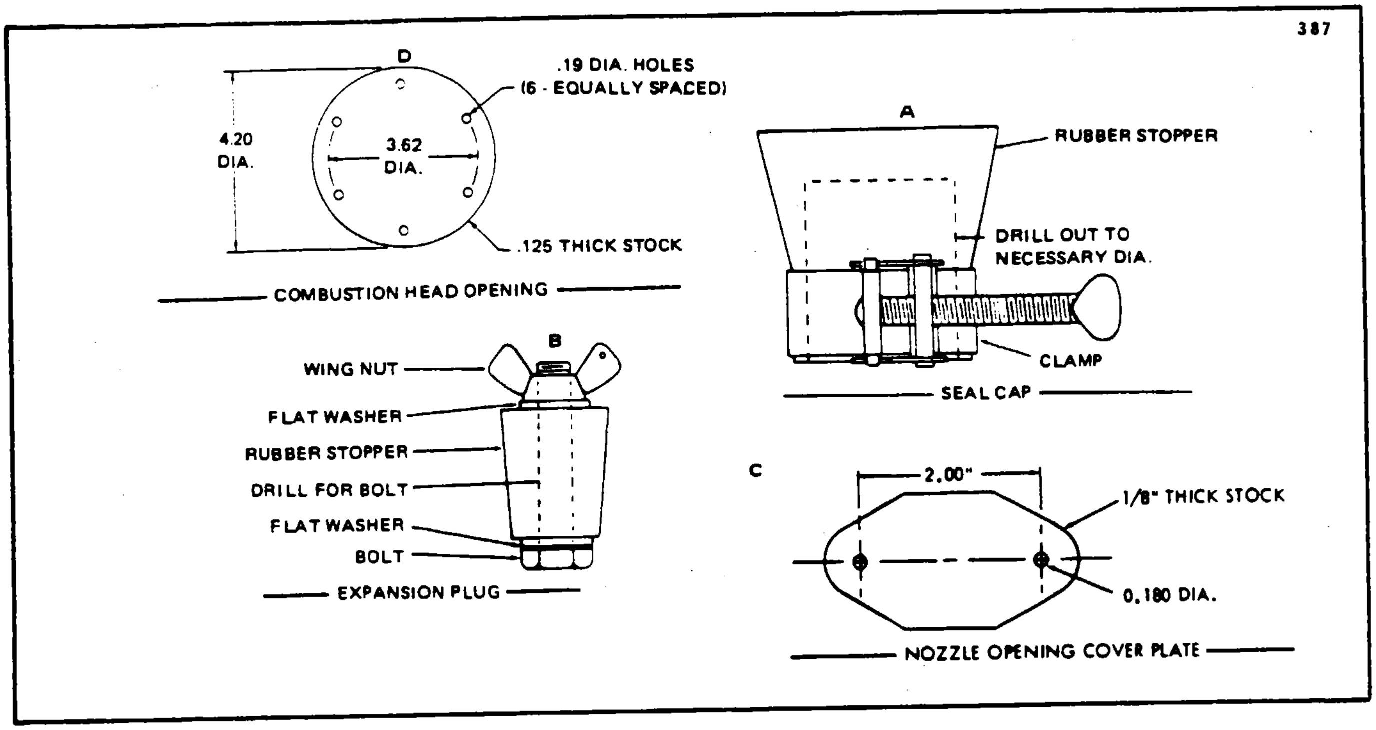


Figure 13-15. Plugs And Caps For Combustion Tube Leak Test

g. On 47D65 heaters per Figure 13-14 inspect the fuel feed, nozzle holder and solenoid valve assembly (54) for damaged threads at the fuel line fitting, and for a crimped or cracked fuel line or distorted housing. Check the solenoid for continuity by reading the resistance across the two leads with an ohmmeter. A reading of 75 to 85 ohms at room temperature is normal. If reading is not between these limits, or if the solenoid windings show signs of physical damage or overheating, replace it. Replace preformed packing (42 and 49).

On 47D65-1 heaters per Figure 13-14a inspect the fuel feed, nozzle holder assembly (26) for damaged threads at the fuel line fitting, and for a crimped or cracked fuel line or distorted housing. Check the fuel solenoid for continuity by reading the resistance across the two leads with an ohmmeter. A reading of 100 to 125 ohms at room temperature is normal. If the reading is not between these limits, replace the solenoid.

h. The combustion air pressure switch must respond to delicate pressure changes and should always be checked and/or replaced at overhaul. (Refer to Paragraph 13-60 and Figure 13-16.)

13-55. TESTING.

13-56. COMBUSTION TUBE AND JACKET ASSEMBLY. Test the combustion tube (30) for leaks as follows:

a. Fashion a sealing plate from approximately .125 inch thick flat stock to seal the opening in the combustion tube assembly. (See Figure 13-15.) Use a rubber gasket under the plate and attach the plate with six screws.

b. Make up seals for all remaining openings, except the one used to connect the air pressure source. (See Figure 13-15.) Use rubber stoppers as shown. The combustion air inlet tube can be sealed best with a drilled stopper and clamp. Other openings should be sealed with expansion plugs. The seal used in the exhaust tube should be formed so that it will not deform the air pressure switch tube which protrudes into the exhaust.

c. See that all openings except the combustion air pressure switch connection are plugged. This is the most convenient connection for attaching the test air pressure source.

d. Connect a regulated air pressure supply to the opening that has not been plugged. Apply a pressure of three to five psi to the combustion tube.

e. Submerge the assembly in water for several minutes, while watching for bubbles that would indicate leaks. Turn the combustion tube in the water, so that any entrapped bubbles will be freed. Bubbles will indicate leaks. Small leaks, if accessible can be repaired. (Refer to Paragraph 13-59.)

13-57. FUEL FEED AND NOZZLE HOLDER ASSEMBLY. Test the fuel feed, nozzle holder assembly as follows:

a. Using filtered compressed air, apply 20 psi to drain port, located on the surface of the valve assembly near the threaded nozzle cavity.

b. Immerse the assembly in clean water, with the fuel inlet and the nozzle cavity left open. Use a short piece of tubing to keep the fuel inlet open.

c. Observe for air bubbles, which would indicate leakage. If bubbles appear at either the nozzle cavity or fuel inlet, there is a leak in the fuel tube. If bubbles appear externally at either end of the shroud tube, the shroud tube is leaking.

d. In either of the above cases, the complete fuel feed and nozzle holder assembly must be replaced.

e. If no leaks are found, dry the assembly carefully with compressed air.

13-58. NOZZLE SPRAY TEST. Spray test the nozzle as follows:

a. Install the nozzle in the fuel feed, nozzle holder assembly as described in Paragraph 13-62, and connect the fuel tube including solenoid valve to a source of fuel capable of delivering the fuel at 7.0 psi.

b. Connect the solenoid leads to a 24-volt battery, with a switch in one of the leads to open and close the solenoid when desired.

c. With the solenoid energized and the fuel line connected, observe the spray pattern. It should be conical in shape, with even dispersion in all directions.

WARNING

To avoid the danger of fire, use Stoddard solvent and be sure to keep the atomized spray away from flame.

d. Energize and de-energize the solenoid several times. The spray should shut off completely each time the solenoid is de-energized. There should be no sign of dribbling at the nozzle tip in excess of one or two drops.

e. If the spray pattern is distorted, check for an obstruction and clean the nozzle as described in Paragraph 13-54. If this fails to provide a normal spray pattern, replace the nozzle.

f. If the nozzle continues to dribble, the solenoid valve is not closing properly. Replace the fuel feed and nozzle holder assembly on 47D65 heater assembly or solenoid on 47D65-1 heater assembly.

13-59. REPAIR OF COMBUSTION TUBE.

a. If welding is attempted, clean the area thoroughly with a stainless steel brush.

CAUTION

Do not use a brush with ordinary steel bristles, as it would cause subsequent damage to the metal.

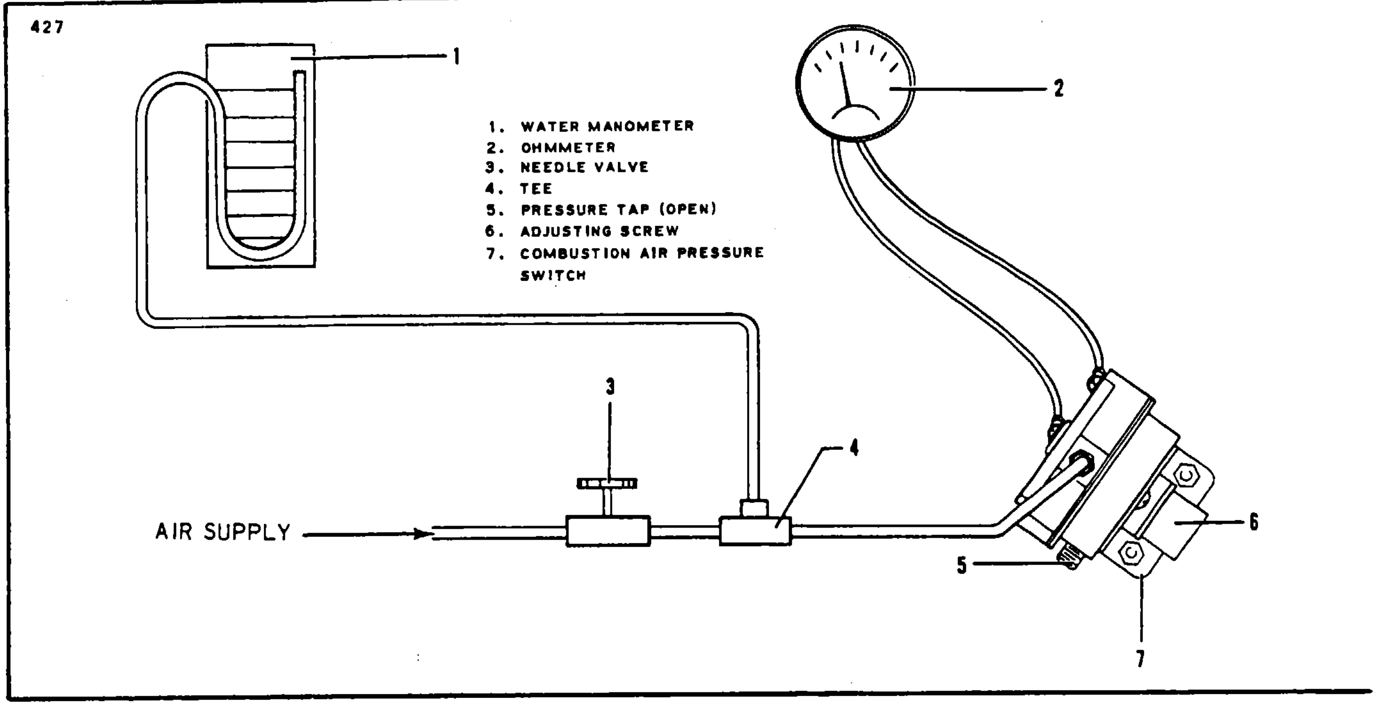


Figure 13-16. Test Setup - Combustion Air Pressure Switch

b. Wipe the area to be welded with a 30-percent solution of nitric acid, then weld with stainless stee rod (SAE Type 309, using Solar No. 16GH flux), if the welding is done with an acetylene torch. If th Heliarc method is used, use either Solar Type I or Type B flux. If a stainless steel rod is not available, piece of clean scrap heater combustion tube may be used as repair material. Make sure severe weldin stresses are not present after welding.

NOTE

After welding, test the combustion tube for leaks as outlined in Paragraph 13-56.

13-60. TESTING COMBUSTION AIR PRESSURE SWITCH. (Refer to Figure 13-16.)

a. Connect an adjustable air pressure line that can be controlled in a range of zero to 5.0 ± 0.: inches of water, to the switch opening with a water manometer and needle valve in the line ahead of th switch. Switch must be tested in the same position as installed in the airplane.

b. Connect an ohmmeter across the switch terminals to determine the exact instant of switcl closing.

c. Apply air pressure, slowly allowing it to build up from zero. The switch contacts should close a: 0.5 ± .1 inches of water which will be indicated on the manometer.

NOTE

The switch has a differential pressure tap and this opening must be left open to atmosphere during the test.

d. Make several trials to insure switch reliability. Be sure to increase and decrease the air pressure slowly in order to produce accurate indications.

e. If an adjustment is required, rotate the adjusting screw clockwise to increase and counterclockwise to decrease settings.

13-61. RECIRCULATING FAN AND COMBUSTION AIR BLOWER TEST. The following tests should be performed as outlined in the succeeding paragraphs.

a. Check recirculating air and combustion air motors for correct RPM and current drain.

b. Connect either motor to a 24-volt DC power supply. Rotation should be counterclockwise when viewed from the shaft end.

c. The combustion air blower motor should rotate at approximately 7500 RPM at rated voltage. Current drain is approximately three amperes.

d. The recirculating fan motor should rotate at approximately 11,300 RPM at rated voltage. Current drain is approximately 12.5 amperes.

e. If current drain is excessive, or if speed is too low, replace the brushes. Recheck both current drain and RPM after brushes are properly run-in. (Refer to Paragraph 13-36.)

f. If, after replacing brushes, operation is still unsatisfactory, replace the motor.

NOTE

The motor checks described above for the combustion air motor should be made without the blower housing attached.

13-62. REASSEMBLY OF HEATER. (Refer to Figure 13-14 or 13-14a.)

a. For reassembly of the 47D65 heater, refer to Figure 13-14. When reassembling the heater use all new gaskets and O-rings. (Refer to Note on Figure 13-14 for screw and gasket coating.)

1. Reconnect the combustion air switch (20) to the combustion air inlet tube extending from the jacket assembly (30). Install the elbow (19) to the switch and connect the combustion air switch tube (17).

2. Install the terminal board (4) and insulator (6) on the combustion tube and jacket assembly (30) with four screws (61) and lock washers (61).

3. Install the limit switch (7) and gasket (8) to the jacket assembly, and secure with flat washers (3), lock washers (2) and screws (1).

4. Assemble the fuel feed, nozzle holder and solenoid valve assembly (54) by carefully sliding the solenoid coil (43) onto the valve assembly (45) and installing a new preformed packing (42), cover (41), lock washer (40) and securing the complete assembly with a machine screw (39).

5. Install the combustion head assembly (38) into the combustion tube and jacket assembly (30) being certain to align the spark plug holes. Secure the combustion head assembly (38) to the jacket with six lock washers (37) and machine screws (36). Leave the screws (36) loose at this time.

6. Install the spark plug (18) by screwing it into the threaded opening, making sure that the spark plug gasket is in position. Tighten to a torque of 28 foot-pounds, using a 7/8 inch deep socket wrench. Then tighten the six screws (36).

7. If the valve assembly (45) was disassembled, reassemble as follows: holding the plunger (47) upright, insert the spring (46). Install the valve body down over the plunger and spring. Turn this assembly upright and install the seat (48) and preformed packing (49).

8. Remove the spray nozzle (35) from the polyethylene. Screw the nozzle into the nozzle holder and tighten to 75 to 100 inch-pounds. It is very important to torque the nozzle to this valve, as incorrect tightening could cause improper heater operation and "drool." Over torque can cause nozzle core to become loose.

CAUTION

The spray nozzle is susceptible to damage if the face is contacted by any object which would alter the original contour of the face. If this happens, the nozzle must be replaced.

9. Install the fuel feed, nozzle holder and solenoid valve assembly (54) into the heater. Center the fuel inlet fitting in the hole in the jacket. Place the fuel fitting shroud gasket (25), and the shroud (24) on the fuel fitting, and install the gasket (23), nut (22) finger tight.

10. Connect the solenoid ground wire under one of the attaching screws (53). Tighten the two machine screws (53) and the nut (22) with a 3/4 inch deep socket and install the fitting (21).

11. Install the ignition assembly (13) on the heater with four lock washers (10) and screws (9) also install the cable straps (11).

12. Remove the spark plug (18) and adjust the spark gap in accordance with instructions given in Paragraph 13-37c.

13. Complete the assembly, being sure to install the wiring in the same locations and connected to the same terminals as before disassembly. Also slide the adapter (16) onto the combustion air inlet tube and secure with machine screw (15).

b. For reassembly of the 47D65-1 heater, refer to Figure 13-14a. When reassembling the heater use all new gaskets and O-rings. (Refer to Note on Figure 13-14a for screw and gasket coating.)

1. Reconnect the combustion air switch (17) to the combustion air inlet tube extending from the jacket assembly (25). Install the elbow (16) to the switch and connect the combustion air switch tube (14).

2. Install the terminal board (2) and insulator (4) on the ignition bracket with two screws (7).

3. Install the limit switch (5) and gaskets (6) to the jacket assembly, and secure with screws (1).

4. Install the combustion head assembly (30) into the combustion tube and jacket assembly (25) being certain to align the spark plug holes. Secure the combustion head assembly (30) to the jacket with six machine screws (29). Leave the screws (29) loose at this time.

5. Install the spark plug (15) by screwing it into the threaded opening, making sure that the spark plug gasket is in position. Tighten to a torque of 28 foot-pounds, using a 7/8 inch deep socket wrench. Then tighten the six screws (29).

6. Remove the spray nozzle (28) from the polyethylene. Screw the nozzle into the nozzle holder and tighten to 75 to 100 inch-pounds. It is very important to torque the nozzle to this value, as incorrect tightening could cause improper heater operation and "drool." Overtorque can cause nozzle core to become loose.

CAUTION

The spray nozzle is susceptible to damage if the face is contacted by any object which would alter the original contour of the face. If this happens, the nozzle must be replaced.

7. Install the fuel feed and nozzle holder assembly (26) and gasket (27) on the heater with two screws. Center the fuel inlet fitting in the hole in the jacket. Place the fuel fitting gasket (24), and lower cover on the fuel fitting, and install the washer and nut (22) finger tight. Insert a 3/4 inch open end wrench inside the jacket and hold the fuel tube fitting while tightening the nut (22) with a 3/4 inch deep socket wrench.

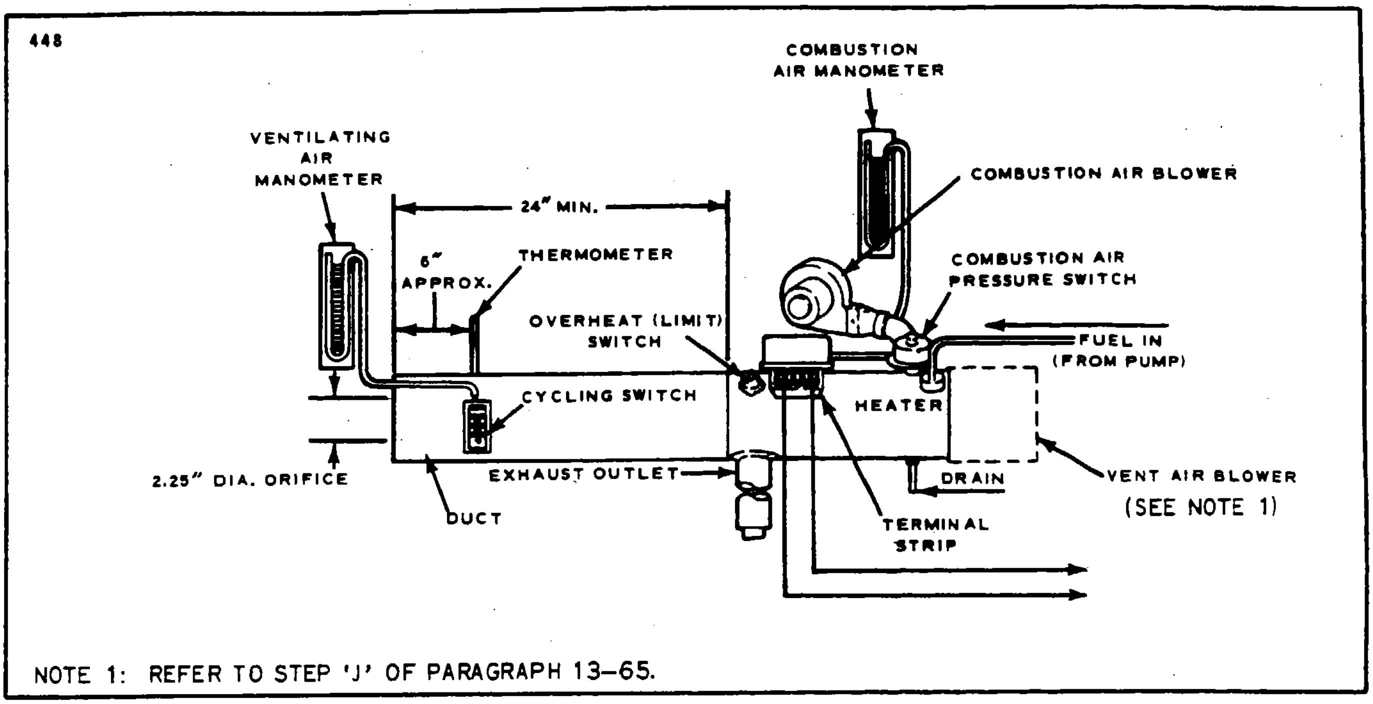


Figure 13-17. Suggested Setup For Heater Operation Test

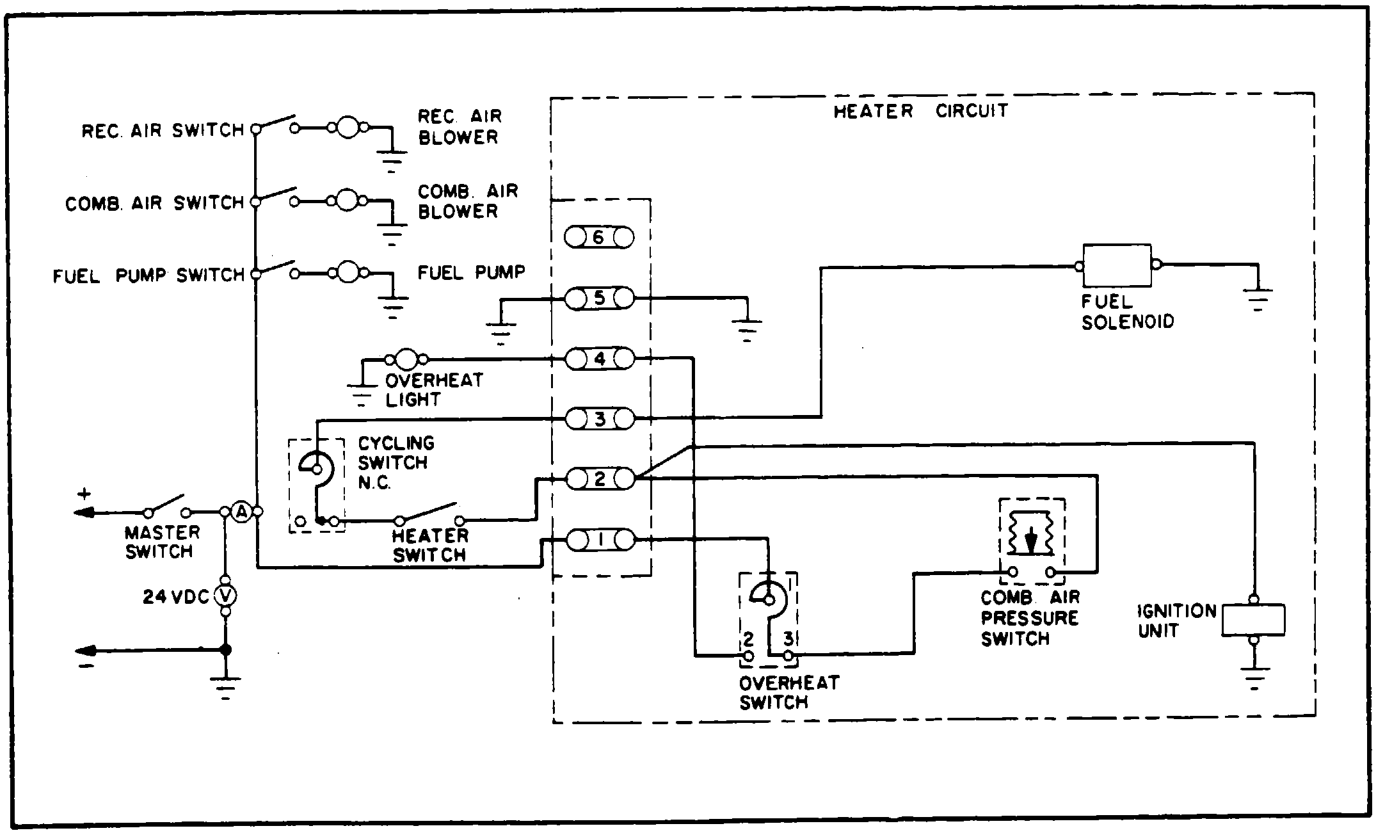


Figure 13-18. Suggested Wiring Connections For Heater Operation Test

8. Install elbow (21) and solenoid (20). Carefully pull solenoid lead wires through the hole in the cover (23) and install grommet.

9. Install ignition assembly (10) on the heater with two screws (8).

10. Remove the spark plug (15) and adjust the spark gap in accordance with instructions given in Paragraph 13-37c.

11. Complete the assembly, being sure to install the wiring in the same locations and connected to the same terminals as before disassembly. Also slide adapter (13) onto the combustion air inlet tube and secure with machine screw (12).

13-63. TEST PROCEDURE.

13-64. GENERAL INFORMATION. A test of all components should have been made after overhaul to insure proper operation. Some shops may not have complete testing facilities for measuring airflows, pressure drops and other factors which would be accomplished in a laboratory-type test. If such a test cannot be made, install the heater and check operation on the ground and in the air to determine if operation is normal. In shops where complete test equipment is available and a complete functional test can be performed, the test routine described in subsequent paragraphs should be made.

13-65. EQUIPMENT REQUIRED. (See Figure 13-17.)

a. An improvised stand to hold the heater during test. The heater should be located far enough away from any combustible material or atmosphere to avoid hazard. A location should be chosen where exhaust can be dispelled. Do not add an excessive extension to the heater exhaust.

b. A source of fuel capable of being regulated from 0 to 10 psi.

c. The combustion air blower to be used with the heater should be used for the test.

d. A 24-volt current supply, which may be a degenerator with a rheostat, ammeter and voltmeter in the line to control and indicate the current drain and voltage output.

e. Two water manometers (zero to 5.0 inch water column) for measuring the pressure in the ventilating air duct and in the combustion air stream.

f. A piece of duct to be attached to the downstream end of the heater. It should have a minimum length of 24 inches and the same diameter as the heater being tested. A 2.25 inch diameter orifice should be centrally located at the outlet end. An aperture should be provided for the thermometer and the cycling switch that is used with the heater (see Paragraph 13-47a), and a static tap should be attached as shown in Figure 13-17.

g. A thermometer with 500°F scale.

h. A fuel-pressure gauge 0 to 15 psi range.

i. A controlled source of compressed air for final leakage test.

j. Vent air blower capable of producing a reading on the ventilating air manometer of 2.6 inches of water.

13-66. OPERATIONAL TEST. (Refer to Figure 13-17 and 13-18.)

a. Install the heater into the test setup and check to be sure that all equipment is mounted, the electrical connections are tight, and mechanical connections are secure.

b. Close the master switch and individually check the operation of the recirculating fan, combustion air blower, and fuel pump.

c. Check to see that the pressure switch light is on. This shows that the combustion air blower is delivering sufficient air to close the air pressure switch.

d. Check the manometer connected to ventilating air pressure tap. It should show a reading of 2.2 to 2.6 inches of water at rated voltage.

e. The manometer connected to the combustion air pressure tap should show a reading of 1.5 inches of water (minimum) at rated voltage.

f. With the fuel pump switch closed, adjust the pump to 7.4 to 7.6 psi. Close the heater switch, the heater should ignite within five seconds. (This time may be slightly longer if air must be purged from the lines on the first trial.)

g. The cycling switch should operate to control the outlet air temperature at approximately 160 to 180 degrees Fahrenheit. This is dependent upon ambient temperature and airflow conditions. If switch operation is within this range the switch is operating normally. Replace the switch if it does not operate within this range. The switch is adjustable. To increase the temperature that the cycling switch is set to cut off, remove the sealant from the small adjusting screw and turn the screw counterclockwise. To decrease the cut-off temperature turn the screw clockwise. After adjustment seal the adjusting screw with Glyptal or equivalent.

h. The cycling switch can be removed from the circuit by means of a cycle switch bypass. Use of the bypass permits checking the operation of the overheat switch.

i. Restrict the ventilating air inlet and observe if the overheat switch shuts off the heater. The overheat light will indicate opening of the overheat switch. It should shut off not lower than 275 degrees Fahrenheit. This shut off temperature is also dependent upon ambient temperature and airflow. The overheat switch is not adjustable.

j. After the overheat switch shuts off, remove the ventilating air restriction. Open the cycle switch bypass. Push the manual reset button on the overheat switch and the heater should ignite and operate normally.

k. Shut down the heater test setup and check all components of the heater to be sure no damage has occurred in the test.

l. Remove the heater from the test setup and install it in the airplane, in accordance with instructions in Paragraph 13-19. Remove the cycling switch from the duct used in the test and install according to Paragraph 13-47a, Section b.

13-67. LEAKAGE TEST.

a. Apply air pressure of 3.0 psi to the combustion tube of the assembled heater. Leakage shall not exceed 0.66 scfm.

b. Apply air pressure of 16 psi to the ventilating air passages. Leakage shall not exceed 1.5 scfm.

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING)

Trouble	Cause	Remedy
Heater fails to ignite.	Heater switch or circuit breaker open.	Turn on heater switch or close circuit breaker.
	Low voltage supply.	Apply external power supply. Attempt to start heater.
	Fuel cut off from tank.	Turn on manual shutoff valve or master solenoid.
	Regulator not operating properly.	Check for low pressure. If it is not regulating at 7.5 ± 0.5 psi, adjust regulator to that value or replace regulator. (Refer to paragraph 13-10 and 13-49.)
	Restriction in fuel nozzle orifice.	Remove the nozzle and clean or replace it. (Refer to paragraph 13-51, a thru h, 13-58 and 13-62.
	Fuel nozzle solenoid not operating.	Remove and check solenoid. Replace if faulty. (Refer to paragraph 13-51, a thru h, 13-58 and 13-62.
	Fuel lines clogged or broken.	Inspect all lines and connections. It may be necessary to disconnect lines at various points to determine where the restriction is located.

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING) (cont.)

Trouble	Cause	Remedy
Heater fails to ignite. (cont.)	Ignition vibrator inoperative.	Replace vibrator. Check for defective radio noise filter. (Refer to paragraph 13-43.
	Manual reset limit (overheat) switch open.	Press reset button firmly and recheck to determine reason for switch opening.
	Combustion air pressure switch open. (Defective switch or low combustion air blower output.)	Check for low blower output due to low voltage and correct it. If switch is defective, replace it. (Refer to paragraph 13-60.)
	Cycling switch open.	Replace if defective. (Refer to paragraph 13-66.)
Recirculating fan fails to operate.	Circuit breaker open.	Close circuit breaker.
	Comfort control master switch OFF.	Turn comfort control master switch ON.
	Worn motor brushes.	Replace motor brushes. (Refer to paragraph 13-29.)
	Motor burned out.	Remove fan assembly and replace motor. (Refer to paragraph 13-31 and 13-32.)
	Defective radio - noise filter.	Replace filter. (Refer to paragraph 13-31.)

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING) (cont.)

Trouble	Cause	Remedy
Recirculating fan uses excessive current and runs at low speed.	Bearings misaligned or preloaded.	Move armature back and forth to relieve preload.
	Faulty bearings.	Replace bearings. (Refer to paragraph 13-31.)
	Brushes not properly seated.	Brushes should be run in longer. (Refer to paragraph 13-36.)
Recirculating fan uses excessive current and runs at high speed.	Shorted turns in field.	Replace motor. (Refer to paragraph 13-31.)
Recirculating fan uses excessive current and runs erratically.	Shorted turns in armature.	Replace motor. (Refer to paragraph 13-31.)
Recirculating fan runs with excessive vibration.	Propeller out of balance.	Rebalance propeller.
	Armature out of balance.	Replace motor. (Refer to paragraph 13-31.)
Combustion air blower fails to run.	Faulty wiring to motor.	Inspect and replace faulty wiring.
	Poor ground connection.	Tighten ground screw.
	Worn motor brushes.	Replace motor brushes. (Refer to paragraph 13-29.)
	Blower wheel jammed. (Usually indicated by hot motor housing.)	Overhaul the combustion air blower. (Refer to paragraphs 13-26, 13-27 and 13-29.

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING) (cont.)

Trouble	Cause	Remedy
Combustion air blower fails to run. (cont.)	Defective radio-noise filter.	Replace filter.
	Faulty or burned-out motor.	Remove combustion air motor for overhaul or replacement of motor. (Refer to paragraphs 13-26, 13-27 and 13-29.)
Heater ignites but burns unsteadily.	Insufficient fuel supply.	Inspect fuel supply to heater, including shutoff valve, solenoid valve and fuel lines. Make necessary repairs.
	Spark plug partially fouled.	Replace spark plug. (Refer to paragraph 13-37.
	Loose primary connection at ignition assembly.	Tighten the connection.
	Faulty vibrator.	Replace the vibrator. (Refer to paragraph 13-43.)
	Combustion air blower speed fluctuates. (Can be caused by low voltage, loose blower wheel, worn brushes or motor.	Remove and overhaul the combustion air blower assembly as required or correct low voltage condition.

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING) (cont.)

Trouble	Cause	Remedy
Heater ignites but burns unsteadily. (cont.)	High voltage leak in lead between ignition assembly and spark plug.	Replace ignition assembly. (Refer to paragraph 13-39.)
	Inoperative ignition assembly.	If vibrator is in good condition, replace ignition assembly only. (Refer to paragraph 13-39.)
	Restriction in fuel nozzle orifice.	Remove nozzle for cleaning or replacement. (Refer to paragraphs 13-51, g and h, 13-58. and 13-62.
	Nozzle loose in retainer or improper spray angle.	Tighten or replace the nozzle as required. (Refer to paragraphs 13-54, f and 13-58.)
Heater ignites then goes out.	Lack of fuel at heater.	Check fuel supply through all components from the tank to the heater. Make necessary corrections.
	Inoperative or chattering combustion air pressure switch.	Adjust or replace switch. (Refer to paragraph 13-60.)
	Inoperative overheat switch.	Replace switch. (Refer to paragraph 13-51k and 13-66.
	Inoperative cycling switch.	Adjust or replace the switch. (Refer to paragraph 13-66 or 13-47a

TABLE XIII-III. TROUBLESHOOTING CHART (HEATING) (cont.)

Trouble	Cause	Remedy
Heater ignites then goes out. (cont.)	Low voltage.	Attach external power.
Heater fails to shut off.	Fuel solenoid valve in heater stuck open.	Remove and replace solenoid assembly. (Refer to paragraphs 13-51,g ; 13-62.
	Inoperative cycling switch.	Check and repair. (Refer to paragraph 13-66 or 13-47a
	Defective cabin comfort control.	Replace control.
	Defective cabin temperature probe.	Replace unit.

13-68. AIR CONDITIONING SYSTEM.

13-69. CABIN AIR CONDITIONING SYSTEM DESCRIPTION. The vapor cycle air conditioning system consists of a variety of parts which make up the complete system. The compressor is an engine mounted, belt driven, two cylinder, reciprocating compressor. It is driven from a power take-off on the rear of the right engine at 3000 RPM maximum through an electric clutch mounted to the compressor. This clutch is used to operate the compressor when desired. The condenser is a fin and tube heat exchanger mounted behind the right engine firewall. The condenser is cooled by air taken from the propeller slip stream, through an adjustable air scoop on top of the right nacelle. This scoop is normally closed in flight and also on the ground when the air conditioner is not operating. It will open on the ground by means of a safety switch located on the right main landing gear, which completes the circuit to open the scoop when the master switch is on and the cabin mercury bulb thermostat calls for air conditioning mode. The condenser provides the heat sink to condense the high pressure Freon vapor. A coaxial tube heat exchanger consists of the low pressure line between the compressor and evaporator being routed inside the high pressure line. This was done to vaporize any liquid Freon that may have passed the Evaporator Control Valve; thus preventing liquid Freon from reaching the compressor, and also eliminates the condensing of moisture on the compressor suction line. The receiver-dehydrator acts as a reservoir to slightly overcharge the system, without flooding the condenser. It also functions as a trap for any air or moisture that was left in the system during the initial charging of the system. The expansion valve controls the flow of Freon into the evaporator core. A capillary tube mounted to the suction line at the evaporator, regulates the operation of the valve. The evaporator is a drawn cup heat exchanger which cools and dehumidifies the air before it enters the airplane.

13-70. CABIN AIR CONDITIONING SYSTEM OPERATION. The air conditioner can be operated independently or in conjunction with the heater, through the use of an electronic controller mounted in the lower right section of the instrument panel. The controller receives its signal from a controllable mercury bulb thermostat. When the thermostat calls for cooling, the controller turns on the air conditioner. Under all normal operations, the cabin thermostat will control the operation of the air conditioner or heater. The air conditioning system uses Freon-12 refrigerant which is drawn into the compressor and pumped to the condenser under high pressure. The Freon vapor is heated as a result of the compression process. As it flows through the condenser, the vapor is cooled by ram air which causes the vapor to condense into a liquid state. This liquid refrigerant then passes from the condenser through a coaxial tube heat exchanger to further reduce its temperature. This liquid refrigerant then enters the receiver-dehydrator assembly, which acts as a reservoir and also functions as a filter to remove any trapped air or moisture that was in the system during the initial charging. High pressure liquid Freon is supplied from the receiver to an expansion valve. This valve meters the refrigerant into the evaporator core at a rate which allows the liquid refrigerant to evaporate. Heat from the evaporator core surface is lost to the boiling and vaporizing refrigerant, which is cooler than the core, thereby cooling the core and the air passing through it. As this process is taking place, moisture (humidity) in the air condenses on the outside surface of the evaporator core and is drained off as water. By the time the refrigerant leaves the evaporator, it has completely vaporized. It then passes through the Evaporator Control Valve which is used to control the evaporator pressure. This is accomplished by restricting the outlet from the evaporator so that the pressure within the evaporator is maintained at a predetermined value to prevent the freezing of atmospheric moisture on the evaporator. The refrigerant vapor then returns to the compressor where the cycle is repeated.

13-71. TROUBLESHOOTING. A table at the end of these instructions will assist in locating and correcting malfunctions which may arise in this system.

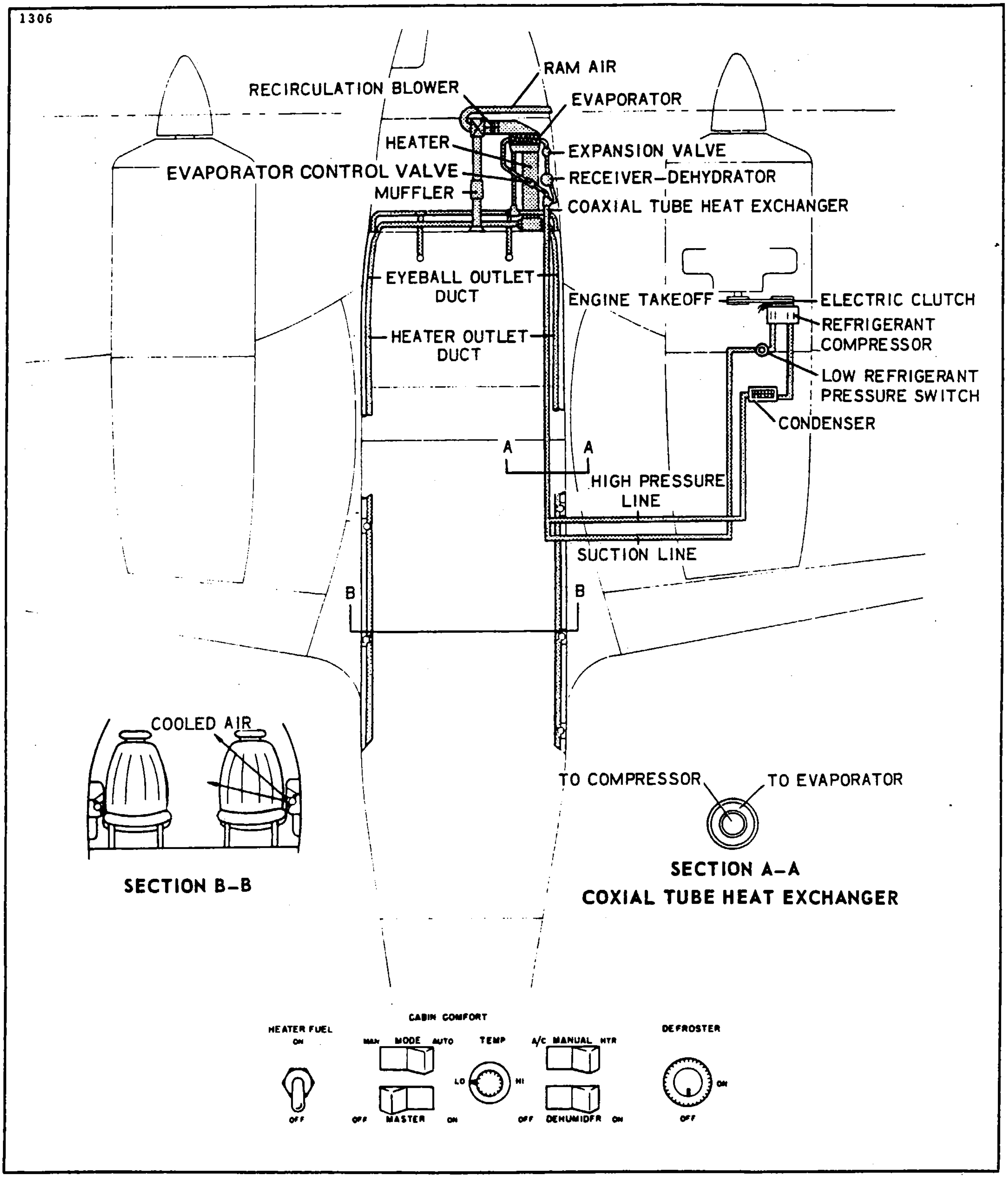


Figure 13-19. Air Conditioning Flow Diagram

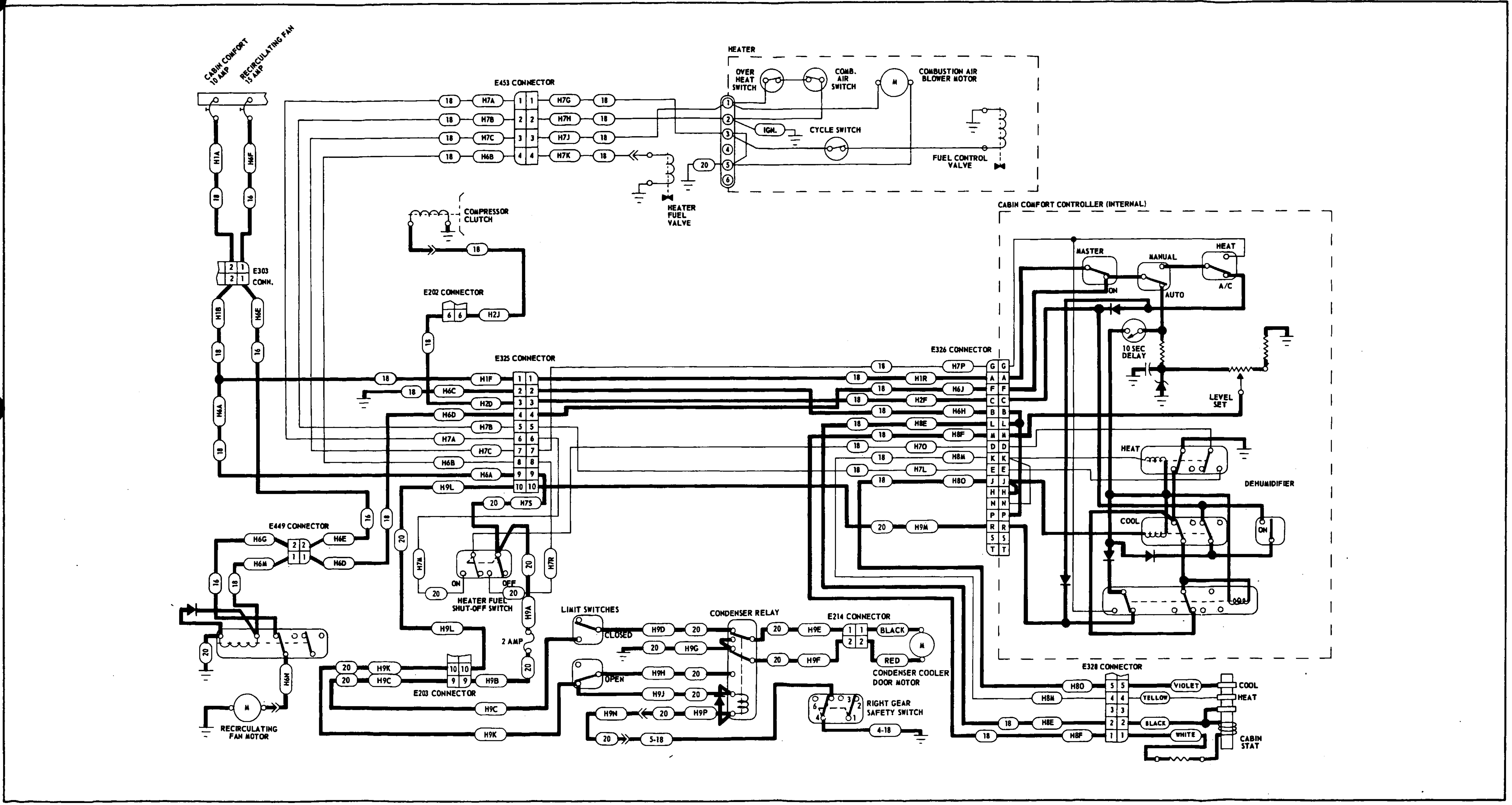


Figure 13-20. Environmental Control - Schematic - (Air Conditioning System)

13-72. MALFUNCTION DETECTION.

The detection of system malfunction largely depends on the mechanic's ability to interpret the gauge pressure readings into system problems. A system operating normally will have a low side gauge pressure reading that will correspond with the temperature of the refrigerant evaporating in the evaporator, allowing for a few degrees temperature rise due to loss in the tube walls and fins. The high side will have a gauge pressure that will correspond with the temperature of the refrigerant condensing in the condenser, allowing for a few degrees temperature drop due to loss in the tube walls and fins.

Any deviation from that which is normal indicates a malfunction within the system due to a faulty control device, obstruction, defective part, or improper installation.

Detection of system malfunction is made easier with the knowledge that the temperature and pressure of Refrigerant 12 is in close proximity between the pressures of twenty and eighty pounds per square inch (p.s.i.). A glance at the temperature-pressure chart will show that there is only a slight variation between the temperature and pressure of the refrigerant in the lower range.

It is correct to assume that for every pound of pressure added to the low side, a temperature increase of about one degree Fahrenheit takes place. For instance, a pressure of 23.8 on the chart indicates a temperature of 24° F. A change of pressure of almost one pound to 24.6 p.s.i. gives us a temperature increase to 25° F.

NOTE

For each 1,000 feet of elevation above sea level, the gauge readings will be about one inch of mercury or 1/2 psi higher than the chart indicates.

It must be pointed out that the actual temperature of the air passing over the coils of the evaporator will be several degrees warmer allowing for a temperature rise caused by the loss in the fins and tubing of the evaporator.

The importance of a seasonal check up of the air conditioning system should be brought to the attention of the customer whenever possible. A thorough check of the system performed in a methodical manner will reveal trouble the customer is often not aware of. Locating and repairing the trouble early will usually result in savings to the customer both in time and additional troubles that too often result from neglect.

A Performance Test of the system is the only positive way in which the complete system can be checked for efficient operation. The air conditioning system should be given this test before work is begun on the system whenever possible, however, if the system is completely inoperative, repairs must be performed before the system can be properly tested. The test can uncover further work that must be performed before the system is brought to its full operating efficiency. The Performance Test should always be performed after repair work has been done and before the aircraft is released to the customer. The serviceman performing this test carefully will insure that the repairs have been properly performed and that the system will operate satisfactorily.

The Performance Test when properly performed includes a thorough examination of the outside of the system as well as the inside. Many related parts are overlooked because it is felt they are of no bearing on the operating efficiency of the unit. For this reason, a thorough visual inspection of the complete system should be performed, followed by an operating inspection of the system.

TABLE XIII-IIIA. TEMPERATURE PRESSURE CHART

Evaporator Pressure Gauge Reading p.s.i.	Evaporator Temperature °F.	High Pressure Gauge Reading p.s.i.	Ambient Temperature °F.
0	-21	72	40
2.4	-15	86	50
4.5	-10	105	60
10.1	2	109	62
11.2	4	113	64
12.3	6	117	66
13.4	8	122	68
14.6	10	126	70
15.8	12	129	71
17.1	14	132	72
18.3	16	134	73
19.7	18	137	74
21	20	140	75
22.4	22	144	76
23.1	23	148	77
23.8	24	152	78
24.6	25	156	79
25.3	26	160	80
26.1	27	162	81
26.8	28	165	82
27.6	29	167	83
28.4	30	170	84
29.2	31	172	85
30	32	175	86
30.9	33	177	87
31.7	34	180	88
32.5	35	182	89
33.4	36	185	90
34.3	37	187	91
35.1	38	189	92
36	39	191	93
36.9	40	193	94
37.9	41	195	95
38.8	42	200	96
39.7	43	205	97
41.7	45	210	98
43.6	47	215	99
45.6	49	220	100
48.7	52	228	102
49.8	53	236	104
55.4	57	260	110
60	62	275	115
64.9	66	290	120

13-73. SPECIAL SERVICING PROCEDURES. The air conditioning system should be serviced by a qualified shop with trained personnel. The following procedures and precautions should be observed.

The efficiency of this system depends upon the pressure-temperature relationship of pure refrigerant. As long as the system contains only pure refrigerant plus a specified amount of compressor oil (which is mixed with the refrigerant), it is considered to be chemically stable. Foreign materials within the system will affect the chemical stability, contaminate the system, and decrease its efficiency.

WARNING

The air conditioner must not be operated with the right engine uncowled. Dangerously high compressor discharge pressures result from the low condenser cooling air flow, caused by the disturbed air flow over the uncowled engine.

If the air conditioner is to be operated for ground testing, then the gauge lines can be run up through the engine cowl flap area to the compressor, being careful to miss the engine exhaust

a. The most accurate way to check the condition of the system is by attaching gauges to the system as shown in Figure 13-24.

b. Always wear safety goggles when handling refrigerant.

WARNING

One of the most important precautions is protection of the eyes when handling refrigerant. Any liquid refrigerant which may accidentally escape is approximately 21.7 °F below zero. Serious injury could result if refrigerant comes in contact with the eyes. If refrigerant comes in contact with the eyes:

1. DO NOT rub the eyes. Rinse the eyes with cold water to gradually get the temperature above the freezing point.
2. Apply a protective film of antiseptic oil over the eyeball to reduce the possibility of infection.
3. Consult a doctor or eye specialist immediately. Should refrigerant come in contact with skin, it should be treated as though the skin had been frostbitten or frozen.

TABLE XIII-IV. ALUMINUM TUBING TORQUE

Metal Tube O.D.	Thread and Fitting Size	Alum. Tubing Torque
1/4	7/16	5-7 ft. lbs.
3/8	5/8	11-13 ft. lbs.
1/2	3/4	15-20 ft. lbs.
5/8	7/8	21-27 ft. lbs.
3/4	1-1/16	28-33 ft. lbs.

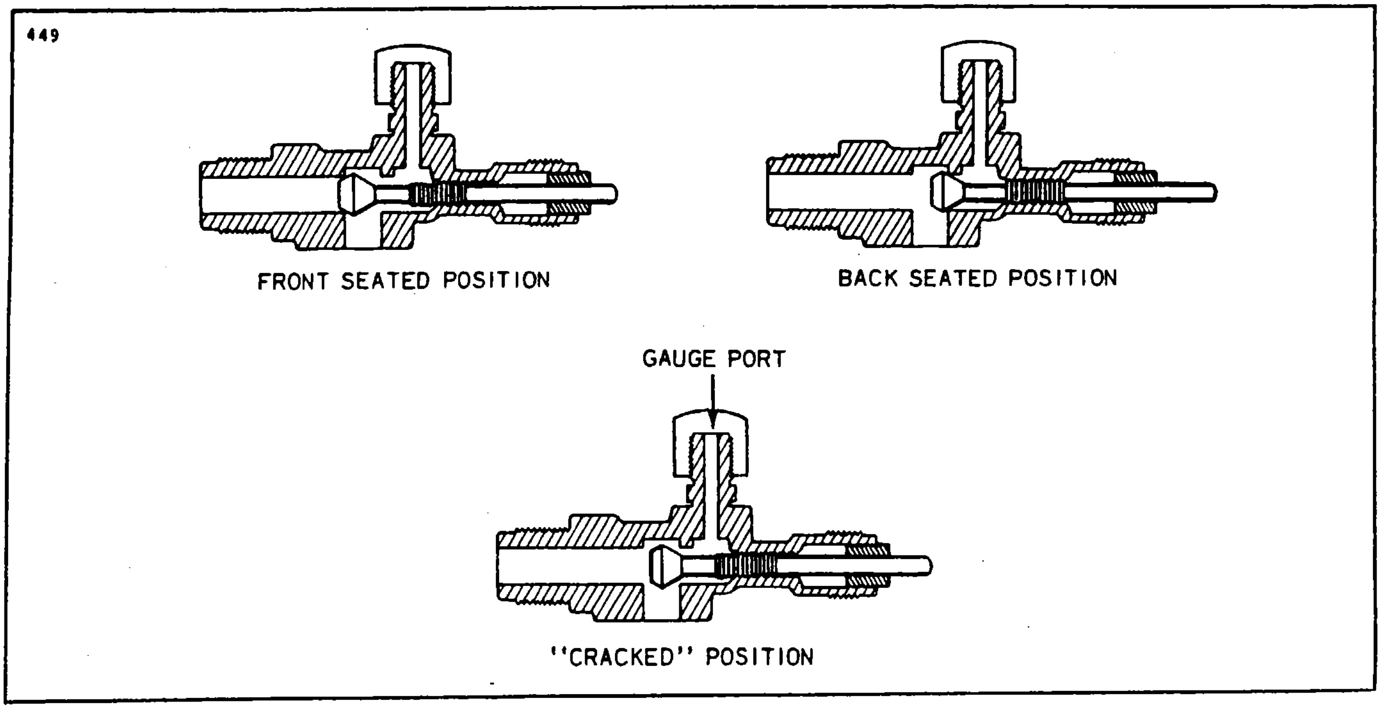


Figure 13-21. Service Valves

c. Large quantities of Freon-12 refrigerant should not be discharged into a closed room. It may displace the oxygen in the air.

d. Large quantities of Freon-12 which come in contact with live flame will produce a poisonous gas.

WARNING

Refrain from smoking when servicing refrigerant.

e. Keep lines capped to prevent foreign material and moisture from entering the system.

f. This is a high pressure system and the pressure should be released slowly before disconnecting any lines.

g. Use clean, dry refrigerant oil which should be contained in a capped container to reduce the possibility of the oil absorbing moisture and dirt.

h. Replace "O" rings when a connection has been broken. Dip new "O" rings in refrigeration oil before using. Do not over torque connections. (Refer to Table XIII-IV.)

i. To insure a consistent seal on all flared and pipe fittings used on the air conditioning system, seal the fittings with Loctite refrigerant sealant.

j. Torque all flare fittings to the table below.

13-74. SERVICE VALVES. (Refer to Figure 13-21.) The discharge and suction service valves are three-position valves and are mounted on each side of the compressor.

The suction side of the compressor is identified by the letter "S" or word "Suction" cast in the cylinder head. The discharge side is identified by the letter "D" or word "Discharge."

The purpose of a three-position valve is to allow a gauge connection to be made and used while the system is in operation. This can be used for service checks, bleeding, evacuating and charging. Also, the compressor may be removed from its bracket to enable engine work to be performed on the airplane by closing the service valves and removing them intact with the lines attached, from the compressor.

When the stem is turned in, the valve is "front seated." When the stem is turned out, the valve is "back

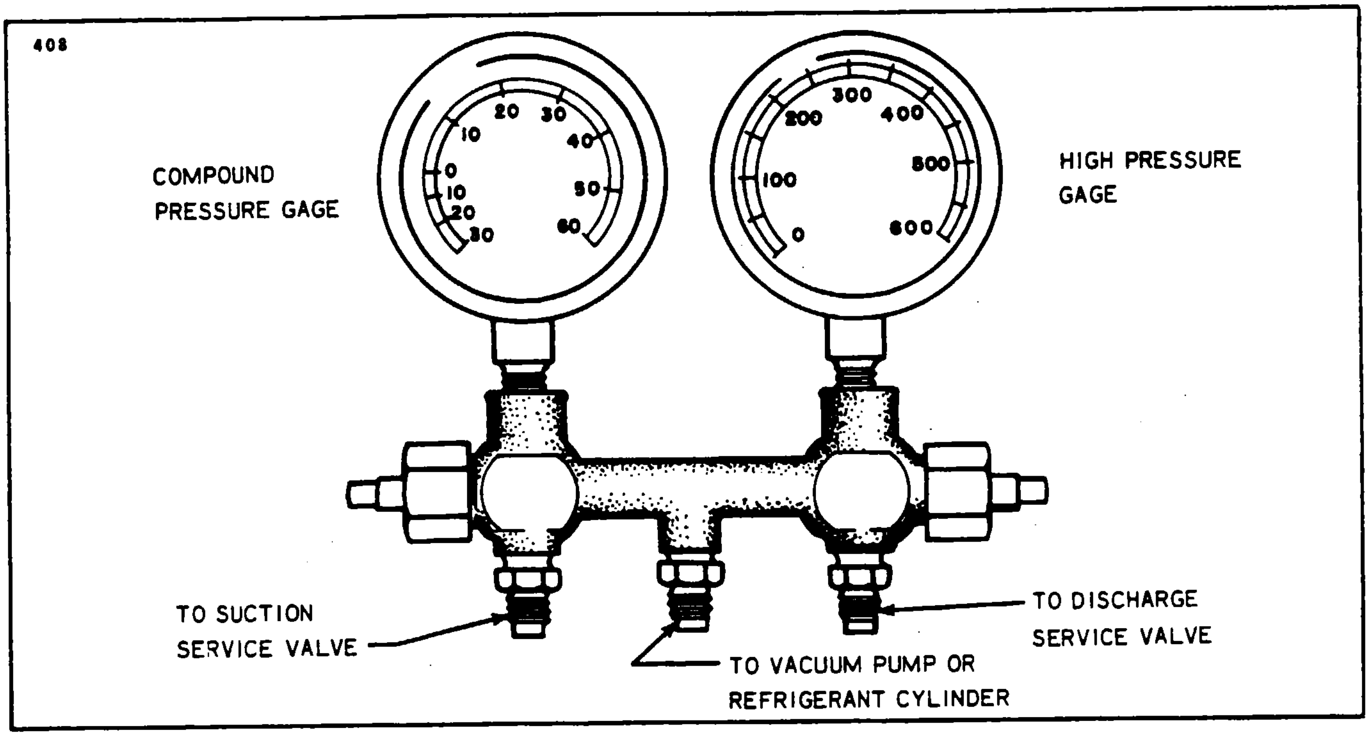


Figure 13-22. Test Gauge And Manifold Set

seated." When the stem is turned to the halfway position, the valve is commonly known as being "cracked."

The "front seated" position allows the compressor to be removed from the system and serviced. The "back seated" position is the normal valve position when the refrigeration system is in service. The "cracked" position allows the refrigeration system to operate normally, and gauge readings to be observed at the same time.

Packing gland nuts should be kept snug to prevent loss of refrigerant. Care should be taken that valve caps and gauge port caps are intact when service work is ended.

13-75 TEST GAUGE AND MANIFOLD SET. The proper testing and diagnosis of the air conditioning system require that a manifold gauge set be attached into the system. This set consists of two gauges mounted to a manifold. One gauge is a high pressure gauge used in the discharge side of the system. The other is a low pressure gauge used in the suction side of the system. The manifold is a device having fittings for both gauges and connection hoses with provisions for controlling the flow of refrigerant through the manifold. See Figure 13-22.

The center port of the manifold set is used for charging or evacuation procedures, or any other service that may be necessary.

Both the high and low side of the manifold have hand shutoff valves. When the hand valve is turned all the way in, in a clockwise direction, the manifold is closed. The pressures on that side of the system will, however, be recorded on the gauge above the hose.

Cracking the hand valve, in the counterclockwise direction, opens the system to the middle service port of the manifold set. This is desirable only when it is necessary to let refrigerant out or into the system. Refer to Figures 13-23 thru 13-25.

13-76. CHECKING THE SYSTEM FOR LEAKS. There are several methods of doing this operation, depending on the type of equipment which is available. Two methods of performing this check will be

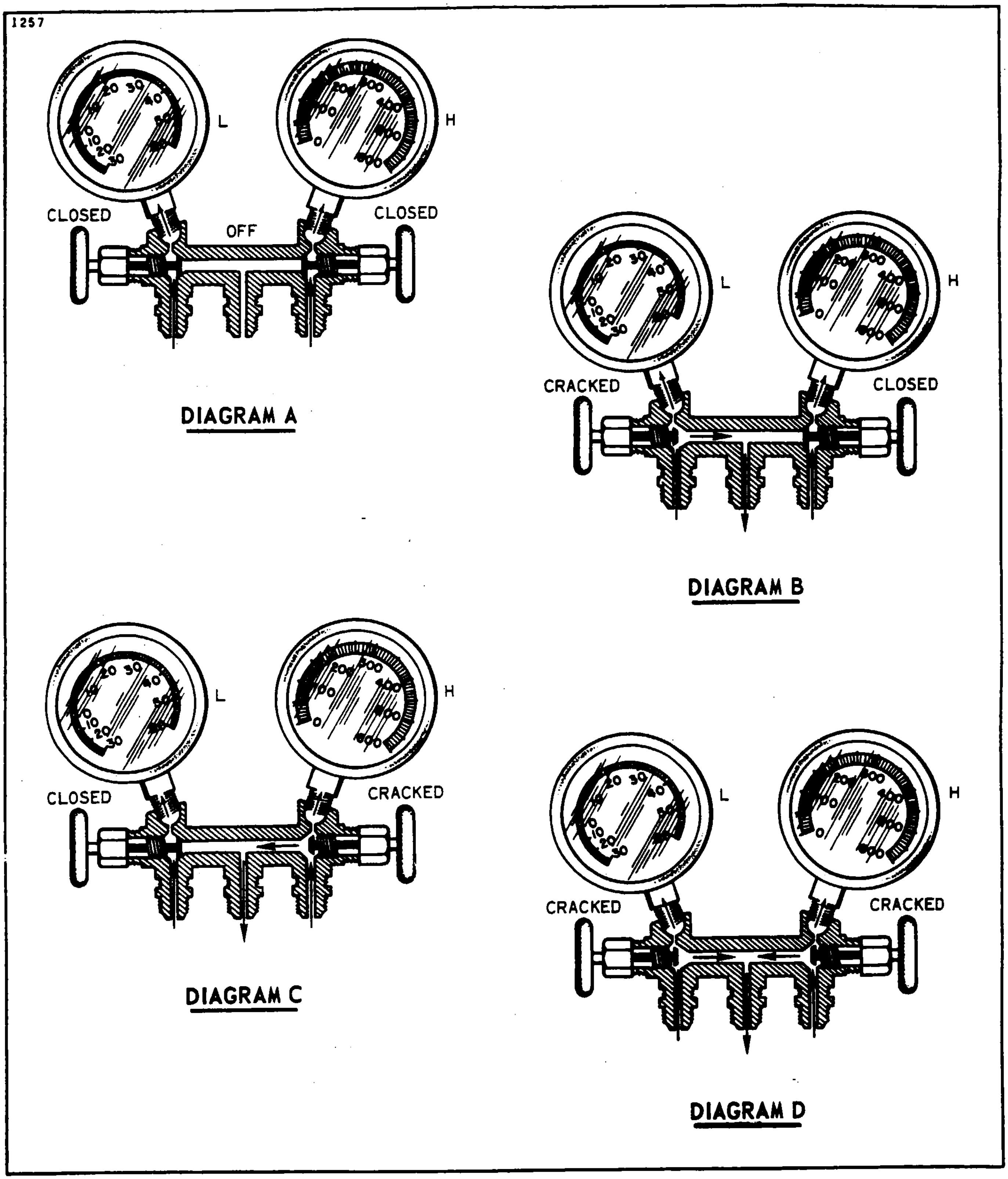


Figure 13-23. Manifold Set Operation

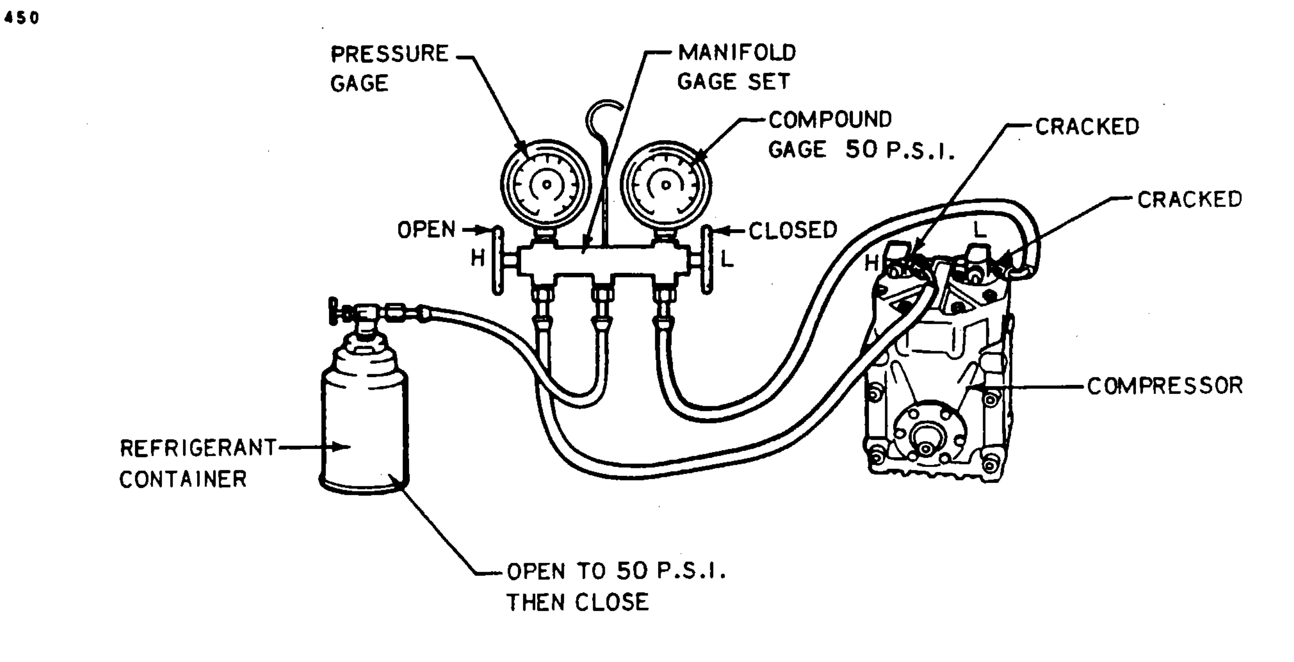


Figure 13-24. Leak Test Hookup

covered in the following paragraphs. Dupont Freon-12 with Dytel Red lead detective is approved and greatly assists in detecting leaks.

13-77. LEAK CHECK - METHOD I.

a. Connect the manifold gauge set into the system and determine if there is any refrigerant in the system. A minimum of 50 psi is needed for leak detection. (Refer to Figure 13-24.)

b. Purge the hoses of air by allowing some refrigerant to escape from the connections at the service valves. Then tighten connections at the service valve.

c. Close the low side manifold valve and open the high side manifold valve. Also, set the service valves on the compressor to the cracked position. (Refer to Figure 13-23.)

d. Open the refrigerant container service valve and allow the pressure at the low side gauge to reach 50 psi at which time close the high side manifold valve.

e. Close the refrigerant container service valve and remove the hose if no leaks are evident.

f. It is advisable to use an electronic leak detector to check this system instead of an open flame leak detector due to the possible presence of gasoline fumes in the engine nacelle.

g. If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.

h. Add oil, if required, (refer to Table XIII-V) then repeat steps a thru e.

i. If no further leaks are found, the system may be evacuated and charged. Refer to Paragraphs 13-79 and 13-80.

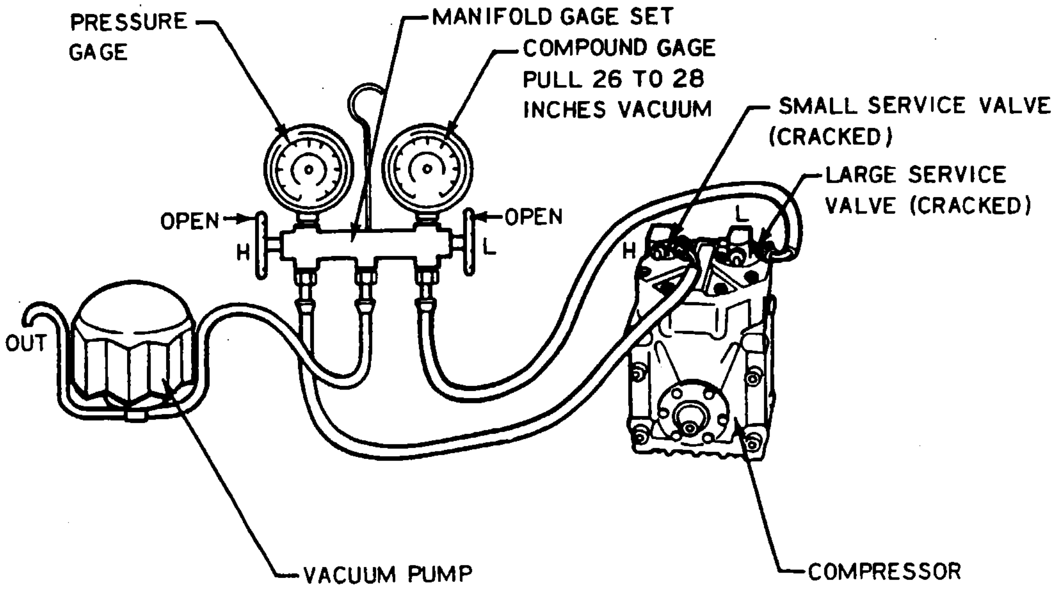
13-78. LEAK CHECK - METHOD II.

a. Remove the access panel at the upper rear portion of the nose baggage compartment to gain access to the Evaporator Control Valve.

b. Also, remove the access panels on the right nacelle if not previously accomplished.

c. Remove the protective cap on the Schrader valve fitting on the Evaporator Control Valve and connect a charging hose with a shutoff valve arrangement to the fitting. The charging hose must have a Schrader fitting or an adapter to fit the valve.

451



NOTE; OPEN BOTH SERVICE VALVES (CLOCKWISE) ONE TURN

Figure 13-25. Evacuation Hookup

d. Connect the other end of the charging hose to a small cylinder of refrigerant and purge the hose by allowing a slight amount of refrigerant gas to escape from the Evaporator Control Valve fitting.

e. The cylinder of refrigerant should be placed upright in a container of warm (125° F max.) water on a small scale.

f. Allow approximately 1/2 pound of refrigerant to enter the system by opening the valve on the charging hose and observing the weight change on the scale.

g. Using an electronic leak detector, check all joints and repair any leaks.

h. After completion of repair of any leaks, proceed to check the system in accordance with one of the methods outlined for any other leaks.

i. If no further repair is required on the system, it is now ready to evacuate in accordance with paragraph 13-79.

13-79. EVACUATING THE SYSTEM. If the system has been operated in a discharged condition or any time the system has been open to atmospheric pressure, the receiver-dryer must be replaced and the system evacuated to remove any trapped air and moisture which has entered it. A vacuum pump capable of pulling 29 inches of mercury or better should be used. As we lower the pressure in the air conditioning system, we lower the boiling temperature of the water (moisture) that may be present. Then we are able to pull this water, in the form of vapor, out of the system. The following table demonstrates the effectiveness of moisture removal under a given vacuum.

	System Vacuum	Temperature °F.
COMPOUND GAUGE READING IN INCHES OF MERCURY VACUUM	27.99	100°
	28.89	80°
	29.40	60°
	29.71	40°
	29.82	20°
	29.88	0°

NOTE

For each 1,000 feet of elevation above sea level, the compound gauge reading will be about one inch lower, numerically.

The following steps should be of help when performing this operation.

a. Remove the cowling from the right engine. (Refer to Section VIII.)

CAUTION

Ascertain that all system pressure is released before attempting the evacuation. (Refer to Paragraph 13-73.)

b. Connect the manifold gauge set to the airplane compressor. (Refer to Figure 13-25.)
c. The high and low manifold hand valves should be in the closed position. (Refer to Figure 13-23.)
d. Connect the center manifold hose to the inlet of the vacuum pump.

NOTE

Make sure the exhaust port on the vacuum pump is open to avoid damage to the vacuum pump.

e. Operate the vacuum pump and open the low side manifold hand valve. Observe the compound, low pressure gauge needle, it should show a slight vacuum.
f. Open both service valves on the compressor to the cracked position. (Refer to Figure 13-25.)
g. Continue to operate the vacuum pump until 26 to 28 inches of vacuum is attained on the low pressure gauge, then extend the operation for another 25 minutes.
h. If the system cannot maintain 26 to 28 inches of vacuum, close both manifold hand valves and observe the compound gauge.
i. Should the compound gauge show a loss of vacuum, there is a leak in the system which must be repaired before continuing with evacuation.
j. If no leaks are evident, reopen both manifold hand valves and continue the evacuation for another 30 minutes.
k. Close both manifold hand valves, stop vacuum pump and disconnect center manifold hose from the vacuum pump.
l. Proceed to charge the system in accordance with paragraph 13-80.

NOTE

The system should be charged as soon as it has been evacuated.

13-80. CHARGING THE SYSTEM. When the system is completely evacuated in accordance with instructions given in paragraph 13-79, one of the following procedures should be used to charge the system.

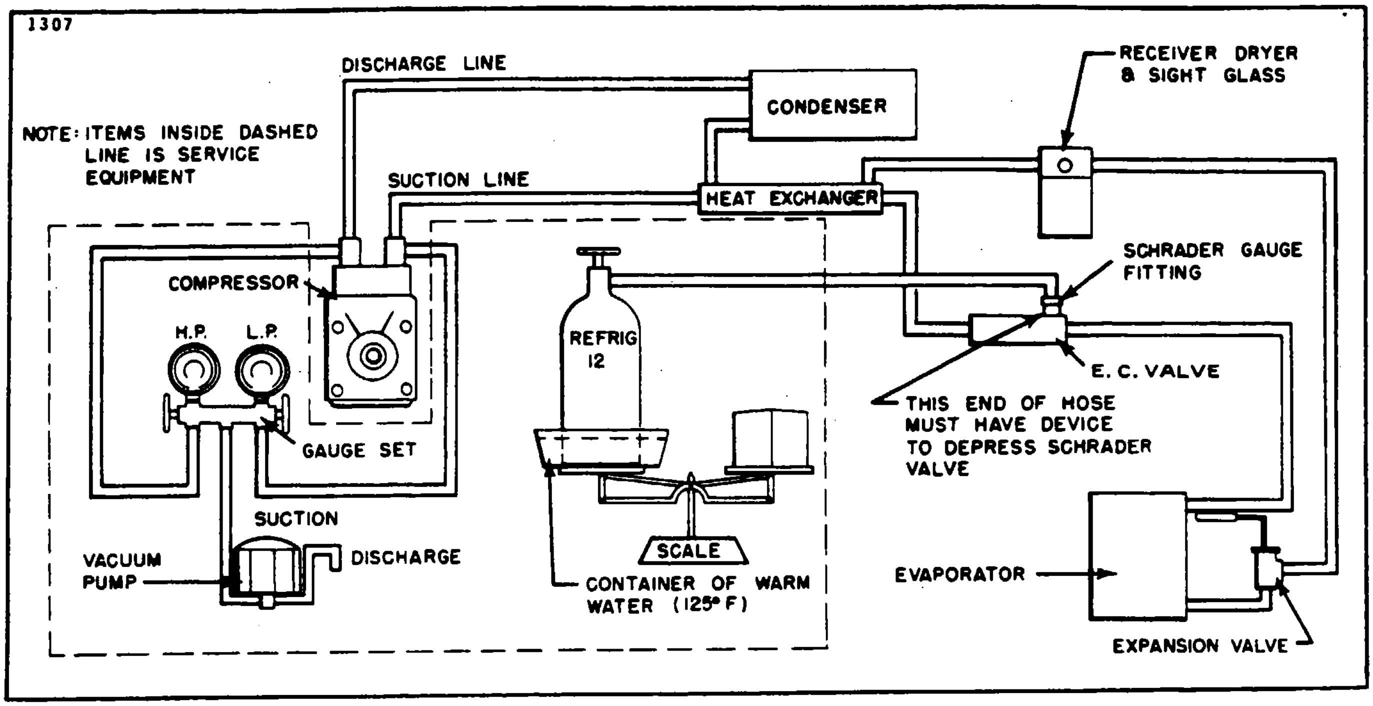


Figure 13-26. Charging Hookup

13-81. WITH A CHARGING STAND. This is the preferred method of charging the system.

a. With the charging stand connected to the airplane's system (refer to Figure 13-27), allow five and one-half pounds of refrigerant to enter the charging cylinder.

b. Open the high pressure control valve and close the low pressure control valve.

c. Open the refrigerant control valve on the charging stand and allow as much liquid refrigerant to enter the high side of the system as possible.

d. After completion of charging, close all valves on the charging stand.

e. Back seat the compressor service valves (fully counterclockwise) and also close the valve on the charging stand.

f. Remove the manifold gauge set and hoses from the compressor using caution due to the small amount of refrigerant remaining in the hoses.

g. Replace all access panels and install the engine cowling. (Refer to Section VIII.)

13-82. USING THE AIRPLANE COMPRESSOR TO CHARGE THE SYSTEM. This method is the least desirable due to the requirement of operating the airplane's right engine to run the compressor.

CAUTION

Ascertain that the area around the airplane is clear and a qualified person is at the controls of the airplane.

a. Remove the access panel at the rear of the nose baggage compartment to gain access to the Evaporator Control Valve and connect the refrigerant charging hose to the valve fitting on the Evaporator Control Valve (refer to Figure 13-26) and purge the charging hose of air.

b. Place the refrigerant container on a scale to observe the amount of refrigerant entering the system.

411

1. COMPOUND GAUGE
2. VALVE, LOW PRESSURE CONTROL
3. VALVE, VACUUM CONTROL
4. CHARGING CYLINDER
5. BRACKET
6. SIGHT GLASS
7. HIGH PRESSURE GAUGE
8. HIGH PRESSURE CONTROL
9. REFRIG. CONTROL
10. CHARGING LINE HOSE HOLDER
11. BRACKET
12. LOW PRESSURE CHARGING LINE
13. HIGH PRESSURE CHARGING LINE
14. VACUUM PUMP
15. OIL FILL LOCATION
16. PLASTIC CAP
17. REFRIGERANT DRUM VALVE
18. VACUUM PUMP VALVE
19. VACUUM PUMP EXHAUST PORT
20. TOP CYLINDER VALVE
21. REFRIGERANT DRUM
22. WEB STRAP
23. REFRIG. DRUM REDUCER
24. CHARGING CYLINDER HOSE
25. VACUUM PUMP INTAKE HOSE
26. VACUUM PUMP SWITCH
27. VACUUM PUMP POWER CORD
28. HEATER PLUG

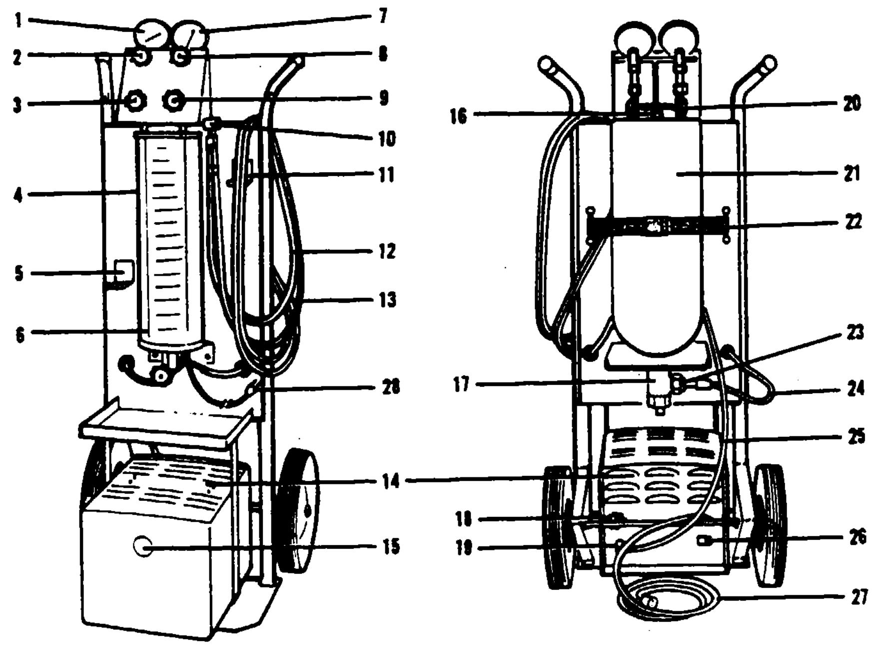


Figure 13-27. Charging Stand

c. Start the right engine and operate it at 900 to 1000 propeller RPM.

d. Operate the air conditioner in the manual mode.

e. Working through the nose baggage compartment, note the weight of the refrigerant container on the scale before allowing any to enter the system.

f. Open the valve on the refrigerant container and allow five and one-half pounds of refrigerant to enter the system (as shown on the scale). Then, close the valve.

g. With the system still operating, observe the sight glass in the top of the receiver-dryer by removing the plastic plug and using a mirror.

h. The sight glass should be clear of any bubbles or foam. If bubbles or foam are seen passing through the sight glass, it is an indication of a low refrigerant charge in the system and more refrigerant is required. This check should be made with OAT of 70°F or higher and cabin air selector in pressurized air position.

i. If more refrigerant must be added to the system, open the valve on the container and observe the sight glass. After the sight glass has cleared, add an additional half-pound of refrigerant to the system.

NOTE

Suspect leaks or inaccurate scale if five and one-half pounds does not fill system.

j. Shut off the air conditioning and airplane engine. Then, remove the charging line from the Evaporator Control Valve with care due to the refrigerant remaining in the hose.

NOTE

A shop cloth should be used to divert escaping refrigerant when disconnecting the charging hose from the Evaporator Control Valve. Recap the valve.

13-83. ADDITION OF PARTIAL CHARGE TO SYSTEM. It is possible to top off this system with refrigerant by the following method.

a. Remove the access panel located on the upper portion of the aft bulkhead in the nose baggage compartment.

b. Connect a charging hose to a refrigerant cylinder and also to the Schrader gauge fitting on the Evaporator Control Valve. (Refer to Figure 13-26.)

c. Purge the charging hose by allowing a small amount of refrigerant gas to escape at the Schrader gauge fitting.

d. Operate the right engine at 900 to 1000 RPM and place the cabin air selector in the pressurized air position. Turn the air conditioner on in the manual mode.

e. Remove the plastic plug from the sight glass in the top of the receiver-dryer.

NOTE

This sight glass can be safely viewed with a mirror through the removable panel at the rear of the nose baggage compartment.

f. With a low refrigerant charge in the system, bubbles will be seen passing thru the sight glass when the system is operating.

g. Open the valve on the refrigerant cylinder.

h. Allow refrigerant to flow into the system until the bubbles disappear from the sight glass.

i. Close the refrigerant valve and check to see that the sight glass remains clear during system operation.

j. When the sight glass stays clear of bubbles, add an additional 1/2 pound of refrigerant to the system.

k. Shut off the air conditioner and engine. Remove the charging hose from the Evaporator Control Valve with care due to refrigerant remaining in the line.

l. Replace the access panels.

13-84. FLUSHING CONTAMINATED SYSTEM. Whenever a system is suspected of contamination it should be flushed in accordance with the following steps:

a. Remove the cowling from the right engine.

b. Discharge system by removing gauge port cap and cracking one of the compressor service valves to allow any remaining refrigerant to slowly escape.

c. Remove the access panel on the right side of the nose section of the airplane.

d. Replace any known defective components of the system.

e. Disconnect the pressure and suction lines from the top of the compressor, and place in container.

f. Remove the protective cap on the Schrader valve fitting on the Evaporator Control Valve and connect a charging hose to the fitting. The charging hose must have Schrader fitting or adapter to fit the valve.

g. Connect the other end of the charging hose to a small cylinder of Refrigerant-11 "clean-up solvent."

NOTE

Refrigerant-12 may be used but bottle must be inverted.

h. Invert bottle and back flush system until the liquid running from the pressure and suction lines in the nacelle is observed to be clean and free of particles.

i. Purge liquid from system by same method using Refrigerant-12 (gas) until all liquid is removed and only gas flows from pressure and suction lines.

j. Replace the receiver-dryer in accordance with paragraphs 13-99 and 13-100, and reconnect pressure and suction lines.

k. Due to loss of lubricant from the system during flushing, the compressor oil level must be raised to 16 ounces per Table XIII-V.

l. Evacuate the system per paragraph 13-79 then recharge according to paragraph 13-80.

13-85. COMPRESSOR SERVICE. It is not advisable to service the compressor in the field. It should be done by a qualified shop which has the special equipment and trained personnel required to properly service the unit.

Maintenance to this unit and its related components is limited to the replacement of worn drive belt and magnetic clutch. Any other service requires removal of the compressor from the system.

It is possible to remove and install the compressor from the rest of the air conditioning system in the airplane without discharging the refrigerant in the system. The following paragraphs should be of assistance whenever this is required.

13-86. COMPRESSOR REMOVAL.

a. Ascertain that the circuit protector is off for the air conditioning system.

b. Remove the cowling from the right engine. (Refer to Section VIII.)

c. Disconnect the electrical leads to the magnetic clutch on the compressor.

d. Front seat both service valves (clockwise) fully on the airplane compressor.

e. Remove both service valves from the compressor with the related pressure and suction lines attached.

CAUTION

Compressor pressure will bleed off at the flanges of these valves, when the bolts are loosened.

f. Loosen the compressor adjustment bolts and raise the compressor to release the tension on the V belt.

g. Remove the belt from the compressor clutch pulley.

h. Support the compressor and remove the four mounting bolts holding the compressor to its mount and remove it from the airplane.

13-87. COMPRESSOR INSTALLATION. When installing the compressor back into the airplane's air conditioning system, it should be purged of air before the service valves are opened (back seated). This is accomplished by the following steps:

a. Support the compressor and align the mounting holes in the compressor housing with the mounting bracket and install the four spacers and cap screws.

b. Raise the compressor and install the V belt over the clutch pulley.

c. Check the pulley alignment by one of the following methods:

1. Visually check if the belt goes from pulley to pulley perfectly straight and there is no sideway bends in the belt as it approaches or leaves the pulleys.

2. A half-inch rod about 18 inches long can also be used to check pulley alignment before installing the V belt by laying the rod in the pulley grooves and making sure the rod falls squarely in the two pulley grooves.

3. With both pulleys aligned, torque the four cap screws 14 to 17 foot pounds.

NOTE

Ascertain that the drive belt is properly aligned, as a misaligned belt will fray and require frequent changes.

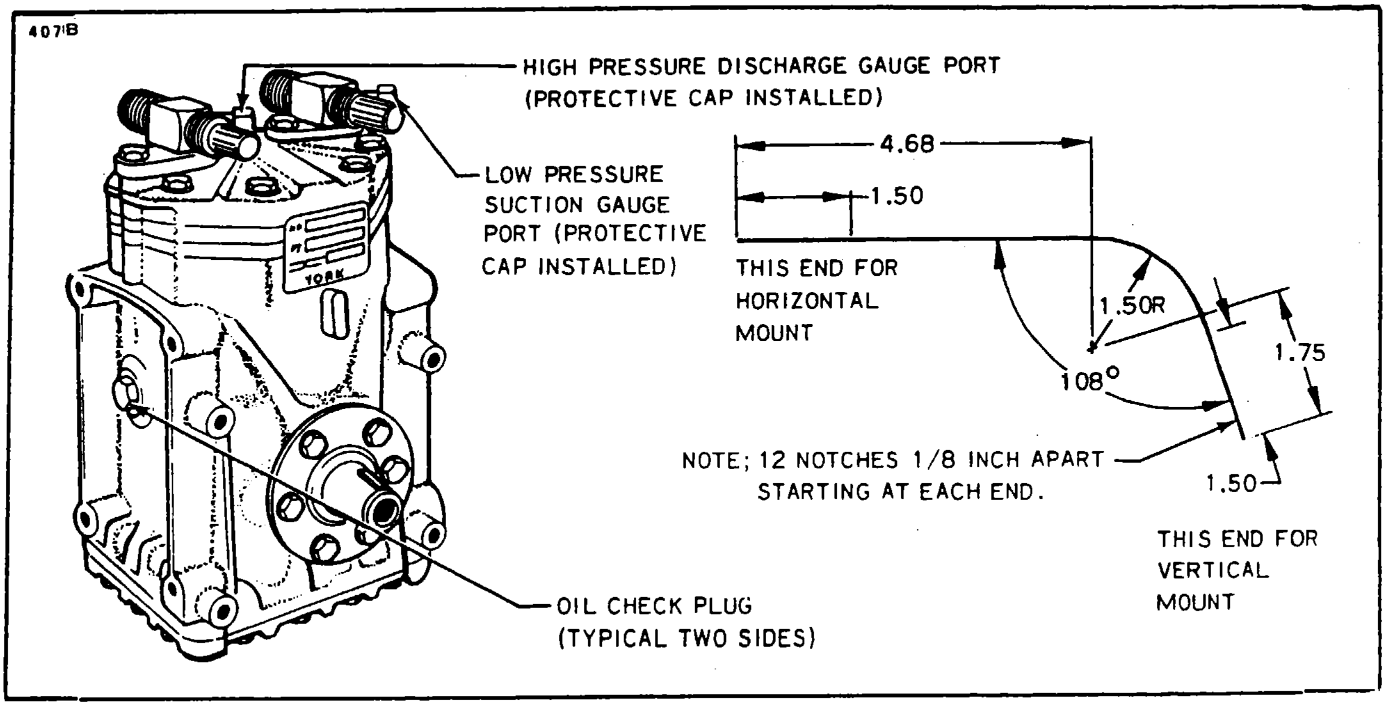


Figure 13-28. Compressor And Fabricated Oil Dipstick

d. Check the oil level in the compressor in accordance with instructions given in paragraph 13-88.

e. With the service valves still front seated (closed), connect them to the compressor.

f. Close all valves (counterclockwise) on the charging stand, and remove the gauge port cap from the low pressure service valve.

g. Connect the blue, low pressure, charging line to the low pressure gauge port (See Figure 13-28.)

h. Operate the vacuum pump and open both the low pressure control valve and the vacuum control valve on the charging stand. Continue to operate pump for 5 minutes after 26 to 28 inches of vacuum is reached.

i. After evacuation, close both the low pressure control valve and vacuum control valve. Wait 5 minutes and observe the vacuum gauge, no more than a 2 inch drop in vacuum is allowed. If the 26 inch vacuum cannot be attained, or if the rise in pressure exceeds 2 inches, check the compressor for leaks. Turn off the vacuum pump.

j. Back seat both service valves on the compressor.

k. Carefully remove the blue line from the low pressure valve. This line will contain a small amount of refrigerant.

CAUTION

It is advisable to cover hands with gloves or service cloth before removing the line from the gauge fitting to prevent skin coming in contact with cold refrigerant.

l. Replace gauge port cap on the low pressure valve and both valve stem caps.

13-88. CHECKING COMPRESSOR OIL. The oil level should be checked at each 1000 hour inspection of the airplane, and also any time the system is serviced for any reason. The following steps should be followed to perform this check:

a. It will be necessary to fabricate an oil dipstick. (Refer to Figure 13-28.)

b. Remove the right engine cowling and the valve stem caps (not gauge port caps) from both the high and low service valves.

c. Front seat both service valves. (Refer to Figure 13-21.)

d. Carefully loosen the oil check plug and allow refrigerant to exhaust from compressor into a shop cloth.

e. The oil level should be checked with the fabricated dipstick and measured from the lowest point in the crankcase. Insert the short end into crankcase.

f. Table XIII-V shows the crankcase oil charge in ounces at various dipstick measurements.

g. Before inserting the dipstick, turn the clutch armature so the shaft key is in the up position. The front face of the compressor clutch is marked with a metal stamped "K" indicating the key position.

h. The compressor should never be operated with less than 6 ounces of oil. When oil is added the level should not go above 10 ounces. The 16 ounce oil level is required in compressors installed on new systems. Approximately 6 ounces is distributed in the system during operation. Replacement compressors should be charged with 10 ounces of oil unless the system has been flushed clean of all oil. When a compressor is changed the system should be run and stabilized in temperature prior to rechecking the oil level. The level should be topped off to 10 ounces if necessary.

NOTE

When adding or changing oil, use only Suniso No. 5, Texaco Capella "E" or equivalent, 500 viscosity. Keep the oil storage container tightly capped at all times.

TABLE XIII-V. COMPRESSOR OIL CHARGE

Series 69 oil charge vs. dipstick depth.				
Oil charge, ounces	6	8	10	16
Vertical Mount	7/8	1	1-1/8	1-7/8

i. After checking or changing the oil, install the oil plug in the oil fill opening and tighten to a snug fit. It is advisable to use a new "O" ring on the plug.

j. Proceed to purge the compressor in accordance with paragraph 13-83, steps f thru l.

13-89. REPLACEMENT OF COMPRESSOR DRIVE BELT.

a. Remove the right engine cowling to gain access to the drive belt on the compressor. (Refer to Removal of Engine Cowling, Section VIII.)

b. Loosen the adjustment bolts on the engine mounted bracket.

c. Raise the compressor to relieve tension on the bolt and remove it from the pulley.

d. Support the compressor and remove the portion of the turbocharger bracket in the center of the drive belt. Then remove the drive belt.

e. With new belt installed, replace the portion of the turbocharger bracket in the center of the drive belt.

f. Install the new belt over the compressor pulley and install the compressor adjustment bolts. Do not tighten at this time.

g. Adjust the drive belt in accordance with paragraph 13-90.

h. Install the engine cowling. (Refer to Installation of Engine Cowling, Section VIII.)

13-90. ADJUSTMENT OF DRIVE BELT TENSION.

The adjustment of the compressor drive belt is very improtant to obtain long drive belt life and proper compressor operation. There are two methods which can be used to adjust the belt tension:

a. Preferred Method:

Hang a bucket or similar container with 125 pounds from a fabricated bracket (refer to Figure 13-29) attached to the compressor bottom. Use two 3/8-16 (Note UNC) bolts and the two available tapped holes parallel with and closest to the pulley. The bracket should allow the weight to hang directly under the pulley center. Loosen the four bolts holding the compressor mounting plate on the mount and allow the weight to pull the belt tight. Ensure that the pulleys are properly aligned in accordance with paragraph 13-87 c, then tighten the mounting bolts. Recheck belt tension after one to two hours of operation.

b. Alternate Method:

Adjust the belt tension with a belt tension tester so that a force of 6.5 to 7.5 pounds at the center of the belt span deflects the belt 0.156 of an inch. Belt tension closer to 7.5 pounds is preferred. Recheck the belt tension after one to two hours of operation. A belt tension tester P/N 4-4730 put out by Balkamp Inc. of Indianapolis, Ind., is ideal for this method.

13-91. MAGNETIC CLUTCH.

13-92. MAGNETIC CLUTCH REMOVAL.

a. Remove the self-locking capscrew and washer from the compressor shaft.

b. Insert a 5/8-11 UNC-2B capscrew in the threaded portion of the hub and tighten. The pressure exerted by the capscrew on the end of the compressor shaft will force off the rotor pulley assembly without damage to the clutch or compressor.

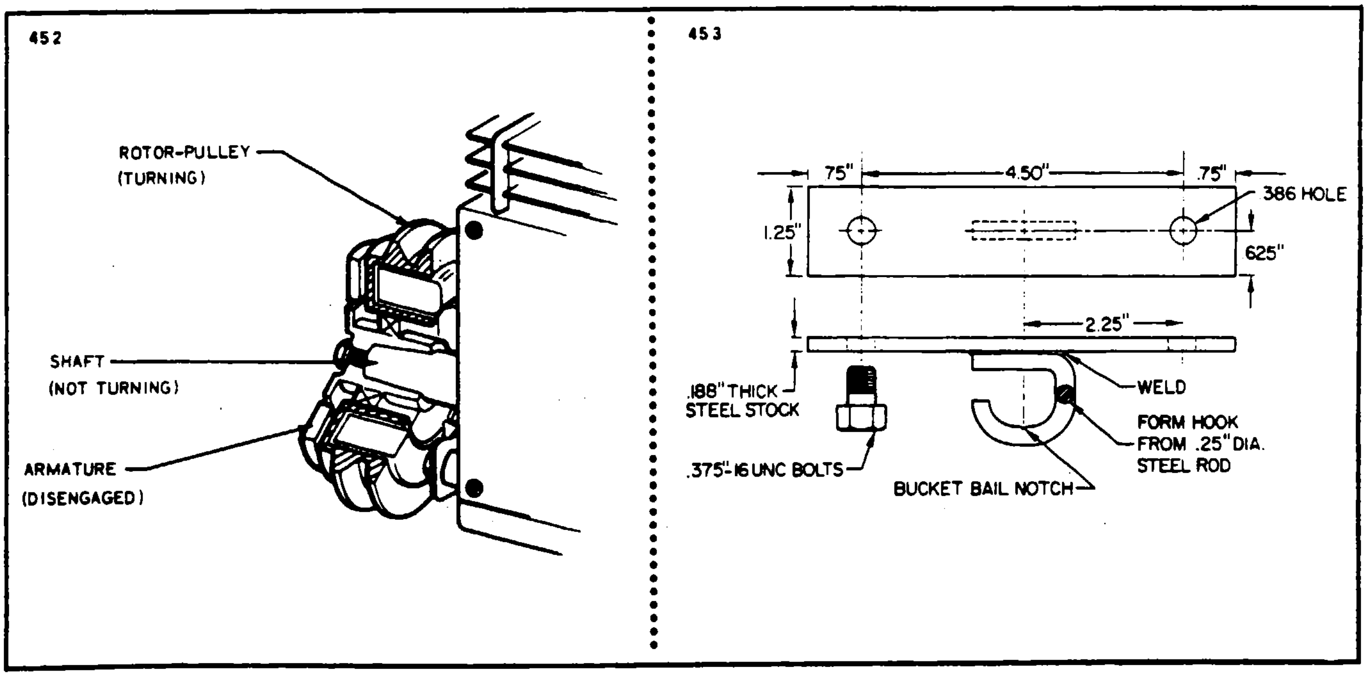


Figure 13-29. Magnetic Clutch and Fabricated Drive Belt Tension Adjustment Bracket

CAUTION

Do not use a wheel puller on the outer diameter of the pulley. This can damage the pulley grooves or clutch bearing.

c. Cut the lockwire on the four bolts securing the field assembly against the compressor bosses and remove the bolts, washer and field assembly.

13-93. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 13-29.)

a. Position the field assembly against the compressor bosses with the electrical leads at the top.

b. Secure the field assembly to the compressor with four bolts and torque to 85 to 120 inch lbs. Safety wire all four bolts. (Use caution not to strip the threads in the compressor body.)

NOTE

The compressor shaft must be clean and free from burrs. Check the Woodruff key for proper position and seating.

c. Align the keyway in the rotor-pulley assembly with the Woodruff key in the compressor shaft.

d. Slide the pulley assembly on to the tapered shaft and secure with washer and self-locking cap screw. Torque the cap screw to 180 to 240 inch lbs.

NOTE

If the clutch is not engaged while tightening the cap screw, insert a spanner wrench into the holes provided in the armature face.

e. Spin the pulley by hand to check for any interference between the field and rotor-pulley assemblies. A rubbing noise can be heard as the pulley rotates if there is interference. The rotor pulley assembly must be removed and the mounting of the field assembly adjusted until the interference is eliminated.

13-94. CONDENSER.

13-95. CONDENSER REMOVAL.

a. Remove the access panels on both sides of the right nacelle, aft of station 116.50 and also the panel in front of the air scoop on top of the nacelle.

b. Disconnect the actuating arms from the air scoop and lay the scoop toward the rear of the nacelle.

c. With the system completely discharged, disconnect the two lines on the outboard side of the condenser.

NOTE

Cap the open lines to prevent moisture and dust from contaminating the system.

d. Remove the bolts which hold the condenser to the mounting brackets in the nacelle by reaching through the holes on the sides of bulkheads 89.31 and 65.69 forward of the condenser.

e. Lift the condenser out of the top of the nacelle, being careful not to bend any of the fins on the condenser core.

13-96. CONDENSER INSTALLATION.

a. Install the condenser into the nacelle through the opening at the top, being certain that the connections on the condenser are outboard and facing forward.

CAUTION

Do not bend the fins during the handling of the condenser.

b. Position the condenser on the mounting bracket and secure in place with six bolts, three on each side. These bolts are installed from the forward side of the mounting brackets, back through the mounting flange on the condenser.

NOTE

It is advisable to change the receiver-dryer whenever the system has been open to the atmosphere.

c. Remove the protective caps from the Freon lines and complete the hookup of the lines to the condenser. Apply a small amount of Loctite refrigerant sealant to the flare only before making the connections to insure a leak free connection. (Torque the fittings - refer to Table XIII-IV.)

d. With the condenser secured in place, proceed to evacuate and recharge the system in accordance with instructions given in paragraphs 13-79 and 13-80.

e. When the system is completely charged, check it for any leaks, in accordance with paragraph 13-76.

f. Replace the access panels and connect the actuating arms to the air scoop. Check adjustment of scoop in accordance with paragraph 13-97.

13-97. ADJUSTMENT OF CONDENSER AIR SCOOP.

a. Adjust actuating motor to stop with approximately 0.66 of an inch between the scoop and the top of the nacelle by adjusting the door actuating arms to close the door tight.

b. Check operation of scoop by selecting the air conditioning mode at the cabin comfort panel with the selector switch in the manual position, and the master switch on. The scoop must open.

c. Adjust the screw on the torque tube tab to open the door three inches.

d. Select the heating mode to close the scoop.

13-98. RECEIVER-DRYER.

13-99. RECEIVER-DRYER REMOVAL. This unit is located next to the evaporator in the nose section of the airplane.

a. Remove the right access panel on the nose section.

b. Discharge the system of all refrigerant before continuing with the removal of the receiver-dryer. Disconnect the refrigerant lines at the receiver-dryer and cap the ends of the lines to prevent contamination of the system.

d. Loosen the two clamps and remove the receiver-dryer from its mounting bracket.

NOTE

This part is not serviceable. It must be replaced with a new one. (Refer to PA-31P Parts Catalog.)

13-100. RECEIVER-DRYER INSTALLATION.

a. Mount the new dryer in the mounting bracket and ascertain that the proper parts are facing the appropriate freon lines.

b. Install new "O" rings (refer to PA-31P Parts Catalog) on the line fittings and lubricate the "O" rings.

c. Uncap and connect the refrigerant lines to the dryer.

CAUTION

Torque the fittings. (Refer to Table XIII-IV.)

d. Evacuate and recharge the system in accordance with paragraphs 13-79 and 13-80.

e. Install the right access panel on the nose section of the airplane.

13-101. EXPANSION VALVE.

13-102. EXPANSION VALVE REMOVAL. (Refer to Figure 13-30.)

a. Remove the access panel on the right side of the airplane nose section.

b. Discharge the system before trying to remove any components. This is done by removing one of the compressor gauge ports and cracking the service valve (see Figure 13-21) letting the Freon escape slowly.

c. Remove the evaporator, shroud, receiver-dryer and related hardware from the airplane. (Refer to paragraphs 13-108 and 13-99.)

d. With the evaporator removed, it is now possible to remove the expansion valve.

CAUTION

Do not kink the capillary tube during removal.

13-103. EXPANSION VALVE INSTALLATION. (Refer to Figure 13-30.)

a. Install the expansion valve to the evaporator and secure the capillary tube to the evaporator outlet line and apply Presstite insulating tape. (Refer to Figure 13-32.)

CAUTION

Do not kink the capillary tube during installation.

b. Install the assembled evaporator into the airplane. (Refer to Paragraph 13-109.)

c. When all the connections are secured and the Presstite insulating tape is installed, proceed to evacuate and charge the system. (Refer to Paragraphs 13-79 and 13-80.)

d. After charging the system, it should be checked for any leaks. (Refer to Paragraph 13-76.)

e. Install the access panel on the right side of the nose section.

13-104. EVAPORATOR CONTROL VALVE.

13-105. EVAPORATOR CONTROL VALVE REMOVAL. (Refer to Figure 13-31.)

a. Remove the access panel on the right side of the nose section.

b. Discharge the system before trying to remove any of the components.

c. Remove the insulating tape from around the Evaporator Control Valve.

d. Disconnect the lines from the Evaporator Control Valve and cap the open ends.

e. Disconnect the clamp which holds the Evaporator Control Valve to the evaporator shroud and remove the valve from the airplane.

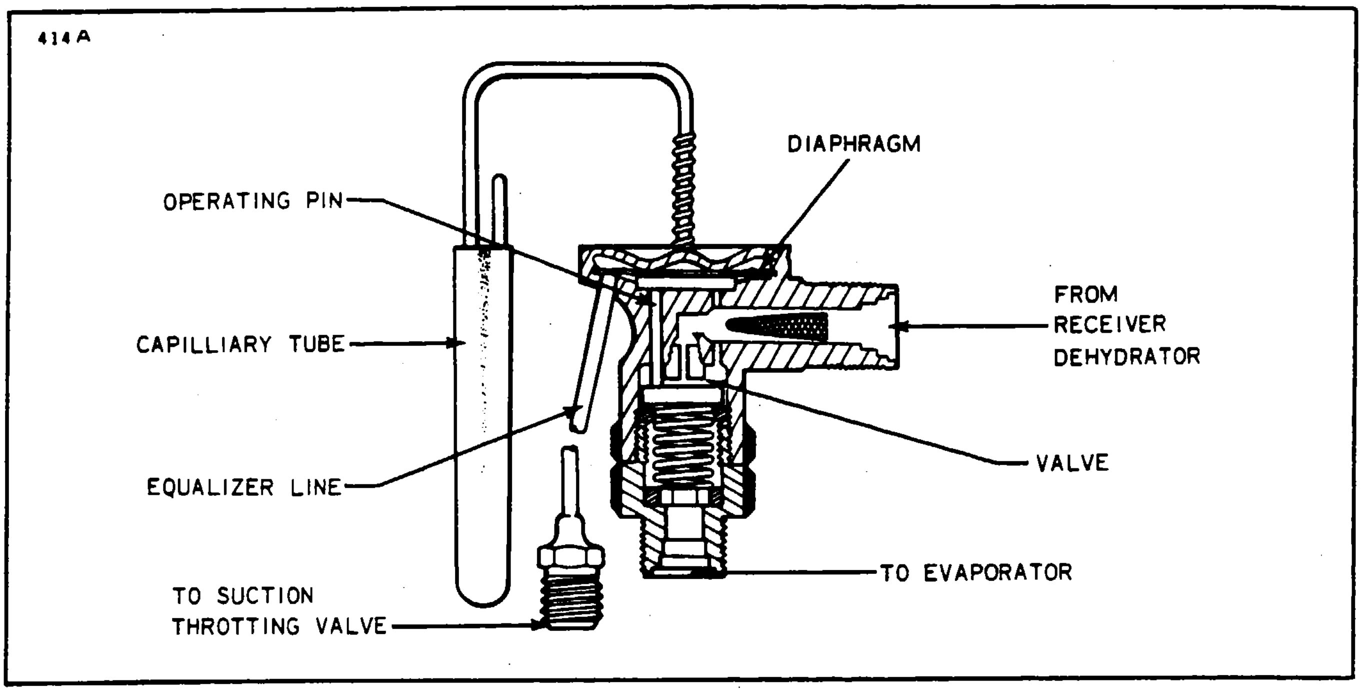


Figure 13-30. Expansion Valve

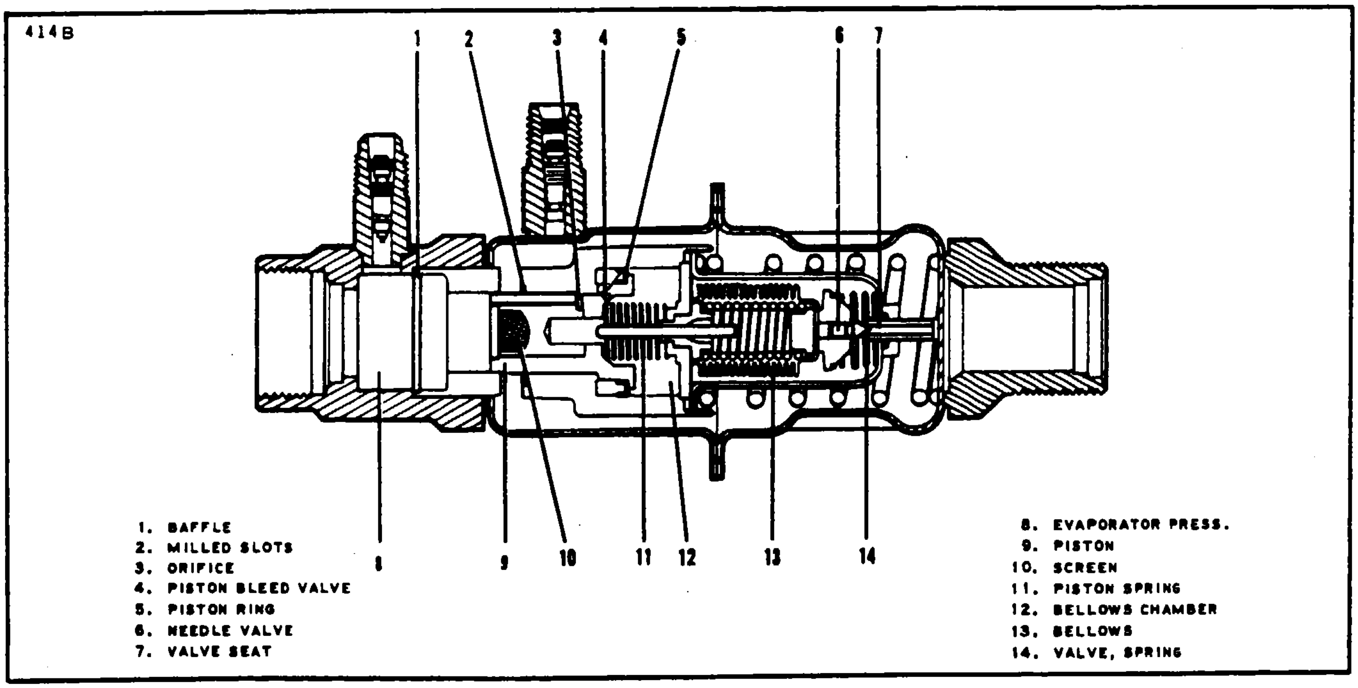


Figure 13-31. Evaporator Control Valve

13-106. EVAPORATOR CONTROL VALVE INSTALLATION. (Refer to Figure 13-31.)

a. Install the Evaporator Control Valve into the airplane as shown in Figure 13-32 and secure it to the evaporator with the existing clamp and connect the Freon lines to the valve.

b. Apply the Presstite insulating tape around the valve and related lines as shown in Figure 13-32.

c. Evacuate and charge the system in accordance with Paragraphs 13-79 and 13-80.

d. Test the system for leaks. (Refer to Paragraph 13-76.)

e. Install the access panel on the airplane and secure it.

13-107. EVAPORATOR.

13-108. EVAPORATOR REMOVAL. This unit is mounted in front of the heater and is enclosed in a fiberglass shroud.

a. The air conditioning system must be completely discharged of refrigerant by removing the protective caps from the service valves and slowly (to prevent oil loss) turn the valves to the cracked position and allow the Freon to escape.

b. Remove the air conditioning duct extending over the heater from the evaporator shroud.

c. Disconnect the forward V-band clamp between the heater and evaporator shroud.

d. Remove the four screws which hold the evaporator shroud in place.

e. Disconnect the refrigerant lines from the receiver-dryer and loosen the clamps and remove the dryer.

f. Remove the insulation on the Evaporator Control Valve and disconnect the refrigerant line which leaves the Evaporator Control Valve.

NOTE

It is advisable to cap all open refrigerant lines when the system is opened to prevent entrance of moisture and dirt.

g. Remove the recirculation fan in accordance with Paragraph 13-30.

h. Open the access plate on the airplane below the evaporator shroud and disconnect the pressurized air inlet line to the shroud. The removal of the heater assembly would expedite the removal of the evaporator.

i. The complete shroud, evaporator, Evaporator Control Valve, and expansion valve can now be lifted out of the compartment for service.

j. The shroud can be separated to remove the evaporator by removing the machine screws and nuts around the edges of the shroud.

13-109. EVAPORATOR INSTALLATION.

a. Secure the two halves of the shroud together around the evaporator with machine screws and nuts, if it was separated. Apply a bead of fuselage sealant between the two halves before securing them. Unit must not leak as it forms part of the Pressurization Envelope.

b. Install the expansion valve and Evaporator Control Valve to the evaporator shroud as shown in Figure 13-32.

c. Install the complete shroud, evaporator, Evaporator Control Valve, and expansion valve into the airplane.

d. Connect the pressurized airline to the lower end of the evaporator shroud and secure with clamp. Also, route the drain hose through the grommet in the fuselage.

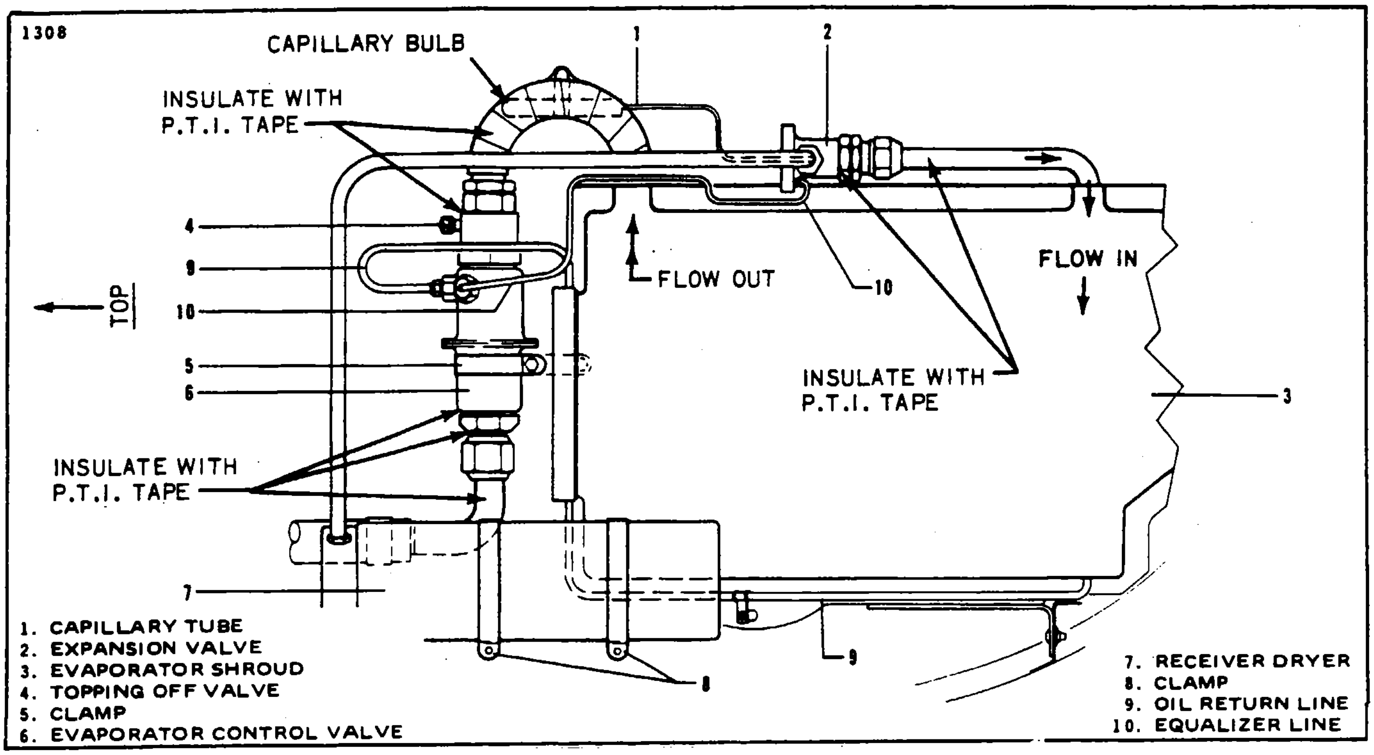


Figure 13-32. Component Installation

e. Install the recirculation fan in accordance with Paragraph 13-30.

f. Connect the refrigerant lines to the Evaporator Control Valve and replace P.T.I. Presstite insulation tape around the Evaporator Control Valve.

g. Install a new receiver-dryer in the mounting bracket and secure it in place with two clamps.

h. Connect the other refrigerant lines to the receiver-dryer.

i. Move the evaporator shroud assembly aft till it is tight against the end of the heater, then install the four screws to secure the shroud assembly in place. (Do not tighten mounting screws until V-band clamp is installed.)

j. Install and secure the V-band clamp around the end of the heater and evaporator shroud.

k. Install the air conditioning air duct over the heater and secure it to the evaporator shroud outlet.

l. Evacuate and recharge the system in accordance with paragraph 13-79 and 13-80.

m. Install the access plate and panels on the nose section of the airplane.

NOTE

Before installing new "O" ring seal, lubricate the "O" rings with refrigerant oil and torque the fittings. (Refer to Table XIII- IV.)

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONER)

Gauge Indication	Probable Causes	Remedy
High discharge pressure.	Overcharge of refrigerant.	Purge excess refrigerant.
	Air in system.	Check for leaks. Bleed charge from system. Evacuate and recharge system.
	Overheated condenser due to blocking air passage.	Clean bugs and dirt from condenser fins. Straighten fins if bent.
	Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve.	Check that capillary bulb is securely clamped to suction line. If capillary bulb OK replace expansion valve.
	Restriction in liquid line from condenser.	Check for kinked hoses and stopped up filter.
Low discharge pressure.	Undercharge of refrigerant. Sight glass shows bubbles or foam.	Add refrigerant until bubbles disappear. Check system leaks.
	Damaged compressor valves or dirt under valves.	Replace compressor
	Blown gasket.	Replace compressor
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
Low suction pressure. (Accompanied by icing evaporator.)	Low air supply through evaporator.	Repair blower or blower motor. Clean stoppage in air ducts.
	Faulty Evaporator Control Valve.	Replace.
	Very dirty evaporator fins and coils.	Clean and flush with water.
Low suction pressure. (evaporator not cold enough) suction gauge may read a vacuum indicating evaporator lacks refrigerant.	Undercharge of refrigerant. Moisture freezing in expansion valve. Valve will show frost.	Add Freon. Install new dryer. Evacuate and recharge system.
	Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary bulb has lost its charge.	Remove screen. Clean with solvent and replace. Warm capillary by holding in hand. If suction pressure does not charge, replace expansion valve.
	Restriction anywhere in liquid line. Restriction will show frost.	Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost.	Clean contact surfaces of suction line and cap bulb. Tighten clamp.
	Expansion valve not closing. Evaporater flooded. Suction line frosted to compressor.	Replace expansion valve.

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
High suction pressure(cont.)	Compressor drive belt slipping.	Adjust belt tension.
	Magnetic clutch slipping.	Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil.
	Strainer at suction service valve clogged.	Clean with solvent and/or replace
	Leaking or broken compressor valves.	Replace compressor

Trouble	Cause	Remedy
System produces no cooling.	Electrical	
	Open circuit breaker.	Reset circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections; check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire to see if loose, broken, or disconnected.
	Clutch coil or solenoid burned out or disconnected.	Check current flow to clutch or solenoid - replace if inoperative.

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
System produces no cooling.(cont.)	Electrical	
	Thermostat sensing element defective.	If system works in manual mode, check thermostat and cabin comfort control panel.
	Circulating fan motor disconnected or burned out.	Check current flow to blower motor - repair or replace if inoperative. 13-30.
	Mechanical	
	Loose or broken drive belt.	Replace drive belts and/or tighten to specifications. 13-89, and 13-90.
	Compressor partially or completely frozen.	Remove compressor for service or replacement. 13-85.
	Expansion valve stuck in open position.	Replace expansion valve. 13-101.
	Refrigeration	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary.

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
	Refrigeration (cont.)	
System produces no cooling. (cont.)	Compressor shaft seal leaking.	Replace compressor.
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
	Low refrigerant switch tripped due to low refrigerant charge.	Connect gauge set to Schrader valve on Evaporator Control Valve (Figure 13-22) and check system pressure. If pressure is below normal for ambient temperature (Table XIII-IIIA), check for leaks and recharge per Paragraph 13-80. If normal and above 55 psi (Table XIII-IIIA), start engine and check refrigerant level per Paragraph 13-82, f. If normal and below 55 psi (Table XIII-IIIA), connect a jumper wire across the low refrigerant switch; start engine and check refrigerant level per Paragraph 13-82, f.

NOTE

After completing repairs of any above causes, the system must have the dehydrator replaced. Then the complete system must be purged, evacuated, and recharged to remove excess moisture.

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling.	Electrical	
	Circulating fan motor sluggish in operation.	Remove fan motor for service or replacement. 13-30.
	Mechanical	
	Compressor clutch slipping.	Remove clutch assembly for service or replacement. 13-91.
	Obstructed blower passage.	Examine entire passage for obstruction. Correct as necessary.
	Insufficient air circulation over condenser coils; fins clogged with dirt or bugs.	Clean condenser coils.
	Evaporator clogged.	Clean with compressed air. Use cleaning solvent to remove cigarette tars.
	Evaporator Control Valve defective.	Replace Evaporator Control Valve. (Refer to Paragraph 13-104.)
	Refrigeration	
	Insufficient refrigerant in system.	Recharge system until bubbles disappear in receiver and gauge readings stablize to specifications. (Refer to Paragraph 13-80.)
	Clogged screen in expansion valve.	Purge system and replace expansion valve. (Refer to Paragraph 13-101.)

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling. (cont.)	Mechanical	
	Expansion valve thermal bulb has lost charge.	Purge system; replace expansion valve. 13-101.
	Clogged screen in receiver.	Purge system; replace receiver. 13-98.
	Excessive moisture in system.	Purge system; replace receiver. 13-98.
	Air in system.	Purge, evacuate and charge system. 13-79, 13-80. (Replace receiver.)
NOTE When a unit must be removed from the system for service or replacement, the system must have the dehydrator replaced also, and the system must be purged, evacuated, and recharged to remove excess moisture.		
Excessively noisy system.	Electrical	
	Defective winding or improper connection in compressor clutch coil or solenoid.	Replace or repair as necessary. 13-91.
	Mechanical	
	Loose or excessively worn drive belts.	Tighten or replace as required. 13-89 and 13-90.
	Noisy clutch.	Remove clutch for service or replacement as necessary. 13-91.

TABLE XIII-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
Excessively noisy system. (cont.)	Mechanical	
	Compressor noisy.	Check mountings and repair; remove compressor for service or replacement. 13-85.
	Compressor oil level low.	Fill with correct specified oil. 13-88.
	Circulating fan noisy; excessive wear in blower motor.	Remove blower motor for service or replacement as necessary. 13-30.
	Refrigeration	
	Excessive charge in system.	Discharge excess freon until high pressure gauge drops within specifications.
	Low charge in system.	Check system for leaks; charge system. 13-79, 13-80.
	Excessive moisture in system.	Replace dehydrator; purge, evacuate, and charge system.

13-110. PRESSURIZATION SYSTEM.

13-111. DESCRIPTION AND PRINCIPLES OF OPERATION. Pressurization air for the cabin of the PA-31P is obtained by bleeding air through a sonic nozzle mounted on each engine turbocharger, and is supplemented by pneumatic engine driven pumps whose primary function is to supply pressurized air for the airplanes's pneumatic system. This set-up provides two sources of pressurized air from each engine. This air is routed through check valves and proceeds to the main pressure line below the cabin floor. It then passes through the pressurized air control box assembly which controls the flow of air that is to be routed to the cabin or overboard. If the air is not needed for pressurization, the control box is actuated to discharge the air below the cabin floor and allowed to flow overboard. When the control box is closed, the air is directed through the environmental control system, and through the air distribution ducts along both sides of the cabin walls. All controls needed for operation and regulation of cabin pressurization are mounted on the lower left side of the instrument panel, along with instruments to simplify setting and check system operation. Both the cabin altitude and rate-of-climb adjustments are controlled by the pilot, through the use of the cabin altitude selector and the cabin rate of change control. This unit is electrically operated off the 24-volt D.C. electrical system of the airplane. Lights indicate whether the unit is on "Ascent" or "Descent" mode of operation. The rate of ascent or descent is variable from 100 to 1,000 feet per minute. A manual cabin altitude selector overrides the electrical control to permit the manual selection of cabin altitude over a range of 500 feet below sea level, to 10,000 feet above sea level. A filtration assembly is part of the control unit. The altitude instrument indicates cabin altitude in feet and the rate-of-climb instrument indicates the rate in which the cabin altitude is changing in feet per minute. The cabin differential pressure gauge indicates the differential pressure between the cabin and outside atmosphere. A pressure warning light mounted on the upper left instrument panel, along with other warning lights, warns the pilot of the cabin differential pressure goes above 5.65 psi by flashing or glows continuously if the cabin altitude is above 10,000 feet above sea level. On serial nos. 31P-1 to 31P-7630019 inclusive a manually controlled dump valve is incorporated in the system to unload the cabin pressure, and on serial nos. 31P-7730001 and up, cabin pressure is unloaded by lifting the access cover to the emergency gear extension lever, if the automatic valves malfunction. A squat switch on the left main landing gear prevents the cabin from being pressurized while the airplane is on the ground. A test switch is incorporated to override the squat switch when testing the system on the ground.

13-112. PRESSURIZATION CONTROLS. The controls and instruments used to operate the pressurization system are grouped together to simplify operation. Both the cabin altitude and rate-of-climb pressure adjustments are controlled by use of the cabin altitude selector and the cabin rate of change control. The altitude instrument indicates cabin altitude in feet and rate-of-climb instrument indicates the rate in feet per minute of cabin altitude change. The cabin differential pressure gauge indicates the difference between the cabin interior and the outside atmosphere. A differential pressure warning light is mounted on the upper left instrument panel along with other warning lights to warn the pilot if the cabin differential pressure passes above 5.65 psi. A manually controlled dump valve is incorporated in the system to unload the cabin pressure in an emergency situation before landing. The dump valve is included on airplanes with serial nos. 31P-1 to 31P-7630019 inclusive. On airplanes with serial nos. 31P-7730001 and up, cabin pressure is unloaded in an emergency situation by lifting the access cover to the emergency gear extension lever. The airplane is not approved for landing with the cabin pressurized. A squat switch on the left main landing gear prevents the cabin from being pressurized while the airplane is on the ground. A test switch is used to override the squat switch when testing the pressurization system before take-off.

NOTE

Any service to the pressurization system should be accomplished by a shop which is equipped and has qualified personnel to perform this service.

13-113. OPERATING INSTRUCTIONS.

a. The following steps should be performed before take-off to insure proper functioning of the pressurization system.

1. Set engine power at 1600 RPM.
2. Set manual air control lever in the pressurized air position.
3. Set cabin altitude selector below field elevation (500 feet).
4. Ascertain that the manual dump control is closed.
5. Activate the test switch to bypass the landing gear safety switch.

NOTE

The system is now in the process of pressurizing the cabin. The cabin rate-of-climb instrument should be observed for a descent indication to show that the system is operating.

6. Release the test switch. This will automatically return to the OFF position and stop the pressurization of the cabin. The landing gear safety switch will cause the dump valve to open and release the cabin pressure.
7. Reset the altitude selector to 500 feet above field elevation.
8. If a prolonged ground delay is evident, set the manual air control lever to outside air to obtain good ventilation.

b. The following steps should be performed to set the pressurization controller for in-flight use.

1. Position the manual air control lever to pressurized air.
2. Set the cabin altitude selector to the desired cabin altitude.
3. Move the cabin ascend, descend switch to the particular mode of operation.
4. Adjust the rate-of-change control to one fourth of the airplane's rate-of-climb or descent (select rate which is comfortable to the passengers).
5. Before descending, reset the cabin altitude selector of field elevation plus 500 feet.
6. Set the cabin ascend, descend switch to descend position.
7. Adjust the rate-of-change control for a comfortable rate of descent.

NOTE

When the airplane reaches pattern altitude, the cabin differential pressure will be equal to the outside air.

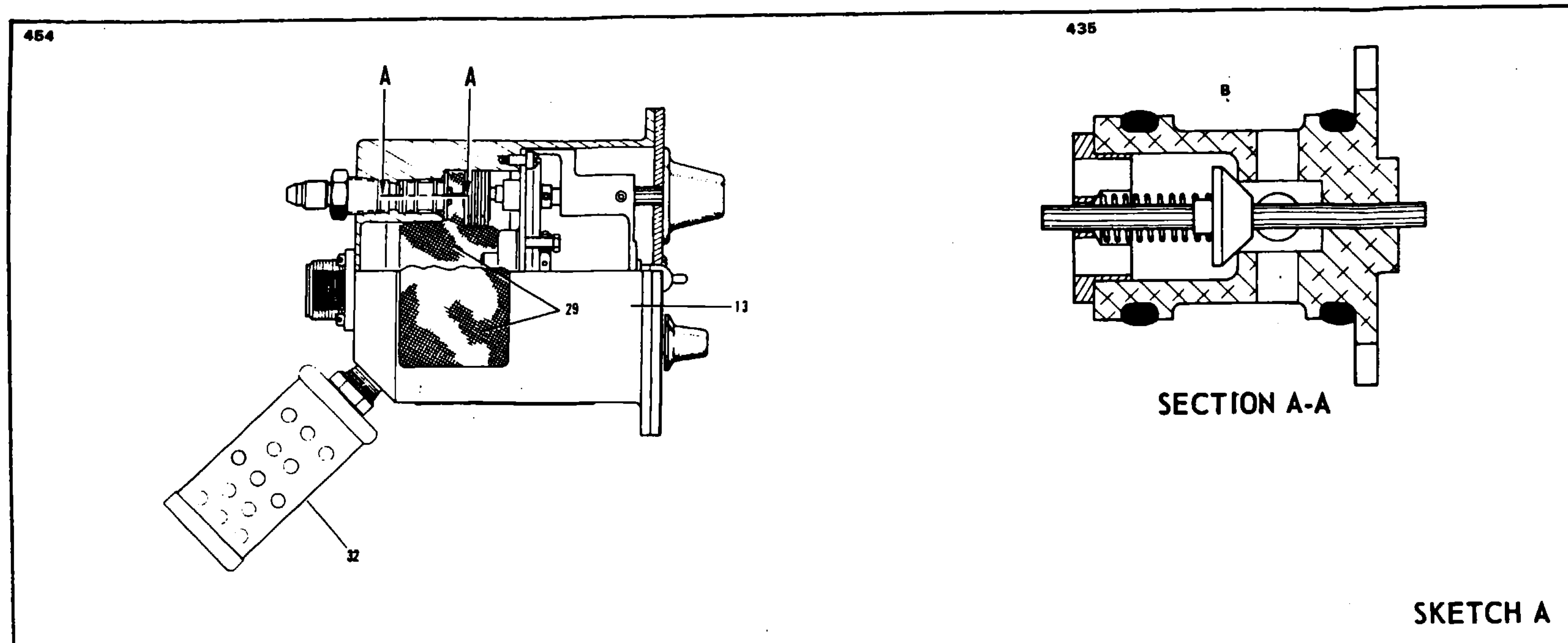
13-114. CABIN PRESSURIZATION CHECK. This pressurization check should be conducted whenever 5.40 to 5.50 psi cabin differential cannot be maintained and/or during every 500 hour inspection. The major areas to be considered when troubleshooting the pressurization system are:

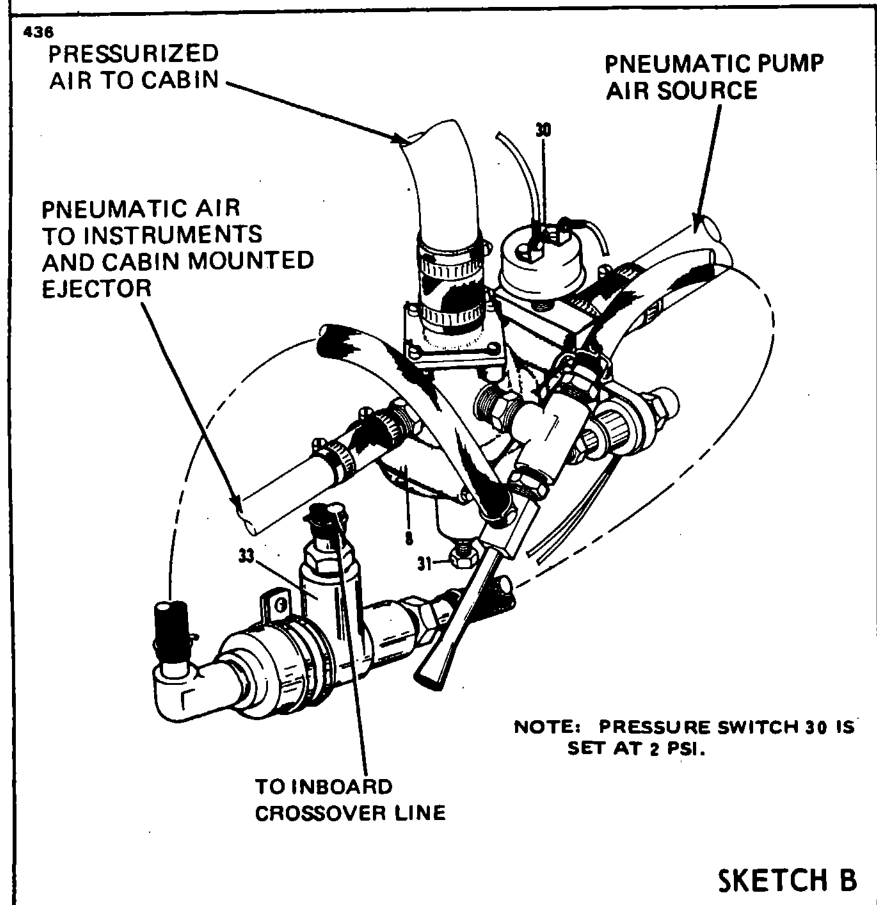
a. The engines and turbochargers.
b. The cabin pressurization control system.
c. The pressurization capsule of the fuselage.

There are two methods of performing these checks; one is a flight check using the instructions given in paragraph 13-113, the other is with the use of a special test unit which can be purchased through Piper Aircraft Corporation and the instructions given in paragraph 13-115. This test unit makes it possible to perform checks b and c in the hangar or shop without operating the engines.

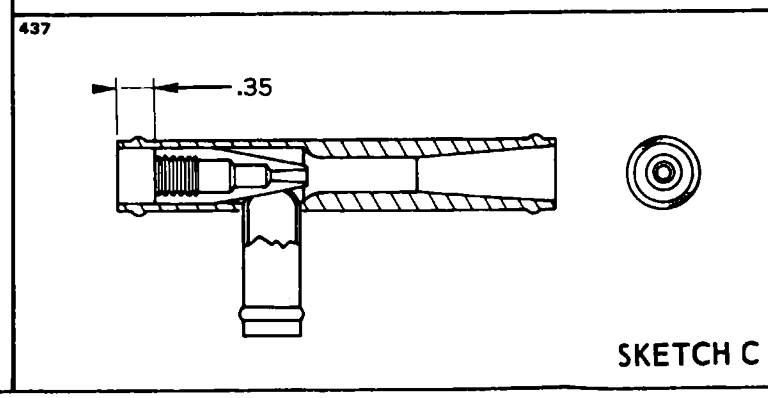
During check a, a normal system will show a momentary rise in cabin altitude followed by a return to a stable condition on the cabin rate-of-climb indicator, when the engines are throttled one at a time from 1800 RPM and 30" of manifold pressure at altitude.

In order to check for leak rate without the test unit the aircraft must be flown to 13,000 feet, the controller set to 1000 feet, the airplane pressurized, and following steps performed:





1. PNEUMATIC PUMP	19. PRESSURE TANK
2. TURBOCHARGER	20. DOOR SEAL
3. SONIC NOZZLE	21. ISOBARIC VALVE
4. INDUCTION AIR FILTER	22. BLEED LINE
5. ALTERNATE AIR SOURCE	23. BLEED SETTING ADJUSTMENT
6. CHECK VALVE	24. SAFETY VALVE
7. ALTERNATE AIR DOOR	25. CABIN PRESSURE WARNING SWITCH
8. REGULATOR	26. RUPTURE DIAPHRAGM
9. FILTER	27. STATIC SOURCE
10. FILTER	28. STATIC SOURCE
11. PRESSURIZATION DUMP VALVE	29. FILTER SCREENS
12. EJECTOR	30. PRESSURE SWITCH
13. PRESSURIZATION CONTROLLER	31. ADJUSTMENT SCREW
14. PRESSURIZATION LINE	32. TOBACCO FILTER
15. PRESSURIZED AIR CONTROL BOX	33. SOLENOID VALVE
16. INSTRUMENT LINE	34. SOLENOID VALVE
17. PRESSURIZATION CONTROL LINE	
18. RELIEF SOLENOID	



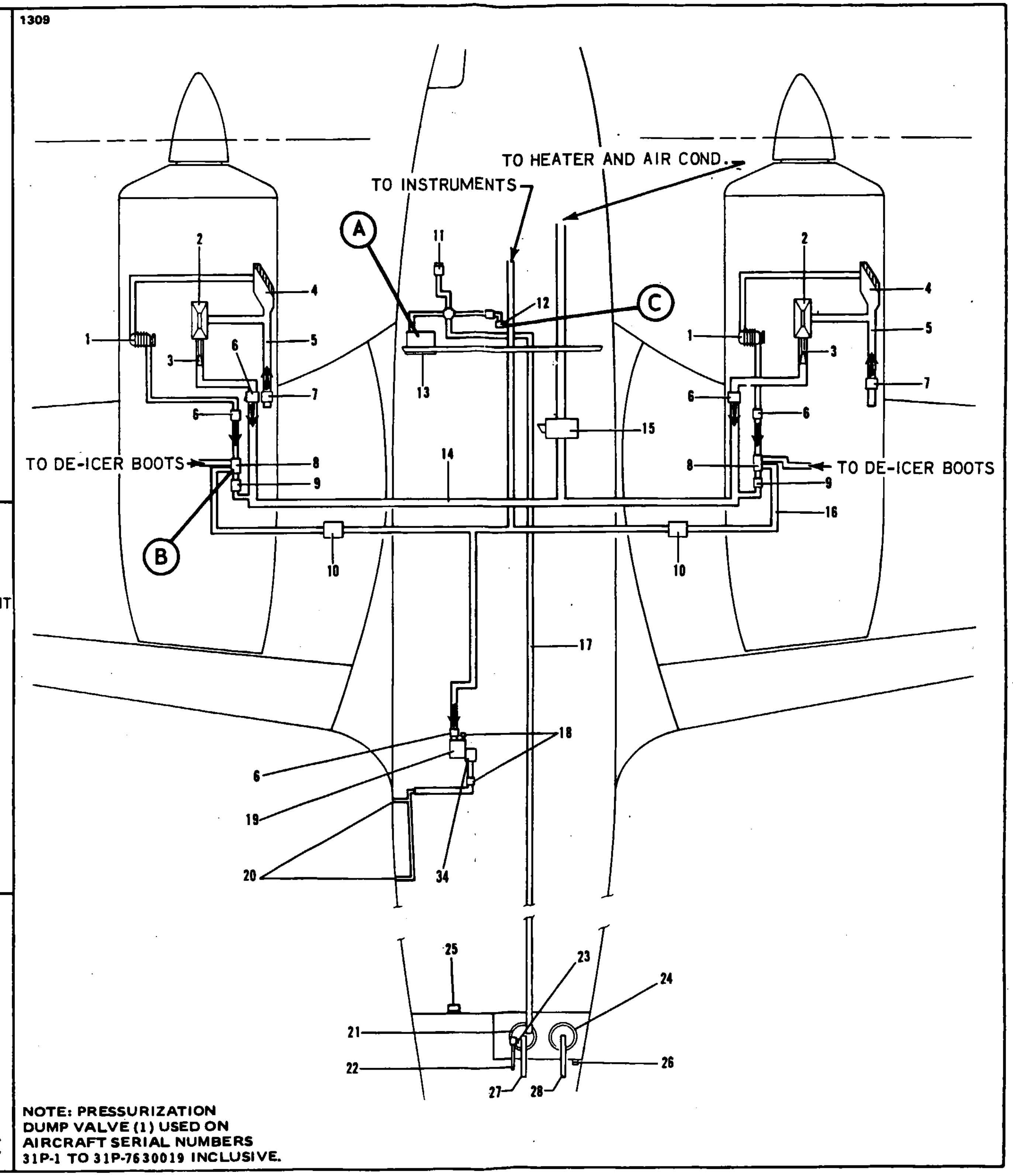


Figure 13-33. Pressurization System Installation

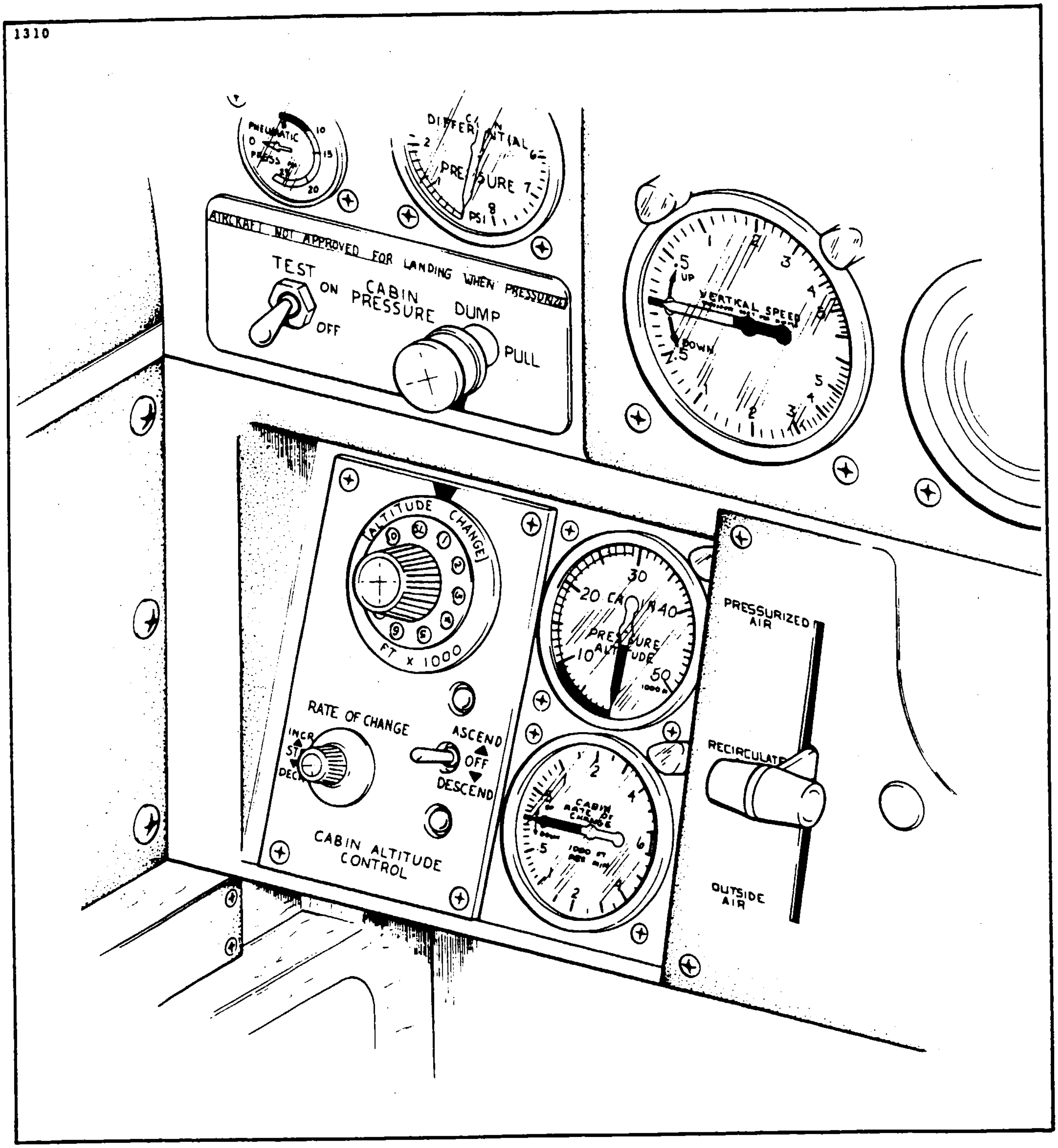


Figure 13-33a. Pressurization Controls
Serial Nos. 31P-1 thru 31P-7300132

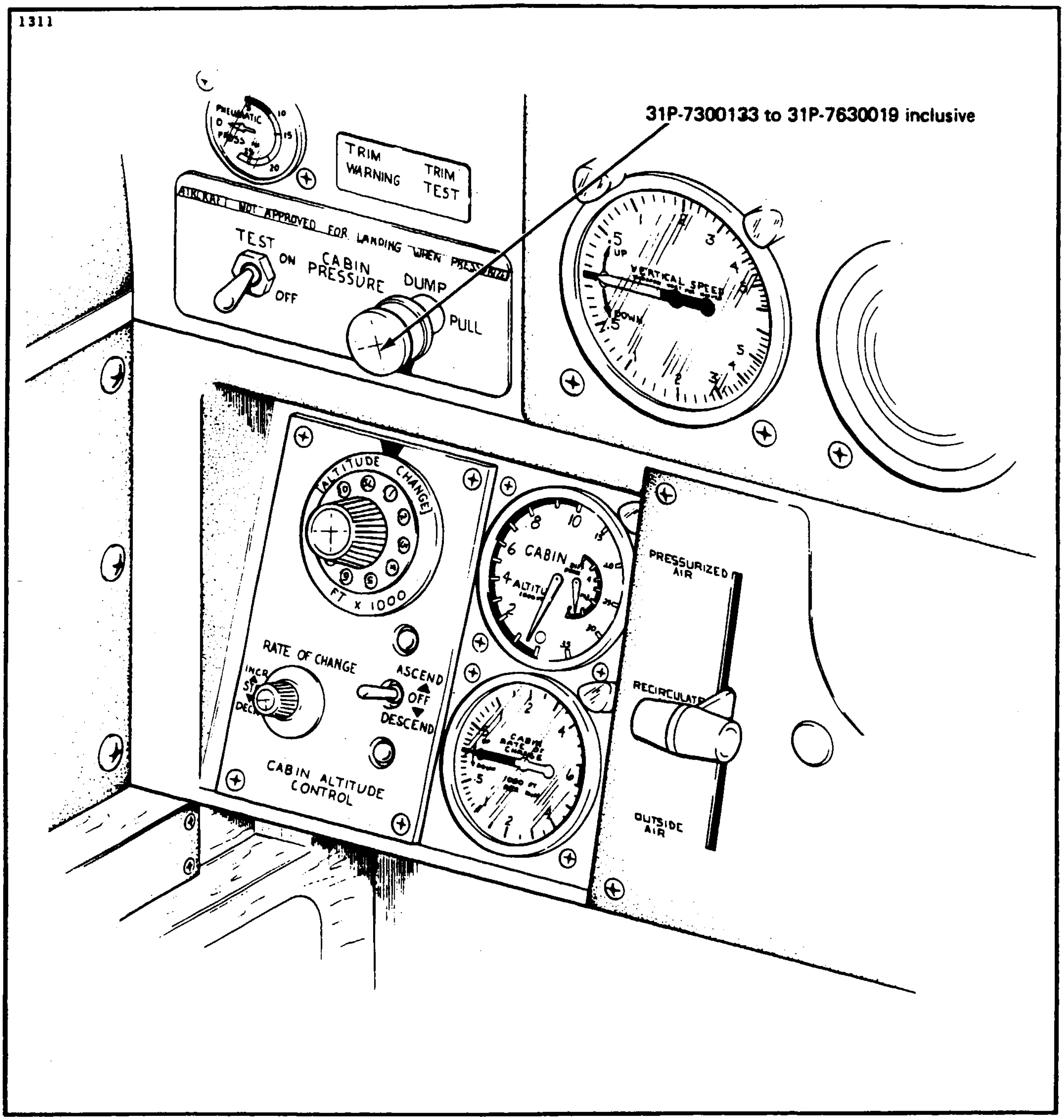


Figure 13-34. Pressurization Controls
Serial Nos. 31P-7300133 and up

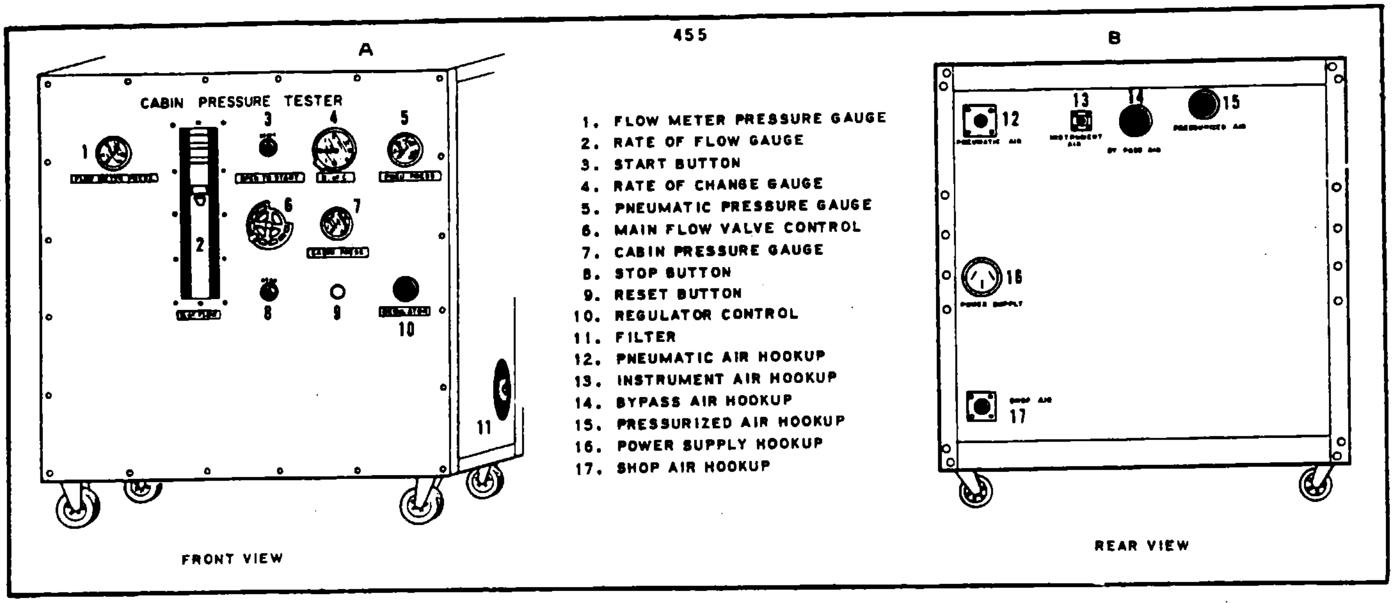


Figure 13-34a. Old Pressurization Test Unit

a. Set the props to 2000 RPM.
b. Set manifold pressure to 24" Hg.
c. Establish a 1000 feet per minute rate of aircraft descent.
d. Slowly pull the throttles back to idle position and maintain the rate of descent.
e. Check the cabin altitude and rate of change.

A normal system may show a momentary cabin climb which will stabilize to a constant cabin altitude or show a rate of descent. If this does not occur and the cabin shows a continuous rate of climb, then check for excessive leakage in the cabin pressurized air ducts.

NOTE

There are several uncapped vent ports in both the front and rear pressure bulkheads. These vent ports must remain open and should not be closed off in any way.

13-115. PRESSURIZATION CHECK WITH TEST UNIT. (Refer to Figures 13-34a, b, c, d, e, f, g and h.)

a. Aircraft Preparation:

1. Remove the left engine upper cowling and the access panels at the rear of the fuselage at station 275.0 to gain access to the rear of the pressure bulkhead.

2. Remove the access panels on the rear of the aft pressure bulkhead to gain access to the isobaric and safety valves.

3. Remove the access panel on the right side of the nose section forward of station 81.00.

4. Remove the trim panel in front of the isobaric and safety valves and disconnect the pressurization control line from the isobaric valve.

5. Move the pressurization control lever to the pressurized position.

b. Test Unit Hookup:

1. Disconnect the pneumatic line by removing the hose from the elbow on the pneumatic pump on the left engine and connect the instrument air line from the test unit as shown in Figure 13-34c.

2. Hookup pneumatic air or pressurizing air from test unit as follows:

(a) Preferred Method: Disconnect the pneumatic hose aft of the sonic nozzle and connect pneumatic air hose from the test unit as shown in Figure 13-34d.

(b) Optional Method: Disconnect and remove the fresh air distribution tube from the air distribution box. Cap the hose from the distribution box with a cap plug fabricated per Figure 13-34g. Connect the pneumatic air line from the test unit to the distribution hose at the forward pressure bulkhead per Figure 13-34f. Make the connection using a fabricated reducer as shown in Figure 13-34h.

3. Remove the protective plug from the fitting identified by the placard stating "Cabin Pressure Test" located on the forward pressure bulkhead (station 81). Connect the cabin reference line from the test unit to the fitting. (Refer to Figure 13-34e.)

4. Connect the test unit to a source of pressurized shop air and connect the unit to a source of electrical power.

c. Test Unit Operation:

1. Deactivate all circuit breakers of operable systems except the cabin pressure control and door seal circuit breakers. Turn on the aircraft electrical power to activate the cabin door seal system.

2. If the airplane has not been placed on jacks, it will be necessary to disconnect electrical power to the vacuum relief solenoid, located above the pilot's rudder pedals behind the instrument panel, to prevent a leak path in the system.

3. Set the pneumatic system pressure on the test unit with the regulator control knob to 20 psi. A readjustment may be necessary after door seal inflation of 10 seconds.

4. Turn the flow rate valve knob to the full bypass position allowing the machine to be turned on, then start it.

5. Turn the flow rate knob in, or to the full increase position as fast as possible to obtain an input rate of flow to the cabin that will exceed the allowable leak rate from the cabin. This differential pressure is needed to close the isobaric and safety valves thus allowing the cabin to begin to pressurize. As the valves begin to close, this action is indicated on the test unit by the cabin rate of change indicator reading a dive. As soon as a dive is indicated, begin to close, or unscrew, the flow rate knob to a position sufficient to maintain a 2,000 foot per minute rate of descent on the rate change indicator. Allow the cabin differential pressure to rise to 5.0 psi.

NOTE

If no personnel are inside the pressurized cabin, the rate of change can be as high as 6,000 feet per minute.

6. When 5.0 psi is reached on the cabin differential gauge, decrease the main flow rate by rotating the flow rate knob until the cabin rate of change gauge indicates zero.

7. Maintain 5.0 psi cabin differential and zero on the rate of change gauge, by use of the regulator control on the test unit.

8. Observe the leak rate on the flow gauge. The normal reading is from 50 to 57 CFM.

NOTE

The reading of the flow gauge on the old unit is taken from the top of the float in the gauge.

9. A reading over 57 CFM on the flow gauge would indicate a bad leak or series of leaks in the pressure vessel which would require repair.

NOTE

There are several uncapped vent ports in both the front and rear pressure bulkheads which must remain open. Do not close these off in any way.

10. After all checks are completed, bring the cabin back down to standard pressure by slowly closing or unscrewing the large flow rate knob. If no one is inside the cabin, a 6,000 foot per minute change is okay otherwise do not exceed a 2,000 foot per minute change for purposes of comfort of the individual inside.

CAUTION

The machine cannot be turned off while there is a pressure differential in the cabin for purposes of rapid depressurization; however if the machine is unplugged, the latter result will occur causing serious discomfort to anyone that may be within the cabin.

11. The checks having been completed, disconnect all the various test unit connections from the aircraft and reconnect the original plumbing.

WARNING

Ascertain that the pressurization control line is reconnected to the isobaric valve and the protective plug installed over the fitting placarded "Cabin Pressure Test." Reconnect electrical power to the vacuum relief solenoid valve if previously disconnected.

12. Replace the access panels, trim panels and engine cowling.

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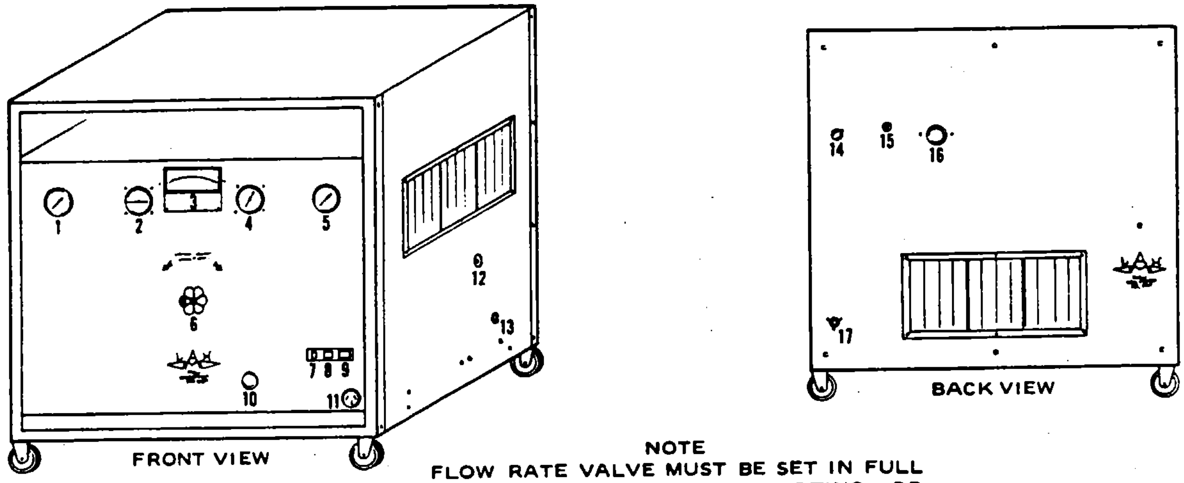
1312



NOTE
FLOW RATE VALVE MUST BE SET IN FULL PUMP BYPASS BEFORE STARTING OR STOPPING UNIT.

1. FLOW METER PRESSURE INDICATOR
2. RATE OF CLIMB INDICATOR
3. RATE OF FLOW INDICATOR
4. CABIN DIFFERENTIAL PRESSURE INDICATOR
5. INSTRUMENT AIR PRESSURE INDICATOR
6. FLOW RATE VALVE
7. CIRCUIT BREAKER
8. START BUTTON
9. STOP BUTTON
10. AIR REGULATOR VALVE
11. ELECTRICAL CONNECTION
12. FILL PORT
13. SIGHT GAUGE
14. INSTRUMENT AIR
15. CABIN REFERENCE
16. PNEUMATIC AIR OR PRESSURIZING AIR
17. SHOP AIR

Figure 13-34b. New Pressurization Test Unit (Typical)

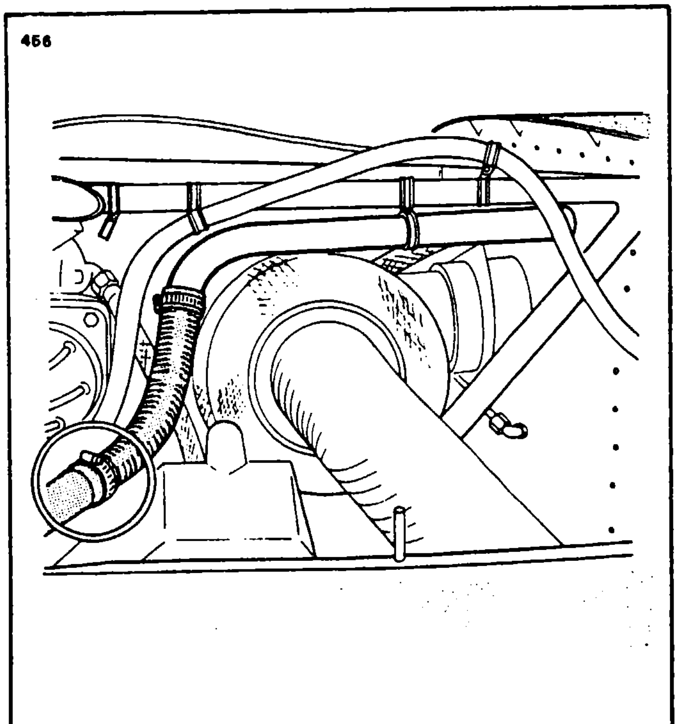


Figure 13-34c. Instrument Air Hookup

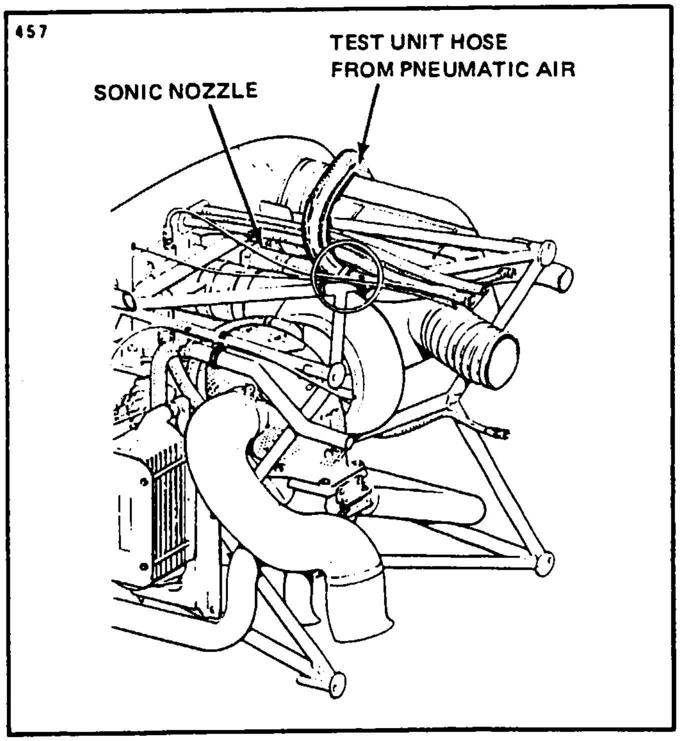


Figure 13-34d. Pneumatic Air Hookup (Preferred)

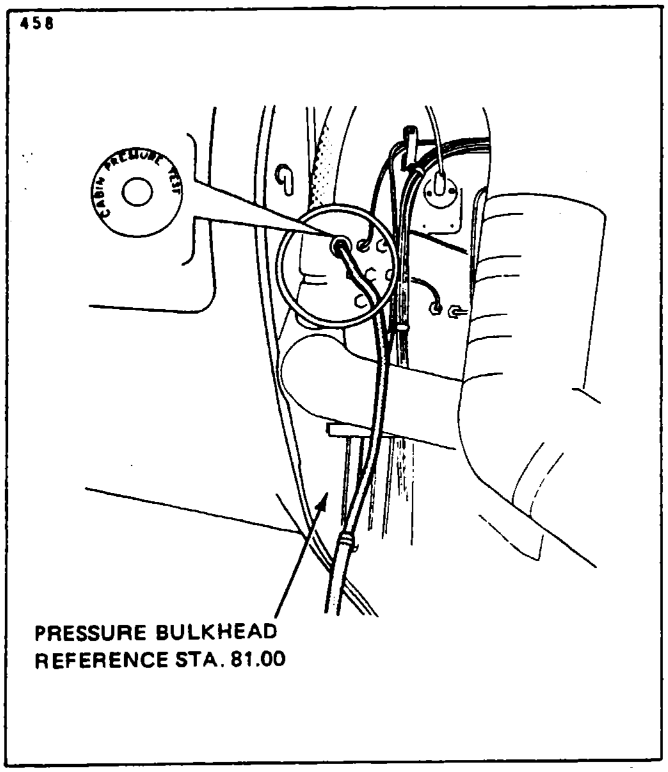


Figure 13-34e. Cabin Reference Hookup

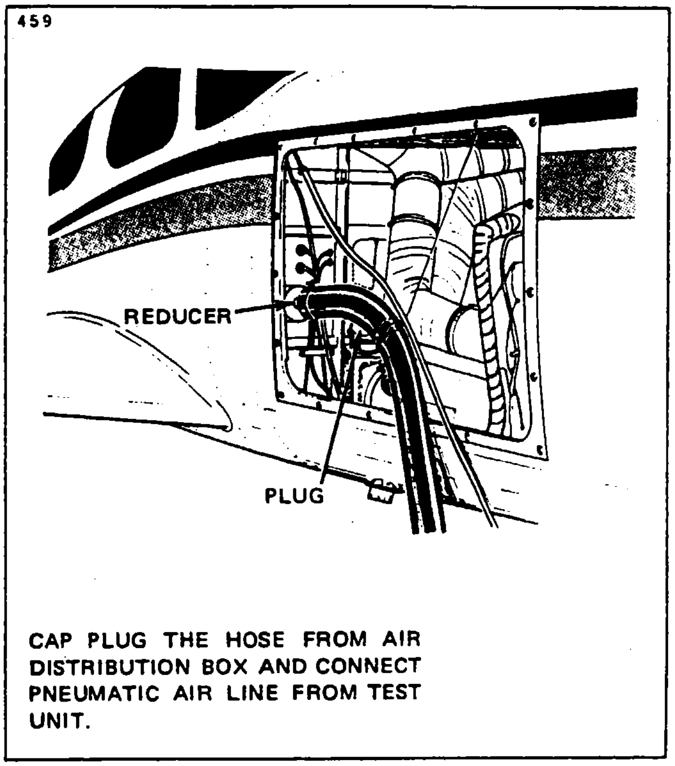


Figure 13-34f. Pneumatic Air Hookup (Optional)

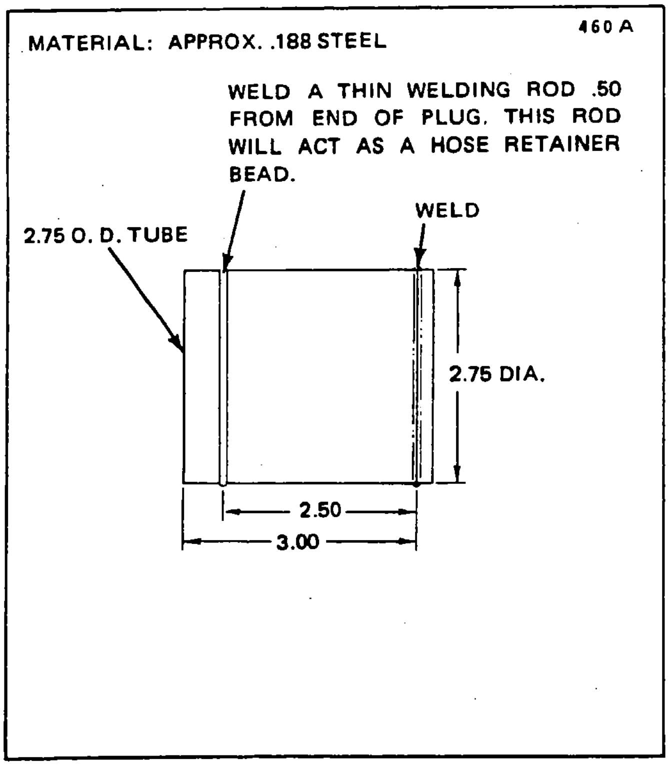


Figure 13-34g. Fabricated Hose Plug

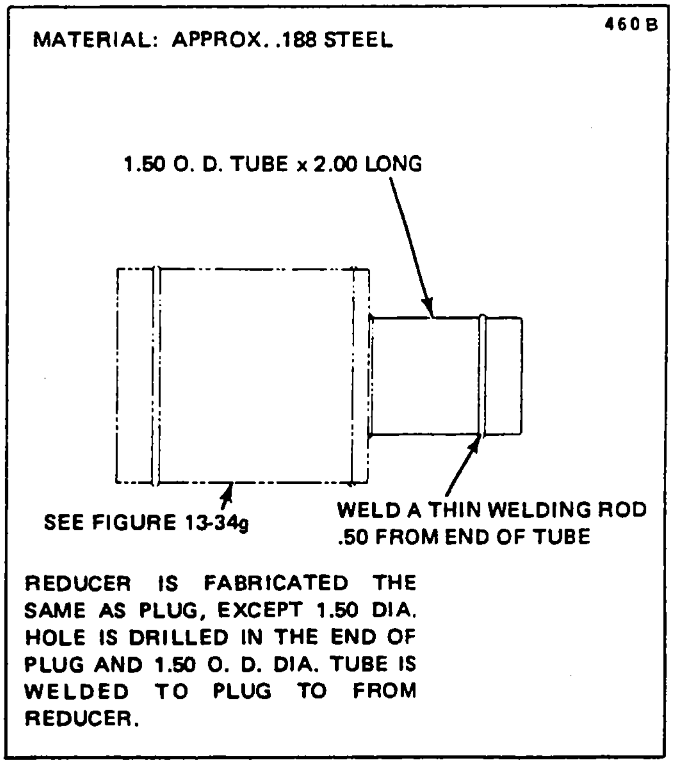


Figure 13-34h. Fabricated Reducer

461

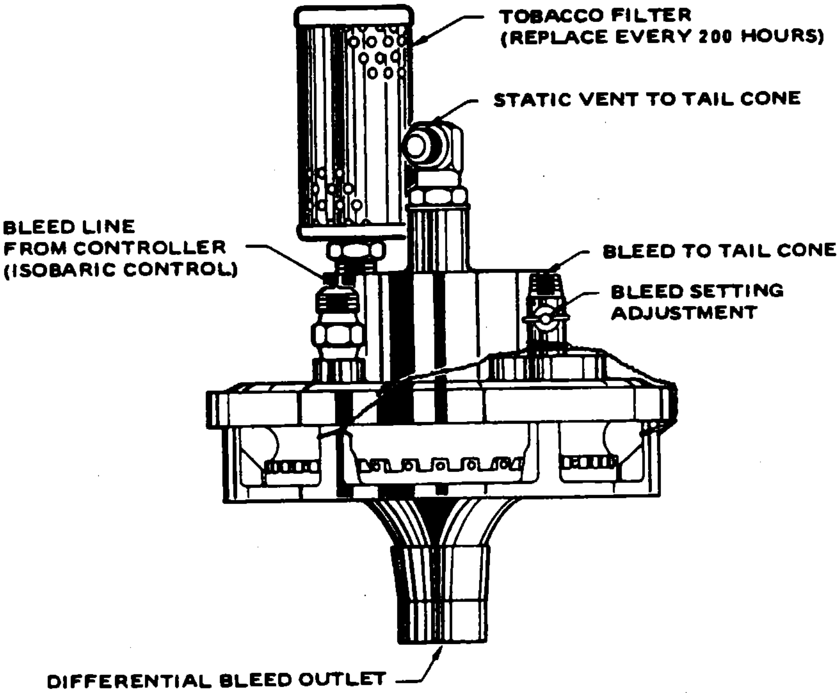


Figure 13-35. Isobaric Valve

1313

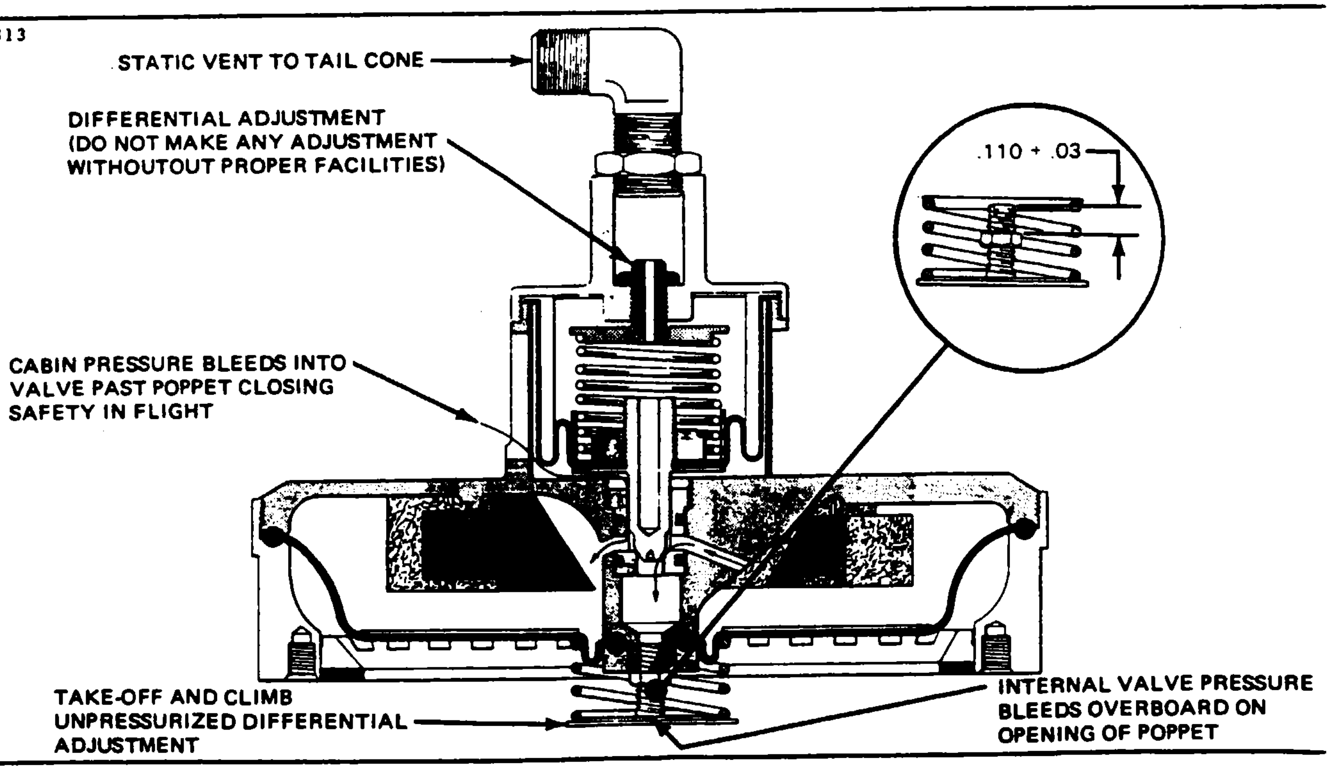


Figure 13-36. Safety Valve

13-116. ISOBARIC VALVE FUNCTION.

Three states of operation exist for the isobaric valve in flight, they are: open, modulating, and closed.

The isobaric valve is controlled by the isobaric controller which is an adjustable aneroid controlled orifice, that stops cabin pressure from reaching the isobaric valve if the controller is set above the cabin altitude, and admits cabin pressure if the controller setting is below the cabin altitude.

The isobaric valve is constantly bleeding off to ambient. It will be forced open by cabin pressure if the flow from the controller stops, or it will go shut if the controller flow exceeds the bleed rate.

The OPEN STATE in flight, with full cabin flow, results in an unpressurized cabin.

The MODULATED STATE occurs as the cabin pressure altitude passes through the controller setting.

The CLOSED STATE occurs when the cabin airflow is sufficiently decreased.

13-117. SAFETY VALVE FUNCTION.

The safety valve is closed in flight, and only opens to control at slightly above normal full differential if the isobaric valve fails to function.

13-118. ISOBARIC AND SAFETY VALVES COMBINED FUNCTION.

The isobaric valve must be held wide open during full throttle application at take-off to prevent cabin pressure rate of dive in excess of 4,000 feet per minute. A vacuum source is obtained from an ejector, and is controlled through a normally closed solenoid that is activated by the landing gear squat switch.

The safety valve is held partially open at the same time through a coil spring assembly. With both valves open, the initial cabin dive rate is less than 1000 feet per minute.

At lift-off the squat switch on the main gear closes the isobaric solenoid thus removing the vacuum source allowing the isobaric valve to close to its normal setting. The safety valve will also slowly close by cabin pressure bleeding into the safety valve. This closing will raise the unpressurized differential thus overcoming most of the aircrafts rate-of-climb. The isobaric control is normally set to begin controlling at 500 feet or more above the airport runway, at which time the safety valve is completely closed.

13-119. DUMP VALVE FUNCTION. (Used on airplanes with serial nos. 31P-1 to 31P-760019 inclusive.)

The dump valve is manually controlled by the pilot. When the valve is opened it releases the pressure in the isobaric feed line to ambient, allowing the cabin pressure to open the isobaric valve.

13-120. RUPTURE DISC. If the rupture disc would rupture and dump the pressure from the cabin overboard, the disc must be replaced before the cabin could be pressurized again.

NOTE

The rupture disc is extremely fragile and must not be touched, except at its border, with any object. Any mark or dent in the direction of rupture will cause unit to fail below normal differential.

13-121. ISOBARIC VALVE REMOVAL.

a. Remove the trim panel in front of the safety and isobaric valves located in the rear pressure bulkhead.

b. Remove the access panel on the left side of the tail section just aft of the entrance door.

c. Disconnect the lines to the isobaric valve, which is the valve located on the left side.

d. Reaching through the tail section access hole, remove the small access plate behind the isobaric valve.

e. Working through this small access hole, remove the six bolts which secure the isobaric valve in place.

f. Remove the valve from the pressure bulkhead.

g. Note the number of turns to close the bleed setting adjustment and mark this data on the valve.

13-122. ISOBARIC VALVE INSTALLATION.

a. Position the isobaric valve onto the shelf in the rear pressure bulkhead. Ascertain that a new gasket is installed between the valve and shelf surface.

b. Working through the small access opening in the rear of the pressure bulkhead 274.0, install the six bolts, with new washers, which hold the valve in place and torque them 13 to 17 in. lbs. (Use the gasket to hold the six bolts in place prior to positioning the valve.)

c. Install the small access plate on the rear of the pressure bulkhead.

d. Install the access plate on the left side of the tail section.

e. Connect the pressurization control line to the valve.

f. Install the trim panel in front of the valves after making sure acoustical material is in good condition.

WARNING

The bleed setting adjustment must be returned to the original setting if moved. If take-off is attempted with the bleed closed, the cabin will pressurize to 5.5 psi at lift-off.

13-123. SAFETY VALVE REMOVAL.

a. Remove the trim panel in front of the safety and isobaric valves located in the rear pressure bulkhead.

b. Remove the access panel on the right side of the tail section aft of station 274.

c. Disconnect the line to the safety valve.

d. Reaching through the tail section access hole, remove the small access plate behind the safety valve.

e. Working through the small access hole, remove the six bolts holding the safety valve in place.

f. Remove the valve from the pressure bulkhead.

13-124. SAFETY VALVE INSTALLATION.

a. Position the safety valve onto the shelf in the rear pressure bulkhead. Ascertain that a new gasket is installed between the valve and shelf surface. Be sure that the diaphragm spring is adjusted per paragraph 13-129a and the diaphragm is level to seat within 1/16 inch.

b. Working through the small access hole in the rear of the bulkhead, install the six bolts with new washers, that secure the valve in place. (Use the gasket to hold the six bolts prior to positioning the valve.)

c. Install the small access plate on the rear of the bulkhead.

d. Install the access panel on the right side of the tail section.

e. Connect the line to the valve.

f. Install the trim panel in front of the valves after making sure acoustical material is in good condition.

13-125. ISOBARIC AND SAFETY VALVE CLEANING. Fluctuation of cabin pressure often indicates dirty isobaric and safety valves. This may be ascertained in the following manner:

a. Working through the tail section access hole in the side of the fuselage, remove the small access plate behind the isobaric or safety valve.

b. Working through this small access hole, compress the valve bellows and inspect the valve housing along the inner rim that the bellows contacts when in the extended position.

c. If the inner rim of the housing is dirty, or if the bellows sticks to the inner rim, wash the rim and bellows with cleaning solvent (Federal Specification P-D-680), or Isopropyl alcohol.

13-126. ISOBARIC AND SAFETY VALVE SETUP. (Refer to Figure 13-35 and 13-36.) The following information should prove most helpful in obtaining the best adjustments of the isobaric and/or safety valves.

Before any work is done on this system the following safety precautions should be studied and thoroughly understood by the people who will do the job, such as the pilot who will fly the airplane and the mechanic who will make the adjustments.

13-127. SAFETY PRECAUTIONS.

a. If a flight is necessary, do not leave any of the plumbing from the pressurization controller to the isobaric valve disconnected.

b. Do not take off with the isobaric valve bleed screw closed.

c. When making in flight adjustments to the isobaric valve bleed screw, do not adjust the screw to less than 3/4 turn open, nor more than 1-1/4 turns open. Always start from a nominal 1 turn open.

CAUTION

Do not close the bleed screw in flight, in an attempt to determine the 1 turn open nominal starting point. This should be done before the flight starts, on the ground.

d. Do not use the bleed screw to adjust the cabin altitude in an attempt to make the cabin altitude agree with the controller setting.

e. Never make bleed screw settings in flight with the safety valve disconnected or defeated in any manner.

f. Do not attempt any adjustments above 15,000 feet in case of depressurization.

g. Do not attempt any adjustment at or near maximum cabin differential as they will have no effect.

h. If an error causes an uncontrolled pressurization the pilot should use the emergency gear extender cover to stop the pressurization. The accepted practice to stop pressurization in this situation is to lift the forward edge of the cover, with his fingers a small amount, to start depressurization, then when the cabin is depressurized the cover should be completely removed to prevent repressurization.

13-128. SYSTEM SETUP PROCEDURE. The following items should be checked for their proper condition or operation:

a. All system lines are secure.

b. The rupture disc is not damaged.

c. The door seal is functioning.

d. Vacuum is being applied to the isobaric valve before lift-off and released after lift-off.

e. The controller is set for 500 feet above the airport altitude before take-off.

f. The cabin leak rate is near its proper level.

g. The outside air control valve and overboard dump valve are operating properly and are not leaking.

13-129. ISOBARIC AND SAFETY VALVE ADJUSTMENT. If a new isobaric and/or safety valve has been installed, the adjustments should be as follows:

a. The safety valve diaphragm spring assembly should be adjusted so that from the top of the jam nut to the top of the threaded portion should be .110 + .03 of an inch. Install the spring assembly into the safety valve until the jam nut makes contact with the valve base then tighten the jam nut 4 to 8 in. lbs. (Refer to Figure 13-36.)

b. The bleed screw on the isobaric valve should be adjusted one turn open (counterclockwise) from the closed position (full clockwise). (Refer to Figure 13-35.)

NOTE

Do not close valve so tight that valve seat is damaged.

13-130. IN FLIGHT ADJUSTMENTS. In flight adjustments require the need of a hand carried altimeter and a rate-of-climb indicator. The following check list should be used before the actual flight:

1. All system lines connected and secure.
2. Safety valve and isobaric valve not damaged.
3. Rupture disc not damaged. (If Installed)
4. Pressurization dump valve installed on airplanes with serial nos. 31P-1 to 31P-7630019 inclusive and outside air control valve operating properly.
5. Isobaric valve bleed screw set.
6. Pressurization control lever set.
7. Pressurization controller set.
8. Proper indication from pressurization test switch.
9. Pilot is briefed on the use of the emergency gear extender cover to stop an uncontrolled pressurization situation.

a. During the ground runup, check that the isobaric valve is fully open. This indicates that vacuum is being applied to the inside of the valve. When the test switch is activated the vacuum is released, check that the diaphragm falls to a position where the sipes just touch the top of the castellations on the valve. (Refer to Figure 13-35.)

b. The in flight settings of the bleed screw and ground setting of the safety valve spring is determined by noting the readings on the hand carried altimeter and rate of climb indicator.

NOTE

Ascertain that the altimeter is calibrated and set at 29.92 for all data, and use an accurate 2-1/2 diameter rate of climb indicator.

13-131. TAKE-OFF AND CLIMB PROCEDURE.

a. Accelerate the engines slowly to full power, taking about five seconds to obtain full power.

b. The maximum dive, noted on the hand carried rate of climb, should be about 600 to 800 feet per minute for best results. However, whatever the reading, note it as the throttle dive.

NOTE

After reading a maximum dive indication the rate of dive should start to reduce and approach a zero indication before lift-off.

c. At lift-off, the vacuum applied to the isobaric valve is released and the diaphragm will fall to its initial setting causing an additional dive in the cabin. This rate of dive, showing on the hand carried instrument, should be about 500 to 1000 feet per minute and then slowly start to return towards zero. Note this dive as the vacuum dive.

NOTE

The vacuum is released from the isobaric valve by the extending of the left main landing gear which has a safety switch on it. So on a rough runway, as the aircraft accelerates and begins to obtain flying speed the safety switch may break and make contact many times just before take-off. As this happens the vacuum is released and applied intermittently and may tend to lower the maximum dive reading a few hundred feet per minute.

d. Climbing out at between 1200 and 1500 feet per minute aircraft rate, note the hand carried rate of climb indication.

NOTE

In this phase of flight the safety valve should be completing its closing phase of operation.

e. If the safety valve diaphragm is adjusted properly the cabin rate should be between 500 feet per minute dive to 800 feet per minute climb. Tolerances and aircraft peculiarities make it virtually impossible to secure a zero rate for this phase of the flight. Note this phase as the climb out rate. It occurs just after lift-off and lasts about 15 or more seconds.

NOTE

After the safety valve closes, the cabin rate of climb will increase to that of the aircraft.

f. Continue the climb out at 85% power when it's safe to do so.

NOTE

Do not confuse the change in cabin rate associated with a power reduction with any of the rates noted in steps 13-131b,c, and e.

g. The cabin rate of climb should begin to decrease from equaling the aircraft rate, and slowly approach zero as the cabin altitude approaches the controller setting. Example: If the controller is set at the number (1) window on the controller dial, the cabin should be near zero rate of climb when the cabin is at 1000 feet as indicated on the hand carried altimeter.

NOTE

The controller may be as much as 500 feet off from the hand carried altimeter. It should be noted that the system has been designed, to have all the errors give a higher cabin altitude than selected, in order that optimum performance can be obtained. Do not attempt to remove this error if less than 500 feet.

h. After pressurization has stabilized, note the cabin altitude, aircraft altitude, and rate of climb indicators. Climb another 4000 feet aircraft altitude and note the change in cabin altitude and cabin rate. If the cabin altitude is decreasing, open the bleed screw 1/8 turn and continue opening the bleed screw by small increments until the cabin altitude is stabilized. If the cabin altitude is climbing, close the bleed screw on the isobaric valve.

NOTE

This is a coarse adjustment and easily set so that the cabin doesn't change more than 20 feet in 1000 feet of aircraft altitude. It has been found that the bleed screw on the isobaric valve should not be opened more than 1-1/4 turns, nor closed less than 3/4 turns without indicating something unusual in the system.

NOTE

The above steps are necessary when new equipment has been installed. Steps 13-130b and 13-131c can be eliminated if just safety valve diaphragm spring adjustments are to be made.

13-132. ADJUSTMENT OF DIAPHRAGM SPRING.

The throttle dive, vacuum dive, and climb out dive gives an indication as to the spring adjustment to be made. Study the data and decide if the throttle dive and vacuum dive is high, normal, or low (700 feet per minute being normal). Determine if the climb out rate is a high dive rate, normal rate, or a high climb rate (500 feet per minute dive to 800 feet per minute climb is the normal rate).

Decide which of the titled paragraphs below covers the particular problem and follow the directions. It will be a big help in understanding the problem to watch the isobaric and safety valve diaphragms together with the hand carried instruments during the take-off and climb out phase of the flight. Removing the valve trim cover at the aft pressure bulkhead will not affect the data.

a. Throttle Dive (Low) and Climb Out Rate (High Climb Rate).

If the throttle dive is low, 600 feet per minute or less, and if the climb out rate is more than 800 feet per minute climb, adjust the safety valve spring to relieve tension (close safety valve diaphragm).

NOTE

To relieve spring tension, screw the springs lower seat counterclockwise looking at the seat. These adjustments must be made after flight, on the ground. The cover plates on the pressure bulkhead may be left off until all adjustments have been completed. Normally one full turn of the spring seat will secure the desired results. However, if the aircraft will not pressurize, the safety valve spring seat may have to be turned counterclockwise two or more turns. Do not confuse the high rate of cabin climb after the safety valve closes and before stabilized cabin pressurization with climb out dive. (Refer to paragraph 13-131c.)

b. Throttle Dive (High) and Climb Out Rate (High Dive Rate).

If the throttle dive is much greater than 800 feet per minute and the climb out dive is greater than 500 feet per minute dive, adjust the safety valve spring seat clockwise to increase spring tension.

Experience indicates from 1/2 to 1 turn of spring seat adjustment will change the rate about 500 feet per minute. Do not make changes of over 2 turns at one time and try to leave the cabin diving slightly during the climb out rate phase of flight.

c. If the dive due to throttle advance is high with little lift-off dive, the indication is that vacuum is not being applied to the isobaric valve.

If the dive due to throttle advance is normal with little lift-off dive, the indication is that vacuum is not being released from the isobaric valve at lift-off.

If the dive due to throttle advance is normal with a very high rate of cabin dive at lift-off, the indication would be that the bleed screw is closed too far.

NOTE

If a high cabin dive rate is noted just after lift-off (3000 feet per minute or greater) and does not quickly subside, the pilot should lift and slowly remove the emergency gear extender cover to stop the pressurization. The indication is that the bleed screw is closed too far or a leak is indicated in the pressurization system. Under these conditions do not rely on the dump control on the instrument panel.

If the aircraft will not pressurize check the following items:

1. Emergency gear extender cover leaking.
2. Main door seal inoperative.
3. Safety valve diaphragm spring tensioned too tight.
4. Controller improperly set before take-off.
5. Aircraft has set idle without being flown for period of time.

The last two items can sometimes be corrected in flight by the following procedure:

1. Accelerate engines to full power.
2. Turn pressurization controller to minimum altitude position and note cabin rate of climb indicator.
3. If the procedure is going to work the cabin rate of dive should increase to about 3000 feet per minute.
4. When the above high dive rate is noted turn the controller smoothly to 500 feet below the aircraft altitude.
5. Decrease power to climb or cruise power to help moderate cabin bump that will occur.
6. Use rate control to bring cabin to desired level.

The above procedure will cause an obvious cabin pressure bump but if the procedure is followed, it will not cause personal discomfort.

13-133. CABIN ALTITUDE SELECTOR.

13-134. REMOVAL OF SELECTOR.

a. Disconnect the electrical connector and the bleed air line from the rear of the cabin altitude selector central assembly. Cap the open ports of the bleed air line and fitting on the selector to prevent dust from entering the system.

b. Remove the four machine screws and nuts, (later aircraft have anchor nuts) which secure the selector to the instrument panel. It may be necessary to remove the cabin pressure and cabin rate of change instruments to gain access to the nuts.

c. The cover plate of the circuit breaker panel may have to be removed to provide clearance for the altitude selector removal from the instrument panel.

d. Remove the selector by lifting the assembly from the face of the instrument panel.

13-135. INSTALLATION OF SELECTOR.

a. Position the selector into the instrument panel cutout from the face side of the panel.

b. Secure the selector to the instrument panel with four machine screws and nuts. Install the cabin pressure and cabin rate of change instruments if they were removed during the removal of the cabin altitude selector.

c. Install and secure the cover plate of the circuit breaker panel if it was removed during the removal of the selector.

d. Remove the protective caps from the bleed air ports of the selector fitting and bleed air line and connect the line to the fitting; also connect the electrical connector to the rear of the selector.

13-136. FILTER REPLACEMENT. There are two tobacco filters; one on the isobaric valve and one on the pressurization controller, and four air line filters installed in the pressurization system of this aircraft. The following instructions will cover the removal and installation of these filters:

a. Removal of filters located in both main wheel wells:

1. To open the inboard doors on the main gear, ascertain that the master switch is off. Then, balance the landing gear selector handle in the down position and operate the hand pump to open the doors.

2. The filters are secured to the main spar web by a strap clamp which must be removed.

3. Disconnect the hose clamps and remove the filters from the line connections.

b. Removal of filters located in both engine nacelles:

1. Remove the inboard access panels from both engine nacelles.

2. The filters are secured inside the nacelle housings by a strap clamp which may be removed.

3. Disconnect the hose clamps and remove the filters from the line connections.

c. Installation of filters located in both main wheel wells:

1. Install the new filters in the main wheel wells.

2. Secure the filters to the main spar web with the strap clamp from the old filter.

3. Connect the air lines to the filters and tighten hose clamps.

4. To close the inboard doors, turn the master switch on, put the landing gear selector handle in the neutral position, and operate the hand pump to close the doors.

d. Installation of filters located in both engine nacelles:

1. Install the new filters in the nacelle housings.

2. Secure the filters to the nacelle housings with the strap clamp from the old filters.

3. Connect air lines to the filters and tighten hose clamps.

4. Replace the inboard nacelle access panels to both engine nacelles.

NOTE

The four air line filters are the throwaway type and should be replaced at every 500 hours or sooner of aircraft operation or whenever a pneumatic pump is replaced. It is highly recommended that both filters be serviced as stated to insure proper operation and service life. The filters are marked with arrows to insure being installed in the system properly (arrow points in the direction of air flow). (Refer to PA-31P Parts Catalog for part numbers.)

WARNING

If filters are not replaced as stated in above note, there is a restriction of air flow thus reducing existing or new pneumatic pump service life.

e. Removal of tobacco filter from controller:
 1. The filter is accessible from underneath the instrument panel. Remove the filter and discard.

f. Installation of tobacco filter on controller:
 1. Place teflon tape on the threads of the filter and secure into place.

g. Removal of tobacco filter on isobaric valve:
 1. Remove the trim panel in front of the safety and isobaric valves located in the rear pressure bulkhead.
 2. Disconnect the filter from the valve and discard.

h. Installation of tobacco filter on isobaric valve:
 1. Place teflon tape on the threads of the filter and secure in place.
 2. Reinstall the trim panel.

NOTE

The tobacco filters are the disposable type and must be replaced every 500 hours of normal use. (Refer to PA-31P Parts Catalog for part number.)

13-137. PRESSURIZATION CONTROLLER CLEANING. (Refer to Figure 13-37.) Fluctuation of cabin pressurization, when the system is properly set up after takeoff, could be caused by a sticking poppet valve in the pressurization controller, located in the lower left corner of the instrument panel. The cause of this problem is tobacco deposits on the poppet valve. The degree of fluctuation depends on how long the deposits have been present and how much smoking occurs in the cabin during flights. The following information should be used to clean the poppet valve and correct the problem:

a. Obtain a can of aerosol solvent such as MS-160 "FREON" T-P35 solvent, manufactured by the Miller-Stephenson Chemical Co., Inc. or an equivalent type.

b. Disconnect the electrical connector and the .250 inch line from the rear of the controller.

WARNING

Wear safety glasses when working with this type of solvent to prevent the spray from getting into the eyes. The propellent in the aerosol can is FREON and alcohol, and dangerous freezing of the eyes could occur if liquid from the can is allowed to touch the eyes. Do not breath the vapors for a prolonged period of time. If contact with the eyes occurs, wash immediately with water and consult a physician.

c. Attach the spray extension to the aerosol can. (Refer to Figure 13-37.)

d. Set the altitude selector on the face of the controller to the lowest altitude position.

e. Insert the spray nozzle about 1.50 inches into the controller through the .250 fitting. (Refer to Figure 13-37.)

f. Apply solvent for a period of one second and allow two minutes to elapse before applying another one second application.

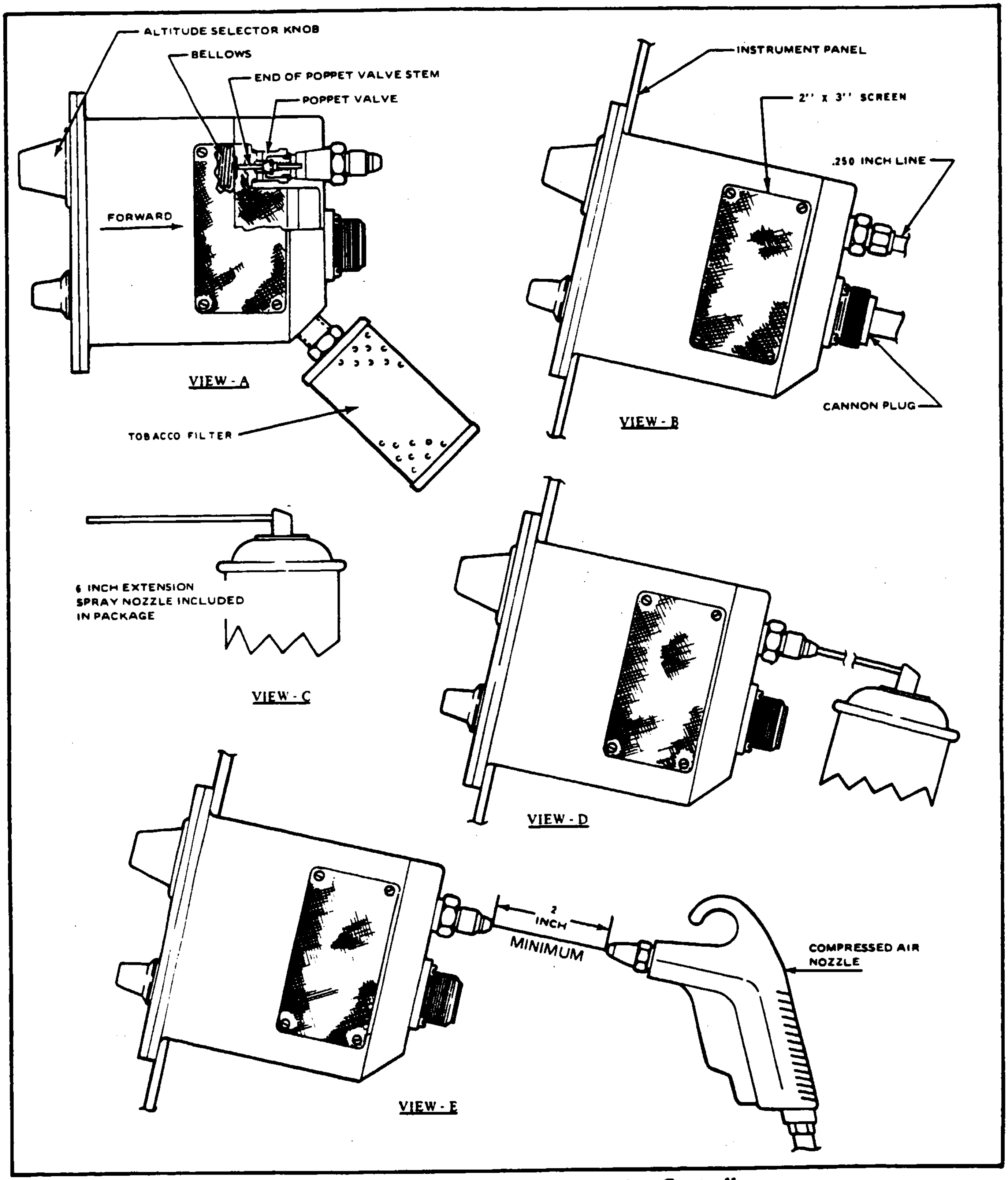


Figure 13-37. Cleaning of Pressurization Controller

g. Using a compressed air nozzle as shown in Figure 13-37, blow into the fitting to remove all solvent and residue. Maintain minimum 2" distance from controller port.

NOTE

Cleaning is not a normal maintenance item with properly maintained tobacco tar filters. Clean only if a sticky poppet is suspected. Do not use more than 20 psi air pressure at the nozzle. Tighten filters only with the hex at the end of the threads. Filter will be damaged if tightened by gripping the body.

h. For badly fouled controllers, another application of solvent may be required. (Repeat Step g.)
i. If the cleaning solvent fails to free the poppet valve, the controller must be removed from the instrument panel for further service.
j. With the controller removed from the panel, remove the four small screws holding the 2 x 3 inch screen on the side of the controller and remove the screen. Due to the screws being of different lengths, they should be marked so they may be reinserted in their proper locations. The end of the poppet valve stem is now accessible. (Refer to Figure 13-37.)
k. Turn the controller selector knob to maximum altitude position, and using a thin screwdriver or knife blade, depress the end of the poppet stem to break the stickiness. Now clean the poppet as outlined in Steps e thru h.
l. After cleaning the controller, install the screen and remount the unit in the airplane. Reconnect the .250 inch line and electrical connection, being careful to prevent any leaks at the .250 inch fitting.

13-138. TESTING CABIN ALTITUDE CONTROLLER. Replace controller when any one of the test procedures fail described in Paragraphs 13-138 thru 13-142.

13-139. ELECTRICAL TEST OF THE CABIN ALTITUDE CONTROLLER (P/N 48317-00). (Refer to Figure 13-38.)

NOTE

Electrical test may be performed with the controller in the airplane or on the bench.

a. Connect electrical test harness, which may be fabricated as per Figure 13-38, to controller.
b. With power to the controller and the ascend/descend switch in the OFF position, select an altitude change with the outer altitude change ring.

NOTE

Altitude select knob should not move.

c. Time the altitude selector knob movement as follows:
1. Position the ascend/descend switch to ascend and turn the rate of change knob to full decrease. The altitude selector knob should move 200 ± 100 feet per minute.
2. Position the ascend/descend switch to descend and turn the rate of change knob to full decrease. The altitude selector knob should move 200 ± 100 feet per minute.
3. Position the ascend/descend switch to ascend and turn the rate of change knob to full increase. The altitude selector should move 1000± 200 feet per minute and the ascend light should be on. on.

4. Position the ascend/descend switch to descend and turn the rate of change knob to full increase. The altitude selector knob should move 1000 $\pm$ 200 feet per minute and the descend light should be on.

d. Check that the altitude change knob stops within 200 feet at the selected altitude.

e. Check the Electro-Luminescent placard for visibility.

NOTE

Use 110 volts AC (400 cps) for best placard lighting visibility.

13-140. VACUUM CHECK OF THE CABIN ALTITUDE CONTROLLER (P/N 48317-00). (Refer to Figure 13-38.)

NOTE

Vacuum check controller installed in the airplane.

a. Remove pneumatic control line from the controller and the isobaric valve. Cap the control line at the controller.

b. Connect a vacuum source with a sensitive rate of change and an altimeter to the control line at the isobaric valve.

c. Close dump valve on instrument panel if aircraft is equipped with one.

d. Check for leaks in the control line by pulling vacuum of 6500 feet above local pressure altitude and sealing off vacuum source. After the initial dive indication, the rate should settle to 100 feet per minute or less. If the leak is more than 100 feet per minute the leak should be found and corrected.

e. Remove the cap from the control line at the controller and connect the line to the cabin controller.

f. Position the altitude selector to 5000 feet above the local altimeter setting and pull vacuum equivalent of 6500 feet of altitude.

g. Seal off the vacuum source and after the initial dive indication, the rate should settle to no more than 400 feet per minute.

13-141. VACUUM RELIEF CHECK FOR CABIN ALTITUDE CONTROLLER (P/N 48317-00). (Refer to Figure 13-38.)

NOTE

Check vacuum relief of cabin controller in the airplane.

a. Set the altitude selector to 5000 feet above the local altimeter setting, and pull vacuum equivalent to 6500 feet of altitude.

b. Turn the altitude selector slowly toward the local pressure altitude. The vacuum should be lost when the controller setting reaches 1500 to 1000 feet above the local pressure altitude. A rapid increase in rate of dive will be indicated on the test system rate of climb indicator.

13-142. CALIBRATION CHECK FOR CABIN ALTITUDE CONTROLLER (P/N 48317-00). Before checking calibration, make a vacuum check and a vacuum relief check.

NOTE

Calibration check can only be made with the controller installed in the airplane.

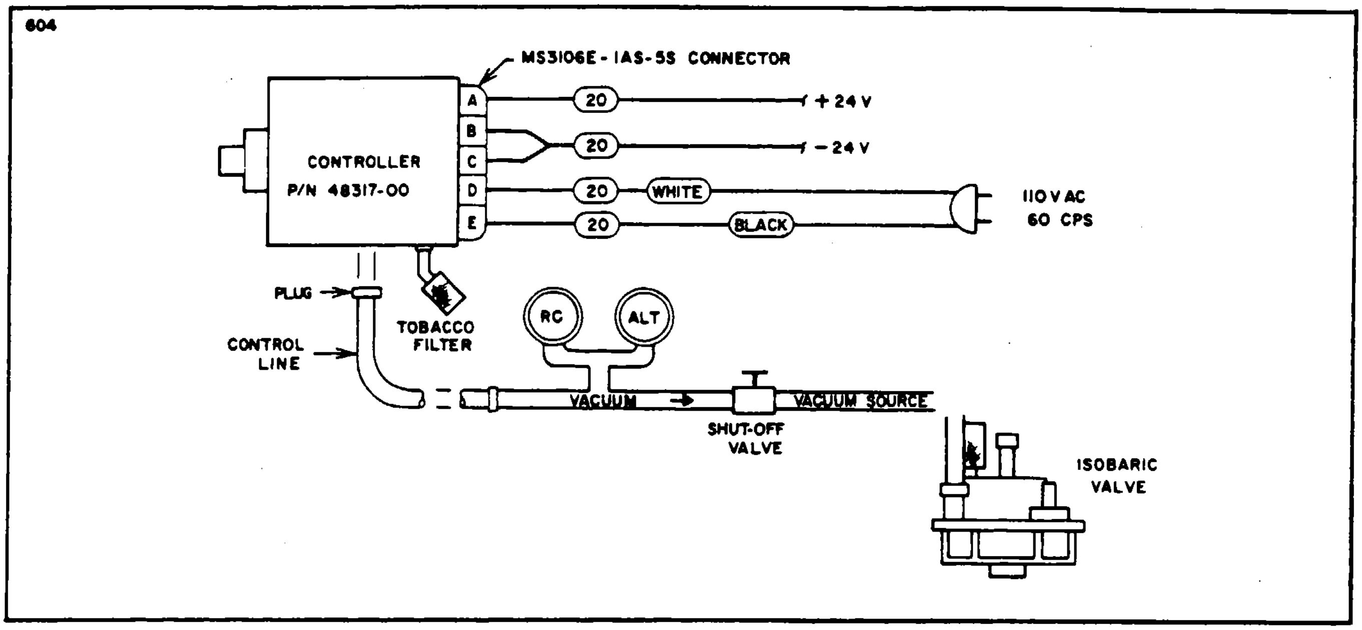


Figure 13-38. Cabin Altitude Controller (P/N 48317-00)

a. Fly aircraft level at 1000 feet below altitude equivalent to maximum differential with cabin set to sea level.

b. With hand carried sensitive altimeter set to 29.92, record the cabin altitude at various controller altitude settings.

c. If the resulting cabin altitudes are within ± 300 feet of those selected the unit is in calibration.

13-143. DOOR SEAL SYSTEM.

13-144. DESCRIPTION OF DOOR SEAL SYSTEM. The constant displacement dry air pumps supply air to the pneumatic regulators located in the right side of each engine nacelle. These regulators provide back pressure regulation to maintain the nominal 5.5 psig system pressure until deicer boots or cabin door seal air is required. If the door seal accumulator tank located below the floor under the left rear passenger seat has a pressure drop below 15 psig, the pneumatic regulators increase the system pressure to a nominal 18 psig for ten seconds to fill the accumulator tank. A check valve located at the end of the accumulator inlet then prevents the 18 psig air charge from flowing back into the system when the system pressure returns to 5.5 psig. The purpose of the accumulator tank is to store air for the door seal and to smooth out its operation. There is a 14 psi pressure switch located in the nose of the accumulator tank just aft of the check valve. The switch monitors pressure in the tank and supplies a source of voltage to a latching relay mounted on the electrical accessory shelf located above the radio shelf in the nose section of the aircraft. This latching relay is used to complete the circuit when required by the accumulator pressure switch, thus activating the pneumatic regulators to supply 18 psig pressure to the system. At the same time the regulators are activated, current is also supplied to the time delay relay mounted on the brake fitting support channel below the instrument panel which will unlatch the latching relay after a ten second delay, allowing the pneumatic regulators to return to their nominal 5.5 psig setting. The use of high pneumatic pressure only when required by deicer boots or cabin door seal allows the pump load to remain as low as possible for a large percentage of system operating time. During deicer operation (if installed) or whenever the main entrance door seal accumulator requires repressurization, the pneumatic system pressure will automatically increase to 18 psig. Certain malfunctions of the pneumatic system electrical components may result in continuous high pressure readings (above the green arc) on the pneumatic pressure gauge. This condition will result in very rapid pneumatic pump wear.

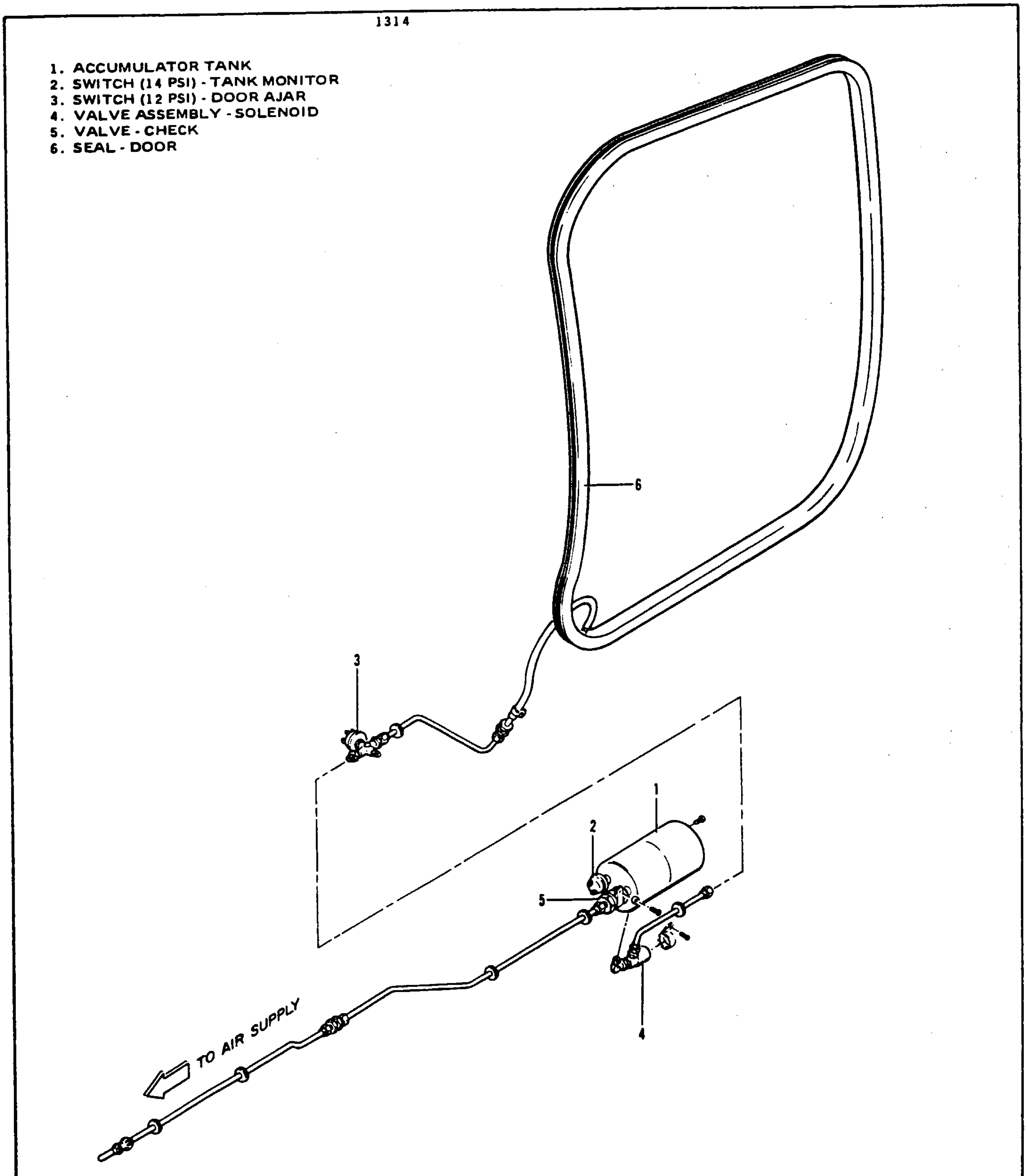


Figure 13-39. Cabin Door Inflation System Installation

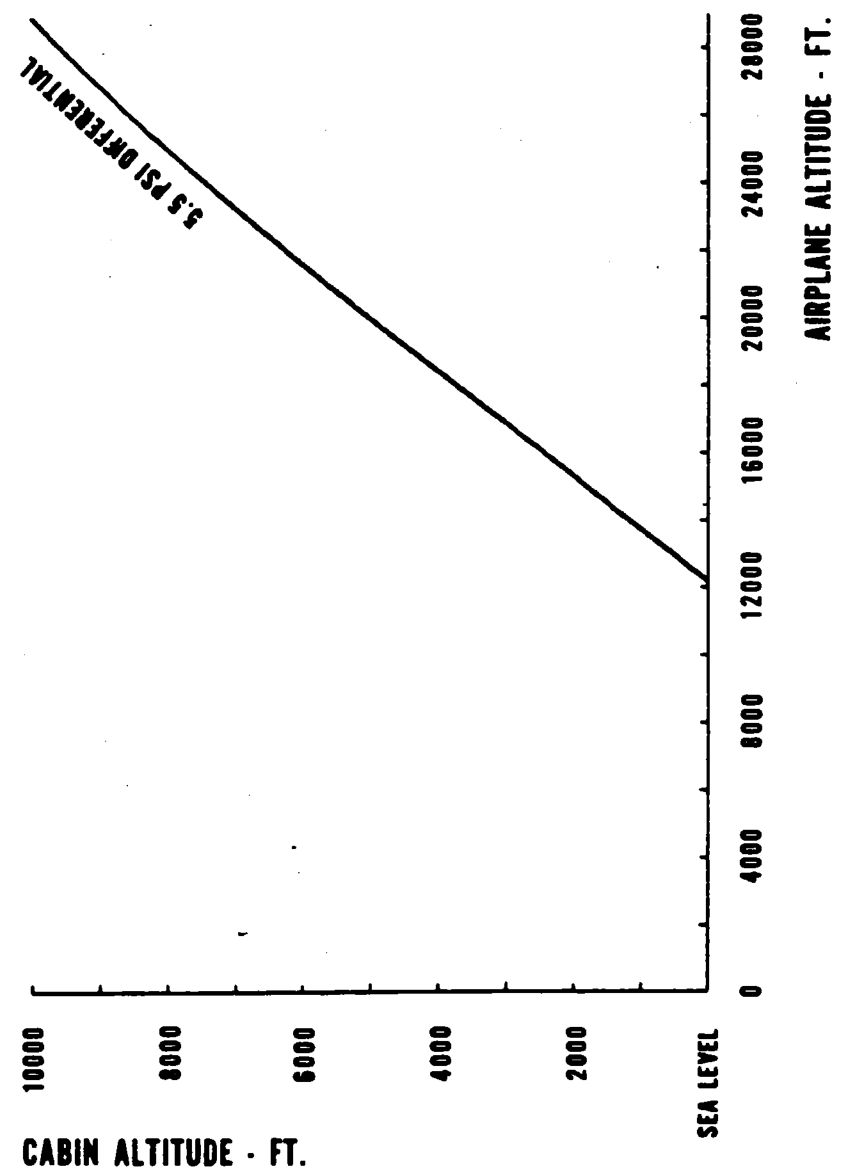


Figure 13-40. Cabin Altitude vs. Airplane Altitude

TABLE XIII-VII. TROUBLESHOOTING CHART (PRESSURIZATION SYSTEM)

Trouble	Cause	Remedy
Cabin will not pressurize.	Dump valve open.	Close valve; Adjust valve control cable.
	Defective Isobaric control valve.	Replace valve.
	Bleed setting improperly set on new valve.	Set to specifications. Refer to paragraph 13-126.
	Defective safety valve.	Replace valve.
	Improperly adjusted takeoff dive control springs.	Adjust to specifications.
	Defective landing gear squat switch.	Replace switch.
	Faulty electrical wiring.	Replace or repair wiring.
	Door seal not operating.	Repair and check door seal.
	Excessive leakage in pressurization ducts.	Locate leak and tighten connection.
	Defective pressurized air dump valve.	Replace or repair valve.
	Ruptured diaphram safety valve.	Replace diaphram.
	Defective cabin altitude control.	Replace cabin altitude control.
	Excessive cabin leakage.	Locate and repair leak.

TABLE XIII-VII. TROUBLESHOOTING CHART (PRESSURIZATION SYSTEM) (cont.)

Trouble	Cause	Remedy
Cabin will not pressurize. (cont.)	Valve on pressurized air control box won't close.	Adjust or lubricate valve or control linkage.
	Valve on outside air control box won't close.	Adjust or lubricate valve or control linkage.
Cabin pressure will not maintain control setting.	Dump valve partially open.	Close valve; adjust valve control cable.
	Defective Isobaric control valve.	Replace valve.
	Defective safety valve.	Replace valve.
	Defective pressurized air dump valve.	Replace or repair valve.
	Defective cabin altitude controller.	Replace cabin altitude control.
	Pressurization duct leakage.	Locate leak and tighten connection.
	Cabin leakage.	Locate and repair leak.
	Defective rate of climb indicator.	Replace.
	Defective cabin altitude pressure gauge.	Replace gauge.
	Isobaric and/or safety valve out of adjustment.	Adjust valves in accordance with paragraph 13-126.
	Dirty poppet valve in cabin altitude controller.	Clean poppet valve Paragraph 13-137.

TABLE XIII-VII. TROUBLESHOOTING CHART (PRESSURIZATION SYSTEM) (cont.)

Trouble	Cause	Remedy
Cabin pressure will not maintain control setting. (cont.)	Foreign matter on Isobaric control valve or safety valve seats.	Clean valve seats. Refer to paragraph 13-125.
	Leak in Isobaric valve control line.	Locate leak and tighten connection.
	Sticking poppet valve inside controller.	Clean valve seat. Refer to Paragraph 13-137.
Cabin pressure excessively high.	Isobaric control valve bleed off and static lines clogged.	Clean bleed off and static vent lines.
	Defective cabin over pressure switch.	Replace.
	Defective cabin altitude pressure gauge.	Replace gauge.
	Safety valve static vent clogged.	Clean vent line.
	Defective safety valve.	Replace valve.
	Isobaric and/or safety valve out of adjustment.	Adjust valves in accordance with paragraph 13-126.
Cabin climbs well beyond controller setting and initiates with large spike.	Dirty poppet valve in cabin altitude controller.	Clean poppet valve Paragraph 13-137.

TABLE XIII-VII. TROUBLESHOOTING CHART (PRESSURIZATION SYSTEM) (cont.)

Trouble	Cause	Remedy
Cabin door unsafe light will not go out.	Latching relay sticking in the open position.	Lubricate the mechanical parts (sparingly) with "Glide Air" or equivalent.
	Switch or switches in door frame out of adjustment.	Adjust per paragraph 11-90.
	Defective pressure switch.	Replace switch.
	Short to ground.	Check wiring and repair.
Cabin door unsafe light will not come on.	Circuit breaker open.	Reset circuit breaker.
	Broken wire or loose connection.	Check wiring and repair.
No pressure to door seal.	Leak in door seal pressure system.	Check and repair door seal pressure system.
Pneumatic pressure continuously high.	Cabin door seal switch failed in closed position.	Replace switch.
	Door seal switch pressure setting too high.	Replace switch.
	Leak in door seal system.	Repair system.
	Regulator solenoid malfunction.	Replace solenoid.
	Deicer solenoid malfunction.	Replace solenoid.
	Deicer timer malfunction.	Replace timer.
	Deicer boots selector switch stuck in ON position.	Replace switch.

SECTION XIV
ACCESSORIES AND UTILITIES

Paragraph			Aerofiche Grid No.

Paragraph		Aerofiche Grid No.

Paragraph		Aerofiche Grid No.
14-90.	Wing Inspection Light	4I12
14-91.	Introduction	4I12
14-92.	Description and Operation	4I12
14-93.	Servicing	4I12
14-94.	Removal	4I12
14-95.	Installation	4I12
14-96.	Copilot's Heated Windshield	4I12
14-97.	Windshield Wipers	4I12
14-98.	Propeller Synchronizer	4I13
14-99.	Description of Propeller Synchronizer System (Woodward)	4I13
14-100.	Functional Test	4I13
14-101.	Troubleshooting with Minimum Field Equipment	4I13
14-102.	Ground Check	4I13
14-103.	Flight Checks	4I18
14-104.	Maintenance	4I18
14-105.	Removal of Trimmer Assembly	4I18
14-106.	Installation of Trimmer Assembly	4I19
14-107.	Removal of Actuator	4I19
14-108.	Installation of Actuator	4I20
14-109.	Service of Actuator	4I20
14-110.	Removal of Control Box	4I20
14-111.	Installation of Control Box	4I20
14-112.	Test Equipment	4I21
14-112a.	Bench Testing the Actuator	4I21
14-113.	Propeller Synchrophaser (Woodward)	4J3
14-114.	Description of Propeller Synchrophaser System	4J3
14-115.	Functional Test	4J3
14-116.	Troubleshooting with Minimum Field Equipment	4J3
14-117.	Ground Check	4J4
14-118.	Maintenance	4J4
14-119.	Removal of Control Box	4J4
14-120.	Installation of Control Box	4J4
Appendix	Window Inspection and Repair - Standard Practices	4J11

SECTION XIV

ACCESSORIES AND UTILITIES

14-1. INTRODUCTION. This section covers accessories and utilities which are available in this airplane and are not covered in other sections of this Service Manual. This information provides instructions for remedying difficulties which may arise in any of the accessories or utilities and the instructions are organized so the mechanic may refer to whichever component or system he must repair or adjust.

14-2. OXYGEN SYSTEM.

14-3. DESCRIPTION AND PRINCIPLE OF OPERATION. The oxygen system consists of a DOT 3AA1800 oxygen cylinder and regulator, filler valve, pressure gauge, outlets and masks, and an ON/OFF control. High pressure is routed from the cylinder and regulator to the pressure gauge. Low pressure is routed from the cylinder and regulator to the outlets and masks whenever the control knob is pulled to the ON position. Each outlet has a spring-loaded valve which prevents the flow of oxygen until a mask hose is engaged in the outlet.

14-4. TROUBLESHOOTING. A troubleshooting chart is located at the back of the oxygen system portion of this section.

14-5. SAFETY PRECAUTIONS. Utmost care must be exercised in servicing, handling and inspection of the oxygen system. A fully charged oxygen cylinder contains enough pressure to cause serious injury to personnel and damage to equipment. Keep hands, tools and working area clean and post NO SMOKING signs. Keep all components of the system free from oil, grease, gasoline, and all readily combustible material. Never allow electrical equipment to come in contact with the oxygen cylinder. Keep fire and heat away from oxygen equipment and take care not to generate sparks with carelessly handled tools.

14-6. INSPECTION AND OVERHAUL TIME LIMITS. It is recommended that inspection and overhaul be conducted by a DOT Approved Station or the manufacturer, Scott Aviation. The following checks and chart gives recommended inspection and overhaul time for the various parts of the oxygen system.

a. The 3AA1800 oxygen cylinder should be tested every five years. The month and year of the last test is stamped on the cylinder beneath the DOT identification.

b. The outlets should be checked for leakage both in the non-use condition and for leakage around an inserted connector.

c. The high pressure gauge may be checked for accuracy by comparing its indicated pressure with that of a gauge of known accuracy.

d. Inspection of the regulator may be affected by introducing into an outlet, a mask connector, to which is attached a 100 psi gauge. With one other outlet flowing through a plugged-in mask, the indicated regulator output pressure shall be not less than 45 psi at sea level with 200 psi supply cylinder pressure. It should be noted that the permissible leakage through the 1/16 diameter vent hole in the side of the upper regulator housing is 10 cc/min. maximum, when the regulator is turned on. There shall be no external leakage anywhere on the regulator when it is turned off. All fittings shall be leak free.

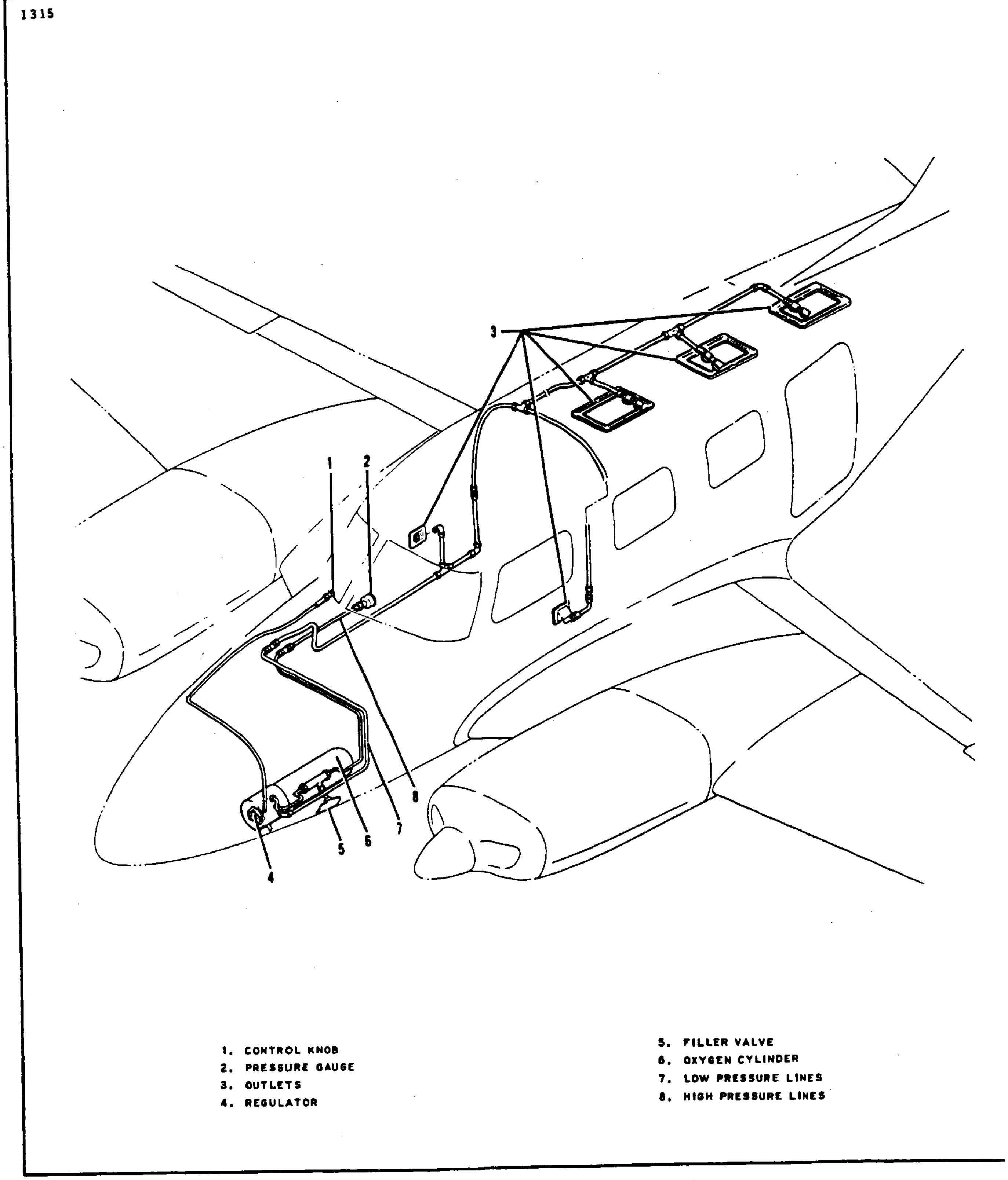


Figure 14-1. Oxygen System Installation

14-7. TESTING FOR LEAKS. Apply detector fluid type CD-1 solution or its equivalent. The solution should be shaken to obtain suds or foam. The suds or foam should be applied sparingly to the joints of a closed system. Look for traces of bubbles. No visible leakage should be found. Repair or replace any defective parts and retest system. With the system pressurized to service pressure, further test can be made. The rate of any leak should not exceed one percent of the total supply per 24 hour period. All traces of the detector fluid should be wiped off at the conclusion of the examination.

14-8. MAINTENANCE.

a. Check that all lines have sufficient clearance between all adjacent structures and are secured in place. Also check the cylinder to be sure it is securely mounted.

b. Check the cylinder for the DOT identification number and for the date of the last inspection and test.

c. If cylinder is completely empty, it must be completely disassembled and inspected in a DOT approved facility before recharging.

d. Any lines that are defective should be replaced with factory replacements.

e. Clean all lines and fittings as described in paragraph 14-9.

f. Use Ribbon Dope Thread Sealant (Permacel 412) on male ends of fittings only. Wrap thread in direction of thread spiral, beginning with the second thread on the fitting. Avoid getting any sealant into the lines.

TABLE XIV-I. OXYGEN SYSTEM COMPONENTS LIMITS

PARTS	INSPECTION	OVERHAUL
Regulator	300 Flight Hrs.	5 Yrs.
Pressure Gauge	300 Flight Hrs.	5 Yrs.
High Pressure Lines	300 Flight Hrs.	
Low Pressure Lines	300 Flight Hrs.	
Outlets (Cabin)	300 Flight Hrs.	5 Yrs.
External Recharge Valve	Each Use	Replace Every 5 Yrs.
Masks	Each Use	Replace as Necessary

14-9. CLEANING OPERATIONS. To remove oil and grease from tubing and fittings, one of the following cleaning methods may be used:

a. First Method:

1. A vapor degreasing with stabilized trichlorethylene conforming to specification MIL-T-7003 shall be used.

2. Blow tubing clean and dry with a stream of clean, dried, filtered air. Care shall be taken to insure that the interior of the tubing and fittings are thoroughly cleaned.

b. Second Method:

1. Flush with naptha conforming to specification TT-N-95.
2. Blow clean and dry off all solvent with water pumped air.
3. Flush with anti-icing fluid conforming to specification MIL-F-566 or anhydrous ethyl alcohol.

4. Rinse thoroughly with fresh water.

5. Dry thoroughly with a stream of clean, dried, filtered air or by heating at a temperature of 250° to 300° F for a suitable period.

6. The solvents may be reused provided they do not become excessively contaminated with oil. This condition shall be determined as follows:

(a) Evaporate 100 milliliters of the liquid to dryness in a weighed glass dish. Evaporation may be accomplished by heating at 200° F for one-half hour.

(b) After evaporation, cool and weigh the residue. The solvent shall not be used if the residue exceeds 100 milligrams in weight.

c. Third Method:

1. Flush with hot inhibited alkaline cleaner until free from oil and grease.
2. Rinse thoroughly with fresh water.
3. Dry thoroughly with a stream of clean, dried, filtered air or by heating at a temperature of 250° to 300° F for a suitable period.

14-10. REMOVAL OF OUTLETS.

a. Using a suitable spanner wrench, remove the outer half of the outlet.
b. Remove the screws holding the trim panel and remove the panel.
c. The outlet can now be removed from the low pressure line.

14-11. INSTALLATION OF OUTLETS.

a. Apply a sealant to the male end of the fitting.
b. Connect the outlet to the low pressure line.
c. Position the trim panel and secure with screws.
d. Position the outer half outlet and secure with a suitable spanner wrench.
e. Torque the fittings into the outlets approximately 30 inch pounds. Do not over torque as this could damage the outlet.

14-12. PURGING THE SYSTEM. The system should be purged whenever the cylinder pressure falls below 50 psi or if any lines are left open for any length of time. Also, whenever there are any offensive odors present it will be necessary to purge the system. Use the following procedure:

a. Park the airplane in a NO SMOKING area.
b. Keep all doors and windows open.
c. Be sure all electrical systems are shut off.
d. Connect the oxygen recharging unit to the filler valve.
e. Plug the oxygen masks into the outlet valves and turn on the system.
f. Set the recharging unit pressure regulator to deliver 50 psi and let the system purge for one hour. If any odor is still present repeat the procedure for one or more hours. If the odor persists after the second purging, replace the cylinder.

14-13. CLEANING OF FACE MASKS. The disposable masks are designed for one-time use and require no maintenance. The pilots and co-pilots masks can be cleaned as follows:

a. Remove the microphone from the mask.
b. Remove the sponge rubber discs from the mask turrents. Do not use soap to clean sponge rubber discs, as this would deteriorate the rubber and give off unpleasant odors. Clean in clear water and squeeze dry.
c. Wash the rest of the mask with a very mild solution of soap and water.
d. Rinse the mask thoroughly to remove all traces of soap.
c. Make sure the sides of the breathing bag do not stick together while drying, as this may decrease the life of the rubber in the bag. The mask can be sterilized with a solution of 70 percent ethyl alcohol.

14-14. REMOVAL OF OXYGEN CYLINDER AND REGULATOR. The cylinder is located in the left side of the nose section below the radio shelf. The following steps should be used to remove the cylinder and regulator from the airplane.

a. Remove the access panel on the left side of the nose section just aft of the baggage compartment door.

b. Remove the radio equipment and radio shelf.

CAUTION

Be sure the valve on the cylinder is closed before disconnecting any lines from the regulator.

c. Remove the access cover from the shroud assembly.

d. Disconnect the control cable and pressure lines from the regulator.

e. Loosen and separate the clamps that hold the cylinder in place.

f. Remove the cylinder from the airplane through the access opening at the side of the nose section. Use caution not to bump the neck of the cylinder and regulator. The regulator can be removed from the cylinder at this time if the cylinder is completely discharged of all pressure.

14-15. INSTALLATION OF OXYGEN CYLINDER AND REGULATOR.

a. With the regulator attached to the cylinder, place it into the airplane through the access opening with the regulator to the front of the airplane. Be careful not to bump the regulator and cylinder when installing them.

b. Position the cylinder so the control on the regulator aligns with the control cable.

c. Secure the cylinder in place by connecting and tightening the two clamps.

d. Connect the pressure lines and control cable to the regulator.

e. Install the access cover on top of the shroud assembly.

f. Replace the radio shelf and install or connect the radio equipment.

g. Replace the access panel over the nose section and secure it.

h. Recharge the oxygen cylinder (Refer to Filling Oxygen Cylinder, Section II.) if not already accomplished.

CAUTION

Ascertain that the cylinder is empty before removing regulator.

14-16. REMOVAL OF FILLER VALVE.

a. Remove the access panel on the left side of the nose section.

b. Ascertain that the valve on the regulator is closed.

c. Disconnect the tee fitting from the filler valve.

d. Remove the three nuts and bolts holding the filler valve in place and remove the valve through the access door on the outside of the fuselage, below the valve.

14-17. INSTALLATION OF FILLER VALVE.

a. Place the valve into position through the access door and secure with three bolts and nuts.

b. Connect the tee fitting to the valve using thread sealant and instructions given in paragraph 14-8.

c. Replace the access panel on the side of the nose section.

14-18. REMOVAL OF PRESSURE GAUGE. Ascertain that the control valve is closed and there is no pressure in the system.

a. Disconnect the line from the back of the pressure gauge.

b. Loosen and remove the retainer nut and clamp holding the gauge in place.

c. Pull the gauge out from the front of the panel.

14-19. INSTALLATION OF PRESSURE GAUGE.

a. Place the gauge into the panel from the front and replace the clamp and retainer nut on the back of the gauge. Be sure the gauge is positioned properly before tightening the clamp.

b. Reconnect the line at the rear of the gauge.

TABLE XIV-II. TROUBLESHOOTING CHART (OXYGEN SYSTEM)

Trouble	Cause	Remedy
No indication of pressure on pressure gauge.	Cylinder empty or leak in system has exhausted pressure.	Charge system and check for leaks.
	Pressure gauge defective.	Replace pressure gauge.
	Defective regulator.	Replace regulator.
Pressure indication normal but no oxygen flowing.	Oxygen cylinder regulator assembly defective.	Replace regulator assembly.
	Control out of adjustment.	Adjust control.
Offensive odors in oxygen.	Cylinder pressure below 50 psi. Foreign matter has entered the system during previous servicing.	Purge the oxygen system. Refer to Paragraph 14-12.

14-20. PROPELLER DEICING SYSTEM.

14-21. DESCRIPTION AND PRINCIPLES OF OPERATION. (Refer to Figure 14-2.) The Propeller Deicing System consists of an electrically-heated deicer (9) bonded to each propeller blade, a slip ring and brush block assembly to transfer electrical power to the rotating deicers on the propellers, a timer (7) to control the cycling of the system, a shunt (5) and ammeter (4) to monitor the operation of the system, a switch (1) to control system operation, a circuit breaker (8) to protect the system and related wiring harnesses and connector (3) to complete the circuit.

To conserve electrical power which is drawn from the aircraft electrical system the current is cycled to the deicer heaters at timed intervals rather than continuously. Each deicer has two separate heaters; one for the outer half and one for the inner half. By heating all outer or inner heaters on only one propeller at a time, rotational balance is held during deicing. Current is drawn from the airplane electrical system through the switch, ammeter and timer. The timer successively delivers current via the slip ring and brush block arrangement to (phase 1) the outer heaters on the right propeller, (phase 2) the inner heaters on the same propeller, (phase 3) the outer heaters of the left propeller and (phase 4) the inner heaters on the left propeller. The timer energizes each of these four phases in turn for about 34 seconds and then repeats the cycle as long as the control switch is on. The cycling sequence given is vital so that outboard heaters on each propeller operate before the inboard heaters. See cycle sequence. (Refer to Figures 14-3 thru 14-6.) The system may be used continuously in flight if needed.

NOTE

Heating may begin at any phase in the cycle depending on the timer position when the switch was turned off from previous use.

a. Deicers: The deicers contain special heater wires protected by fabric plies and by oil and abrasion-resistant rubber. The side of the deicer cemented to the propeller has a dull finish whereas the air side finish is "glossy". Each deicer has a separate lead for the inboard and outboard heater and a third lead which is a common ground. These leads are so marked. An unmarked ground can be identified by using an ohmmeter across the three possible pairs of leads. One pair will show twice the resistance of the other pairs. The latter are the "hot" leads and the lead excluded from the pair that shows twice the resistance of the other pairs is the ground lead. All deicers used on this airplane must be of the new design, which includes a grey plastic patch where deicer and strap join.

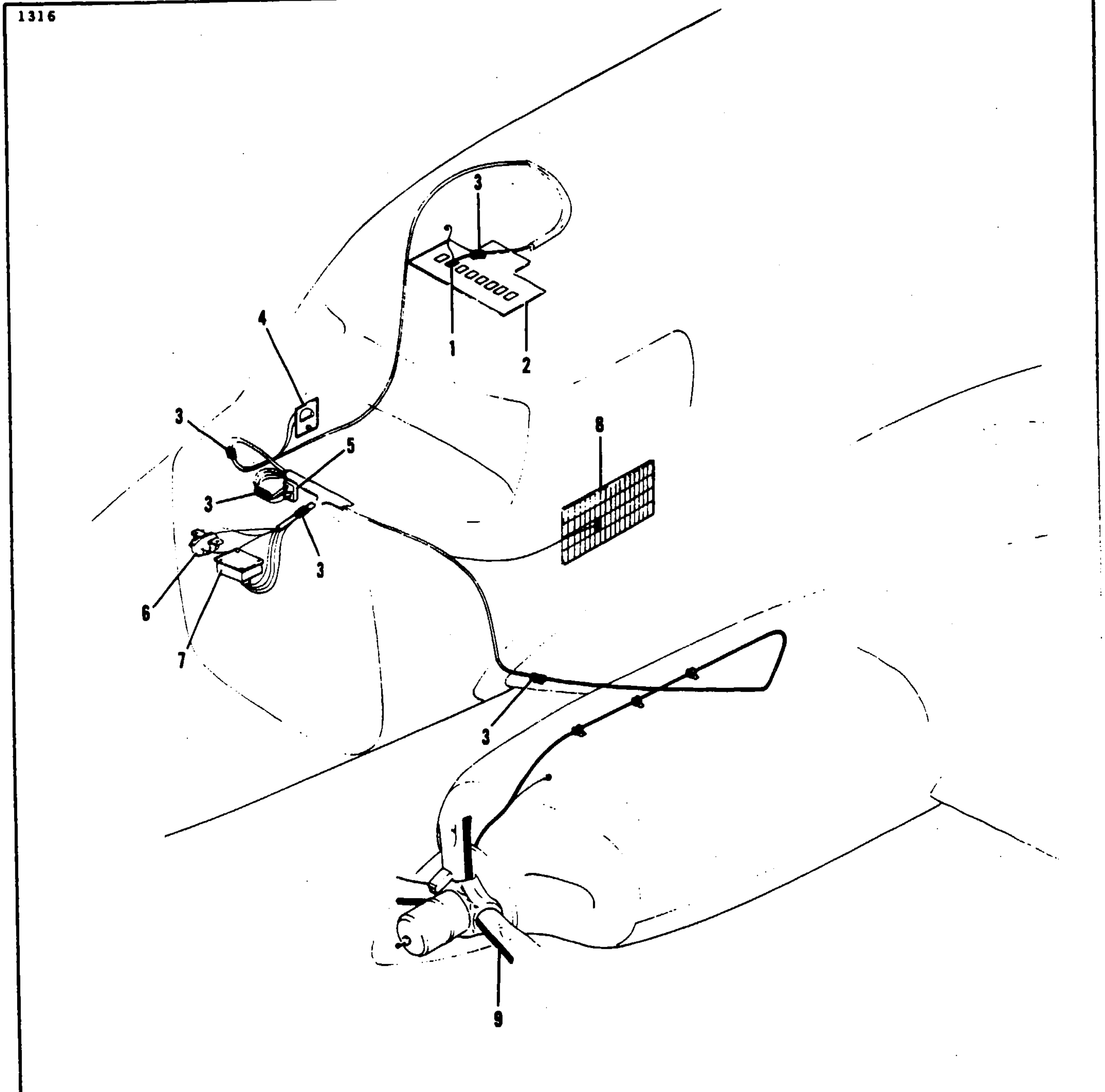
b. Slip Rings, Brushes and Brush Blocks: To transfer electrical power to the rotating deicers, a brush block assembly is mounted on the engine or similar stationary member and has brushes which are spring loaded to press against the revolving slip rings. The slip ring assembly is mounted on the back side of the propeller hub.

c. Timer: The timer is a sealed unit. If found inoperative, it must be replaced as an assembly - no field repairs are authorized. For timer function, refer to paragraph 14-51.

d. Ammeter: The ammeter is designed for each particular system and it is therefore important that the correct replacement part number be used if replacement should be required. In the event of low aircraft battery voltage (very possible in ground checks), the ammeter readings will be lower than at full voltage. Provided the ammeter needle reads in the shaded range on the scale, (full aircraft voltage) current flow is considered as normal.

e. Switch: The switch is mounted in the overhead switch panel.

f. Circuit Breaker: The circuit breaker is mounted in the circuit protector panel at the lift side of the cockpit.



1. DEICER SWITCH
2. OVERHEAD SWITCH PANEL
3. HARNESS CONNECTOR
4. AMMETER
5. SHUNT
6. DEICER RELAY
7. DEICER TIMER
8. CIRCUIT BREAKER PANEL
9. DEICER BOOT

Figure 14-2. Propeller Deicer System Installation

14-22. DEICER SYSTEM OPERATIONAL CHECK.

a. Chock the wheels and operate the engine at near take-off power.

b. Turn deicer system switch ON and observe deicer ammeter for at least two minutes.

c. The ammeter needle must "flicker" approximately every 34 seconds as the step switch of the timer operates.

d. With engines stopped, turn deicer switch ON and feel deicers on propellers for proper sequence of heater operation.

e. The starting point is not important but the sequence is vital and must be: Right Outboard, Right Inboard, Left Outboard, Left Inboard heaters, in that order.

f. Temperature rise should be noticeable and each heater should warm for about 34 seconds.

g. Local hot spots indicate surface damage of deicer heaters and should be repaired.

14-23. TROUBLESHOOTING. Troubles peculiar to the deicing system are listed in Table XIV-VI at the end of these instructions, along with their probable causes and suggested remedies.

14-24. USING THE AMMETER. Whether in flight or during ground testing, the ammeter can be used to indicate the general nature of most electrical problems. The troubleshooting chart is primarily based on this use of the ammeter and assumes that the user does understand all normal operating modes of the system as given in Principles of Operation, Paragraph 14-21.

NOTE

When troubleshooting, first use the "ammeter test" and "heat test" to determine which circuits are involved. Use circuit diagram for assistance to check voltages or continuity.

14-25. HELPFUL TIPS.

a. If the ammeter reading drops to one-third normal current this indicates that one heater circuit is open.

b. Excess current reading on the ammeter always indicates a power lead is shorted to ground. Thus, when trouble of this nature is found it is vital that the grounded power lead be located and corrected.

c. A considerable number of timers that have been returned for repair proved to be fully workable when tested. Accomplish the test described in paragraph 14-51 before concluding that the timer is defective.

14-26. INSPECTION.

14-27. 50-HOUR INSPECTION.

a. Lock brakes and operate engines at near take-off power. Turn deicer system switch ON and observe deicer ammeter for at least two minutes. Ammeter needle must reset within the shaded band except for a "flicker", approximately every 34 seconds, as the step switch of the timer operates. If not, refer to the appropriate entry of the troubleshooting chart.

b. With engines stopped, turn deicer switch ON and feel deicers on propellers for proper sequence of heater operation. The starting point is not important but sequence is vital and must be: Right Outboard, Right Inboard, Left Outboard and Left Inboard heaters, in that order. Temperature rise should be noticeable and each heater should warm for about 34 seconds. Local hot spots indicate surface damage of deicer heaters - inspect and repair in accordance with paragraphs 14-38 to 14-41.

1254A

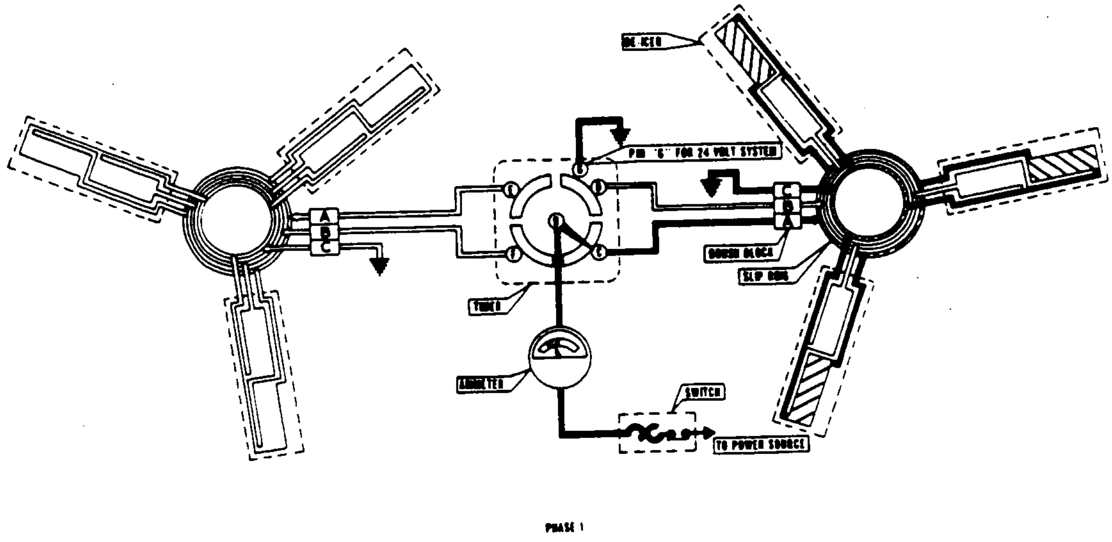


Figure 14-3. Electrical Diagram Showing Cycle Sequence

1254B

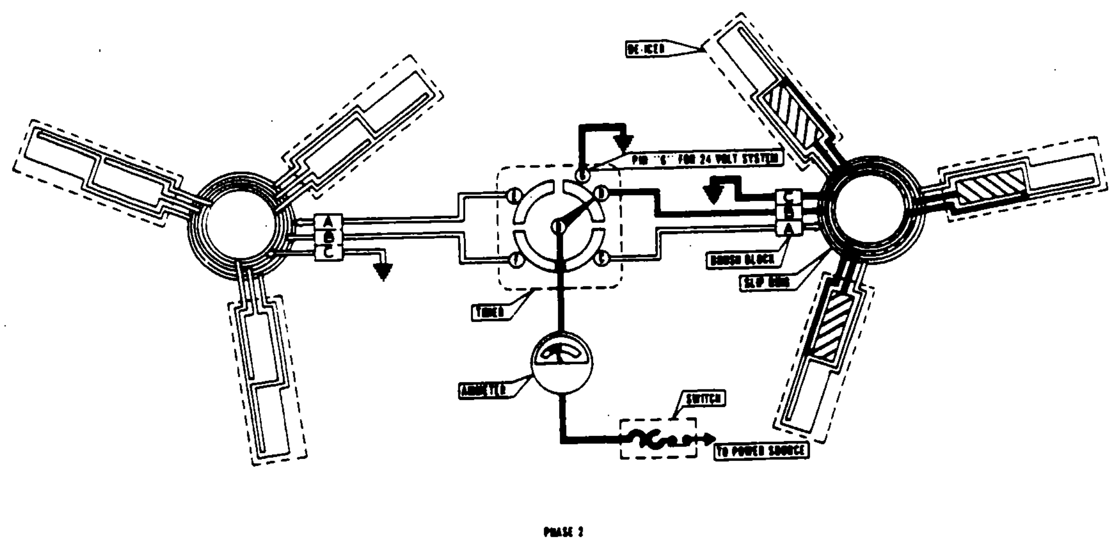


Figure 14-4. Electrical Diagram Showing Cycle Sequence

1254 C

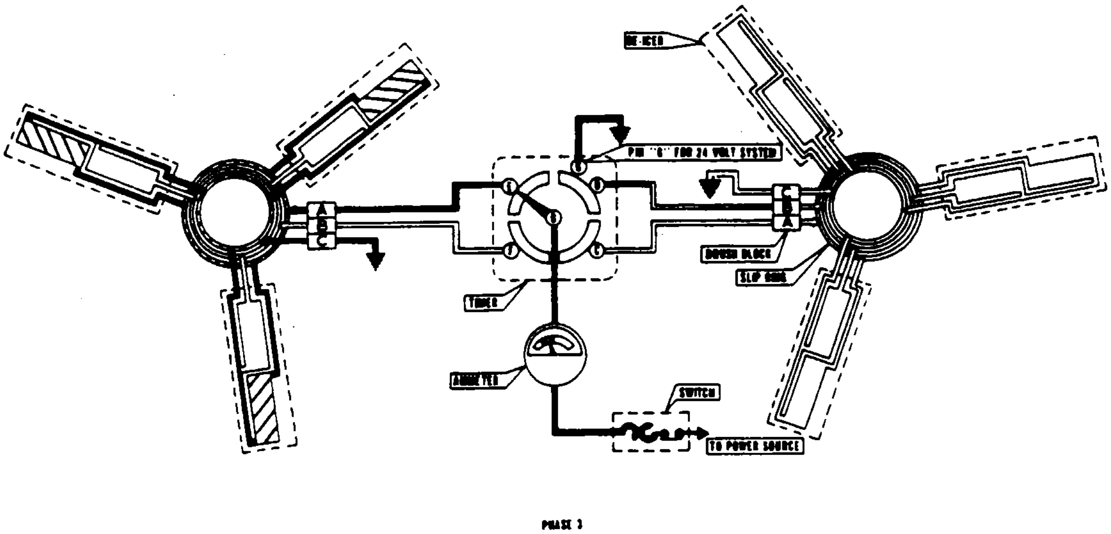


Figure 14-5. Electrical Diagram Showing Cycle Sequence

1254 D

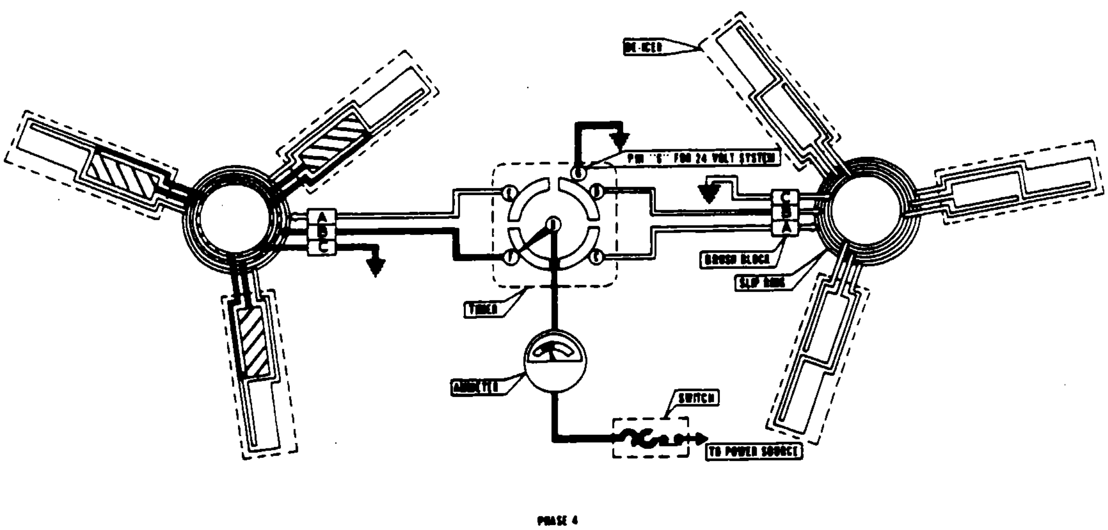


Figure 14-6. Electrical Diagram Showing Cycle Sequence

c. Remove spinner dome and open access doors as required. With assistant observing deicer ammeter and with deicer switch ON, flex all accessible wiring - particularly the deicer lead straps, leads from slip ring assembly and the firewall electrical connectors and their wiring. Any movement of the ammeter needle - other than the "30-second flicker" of cycling - indicates a short or open that must be located and corrected.

14-28. 100-HOUR INSPECTION.

a. Remove cowling in accordance with Removal of Engine Cowling, Section VIII.

b. Conduct 50-hour inspection.

c. Check for radio noise or radio compass interference by operating the engine at near take-off power and with radio gear ON while turning deicer switch ON and OFF. If noise or interference occurs with deicer switch ON, and disappears when switch is OFF, see troubleshooting chart.

d. Ascertain that all clamps, clips, mountings and electrical connections are tight. Check for loose, broken or missing safety wire.

e. Deicers: Closely check deicers for wrinkled, loose or torn areas. particularly around the outboard end and where the strap passes under the strap retainer. Look for abrasion or cuts, especially along the leading edge and the flat or thrust face. If heater wires are exposed in damaged areas or if rubber is found to be tacky, swollen or deteriorated (as from oil or solvent contact), replace the damaged deicer in accordance with paragraphs 14-40 to 14-45.

NOTE

Check that strap restrainers are correctly located and secure. Look for cracks or other damage. Operate propeller from "full pitch" to "feathering" and check that deicer lead straps do not come under tension, or are pinched by propeller blade. (Refer to Figures 14-17 or 14-18.)

f. Slip Rings: Check slip rings for gouges, roughened surface, cracks, burned or discolored areas and for deposits of oil, grease or dirt.

1. Clean greasy or contaminated slip rings with CRC 2-26 solvent. (This solvent is available from CRC Chemicals Div. Webb Inc., CJ10 Limekiln Pike, Dresher, Pa. 19025

2. If uneven wear is found or if wobble is noticed, set up dial indicator as shown in Figure 14- 7 to check alignment of slip rings to propeller shaft.

g. Brush Block - Brushes: Examine mounting brackets and housing for cracks, deformation or other physical damage.

1. Test that each brush rides fully on its slip ring over 360°. Figure 14-8 shows wear pattern if this condition is not corrected. If alignment is off, shim where brush block attaches to bracket. The shim is a series of laminates and may be peeled for proper alignment of brushes to slip rings. A new shim may be necessary.

2. Check for proper clearance of brush block to slip rings as shown in Figure 14-10. If not correct, loosen mounting screws and move in elongated holes to correct block position before tightening securely.

3. Check brushes for wear limitation (refer to Paragraph 14-30 and Figure 14-9.)

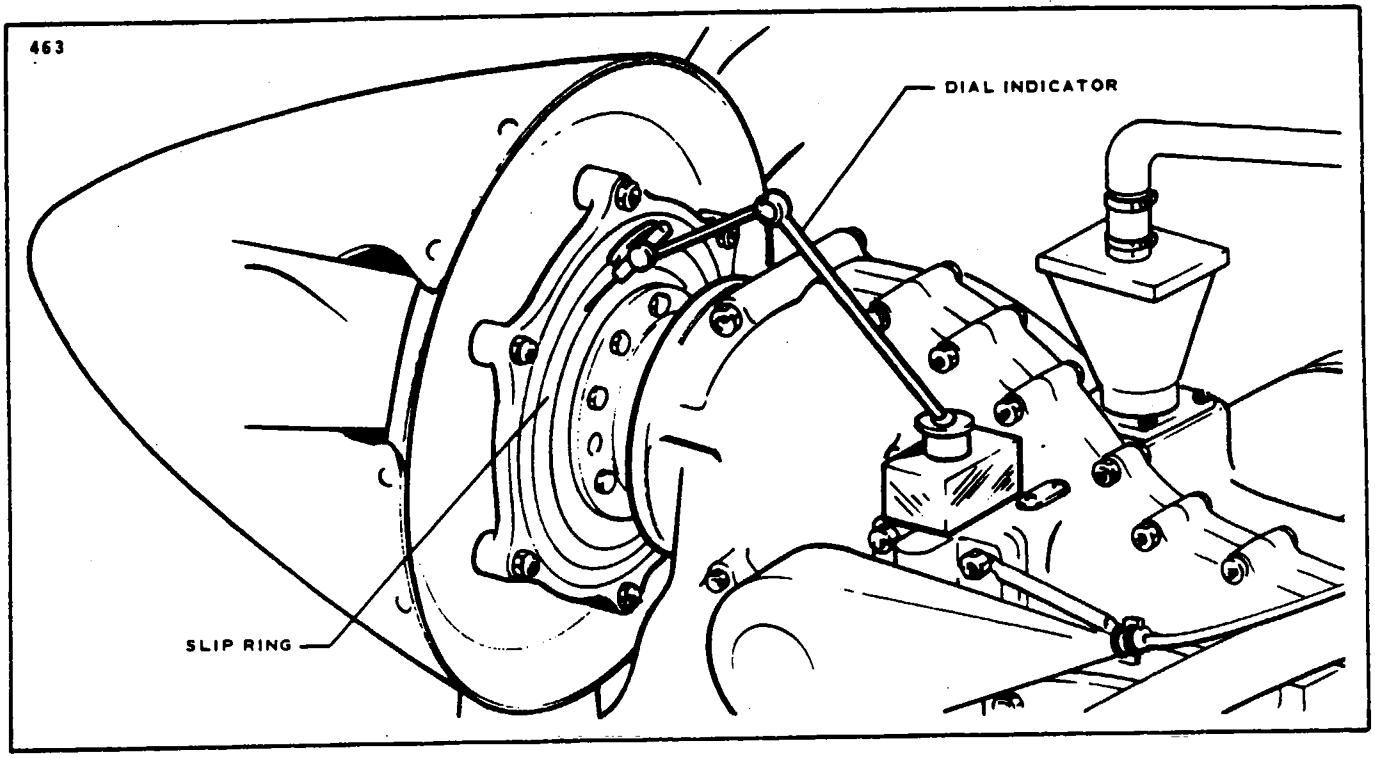


Figure 14-7. Typical Use of Dial Indicator

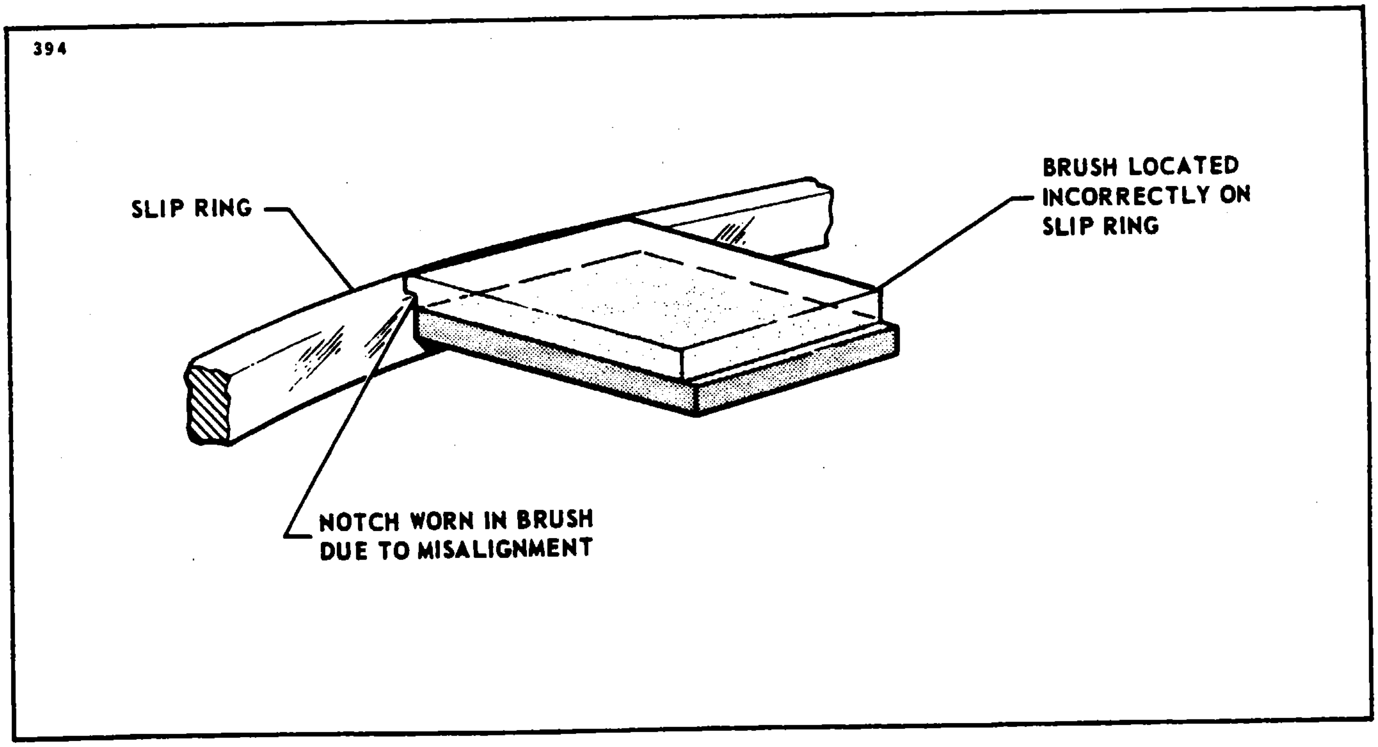


Figure 14-8. Centering of Brushes on Slip Rings

4. Visually check brush block for approximately 2° angle of attack. (Refer to Figure 14-10.) If not, loosen mounting screws and twist block, but be sure to hold clearance limits shown when tightening.

h. System Wiring: With deicer system operating, have assistant observe ammeter while visually inspecting and physically flexing wiring from brush blocks through firewall, to timer, to ammeter, to switch and to aircraft power supply. The ammeter will flicker as the timer switches approximately every 34 seconds in the cycle. Jumps or flickers at other times indicates loose or broken wiring in the area under examination at that moment. In such case, check continuity through affected harness, while flexing and prodding each wire in the area that gave initial indication of trouble. Use the wiring diagram in Figures 14-11 to trace circuitry.

14-29. REPAIR PROCEDURE FOR INDIVIDUAL COMPONENTS.

14-30. CHECKING FOR BRUSH WEAR.

Insert small diameter wire through hole in rear of brush retainer assembly (refer to Figure 14-9). Replace brushes if the length of the inserted portion of wire measures more than 1.625 inches.

14-31. REPLACEMENT OF BRUSHES.

a. Disconnect leads from terminals on brush retainer assembly.
b. Remove brush retainer assembly from mounting bracket by removing attaching screws.
c. Separate brush retainer assembly by the following procedure. (Refer to Figure 14-9.)
    1. Remove terminal block by removing the four attaching screws.
    2. Move the guide block laterally to disengage the dowl pins from retainer block.
    3. Heat terminal stud to melt solder in order to remove brush leads from stud.
d. Reassemble brush retainer assembly by the following procedure.
    1. Install insulation on "A" & "B" brush leads.
    2. Solder brush leads to terminal stud.

NOTE

New springs should always be used when replacing brushes.

3. Position brushes and spring into guide block and engage the guide block on to the dowl pins on the retainer block.

4. Position terminal block on brush retainer assemble with four attaching screws.

e. Position brush retainer assembly on mounting bracket and secure with attaching screws.

CAUTION

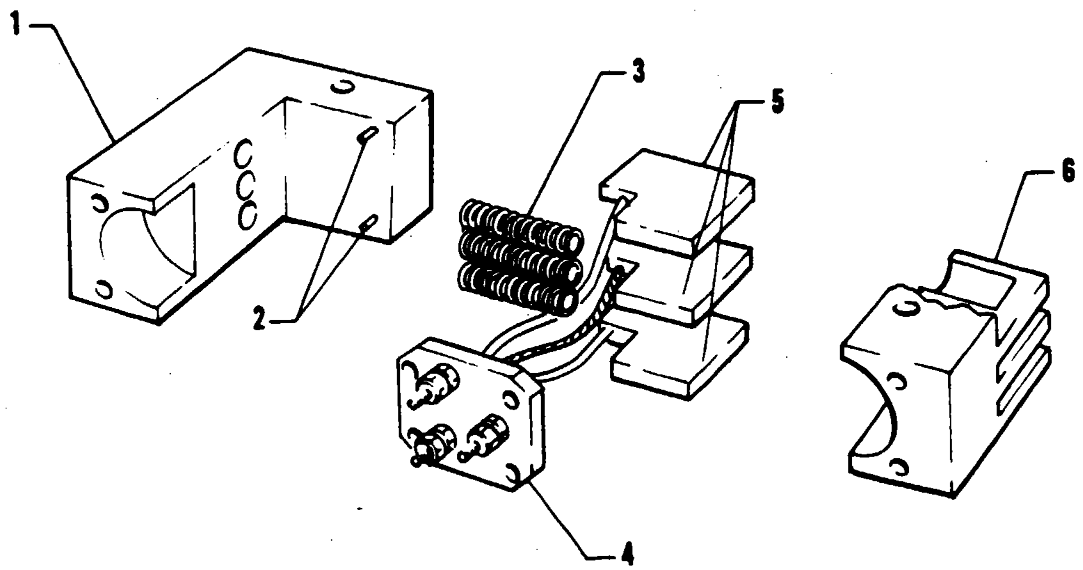
Side loads on brushes should be avoided to prevent brush damage.

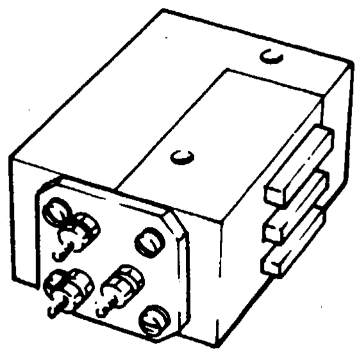
f. Attach electrical lead to terminal studs making certain the lead is connected to proper stud.

g. Check for free movement of brushes by pushing the brushes back into the block and allowing the spring pressure to return them. DO NOT SNAP. If free movement is impaired, correct the restriction and recheck.

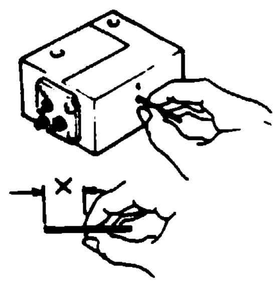
h. Reinstall the brush block to the mounting bracket utilizing the hardware removed in paragraph 14-31, b.

464





1. RETAINER BLOCK
2. DOWEL PINS
3. SPRINGS
4. TERMINAL BLOCK
5. BRUSH
6. GUIDE BLOCK



MEASURING BRUSH WEAR

X-DIMENSION (INCHES)	
SHOULD REPLACE	MUST REPLACE
1-1/2	1-5/8

Figure 14-9. Brush Block Assembly and Brush Wear Check

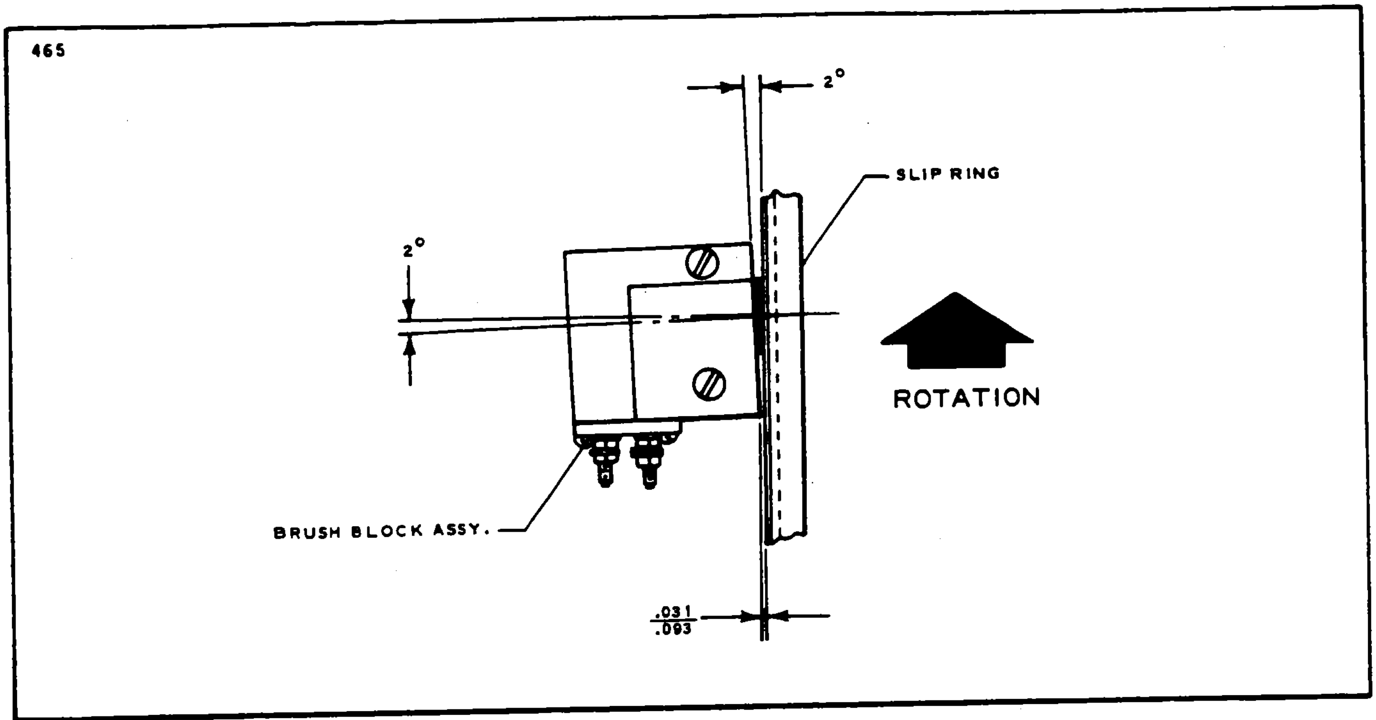


Figure 14-10. Angle of Contact - Brushes to Slip Rings

NOTE

New deicer brushes must be run in a minimum of two hours of engine operation prior to energizing the deicer boots. Brushes should be checked for proper seating and alignment after the run in period.

14-32. ALIGNMENT OF NEW BRUSHES. Anytime the brush block assembly is dismounted, the alignment at reinstallation must be checked as described in paragraph 14-28, g and Figure 14-10.

NOTE

New deicer brushes must be run in a minimum of two hours of engine operation prior to energizing the deicer boots. Brushes should be checked for proper seating and alignment after the run in period.

TABLE XIV-III. POWER REQUIREMENT FOR 28 VOLT DC SYSTEM

PROP.	TIMER SEQUENCE	ELEMENT HEATED	TIME SECS.	LOAD AMPS
RIGHT.	C	OUTBD	34	14-18
	D	INBD	34	14-18
LEFT.	E	OUTBD	34	14-18
	F	INBD	34	14-18
TOTAL CYCLE TIME - 2.2 MINUTES				

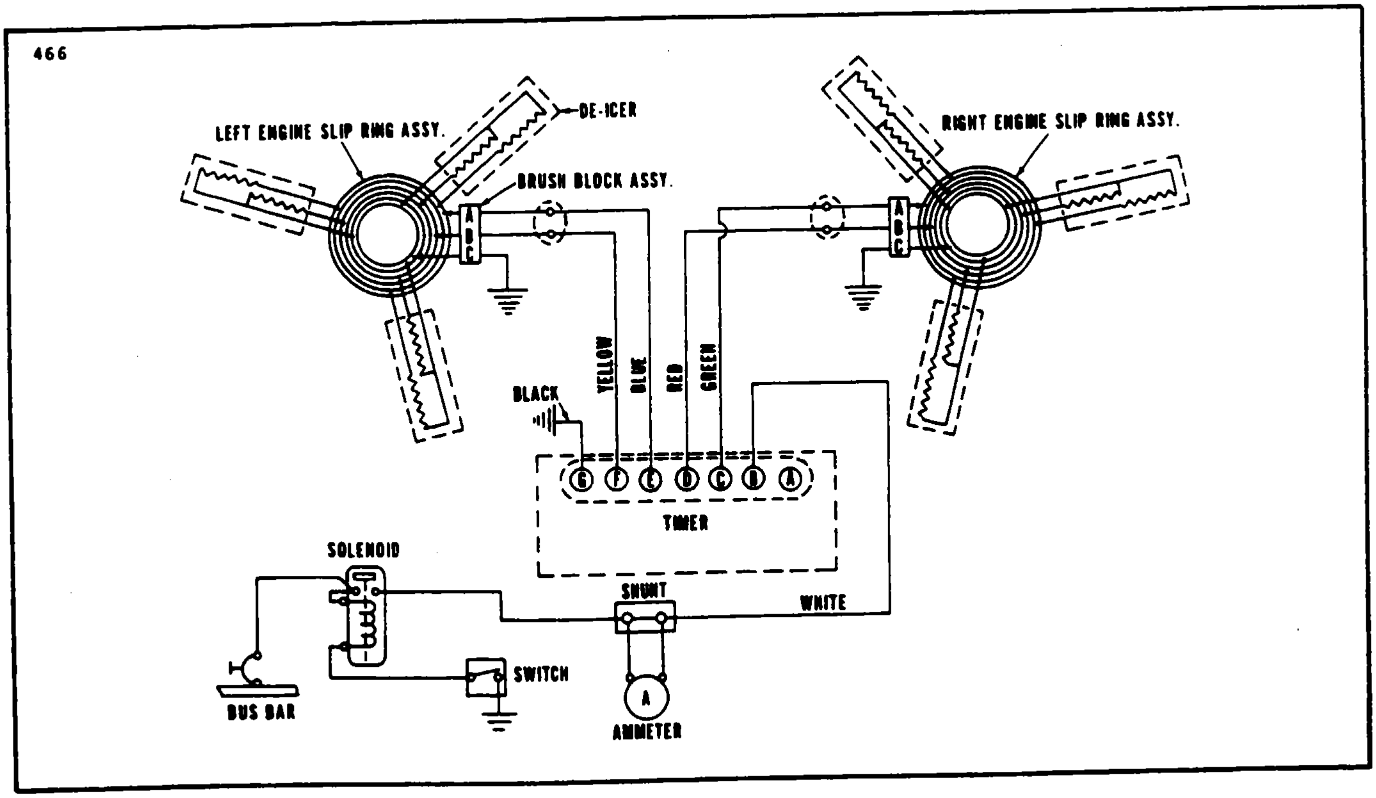


Figure 14-11. Wiring Schematic, Electric Propeller Deicing System

14-33. SLIP RINGS

14-34. MACHINING OF THE SLIP RING.

Slip rings with roughened or damaged surfaces can be machined to give prolonged service life. With slip ring assembly removed from propeller hub, mount in lathe not to exceed 0.002 run-out over 360 degree rotation with respect to the mounting surface of the slip ring assembly.

Take a light cut for smooth finish and cut no deeper than required to remove surface damage. Contact surfaces of the three slip rings must be parallel within 0.005 inch and flat within 0.005 inch overall - deviation from flat not to exceed 0.002 inch over a 4 inch arc. If necessary, undercut insulation between slip rings to a depth of 0.020 to 0.030 inches below the contact surface of the slip rings. The minimum dimension for re-facing slip ring assemblies, should not be less than 1.160 inch between the copper slip ring surfaces and the legs of the slip ring assembly.

NOTE

If in machining, the solder or braze connection on the underside of the slip ring is exposed, replacement of the slip ring assembly will be necessary.

14-35. REPLACEMENT OF SLIP RINGS. Slip ring assemblies that are open or shorted electrically, cracked or damaged structurally, or which have damaged surfaces beyond the scope of minor repair to clean up, should be replaced with a new slip ring assembly.

14-36. DEICER BLADES.

14-37. RESISTANCE CHECK OF DEICER BLADE. To determine incorrect resistance, short or open at the brush-to-slip ring contact, disconnect harness at the timer and use an ohmmeter to read resistance from each deicer circuit lead (pins C, D, E and F of harness plug) to ground. It should read 1.55 to 1.78 ohms. If this reading is not obtained, disconnect the deicer lead straps to measure heater resistances individually. Individual heater should be 4.58 to 5.26. If the check through the deicer system is off limits but the check through the heater is satisfactory, trouble is probably in the brush-to-slip ring area; if the heater check is off limits, the deicer is damaged and must be replaced.

14-38. REPLACEMENT. If tests show the blade deicer to have an open circuit, to be the wrong resistance or to be visibly damaged beyond repair as outlined in paragraph 14-28 of this section, replace the deicer as directed in paragraphs 14-40 thru 14-49.

14-39. REPAIR OF DEICER LEAD STRAP. Use B. F. Goodrich Field Repair Kit No. 77-802 which contains rubber patch material sufficient for several repair jobs. Cements and solvents specified in these directions are not included in the kit. (The abbreviation "MEK" in further steps stands for Methyl Ethyl Ketone.) The following steps apply wherever "cementing" is specified in the text.

a. Clean the area to be bonded or patched with MEK or acetone to remove all grease and dirt. It is vital that surface be clean for good cementing job. After last wipe with cleaner, quickly wipe surface with a clean dry lint-free cloth to remove solvent film.

b. Apply one even coat of EC1300L or EC1403 cement (Minnesota Mining and Mfg. Co.) to area to be bonded or patched and allow to dry (approximately one hour above 40 °F). Apply second even coat of EC1300L or EC1403 cement and allow to dry.

c. Cut the patch (.020 thick rubber to about 1/4 inch large on all sides of the damaged area). The protective paper is on the side to be cemented. Apply masking tape on the open side to prevent the patch from curling as cement dries then strip off protective paper and apply EC1300L or EC1403 cement in a smooth even coat. Allow to air dry. After one hour, apply second coat and allow to air dry.

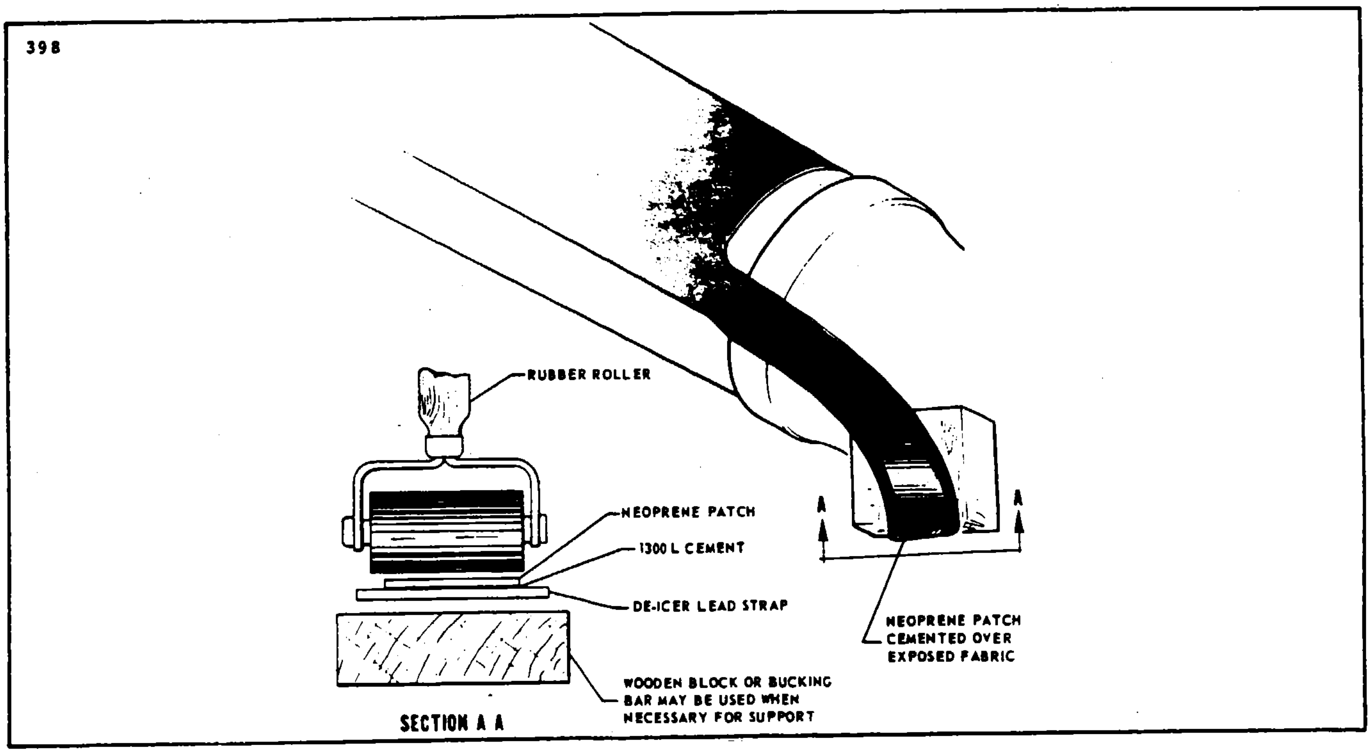


Figure 14-12. Repair of Lead Strap

d. With cement surfaces either dry or with just a trace of "tachiness", apply light coat of MEK or Toluol over these surfaces to "re-tackify" and quickly complete the cementing job as directed. Allow one hour to air dry before peeling off the masking tape or mylar coating on the air side. Rub edges and center of patch to see that it is holding before releasing for flight. (Approximately 24 hours.)

NOTE

Do not touch cemented surface with dirty or oily fingers.

14-40. REMOVAL OF DEICER.

a. Disconnect terminals of propeller deicer from studs on the spinner bulkhead.

b. Use MEK or Toluol to soften the adhesion line between the deicer and the propeller blade.

c. Starting at one corner of the deicer, loosen enough of the deicer to grasp in the jaws of a vise grip pliers or similar tool.

d. Apply a steady pull on the deicer to pull it off the propeller surface. Continue using MEK or Toluol to soften the adhesion lines. Unless the deicer being removed is damaged and is to be scrapped, cushion the jaws of any pulling tool used to prevent damage to the deicer surface. Remove very slowly and carefully. If deicer has failed and is to be returned under request for warranty, extreme care should be exercised so that no additional damage is incurred to the deicer during and after removal.

e. Remove residual cement from blade. Use Turco 3 or equivalent to help with dried cements.

14-41. BLADE PREPARATION.

a. Mark and cut from masking tape a pattern the size of the propeller deicer including the first inch of the lead strap. (Refer to Figure 14-15.)

b. Place a mark at the hub end of the blade in line with the blade leading edge. The location for this mark can be determined by sighting along the leading edge. Starting at the hub (see NOTE below), center the pattern on this mark and stick the pattern to the leading edge. Mark the position of the deicer lead strap where it crosses the hub.

NOTE

All deicers on a single propeller must be located the same distance from the hub for rotational balance.

c. Remove the pattern and remove any paint in the marked off area. Clean down to bare metal. Next, clean the area thoroughly with MEK or acetone. For final cleaning, wipe the solvent off quickly with a clean dry lint-free cloth to avoid leaving a film.

CAUTION

Cleanliness of metal and rubber parts cannot be too highly stressed. Only perfectly clean surfaces will assure maximum adhesion.

d. Using a pencil or pen, mark a centerline at the hub of the propeller blade and on the tape at the outboard edge of the masked area.

14-42. CEMENT APPLICATION.

a. Using a silver pencil, mark a centerline on the glossy side of the deicer.

b. Moisten a clean cloth with MEK or acetone and clean the unglazed surface of the deicer, changing cloth frequently to avoid contamination of the clean area.

c. Thoroughly mix the EC1300L or EC1403 cement. Apply one even brush coat of cement to the unglazed back surface of the deicer. Cement one inch of the deicer lead strap. Allow to air dry for a minimum of one hour at 40° F or above, when the relative humidity is less than 75%. If the humidity is 75% to 90%, allow two hours drying time. Do not apply cement if the relative humidity is higher than 90%. After allowing the proper amount of drying time, apply a second even brush coat of EC1300L or EC1403 cement.

NOTE

If curling of the deicer edges is a problem, apply masking tape to the edges of the glazed side before applying cement to the unglazed side. Remove the tape before starting to install the deicer.

d. Apply an even brush coat of EC1300L or EC1403 cement on the cleaned surface of the propeller blade, immediately after the second coat of cement has been applied to the deicer. This timing is important for the cement on both surfaces to reach the tack stage at the same time.

TABLE XIV-IV. REQUIRED MATERIALS FOR REPAIR OF PROPELLER DEICER

The materials and tools listed below are commercially available and are not supplied by B.F. Goodrich in kit form:

Item	Amount
Cement EC 1300L or EC 1403 (3M Mfg. Co.)	1 pt. per six blades
Sealer A56B (B.F. Goodrich)	½ pt. per six blades
Cleaning Solvent MEK (Methyl Ethyl Ketone) or Acetone	
B.F. Goodrich Filler 82-075A and B or 3M Sealer EC-801 and EC-1031	
B.F. Goodrich Sealer 82-076-1 and -2 or Lowe Brothers' paint C-19861, C21871 and C-16176.	
Cleaning Cloth - any clean, lint-free cloth	
2 inch Rubber Hand Roller	
1/4 inch Metal Hand Stitcher	
Scissors	
Turco #3 (Turco Products Co.)	1 pt. per six blades
Masking Tape	

NOTE

MEK can be used instead of Toluol to tackify cement: however, tests show that MEK causes rapid drying and provides only 10 seconds working time for deicer application compared with 40 seconds for Toluol.

14-43. INSTALLATION OF DEICER AND REQUIRED MATERIALS. It is imperative that the following instructions be followed exactly to insure maximum adhesion to the propeller blades.

a. When the cement coats are tacky dry on both propeller surface and deicer surface, proceed as follows:

1. Position the deicer on the propeller leading edge, using centerlines starting from the hub. (Refer to Figure 14-15.) Make sure that the strap will fall in the position previously marked. Working towards the tip, tack the deicer centerline to the leading edge of the propeller blade. Use tackifying solvent as necessary. If the deicer is allowed to get off course, pull up with a quick motion and remove deicer. Recement per paragraph 14-42, c and d if necessary before proceeding. Roll firmly along the centerline with a rubber roller, as shown in Figure 14-16.

2. Roll the tapered edges, especially the inboard edge, of the deicer with a narrow steel stitcher roller.

CAUTION

To avoid damage to resistance wires, do not use metal stitcher on body of deicer.

3. Apply one even brush coat of sealer around the edges of the installed deicer.

4. Remove the masking tape from the blade immediately after applying the sealer.

5. Allow 24 hours cement curing time before turning up propeller. Allow 72 hours curing time before operating the deicers. Handle the propeller carefully to prevent damage to the deicers.

14-44. PREPARATION AND APPLICATION OF SEALER. Deicers loosened due to destruction of adhesive bond by lubricants do not respond well to recementing. Therefore, removal, cleaning, and reinstallation of the deicers are recommended. Refer to paragraphs 14-40 and 14-43.

a. Clean an area .500 inch wide around the circumference of the deicer down to the bare metal. Use MEK or Acetone and clean thoroughly.

b. Clean outer .500 inch of all deicer edges and back under deicer about .250 inch on all sides past loosened areas with MEK or Acetone. For final cleaning, quickly wipe off solvent with a clean, dry, lint-free cloth to avoid leaving a film.

c. Recement loosened areas of deicers in accordance with paragraph 14-42.

d. Mix the filler, sealer or paint thoroughly and in the proper proportions by weight, as given in the following steps.

1. 82-075A/B - one part A/one part B
2. 82-076-½ - Twelve parts - 1/one part - 2
3. EC-1031/EC-801 - Twelve parts 1031/one hundred part 801
4. C-19861/C-21871/C-16176 - one part 19861/seven parts 21871/two and two thirds parts 16176.

e. Locate masking tape approximately -.125 inch beyond cemented area around deicer to allow application of filler directly to metal. Apply one even brush coat of 82-075A/B filler (or EC-801 sealer) over .125 inch of bare metal, cemented area and about .125 of an inch of deicer. (See Figure 14-13.)

f. Insure that a fillet of filler completely covers the area between deicer strap and blade. (See Figure 14-14.) Immediately remove masking tape and allow filler to dry for six hours.

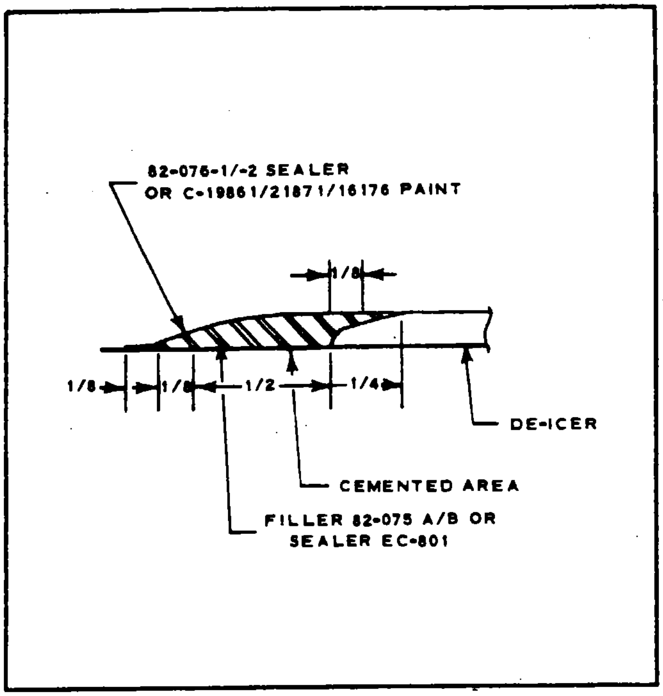


Figure 14-13. Sealer Application (Boot)

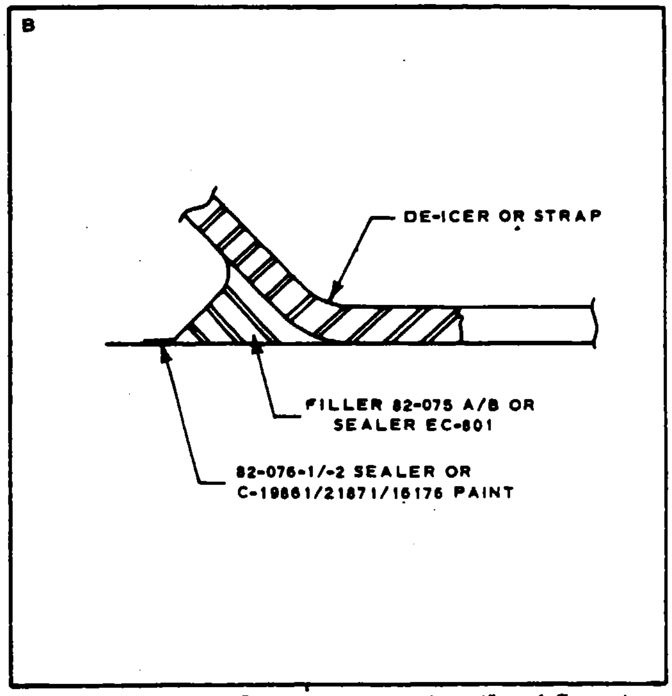


Figure 14-14. Sealer Application (Lead Strap)

g. Apply new masking tape approximately .125 of an inch beyond filler to allow application of sealer directly to metal. Apply one even brush coat of 82-076-1/2 sealer (or C-19861/C- 16176 paint) over .125 of an inch of bare metal, filled area and .250 of an inch of deicer. (See Figure 14-13.)

h. Insure that sealer completely covers area between deicer strap and blade. (See Figure 14-14.) Immediately remove masking tape and allow sealer to dry for 24 hours before starting engine.

14-45. WRINKLED DEICERS. (Refer to Figure 14-16.) If edge of deicer is found wrinkled or loose, try recementing. Use MEK or Toluol to loosen the bond for an additional 1/4 inch beyond the loose or wrinkled area. Apply one coat of EC1300L or EC1403 cement to the deicer and propeller bonding surfaces and allow to air dry for one hour. Then apply a second coat of EC1300L or EC1403 cement to both the deicer and bonding surface. Allow to dry. Retackify with MEK or Acetone and press with fingers to work out wrinkles or to secure loose edges. If material has stretched and will not cement flat, replace the deicer.

14-46. ELECTRICAL CHECK.

a. Check the electrical resistance of each of the two elements within the deicer. Refer to Schematic, Figure 14-11, and Resistance Readings. Refer to Table XIV-V.

b. Check for intermittent open circuits by tensioning the deicer strap slightly while measuring the resistance. Also, press lightly on the deicer surface in the area adjacent to the strap retainer. Resistance must not vary.

c. Identification of the circuits within the element may be confirmed by referring to the resistance values and schematic diagram, Figure 14-11. Proper identification is necessary in order to make the system cycle properly and to obtain the correct amperage values during system operation. Minimum and maximum ohms between common ground and either of the other terminals is 4.58 to 5.26.

NOTE

These resistances apply only to deicers that are not connected to terminal studs.

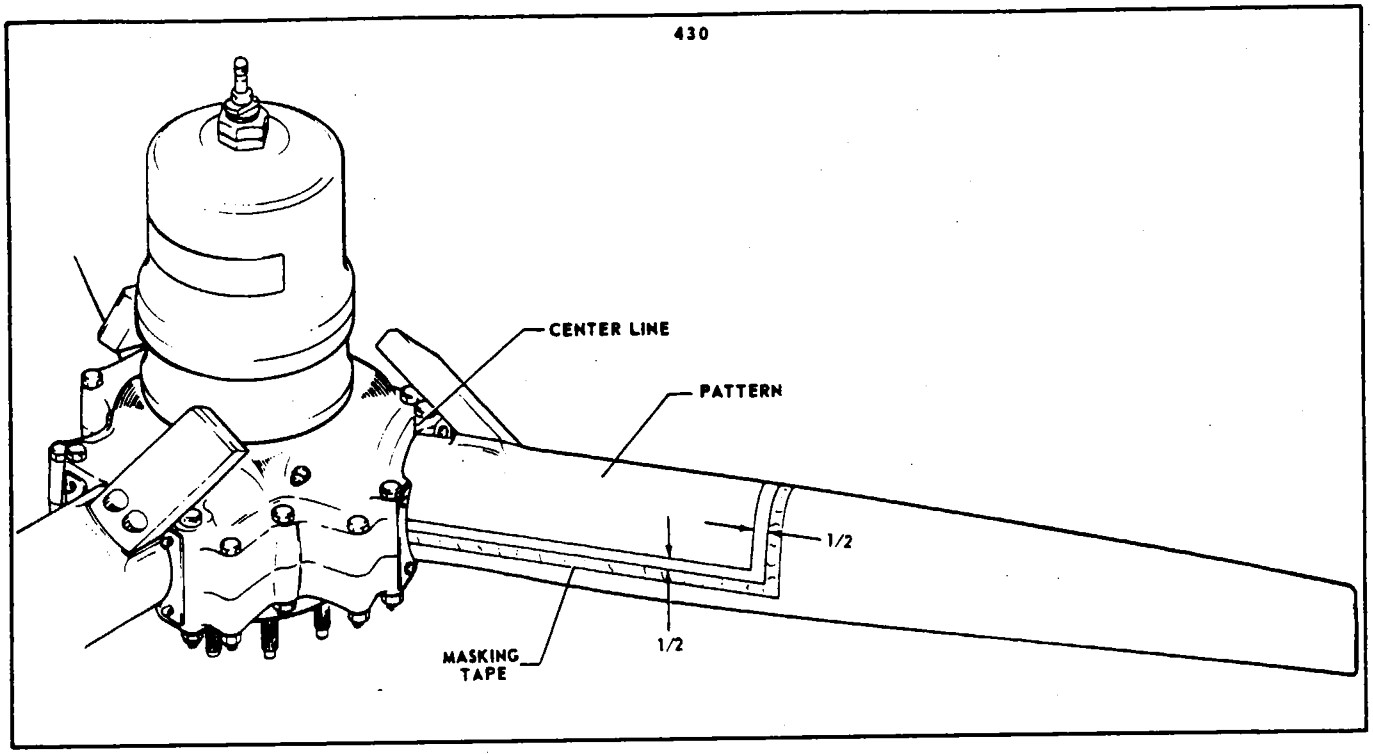


Figure 14-15. Installation of Deicer Boots

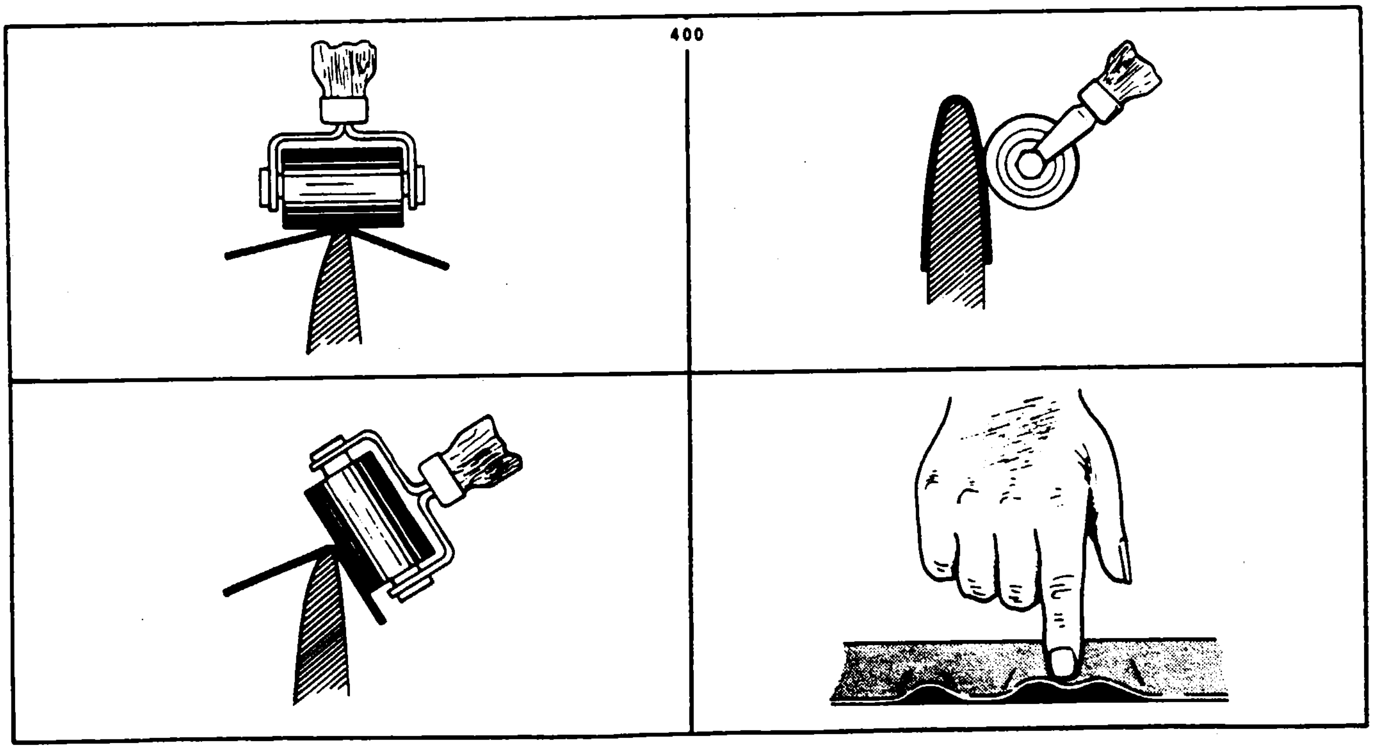


Figure 14-16. Wrinkled Deicers

14-47. INSTALLATION OF DEICER STRAPS AND WIRE HARNESS.

a. The deicer lead strap is fastened to the bulkhead in the same positions from which they were removed.

b. The deicer strap is to be attached to the studs on the spinner bulkhead.

CAUTION

Never use Type "B" star washer (teeth on outer diameter) adjacent to tongue of deicer terminals.

c. Make certain that there is no slack in the deicer lead strap between the terminals and the clip. This is important because it assures enough slack between the clip and the strap restrainer to allow for proper feathering. A test should be conducted on each propeller deicing system to insure that deicer lead straps are installed in such a manner that the propeller can be moved from full low pitch through the feathering position without placing the straps in tension.

NOTE

Deicers should have a piece of gray plastic bonded to the air side (shiny side) of the deicer strap as shown in Figure 14-17.

d. If damage occurs to slip ring wire harness, rubber spacers or hose clamps, replace damaged parts.

14-48. BALANCING. To assure balance of the propeller assembly, the original balancing weights or their equivalents must be reinstalled. The weights must be left in their original position on the propeller hub. The restrainer and weights should not interfere with any part of the propeller assembly under any condition. If for any reason balance weights were removed, reinstall safety wire on screws.

14-49. FINAL ELECTRIC CHECK.

a. Make certain that all terminals are tight. Do not over-torque.

b. Check the electrical resistance between the deicer terminals or between the slip rings. The reading should be:

TABLE XIV-V. ELECTRICAL RESISTANCE

Resistance Check	Max.	Min.
1 Blade each Element	5.26	4.58
3 Blades in Parallel	1.78	1.55

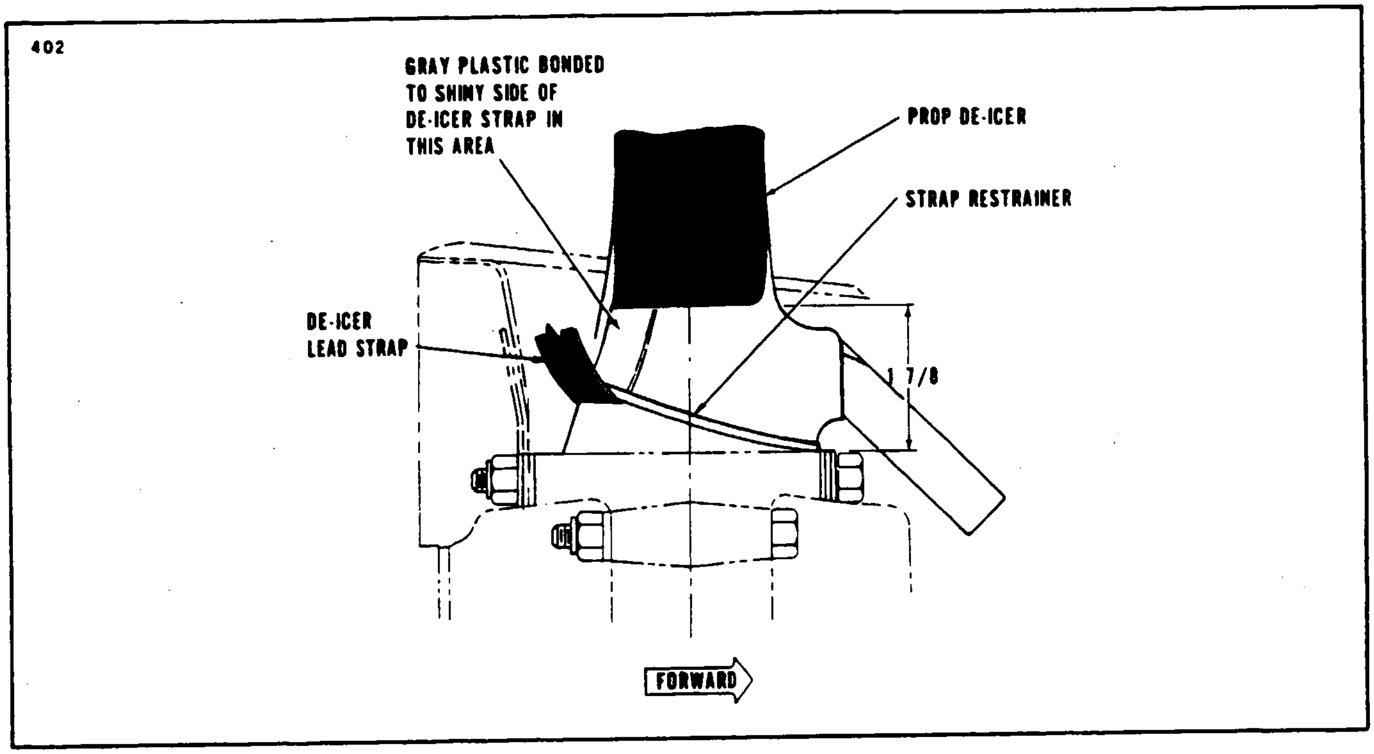


Figure 14-17. Propeller Blade in Low Pitch

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c. If the propeller is installed on an airplane, the deicer circuits on the propeller must be electrically isolated from the rest of the airplane wiring when making the above resistance check. The isolating can be done by any one of the following methods:

1. Remove the brush block.
2. Retract the brushes and slip a sheet of paper between the brushes and the slip rings. If this method is used, make certain that the brushes are not misaligned or damaged by insertion of the paper shim.
3. Disconnect the timer and engine wire harness at any convenient place.

d. Reconnect any circuits that may have been disconnected, or remove paper shims that might have been used for making the final electrical check.

NOTE

Electrical continuity checks shall be made without rotating the propellers while the boot switch is ON.

14-50. OTHER COMPONENTS. Do not attempt internal repairs of the timer, ammeter, or switch. If inoperative, these components must be replaced with one of the correct part number. For any other repair or maintenance problems not covered in this manual, inquire at Aerospace and Defense Products Division of the B. F. Goodrich Company, Akron, Ohio 44318.

14-51. TIMER TEST. Field experience indicates that too often the timer is considered at fault when the true trouble lies elsewhere. Before removing a timer as defective, perform this test:

a. Disconnect wire harness at timer and with deicer switch ON check voltage from pin B of harness plug to ground. If system voltage is not present, the fault is not in the timer. If system voltage is present at pin B, check ground circuit using ohmmeter from pin G to ground. If no circuit is shown, the fault is in ground lead, not in timer. If ground connection is open, the timer step switch will not change position.

b. When power and ground circuits have been checked, connect a jumper wire from pin B of harness to B contact of timer socket to power timer. Connect a jumper wire from pin G of harness to G contact of timer socket to complete the power circuit. Now use voltmeter from ground to the timer socket and check that timer is cycling to deliver system voltage to C, D, E, and F contacts in that order. (The starting point is not important but sequence must be as given.) Each of these four contacts must deliver voltage for approximately 30 seconds, in turn, and there must be zero voltage on the three contacts not energized.

c. If the timer meets these requirements, it is not the cause of the trouble. If it fails to perform as indicated, the trouble does lie in the timer and it should be replaced.

TABLE XIV-VI. TROUBLESHOOTING CHART (PROPELLER DEICER SYSTEM)

Trouble	Cause	Remedy
Ammeter shows zero current. (All 4 phases of the 2 minute cycle.)	Tripped circuit breaker switch.	Locate and correct short before setting circuit breaker.
	Defective power source.	If no voltage into switch, locate and correct open.
	Circuit breaker-switch faulty.	If no voltage at switch output with voltage at switch input, replace the switch. If voltage is satisfactory at switch output, go to next step.
	Ammeter faulty. (If some or all Deicers heat with ammeter at zero, replace the ammeter.)	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.
	Open ammeter to timer.	Disconnect harness at timer and check voltage at pin B (of harness) to ground. If none, locate and correct open.
Ammeter shows normal current part of cycle, zero current rest of cycle.	Open circuit between timeer and brush block assembly.	Use heat test to find Deicers not heating and test for voltage on that contact of wire harness plug. (At brush block assembly.) If zero over 2 minutes, locate and fix open in wiring from timer to wire harness plug.

TABLE XIV-VI. TROUBLESHOOTING CHART (PROPELLER DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
Ammeter shows normal current part of cycle, zero current rest of cycle. (cont.)	Open between brush block assembly and Deicer lead straps.	If there is voltage to brush block wire harness plug, try voltage at junction of Deicer lead and slip ring lead. If no voltage, find and correct open in wiring within brush block or no contact of brush to slip ring.
	No ground circuit, one engine.	If voltage is found at Deicer leads, locate and fix open from Deicer to ground.
Ammeter shows normal current part of cycle, low current rest of cycle.	Inner and outer Deicers heating same phase.	Locate and repair incorrect connections.
	Open in Deicer or slip ring leads.	Disconnect Deicer straps to check heater resistance as in paragraph 14-46. If satisfactory, locate and fix open in slip ring leads.
	High resistance in circuit with low current.	If not in contact of brush to slip ring (including ground brush), trace wiring to Deicer and to timer to fix partially broken wire, loose or corroded connection.
Ammeter shows low current over entire cycle.	Aircraft voltage low.	Check voltage into switch.
	Ammeter faulty.	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.

TABLE XIV-VI. TROUBLESHOOTING CHART (PROPELLER DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
Ammeter shows low current over entire cycle. (cont.)	High resistance up to timer.	Check for partially broken wire, loose or corroded connection in wiring from aircraft supply to timer input.
Ammeter shows excess current over entire cycle.	Ammeter faulty.	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.
	Ground between ammeter and timer.	Disconnect harness at timer and with ohmmeter check from pin B (of harness) to ground. If ground is indicated, locate and correct.
Ammeter shows normal current part of cycle, excess current rest of cycle.	Ground between timer and brush block.	Disconnect leads at brush block and, with ohmmeter, check from power leads to ground. If ground is indicated, locate and correct.
	Ground between brush block and Deicers. (Excluding ground brush circuit.)	If no short exists at brush-slip ring contact check for ground from slip ring lead to propeller assembly while flexing slip ring and Deicer leads. If a ground is indicated, locate and correct.
	Short between two adjacent circuits.	Check for cuts or low resistance between circuits, if any, locate and correct.

TABLE XIV-VI. TROUBLESHOOTING CHART (PROPELLER DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
Ammeter shows normal current part of cycle, excess current rest of cycle. (cont.)	Timer faulty.	Test timer as in paragraph 14-51.
Ammeter does not "flick" approximately every 30 seconds.	Timer ground open.	Disconnect harness at timer and check with ohmmeter from pin G (of harness) to ground. If no circuit, fix open per schematic diagram.
	Timer contacts are welded (caused by short circuit in system.	Test timer as in paragraph 14-51. If timer does not cycle with voltage at pin B, replace timer but be sure short causing original failure has been located and corrected.
Ammeter flicks between 30 second phase periods.	Loose connection between aircraft power supply and timer input.	If trouble occurs over entire cycle, trace wiring from power source to timer input to locate and tighten loose connection.
	Loose or poor connection timer to Deicers.	If trouble occurs in part of cycle, find which Deicers are affected and check for rough or dirty slip rings causing brush to "skip". If not this, trace circuits to locate and fix loose or poor connection. (If all Deicers on one propeller are affected, check the ground circuit.) Flex Deicer straps for break in Deicer straps.

TABLE XIV-VI. TROUBLESHOOTING CHART (PROPELLER DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
Ammeter flicks between 30 second phase periods. (cont.)	Timer cycles erratically.	Test timer as in paragraph 14-51.
Radio noise or interference with Deicers on.	Brushes "arcing".	Check brush alignment as shown in Figures 14-13 and 14-17. Look for rough or dirty slip rings. If this is the cause, clean, machine or replace slip ring assembly, as required. Check slip ring alignment. (Refer to paragraph 14-34.
	Loose connection.	Refer to "Ammeter flicks between 30 second phase periods."
	Switch faulty.	Try jumper wire across switch - if radio noise disappears, replace the switch.
	Wiring located within 8 inches of radio equipment wiring.	Relocate at least 8 inches away from input wiring to radio equipment.
Cycling sequence not correct.	Crossed connections.	Check system wiring circuit diagram for improper connections. (Refer to Figures 14-14 or 14-15.)
Rapid brush wear or frequent breakage.	Brush block out of alignment.	Check brush alignment. (Refer to paragraph 14-33.)
	Slip ring wobbles.	Check slip ring alignment with dial indicator as shown in Figure 14-12.

14-52. PNEUMATIC DEICING SYSTEM.

14-53. INTRODUCTION. This portion of section XIV provides service and maintenance procedures for the pneumatic deicing system. This information is current as of the time of this issue.

14-54. DESCRIPTION AND PRINCIPALS OF OPERATION. Through the engine-driven pneumatic pumps, the deicing system will normally apply vacuum to the deicers at all times, except when they are being inflated. Deicer inflation is affected by the deicer system control switch. Through actuation of the ON-OFF switch, the timer energizes the Pneumatic pressure control valves for 6 seconds. The boot solenoid valves are energized and port pressurized air directly to the boots to inflate all deicers on the plane. The deicer pressure, normally 18 psig, is regulated by the high stage of the Pneumatic Pressure control valves. Upon automatic de-energization of the control valves by the timer, the deicer solenoid valves permit the deicer pressurizing air to return to the solenoid valves and be exhausted overboard. System vacuum is then reapplied to the deicers to hold them close to the surface skin. Deicer pressure can be monitored during deicer inflation through the Pneumatic pressure gauge located on the instrument panel.

The deicer is essentially a fabric reinforced rubber sheet containing built-in inflation tubes. Deicers are attached by means of a cement to the leading edge of the surfaces to be protected.

There are plastic air connections on the back side of the deicer called an "air connection stem". Each stem projects from the underside of the boot into the leading edge, through a round hole provided in the metal skin, for connection to the airplane air supply system.

Air pressure from engine-driven pumps is supplied to the inflatable tubes by the pneumatic system. Inflation sequence is controlled by a timer and solenoid operated valves located near the deicer air inlets.

Deicers are installed along each wing and tail surfaces leading edges. All sections operate simultaneously.

A thin coating of conductive cement is provided over the neoprene ply to dissipate static electric charges. These charges, if allowed to accumulate, would eventually discharge through the boot to the metal skin beneath, causing static interference with the radio equipment and possible punctures in the rubber. Also, such static charges would constitute a temporary fire hazard after each flight.

14-55. TROUBLESHOOTING. In the utilization of the troubleshooting charts at the end of these instructions, it must be assumed that the engine-driven pneumatic pumps and the airplane electrical system are operational. It is further assumed that the deicer system installation was made in an approved manner.

14-56. OPERATIONAL CHECK. The pneumatic deicing system should be checked at least every 100 hours. This check can be done on the ground. A visual inspection should be performed to determine the condition of the deicer boots, and any areas in need of repair should be taken care of before continuing with the operational check of the system.

With one engine operating, turn on the deicing system. The pressure will fluctuate as the tubes inflate and deflate. Check the pneumatic pressure gauge. If pressure is satisfactory, observe the operation of the deicers carefully for evidence of malfunctioning. Look for tubes which leak or fail to inflate and deflate properly. Repeat the procedure for the other engine. During the activation of the pneumatic deicing system in its automatic mode, should the boots remain inflated, the deicer boot actuating switch must be returned to its off position. Under this condition the pneumatic boots can only be operated manually by using the on-off positions of the deicer boot actuating switch. Should this problem exist, it is an indication that the cabin door seal switch has failed in its closed position and should be replaced.

14-57. ELECTRICAL TEST. With engines off, turn airplane battery switch to ON position.

a. Timer: Turn deicer system switch to ON position. Timer should begin to operate immediately. Turn system switch to OFF position. Timer should immediately re-cycle to start position as evidenced by a brief timer "chatter". If timer does not function:

1. Reset circuit breaker and recheck.
2. Check circuit from power source, through circuit breaker, to system switch, to timer, to ground.
3. Replace timer.

b. Solenoid Valves: Check both solenoid valves, one in each nacelle. Turn system switch to ON position. Solenoid valve should be actuated immediately for 6 seconds, as evidenced by an audible "click" that can be felt if hand is placed on a solenoid. If solenoid valve does not function:

1. Unplug electrical connector at solenoid. Attach test light or other suitable test equipment to connector and re-actuate system switch. If test equipment does not indicate complete circuit:
   (a) Check circuit from timer, to solenoid connector, to ground.
   (b) Replace timer.
2. Use ohmmeter to check solenoid for open circuit. If solenoid circuit is open, replace solenoid valve.
3. Remove solenoid safety wire and unscrew solenoid.

CAUTION

Do not lose steel hex actuator pin or valve poppet.

4. Reattach connector to solenoid, insert hex actuator pin into solenoid, and re-actuate system switch. If pin is not ejected from solenoid, replace control valve.

14-58. PRESSURE LEAKAGE TEST.

a. This test can be performed in either the left or right nacelles.

b. Cap the overboard ports of the control valve.

c. Connect a source of clean air to the inlet port of the control valve. It is necessary that the inlet pressure be a minimum of 18-20 psig to perform this test. Observe the system pressures on the airplanes pneumatic pressure gauge.

d. Apply 18 psig pressure to the system by means of a hand operated valve, trap the pressure in the deicer system. Observe the system for leakage. The leakage rate should not exceed a pressure drop of 4.0 psig per minute.

e. Remove test equipment, lubricate all threads, and replace all system components.

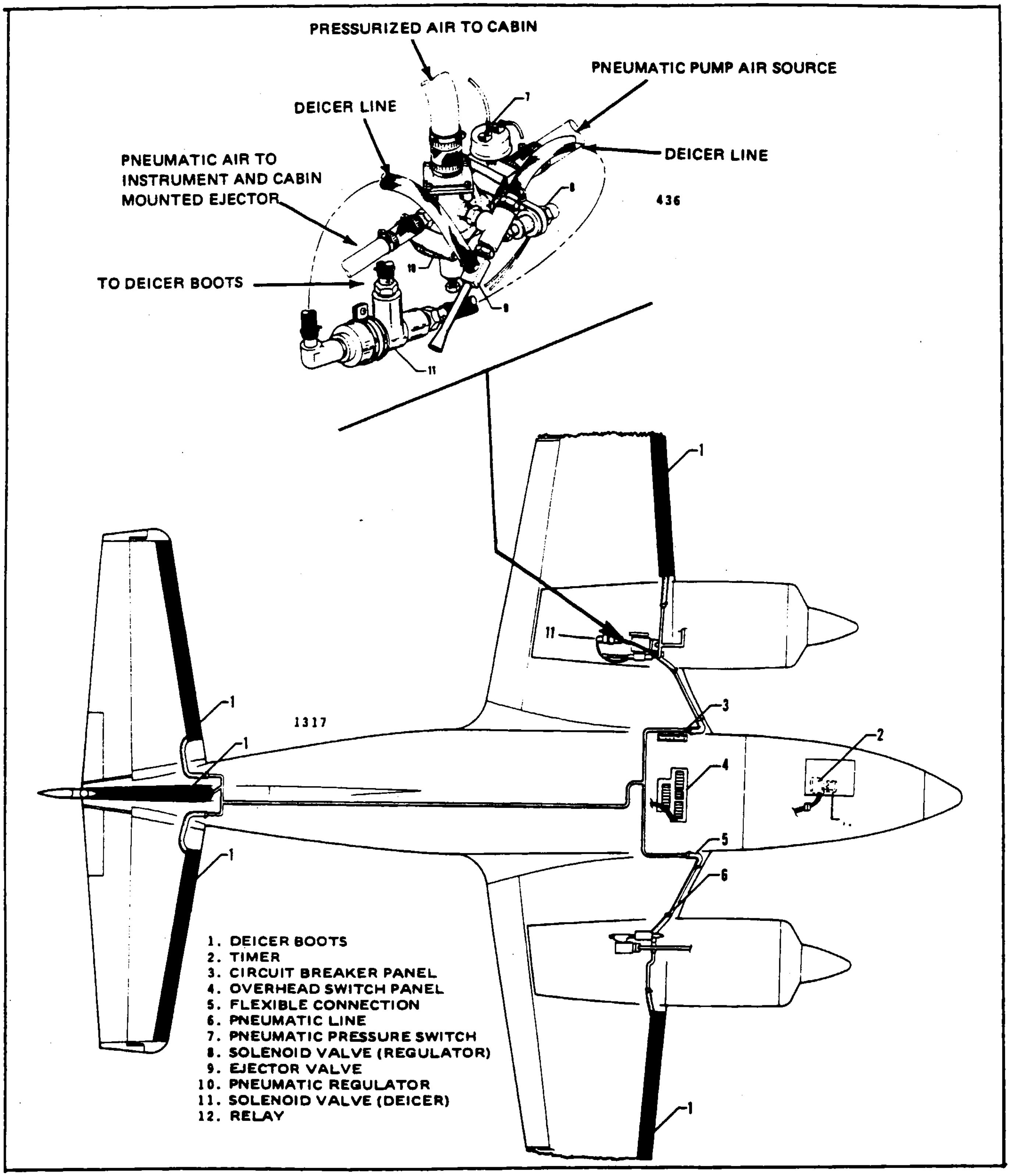


Figure 14-18. Pneumatic Deicer System Installation

14-59. PNEUMATIC REGULATOR ADJUSTMENT. The pneumatic regulators are adjusted to provide adequate pressure for the airplane instruments and any other equipment. Refer to Section X of this Service Manual for the proper procedure.

14-60. COMPONENT MAINTENANCE AND REPLACEMENT.

14-61. AIR FILTER. The inline air filter, located behind the pneumatic pump, should be replaced every 500 hours of engine operation. Replace with Donaldson EBDOZ-0014 filter (2 required).

14-62. CONTROL VALVES. After 100 hours of engine operation, the valve poppet and internal lining of the control valve can become coated with a film of dried oil causing the valve to stick. To determine if valve poppet is sticking, perform electrical test. If solenoid checks satisfactorily, remove valve poppet and clean control valve bore and poppet. To clean:

a. Remove safety wire and electrical connector. Unscrew solenoid.

CAUTION

Do not lose steel hex actuator pin.

b. Remove valve poppet. It may be necessary to apply slim nose pliers to pin projection to pull poppet from valve.

c. Thoroughly clean valve bore and poppet with commercial hydrocarbon type solvent.

d. Reassembly valve and re-safety wire solenoid.

14-63. TIMER. No field maintenance is recommended. See Parts Catalog for replacement or vendor for repairs.

14-64. INSPECTIONS. A ground check of the entire deicer system should be made at least every 100 hours. To permit ground checking the system without engine operation, remove engine cowling and disconnect pressure line from pneumatic pump and connect regulated shop air.

Before checking the system, all deicers should be inspected for damaged areas and repaired according to the procedure in this section outlining the cold patch or vulcanized repairs. In order to check the system, a deicer piping diagram drawing is necessary to determine the operating pressure and the inflation time alloted to the deicers. Once the operating pressure is known, obtain the test pressure.

TABLE XIV-VII. OPERATING PRESSURES

Recommended Operating Pressure PSIG	Test Pressure in PSIG	
	MIN.	MAX.
15	13	17
18	16	20

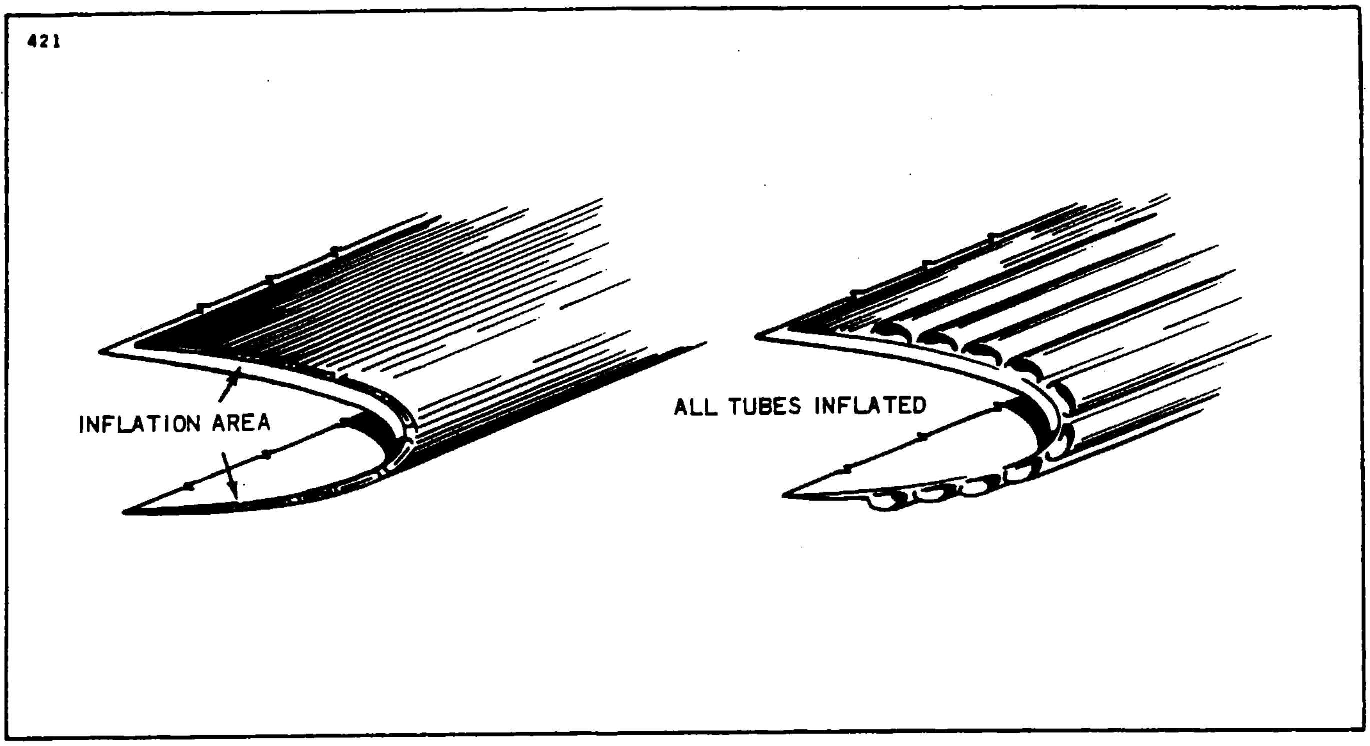


Figure 14-19. Pneumatic Deicer Boots Operation

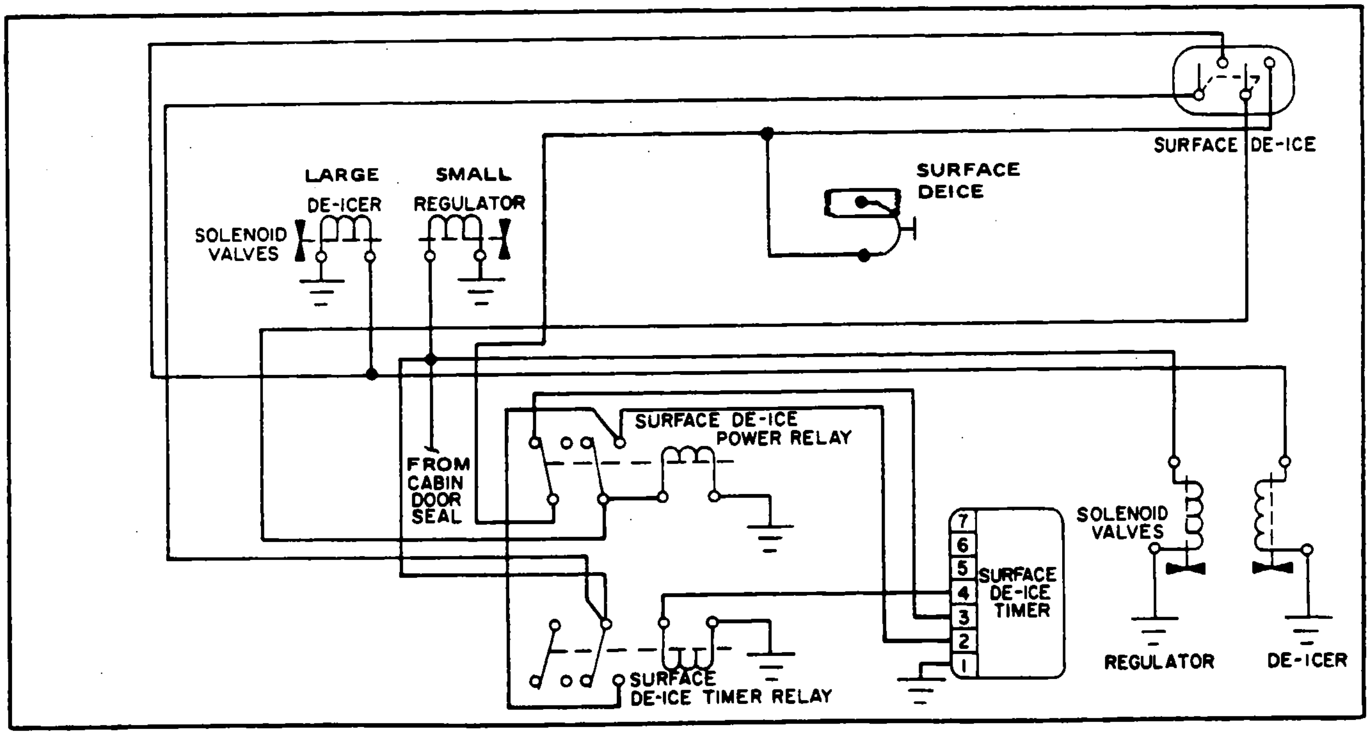


Figure 14-20. Pneumatic Deicer System Schematic

14-65. GROUND PROCEDURE. After the test pressure range is established, connect an external source o air providing this pressure to the test plug. When the air supply is turned on, the check valves in the line from the pumps close automatically. The deicer system should be within 1 psig of the recommende operating pressure with each inflation.

If deicers do not reach the operating pressure, check the inflation time to ascertain that the solenoi valve is open the specified length of time. If this is not the cause of the trouble or if the boot deflate slowly, the lines or valves may be plugged. Then the lines should be disconnected and blown clear.

Check the timing of the system through several complete cycles. If cycle time is more than 5 second off the specified time (3 min. ± 30 Sec.), determine and correct the difficulty.

Inflation must be rapid to provide efficient deicing. Deflation should be completed before the nex inflation cycle of the boots.

14-66. 100-HOUR INSPECTION. At each 100-hour inspection of the airplane, inspect and operate th deicer boots. Make checks as follows:

a. Carefully inspect the deicers for evidence of damage or deterioration and repair or replac damaged boots.

b. Resurface boots which show signs of considerable wear or deterioration.

c. Inspect all hose connections which form a part of the pneumatic deicing system. Replac deteriorated sections of non-kink hose.

d. Check the operation of the boots and the operating pressure of the system as outlined i paragraph 14-56.

e. If new or replacement boots have been installed, check the tube inflation to make sure that th air connection stems have been properly connected.

f. Disconnect all drain lines in the system and check for proper drainage.

g. Check the on-off control switch for freedom of action. Check associated electric wiring.

h. Remove the copper mesh filter element from the secondary oil separator (deicing air filter) an wash in gasoline. While the filter element is drying, clean out the bowl of the secondary oil separator.

NOTE

This operation may be omitted if the boots were installed on the airplane subsequent to the last previous 100-hour check.

14-67. REMOVAL OF BOOTS. The removal of deicer boots should be done in a well ventilated area to avoid difficulty from the fumes of the solvents. Materials required to remove the boots are: Turco 388 or Kelite 21 to remove dried cement, and MEK (Methylethylketone) in squirt can.

NOTE

Disconnect line fittings from boot fittings.

a. Starting at one corner of the upper trailing edge of the deicer, apply a minimum amount of solvent to the seam line while tension is applied to peel back the corner of the deicer.

b. Using a pressure handle squirt can filled with solvent, separate the deicer boot from the surface for a distance of 4 inches all the way along the upper trailing edge.

c. The area between the deicer and the wing which has now been separated will act as a reservoir for the solvent, therefore, the deicer can be pulled down towards the leading edge with a uniform tension.

d. From the centerline of the leading edge to the lower trailing edge of the deicer, use the pressure handle squirt can to soften the bond between the deicer and the wing skin.

e. Use Kelite 21 or Turco 388 to clean the dry cement off the exposed wing area, and clean the area thoroughly with MEK (Methyl Ethyl Ketone).

14-68. REPAIR OF BOOTS. Deicer repairs are classified as cold, when made on the boot installed on the airplane, and vulcanized, made on the demounted boot in the shop.

14-69. COLD REPAIR. The materials and supplies for making cold repairs are listed in Table XIV-VIII.

a. SCUFF DAMAGE. This type of damage will be most commonly encountered and, fortunately, it is not necessary in most cases to make a repair. On those rare occasions when the scuff is severe and has caused the removal of the entire thickness of surface ply in spots (the brown natural rubber underneath is exposed). repair the damage using part No. 74-451-16 and proceed as follows:

1. Clean the area around the damage with a cloth dampened slightly with solvent. Buff the area around the damage with 74-451-75 emery buffing stick so that it is moderately but completely roughened. Wipe the buffed area with a clean cloth slightly dampened with solvent to remove all loose particles.

2. Select a patch of ample size to cover the damaged area. Apply one even thorough coat of cement, Part No. 74-451-20, to the patch and the corresponding damaged area. Allow cement to set a couple of minutes until tacky.

3. Apply the patch to the deicer with an edge, or the center, adhering first. Work down the remainder of the patch carefully to avoid trapping air pockets. Thoroughly roll the patch with stitcher-roller, Part No. 74-451-73, and allow to set for ten to fifteen minutes.

4. Wipe the patch and surrounding area from the center outward with a cloth slightly dampened with solvent. Apply one light coat of A-56-B conductive cement, Part No. 74-451-11, to the patched area.

5. Satisfactory adhesion of patch to deicer will be reached in four hours. Deicer may be inflated for checking repair in a minimum of 20 minutes.

b. TUBE AREA DAMAGE. Repair cuts, tears or ruptures to the tube area with fabric reinforced patches, Part No. 74-451-16, -17, -18 or -19, depending on size of damaged area.

1. Select a patch of ample size to cover the damage and to extend to at least 5/8 inch beyond the ends and edges of the cut or tear. If none of the patches is of proper size, cut one to the size desired from one of the larger patches. If this is done, bevel the edges by cutting with the shears at an angle.

TABLE XIV-VIII. MATERIAL AND SUPPLIES FOR COLD REPAIR

Part No.	Quantity	Description
74-451-C (FSN1650-856-7939)	1	Cold Patch Repair Kit (B. F. Goodrich Co.)
74-451-11	1/2 pt. can	A-56-B Conductive cement
74-451-16	30 pcs.	Small oval patch 1-1/4 x 2-1/2 in.
74-451-17	30 pcs.	Medium oval patch 2-1/2 x 5 inch
74-451-18	10 pcs.	Large oval patch 5 x 10 in.
74-451-19	3 pcs.	Patch 5 x 19 inch.
74-451-20	(2) 1/2 pt.	*No. 4 cement (patching only)
74-451-70	2	Cement brush 1/2 in.
74-451-73	1	1/8 in. Steel stitcher
74-451-75	6	Emery Buffing sticks
74-451-87	1	Buffing Shield

*This cement will give best results with the patches in this kit.

The following items may be procured from the B. F. Goodrich Co., Akron, Ohio, or other manufacturer, as required:

Part No.	Quantity	Description
74-451-21	6 ft. roll x 6 in. wide	Type 21 or 22 fillet
74-451-22	15 ft. roll x 2 in. wide	Neoprene coated splicing tape
74-451-23	4 ft. long x 8 in. wide	Neoprene surface ply
74-451-24 (FSN8040-628-4199 and/ or FSN8040-514-1880)	1 quart	≠EC-1403 cement and/or EC-1300 L
74-451-74	1	2 in. dia. x 2-1/2 in. rubber roller
74-451-100	1	≠EC-801 filler compound

≠Minnesota Mining and Manufacturing Company, Adhesives Division, 411 Piquette Ave., Detroit, Michigan.

TABLE XIV-VIII. MATERIAL AND SUPPLIES FOR COLD REPAIR (cont.)

Part No.	Quantity	Description
The following materials may be obtained from local supply:		
		Toluol
	As required	Clean, lint-free cloths (preferably cheese cloth)
	Rolls	1 in. masking tape
	1	Sharp knife
	6 ft. long	Steel measuring tape
	1	Fine sharpening stone
	As required	320 grit emery cloth
	As required	Hypodermic needles (22 gauge or smaller)
Methylethylketone (MEK) can be used instead of Toluol, however MEK causes very rapid drying and provides only 10 seconds working time compared with 40 seconds for Toluol.		

NOTE

These patches are manufactured so that they will stretch in one direction only. Be sure to cut and apply the patch selected so that stretch is in the widthwise direction of the inflatable tubes.

2. Buff the area around the damage with buffing stick, Part No. 74-451-75, so that the surface is thoroughly roughened.

3. Apply the patch to the deicer with the stretch in the widthwise direction of the inflatable tubes, sticking edge of patch in place, working remainder down with slight pulling action so the injury is closed. Do not trap air between patch and deicer surface.

c. LOOSE SURFACE PLY IN DEAD AREA (NON-INFLATABLE AREA). Peel and trim the loose surface ply to the point where the adhesion of surface ply to the deicer is good.

1. Scrub (roughen) area in which surface ply is removed with steel wool. Scrubbing motion must be parallel to cut edge of surface ply to prevent loosening it. Buff the edges of the adjoining surface ply 1/2 inch with 74-451-75 buffing sticks, taper down to the tan rubber ply. Remove loose particles with solvent and rag.

2. Cut a piece of surface ply material, Part No. 74-451-23, to cover the damaged area and extend at least one inch beyond in all directions.

3. Mask off the damaged boot area 1/2 inch larger in length and width than the size of surface ply patch. Apply one coat of cement, Part No. 74-451-11, to damaged area and one coat to patch. Allow cement to set until tacky. Roll the surface ply to the deicer with 2 inch rubber roller, Part No. 74-451-74. Roll edges with stitcher-roller, Part No. 74-451-73. Apply just enough tension on the surface ply when rolling to prevent wrinkling, and be careful to prevent trapping air. If air blisters appear after surface ply is applied, remove them with a hypodermic needle.

4. Clean excess cement from deicer with solvent.

d. LOOSE SURFACE PLY IN TUBE AREA. Loose surface ply in tube area is usually an indication of the deicer starting to flex fail. This type of failure is more easily detected in the form of a blister under the surface ply when deicer is pressurized. If this type of damage (or void) is detected while still a small blister (about 1/4 or 3/8 inch diameter) and patched immediately, the service life of the deicer will be appreciably extended. Apply repair patch as outlines in paragraph a.

e. DAMAGE TO FABRIC BACK PLY OF DEICER DURING REMOVAL. If cement has pulled loose from the wing skin and adhered to the back surface of the deicer, remove it with clean rags and MEK. In those spots where the coating has pulled off the fabric, leaving bare fabric exposed, apply at least two additional coats of cement, Part No. 74-451-24. Allow each coat to dry thoroughly.

14-70. VULCANIZED REPAIR. It is recommended that vulcanized repairs be made by an approved Deicer Installation Station. The prime purpose of making vulcanized repairs is to make the deicer completely fit for further service. Careful consideration must be given to the overall condition of the deicer. If large parts of the stretch area of a deicer are cracked or checked to a depth of over 0.005 inch, no attempt to repair should be made. Deicers with occasional slight checks in the stretch area may be given a coating of conductive cement to make them serviceable. If the checking is rather deep but restricted to a small area, the deicer may be made serviceable by repairing the damaged area. Deicers which have been swelled or softened by contact with oil, or other harmful agents, should be scrapped. Injuries will vary from minor ripping of the tube or stretch areas which may make repair exceedingly difficult or actually impossible. The determination of just where this division between repairable and unrepairable damage exists will, of necessity, depend upon the careful judgement of the inspector and upon the experience and training of the workman.

14-71. MATERIALS FOR VULCANIZED REPAIRS. The effectiveness of any repair largely depends upon an analysis of the damage and the selection of correct repair material. Deicers are compounded to resist sunlight and weather and retain flexibility. It is recommended that only materials as listed in Table XIV-IX be used in making vulcanized repairs. They are sufficient to supply a one or two man unit for a period of from four to six weeks, repairing deicers with the average amount of miscellaneous types of repairs. Select materials specified for making each repair and avoid substitution. Since many of the materials are dusted with soapstone, wash all materials carefully with washing or cleaning solvent before using. Table XIV-X lists the tools and equipment which have been found suitable for repair work. They are designed for a one or two man repair unit.

TABLE XIV-IX. MATERIALS FOR VULCANIZED REPAIRS

Part No.	Description	Qty.
74-451-B	SUPPORT KIT, High pressure Deicer vulcanized repairs	1
74-451-B-1	. MATERIALS KIT	1
74-451-2	. . NON-STRETCH FABRIC, Uncured rubber coated	15 ft. x 8 in.
74-451-3	. . FABRIC TAPE, Uncured rubber coated	15 ft. x 1 in.
74-451-4	. . TUBE FABRIC, Uncured	15 ft. x 8 in.
74-451-5	. . GUM, 0.005 Uncured	15 ft. x 2-3/4 in.
74-451-6	. . GUM, 0.020 Uncured	15 ft. x 8 in.
74-451-7	. . TREATED PAPER, Holland or silicone	30 ft. x 8 in.
74-451-8	. . VULCANIZING CEMENT, No. 60	1 qt.
74-451-9	. . VULCANIZING CEMENT, No. 61	1 qt.
74-451-10	. . SOAPSTONE	1 qt.
74-451-11	. . CONDUCTIVE CEMENT, *A-56-B	1/2 pt.
74-451-12	. . *NEOPRENE PUTTY	1/2 pt.

*These cements have an extended shelf line if kept under refrigeration from 0 to 40 F.

TABLE XIV-X. EQUIPMENT AND TOOLS FOR VULCANIZED REPAIRS

Part No.	Description	Qty
74-451-B	SUPPLY KIT, High pressure Deicer vulcanized repairs	1
74-451-B-2	. Tool Kit, Complete	1
74-451-B-3	. . Tool Kit, Special	1
74-451-40	. . . VULCANIZER, Large 2-1/2 x 8	1
74-451-41	. . . PADS, Sponge rubber, 3-1/2 x 11	3
74-451-42	. . . CURING METAL, 6 x 10	2
74-451-B-4	. . Tool Kit, Standard	1
74-451-70	. . . BRUSH, Cement, 1/2 in.	2
74-451-71	. . . BRUSH, Cement (Artist)	2
74-451-72	. . . SHEARS, 10 in.	1
74-451-73	. . . STITCHER, 1/8 in. Steel	1
74-451-74	. . . ROLL, Sponge rubber 2-1/2 in.	1
74-451-75	. . . STICKS, Emery buffing	6
74-451-76	. . . KNIFE HANDLE	1
74-451-77	. . . KNIFE BLADE	3
74-451-78	. . . WHETTING STONE	1
74-451-79	. . . HYPODERMIC NEEDLE	6
74-451-80	. . . ELECTRIC BUFFER	1
74-451-81	. . . MANDREL (for felt wheels)	3
74-451-82	. . . WHEELS (felt buffing)	24
74-451-83	. . . STONE, Grinding, pointed	3
74-451-84	. . . STONE, Grinding, flat	4
74-451-85	. . . NUT, Hex	3

14-72. DEFINITION OF TERMS. Terms used in the following instructions are explained below:

a. Wash - to clean a surface by means of a clean cloth moistend with Toluol or MEK. (Benzine or non-leaded gas may be used in place of cleaning solvent.) Do not permit free solvents to remain on any surfaces.

b. Route - to remove rubber surfaces around area to be repaired with a hex nut on a shaft attached to electric buffer.

c. Buff - to roughen surfaces with carborundum buffing sticks or abrasive paper.

d. Cement - to apply two light coats of fifty-fifty mixture of No. 60 and 61 vulcanizing cements unless otherwise specified. Let each coat dry before proceeding.

e. Gum - uncured rubber stock. If cured stock is to be used, it will be so stated.

f. Face Side of Deicer - the side exposed when installed; the conductive surface side.

g. Restore Conductive Surface - after curing a repair on the surface size; apply two coats of A-56-B conductive cement.

NOTE

Do not apply A-56-B conductive cement in any area of any electrical transmitting or receiving equipment.

h. Stitch - to force fabrics or gum elements together with metal or rubber roller; stitch from the center toward the edges to prevent trapping air between the elements.

14-73. GENERAL PROCEDURE. Select a repair room with adequate ventilation and air free of dust and foreign matter. Keep the work bench clean so that foreign objects will not contaminate cement, solvents, or damage deicers, and perform the following steps:

a. Before starting a vulcanized repair, thoroughly clean a fairly large area surrounding the damaged portion, as well as the damage portion itself, of any grease, dirt or talc. Use a neutral soap and water solution, rinse clean and dry with clean cloth.

b. Immediately around area to be repaired, wash carefully with clean cloth moistened in Toluol, or Methyl Ethyl Ketone (MEK) Federal Specification TT-M-261.

c. When routing around a deicer injury, remove or cover all cement containers so that dust particles flying from grinding stone will not contaminate the cement.

d. After buffing or routing an area, remove all dust from the surface of deicer and table.

e. Protect all completed repairs from dust and dirt with a clean piece of holland cloth. Hold holland in place with masking tape. Remove masking tape before curing.

f. Release all air trapped between gum and fabric surfaces and/or deicer surfaces by inserting a hypodermic needle through the ply to the air pocket.

g. Before vulcanizing, remove all excess cement and dust particles by washing with solvent.

h. Use clean brushes when making repairs. Oil, paint or other residue may impair adhesion. Clean cement brushes with benzine or non-leaded gasoline at end of each work day.

i. Use approved safety can for Toluol or MEK. Take screen and spring out of solvent cans before filling so that all sediment may be removed.

j. Cements should be of such a consistency that they can be applied in a thin smooth coating. If they are partially set up or lumpy, addition of the proper solvent may restore their usable characteristics. Otherwise, do not use.

k. Do not attempt repairs in temperatures under 40 °F with listed materials.

l. When humidity is high, moisture may form on freshly washed or cemented areas. If this condition occurs, wipe moisture off with a clean cloth slightly dampened in solvent before proceeding with repair.

m. If but a small area is involved in repair, and temperature or drying conditions are prohibitive, a small canopy erected over the area, under which a lighted electric light bulb is placed, may make repair possible.

n. When repairing deicers, cleanliness is of prime importance. Keep materials, tools, equipment and hands clean at all times.

14-74. CURING. The vulcanizer listed in TABLE XIV-X is adjusted at the factory to heat to 285 ° ±5° F with the line voltage as specified on the name plate. All curing times called for in this manual are for 285 ° F. If line voltage is low, the vulcanizer will not heat to 285 ° F, and, therefore, curing times must be longer than specified.

Since the curing time varies with the type and position of repair being cured, the times are given for each specified type of repair. Cure repairs as follows:

NOTE

Over-curing destroys the flexibility of the deicer. Under-curing prevents the proper bond from taking place. Therefore, always watch cure time and temperature carefully.

a. Preheat vulcanizer.
b. Place sponge pad over bottom of unheated plate.
c. Place a piece of clean, unwrinkled holland (or silicone treated paper) over sponge pad, then place deicer in position over holland, with area to be cured centrally located over bottom platen. (Repair side up.)
d. Place another piece of smooth, clean holland over spot to be cured.

NOTE

If holland or silicone treated paper is not available, spread a thin coat of soapy water over surfaces of metal curing sheet and sponge pad. Allow to dry thoroughly. This will prevent sticking.

e. Place a metal curing sheet over holland and clamp heating element in place. The size of the metal curing plate must be a least one inch larger overall than the heating plate. Tighten heater by hand firmly but not excessively.
f. Cure for full time as given for each type of repair.
g. Test each repair thoroughly after it has cured to determine if fully cured. Test also the strength and soundness of repair. If, in the stretch or other area (except tube), flex and stretch the area by hand several times, and then carefully examine for soundness. If in a tube, inflate to 25 psig.

14-75. SURFACE SCUFFS. Repair as follows:
a. Wash surface to be restored and apply one coat of conductive cement. Allow to dry thoroughly. Add another coat and allow to dry. Dip finger in conductive cement solvent (isopropyl acetate) and rub down with light circular movement. Do not allow finger to become dry.
b. Wipe surface lightly with cloth moistened in isopropyl acetate.
c. Inspect for high or low places. High places require additional rubbing down. For low spots, repeat the last three steps.
d. Allow to dry thoroughly and dust lightly with soapstone.

14-76. DEEP SCUFF THROUGH NEOPRENE SURFACE.
a. Mark off area to be routed and carefully cut the 0.010 inch Neoprene surface ply with knife. This will prevent the surface ply from peeling beyond the area marked when using buffer. Area should include full width of tube and approximately 1/2 inch beyond scuff.
b. Using buffer, route down until pits are removed. Buff 1/8 around outer edge of routed area. Mask off outside of buffed area and cement.
c. Using mill knife or putty knife, apply Neoprene putty, filling cavity flush with surface. Make sure cavity is completely filled. Remove masking tape and cure for 20 minutes.
d. Restore conductive surface. (Refer to paragraph 14-89.)

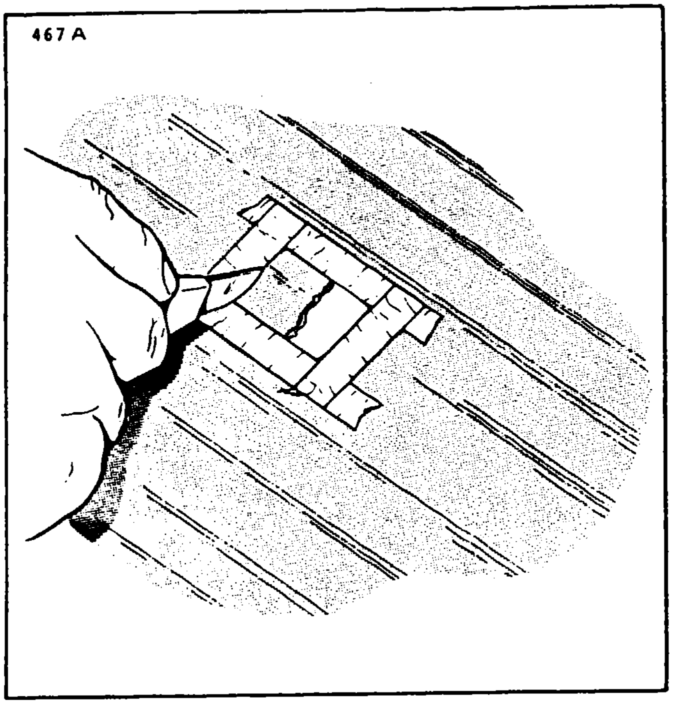


Figure 14-21. Marking and Cutting Scuff

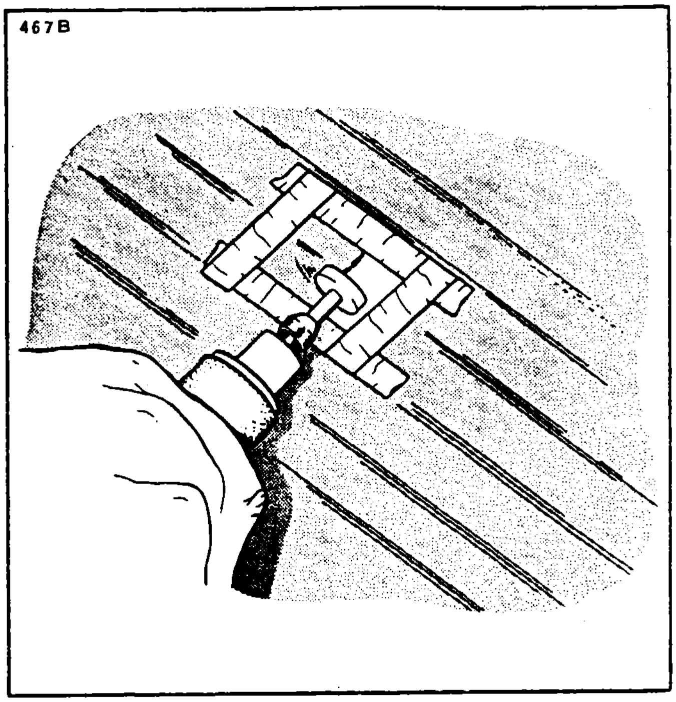


Figure 14-22. Routing Scuff

14-77. HOLES OR TEARS THROUGH SURFACE SIDE OF TUBE AREA. Repair as follows:

a. Mark off area to be routed and carefully cut the 0.010 inch surface ply with knife. This will prevent the surface ply from peeling beyond the area marked when using buffer. Area should include full width of tube and approximately 1/2 inch beyond cut.

b. Using buffer, route down to tube fabric. Extreme care should be taken while using buffer so that surface ply beyond repair area is not loosened and tube fabric is not injured. Wash out area.

c. Cut tube fabric patch slightly larger than size of cavity, making sure that stretch of fabric is across width of tube.

d. Cement buffed area and contact surface of tube fabric patch. Apply tube fabric full size of cavity and stitch. Remove any trapped air using hypodermic needle. Roll up a small piece of 0.005 inch gum (about 1/32 inch diameter and 3/4 inch long) and work in around edge of tube fabric using a sharp pointed object, such as shears. Stitch gum well and cure for 20 minutes.

e. After cure, using carborundum stick, scratch shine off gun and buff surface ply 1/8 inch around repair. Wash repaired area and apply cement.

f. Mask off 1/16 inch beyond repair. Using mill knife or putty knife, apply Neoprene putty, filling cavity flush with surface. Make sure cavity is completely filled. Remove masking tape and cure for 15 to 20 minutes.

g. Restore conductive surface. (Refer to paragraph 14-89.)

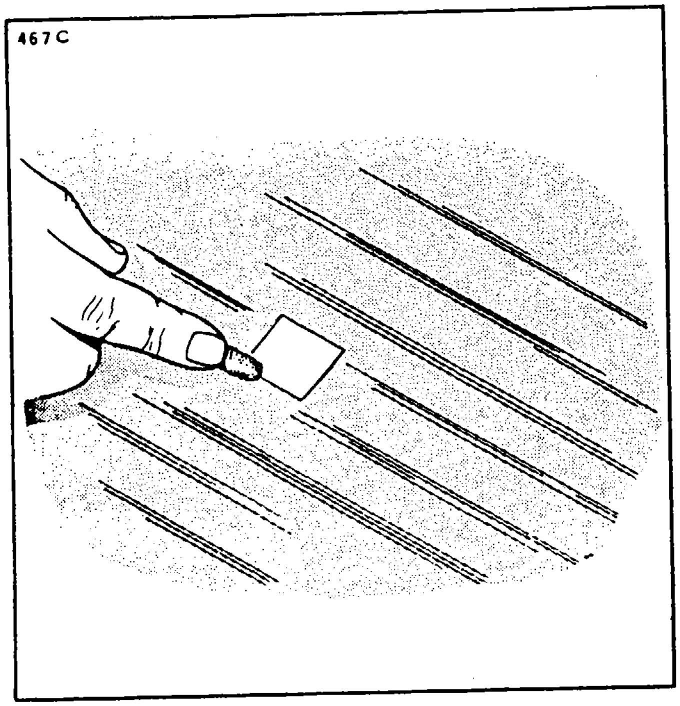


Figure 14-23. Buffing Edge of Repair

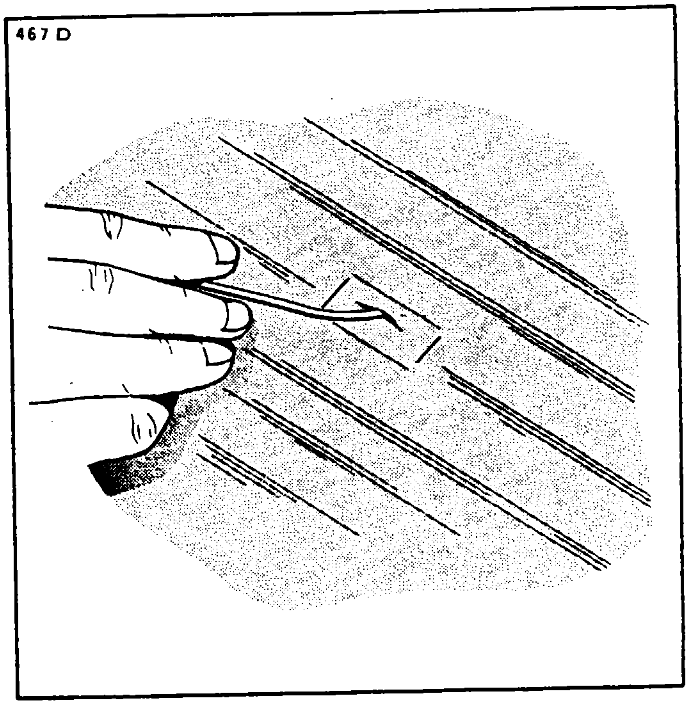


Figure 14-24. Hole through Surface of Tube

14-78. HOLES OR TEARS THROUGH BACK SIDE OF TUBE AREA. Repair as follows:

a. Route off coating down to fabric at least 3/4 inch beyond cut and wash thoroughly, entire buffed area, and cement.

b. Cut fabric patch, wash and cement, then apply fabric patch and stitch. Remove any trapped air using hypodermic needle.

c. Wash and cement repaired area, then apply a thin coat of neoprene putty with mill knife and cure for 22 minutes.

14-79. HOLES OR TEARS THROUGH TWO SIDES. Repair one side at a time in accordance with paragraphs 14-77 and 14-78.

14-80. HOLE THROUGH DEICER EXTENDING FROM ONE TUBE INTO ANOTHER. Repair as follows:

a. Route and buff one side at a time as described in paragraphs d and e.

b. Working on surface side, remove in between tube tape 3/4 inch each direction from tear. Route out in between tube fillet. Do not damage tube fabric wall.

c. Slit fabric on back side of deicer in between tubes 3/4 inch beyond tear.

d. Cut two fabric patches large enough to extend 1/2 inch beyond tear. Stretch of fabric patches must be with width of tube.

e. Wash and cement entire buffed area of deicer and one side of fabric patches.

f. Apply patches, one for each tube, inserting each patch through slit with uncemented sides of patches back to back. Then stitch each patch to surface side first, tension other ends slightly and stitch in place on back side.

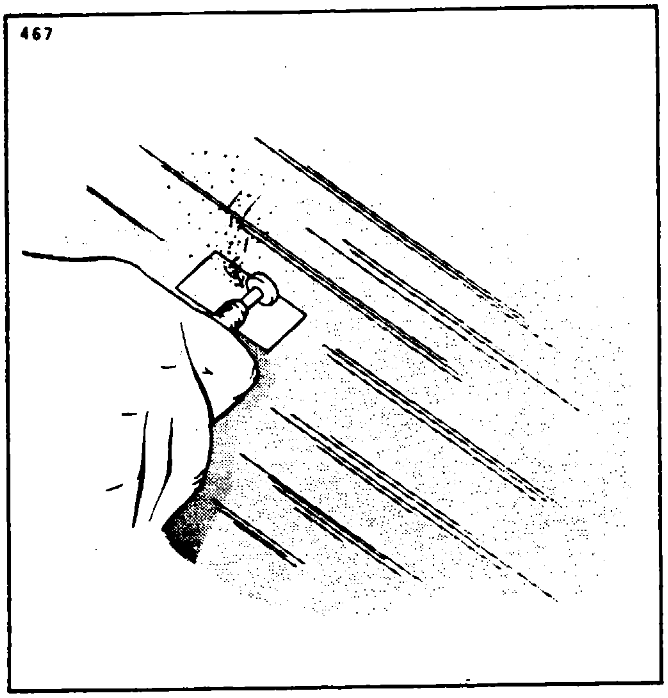


Figure 14-25. Routing to Tube Fabric

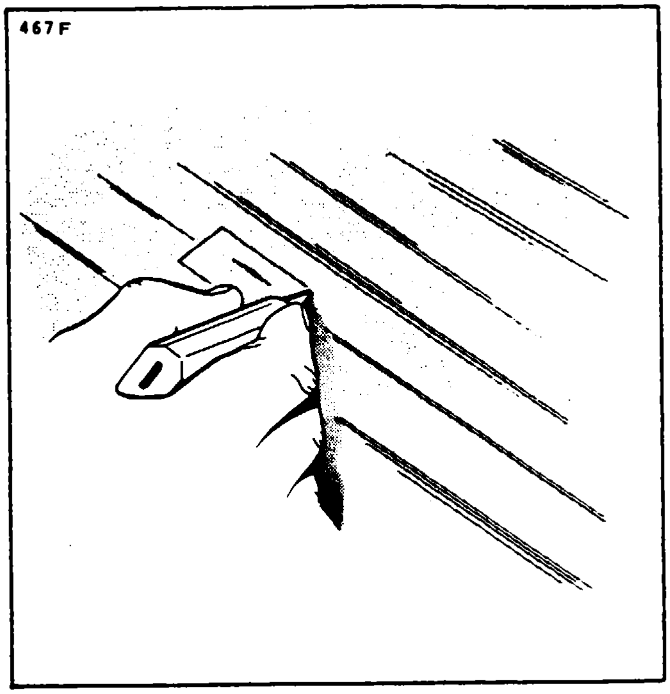


Figure 14-26 Cutting Surface of Tube

g. Wash and cement exposed surfaces of fabric patches.
h. Replace gum in between tubes and apply patch to back side.
i. On surface side, mask off the repaired area and fill flush with neoprene putty.
j. Cure surface side first for 22 minutes, then the back side for 10 minutes.
k. Restore conductive surface on surface side of boot. (Refer to paragraph 14-89.)

14-81. HOLE THROUGH DEICER OUTSIDE OF TUBE AREA. Repair as follows:

a. Repair surface side as described in paragraph d. Then, patch back side as described in paragraph 14-78 and cure complete repair for 22 minutes. Now, restore conductive surface. (Refer to paragraph 14-89.)

14-82. INSTALLATION. The following procedure for installing deicers assume that the airplane has provisions for air connections, etc.

14-83. PREPARATION OF LEADING EDGES. If the leading edges are painted, remove all paint including zinc chromate primer.

a. With one inch (1) masking tape, mask off leading edge boot area, following 1/2 inch margin for non-recessed boots. Take care to mask accurately, thus eliminating the need for cleaning off excess cement later.

b. Clean the metal surfaces thoroughly, at least twice, with MEK or acetone. For final cleaning, wipe the solvent film off quickly with a clean dry cloth before it has time to dry.

NOTE

If desired, zinc chromate primer may be reapplied over bare leading edges. When hard, scuff sand chromate surfaces, then clean before application of cement.

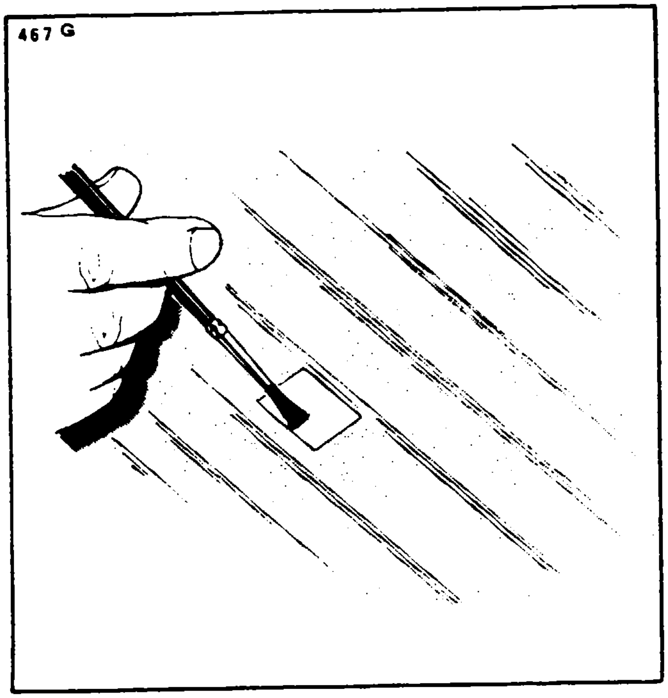


Figure 14-27. Cementing Buffed Area and Patch

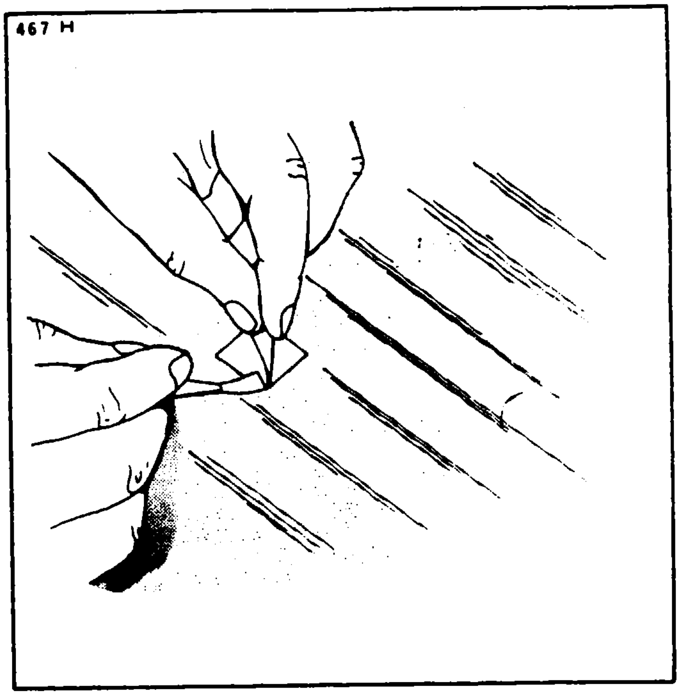


Figure 14-28. Applying and Stitching Fabric

NOTE

It is permissible to install deicers on alodined or anodized surfaces.

c. Fill gaps of skin splices that lead under deicers with sealing compound EC-801.

d. Remove the sump plugs from the air conditioning grommets. In some cases, it will be necessary to remove sections of doped fabric used to cover the air connection holes. Draw out the ends of the non-kink hose section so that they protrude through the connection holes in the leading edge. If hose is cracked or deteriorated, replace with new hose.

14-84. PREPARATION OF DEICER. Moisten a clean cloth with MEK or acetone and carefully clean the rough, back surface of the boot at least twice. Change cloths frequently to avoid recontamination of the cleaned areas.

14-85. MOUNTING DEICER ON LEADING EDGE. Thoroughly mix EC-1300L cement before using. Apply one even brush coat to the cleaned back surface of the boot and to the cleaned metal surface. Allow the cement to air dry for a minimum of one hour. Apply a second coat to both surfaces and allow to air dry a minimum of one hour. Ambient temperature for installation should be held between 40 and 110 F. However, longer drying time of the cement coats may be required as the humidity approaches 99%. Deicer and leading edge may be cemented for a maximum of 48 hours before actual installation, if cemented parts are covered and kept clean.

Snap a chalk line along the leading edge of the airfoil section. Intensify chalk line on leading edge and the white reference line on the boot with a ball point pen. Most boots are made with an excess of material

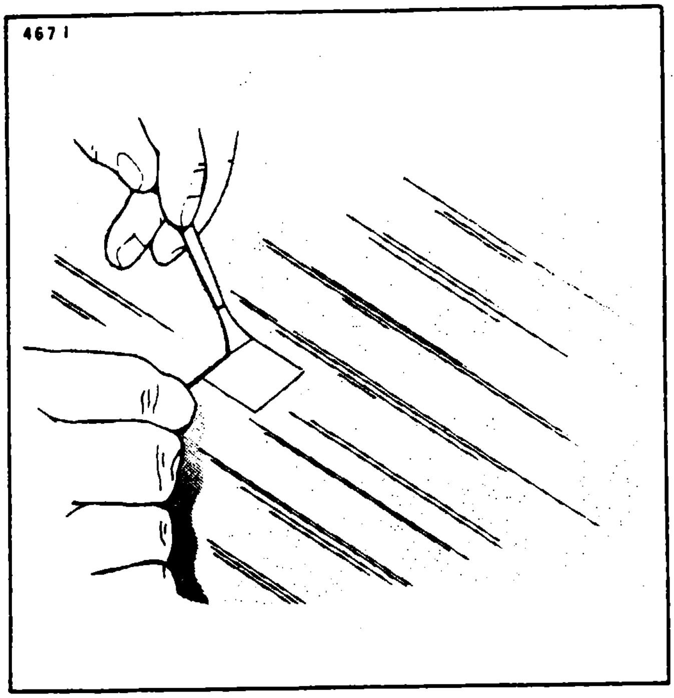


Figure 14-29. Placing and Stitching Gum

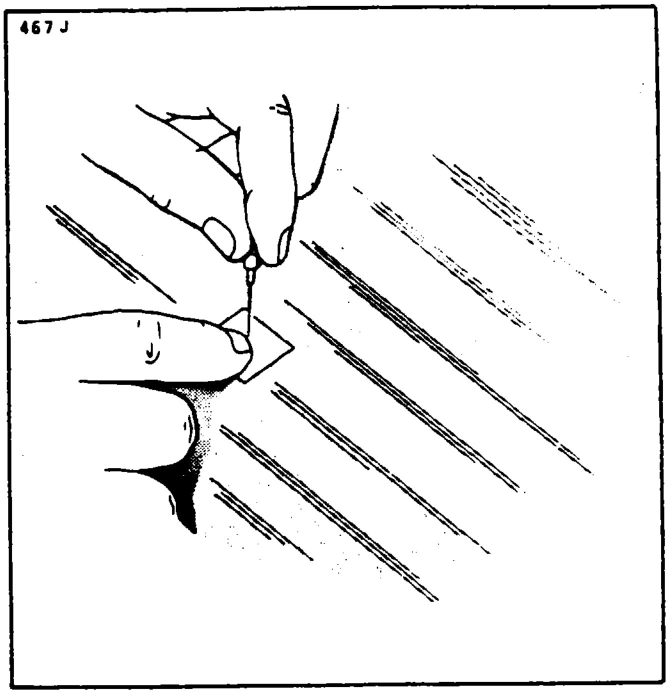


Figure 14-30. Removing Trapped Air

at the inboard and outboard edges for final trimming after installation and some recessed boots trim on the upper and lower edges.

Securely attach hose to deicer connections using clamps or safety wire.

a. Holding the backside of the boot close to the leading edge, fasten the end of each non-kink hose to the corresponding air connection stem. Tinnerman or other suitable non-kink hose clamps should be used for this purpose. Tighten each clamp with a pair of slip joint pliers but do not squeeze the clamp so tight that the hose is damaged.

NOTE

If non-kink hose clamps are not available, wrap each hose connection with several turns of friction tape. Over the tape wrap two separate bindings of safety wire, about 1/2 inch apart. Each of these bindings should consist of several turns of wire. Twist together the ends of each binding to tighten. Press the twisted ends down against the hose. Finally, wrap the wire with several additional turns of friction tape.

b. Push the hose connections into the leading edge grommets or seals, as the case may be. Obtain sufficient personnel to hold boot steady during installation. (Limit handling cemented side of boot with fingers.) Continue installation by reactivating the cement along the centerline leading edge surface and boot in spanwise strips approximately 6 inches wide. Rubber roll the deicer firmly against the wing leading edge, being careful not to trap any air under the deicer. Always roll parallel to the inflatable tubes. Position the deicer centerline to coincide with leading edge centerline. Hold boot in this position while reactivating about 3 inches around connections and around corresponding holes in leading edge, using a clean lint free cloth moistened with Toluol. Insert connections in leading edge holes when cement has dried to a tacky state, and rubber roll boot to leading edge in tackified area.

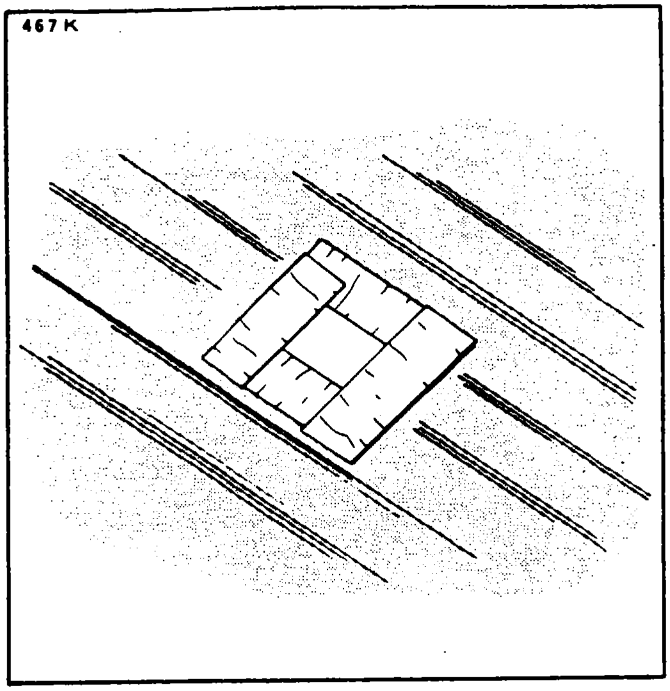


Figure 14-31. Masking Repair

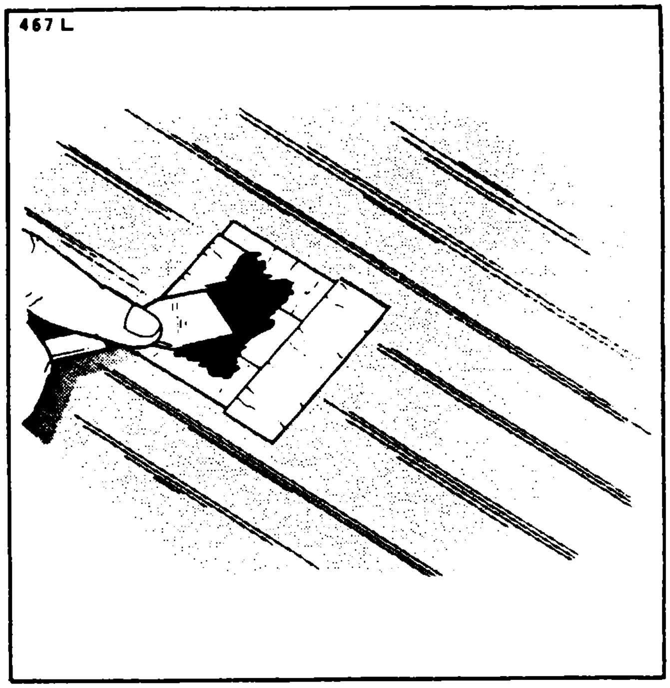


Figure 14-32. Applying Neoprene Putty

c. If the deicer should attach "off course", use MEK to remove and reposition properly. Avoid twisting or sharp bending of the deicer.

d. Rubber roll, apply pressure over entire surface of the deicer. All rolling should be done parallel to the inflatable tubes. Roll trailing edges with a narrow stitcher roller.

CAUTION

Avoid excessive soaking or rubbing of the cement which could remove the cement from the surface.

Remove all masking tapes, and clean surfaces carefully with Toluol so that no solvent will run under deicer edges.

e. Apply masking tape to deicer edges where exposed trimmed ends or gaps between sections are to be filled with MMM EC-801 sealing compound.

Apply masking tape to deicer approximately 1/4 inch in from trailing edges, and tape wing skin approximately 1/4 inch from trailing edges, both forming a neat, straight line.

f. Apply a brush coat of A-56-B cement to surfaces between tapes and to EC-801 seams, being sure that the conductive coating (A-56-B) is continuous from the deicer surface to the wing painted surface.

g. Remove taps immediately after applying A-56-B cement (before cement dries).

NOTE

Application of A-56-B conductive cement is not necessary on deicers that have "CONDUCTIVE" noted on labels.

CAUTION

The cements and solvents used for installation are flammable and their fumes slightly toxic. Therefore, all work should be done in a well-ventilated area away from any sparks or flames. (Use of solvent resistant type gloves is recommended.)

In the event it becomes necessary to remove or loosen installed boots, use MEK to soften the "adhesion" line. A minimum of this solvent should be applied to the seam line while tension is applied to peel back the boot. This removal should be slow enough to allow the solvent to undercut the cement, thus preventing injury to the part. Excessive quantities of solvent must be avoided.

14-86. ADHESION TEST. Using excess boot material trimmed from the ends of any wing and empennage deicers, prepare one test specimen for each deicer installed. This specimen should be a 1 x 8 inch full thickness strip of boot material cemented to the wing skin adjacent to installed boot following the identical procedure used for installation. Leave one inch of the strip uncemented to attach a clamp. Four hours or more after the installation, attach a spring scale to the un-cemented end of each strip and measure the force required to remove strip at the rate of one inch per minute. The pull should be applied 180° to the surface. (Strip doubled back on itself.)

A minimum of five pounds tension (pull) shall be required to remove the test strip. If less than five pounds is required, then acceptability of the boot adhesion shall be based on the following tests:

a. Carefully lift one corner of boot in question sufficiently to attach a spring clamp.

b. Attach a spring scale to this clamp and pull with force 180° to the surface and in such a direction that the boot tends to be removed on the diagonal.

c. If a force of five pounds per inch of width can be exerted under these conditions, the installation shall be considered satisfactory. Remember, the width increases as the corner peels back.

d. Re-cement corner following previous procedure.

e. Failure to meet this requirement shall result in reinstallation of the boot.

NOTE

Possible reasons for failure are: dirty surfaces, cement not reactivated properly, cement not mixed thoroughly. Corrosion of the metal skin may occur if good adhesion is not attained, especially around rivet heads and metal skin splices.

If these adhesion requirements are met, the airplane may be flown immediately. Do not inflate deicers within 12 hours of installation or until adhesion strength of 8 to 10 pounds is obtained.

14-87. MAINTENANCE. Clean deicers when the airplane is washed with a mild soap and water solution. In cold weather, wash the boots with the airplane inside a warm hangar if possible. If the cleaning is to be done outdoors, heat the soap and water solution before taking it out to the airplane. If difficulty is encountered with the water freezing on the boots, direct a blast of warm air along the region being cleaned, using a portable type ground heater.

As alternates, use benzol or non-leaded gasoline. Moisten the cleaning cloth in solvent, scrub lightly, and then, with a clean, dry cloth, wipe dry so that the cleaner does not have time to soak into the rubber. Petroleum products such as these are injurious to rubber and, therefore, should be used sparingly.

14-88. ICEX APPLICATION. B. F. Goodrich Icex is silicone base material specifically compounded to lower the strength of adhesion between ice and the rubber surfaces of airplane deicers. Icex will not harm rubber, and offers added ozone protection.

Properly applied and renewed at recommended intervals, Icex provides a smooth polished film that evens out the microscopic irregularities on the surface of rubber parts. Ice formations have less chance to cling. Ice is removed faster and cleaner when deicers are operated.

It should be emphasized that Icex is not a cure-all for icing problems. Icex will not prevent or remove ice formations. Its only function is to keep ice from initially getting a strong foothold, thus making removal easier.

One 16 oz. pressurized can of Icex will cover deicer surfaces of the average light twin-engine plane approximately three times. It is also available in quart cans (unpressurized).

Before applying Icex, thoroughly clean deicer or other rubber surfaces with a rag dampened with non-leaded gasoline. Follow by a scrub wash of mild soap and water. Allow time for surfaces to dry.

Shake the Icex can well. Hold the nozzle approximately 12 inches from the surface and spray. Apply sparingly. If the application is too heavy, it results in a sticky surface which is very undesirable because it will pick up runway dust and prevent best ice removing efficiency.

Due to the natural abrasive effects on leading edges of deicers, during flight, reapply Icex every 150 flight hours on wings and empennage deicers.

14-89. RESURFACING CONDUCTIVE CEMENT. The following materials are required to remove and replace the old, damaged coating:

Fine grit sandpaper.
Two-inch paint brush.
One-inch masking tape.
Conductive neoprene cement, No. A-56-B, B. F. Goodrich Co.
Isopropyl Acetate, Federal Specification TT-I-720, as cleaning or thinning solvent.
Alternate solvent - (Toluol or Toluene may be used as an alternate for isopropyl acetate.)

CAUTION

Cements and solvents used for resurfacing are flammable and their fumes slightly toxic. Therefore, all work should be done in a well-ventilated area away from any sparks or flames.

During cold weather, place the airplane in a warm hangar and locate so that the boots are in line with one or more blast heaters. Do resurfacing before any other work on the airplane to allow as much time as possible for the new coat to cure.

NOTE

If, for some reason the resurfacing cannot be done indoors, it may be deferred at the discretion of the inspector, until a warm, clear day permits the work to be satisfactorily accomplished outdoors. However, if the deicers are in such condition that immediate resurfacing is required, remove them from the airplane and resurface in a shop.

Clean deicer thoroughly with isopropyl acetate.

a. Roughen entire surface of boot. using a fine grit sandpaper.

b. Clean surface again with clean lint-free cloth moistened with cleaning solvent.

c. Apply masking tape beyond upper and lower trailing edges, leaving a 1/4 inch gap of bare metal.

d. Mask off any legible deicer brands.

e. Apply one brush coat of A-56-B cement to deicer and allow to dry at least one hour. Then apply second coat and allow to dry at least four hours before operating deicers. Plane may be flown as soon as cement is dry.

NOTE

If A-56-B cement has aged 3 months or over, it may be necessary to dilute the cement with isopropyl acetate to obtain proper brushing consistency. Mix thoroughly, approximately 5 parts cement to one part isopropyl acetate.

TABLE XIV-XI. TROUBLESHOOTING CHART
(PNEUMATIC DEICER SYSTEM)

Trouble	Cause	Remedy
Deicers do not inflate. Both engines operating at minimum cruise RPM or either engine at 1600 propeller RPM.	Open circuit breaker.	Push circuit breaker to reset.
	System connection loose or wire broken.	Tighten or repair as required.
	Timer not functioning.	Test or replace as required.
	Control valves not functioning.	Make electrical test. Check for sticking poppet. Clean.
	Lines blocked or not connected.	Blow out lines and inspect connections. Make air leakage test.
	Solenoid not grounded.	Ground.
Deicers inflate slowly (inflation time - 6 seconds).	Lines partially blocked or not connected securely.	Blow out lines and inspect connections. Make air leakage test.
	Deicer valve not functioning.	Check fitting in deicer port for proper installation.
	System pressure not being reached.	Check performance to manufacturer's specifications.
	Deicer puncture.	Repair per specification or replace.

TABLE XIV-XI. TROUBLESHOOTING CHART
(PNEUMATIC DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
Deicers deflate slowly.	Pressure regulator set too slow.	Readjust pressure regulator.
	Lines partially blocked.	Inspect and blow out lines.
	Overboard line from control valve partially blocked.	Inspect and blow out lines.
All switching operates properly, but Autopilot is inoperative.	No pressure at servo actuators.	Check for clogged or disconnected lines. Blow out lines.
	Bypass valve sticking.	Check valve - replace if required.
	Inoperative servo actuator.	Replace servo.
	Low pneumatic pressure.	Adjust pressure regulator.
Deicer boots remain inflated.	Deicer timer malfunction.	Replace timer.
	Deicer solenoid malfunction.	Replace solenoid.
	Ejector outlet plugged.	Clean ejector.
	Selector switch stuck in ON position.	Replace switch.

14-90. WING INSPECTION LIGHT.

14-91. INTRODUCTION. This light is used in conjunction with the pneumatic deicing system and will aid the pilot to detect any ice formation on the left wing leading edge during night flying operations.

14-92. DESCRIPTION AND OPERATION. The light is mounted in the left outboard edge of the left nacelle just above leading edge of the wing. It is a sealed beamed, 24 volt unit, which is controlled from a rocker type switch mounted in the overhead switch panel. The light is positioned in the nacelle to illuminate the leading edge of the wing when the switch is activated in the cockpit.

14-93. SERVICING. The only service required of this unit is the replacement of a burned out lamp with a new lamp P/N4593.

14-94. REMOVAL.

a. Be sure the switch is in the off position.
b. Remove the eight screws which secure the lamp and bracket to the nacelle.
c. Pull the lamp assemble partially out of the nacelle to gain access to the wire connections on the back of the lamp.
d. Remove the four clips holding the lamp to the bracket and remove the lamp.

14-95. INSTALLATION.

a. Position the gasket and lamp on the bracket with the lamp filament running parallel with the longer edge surface of the bracket.
b. Install the four clips and secure with screws and nuts.
c. Connect the electrical leads to the back of the lamp assembly.
d. Position the lamp and bracket assembly on the nacelle and secure with eight screws.
e. Activate the switch in the cockpit to check the lamp operation.

14-96. COPILOTS HEATED WINDSHIELD. This is the same type of windshield which is standard on the pilot's side and is serviced in the same manner as the standard left windshield. Refer to Section IV.

14-97. WINDSHIELD WIPERS. The windshield wiper on the right windshield is operated off the same motor as the standard wiper. A flexible shaft is routed from the left converter to the converter on the right which operates the right wiper. Refer to Section IV.

14-98. PROPELLER SYNCHRONIZER

14-99. DESCRIPTION OF PROPELLER SYNCHRONIZER SYSTEM (WOODWARD).

The system consists of two special governors with magnetic pickups, a control box to monitor the system, a actuator and trimmer assembly to regulate the slave propeller governor, and a control switch and circuit protector with related wire harnesses.

The function of the propeller synchronizer system is to automatically match the propeller RPM of both engines. This is accomplished by using the left engine propeller governor as the master unit and the right propeller governor as the slave unit. Both governors have magnetic pickups which feed electrical pulses into a control box mounted on the elevator control mounting bracket next to the bulkhead at station 81.00 below the right side of the instrument panel. This control box detects any difference in the electrical pulses and in turn activates a stepping type actuator motor mounted on the right engine, which trims the right engine propeller governor through a flexible shaft from the actuator motor to the trimmer assembly on the right engine propeller governor control, thus maintaining the same propeller RPM as the master left propeller governor, within a limited range.

Normal governor operations are not changed, but the synchronizer will continuously monitor the propeller RPM and regulate the slave governor as required, as long as the system is on. The limiting range of operation is built into the system to prevent the slave propeller governor from loosing more than a fixed amount of propeller RPM in case the master engine and propeller is feathered with the system in operation.

NOTE

> Manually set the R.P.M. as close as possible before activating the system. When the propellers are synchronized manually there is a ± 67 R.P.M. maximum effective synchronizing range when the system is activated.

14-100. FUNCTIONAL TEST. This test should be done in flight. First synchronize the propellers manually and then switch the synchronizer ON. Now slowly adjust the master engine propeller governor control lever, in small increments, to increase and decrease the RPM. The RPM range over which the slave engine will remain synchronized with the master engine is the limited range. With the system ON, move the master engine propeller governor control lever to a point which is close to the end of this limited travel. Now turn the system OFF. An unsynchronized condition will develop as the actuator moves the trimmer to its mid-position. When the system is turned ON again, synchronization will resume. If the units do not synchronize, the actuator has reached the end of its travel and must be recentered in the following manner:

a. Turn the system switch OFF.
b. Manually synchronize the engines.
c. Turn the system switch ON.

If the system does not operate properly perform the ground checks in accordance with paragraph 14-101.

14-101. TROUBLESHOOTING WITH MINIMUM FIELD EQUIPMENT.

The following information will help locate system malfunction in the field with the minimum amount of equipment. The usual mechanics tools and an ohmmeter and volt meter are all that is needed.

14-102. GROUND CHECK. (Refer to Figure 14-33.)

a. Ascertain that the cause of the problem is not one of the following: master switch off, circuit protector tripped or Jones plug receptacles not properly mated. The two halves of Jones plug should be safety wired together if retaining clips are not provided. Continue with remaining ground checks if one of the above was not the problem.

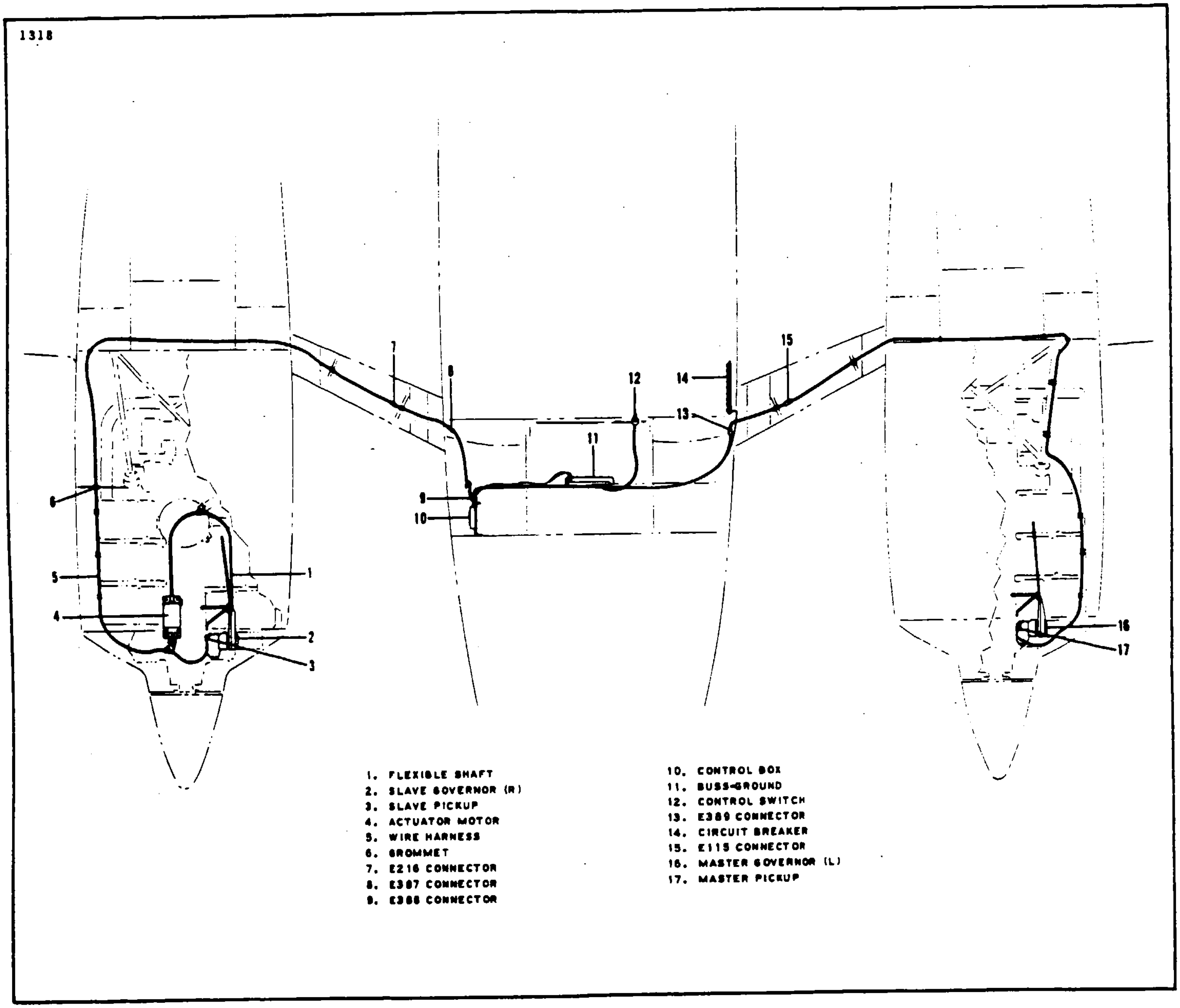


Figure 14-33. Propeller Synchronizer Installation

TABLE XIV-XII. SYNCHRONIZE WIRING TEST
DEFECTIVE ACTUATOR TEST

STEP NO.	TEST BETWEEN RECEPTACLE NUMBERS	With Actuator Centered	OBTAIN With Actuator Uncentered 180° Turn Clockwise (Facing Drive End) To Uncenter (Decrease)	Counterclockwise (Facing Drive End) To Uncenter (Increase)	ACTION (If Out of Limits)
1	5 & 1	open circuit (high resistance)	6.5 to 8.5 ohms	6.5 to 8.5 ohms	Bench Check the Actuator
2	5 & 3	open circuit (high resistance)	closed circuit (0 to 1.0 ohms)	13 to 17 ohms	
3	5 & 4	open circuit (high resistance)	13 to 17 ohms	closed circuit (0 to 1.0 ohms	
4	4 & 1	6.5 to 8.5 ohms	6.5 to 8.5 ohms	6.5 to 8.5 ohms	
5	4 & 3	13 to 17 ohms	13 to 17 ohms	13 to 17 ohms	
6	3 & 1	6.5 to 8.5 ohms	6.5 to 8.5 ohms	6.5 to 8.5 ohms	

DEFECTIVE PICKUP TEST

STEP NO.	TEST BETWEEN RECEPTACLE NUMBERS:	OBTAIN	ACTION (if out of limits)
7	8 & 7 (with 6 disconnected at pickup)	52-68 ohm	Repair wiring if at fault. Replace governor if pickup is at fault; replace pickup (Approved Governor Shop)
8	8 & 6 (with 7 disconnected at pickup)	52-68 ohm	
9	8 & aircraft ground	open circuit (very high resistance)	

AIRCRAFT WIRING TEST

STEP NO.	TEST BETWEEN RECEPTACLE NUMBERS:	OBTAIN	ACTION (if out of limits)
10	1 & aircraft ground	short circuit zero ohms	Trace wiring to determine poor ground
11	2 & aircraft ground	open circuit (very high resistance) 500-ohms	Trace wiring to remove fault

TABLE XIV-XII. SYNCHRONIZER WIRING TEST(cont.)

CONTROL BOX TEST

STEP NO.	TEST BETWEEN RECEPTACLE NUMBERS	METER READING	ACTION (If out of Limits)
12	2&1	Same as supply voltage. Polarity of pin No. 2 must be positive and pin No. 1 must be negative.	Trace wiring to determine fault or reversed polarity.

b. Before continuing be sure the control box is unplugged, the master switch is off, and the synchronizer circuit protector is pulled.

c. Separate the control box and the airplane harness at the Jones plug (9). Make certain that the synchronizer OFF/ON switch Jones plug is not mistaken for Jones plug (9) noted above.

d. Perform the tests listed in Table XIV-XII, Synchronizer Wiring Test. Complete each step regardless of how recently the installation was made. Observe the following cautions and note before starting test.

CAUTION

Do not plug in control box until this test has been satisfactorily completed. Even with the switch OFF the box could be seriously damaged.

NOTE

Make the test, using an ohmmeter to a fabricated Jones pigtail connected to the Jones plug socket. Zero the ohmmeter and read on the X1 or X10 scale.

CAUTION

Do not probe the Jones plug. Use a fabricated pigtail. Failure to do so will result in loose pin connections and faulty synchronizer operation.

e. Visually observe the governor-mounted speed pickups for oil leaks or evidence of loosening. This could indicate a change in the pickup clearance.

f. Remove the flexible shaft at the actuator in the right engine nacelle. Insert a screwdriver in the actuator and rotate it through its range. It should rotate freely except for the ratcheting effect of the detent wheel. Normal output torque is 1.5 inch-pounds. Leave the actuator in the center of its range.

g. Adjust the governor trimmer by rotating the flexible shaft to check the amount of torque required. An excellent torque level is one that allows you to adjust the trimmer by turning the squared end of the flexible cable with your fingers. It is more difficult to turn the shaft in the decrease RPM direction. In no case should you need a turning fixture of over .25 inch in diameter on the end of the cable to rotate the trimmer freely throughout its full range. Recenter the trimmer and secure it to the actuator. This check has verified an acceptable friction level of the rotating parts.

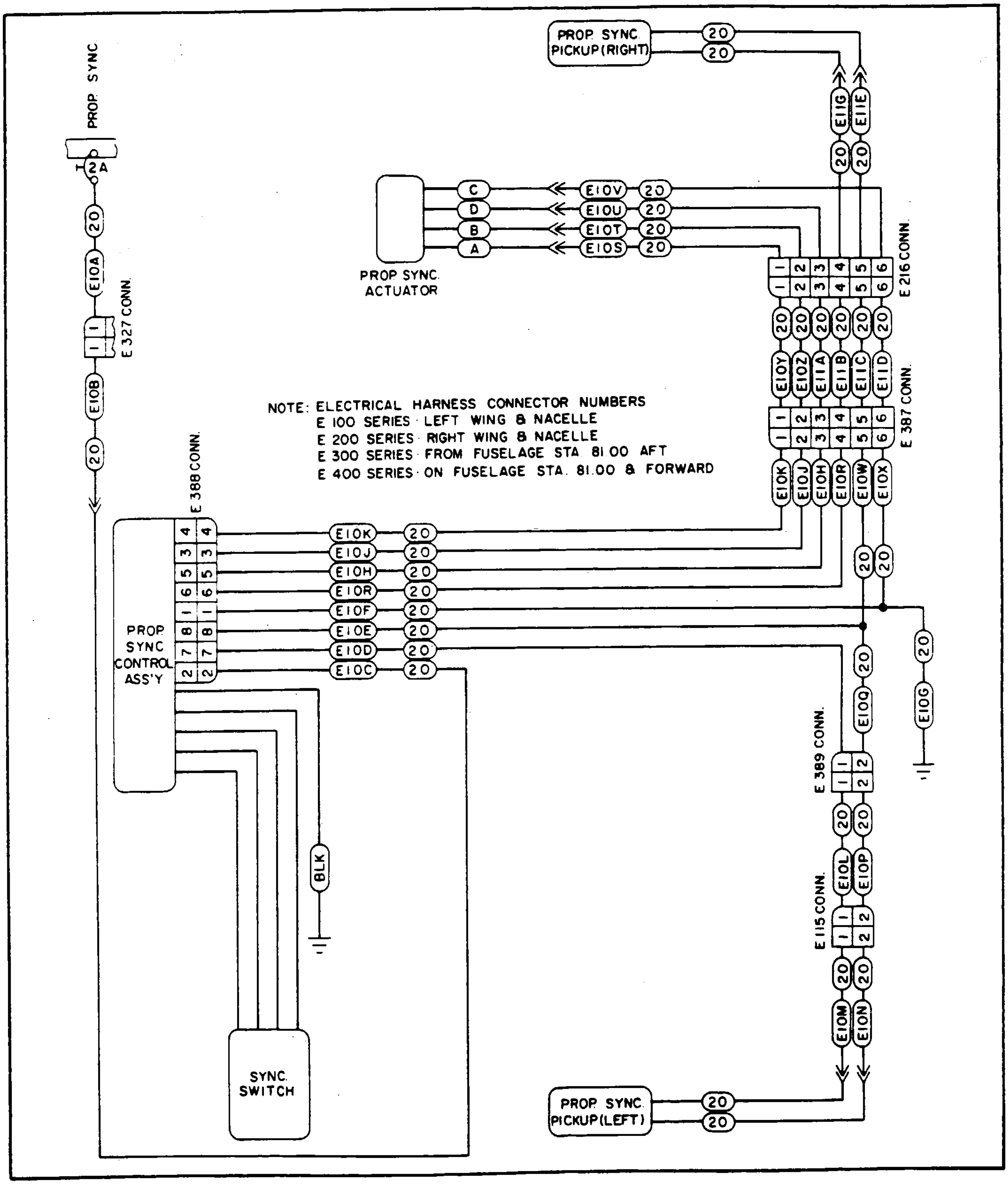


Figure 14-34. Propeller Synchronizer Schematic

h. Using the pigtail previously connected to the Jones plug, run the engines near cruise RPM, test Pins 6 and 8 for the slave engine pickup voltage. Test Pins 7 and 8 for the master engine pickup voltage. These values should be between 1/2-volt minimum and 3-volts maximum. These are RMS voltages and read on a 5000 ohm/volt AC voltmeter. If all the preceding tests are satisfactory, the airplane can be flown.

14-103. FLIGHT CHECKS. Perform the functional in flight test in accordance with paragraph 14-100. If the system will not pass this test try the following steps:

1. With the synchronizer ON, see if the synchronizer action is affected by RPM and/or power setting, particularly at lower cruise RPM and power settings. This would indicate a possibly unacceptably rough governor drive. If operation at lower RPM results in improved synchronization, the drives to the governors should be investigated.

2. Reduce the electrical load. Turn off all electrical equipment including the alternators. Leave the magnetos, master, and synchronizer switches ON. If the synchronizing improves, there is a possibility that abnormal voltage spikes on the bus from some other electrical accessory have been upsetting the synchronizer. Isolate the offending electrical accessory and repair it. If the trouble has been traced to the control box, exchange it for another unit.

NOTE

If troubles still persist with the system, it should be checked by an approved governor overhaul station or the Woodward Governor Company.

14-104. MAINTENANCE. Little maintenance is required on this system apart from visual inspection at the time of regular airplane inspections. Ascertain that the electrical connections, flexible shaft and related components are securely attached. Every 100 hours inspect the rod end assembly, paying particular attention to the bearing.

Engine oil should be kept clean. Dirty engine oil will deposit sludge and varnish on the internal governor parts and cause sluggish operation. This would require disassembly and cleaning of the governors by an approved overhaul facility.

CAUTION

The control box and actuator have the capability of damaging each other as follows: If the control box turns on steady it will burn out one or both actuator motor windings. If the actuator leads are shorted to ground, the power transistors in the control box will be permanently damaged. Therefore when replacing a damaged component, complete the electrical test in Table XIV-XII to insure the other component is undamaged.

14-105. REMOVAL OF TRIMMER ASSEMBLY. (Refer to Figure 14-35.)

a. Remove the right engine cowling.

b. Remove the governor shield.

c. Cut the safety wire between the trimmer assembly and the nut securing the flexible shaft to the trimmer.

d. Remove the flexible shaft from the trimmer.

e. Loosen the locknut on the propeller control rod.

f. Remove the locknut, bushing and bolt securing the trimmer rod end to the governor control lever and remove the trimmer assembly.

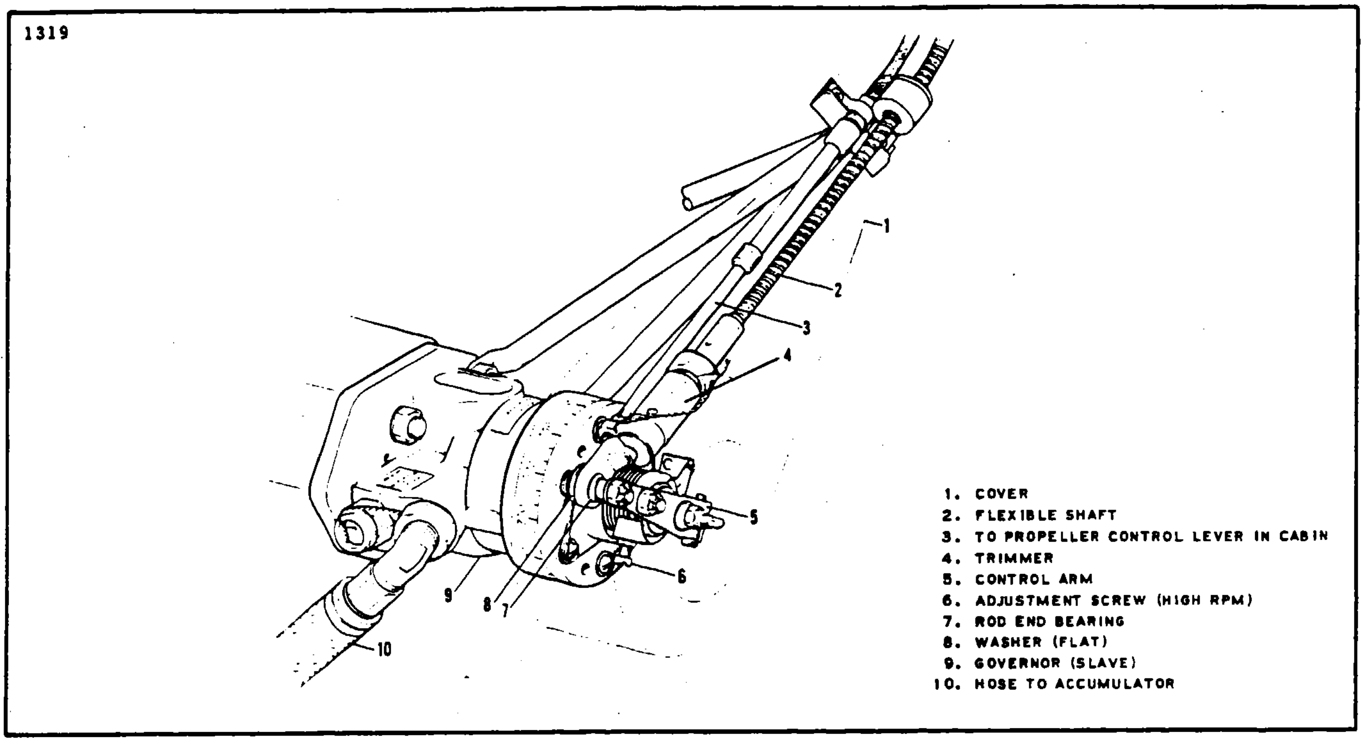


Figure 14-35. Trimmer Assembly

14-106. INSTALLATION OF TRIMMER ASSEMBLY.

a. Position the trimmer onto the propeller control rod.

b. Align the trimmer assembly rod end with the governor control lever and secure the control rod locknut.

c. Ascertain that the trimmer assembly is at its neutral position by rotating the splined shaft in the trimming assembly by hand and counting the total number of turns available from stop to stop, then return to the center position.

d. Install the bolt, bushing and locknut securing the trimmer rod end and the governor control lever.

e. Rig the governor control in accordance with rigging procedures given in Section VIII.

f. Again manually rotate the trimmer to one end of its travel. Now move the cockpit propeller control through its complete range and observe the governor speed adjustment lever to be certain it hits both maximum and minimum RPM stops. Repeat this procedure with the trimmer rotated to the opposite end of its travel. This will assure that the standard governor rigging allows stop to stop travel with any possible trimmer setting. Reposition the trimmer to its center position.

g. Before connecting the flexible shaft to the trimmer assembly ascertain that the actuator motor is at its center position. (Refer to paragraph 14-108.)

h. With the trimmer assembly and actuator motor at these centered positions connect the flexible shaft to the trimmer and secure with nut and safety wire as shown in Figure 14-35.

i. **Install the propeller governor shield, and replace the engine cowling.**

14-107. REMOVAL OF ACTUATOR.

a. **Remove the right engine cowling.**

b. Disconnect the electrical plug from the actuator and also the flexible shaft.

c. Remove the four locknuts and screws holding the actuator in place.

14-108. INSTALLATION OF ACTUATOR.

a. Before installing the actuator ascertain that the motor is at the center of its range by inserting a screwdriver in the actuator drive and turning it by hand and counting the total number of turns from stop to stop, then return the actuator drive to the center position.

b. Install the actuator to the mounting bracket and secure in place with four screws and locknuts.

c. Connect the flexible shaft to the actuator and secure with nut and safety wire.

d. Connect the electrical plug and replace the engine cowling.

14-109. SERVICE OF ACTUATOR. At the time of governor overhaul, remove the cover from the actuator and clean the internal parts, such as micro-switches and electrical connections, etc. Apply Alpha-Molykote "G" to the spiral groove of the switch actuating disc at one end of the motor

14-110. REMOVAL OF CONTROL BOX.

a. Disconnect the Jones plug, the wire going to the bus and the harness going to the switch.

b. Remove the four machine screws and locknut and remove the control box.

NOTE

The control box is a transistorized unit which cannot be serviced in the field. Special Woodward Test Unit No. 213600 can be used to explore the control box and locate any malfunctioning.

NOTE

If an actuator is replaced because of a shorted or open windings, the control box must also be replaced unless you determine that it is undamaged.

14-111. INSTALLATION OF CONTROL BOX.

a. Install the control box to the mounting bracket and secure with four screws and locknuts.

b. Connect the wires going to the switch, and airplane bus.

c. Connect the Jones plug and secure with safety wire if it does not have retaining clips.

14-112. TEST EQUIPMENT. Various test equipment can be purchased from the Woodward Governor Company of Rockford, Illinois to help accomplish a complete check of the synchronizer system, along with their Service Bulletin 33049D. It is suggested the test instrument P/N 213600 be purchased from Woodward to allow complete testing of the synchronizer system. A small test instrument P/N T-46192 can be built in the field from the diagram and parts list in Figure 14-36. This instrument has pulse indicating lights and jacks for checking voltages and ohm values only as given in Table XIV-XII, Synchronizer Wiring Test. Test instrument P/N 213600 has pulse indicating lights, jacks for checking voltages and ohm values, and an oscillator system with which magnetic pickup output may be simulated. This allows partially checking the control box without running the engines.

When using the test instrument instead of a fabricated Jones pigtail, tne instrument is plugged into the system at the same location used by fabricated Jones pigtail. (Refer to Paragraph 14-102.) The ground check is conducted the same as Paragraph 14-102 with the exception of the instrument replaces the fabricated pigtail. Do not connect control box to instrument until test per Paragraph 14-102 has been completed.

14-112a. BENCH TESTING THE ACTUATOR. Use an ohmmeter on the pins of the actuator disconnect. Zero the ohmmeter and read on the X1 scale. Table XIV-XII steps 1 to 6 gives actuator test from the Jones plug through the harness to the actuator. See Propeller Synchronizer Schematic and convert receptacle numbers in Table XIV-XII to actuator leads and perform steps 1 to 6 of Table XIV-XII directly on actuator. Replace any actuator which does not meet the values given in Table XIV-XII after bench testing. Check for continuity of the four actuator leads, with reference to Table XIV-XIIA.

If either test unit is plugged into the system during flight or ground testing, the pulsing and direction of pulsing of the actuator will be indicated by the flashing lights of the test unit. Refer to Table XIV-XIIB for description of control box malfunction or system defects which can be detected by the lights on the test units, along with the probable cause and suggested remedy.

TABLE XIV-XIIA. AIRCRAFT WIRING CHECK WITH ACTUATOR REMOVED

Jones Pin 1 to aircraft ground	0 Ohms
Jones Pin 3 to aircraft ground	Open Circuit (Very High Resistance)
Jones Pin 4 to aircraft ground	Open Circuit (Very High Resistance)
Jones Pin 5 to aircraft ground	Open Circuit (Very High Resistance)

PARTS LIST FOR T-46192 SYNCHRONIZER TEST INSTRUMENT

BOX: (1) Hammertone gray aluminum 3-1/4" x 2-1/8" x 1-5/8" Bud Box Co. P/N CU-2101-A

BANANA JACK: (8) H.H. Smith Co., type 1509 (black)

LAMP: (2) Dialco midget flange type white lens pilot lamp series no. 177-8430, type no. 0975-503 or Drake midget flange type white lens pilot lamp no. 5131-038-304

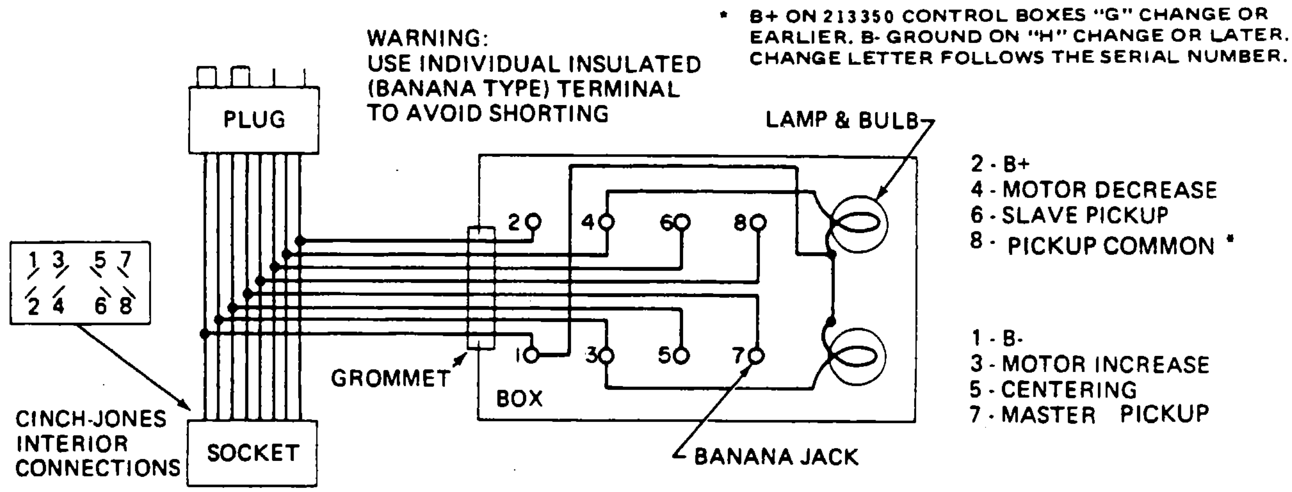
CABLE: (6 ft.) Vinyl covered plastic insulated cable, Belden types 8448 (8 #22 stranded wires)

GROMMET: (1) 5/8" O.D. x 3/8" I.D. black rubber grommet

PLUG: (1) Cinch Jones 8 connector plug P/N P-308 CCT

SOCKET: (1) Cinch Jones 8 connector socket P/N S-308 CCT

BULB: (2) Miniature Flange Base Lamp



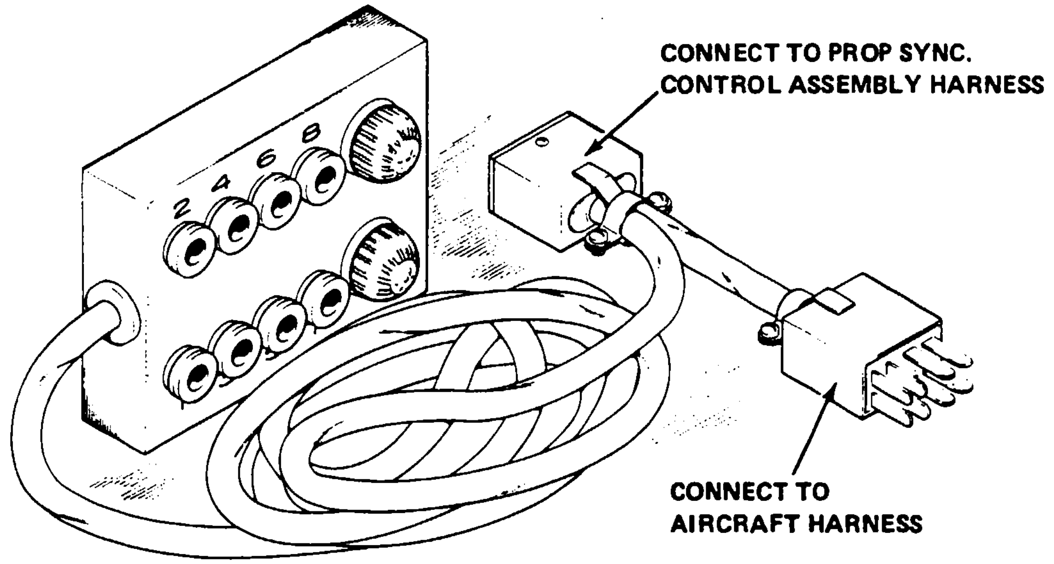


Figure 14-36. Test Instrument T-46192

TABLE XIV-XIIB. TROUBLESHOOTING CHART (ACTUATOR)

Trouble	Cause	Remedy
Double pulsing (both lights flashing simultaneously).	Excessive voltage spikes on bus caused by generator or other electrical accessory.	Repair the offending accessory.
	Malfunctioning control box.	Return to Woodward Governor Company for repair.
	Magnetic pickup voltage incorrect.	Return to Woodward Governor Company for repair.
Either or both lights on continuously.	Malfunctioning control box, actuator, or wiring.	Determine the malfunction with wiring check sheet.
No pulsing activity.	Malfunctioning control box.	Determine the malfunction with the wiring check sheet or 213600 test instrument.
Excessive pulsing in one direction.	Excessive torque required to trim the governor in one direction (this assumes the governor and propeller are equally responsive in each direction).	Check for high friction level or misalignment in the flex shaft or trimmer.

TABLE XIV-XIII. TROUBLESHOOTING CHART (PROPELLER SYNCHRONIZER)

Trouble	Cause	Remedy
Synchronizer hunting.	Binding of the governor control arm, trimmer assembly, and/or rod end.	Correct any mechanical binding. Replace Uniball of rod end if binding.
	Master governor speed is varying.	Overhaul governors.
Synchronizer runs out of synchronization when turned on.	Reversed speed pickup leads, or Jones plug leads.	Perform step 7 and 8 of test for defective pickup.
	Intermittent shorts or opens in the pickup or its wiring.	Monitor pickup voltage produced Replace defective pickup.
Synchronizer will not center.	Defective pickup.	Replace.
	Defective control box.	Replace.
	Mechanically misrigged	Rerig.
	Defective centering mechanism.	Replace actuator.
	Rod end, flexible shaft or actuator mechanically bound up.	Reduce friction to an acceptable level.
Lack of range.	Improper rigging.	Rerig properly.
	Trying to synchronize too close to a mechanical stop.	Adjust prop control in cockpit to move speed control lever further away from stop.
	Defective control box.	Replace the control box.
	Mechanical binding of trimmer or actuator.	Adjust trimmer or actuator to operate smoothly from stop to stop.

TABLE XIV-XIII. TROUBLESHOOTING CHART (PROPELLER SYNCHRONIZER) (cont)

Trouble	Cause	Remedy
Synchronizer corrects in one direction only.	One side of actuator motor defective.	Replace actuator.
	One side of control box defective.	Replace control box.
	Mechanical binding in one direction.	Correct binding.
	Improper rigging.	Rerig.
Slow to synchronize and won't hold synchronization.	Defective control box.	Replace control box.
	Excessive voltage spikes from other electrical accessory.	Repair off ending electrical accessory.
	Excessive mechanical friction.	Correct mechanical binding.
Synchronizer operates intermittently.	Excessive mechanical friction.	Current mechanical binding.
	Intermittent short in pickup or wiring.	Repair pickup lead or replace pickup.
	Intermittent fault in control box.	Replace control box.
	Intermittent open in actuator or motor leads.	Replace actuator or repair leads.
	Defective electrical plug connector.	Replace plug connector.
	Excessive voltage spikes on bus from other malfunctioning electrical accessory.	Repair offending electrical accessory.

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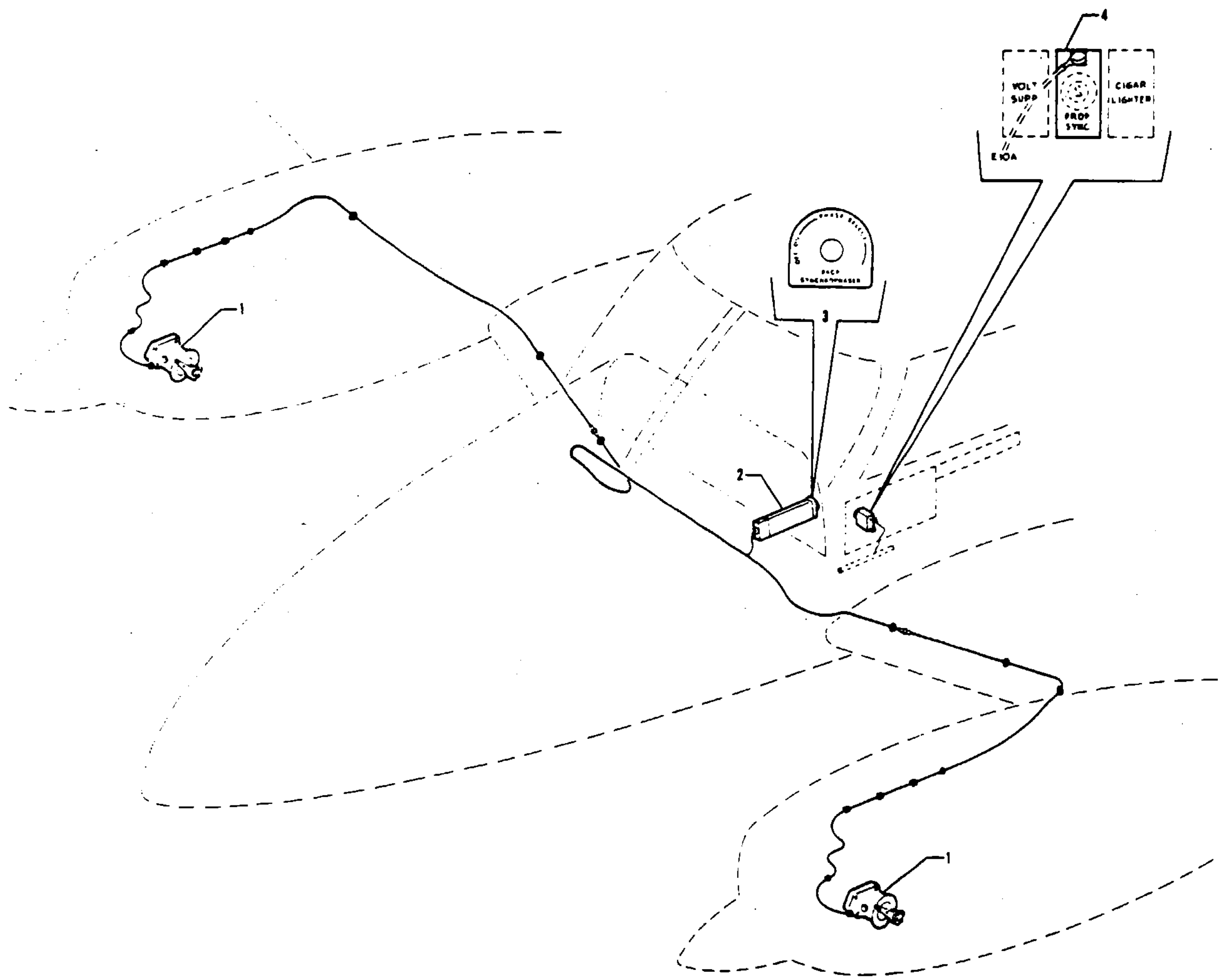


1. GOVERNOR ASSEMBLY
2. CONTROL BOX ASSEMBLY
3. PLACARD
4. CIRCUIT BREAKER

Figure 14-37. Propeller Synchrophaser Installation (Woodward)

14-113. PROPELLER SYNCHROPHASER (WOODWARD).

14-114. DESCRIPTION OF PROPELLER SYNCHROPHASER SYSTEM. (Refer to Figure 14-37.) The synchrophaser system provides propeller speed synchronization, and in addition, allows the pilot to select the most desirable phase relationship (propeller blade position) between the two engines. Each propeller governor contains a magnetic pickup and an electromagnetic biasing coil. The magnetic pickup in each governor senses the speed of rotation of the governor's flyweight head. Since each governor is driven by the engine crankshaft, the frequency of the electrical signal, generated by each magnetic pickup, indicates engine speed. The magnetic pickup in each governor generates one pulse per revolution and the time between each pulse can be compared. The control box allows the pilot to adjust the phase relationship between the two individual engine pulses, thus, the control box can trim the governor's speed settings and propeller blade relationship. This system has no master or slave engine.

14-115. FUNCTIONAL TEST. This test shall be done in flight. Synchronize the engines manually, and turn "ON" synchrophaser.

NOTE

In the synchrophaser system the initial rotation of the control knob turns the system "ON", synchronizing the propellers. Further rotation changes the phase relationship of the propellers. This enables the pilot to select any phase relationship desired.

The engine R.P.M. difference must be within 15 to 20 R.P.M. To enable the synchrophaser to capture control of engine speed, slowly advance either propeller control lever to increase R.P.M. of one engine in small increments until the engines loose synchronization. Pull the "Prop Sync" circuit breaker, note engine on which R.P.M. was increased is approximately 50 R.P.M. higher than other engine. (Synchrophaser control range is +50 engine R.P.M.) Reset the "Prop Sync" breaker and slowly return the propeller control lever in small increments toward its original position and note synchronization again occurs when both engines arrive within 15 to 20 R.P.M. of each other. Slowly rotate control knob and audibly detect the propeller phase relationship change.

14-116. TROUBLESHOOTING WITH MINIMUM FIELD EQUIPMENT. The following information will help locate system malfunction in the field with minimum amount of equipment. The usual mechanics tools and an ohmmeter and voltmeter will perform the tests and troubleshooting noted in Tables XIV-XIV and XIV-XV. The tests and Troubleshooting Tables XIV-XIV and XIV-XV are not exhaustive; an authorized governor repair shop or Woodward, must be consulted for complete test and repair of governor and/or complete test of control box.

NOTE

The control box is not repairable as it is encapsulated with a cushioning material to protect against vibration.

NOTE

Governor overhaul is a major repair (FAR 43 - Appendix A) and must be performed in accordance with the provisions of FAR 43.3 and FAR 145.31.

Also, consult propeller synchrophaser schematic Figure 14-38 as an aid to system troubleshooting.

14-117. GROUND CHECK.

a. On previously installed installations ascertain that the following checks are accomplished before detailed test listed in Step b and in Table XIV-XIV are accomplished:

1. Ascertain that the master switch is on and the circuit protector is not tripped.
2. Determine that the plug receptacle is properly mated with the plug in the airplane wiring harness.

b. Observe the following Notes and Cautions listed and proceed with tests listed in Table XIV-XIV.

NOTE

Before starting this test, be sure the control box is unplugged, the master switch is off, and the synchronizer circuit protector is pulled.

CAUTION

Do not plug in control box until this test has been satisfactorily completed. Even with the switch OFF the box could be seriously damaged.

NOTE

Make the test, using an ohmmeter to a fabricated Jones pigtail connected to the Jones plug socket. Zero the ohmmeter and read on the X1 or X10 scale. Ohmmeter reading may be 20% higher during heat soak following shutdown.

CAUTION

Do not probe the Jones plugs. Use a fabricated pigtail. Failure to do so will result in loose pin connections and faulty synchrophaser operation.

14-118. MAINTENANCE. Little maintenance is required on this system apart from visual inspection at the time of regular airplane inspections. Ascertain that the electrical connections and related components are securely attached.

Engine oil should be kept clean. Dirty engine oil will deposit sludge and varnish on the internal governor parts and cause sluggish operation. This would require disassembly and cleaning of the governors by an approved overhaul facility.

14-119. REMOVAL OF CONTROL BOX.

a. Disconnect plug from back of control box.

b. Remove switch knob, lock washer and nut from instrument panel side of control box and remove the control box.

NOTE

The control box is not repairable as it is encapsulated with a cushioning material to protect against vibration.

14-120. INSTALLATION OF CONTROL BOX.

a. Install the control box in the reverse order of disassembly.

CAUTION

Do not plug in control box until the tests noted in Paragraph 14-117, Step b, have been satisfactorily completed. Even with the switch off the box could be seriously damaged.

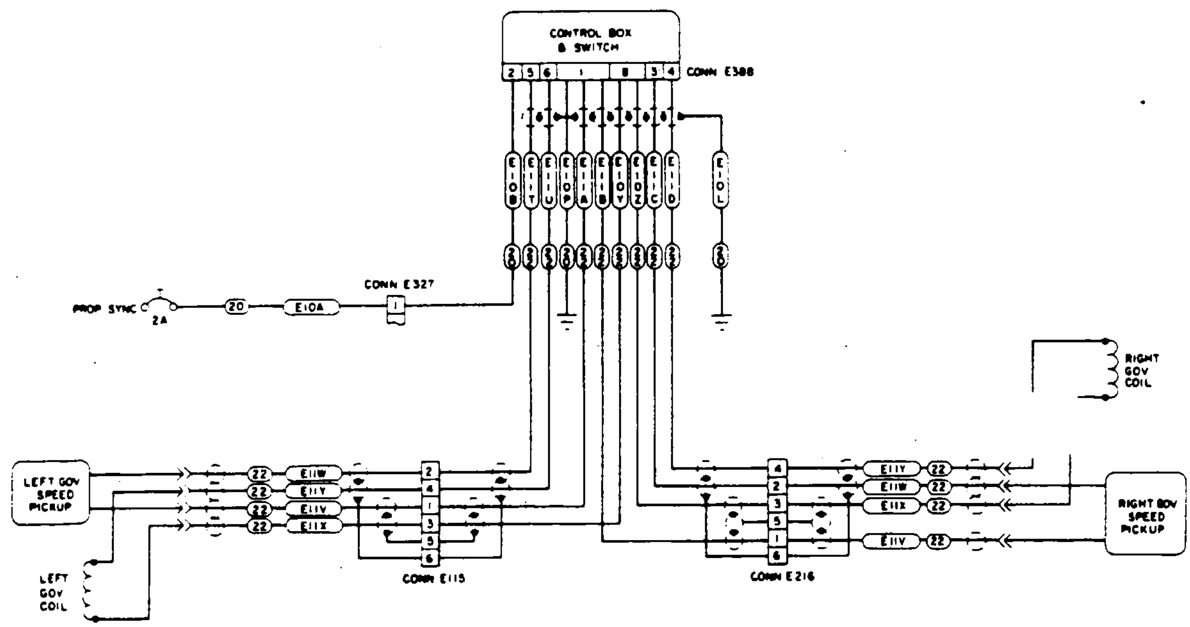
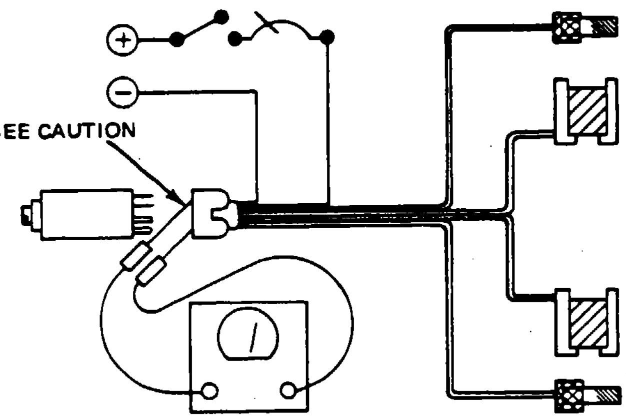


Figure 14-38. Propeller Synchrophaser Schematic

TABLE XIV-XIV. SYNCHROPHASER SYSTEM TEST

Use Ohmmeter on X1 or X10 Scale — Resistance May Be 20% Higher After Heat Soak

Test #	System & Test Equipment Configuration	Test Between Receptacle #'s	Required
1	STATIC CHECK — Master switch "off" control box disconnected, C/B pulled.	1 & Ground	0 Ohms
2		2 & Ground	Open Circuit
3		3 & Ground	52 - 68 Ohms
4		4 & Ground	Open Circuit
5		5 & Ground	52 - 68 Ohms
6		6 & Ground	Open Circuit
7		8 & Ground	Open Circuit
8		4 & 8	110 - 140 Ohms
9		6 & 8	110 - 140 Ohms
10	Master Switch "On" & C/B reset control box still unplugged 	2 & 1	Supply Voltage 2 (+) & 1 (−)

CAUTION

Do not probe the Jones plugs. Use a fabricated pigtail. Failure to do so will result in loose pin connections and faulty synchrophaser operation.

TABLE XIV-XV. TROUBLESHOOTING CHART (PROPELLER SYNCHROPHASER)

Trouble	Cause	Determined By Test No.	Remedy
Synchrophaser inoperative.	Defective power lead or circuit breaker.	2	Repair lead or replace circuit breaker.
	Defective ground lead.	1	Repair lead.
	Magnetic pickup "OPEN" or "SHORTED" to ground.	1,3,5	Replace governor.
	Pickup wiring or connector "OPEN" or "SHORTED" to ground.	1,3,5	Repair wiring or connector.
	Faulty receptacle half at system connector.	Each receptacle should provide drag on a .045" feeler.	Replace connector.
	Control box defective.	Verify by eliminating items 1 thru 10, plus additional checks to be performed by authorized Governor Shop or Woodward.	Replace control box.

TABLE XIV-XV. TROUBLESHOOTING CHART (PROPELLER SYNCHROPHASER) (cont.)

Trouble	Cause	Determined By Test No.	Remedy
RPM Surge or Hunt*	Sync coil, leads, aircraft wiring or connectors "OPEN."	8,9	Replace governor or repair or replace leads, wiring or connector.
	Sync coil, leads, aircraft wiring or connectors "SHORTED" together. Results in permanent control box damage.	8,9	Replace governor or repair or replace leads, wiring or connector. Replace control box after testing 1 thru 10.
NOTE * Magnitude and frequency of speed hunt will vary depending on which coil is defective and whether the basic governor speed setting of that governor is equal to, higher than, or lower than the other governor.			
Left engine increases RPM out of sync when synchrophaser is turned on.	Left coil, coil lead, associated wiring or connector grounded. Left pickup output low.	6	Replace governor or repair or replace wiring or connector.
Right or left engine increases RPM out of sync when synchrophaser is turned "ON."	Pickup or associated wiring on engine which increases "OPEN." Pickup output low.	3,5	Repair "OPEN" wiring or replace governor.

TABLE XIV-XV. TROUBLESHOOTING CHART (PROPELLER SYNCHROPHASER) (cont.)

Trouble	Cause	Determined By Test No.	Remedy
Insufficient Syn-chrophaser Range	Right coil, coil lead, associated wiring or connector grounded.	4	Replace governor; re-pair wiring; repair or replace connector.
System synchrophases but is marginally stable.	Pickup or coil leads swapped between left and right engines.	1,5,6,8 - Left 1,3,4,8 - Right	Correct wiring per wiring schematic, Figure 14-38.
Circuit Breaker "trips."	Power lead short or defective control box.	2,8	Remove fault. Replace control box after testing 1 thru 10.

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APPENDIX

WINDOW INSPECTION AND REPAIR — STANDARD PRACTICES

1. **Window Inspection.**

a. DEFINITIONS. The following apply to all cockpit and cabin windows.

Critical	The viewing area of the windshields used for taxiing, takeoff, climb, cruise, and landing.
Semi-Critical	The viewing area used for general flight vision.
Non-Critical	Viewing areas not normally used for flight operations.
Distortion	Lines in windows or windshields that cause waviness in objects when looking through the window or windshield.
Crack	Critical narrow break, fissure, or separation extending through the entire thickness of the transparent material.
Craze	Fissure on the surface of the transparent material that does not penetrate the full thickness of the material.
Crazing	Mesh of fine hairline cracks that do not penetrate the full thickness of the material, located on the surface or within the structure of the transparent material.
Star Craze	A condition where several fissures radiate from a central point.
Wedge	A condition in a piece of optical glass having a progressive variation in thickness or absorption from one side to the other.
Scratch	An abrasion on the surface of the material caused by contact with rough abrasives or sharp objects.
Hairline Scratch	Visible scratch undetectable when passing a fingernail over the scratch. Considered non-critical other than being an appearance defect.
Light Scratch	A scratch measuring less than 0.010 inch (0.254 mm) deep. Can be detected when passing a fingernail over the scratch. Considered non-critical except for appearance.
Heavy Scratch	A scratch measuring more than 0.010 inch (0.254 mm) deep. Can be detected when passing a fingernail over the scratch. This type of scratch may be accompanied by chipping along the edge. Considered critical when occurring to inner glass ply. Considered semi-critical when occurring to outer glass ply within certain limitations (see inspection criteria). Considered non-critical within certain limitations (see inspection criteria) when occurring to acrylic surfaces.
Chip	A chip is considered a small scratch.
Haze	A foggy appearance located on the surface of the transparent material.
Blemish	Speck, air bubble, or other minor imperfection imbedded in the transparent material.
Mark-Off	An almost nonexistent shallow depression on the surface possessing practically no depth. Discernible only due to a noticeable rim or roughened surface caused by mold surface defects transferred to the surface during the forming operation.
Delamination	Visible evidence of a physical break of the bond between the plastic interlayer and either glass ply. Delamination may be caused by laminating stresses, preload on installation, or excessive heat.

b. CRITICAL AREA INSPECTION - GLASS WINDSHIELDS. A critical area is the area of the laminated glass windshields used for taxiing, takeoff, climb, cruise, and landing.

(1) Cracks could occur in either the inner, outer, or both panes. Cracking in either pane is critical and cause for immediate replacement.

(2) Crazing.

(a) Crazing in the windshields is critical.
(b) Determine depth of craze using a calibrated depth gauge or scale (see Figure 14-APP-1).
(c) A craze of 0.062 inch (1.575 mm) depth is cause for immediate replacement. A craze of 0.031 inch (0.787 mm) depth is cause for replacement at the earliest opportunity.
(d) Crazing in any portion of the windshields requires replacement.

(3) Blemishes.

(a) Blemishes in windshields form in the vinyl plastic interlayer bonding the two glass panes together.
(b) Blemishes in the critical or semi-critical portion of the windshields are not acceptable unless 0.062 inch (1.575 mm) or smaller in circumference, including distorted area.
(c) No more than two blemishes, at least 12 inches (30.48 cm) apart are acceptable in the windshields.
(d) No more than two blemishes within a two inch (5.08 cm) area along the upper portion of the windshields are acceptable.

(4) Haze or foggy appearance on the glass is not acceptable if the amount of haze/fog causes an obstruction of vision in the area used for operation of the aircraft.

(5) Scratches.

(a) A scratch, no longer than 0.062 inch (1.575 mm) long and no deeper that 0.020 inch (0.508 mm) is acceptable.
(b) Heavy scratches on either glass ply are cause for immediate windshield replacement.
(c) Hairline scratches may be waxed and buffed out.

(6) Delamination.

(a) Cloudy or milky appearance in the delamination indicates moisture or solvent penetration. Windshields with this condition should be replaced at the earliest opportunity.
(b) Delaminated areas characterized by irregular or jagged boundaries indicate uneven separation of the vinyl and glass. This condition may cause the vinyl to pull chips from the inner glass surface, resulting in failure of the glass ply. Conduct periodic inspections to determine if the damage is progressive or if chipping of the inner glass surface is present.

(7) Mark-Off of such low intensity that vision quality is not impaired and that is not visible when looking through the windshield is acceptable.

(8) Distortion. Slight horizontal distortion is acceptable, if: there are no more than two lines; they do not occupy more than 25 percent of the windshield area, and; they are separated by a minimum of six inches (15.24 cm).

c. SEMI-CRITICAL AREA INSPECTION - GLASS WINDSHIELD, COCKPIT ACRYLIC WINDOWS. Semi-critical areas are the perimeter of the glass windshield and areas of cockpit acrylic windows used for general flight vision.

(1) Mark-Off of such low intensity that vision quality is not impaired and that is not visible when looking through the windshield is acceptable.

(2) Distortion.

(a) A moderate amount of distortion is acceptable along the lower portion of the windshield if no more than 1.5 inches (3.81 cm) above the windshield retrainer strip.

(b) Distortion may not be so severe that it restricts vision or diverts runway lines or section lines more than 45°.

(c) Slight horizontal distortion is acceptable, if: there are no more than two lines; they do not occupy more than 25 percent of the windshield area, and; they are separated by a minimum of six inches (15.24 cm).

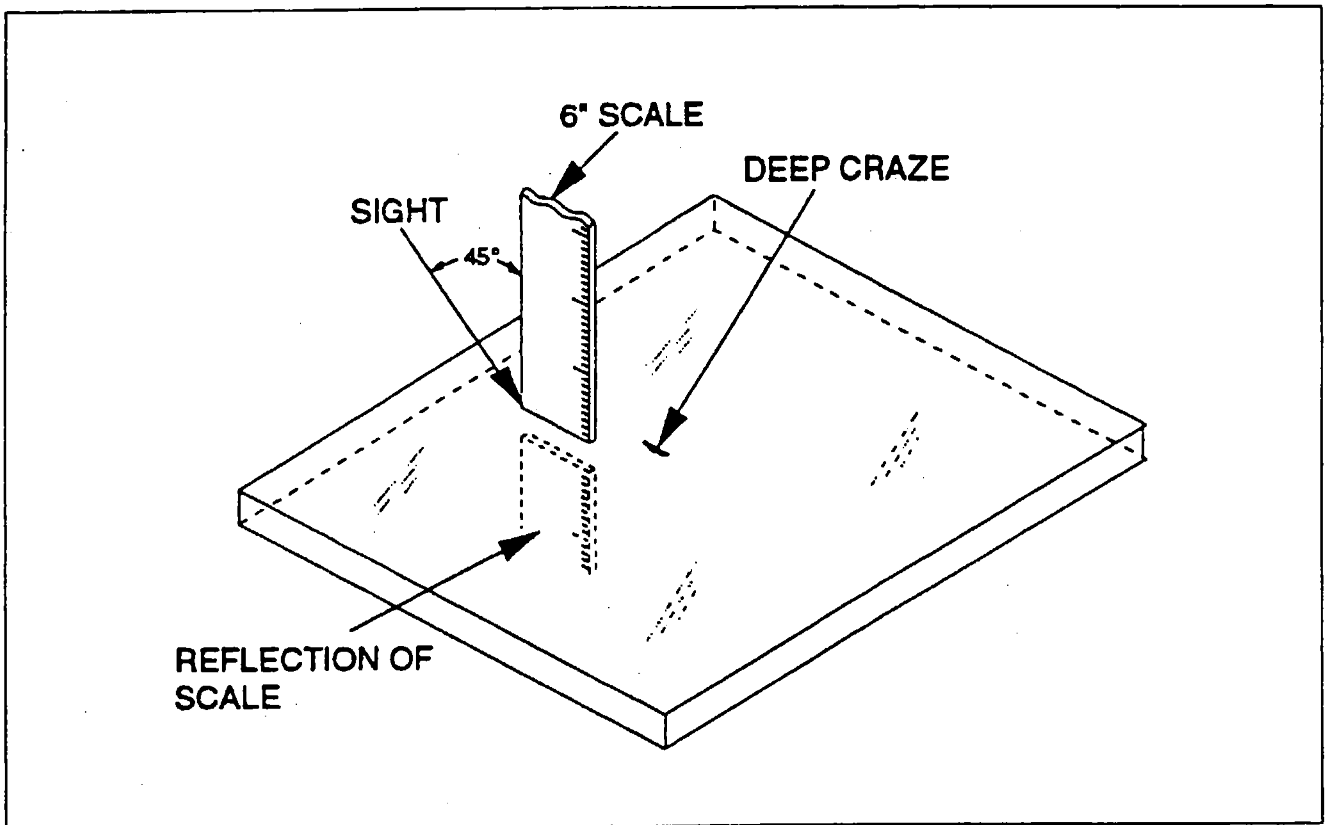

Figure 14-APP-1. Determining Depth of Craze.

(3) Crazing.

(a) Crazing in the windshields is critical.

(b) Determine depth of craze using a calibrated depth gauge or scale (see Figure 14-APP-1).

(c) A craze 0.031 inch (0.787 mm) deep is cause for replacement at the earliest opportunity.

(d) Crazing in any portion of the windshields requires replacement.

(4) Haze or foggy appearance on the glass is not acceptable if the amount of haze/fog causes an obstruction of vision in the area used for operation of the aircraft.

(5) Blemishes.

(a) Blemishes in windshields form in the vinyl plastic interlayer bonding the two glass panes together.
(b) Blemishes in the critical or semi-critical portion of the windshields are not acceptable unless 0.062 inch (1.575 mm) or smaller in circumference, including distorted area.
(c) No more than two blemishes, at least 12 inches (30.48 cm) apart are acceptable in the windshields.
(d) No more than two blemishes within a two inch (5.08 cm) area along the upper portion of the windshields are acceptable.

(6) Scratches.

(a) Light scratches in the lower portion of the window and windshield are acceptable if they do not extend more than 1.00 inch (2.54 cm) from the outside windshield retainer and are less than 1.00 inch (2.54 cm) long.
(b) Scratches in acrylic windows may be reworked if:

1) They are less than 0.030 inch (0.762 mm) deep.
2) 0.310 inch (7.874 mm) panes are a minimum of 0.279 inch (7.087 mm) thick after rework.
3) 0.375 inch (9.575 mm) panes are a minimum of 0.338 inch (8.618 mm) thick after rework.
4) 0.380 inch (9.652 mm) panes are a minimum of 0.342 inch (8.687 mm) thick after rework.
5) No vision distortions in critical and semi-critical areas as a result of rework.

(c) Replace acrylic windows with scratches that cannot be reworked in accordance with these standards.

(7) Delamination.

(a) Cloudy or milky appearance in the delamination indicates moisture or solvent penetraton. Windshields with this condition should be replaced at the earliest opportunity.
(b) Delaminated areas characterized by irregular or jagged boundaries indicate uneven separation of the vinyl and glass. This condition may cause the vinyl to pull chips from the inner glass surface, resulting in failure of the glass ply. Conduct periodic inspections to determine if the damage is progressive or if chipping of the inner glass surface is present.

(c) Replace windshield if any of the following condition are noted:

1) Evidence of chipping of inner glass surface.
2) Area of vision required for safe operation is affected (pilot's discretion).
3) Windshield heat system inoperative.

(8) Cracks. Inspect for cracks as directed in paragraph 1e, Crack Inspection - Acrylic Windows.

d. NON-CRITICAL AREA INSPECTION - CABIN WINDOWS. A non-critical area is a portion of a window not used for flight vision.

(1) Mark-Off in moderate amounts is acceptable provided that visibility is not impaired.

(2) Distortion.

(a) Distortion along the sides of the window within 0.5 inches (1.27 cm) or less of the retainer is acceptable.
(b) Distortion along the upper portion of the window is acceptable if distortion does not extend downward more than 2.00 inches (5.08 cm) from the top and does not impair vision.
(c) Distortion of the main body of the side window is acceptable providing the distorted area does not exceed 25 percent of the winddow area.

(3) Crazing.

(a) Crazing in the window is critical.
(b) Determine depth of craze using a calibrated depth gauge or scale (see Figure 14-APP-1).
(c) A craze of 0.062 inch (1.575 mm) depth is cause for immediate replacement. A craze 0.031 inch (0.787 mm) deep is cause for replacement at the earliest opportunity.
(d) Crazing in any portion of the winddow requires replacement.

(4) Haze or foggy appearance on the glass is not acceptable if the amount of haze/fog causes an obstruction of vision in the area used for operation of the aircraft.

(5) Cracks. Inspect for cracks as directed in paragraph 1e, Crack Inspection - Acrylic Windows.

e. CRACK INSPECTION - ACRYLIC WINDOWS.

(1) Perform this inspection annually or each 1,000 hours, whichever occurs first.

— Note —

This inspection should also be performed after repainting when any chemical stripping agent was used. Use the prism method described in step (3) to inspect the entire circumference of the window for stripper damage/etching; especially in areas concealed by window frames, retainers, plates, or collars.

(2) Inspect window panes as follows:

(a) Inspect sealant for signs of wear, deterioration, and positive contact with mounting surfaces.
(b) Inspect window frames, retainers, plates, and collars for cracks, loose rivets or screws, corrosion, and structural defects.

(3) Inspect emergency exit and eyebrow window bolt holes as follows, using Window Inspection Kit - P/N 766-294. (A 45° acrylic prism and glycerin may be used if kit not available.)

(a) Clean area to be inspected with soap and water to ensure surface is free of oil, dirt, and wax.

(b) Determine which immersion oil to use: Type A in cold weather; Type B in hot weather.

(c) Apply a small amount of oil to the surface of window adjacent to bolt hole. On initial application, use a small amount of oil applied directly to one 90° face of inspection prism in contact with glass or acrylic (see Figure 14-APP-2).

(d) Press oiled face of prism to glass or acrylic. Slide prism around until a constant film of oil extends across prism face and window surface.

(e) Look into 90° face of prism (see Figure 14-APP-2). The image of an unfractured fastener hole will appear as a frosty cylinder.

(f) If hole is countersunk, cylinder will appear to have a cone setting on one end as seen in Figure 14-APP-2.

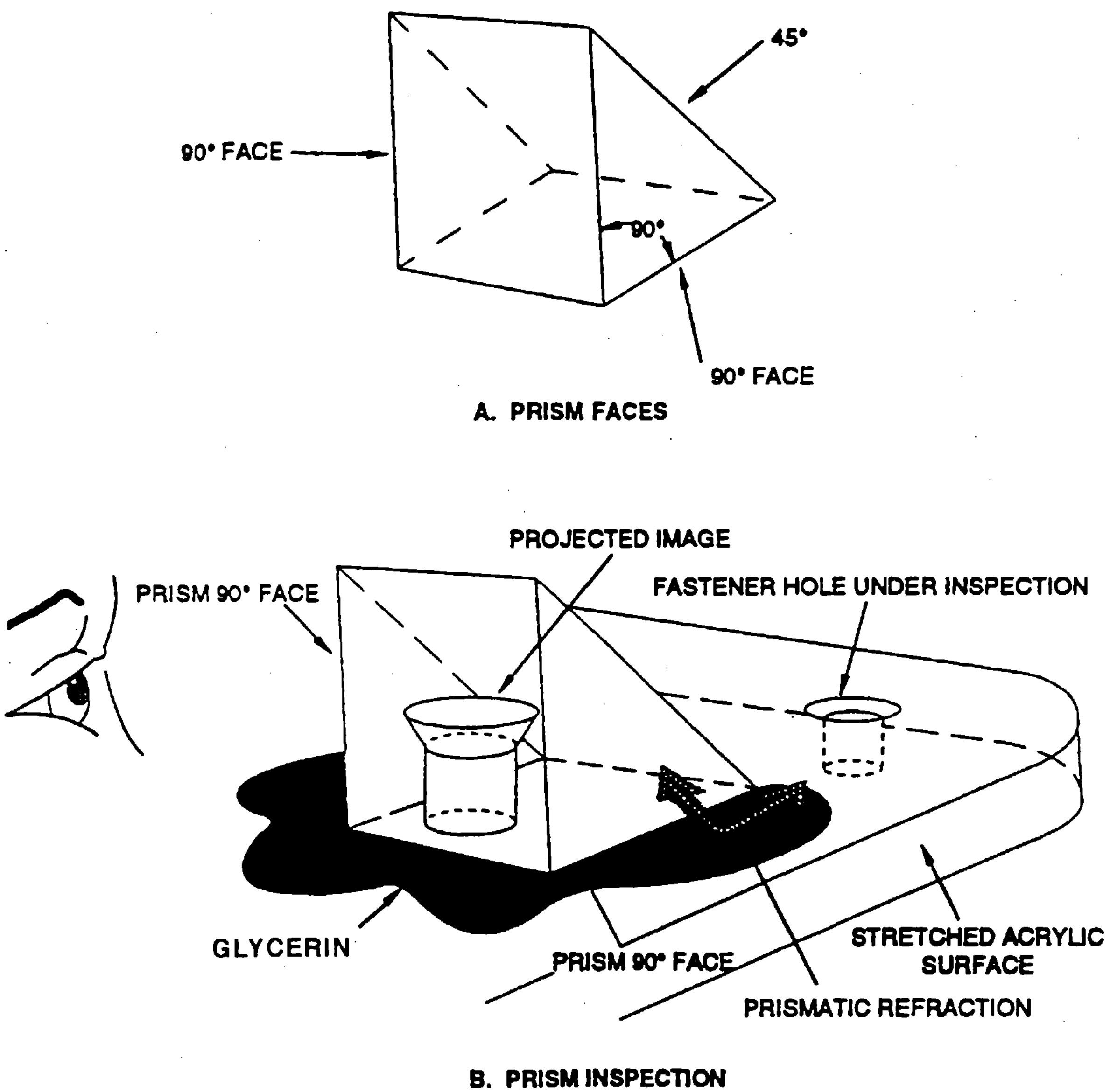

Figure 14-APP-2. Visual Inspection

(g) The image of a cracked hole will appear as a frosty or reflective projection extending from the hole (see detail A-A, Figure 14-APP-3).

(h) The image of a crack from one hole to another will appear as a frosty or reflective irregular surface (see detail B-B, Figure 14-APP-3).

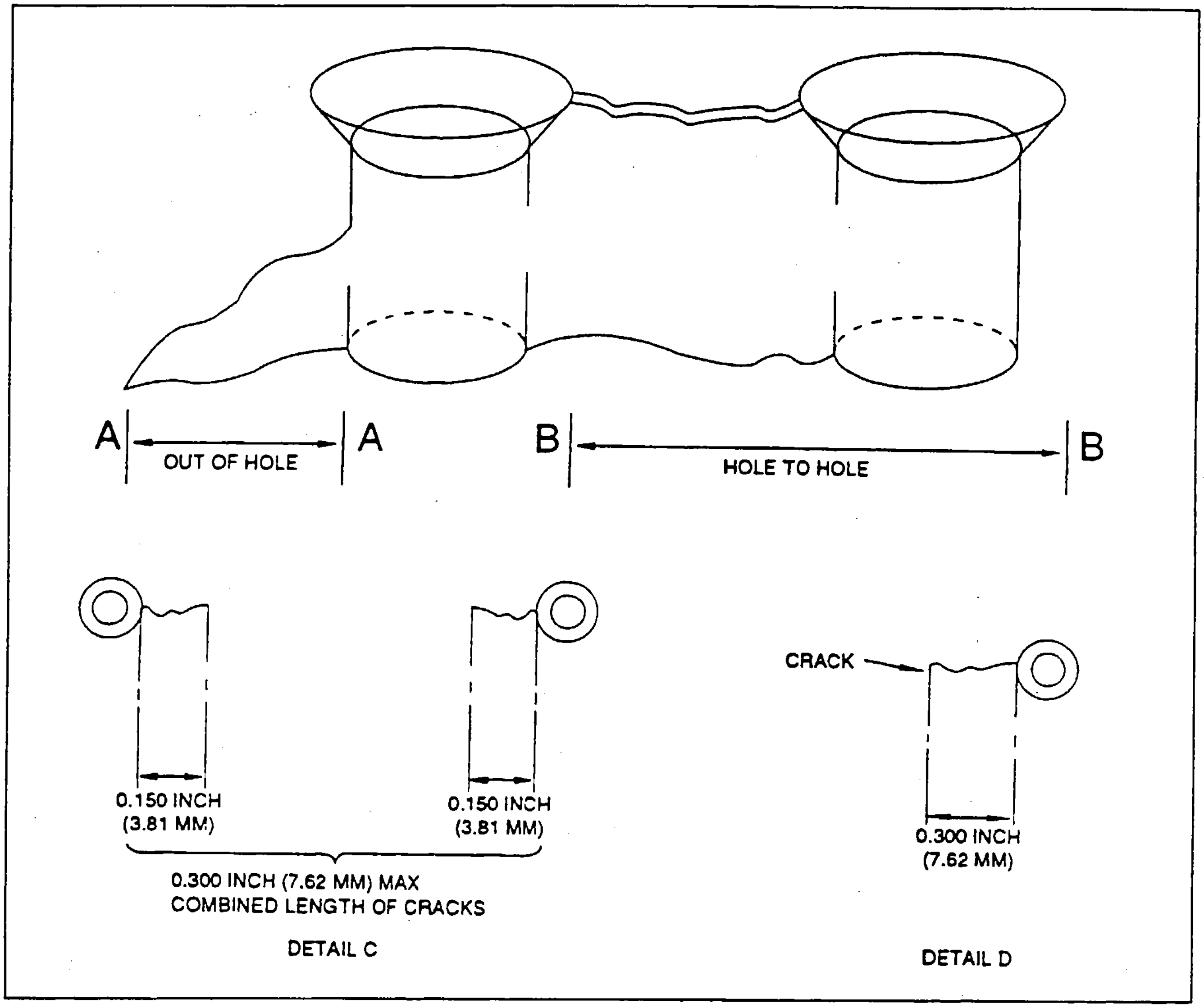

Figure 14-APP-3. Crack Limitations.

(4) Crack Limitation.

(a) The maximum acceptable length of a crack from any single screw hole is 0.300 inch (7.62mm).

(b) The maximum combined length of multiple cracks into the space between two adjacent bolt holes is 0.300 inch (7.62mm) (see Figure 14-APP-3).

(c) If a crack less than 0.300 inch (7.62mm) is left unrepaired, reinspect the window each additional 25 hours of aircraft operation.

(d) A maximum of three bolt holes with cracks less that 0.299 inch (7.59mm) long are acceptable in any one window pane before that window pane must be replaced.

(e) Replace window pane if a single crack or combination of adjacent facing cracks exceed 0.300 inch (7.62mm) in length.

(5) Chips, Scratches, and Crazing Limitations.

(a) Scratches in acrylic windows may be reworked if:

1) They are less than 0.030 inch (0.762 mm) deep.
2) 0.310 inch (7.874 mm) panes are a minimum of 0.279 inch (7.087 mm) thick after rework.
3) 0.375 inch (9.575 mm) panes are a minimum of 0.338 inch (8.618 mm) thick after rework.
4) 0.380 inch (9.652 mm) panes are a minimum of 0.342 inch (8.687 mm) thick after rework.
5) No vision distortions in critical and semi-critical areas as a result of rework.

(b) Replace acrylic windows with scratches that cannot be reworked in accordance with these standards.

2. **Window Repair / Rework Procedure (Side Acrylic Windows Only).** The following methods should be used for repairs:

a. AREAS WITH SMALL SCRATCHES:

(1) Clean the window, using generous amounts of water and a mild detergent.

(2) Polish the window with an approved compound and soft cloth.

(3) Clean and wax the polished area.

b. AREAS WITH LARGE SCRATCHES, GOUGES AND NICKS: Areas with damages exceeding .003 of an inch depth or those with less than .003 of an inch in depth, having sharp edges which cause hanging of fingernail should be locally rounded out or buffed.

(1) Clean the window using generous amounts of water and a mild detergent.

(2) Use a scratch removal kit, such as the type supplied by Micro-Surface Finishing Products Inc., P.O. Box 456, Wilton, Iowa, to remove the defective area, blend and buff.

(3) Using 400A wet or dry abrasive paper wrapped around a smooth rubber block and generous amounts of water, lightly sand over and around the defected area in a circular motion, extending in a diameter equal to two or three times the defected area.

(4) Continue sanding until the initial defect is no longer apparent. Thoroughly flush the area with water.

(5) Using 600A wet or dry abrasive paper, repeat step (3). Continue sanding only until the hairline scratches caused by the coarse sanding are no longer apparent. Sand a larger area than that covered by the original sanding operation. Thoroughly wash the area.

(6) Finish the repair using instructions given in Method a.

CAUTION

Any acrylic window which may have been damaged by paint thinner, paint remover or other softening agent must be replaced. NO repair is permitted for this type of damage.

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