Aviation Competence Centre
First Class Education

Boeing 707

Hydraulics

Training manual

For training purposes only
LEVEL 3

ATA 29

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LIST OF ILLUSTRATIONS

1. GENERAL.

The hydraulic power system supplies fluid under pressure of 3000 psi to the hydraulically operated systems. Two separate and independent hydraulic systems are used.The two systems are designated as the utility and auxiliary hydraulic systems.

- The utility hydraulic system supplies hydraulic power to the outboard spoilers, nose wheel steering, main wheel brakes, flaps, landing gear and main gear leveling cylinder and snubber units.
- The auxiliary hydraulic system supplies hydraulic power to the inboard spoilers rudder power control system, and the main wheel brakes when the brake interconnect valve is opened.
  "The hydraulic power to the it Main Cargo Door is supplied by a dc motor-driven pump"

Skydrol 500, a fire resistant hydraulic fluid, is utilized within the utility and auxiliary hydraulic systems. The utility hydraulic system may supply as much as 44 gpm, at 3000 psi, to the utility-operated systems.

Hydraulic Fluid.
Main standard fluid in both systems : SKYDROL LD4

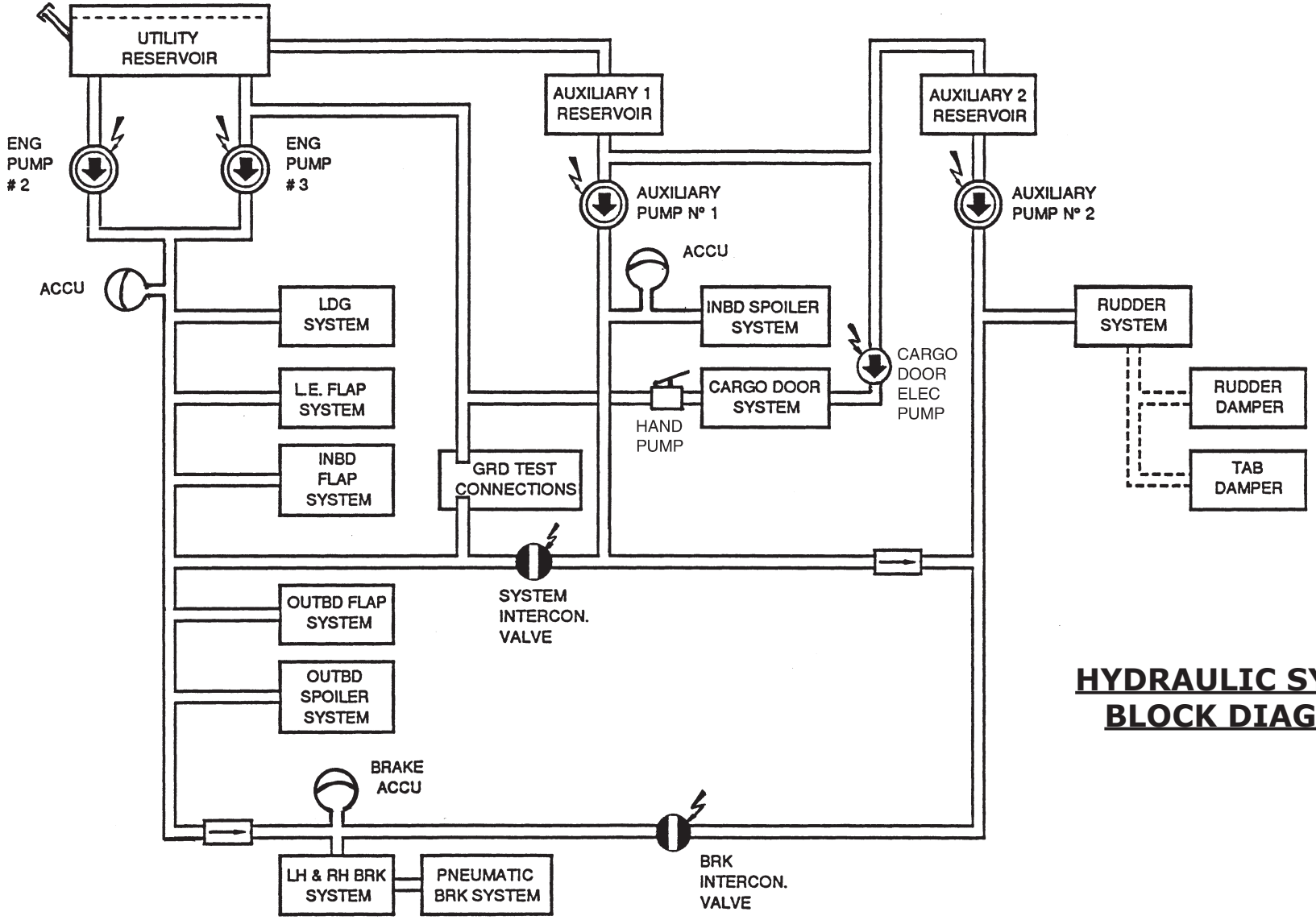
If the main fluid is not available, following alternate fluids may be used :

- SKYDROL 500 B-4
- CHEVRON HYJET IV

CAUTION: USE ONLY THE APPROVED HYDRAULIC FLUIDS.
OTHER HYDRAULIC FLUIDS ARE INCOMPATIBLE AND CAUSE DAMAGE TO HYDRAULIC SYSTEM COMPONENTS.

WARNING: THESE HYDRAULIC FLUIDS ARE HIGHLY CAUSTIC CAUSING IRRITATION AND CHEMICAL BURNS. CONTACT WITH SKIN AND EYES MUST BE AVOIDED

NOTE: The three fluids may be mixed in any proportion and used without any restriction.



HYDRAULIC SYSTEM BLOCK DIAGRAM

2. CONTROL AND INDICATION.

1. FIRE Switches ENG 2 & 3.
When pulled the corresponding hydraulic fluid shutoff valve closes. Furthermore the corresponding ENG PUMPS (2 and/or 3) LOW PRESS caution light becomes inoperative.

2. RUDDER BOOST Low Pressure Warning Light (Red).
When on, indicates pressure in supply line to rudder power control unit is below approximately 2500 psi when it should be 3000 psi.

3. BRAKE PRESSURE Indicator.
Indicates pressure output in thousands of psi (with subdivisions in hundreds). Normal pressure is 3000 psi. When the system is depressurized it gives accumulators precharge. Normal precharge is 750 psi at 21 °C.

4. HYD QTY RESERVOIR Indicator.
Indicates hydraulic fluid quantity in utility reservoir in gallons. Gage indicates full (F) whenever the reservoir contains approximately 6 gallons.

5. AC AUX PUMPS 1 RUDDER & SPOILERS Low Press Caution Light.
This amber light when illuminated indicates that the pump outlet pressure is below 1200 (±250) psi and extinguishes above 1200 psi.

6. AC AUX PUMPS 2 RUDDER Low Press Caution Light.
This amber light when illuminated indicates that the pump outlet pressure is below 1200 (±250) psi and extinguishes above 1200 psi.

7. ENG PUMPS 2 and 3 Low Press Caution Lights.
These amber lights when illuminated indicates that the pump pressure is below 1200 (± 250 psi) and extinguishes above 1200 psi. When the corresponding fire switch is pulled the lights are overridden OUT.

8. HYD FLUID SHUTOFF Switches ENG 2 and ENG 3
These guarded switches are normally in the OPEN position. The respective engine pump switch must be OFF to arm the hydraulic fluid shutoff switch. Valves are overridden CLOSE when the corresponding fire switch is pulled.

CAUTION : OPERATION OF HYDRAULIC PUMPS FOR MORE THAN 5 MINUTES WITH FLUID SHUTOFF VALVE CLOSED AND ENGINE ROTATING (WINDMILLING OR NORMAL OPERATION) CAN DAMAGE PUMPS

9. ENG PUMPS 2 and 3 Switches.
In ON position provide normal operation of the pumps. In OFF position the pumps are depressurized and there is no flow to the system. If no electrical power is available, pumps are automatically pressurized.

10. INTERCONNECT VALVE Switch.
This switch operates the system interconnect valves. When set to position BRAKE it connects the auxiliary system to brakes (both pumps).
When set to SYSTEM it opens the interconnect valve if the aircraft is powered by EXT. PWR or APU with ext. power contactor closed. Only aux pump No. 1 can supply the utility system. In the OFF pos. both interconnect valves close.

11. AC AUX PUMPS 1 and 2 (RUDDER & SPOILERS: 1; RUDDER: 2) Sws.
Position ON provides normal operation of the pumps.

12. UTILITY PRESSURE Indicator.
Indicates pressure output in thousands of psi (with subdivisions in hundreds). Normal pressure is 3000 psi. When the system is depressurized it gives accumulators precharge. Normal precharge is 2000 Psi at 21 °C.

13. RUDDER PRESSURE Indicator.
Indicates pressure output in thousands of psi (with subdivisions in hundreds). Normal pressure is 3000 psi or 2250 psi depending upon airspeed and flap position. With auxiliary system depressurized it reads 0 psi.

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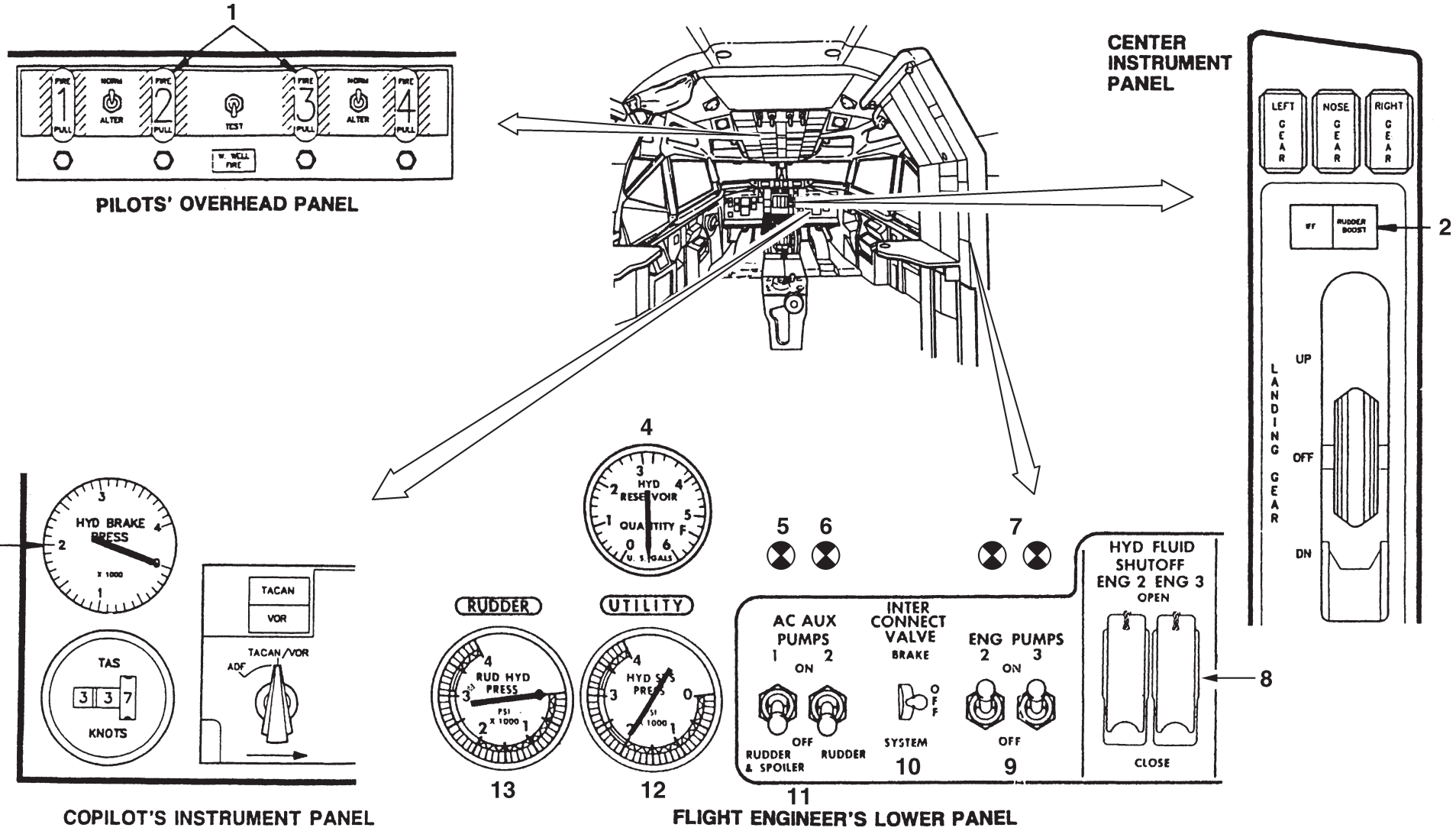


CONTROL AND INDICATION

3. UTILITY HYDRAULIC SYSTEM.

The utility hydraulic system provides hydraulic power for operation of landing gear, flaps, outboard spoilers, brakes, NLG steering and cargo door (hand pump only) at a pressure of 3000 ± 250 psi. Two engine-driven pumps, operated by No. 2 and No. 3 engines, supply pressure for the utility system.

The utility reservoir is located in the left wheel well. The capacity of the reservoir and expansion tank is 6.9 US gallons. A quantity gage on the flight engineer's panel indicates from zero to F gallons. When the reservoir contains approximately 6 gallons, the quantity gage is pegged at the full (F) mark. The reservoir is interconnected with the auxiliary reservoir, so that the auxiliary reservoir is filled from the utility reservoir. The interconnection is placed at the 3.2 gallon level, so that loss of fluid in the auxiliary system leaves a minimum of 3.2 gallons in the utility reservoir. The reservoir is pressurized to approximately 40-45 psi with engine bleed air from the inboard engines. System pressure relief valves open at 3500 psi (increasing) and close at 3100 psi (decreasing). Fluid returning to the reservoirs passes through a filter except fluid from the brakes which returns by a separate line by-passing the return filter.

The utility system has an accumulator located in the right wheel well which acts as a surge damper. The accumulator has a pressure gage mounted on the gas side to indicate either charging pressure (pumps OFF) or system pressure (pumps ON). The utility system also pressurizes a brake accumulator, located in the right wheel well. The brake accumulator is normally charged by the utility pumps, but it can be charged by the auxiliary pumps if the brake interconnect valve is open. The brake accumulator pressure gage is mounted on the gas side to indicate accumulator charging pressure (pumps OFF) or system pressure (pumps ON). A pressure transmitter which operates the cockpit brake pressure gage is also mounted on the gas side of the accumulator.

Utility Pumps.
A solenoid operated depressurizing valve allows to reduce the pump delivery to zero. In that case, an automatic blocking valve installed at the outlet of the pump isolates the pump from the hydraulic system.

Supply Shutoff Valves.
When the supply shutoff valves are closed, the lubricating oil circulation is also stopped. Therefore the maximum duration of closing for trouble shooting purposes is 5 minutes (non cumulative time). If this time has been exceeded, the pump and filter must be checked by maintenance prior to next flight.

Filters.
Both systems are provided with several pressure/ return filters.
However, the utility return filter is a two stage filter. Each stage incorporates a differential pressure sensor which will extend an indicator plunger when the filter is contaminated.

Hydraulic Fluid Cooling Circuits.
Cooling bleeds are installed at both engine driven pumps outlets and in the leading edge flap hydraulic lines to allow continuous circulation for utility system cooling.

3.1. Air Pressure System.

Reservoir Pressure Regulator.
The air pressure regulator maintains a constant pressure of 40 to 45 psi in the hydraulic reservoir and operates as a vacuum relief valve. The regulator consists of the pressure valve, poppet valve, spring and diaphragm.

The ambient (vent), reservoir and pressure ports of the regulator are attached to flexible hoses. Adjustment of the regulator is accomplished by adjusting the screw in the ambient port. The regulator is located in the left wing outboard of the main wheel well. Ambient pressure and spring pressure acting on the diaphragm control the regulator. Air from engines 2 and 3 flows to the regulator. When the reservoir is below regulated pressure, air will flow through the poppet valve to the reservoir until the regulated pressure is obtained. As pressure in the reservoir overcomes spring and ambient pressure the poppet closes, preventing air from entering.

As air pressure in the reservoir rises over regulated pressure, air pressure inside the reservoir overcomes spring and ambient pressure opening the pressure valve allowing air to escape until regulated pressure is obtained.

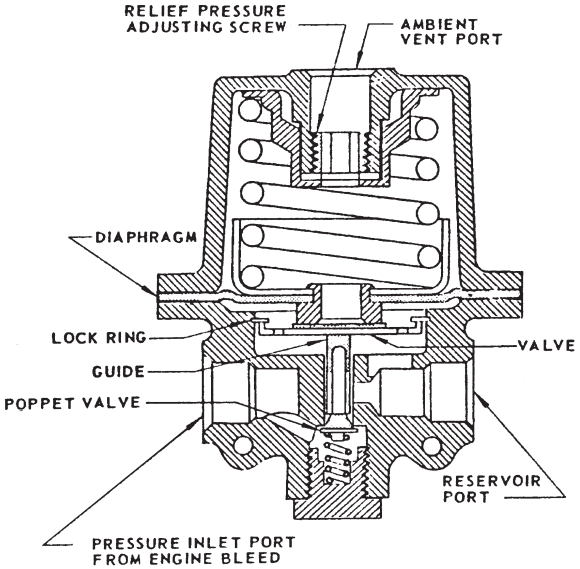
As pressure in the reservoirs drops 0.50 psi under ambient pressure P the ambient valve opens allowing engine and ambient air to enter the reservoir preventing vacuum in the reservoir.

On later airplanes, a reservoir manual depressurization valve is installed downstream of the pressure regulator to permit depressurization of the hydraulic reservoir prior to removal of filler cap. The valve is located above and just aft of the utility reservoir and is operated by depressing a spring-loaded plunger on its body. On earlier airplanes the reservoir may be depressurized by slowly unscrewing the filler cap 3 full turns and allowing the compressed air to escape.

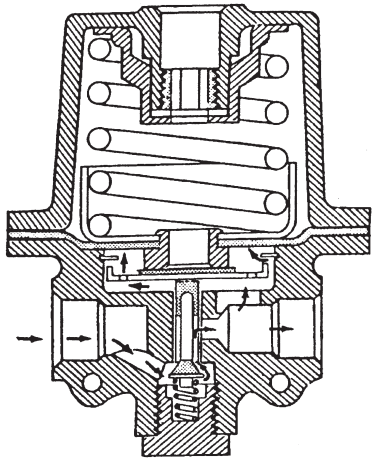
Charging Valve.
A reservoir charging valve and a swing check valve are used to .pressurize the hydraulic reservoirs to functionally test the pressurization system and the rudder snubbers and dampers

The check valve and charging valve are on a separate line which tees into the air pressure line just upstream of the filter and air pressure regulator.

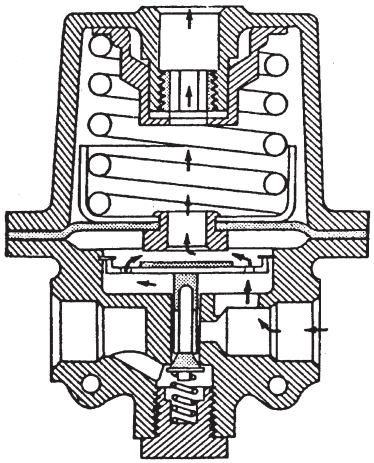
HYDRAULIC RESERVOIR PRESSURE REGULATOR



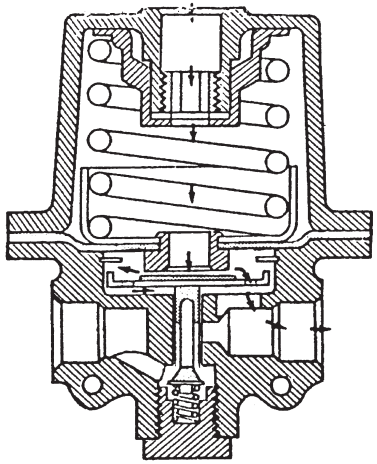
CHARGED



CHARGING



DISCHARGING

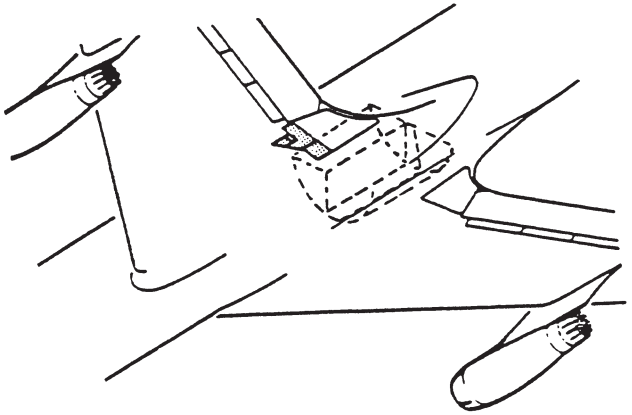


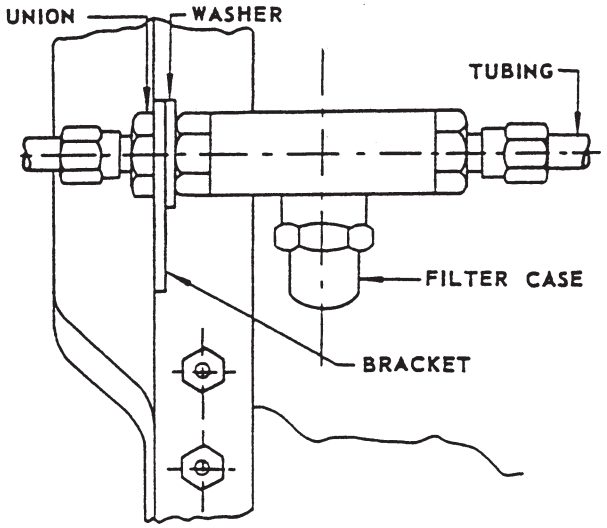
VACUUM RELIEF

3.2. Reservoir Air Filters.

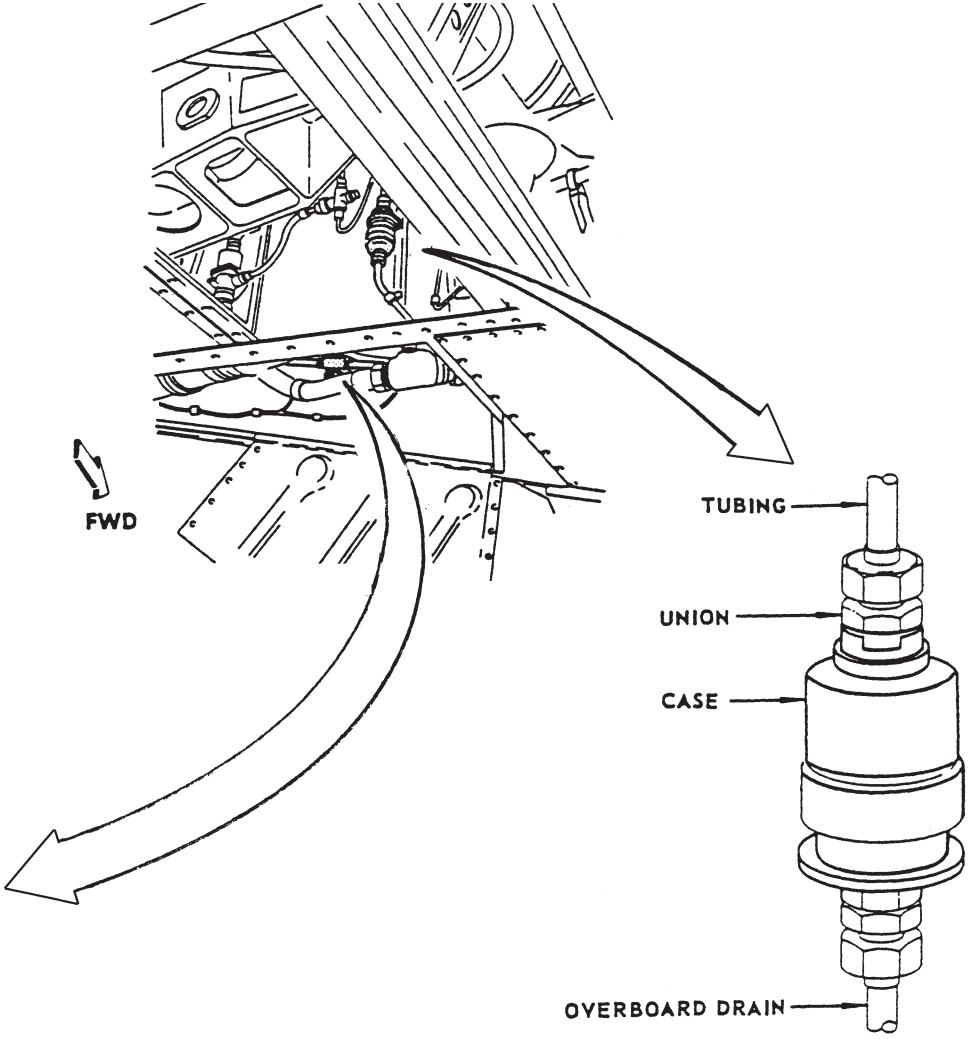
The ambient filter removes foreign material from the air entering the regulator. The ambient filter has a replaceable micronic element.
The filter is located in the left wing outboard of the main wheel well.

A non-clogging metal element air pressure filter is used to filter engine bleed air entering the air pressure regulator. The filter is located in the left wing outboard of the main wheel well.





RESERVOIR PRESSURE AIR FILTER



AMBIENT AIR FILTER

AIR FILTERS

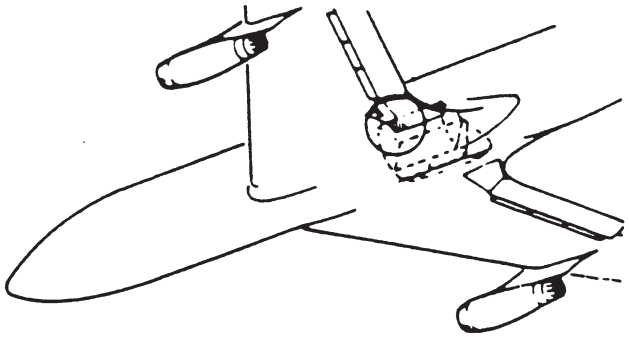
3.3. The Hydraulic Reservoirs.

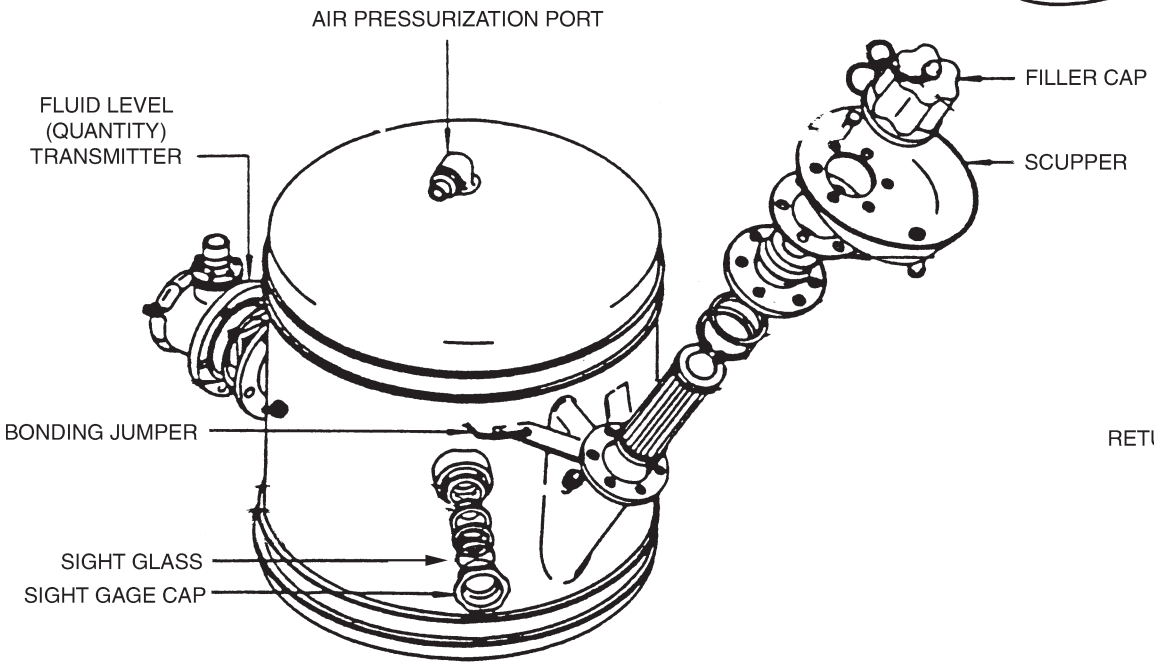
The utility hydraulic reservoir supplies hydraulic fluid to the utility hydraulic system. The reservoir is an airtight pressurized vessel consisting of a sight gage, baffle plates, antivortexing cover and a filler cap that attaches to the filler neck, which contains a filler screen. Baffle plates inside the reservoir reduce aeration of the fluid. Above the utility supply port is an antivortexing cover to reduce vortexing as fluid is supplied to the system. The reservoir is pressurized by engine bleed air. Supply, return, drain, pressurization and auxiliary reservoir supply ports are fitted with attaching lines. The utility and auxiliary reservoirs with pressurized fluid. The auxiliary reservoirs have access to all but the last 3 gallons of fluid in the utility reservoir. Attached to the reservoir is a fluid quantity transmitter which ‘is connected electrically to an indicator on the flight engineer’s lower panel. Attached to the filler neck of the reservoir is a scupper with a drain line prevent spillage of fluid into the wing area during servicing. The filler screen in the filler neck of the reservoir prevents foreign material from entering the reservoir during servicing. The reservoir is located outboard of the left main wheel well in the wing fillet.

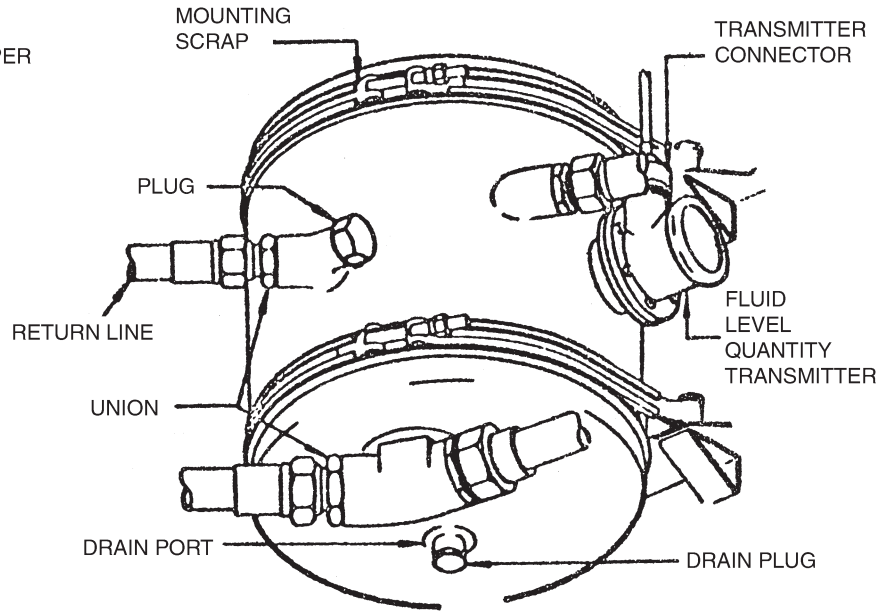
The utility reservoir has a capacity of 5.4 gallons. On airplanes equipped with an expansion tank, the reservoir capacity is increased to 6.9 gallons. The expansion tank is located in the upper left hand corner of the left wheel well. See figure for expansion tank effectivity.

There are two methods by which the utility hydraulic reservoir can be filled, through the reservoir filler neck, or through the pressure fill fitting on the utility return filter support bracket. Two 1.4 gallon capacity auxiliary hydraulic reservoirs supply fluid to the auxiliary hydraulic pumps. The No. 1 reservoir installed in the left wing fillet supplies fluid to the No. 1 auxiliary pump. The No. 2 auxiliary reservoir installed in the right wheel well supplies fluid to the No. 2 auxiliary pump. The air tight pressurized cylindrical shaped reservoirs have pump supply, system return, drain and auxiliary supply ports. The reservoirs are serviced and pressurized through a line from the utility reservoir. Each reservoir has a float operated switch mounted at top of reservoir, for the low level warning system.

Cold Soak.
Contraction of hydraulic fluid and accumulator gas due to cold soak causes a gradual reduction in hydraulic fluid quantity. The amount of volume loss varies, depending upon the initial temperature of the fluid and the accumulator air and the ultimate temperature they reach after cooling by the ambient air. Cold soak usually occurs during long periods of cruise at low outside air temperatures due to the little transfer of fluid to generate heat. Nearly all of the volume loss is regained after the aircraft descends to warmer levels and the hydraulics are used. During initial pressure build-up the indicated quantity may decrease by 0.5 gallons due to nitrogen compression in the accumulators.







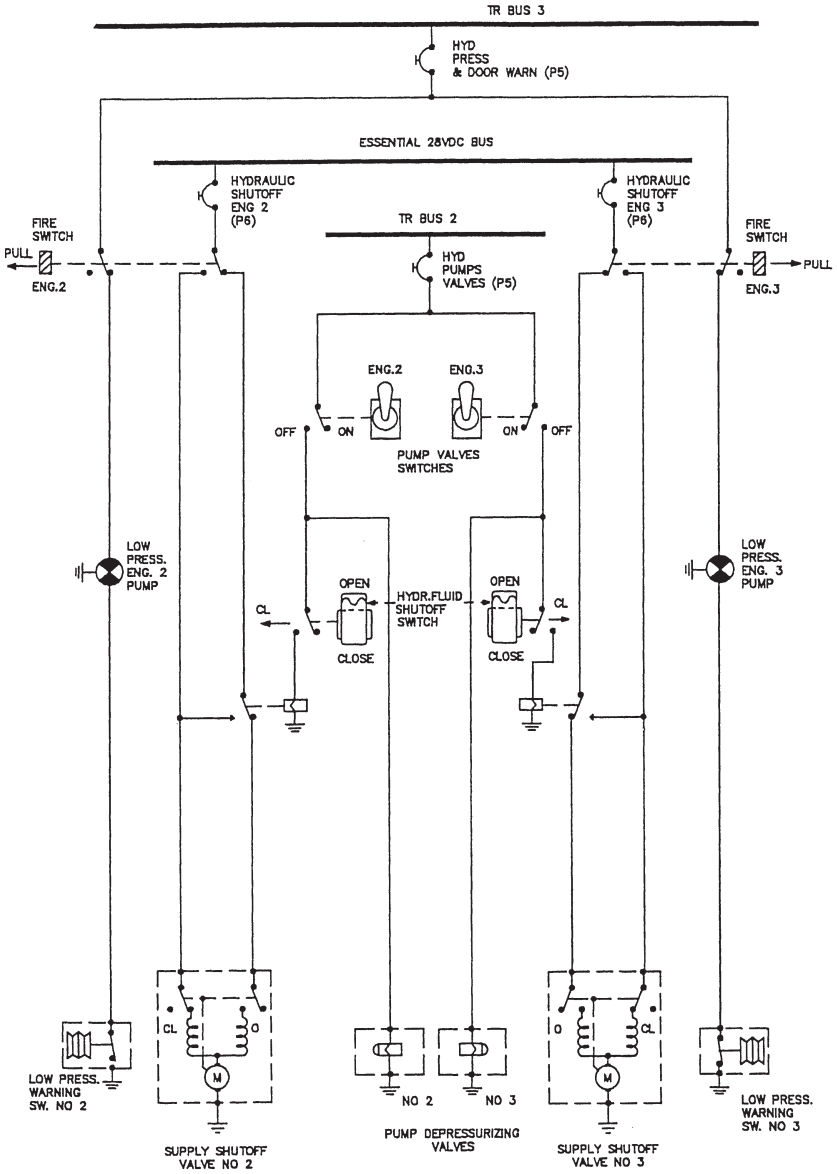
UTILITY RESERVOIR

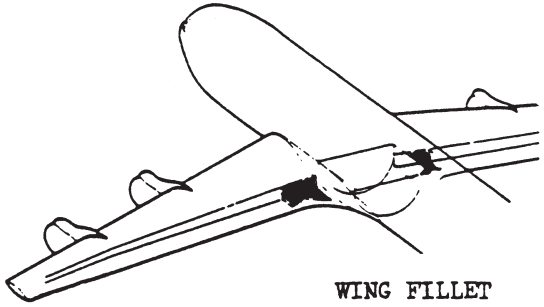
3.4. Hydraulic Supply Shut Off Valves.

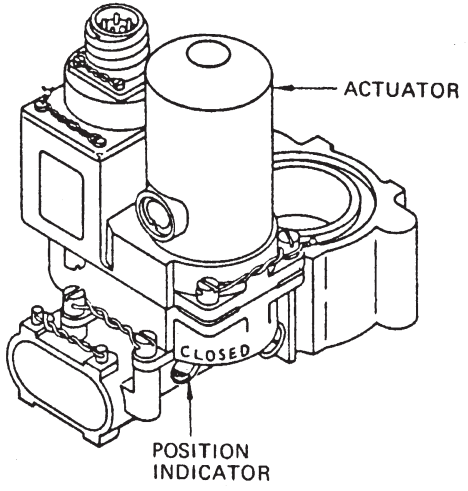
The hydraulic supply (fire) shutoff valve is provided to stop the flow of hydraulic fluid to the engine area in the event of engine fire. The supply shutoff valve is a sliding gate type valve which is motor driven by 28-volt dc power from the essential bus circuit breaker panel. A valve is located in each engine driven pump supply line, mounted in the wing rear spar, outboard of the left and right wheel wells (See figure). The valves are controlled either by separate engine fire switches on the pilot's fight shield, or by separate hydraulic shutoff switches. On some operator's B707 airplanes the hydraulic shutoff switches are on the copilot's instrument panel. The hydraulic fluid shutoff switches contain switch guards lockwired with 22 gage brass lockwire. If the switch guard lockwire is broken, investigate to determine if pump was operated in excess of 5 minutes with the shutoff valve closed. If so, pump must be replaced and system checked for contamination.

NOTE: Except when an emergency dictates, it is not recommended to close a supply shutoff valve switch for a period of more than five minutes.

NOTE: Actuation of an engine fire switch will remove power from the utility system pump low pressure light on the hydraulic pump for that engine.







HYDRAULIC SUPPLY SHUTOFF VALVE

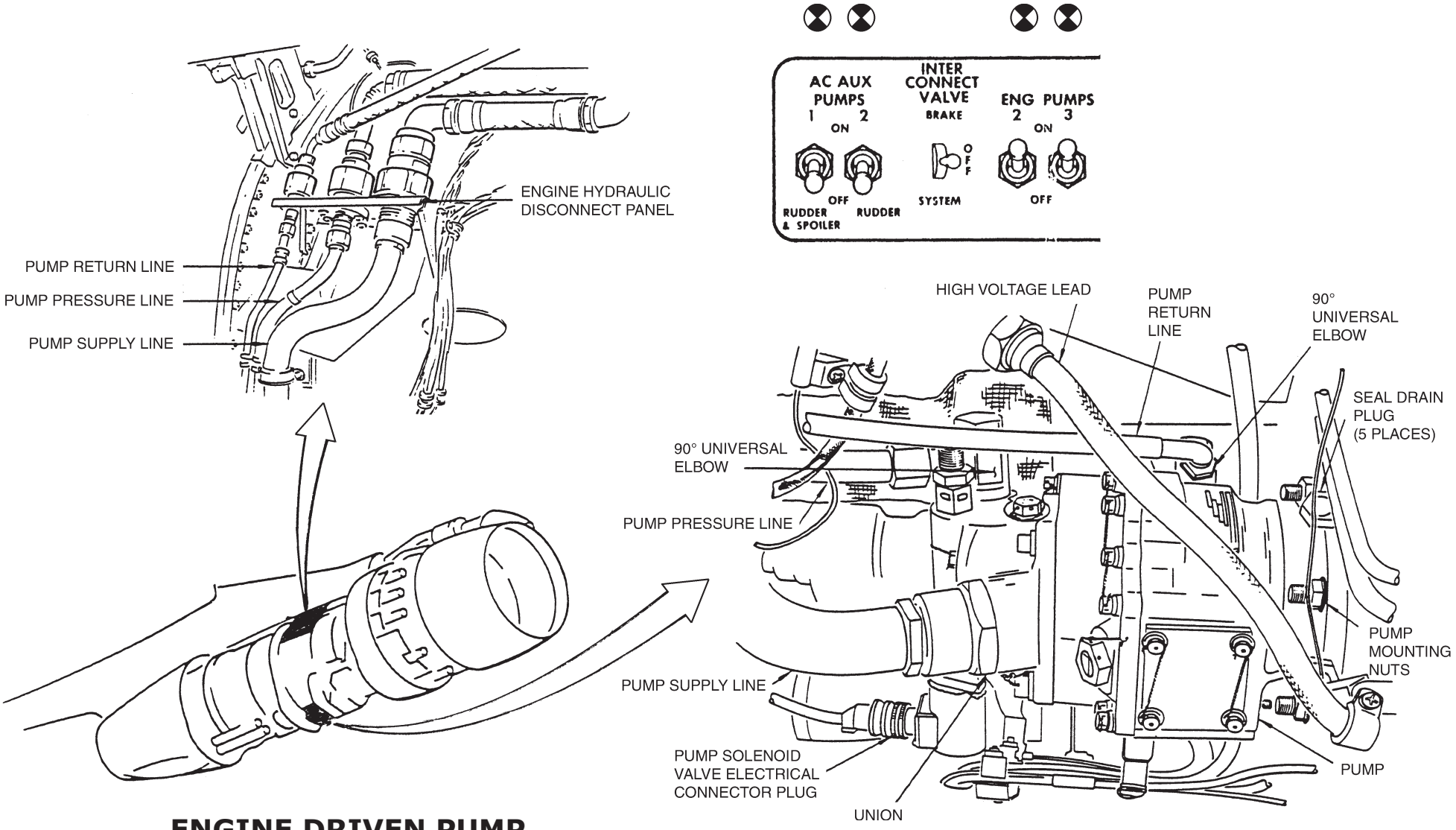
3.5. Engine Driven Hydraulic Pump (EDP).

A variable displacement, pressure compensated, engine driven hydraulic pump is installed on each of the inboard engines. The pump, which is a multiple piston type of pump, incorporates a solenoid bypass feature utilize to reduce pump output when desired by the crew.

The pump incorporates a pressure regulator which will maintain the pressure output from the pump to between 2800psi and 3100psi.

The B707 uses two types of hydraulic pumps, an ABEX pump and a VICKERS pump, these pumps are accessible by opening the R/H cowl, and removing the hinged fan duct on the right hand side of the engine. The hyd. pump is attached by a "QAD" ring.

NOTE: To prevent hydraulic fluid from overheating the pump should not be unnecessarily depressurized, and depressurized operating time should not exceed 10 minutes.
Since the valve solenoid is energized with the pump switch off the utility system pump switches should be left ON after engine shutdown to prevent overheating of the pump valve solenoid.



ENGINE DRIVEN PUMP

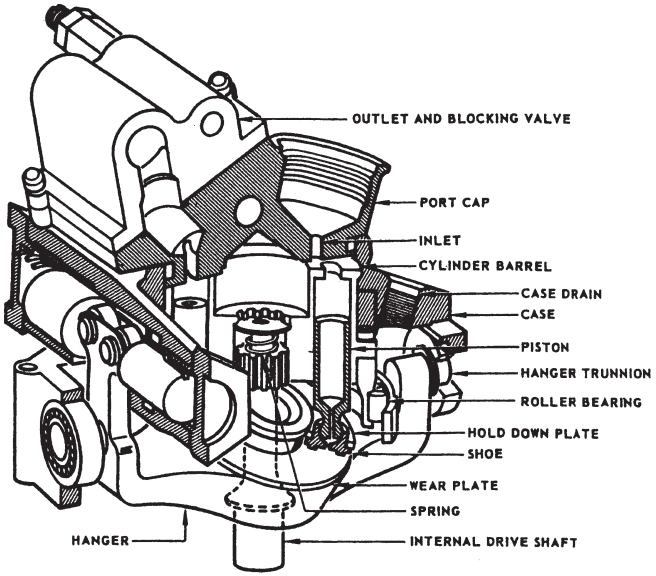
EDP Detailed.
During pump operation hydraulic fluid enters the pump through the inlet port, to the yoke passages which route the fluid to the valve plate of the cylinder block and into the cylinders of the block. The cylinder block contains nine (9) pistons which are connected to a driveshaft driven by the accessory drive of the engine, rotating the driveshaft pressurizes the fluid in the cylinder, which forces the fluid out of the yoke into the outlet port and the pressure lines of the aircraft. The pressure in the outlet port is tapped off to the pressure control regulator which meters the pressurized fluid into the yoke control actuator thereby positioning the yoke and controlling the pump output.

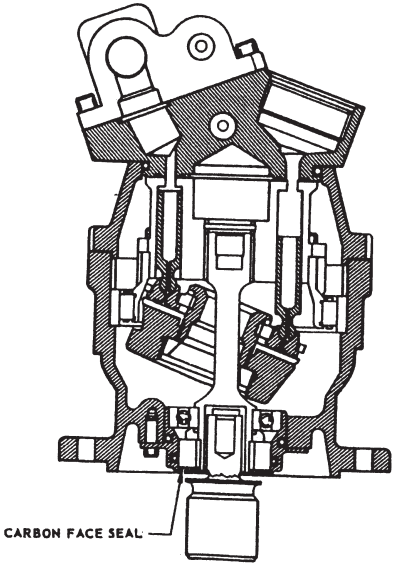
The regulator is set to give a maximum pump output pressure of 3000psi (nominal). Maximum flow output of the pump (max. yoke angle) at 3500 RPM and pressure BELOW 2850psi is 22.5 USgal. pr. min.
When the output pressure exceeds 2850psi the pump pressure control regulator begins to reduce the yoke angle towards the zero position. As the pump output pressure rises displacement of the pump is decreased till at 3000 psi the flow output of the pump is reduced to zero.

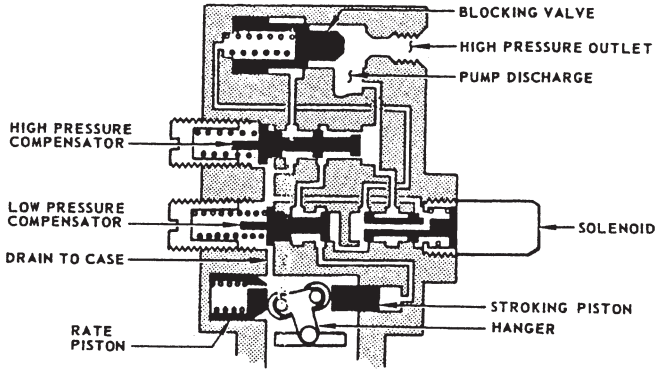
If pumps are run dry for more than five (5) minutes, the pumps MUST be changed and associated filters too!

Static leakage from the pump drive pad should not exceed 100 drops pr. min.

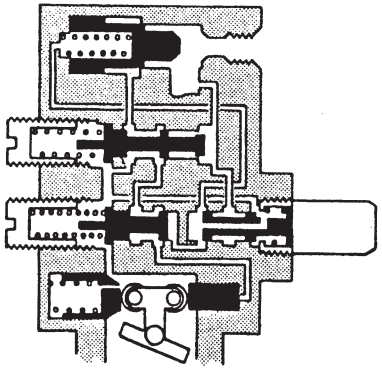
Pump drive spline is lubricated with Silkolene anti-seize compound.



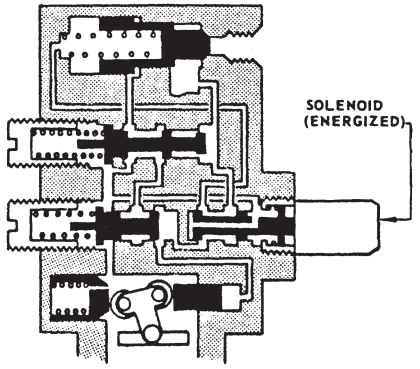




A. FULL PRESSURE, NO FLOW CONDITION



B. FULL PRESSURE. FULL FLOW CONDITION



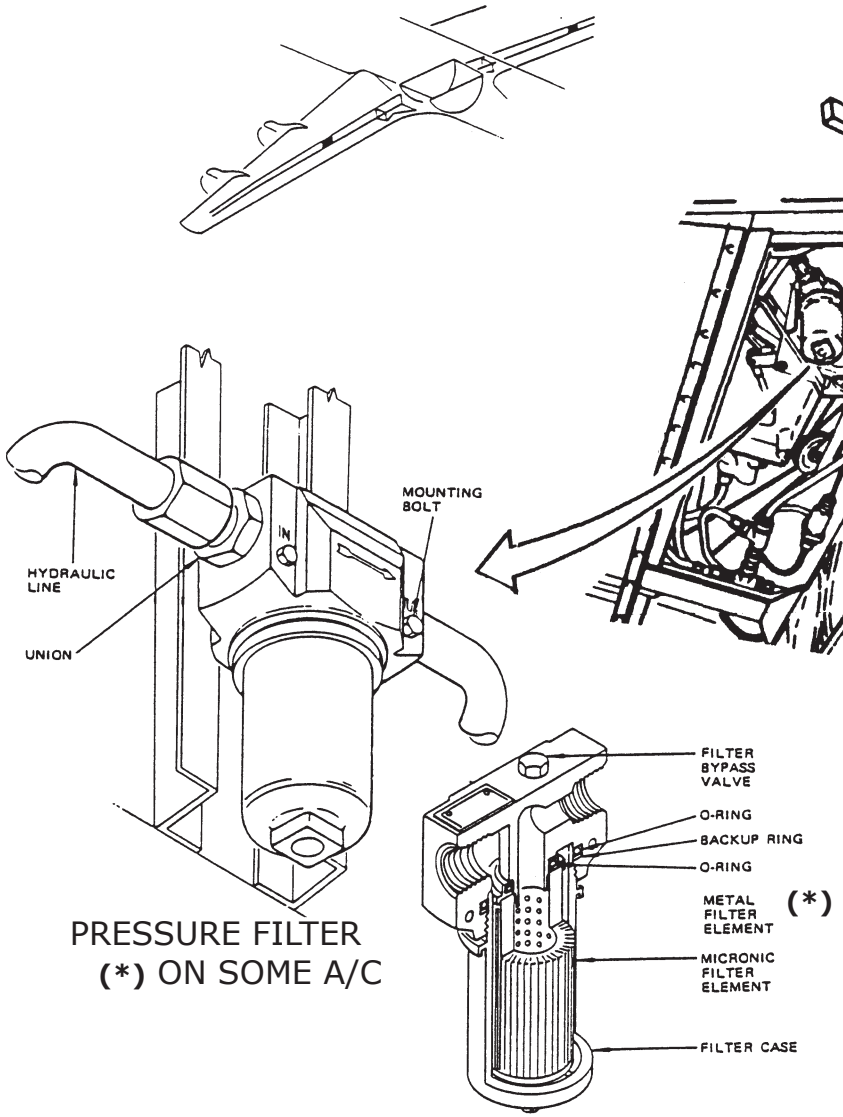
C. DEPRESSURIZED AND BLOCKED CONDITION

ENGINE DRIVEN PUMP

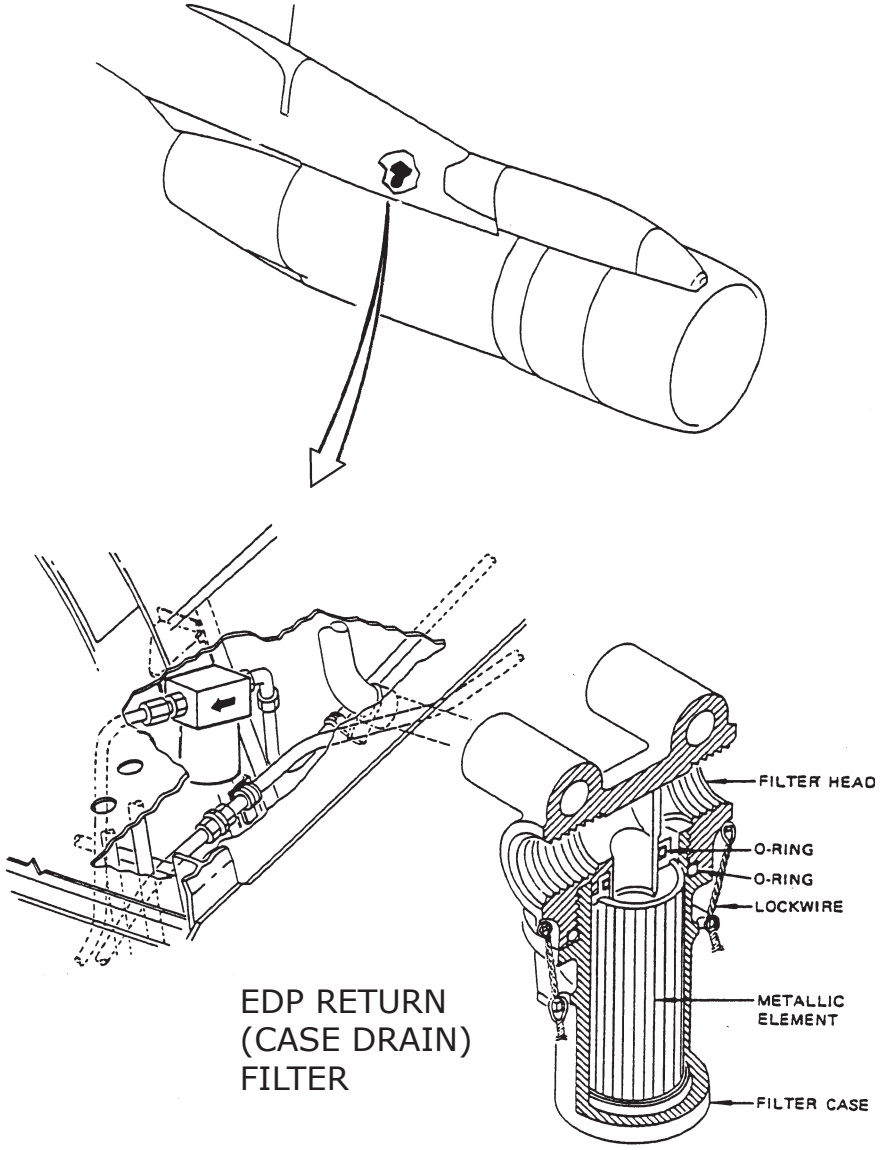
3.6. Filters.

Pressure Filters.
Pressure filters prevent foreign particles from entering hydraulically operated systems with fluid discharged by the pumps. The filtershave a metallic, nonclogging cleanable element and no bypass valve. Utility pressure filters are mounted on spoiler control housing on the rear spar of each wing outboard of the inboard engine struts. Auxiliary pressure filters are in the wing fillet areas outboard of the wheel wells.

Pump Return Filter.
The utility pump return filters remove foreign particles from the hydraulic fluid in the pump return lines before fluid returns to the reservoir. The return filters have a metallic, nonclogging cleanable element. The filters are installed in each inboard engine strut just aft of the strut closure rib.



PRESSURE FILTER
(*) ON SOME A/C



EDP RETURN
(CASE DRAIN)
FILTER

FILTERS

System Return Filter.
The utility system return filter removes foreign particles from the hydraulic fluid before entering the hydraulic reservoirs. It is located on the forward bulkhead of the LH MG wheel well. The filter is a two-stage assembly wherein all fluid passes through the primary stage element in which all contamination of 3.0 micron size or larger is removed from the fluid. When the flow exceeds 5 GPM and the return system pressure reached
60 ± 9 psi, a relief valve opens and permits the excess fluid to flow through the second stage filter.

A differential pressure indicator with a red-tipped "pop-up" button is installed in each stage of the filter assembly to visually indicate a clogged element.

The following listed actions shall be taken whenever a differential pressure indicator button is found to be popped on the APM ULITPOR two-stage return system filter assembly. This filter assembly is located on the forward bulkhead of the left hand main gear wheel well.

Action Required.

Condition A.
Primary stage indicator button (inboard location on filter head) is popped :

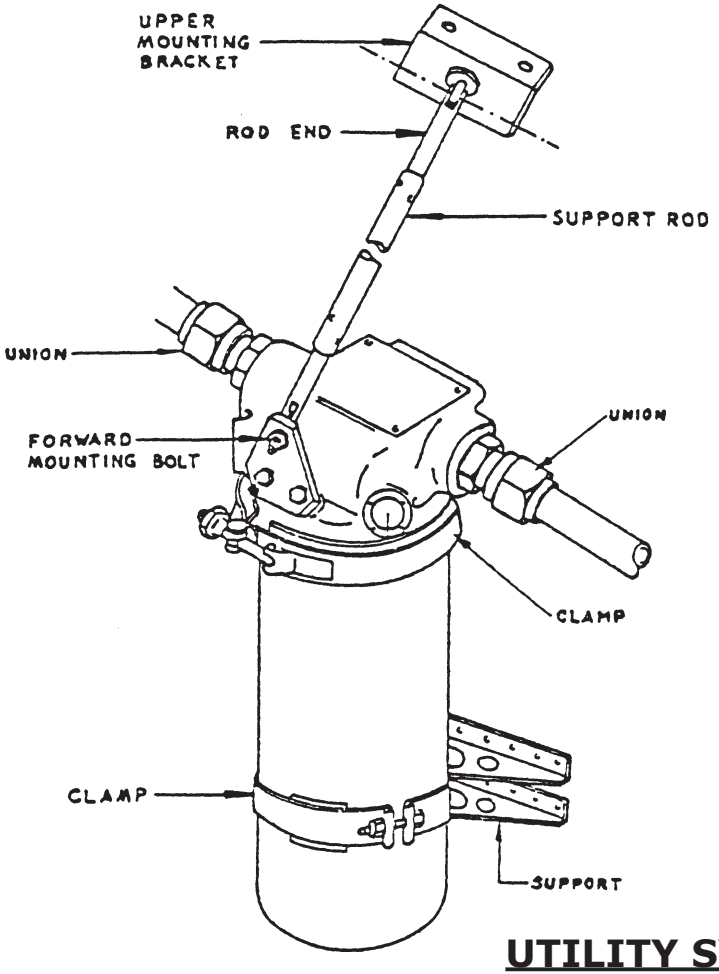
- Action required : replace the primary stage filter element.

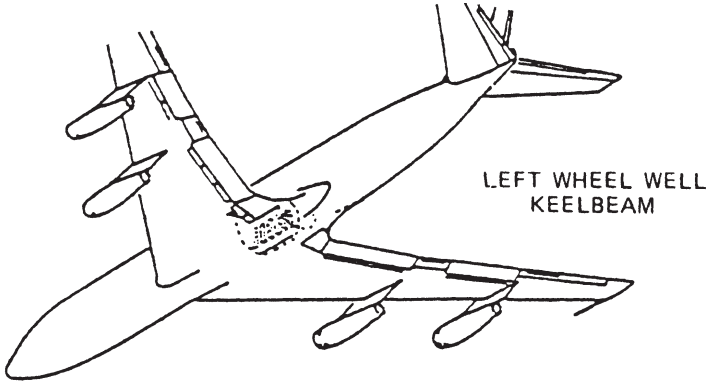
Condition B.
Second stage indicator button (outboard location on filter head) is popped :

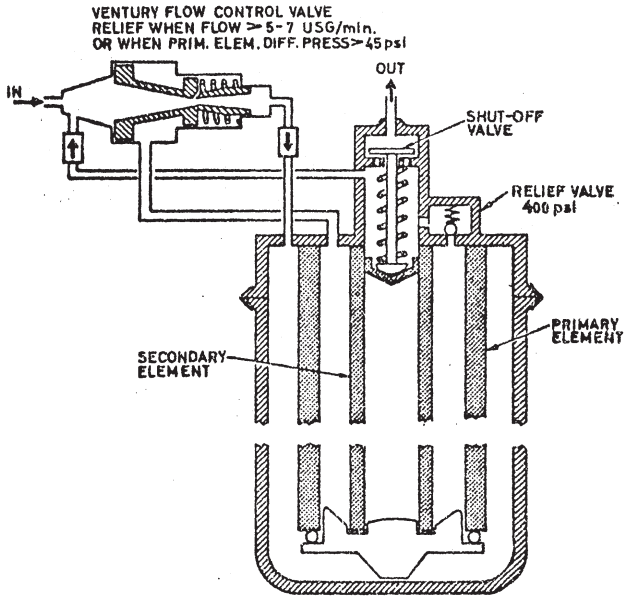
- Action required : replace both the primary and second stage filter elements.

Condition C
Both stage indicator buttons are popped.

- Action required : replace both the primary and second stage filter elements.



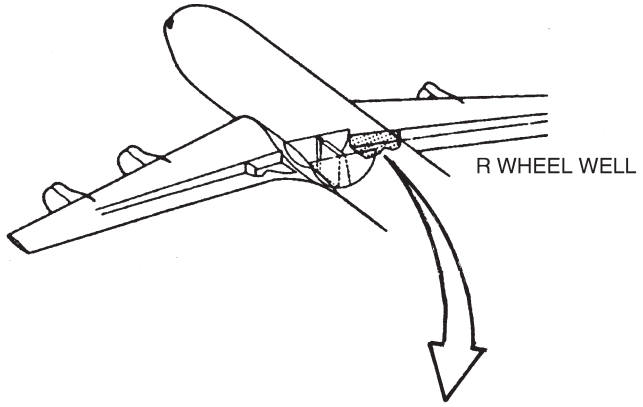


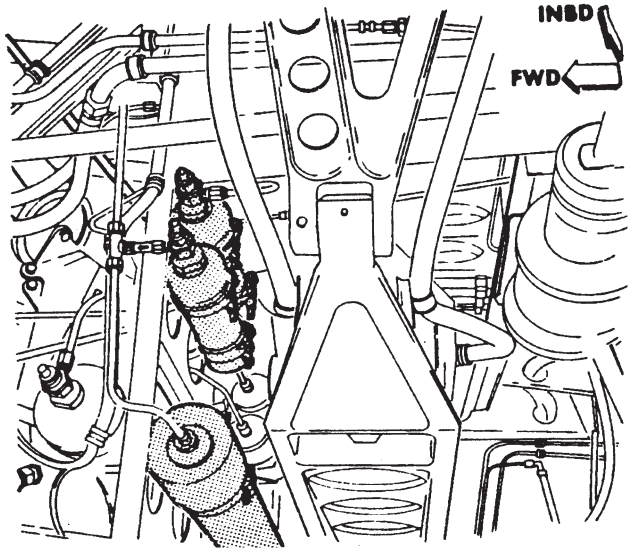


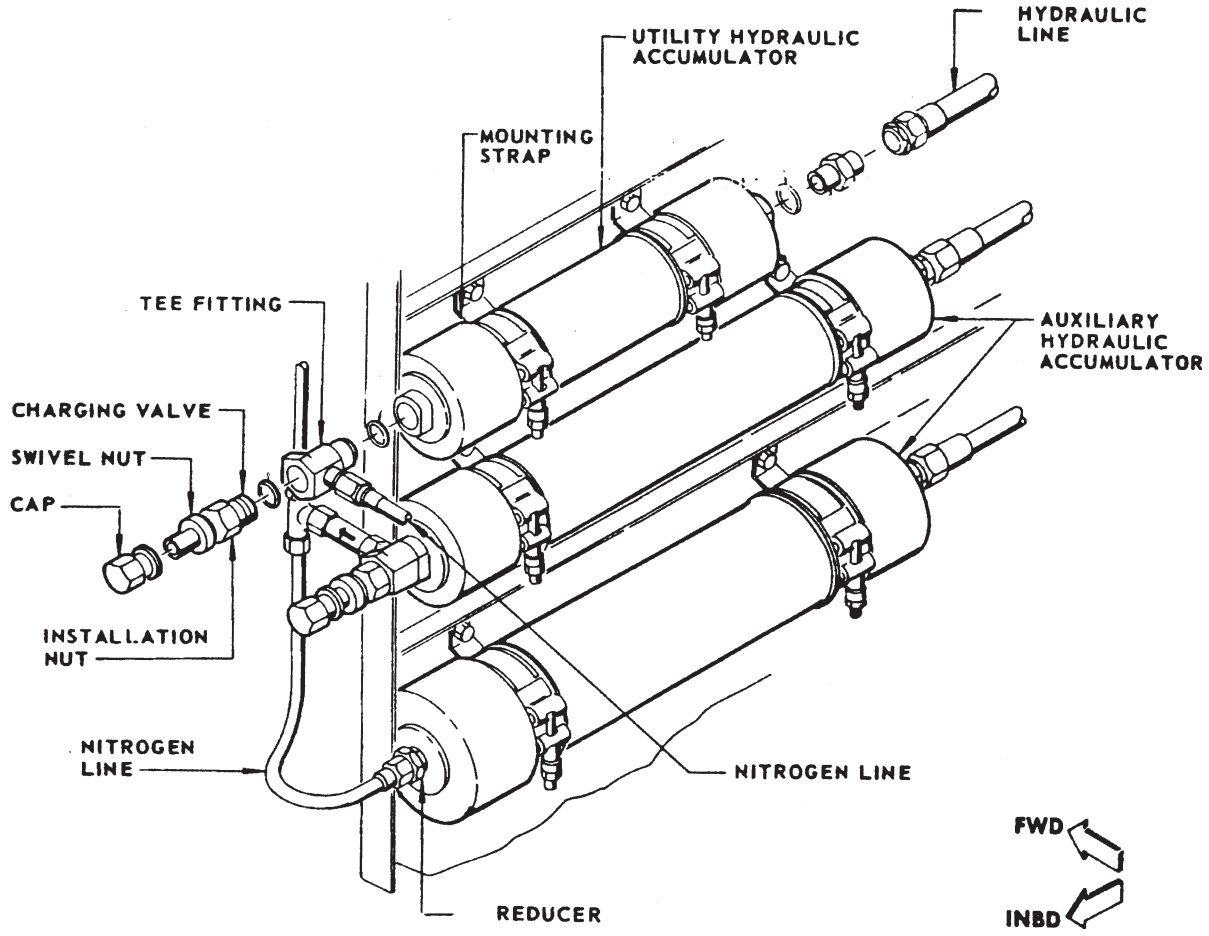
UTILITY SYSTEM - RETURN FILTER

3.7. Accu's.

The hydraulic accumulators are used to absorb and dampen sudden pressure surges in the hydraulic system. The accumulators are cylindrical, free floating piston type units which are precharged with nitrogen. Nitrogen lines and hydraulic pressure lines are connected to the accumulators. The precharge of the accumulators varies with temperature. The utility and auxiliary accumulators are located outboard of the right main wheel well.





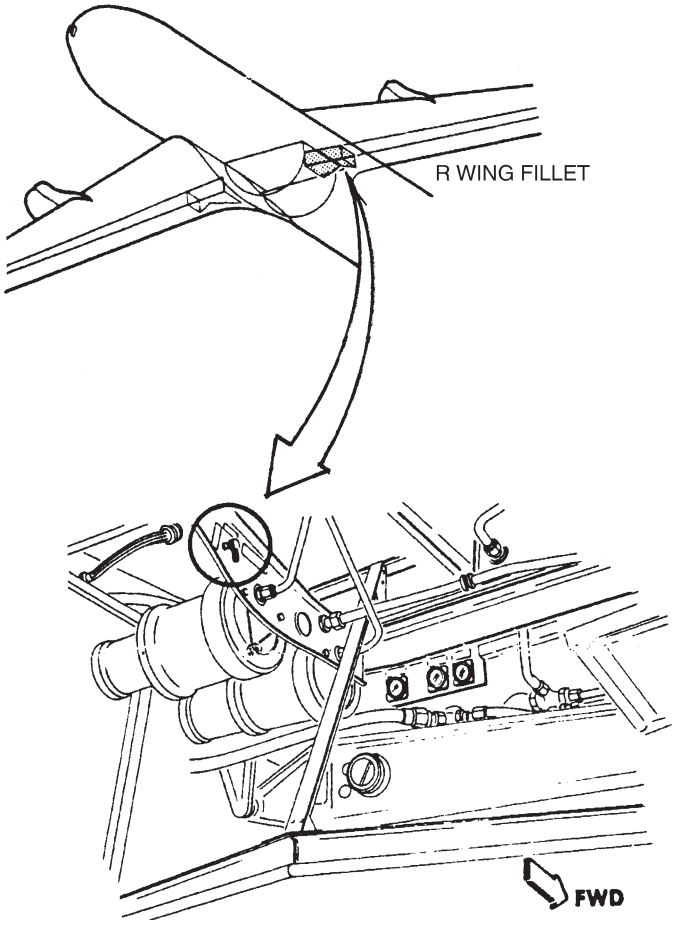


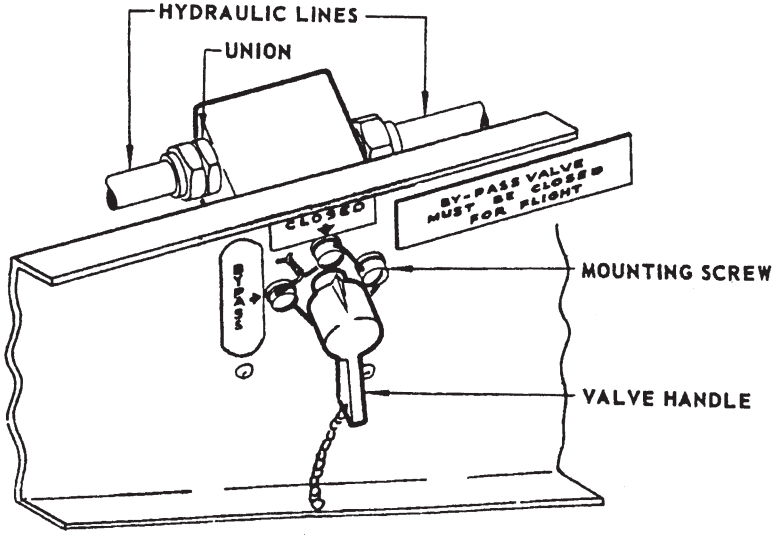
UTILITY SYSTEM - ACCU'S

3.8. Bypass Valve.

A manually-operated bypass valve can be used to depressurize or bleed the utility hydraulic system for maintenance purposes when the airplane is on the ground. It is operated by a handle in the right wheel well.
The handle has BYPASS-CLOSED positions. Positioning the handle to BYPASS will depressurize the utility hydraulic system by internally connecting the pressure line to the return line. Positioning the handle to CLOSED will allow the system to be pressurized. The valve must be safety wired CLOSED prior to flight. The valve is located in the R.WING FILLET, outboard of the main wheel well.

Hydraulic Fluid Cooling Circuits.
Fixed bleeds in the leading edge flap hydraulic lines and the engine pump cooling loops under full utility system pressure allow continuous circulation of approximately 2 GPM of fluid for utility system cooling. When the utility system is pressurized on the ground by the No. 1 auxiliary hydraulic pump only through the Systems interconnect valve, the utility pressure will be less than 3000 psi.





UTILITY SYSTEM - MANUAL BYPASS VALVE

4. AUXILIARY HYDRAULIC SYSTEM.

The auxiliary hydraulic system provides hydraulic pressure to the rudder controls, inboard spoilers, cargo door, and through interconnect valves to the utility hydraulic system and brakes.
With no load on the system, pump pressure should be 3000 ±200 psi.

There are two electric pumps with separate reservoirs in the system. A leak in auxiliary reservoir No. 1 depletes the utility reservoir to 3,2 gallons, but does not affect auxiliary reservoir No. 2. A leak in auxiliary reservoir No. 2 depletes the utility reservoir to 3,2 gallons and empties both auxiliary reservoirs.

Pump No. 1 supplies pressure to the entire auxiliary system. If the interconnect valve is set to SYSTEM, the No. 1 auxiliary pump can also pressurize the utility system when external power or APU is powering the "sync bus". Pump No. 2 normally supplies only the rudder. When the interconnect valve is set to BRAKE, either pump can supply pressure to the brakes. Pressure switches operate low pressure (LOW PRESS) caution lights. The system relief valve opens at 3500 psi and closes at 3100 psi. The auxiliary hydraulic system contains two accumulators which act as surge dampers and also provide a backup source of hydraulic fluid under pressure. The accumulators are located in the right wheel well. A pressure gage is mounted on the gas side of the accumulators to measure charging pressure (pumps OFF) or system pressure (pumps ON).

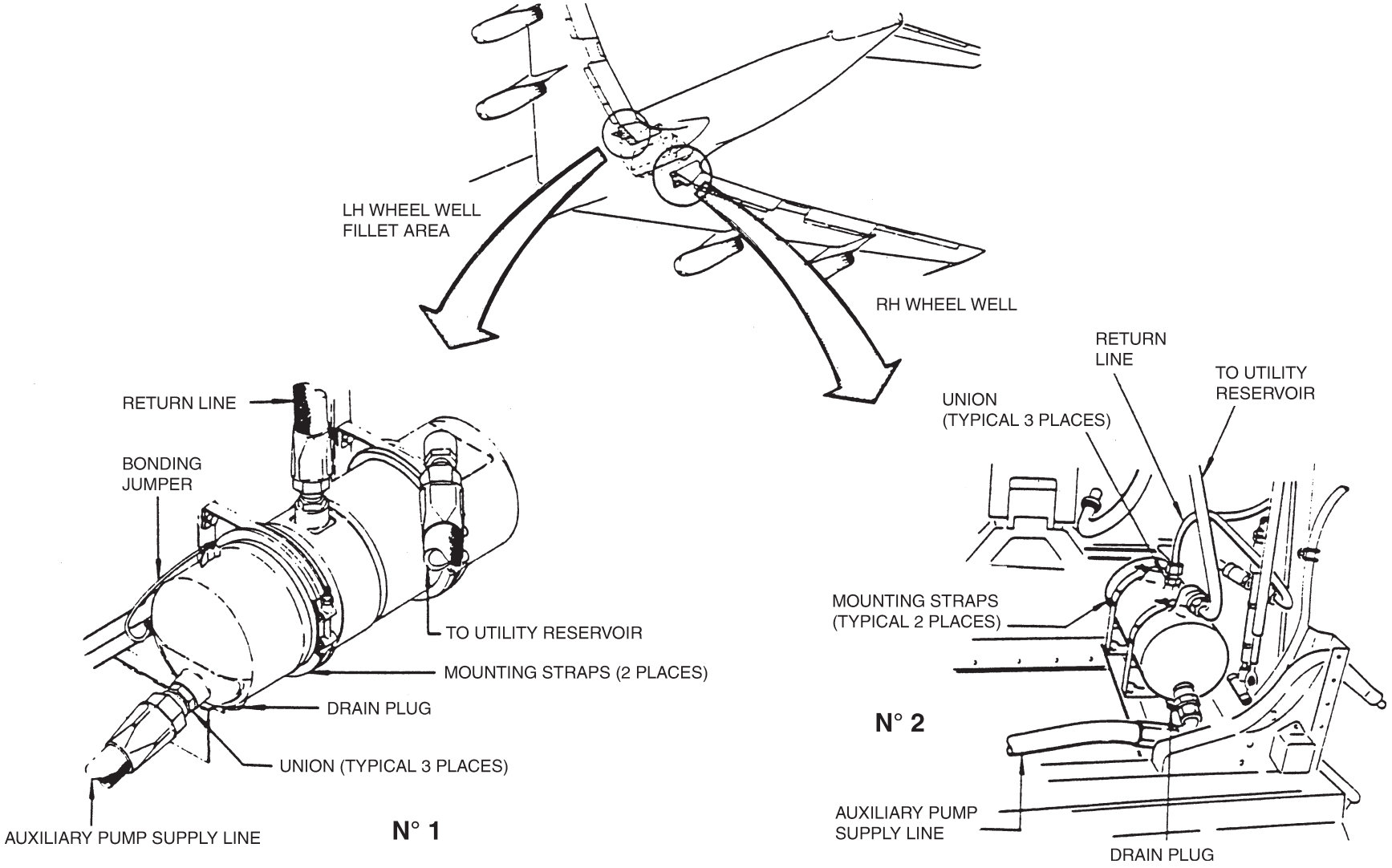
Rudder Pressure Indicator.
The pressure of the auxiliary system is given by the RUDDER pressure indicator (FE's lower panel), which will normally read 3000 or 2250 psi, depending upon the airspeed and the position of the flaps (see "FLIGHT CONTROLS"). With the auxiliary system depressurized, this indicator will read zero psi.

SEE HYDRAULIC SYSTEM PAGE 67-68

4.1. Utility Reservoirs.

Auxiliary Hydraulic Reservoirs.
The No. 1 auxiliary reservoir located in the left wheel well fillet area is filled from the utility reservoir by a connecting line at the utility reservoir.
Supply of fluid and loss of fluid from the utility system will not affect the level in the auxiliary reservoir.
The No. 1 auxiliary reservoir supplies both the No. 1 auxiliary pump, the DC hydraulic pump, and the No. 2 auxiliary reservoir, which incorporates an air bleed fitting for system servicing.

The No. 2 auxiliary reservoir located in the RH wheel well area feeds the No. 2 auxiliary pump to pressurize the rudder boost. Return fluid from the rudder system discharges into this No. 2 auxiliary reservoir. Return fluid from the inboard spoilers discharges into the No. 1 reservoir. High pressure air is bled from the two inboard engines through a 40 to 45 psi pressure regulator into the utility reservoir. This pressure is transmitted through the hydraulic supply tubes into the two auxiliary reservoirs. The pressure insures a positive supply of hydraulic fluid into the pumps.



AUXILIARY RESERVOIRS

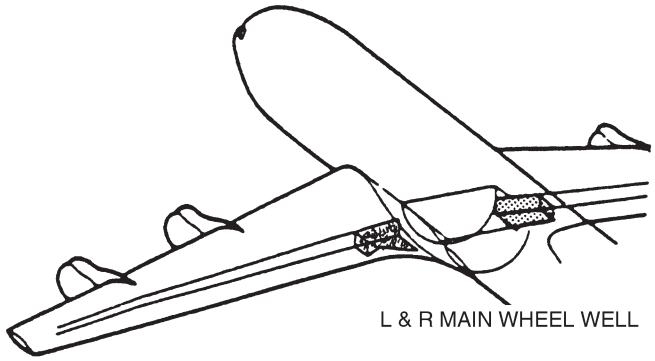
4.2. The Auxiliary pumps.

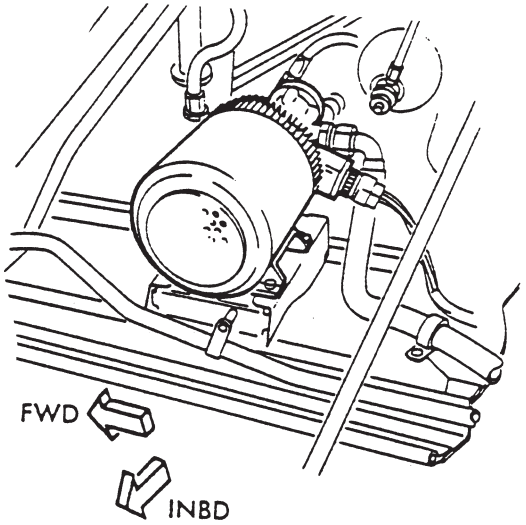
The auxiliary hydraulic pumps are operated throughout flight to supply hydraulic fluid to operate the inboard spoilers and the rudder power unit. Each assembly consists of a three phase AC motor and a variable delivery, positive pressure hydraulic pump.
The hydraulic pump consists of the units shown in Figure. Pump pressure is regulated at 3000 psi and each pump can deliver 3 GPM at maximum output. Pump pressure, return and supply ports are connected to flexible hoses. Pump assemblies are located outboard of left and right main wheel wells. Three phase 115 volt ac operates the pump motors. 28 volt dc relays control motor power. Pressure compensation inside the pump varies the ratio between the volume of fluid that is delivered to the system and the volume that is recirculated within the pump. Some fluid is discharged out the return port. With two phase motor operation (one phase open), one pump can deliver 1-1/2 gpm. at normal system pressure. Pump switches are located on copilot's instrument panel.

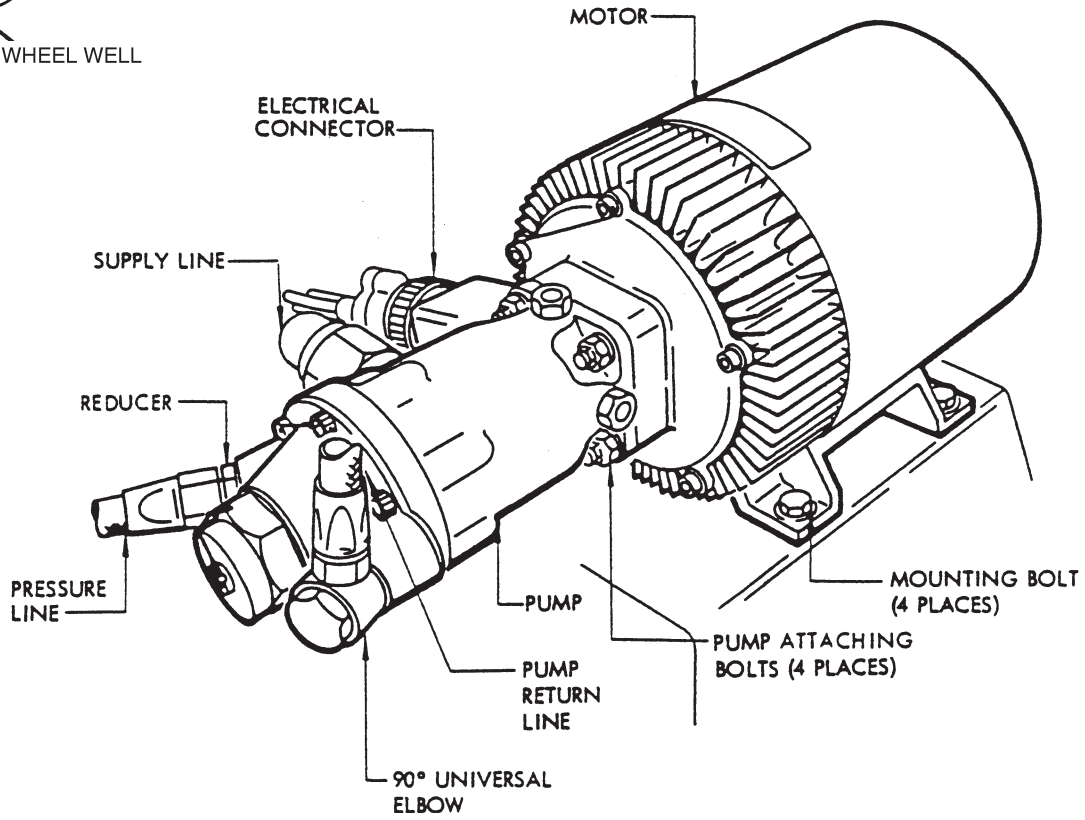
The electric motor is directly coupled to the pump shaft. The direct drive motorpump assembly is completely interchangeable, physically and operationally, in all respects with the reduction gerabox motorpump assembly previously installed in this application.

The motorpump driveshaft and the motor endbell bearing is lubricated continuously in service by hydraulic fluid from the pump housing area; a magnetic type shaft seal in the motor endbell retains the oil flow inside the motorpump driveshaft and motor endbell cavity. No periodic oil servicing is required by the direct drive motorpump assembly. A vent port is located at the 6:00 o'clock position on the rotor drive area to atmosphere and should be OPEN at all times. DO NOT PLUG this port.

CAUTION : THE DIRECT DRIVE MOTORPUMP ASSEMBLY STOCKED UNDER ONE PART NUMBER, MUST BE REPLACED AS AN ASSEMBLY WHEN REQUIRED. DO NOT SEPARATE THE PUMP FROM THE MOTOR.







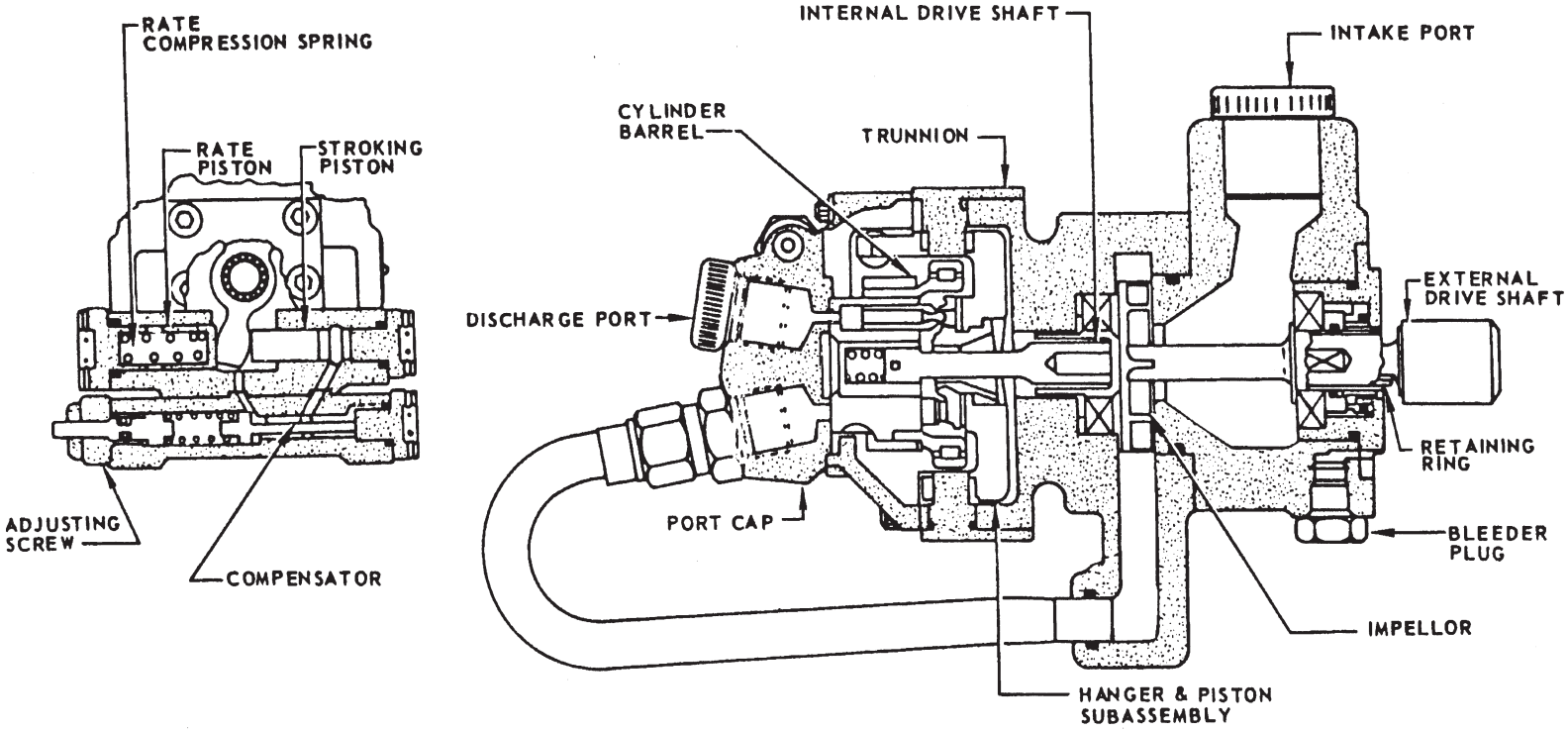
AUXILIARY PUMPS

Auxiliary Pump Operation.
The auxiliary pump consists of a housing and a cover, a pumping mechanism with the driving cam shaft, and the pump controls. The pumping mechanism consists of seven pistons with pressure aads and piston collars, a nutating plate, a stationary cylinder block with a piston guide disc, and seven line discharge valves (checks). The pistons are hollow and have two rings of radial orifices through which part of the hydraulic fluid can escape during the discharge stroke. The pressure pads swivel freely on the piston heads and slide on the camshaft inclined plane. The nutating plate is always parallel with the camshaft inclined plane and by means of piston collars withdraws the pistons from the cylinder block during the intake (suction) stroke. The cylinder block has a central hole for the compensator cylinder (bushing), and fluid passages for the compensator control. The base of the block has seats for the spring loaded discharge valves.

The pump control (compensator) consists of a compensator cylinder (bushing), a compensator stem with a plate carrying piston sleeves, and a compensator spring unit. A small difference in the stem diameter provides an annular area on which the pressure of discharged fluid produces a force.

This force is opposed by the control spring. When the discharge pressure exceeds 3000 psi, the hydraulic force on the stem overcomes the control spring and pushes the compensator stem with piston sleeves away from the driving shaft. The sleeves keep the discharge holes uncovered during nearly the whole discharge stroke, and no fluid is delivered to the pressure line. A small quantity of fluid discharged through the piston bypass holes to the return line, provides just enough fluid circulation for the cooling and lubrication of the pump during idling periods.

Variable delivery is obtained by discharging part of hydraulic fluid back into the intake area during each discharge stroke. The amount of fluid discharged back is controlled by piston sleeves, covering the discharge orifices of each piston during a partoff the discharge stroke. When there is no fluid demand, the discharge orifices remain free during nearly the whole discharge stroke, and all fluid is discharged back to the pump case. When fluid is required,
the orifices are covered during the whole stroke and all fluid is discharged into the pressure line. The period of orifice covering depends on the position of piston sleeves. A small quantity of the fluid is discharged into the return line at the end of each discharge stroke through the bypass orifices in the piston.

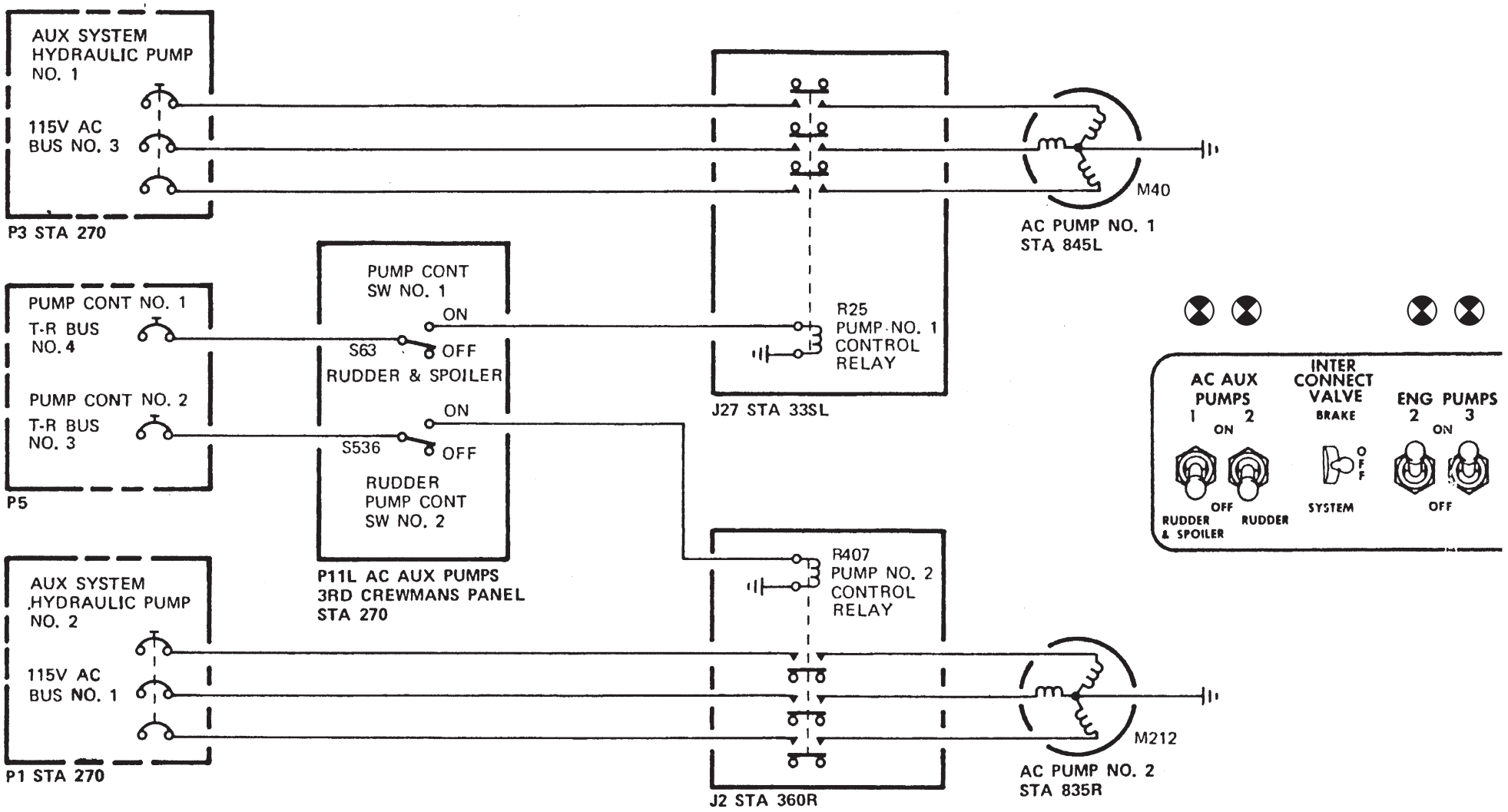


AUXILIARY HYDRAULIC PUMP

Auxiliary Pump Control.
Two lever lock type auxiliary hydraulic pump switches are located on the copilot's instrument panel. Positioning the switches to "ON" energizes the 28-volt dc relays to connect 115-volt ac power to the pump motors. The pumps start at full volume flow and pressure rises. At 1200 (± 250) psi pressure switches open and low pressure warning lights are extinguished. At 2000 psi skydrol enters the auxiliary accumulator. Near 3000 psi pump compensators reduce pressure port output by increasing the proportion of pump displacement that is recirculated within the pump and discharged through the return port. Fluid from pump No. 1 (left) supplies both inboard spoilers and the rudder power system. No. I supplies hydraulic power to the Main Cargo Door. Output from pump No. 2 (right) is directed by check valves to supply only the rudder power system and the auxiliary Accumulator.
Both pumps vary output volume to operate at a stable pressure near 3000 psi.

To shut down the auxiliary hydraulic pressure system the pump switches are positioned "OFF". Pump No. 1 pressure lines can be depressurized by operation of the 'Inboard spoilers or the rudder. Pump No. 2 pressure lines can be depressurized only by cycling the rudder power control system.

Return and supply line pressures are reduced to atmospheric by unscrewing the utility reservoir filler cap to vent pressurization air.

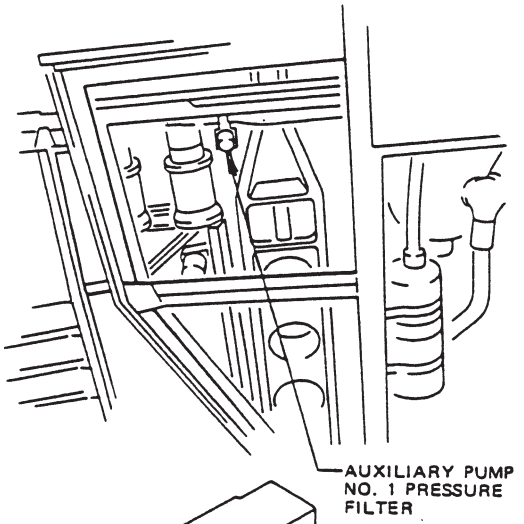


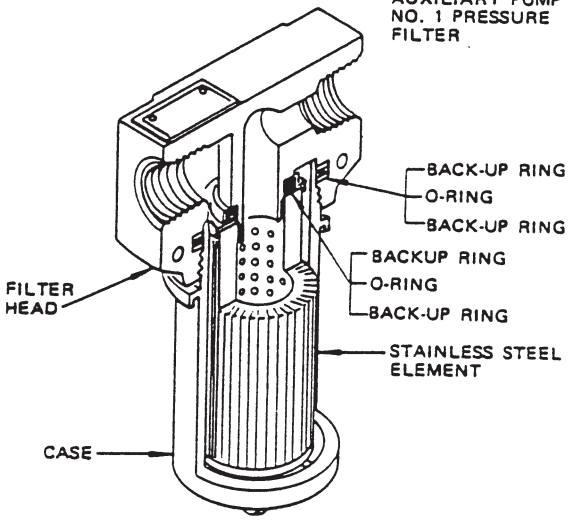
AUXILIARY PUMP CONTROL

4.3. Filters.

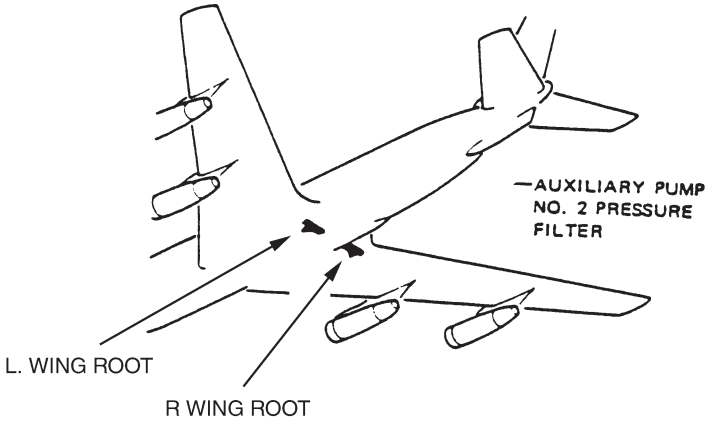
Auxiliary System Pressure Filters.
The auxiliary system pressure filters are of the inline type. The ports in the filter head are marked “IN” and “OUT” there is no bypass nor is there a differential pressure indicator provided on these units. The No. 1 aux. filter is located in the left wing root just above and fwd. of the “Walking beam”, accessible from the wheel well. The No.2 aux. filter is located on the rear spar of the wing in the right wing root, access is via a panel on the bottom of the wing T/E structure.

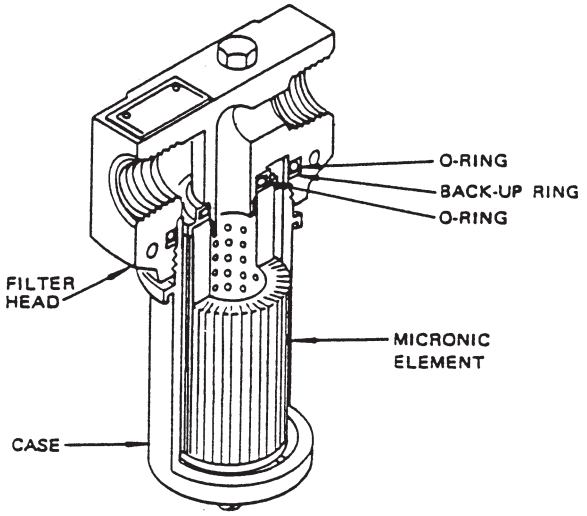
Auxiliary Return Filters.
Two auxiliary system return filters are installed in the aircraft, each in the return flow line to the associated reservoir. They assist the utility system filter in removing contamination from the system fluid before it returns to the reservoirs. Incorporated in the filters is a replaceable micronic element and a relief valve in the head of the filter. The relief valve opens at 20 to 30 psi differential pressure to bypass fluid in the event of a closed filter element and closes at not less than 20 psi differential pressure.





PRESS FILTER





RETURN FILTER

AUXILIARY SYSTEM - FILTERS

5. INTERCONNECT VALVES.

5.1. System Interconnect Valves.

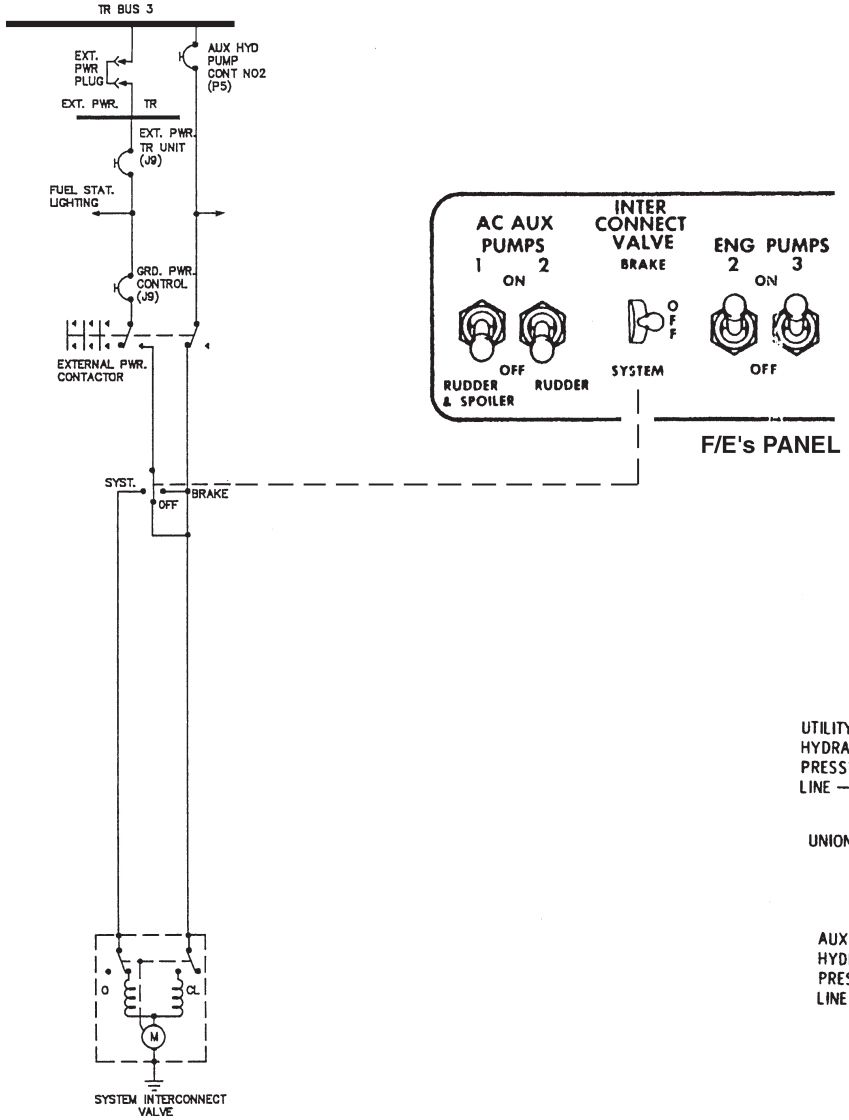
The systems interconnect valve is used for connecting the pressure lines of the utility and auxiliary hydraulic systems in order to pressurize either system by one source of hydraulic pressure. The valve is a motor operated valve, consisting of a motor, rotor type valve and three port housing (one port plugged). The valve can be operated on the ground only. Two electrical power sources are available for valve operation. For normal ground operation the valve is wired through the external power contactor normally open auxiliary contact, and receives 28 volts dc from the external power shield (J9). The second power source is provided to close the valve in case the interconnect valve contact switch was not moved to the "CLOSED" position prior to the removal of external power. This power source is wired through the external power contactor normally closed auxiliary contact and receives 28 volts dc from the radio and T-R circuit breaker panel (P5). The valve is controlled by the interconnect valve switch on the copilot's instrument panel, and installed in the right wheel well on the inboard wall. A manual override handle is provided on the valve for operating the valve on the ground without electrical power.

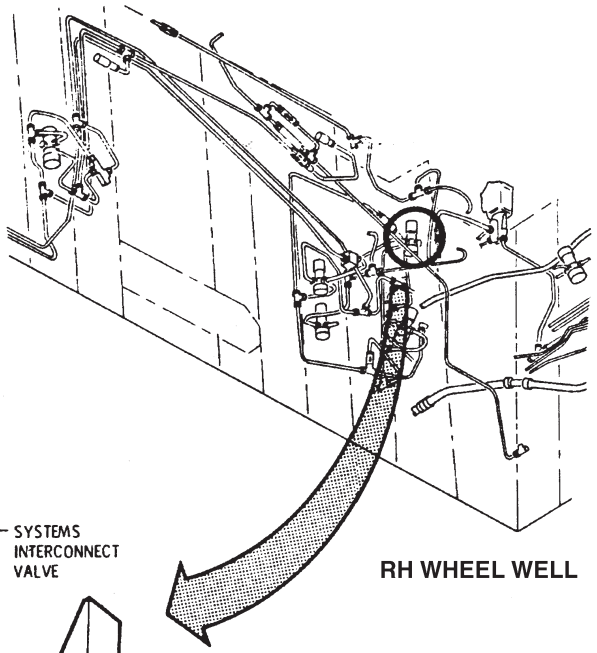
When appropriate electrical power is available to operate the system interconnect valve, pressure sides of the utility and auxiliary hydraulic systems are joined when the interconnect valve is open. Any hydraulic component can then be operated by hydraulic service cart or by an airplane pump not in the components normal supply system. No. 2 auxiliary hydraulic pump, however, is still limited to the rudder system only.

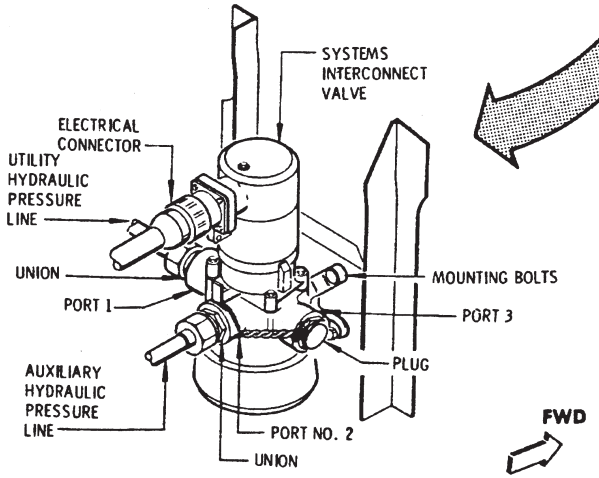
With the interconnect valve open and both systems being pressurized with the auxiliary pumps, a pressure reading between 2100 and 2200 psi is within tolerances. This low pressure reading is due to system bleeds, and normal system internal leakages due to component wear.

Test.
The system interconnect valve can be tested by using either auxiliary system pump, or external hydraulic power (whichever method is more conveient).

CAUTION: MAKE CERTAIN BYPASS VALVE IS CLOSED BEFORE PRESSURIZING UTILITY SYSTEM. RETURN LINES WILL NOT STAND HIGH PRESSURE.







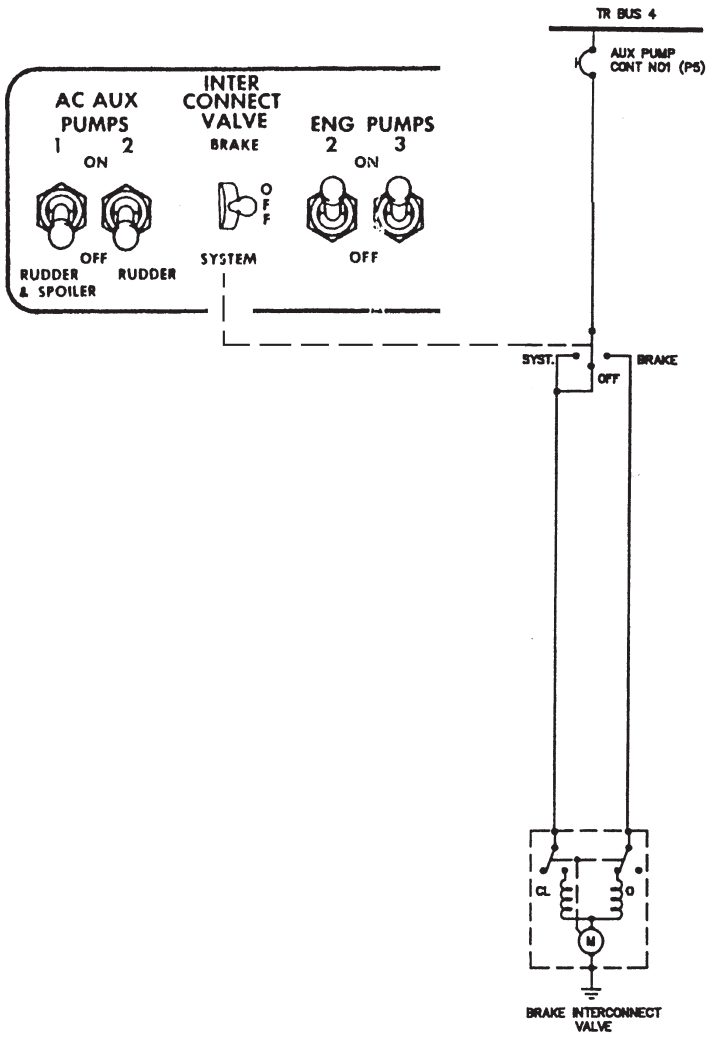
SYSTEM INTERCONNECT VALVE

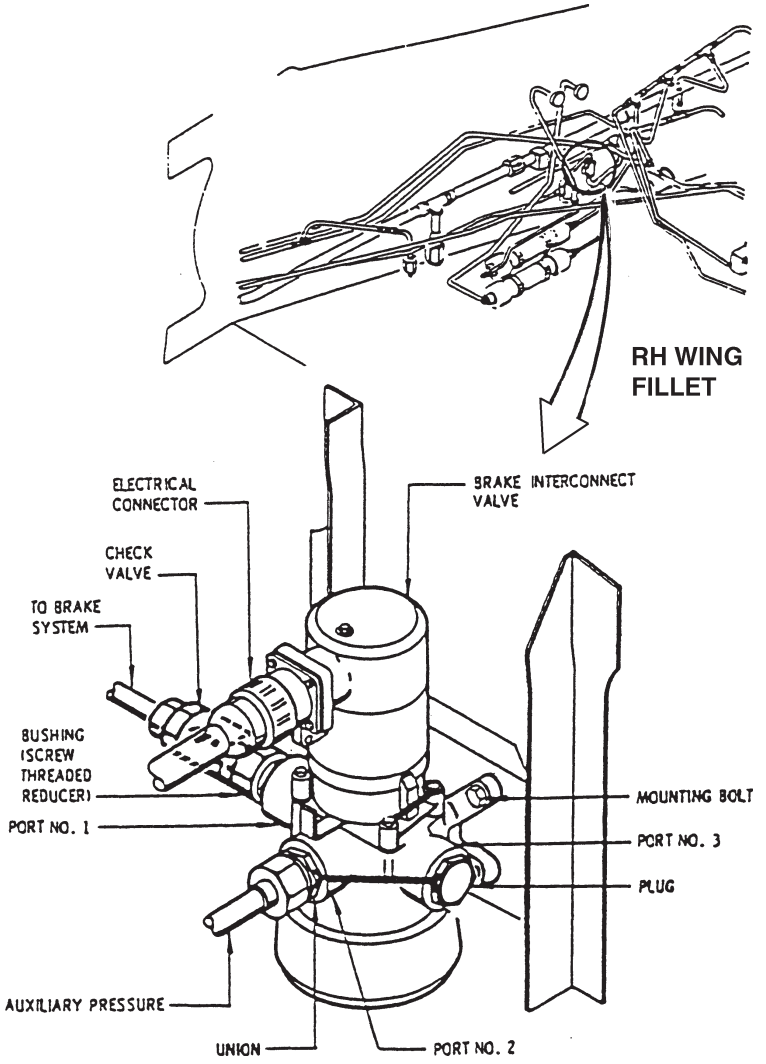
5.2. Brake Interconnect Valve.

The brake interconnect valve is used for connecting the auxiliary hydraulic system pressure line to the brake system, allowing brake operation and brake accumulator charging using auxiliary system pressure. The valve is a motor operated valve, consisting of a motor, rotor type valve and three port housing (one port plugged). The valve is powered by 28 volts dc and controlled by the interconnect valve switch on the copilot's instrument panel. The valve is in the left wing fillet. A manual override handle is provided on the valve to operate the valve on the ground without electrical power.

The brake interconnect valve permits charging the brake accumulator and operation of the brakes by the auxiliary hydraulic system.

Placing the interconnect switch in the "BRAKE" position, when the radio and T-R circuit breaker panel (P5) is energized opens the valve.





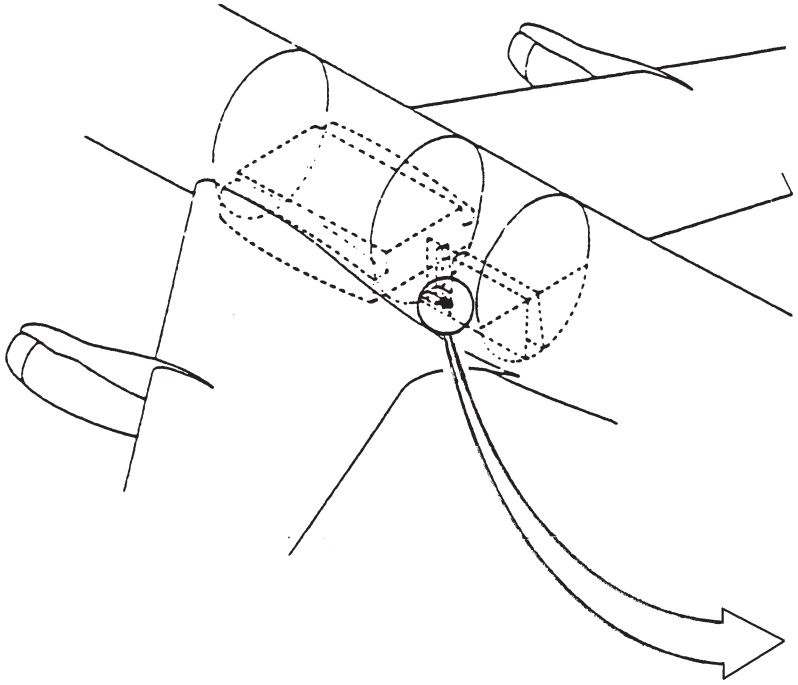
BRAKE INTERCONNECT VALVE

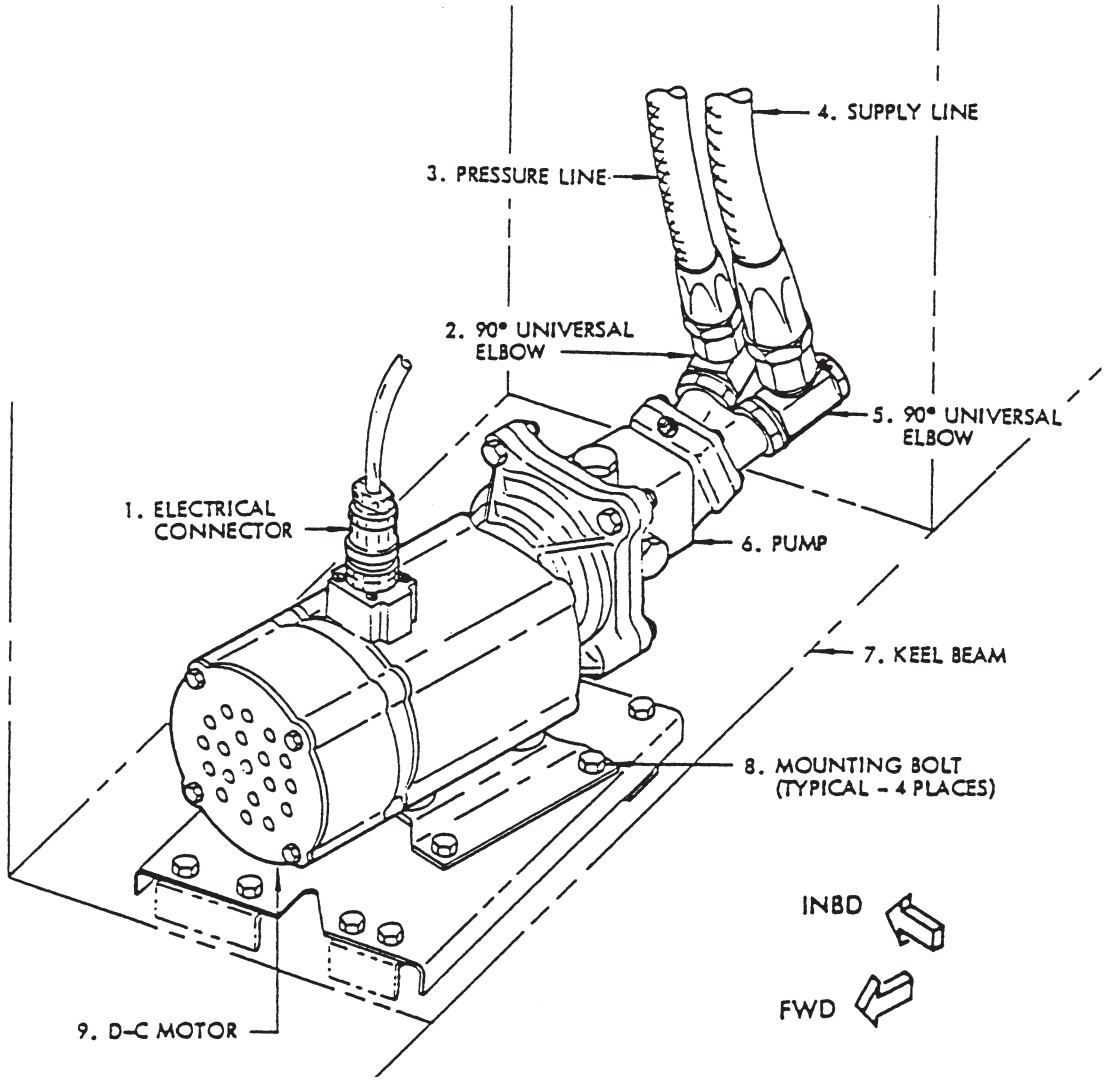
6. MAIN CARGO DOOR HYDRAULIC PUMP.

The main cargo door hydraulic pump is a high pressure, fixed displacement, axial piston pump. Pressure is controlled by a relief valve in the system. The pump is mounted on the keel beam in the left wheel well. The pump is driven by a DC motor attached directly to the pump.

The motor is controlled by the main cargo control switch on the cargo attendant panel. When the switch is in either the OPEN or CLOSE position, DC power closes a relay in the J9 panel which connects power from TR bus No. 4 to the motor.

The electric pump uses fluid from aux. reservoir No. 1 to operate the door. In case of failure of the electric hydraulic pump, the main cargo door can be opened by means of a hand pump, located at the right wheel well. The hand pump uses fluid from the utility reservoir. See also subsection I-W, “MISCELLANEOUS EQUIPMENT AND SERVICING”.




4. SUPPLY LINE
3. PRESSURE LINE
2. 90° UNIVERSAL ELBOW
5. 90° UNIVERSAL ELBOW
1. ELECTRICAL CONNECTOR
6. PUMP
7. KEEL BEAM
8. MOUNTING BOLT (TYPICAL – 4 PLACES)
INBD
FWD
9. D-C MOTOR

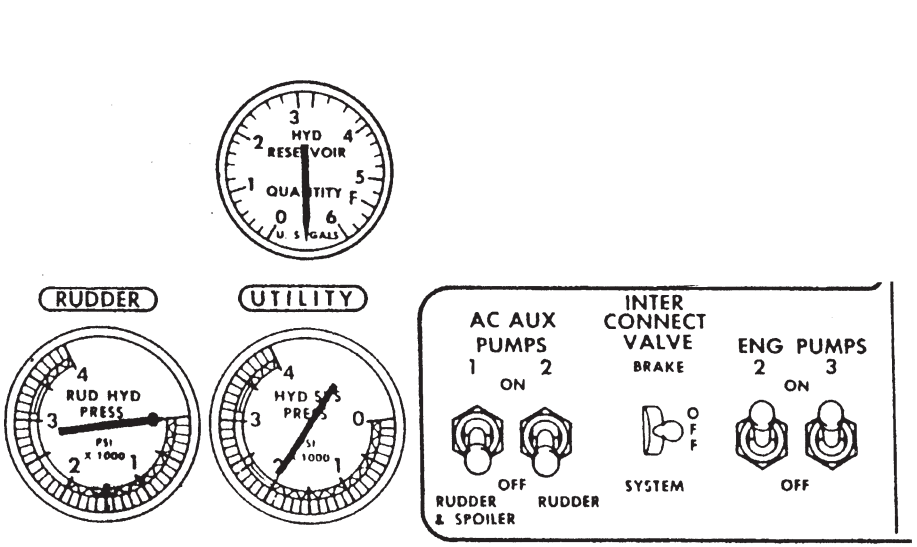
7. INDICATING AND WARNING.

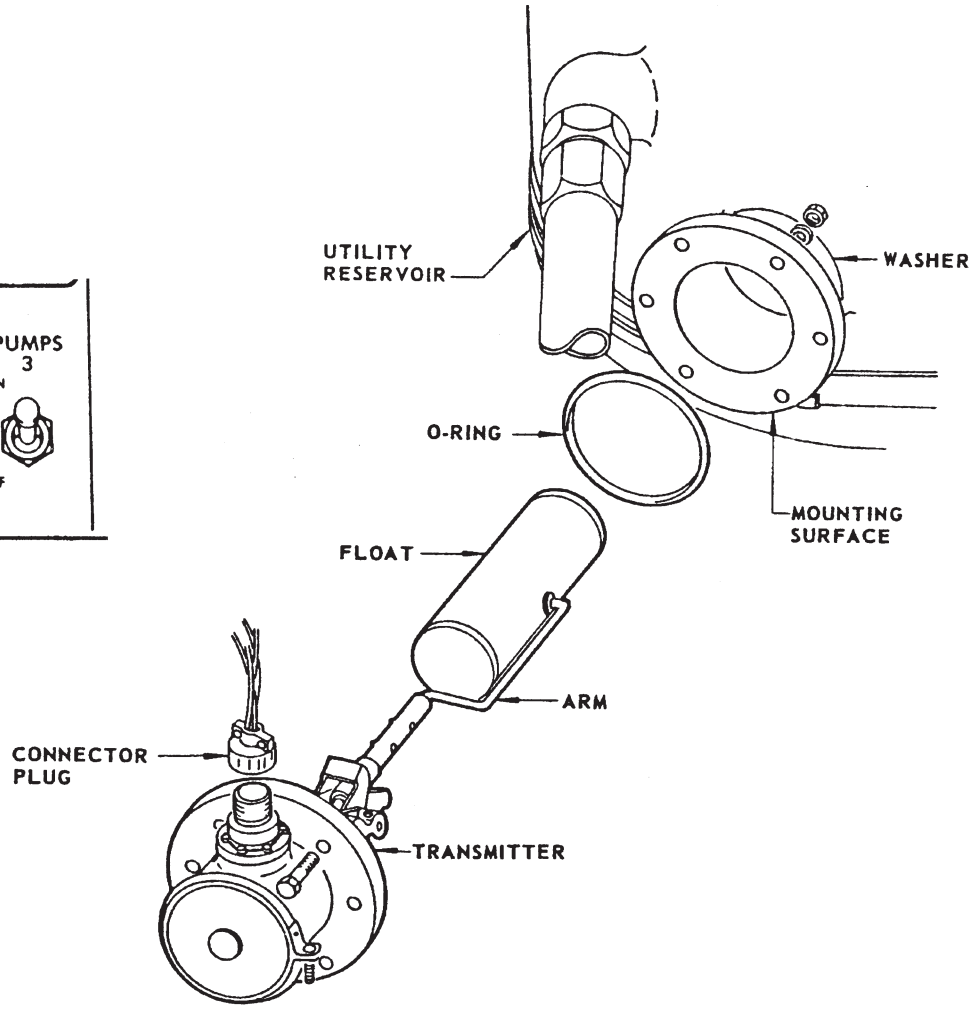
7.1. Quantity indicating system.

The hydraulic fluid quantity indicating system provides indication in the control cabin of the fluid quantity in gallons in the utility reservoir. The system consists of a float type level transmitter in the reservoir and an indicator calibrated in gallons and installed on the engineer's instrument panel.

The system is powered by 28 volts dc supplied through a circuit breaker on the radio and T-R circuit breaker panel (P5). A change in reservoir fluid level causes the float and float arm to move up or down. The float arm actuates sliding contacts of a special variable resistor. Changes in resistor. Changes in resistor currents are senses and recorded by the indicator.

A magnet in the indicator moves the indicator needle "off scale" when there is no electrical power to the indicator.





QTY INDICATOR

7.2. Pressure Indication.

The hydraulic pressure indicating system consists of a synchro transmitter and indicator set, for an indirect indication of pressure in the utility hydraulic power system, and two direct reading pressure gages for the utility and auxiliary system. When the hydraulic systems are depressurized, the indicating system shows the preload pressure of the accumulator nitrogen charges.

The pressure transmitter is connected to the nitrogen side of the utility accumulator. The transmitter senses pressure changes and sends corresponding electric signals to the pressure indicator on the copilot's instrument panel. The system is powered by 28 volts ac supplied through a circuit breaker on the 28 volt ac circuit breaker panel (P7) .

The direct reading pressure gages are connected to the nitrogen sides of the utility and auxiliary accumulator. The pressure transmitter and the pressure gages are located in the right wing fillet, near the accumulators (the gages are above the transmitter outboard of the accumulators).

The hydraulic pressure indicating system consists of a synchro transmitter and indicator set, for an indirect indication of pressure in the utility hydraulic power system, and two direct reading pressure gages for the utility and auxiliary system. When the hydraulic systems are depressurized, the indicating system shows the preload pressure of the accumulator nitrogen charges.

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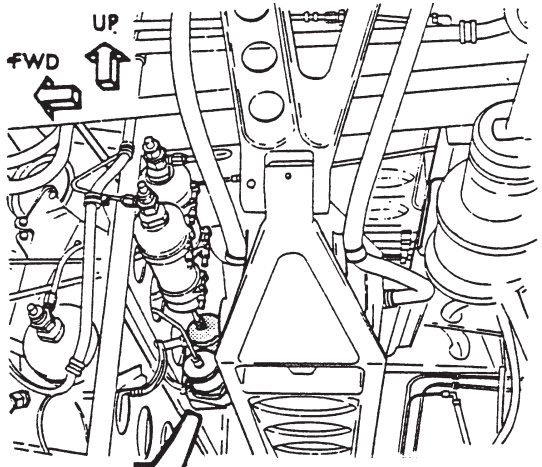
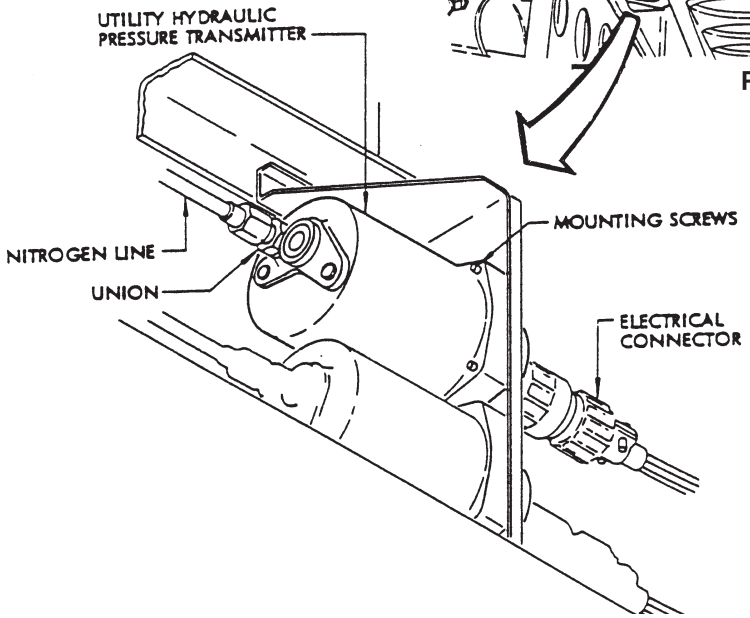
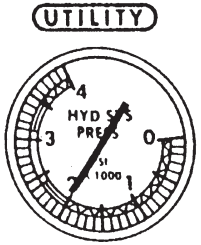


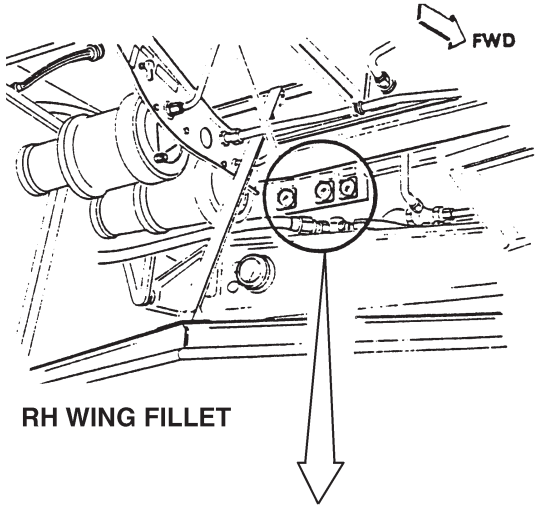
RH WING FILLET



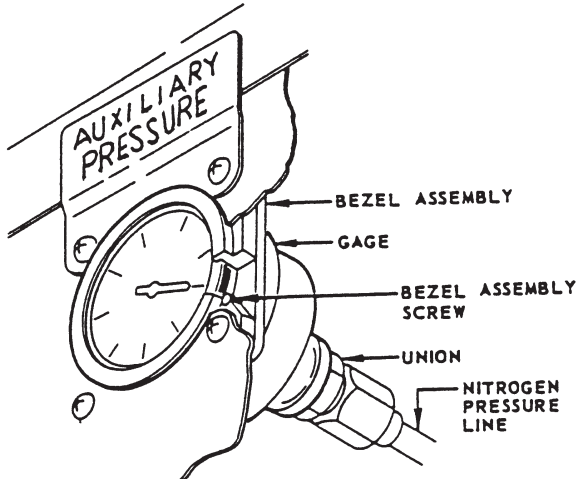


F/E's LOWER PANEL

COPILOT's INSTRUMENT PANEL



RH WING FILLET



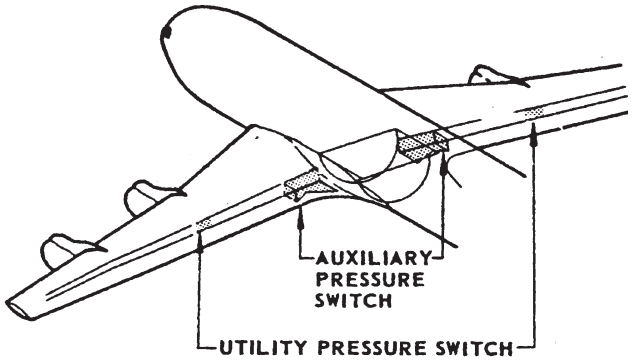
HYD PRESS INDICATION

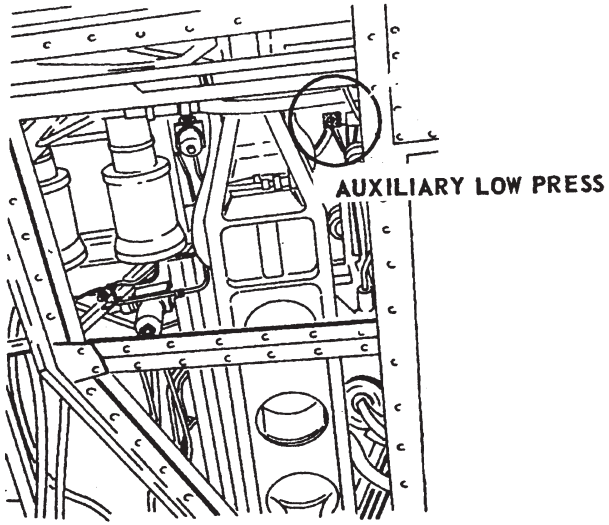
7.3. Low Pressure Warning.

The hydraulic low pressure warning system gives a visible warning signal when the pump deliver pressure is low. Four independent systems are installed, one for each hydraulic pump. The warning system consists of a low pressure warning switch and an a er low pressure warning light. On some airplanes a second a er low pressure warning light is provided for each warning system. Each system warning light illuminates when electric power is on and the pump deliver pressure drops below the preset pressure of the low pressure warning switch. The light goes off when the pump pressure increases to 1200± 250 psi, and comes on at 100 psi below light-off pressure. The warning systems are powered by 28 volts dc supplied through circuit breakers on the radio and T-R circuit breaker panel (P5)

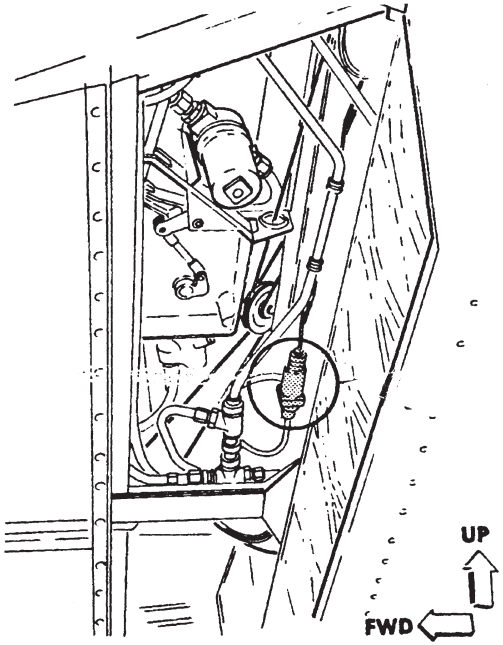
The low pressure warning switch for the engine driven is on the rear spar aft of its respective engine. A flow restrictor is installed between the pressure line and switch. The Rudder and Spoiler pump low pressure switch is in the outboard area of the left wing fillet. The rudder pump low pressure switch is in the right wheel well. On some airplanes the four low pressure warning lights are on the co-pilot's instrument panel. On some airplanes four low pressure warning lights are on the co-pilot's instrument panel, and four low pressure warning (repeater) lights are on the flight engineer's instrument panel. On some airplanes the hydraulic low pressure warning light for both engine driven pumps will not illuminate when the pump valves are turned to the "OFF" position even though the hydraulic pressure is below 1200 psi.

On some airplanes the low pressure warning light for both engine driven pumps will not illuminate if the pump valves are turned to the "OFF" position, and/or the engine fire switches are in the "FIRE" position.

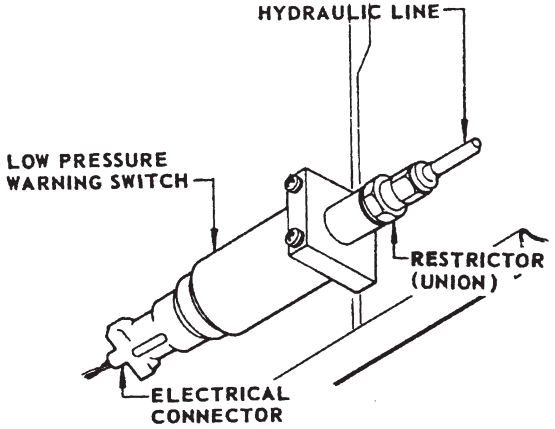


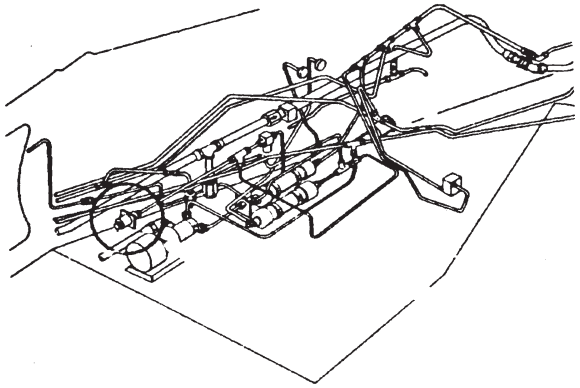


LEFT WING FILLET AREA



UTILITY LOW PRESSURE SWITCH LOCATION





RIGHT WING FILLET AREA

HYDRAULIC LOW PRESS WARNING

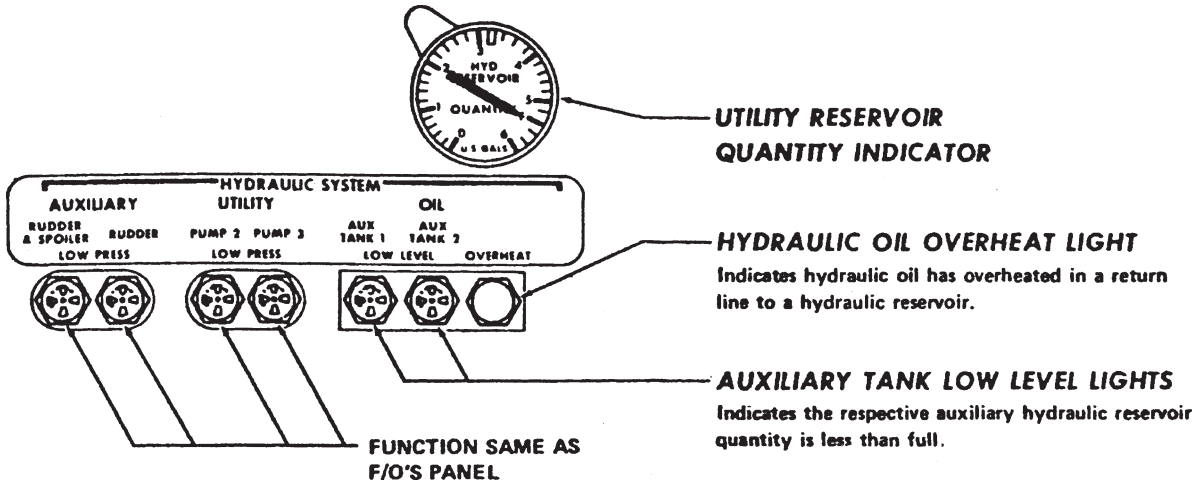
7.4. Optional Warning.

Hydraulic Fluid Overheat Warning. (Only Some-airplanes)
Hydraulic fluid overheat warning is provided through overheat switches in the return lines to the utility and auxiliary reservoirs. The overheat switches control a fluid overheat warning light on the flight engineer's lower panel and also the master warning light on the pilot's instrument panel.

Either switch energizes the warning light when the fluid temperature reaches about 190°F. The system operates on 28-volt dc power from the radio and T-R circuit breaker panel (P5).

On some airplanes one utility and one auxiliary overheat switches are provided. On some airplanes one utility and two auxiliary overheat switches are provided. The utility overheat switch is installed on the return port of the utility reservoir. The auxiliary overheat switches are on the return line just upstream of its respective auxiliary reservoir.

Auxiliary Hydraulic Fluid Low Level Warning (only some airplanes).
The auxiliary hydraulic reservoir fluid level warning system provides an indication of low fluid level in the auxiliary reservoirs. Each reservoir is provided with a fluid level warning system, and consists of a float type switch in the reservoir and an amber low level warning light on the engineer's instrument panel. Each system operates on 28 volt dc power from the radio and T-R circuit breaker panel (P5).



OPTIONAL WARNING

8. FILLING PROCEDURE.

The utility hydraulic reservoir is serviced either through the filler neck, or by attaching a pressure line to the pressure fill fitting on applicable airplanes. Access to the pressure fill fitting is obtained by opening the left wheel well door, and it is located on the forward bulkhead.

The auxiliary reservoir is serviced automatically when the utility reservoir is serviced. Reservoir filling procedure is the same with or without the hydraulic system pressurized. The brake system should be pressurized during reservoir servicing.

Service Utility and Auxiliary Reservoir.

Depressurize Utility Reservoir.
On airplanes not equipped with a manual depressurization valve, slowly unscrew reservoir cap 3 full turns until compressed air has escaped.

CAUTION: RESERVOIR IS PRESSURIZED TO 45 PSI AIR CHARGE.
DO NOT REMOVE FILLER CAP UNTIL RESERVOIR IS DEPRESSURIZED OR FLUID WILL ESCAPE.

NOTE: First 3 turns of cap allows air charge to escape. Some fluid may bleed into scupper, therefore, provisions should be made to catch scupper drainage.

On airplanes equipped with a manual depressurization valve,
remove screws and depress knurled button on depressurization valve.

NOTE: Depressurization valve is located above and just aft of utility reservoir.

On airplanes with two auxiliary reservoirs, unscrew bleeder plug on No. 2 auxiliary reservoir 3 turns to allow air to escape.

Fill the reservoir with BMS 3-11 hydraulic fluid.

Pressure - filling Procedure.
Locate the reservoir pressure-filling port on the forward bulkhead of the left main gear wheel or on the center keel beam bulkhead near the utility return filter installation. It will be identified by placard UTILITY HYD RSVR PRESSURE FILL PORT.

Remove dust cap from the connector. Attach pressure service cart mating connector half and hose to aircraft system.

Fill reservoir by operating the hand pump on the cart (or the regulating valve on the air pressurized carts) until the "bullseye" fluid level gauge on the utility reservoir is completely covered with fluid.

Remove pressure servicing cart connector from the aircraft fitting. Replace dust cap on the pressure port connector.

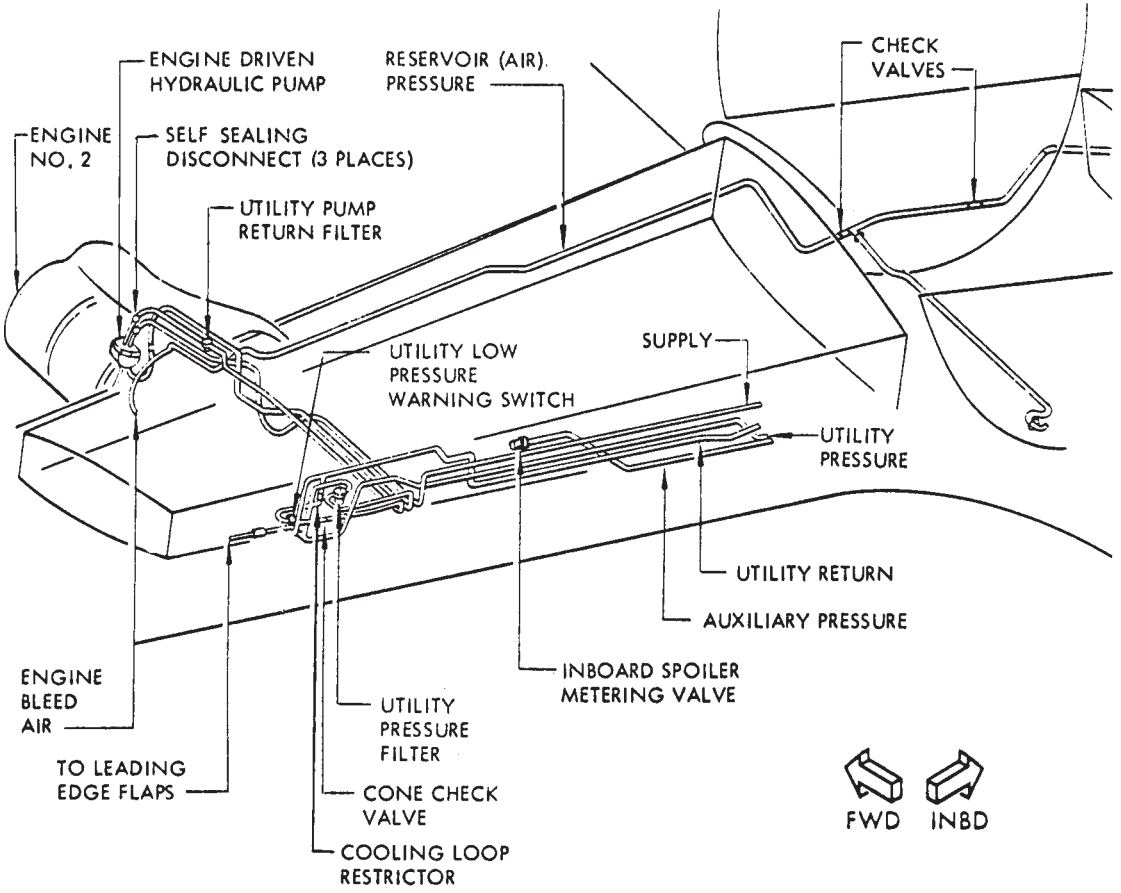
Manual filling procedure.
Manually fill reservoir with fluid to top of filler neck, allowing any entrapped air to escape from filler neck during servicing.

NOTE: Overflow usually occurs during manual filling operation.
Precautions should be taken to catch overflow.

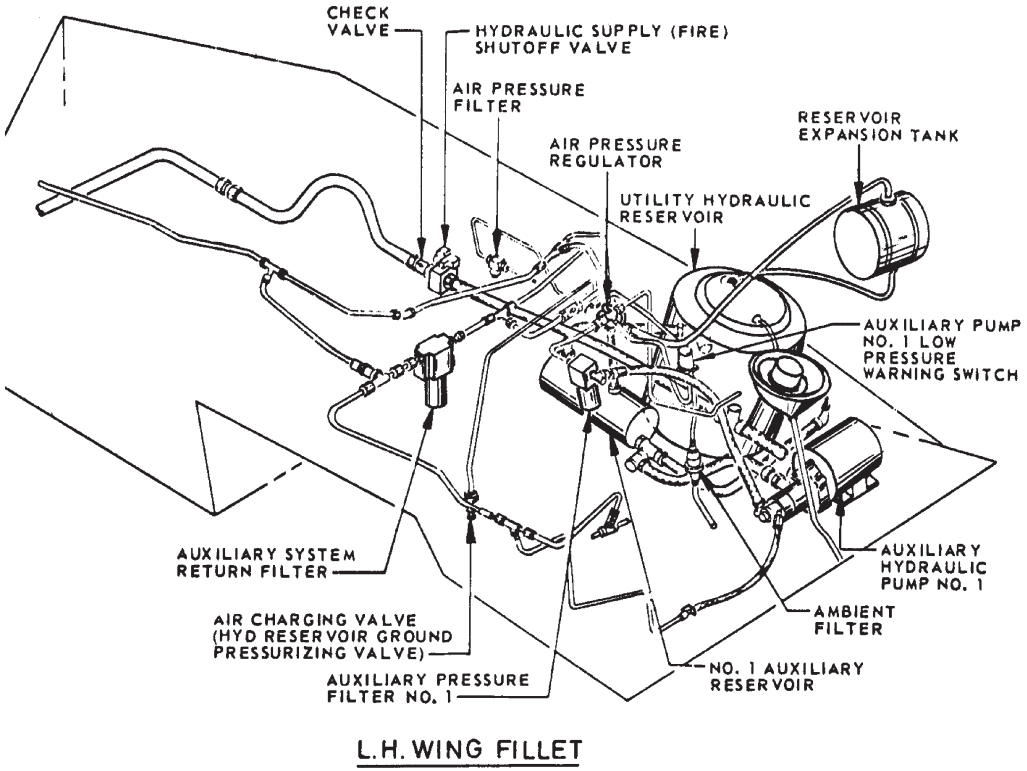
Assure that the "bullseye" fluid level gauge on reservoir remains completely covered with fluid.

Assure that No. 2 auxiliary reservoir is filled to the top of the bleed plug. Torque bleed plug to 50 pound-inches and safety wire in place.

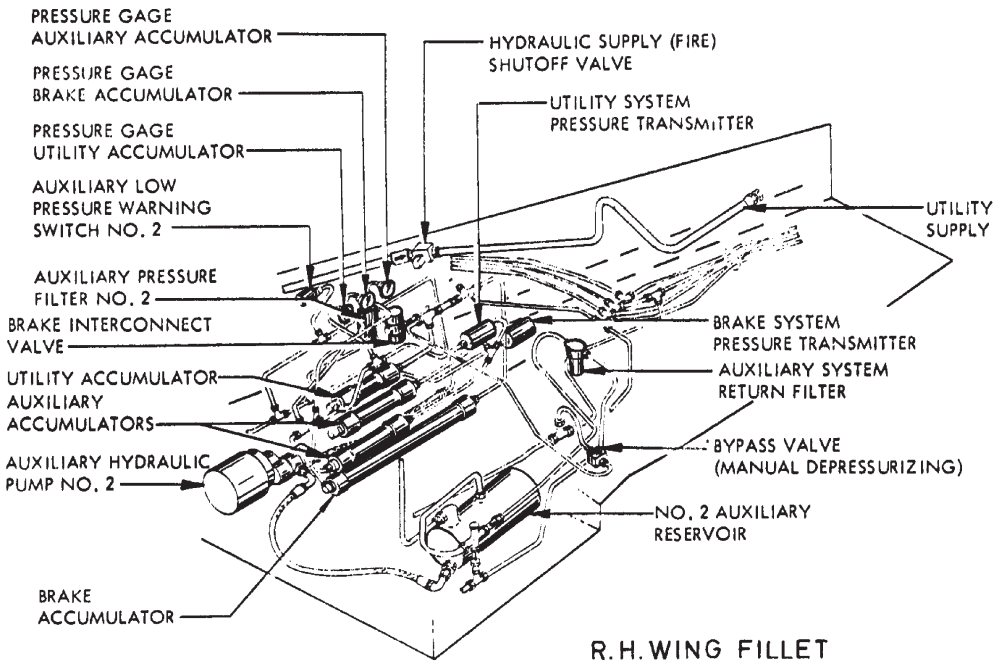
Replace utility reservoir filler cap.



COMPONENT LOCATION (SHEET 1)

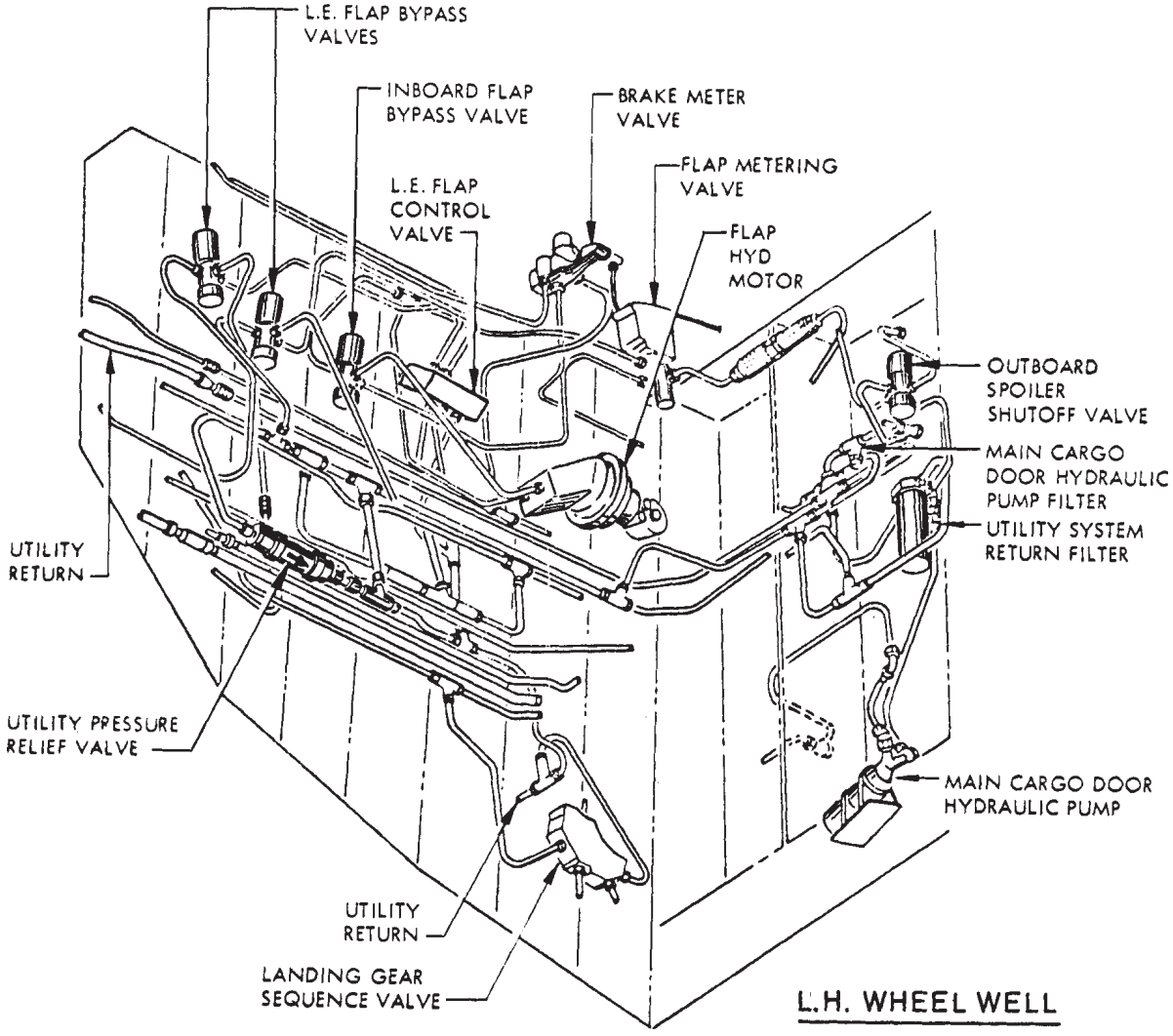


L.H. WING FILLET

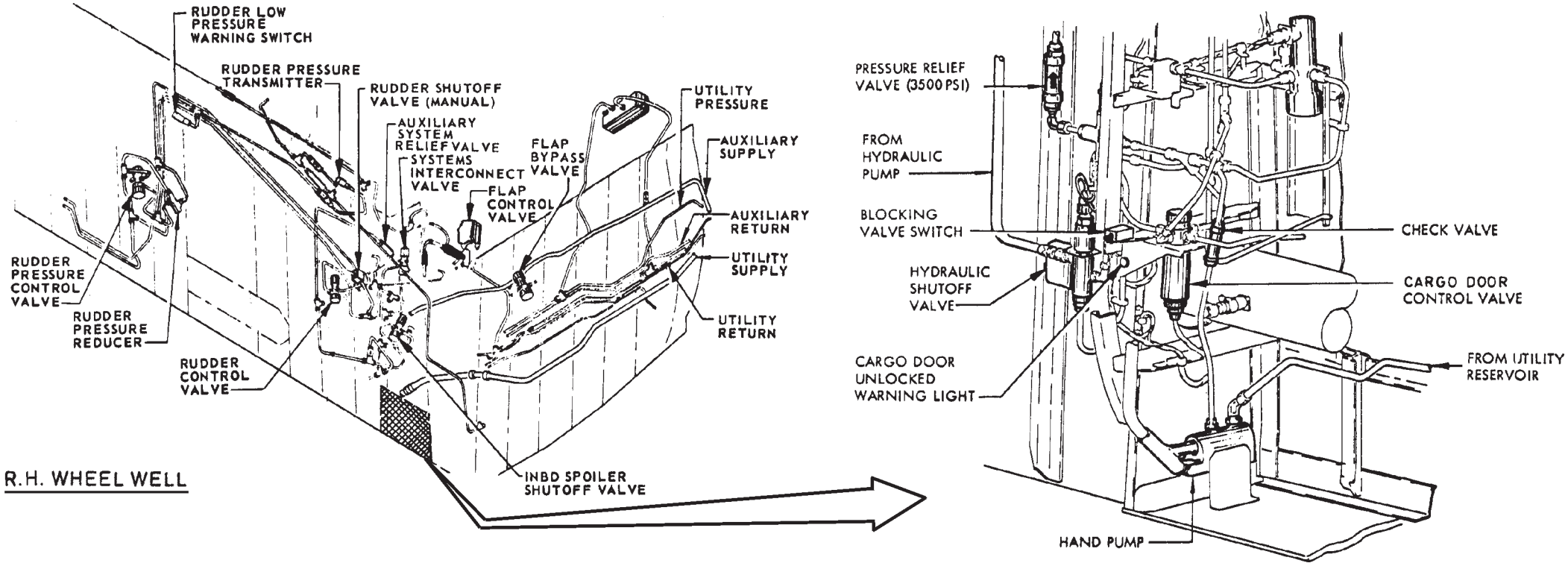


R.H. WING FILLET

COMPONENT LOCATION (SHEET 2)



COMPONENT LOCATION (SHEET 3)



COMPONENT LOCATION (SHEET 4)

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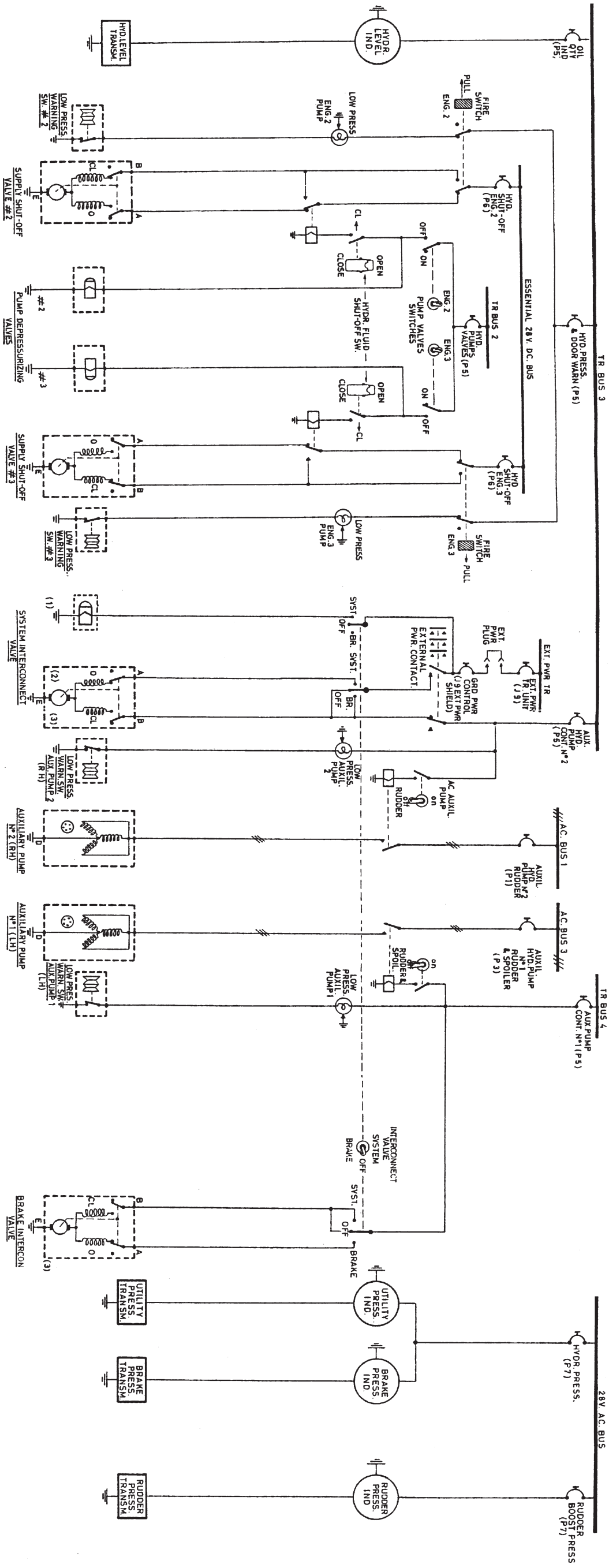
HYDRAULIC SYSTEM ELECTRICAL DIAGRAM



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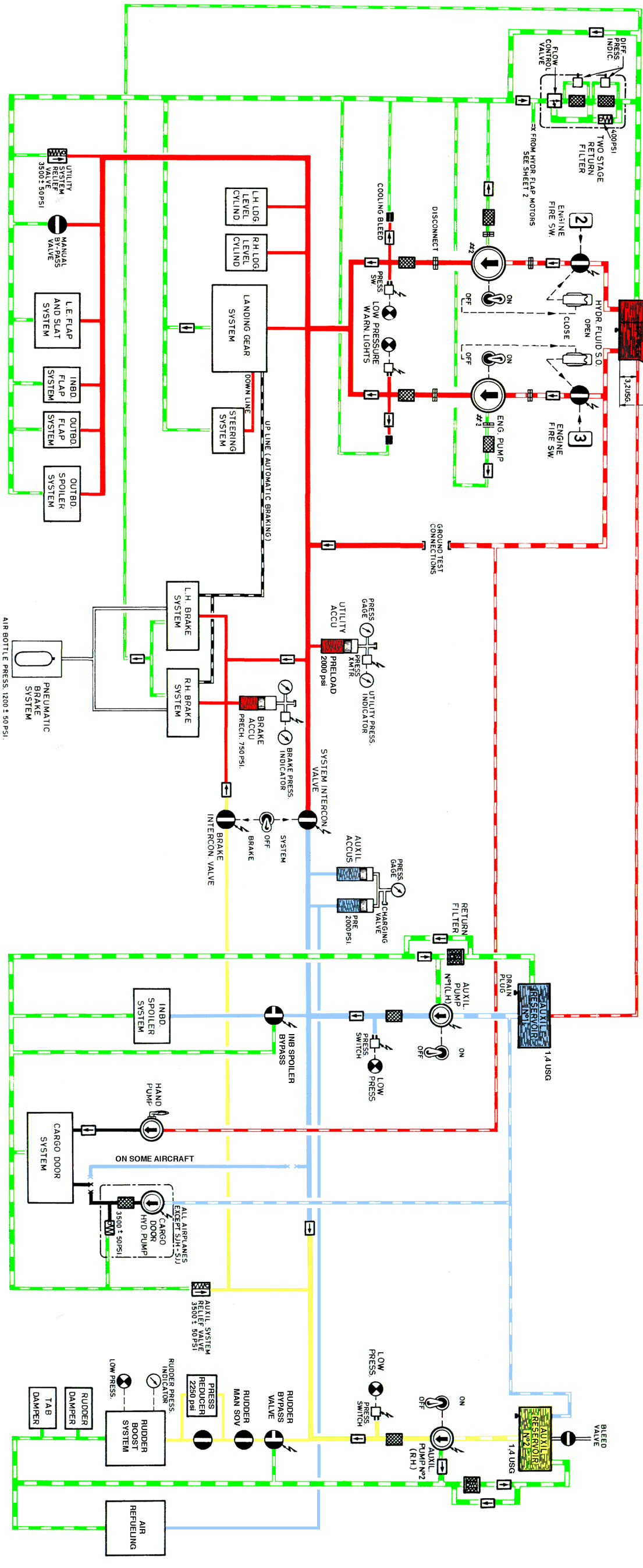
HYDRAULIC SYSTEM



FLIGHT ENGINEER'S LOWER PANEL

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