SECTION V

SECTION V

# HYDRAULIC GIMBAL SYSTEM

## MAINTENANCE

5-1. SCOPE OF SECTION

5-2. This section provides a description, functional analysis and maintenance instructions on the LLTV hydraulic gimbal system. The maintenance instructions include servicing and testing removal and installation, and test equipment.

5-3. DESCRIPTION AND LEADING PARTICULARS

5-4. The hydraulic gimbal system consists of a roll (figure 5-1) and a pitch actuator, a hydraulic reservoir and pump (figure 5-2), a hydraulic accumulator (figure 5-3) and various valves, switches and couplings (figure 5-4). The hydraulic system supplies power to two electro-hydraulic servo-actuators for pitch and roll attitude control of the jet engine during the Local Vertical mode, Engine Centered mode, Lunar Simulation mode, and Gimbal Locked mode of operation.
The hydraulic actuators are controlled by one of the following methods: (1) electronically through the servo valve or (2) electro-mechanically through the actuator centering port. Refer to section XI for a description of the electronic control subsystem.

5-5. FUNCTIONAL ANALYSIS

5-6. Primary hydraulic pressure is supplied by an engine-driven,

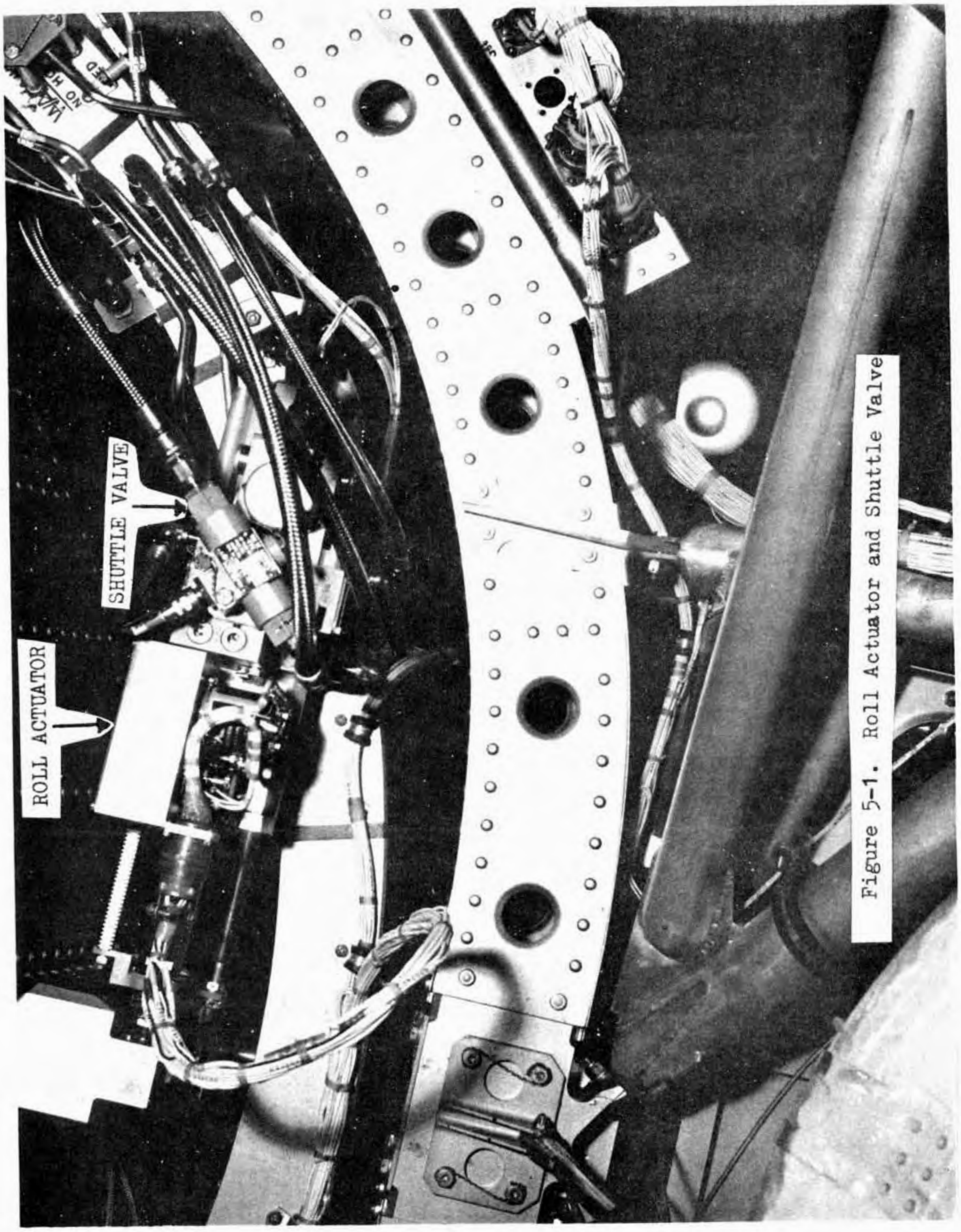



Figure 5-1. Roll Actuator and Shuttle Valve

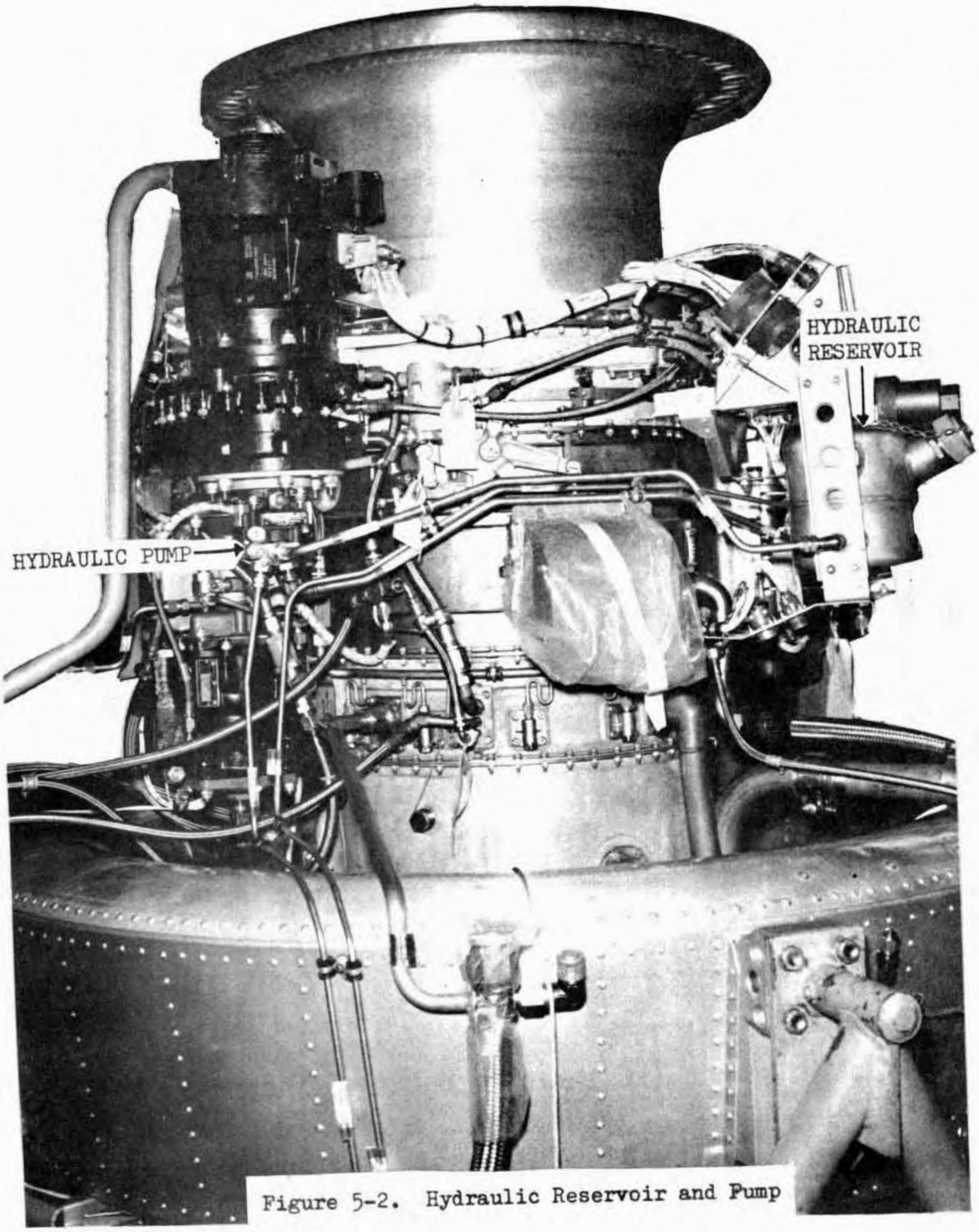



Figure 5-2. Hydraulic Reservoir and Pump

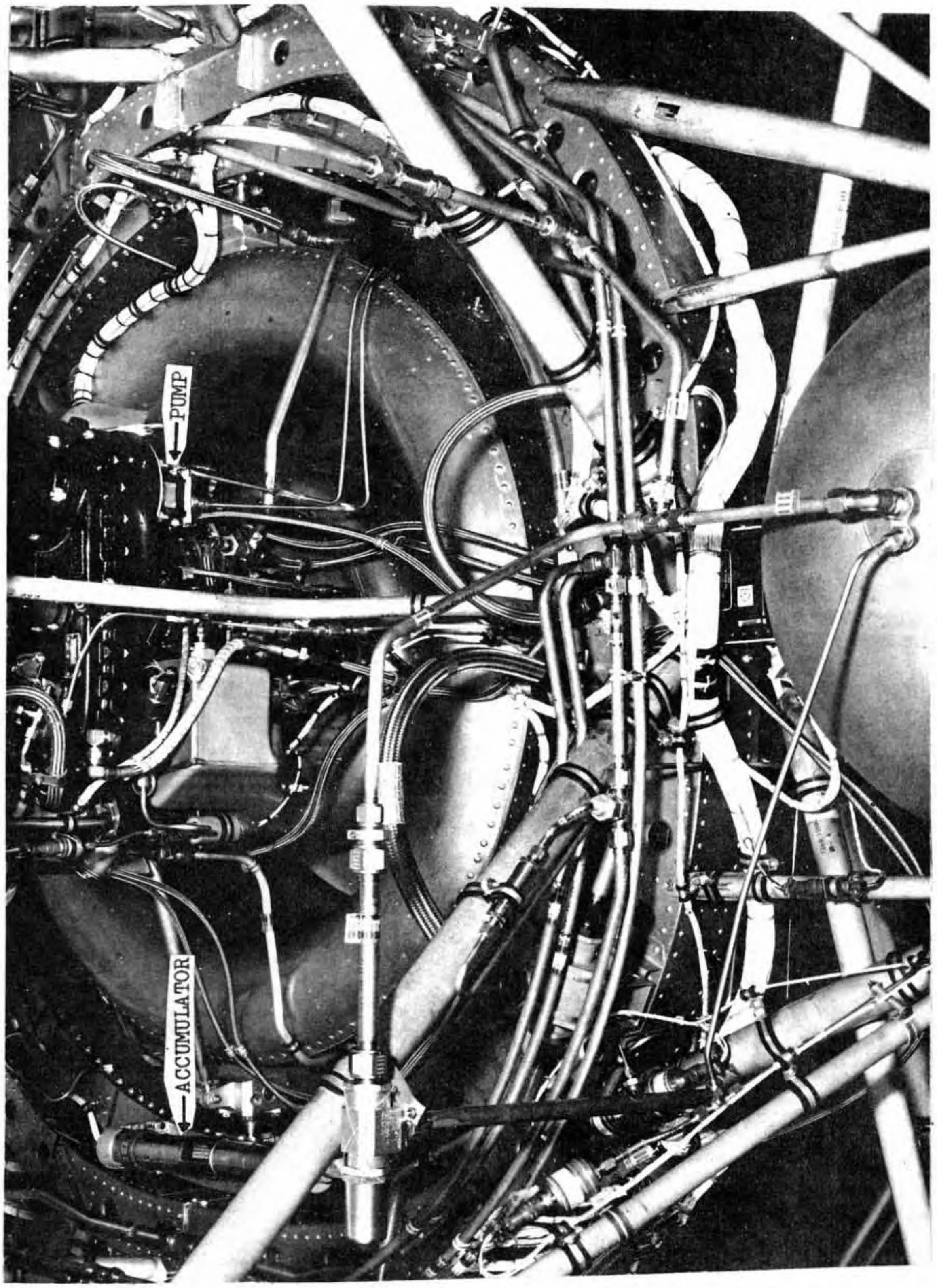



Figure 5-3. Hydraulic Accumulator and Pump

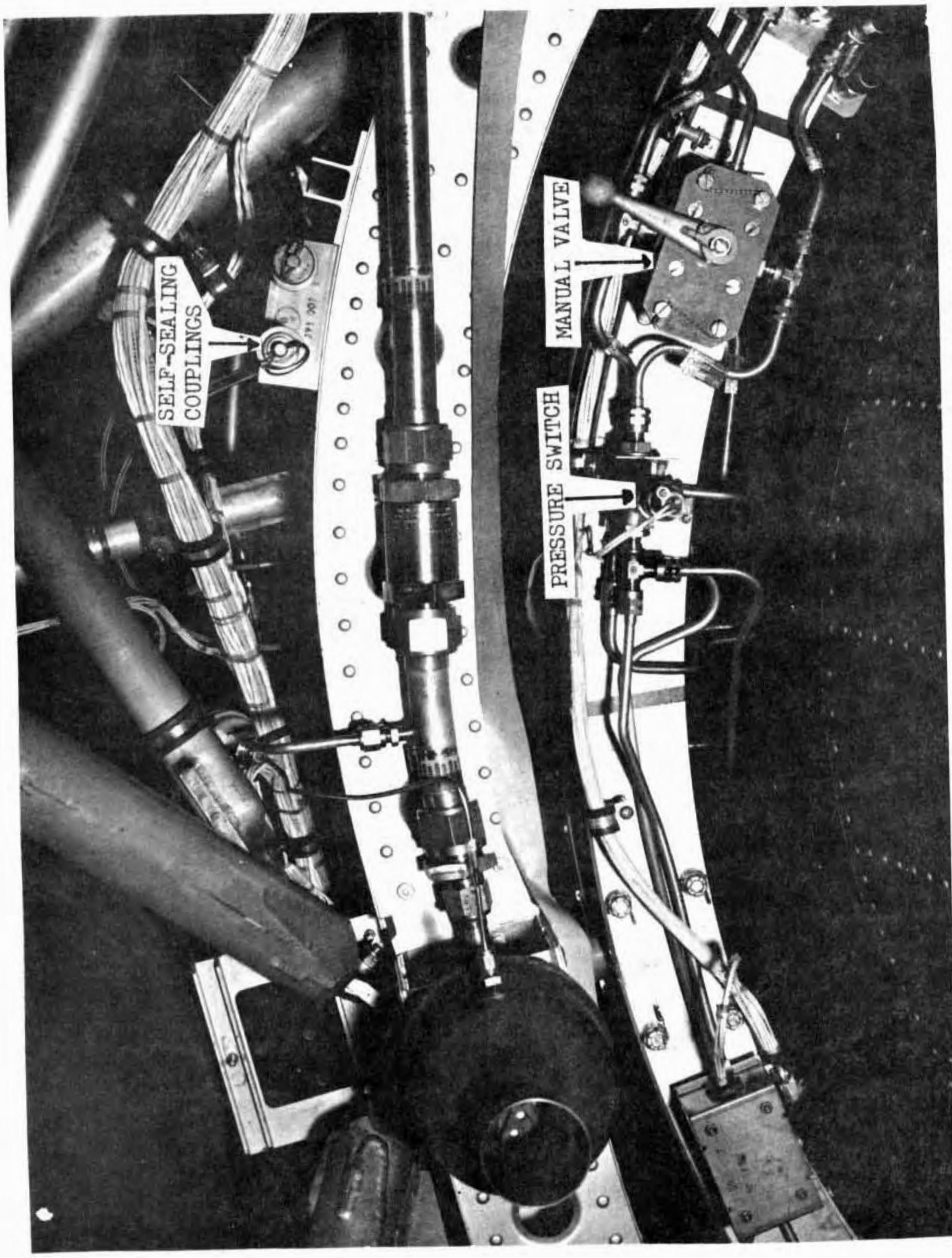



Figure 5-4. Miscellaneous Hydraulic Gimbal Components

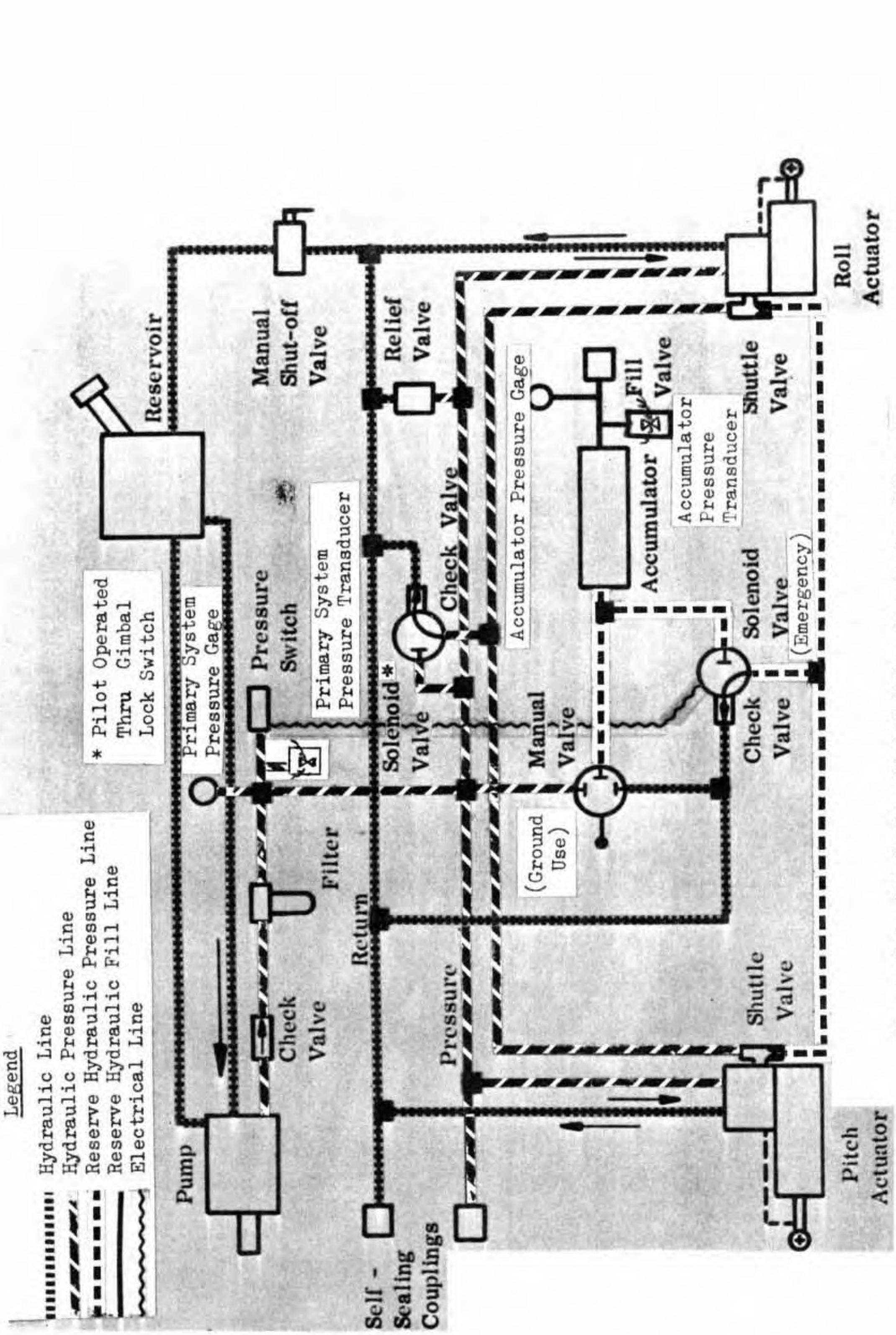



Figure 5-5 Jet Engine Gimbal Hydraulic System Schematic

variable displacement-type pump (figure 5-5) using hydraulic fluid from the reservoir. A reserve hydraulic pressure source is provided by the hydraulic accumulator and is used for centering the engine in the Emergency Gimbal Locked mode in the event the hydraulic system pressure drops below 1350 ± 50 psi. Check valves at the pump outlet and in the return port of both solenoids prevent reverse flow during ground operation with an auxiliary hydraulic power supply. The relief valve prevents system over-pressurization in event of a pump malfunction. Self-sealing couplings, a manual reservoir shutoff valve, the pump check valve and the check valves in the return ports of the solenoid valves, provide the necessary isolation for ground checkout of the hydraulic system.

5-7 A hydraulic accumulator provides the source of hydraulic pressure during the Emergency Gimbal Locked mode. This mode moves the engine to the Z-body axis. A cam operated centering valve in each actuator provides the mechanism to center the engine. A decrease in normal hydraulic pressure is sensed by the hydraulic low pressure switch and energizes an emergency relay K6 which actuates the emergency Gimbal lock solenoid, L2. This causes the normally closed 3-way solenoid valve to apply pressure from the accumulator to the centering (shuttle) valves on the roll and pitch actuators. This pressure overrides the servo-controlled valve to hold the gimbals in the center position.

5-8. When the Gimbal Lock mode is selected by the pilot, the gimbal lock solenoid L1 is energized and applies hydraulic pressure from the normal source to the centering (shuttle) valves on the pitch and roll actuators. The L1 solenoid valve can also be energized by the avionic system.

5-9 In the event the gimbal lock switch on hand controller fails to operate, a pressure switch located in the normal gimbal lock side of the shuttle valve loop, triggers the emergency gimbals locked solenoid in the emergency side of the shuttle valve loop.

5-10. SERVICING AND TESTING

5-11. The servicing and testing procedures for the hydraulic gimbal system are provided in paragraphs 5-11 through 5-17. Step-by-step procedures and test equipment are provided.

5-12. TEST EQUIPMENT

5-13. An accumulator pressure cart and Hydraulic Test Stand D6 and D6A are required for servicing and testing the hydraulic gimbal system.

5-14. STEP-BY-STEP PROCEDURES

5-15. The following paragraphs provide step-by-step procedures for flushing, filling and testing the hydraulic gimbal system.

5-16. FLUSHING PROCEDURE - Refer to paragraph 2-49 for flushing procedure.

5-17. FILLING - After initial installation and after major maintenance fill system. (Refer to paragraph 2-50)

5-18. TESTING - To test for external and internal leakage refer to paragraph 2-51.

5-19. REMOVAL PROCEDURES

5-20. The removal procedures for the major components of the hydraulic gimbal system are described in paragraphs 5-21 through 5-31

5-21. HYDRAULIC ACTUATORS

5-22. The removal procedure of the roll and pitch hydraulic actuators is essentially the same for both actuators.

NOTE

Prior to removal of any hydraulic components, vent the accumulator hydraulic pressure by placing manual 3-way valve, 7260-390009-1 in DUMP position.

5-23. To remove and actuator, proceed as follows:

A. Remove, cap, and identify all hydraulic flex lines to actuator and shuttle valve, using clean pressure type caps and plugs. Assure wire bundles are protected. Prepare to catch some fluid drainage from system. Cap all actuator ports.

B. Disconnect electrical connector.

C. Block gimbal ring in stationary position, using wooden blocks between inner and outer ring.

5-24. ROLL ACTUATOR - To remove the roll actuator proceed as follows:

CAUTION

Exercise extreme care to prevent damage to actuator during removal.

A. Remove bolt and washer securing actuator to engine mount.

B. Remove bolt and washer securing actuator to gimbal ring.

C. Remove roll actuator and secure piston.

D. Install dummy actuator immediately.

5-25. PITCH ACTUATOR - To remove pitch actuator proceed as follows;

A. Remove bolt and washer securing actuator to gimbal ring.

B. Remove bolt and washer securing actuator to vehicle main frame.

C. Remove pitch actuator and secure piston.

D. Install dummy actuator immediately.

5-26. HYDRAULIC PUMP

5-27. Refer to paragraph 6-30 for removal procedures for the hydraulic pump.

5-28. HYDRAULIC RESERVOIR

5-29. Refer to paragraph 6-28 for removal procedures for the hydraulic reservoir.

5-30. HYDRAULIC ACCUMULATOR

5-31. To remove the hydraulic accumulator proceed as follows:

NOTE

Dump hydraulic pressure if any is in accumulator prior to release.

A. Open Schrader Valve to release pre-charge nitrogen pressure from accumulator.

B. Disconnect hydraulic line from fitting. Cap tubing and port, with clean press type fittings.

5-32. INSTALLATION PROCEDURES

5-33. The installation procedures are provided for major components of the hydraulic gimbal system in paragraphs 5-34 through 5-41. See Bell drawing 7161-382003 and 7260-382004.

5-34. HYDRAULIC ACTUATORS

5-35. The installation of the actuators is essentially in the reverse order of removal.

NOTE

After installation of any major component of the hydraulic gimbal system, perform the flushing and filling procedures provided in paragraphs 5-16 and 5-17.

5-36. HYDRAULIC PUMP

5-37. The hydraulic pump is installed in the reverse order of removal Refer to paragraph 6-30.

SECTION VI

## SECTION VI

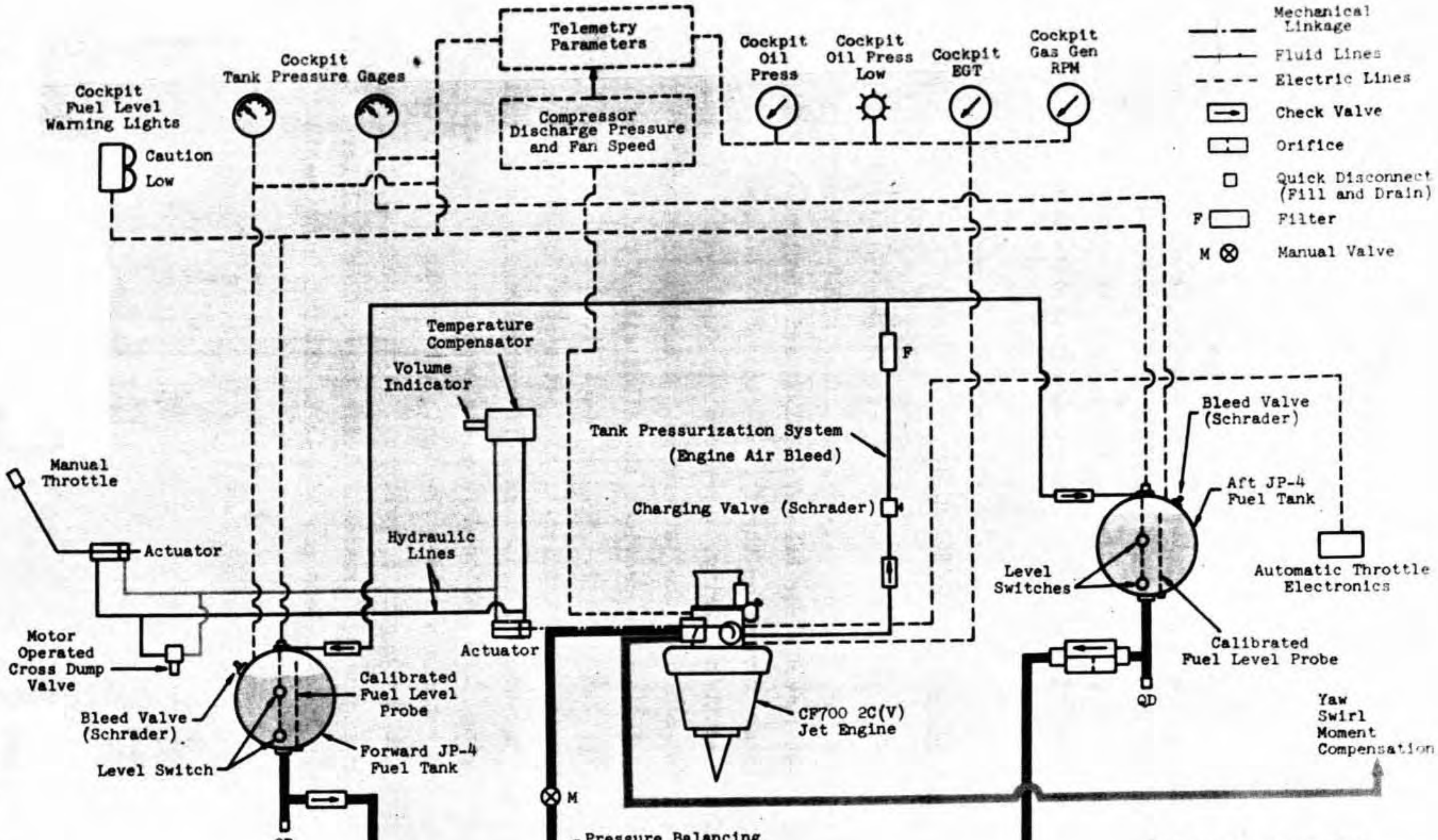
## POWER PLANT MAINTENANCE

### 6-1. SCOPE OF SECTION

6-2. This section provides the description and maintenance instructions for the jet engine and related systems which compose the LLTV jet engine power plant. These systems are fuel, lubrication, compressor air bleed. and control linkage. Refer to General Electric Jet Engine CF700 Maintenance Manual SEI133 for detailed maintenance instruction on the jet engine.

### 6-3. DESCRIPTION AND LEADING PARTICULARS

6-4. The functional relationships of the systems comprising the vehicle power plant are shown in figure 6-1. The modified CF700-2CV jet engine provides thrust requirements for takeoff, flight and simulation of lunar gravity. During lunar simulation the thrust capability counteracts five-sixths of the earth's gravity. The vehicle fuel system provides storage and fuel injection to the jet engine. A combination hydraulic and electrical manual throttle provides the pilot with a primary and backup control of the fuel system. Engine start is provided by an external air start unit. Lubrication of the jet engine is provided through a vented, pressurized, closed-circuit system designed to furnish oil to parts requiring lubrication during engine operation. An air bleed system on the vehicle provides JP4 fuel tank pressurization, by bleeding air from the jet engine compressor. Various cockpit instruments monitor engine performance. Refer to section VIII for detailed maintenance instructions pertaining to cockpit instruments.




| JP4 FUEL QUANTITY | |
|---|---|
| FULL-------------- | 234.0 lb/tank |
| CAUTION (50%)----- | 117.0 lb/tank |
| LOW LEVEL (20%)--- | 46.8 lb/tank |

Figure 6-1. Jet Engine Fuel and Power Control System Schematic

6-5. JET ENGINE SYSTEM - The modified CF700-2CV is provided with bellmouth-type inlet fairings for the gas generator and aft fan inlets. The engine is mounted in a vertical position on gimballing mounts, which permit $\pm 40^{\circ}$ pitch and $\pm 25^{\circ}$ roll relative to the vertical position of the vehicle. Refer to section I of General Electric Jet Engine CF700 Maintenance Manual SEI-133 for a detailed description of the basic engine. Refer to Bell drawing 7260-421010 for other modifications necessary to engine installation with quick engine change (QEC) components.

6-6. JET FUEL SYSTEM - The jet fuel system (figure 6-1) consists of fuel storage tanks for JP4 fuel (MIL-J-5624F) tank pressurization provision (air bleed), fuel level switches, calibrated fuel level drain probes, pressure balancing fuel flow proportioner, fuel level warning lights, tank pressure gages, check valves, filters, and quick-disconnect fill and drain fittings.

6-7. FUEL STORAGE - Two JP4 tanks are mounted symmetrically about the vehicle center of gravity. The desired balance and vehicle center of gravity is obtained by mounting one tank in front of and slightly below the engine and the other tank directly behind and slightly above the engine. A quick-disconnect fitting at the center of the tank bottom provides access for filling. A manually operated, retractable, calibrated fuel level indicator probe in each tank permits partial filling and quantity checking of fuel. A quick-disconnect on the probe also provides access for draining and ground venting. The probe is marked in increments of five pounds of JP4 fuel for a density of 6.5 lb/gallon. Quantity at this density is 234 pounds per tank.

6-8. TANK PRESSURIZATION - The fuel tanks are pressurized prior to flight to $20 \pm {}^{10}_{0}$ psig with gaseous nitrogen through a permanently installed charging valve in the air lines. The rigid air lines are aluminum alloy with flared fittings and are proof-tested to 500 psig. The flexible hose air lines are adequate for 1500 psig working pressures with flared tube fittings. During flight, tank pressure is maintained at approximately 22 psig by bleed air taken from the jet engine compressor. However, during pretakeoff checks, the ground service pressure decreases to less than 5 psig. As the RPM increases at takeoff and during flight, the tank pressure increases up to approximately 22 psig. Pressure in both tanks should increase evenly prior to takeoff. An air filter is located in the air line between the charging valve and the tanks to prevent contamination from the engine bleed air or the preflight pressurization. Check valves at each of the tank pressurization inlets increase flight reliability for retaining tank pressure. No pressure relief valve is required for flight operation.

6-9. FUEL LINES - The fuel lines consist of rigid aluminum and flexible sections. A fuel flow proportioner equalizes fuel flow from the two tanks. Located between the fuel proportioner and tank outlet check valve for each tank is a fuel filter. These filters minimize contamination of the proportioner and engine fuel control. The tank outlet check valves prevent flow back into the tanks in the event of loss of pressure in one tank. The aft tank check valve has a 0.050-inch orifice to provide for thermal pressure relief for trapped fuel in the engine feed lines. A manual fuel shutoff valve is located between the proportioner and engine fuel intake. The valve is detented in a spring-loaded open position and is safety-wired in the open position for flight.

6-10. LUBRICATION SYSTEM - The vented, pressurized, closed-circuit lube system is designed to furnish oil to parts which require lubrication during engine operation. After oil has been supplied to these parts it flows to the sumps where it is recovered and recirculated throughout the system. All system components are engine furnished and engine mounted.

Refer to section I of General Electric Jet Engine CF700 Maintenance Manual SEI-133 for a detailed description of the lubrication system.

6-11. <u>FUEL CONTROL SYSTEM</u> - A combination hydraulic and electrical manual throttle provides the pilot with a primary and backup control of the jet engine main fuel control, respectively. An automatic electronic throttle control subsystem controls the jet thrust during lunar simulation. The pilot can manually override or disengage the automatic throttle clutch at any time. Overrride forces are usually high (25 to 30 pounds), and disengagement is the preferable means of coming out of the autothrottle mode. The manual hydraulic system (figure6-1) consists of the manual throttle, two hydraulic actuators, a motor-operated cross-over valve, a temperature compensator with a volume indicator and hydraulic lines. Located on the manual throttle is a Sim Release switch and an Emergency-Normal switch.

6-12. The two hydraulic actuators provide a closed loop jet engine throttle system. Movement of the manual throttle results in movement of the fuel control cam mounted on the jet engine (figure 6-2). The spring-operated temperature compensator absorbs the pressure buildup caused by temperature changes in the throttle system. The Sim Release switch disengages the autothrottle clutch for manual control of the engine fuel control.

6-13. An emergency electric jet throttle switch permits pilot operation of a motor-operated cross-over valve which interconnects the two sides of the throttle hydraulic system, thus allowing the pilot to operate the throttle lever with negligible back pressure. This switch also simutaneously engages the electrical throttle control actuator used as the automatic electronic throttle to control jet thrust during the lunar simulation mode. The electrical control

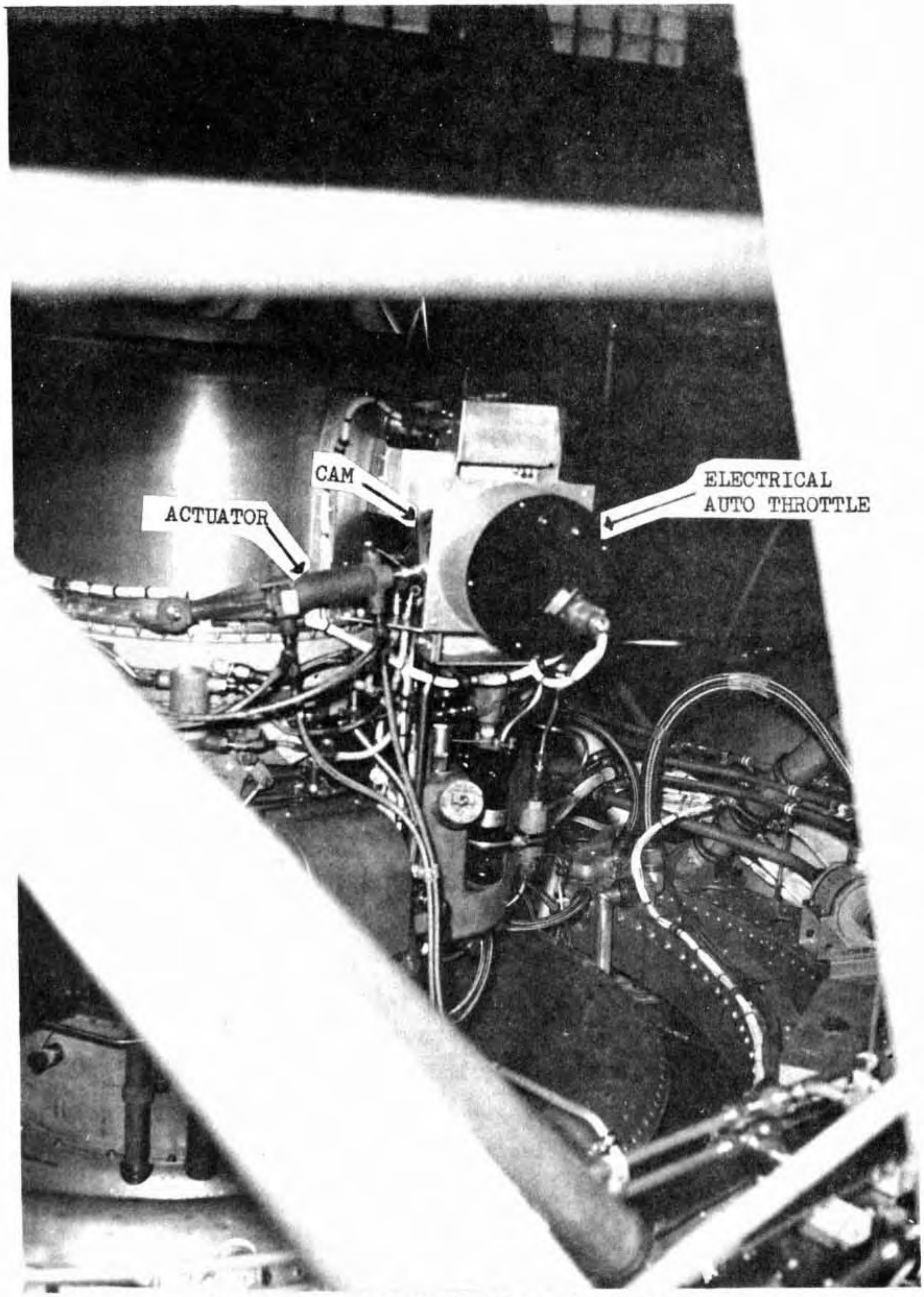



Figure 6-2. Jet Engine Throttle Control

originate from a synchro installed on the jet engine throttle. Refer to section XI for a description of the electrical and electronic control circuits. An operational check of the emergency electrical control can be made without need for reservicing of the primary control.

NOTE

The emergency electric throttle operates slower ($6^{\circ}$.sec) than the manual hydraulic throttle.

WARNING

The power source of the backup electrical throttle is derived from the primary AC bus (phase A). Thus, the emergency throttle is inoperative if the primary AC or DC busses become inoperative.

## 6-14. OPERATIONAL CHECKOUT

6-15. An operational checkout of the jet engine power plant and associated systems is performed by the following procedures outlined in Report Number 7260-928058, Jet Engine Functional Ramp Test. Test equipment requirements are listed in paragraph 3.3 of Report Number 7260-950014.

## 6-16. SYSTEM TROUBLESHOOTING

6-17. Jet engine system troubleshooting can be initiated by performing the steps outlined in paragraphs 4.0 through 4.4 of Jet Engine

Functional Ramp Test, Report Number 7260-928058. For assistance in troubleshooting the jet engine system, refer to paragraph 4.2.1 of Failure Mode Analysis Report Number 7260 -950014.

6-18. REMOVAL AND INSTALLATION PROCEDURES

6-19. The removal and installation procedures for the jet engine, accessories, jet fuel storage tanks, and hydraulic autothrottle system are provided. A list of ground support equipment required for removal of the jet engine is provided in table 6-1. Refer to section II for additional description of the ground support equipment.

TABLE 6-1 GROUND SUPPORT EQUIPMENT

| Nomenclature | Part Number | Use and Application |
|---|---|---|
| Vertical Hoist Sling | 7161-753001 | Supports Engine in Hoist |
| Hoist Adapters | | Provides Connections |
| Maintenance Stand | 1740-554-1667 | Supports and Transports Engine |
| Gimbal Assembly Adapter Kit | 7161-752002A | Mounts Engine to Maint Stand |
| Chain Hoist | | Provides Lifting Force to Eng |
| Horizontal Hoist Sling | 7161-753003 | Supports Engine in Hoist |

6-20. TURBOFAN JET ENGINE REPLACEMENT

6-21. The instructions provide: (1) engine removal from the LLTV, (2) accessory removal, (3) removal of the replacement engine from its shipping container, (4) engine buildup and (5) installation of the engine into the LLTV. See figures 6-3 and 6-4 for engine installation information. Other illustrations in this section highlight the details of engine buildup.

NOTE

Do not stand on the LLTV structure; use ladders or maintenance stands for access.

6-22. REMOVAL FROM LLTV - Perform the following procedures in order listed:

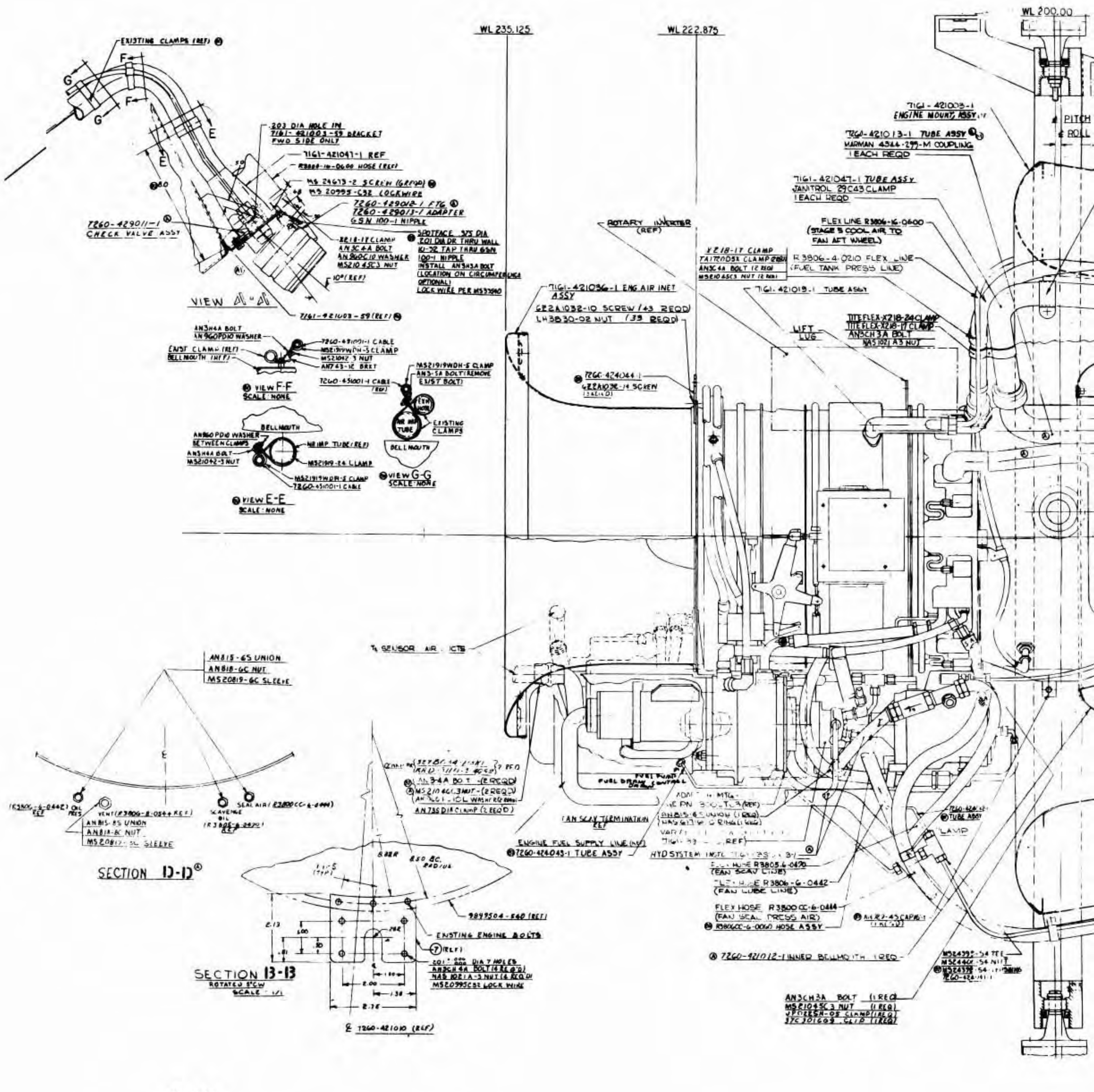
A. Install jet engine fan and compressor inlet covers.

B. Relieve the tension of the center body stress cables by unscrewing their turnbuckles and swing the cables clear of the center body structure.

C. Attach the lift ring of the jet engine vertical hoist sling to an overhead hoisting device (chain fall), having a hook height of at least 22 feet, and attach the hoist adapters to the engine mount pivot fittings. (Refer to figure 6-5).

NOTE

The emergnecy electric throttle operates slower ($6^{o}$/sec) than the manual hydraulic throttle.


WL 235.125
WL 222.875
WL 200.00
EXISTING CLAMPS (REF)
VIEW A-A
7260-429011-1 CHECK VALVE ASSY
7161-421047-1 REF
7161-421003-59 (REF)
7260-429012-1 FTG
7260-429013-1 ADAPTER
GSN 100-1 NIPPLE
VIEW F-F
SCALE: NONE
VIEW E-E
SCALE: NONE
VIEW G-G
SCALE: NONE
BELLMOUTH
EXISTING CLAMPS
ROTARY INVERTER (REF)
7161-421036-1 ENG AIR INLET ASSY
7260-424044-1
7161-421003-1 ENGINE MOUNT ASSY
7260-421013-1 TUBE ASSY
MARMAN 4344-299-M COUPLING
1 EACH REQD
7161-421047-1 TUBE ASSY
JANITROL 29C43 CLAMP
1 EACH REQD
FLEX LINE R3806-16-0600 (STAGE 5 COOL AIR TO FAN AFT WHEEL)
R3806-4-0210 FLEX LINE (FUEL TANK PRESS LINE)
7161-421019-1 TUBE ASSY
LIFT LUG
PITCH
ROLL
T5 SENSOR AIR DUCTS
AN815-6S UNION
AN818-6C NUT
MS20819-6C SLEEVE
SECTION D-D
SECTION B-B
ROTATED 5° CW
SCALE: 1/1
9849504-640 (REF)
EXISTING ENGINE BOLTS
7260-421010 (REF)
FUEL DRAIN
FAN SCAV TERMINATION REF
ENGINE FUEL SUPPLY LINE (REF)
7260-424045-1 TUBE ASSY
HYD SYSTEM INSTL
FLEX HOSE R3806-6-0442 (FAN LUBE LINE)
FLEX HOSE R3800CC-6-0444 (FAN SEAL PRESS AIR)
R3800CC-6-0060 HOSE ASSY
7260-421012-1 INNER BELLMOUTH 1 REQ
AN3CH3A BOLT (1 REQ)
MS21045C3 NUT (1 REQ)

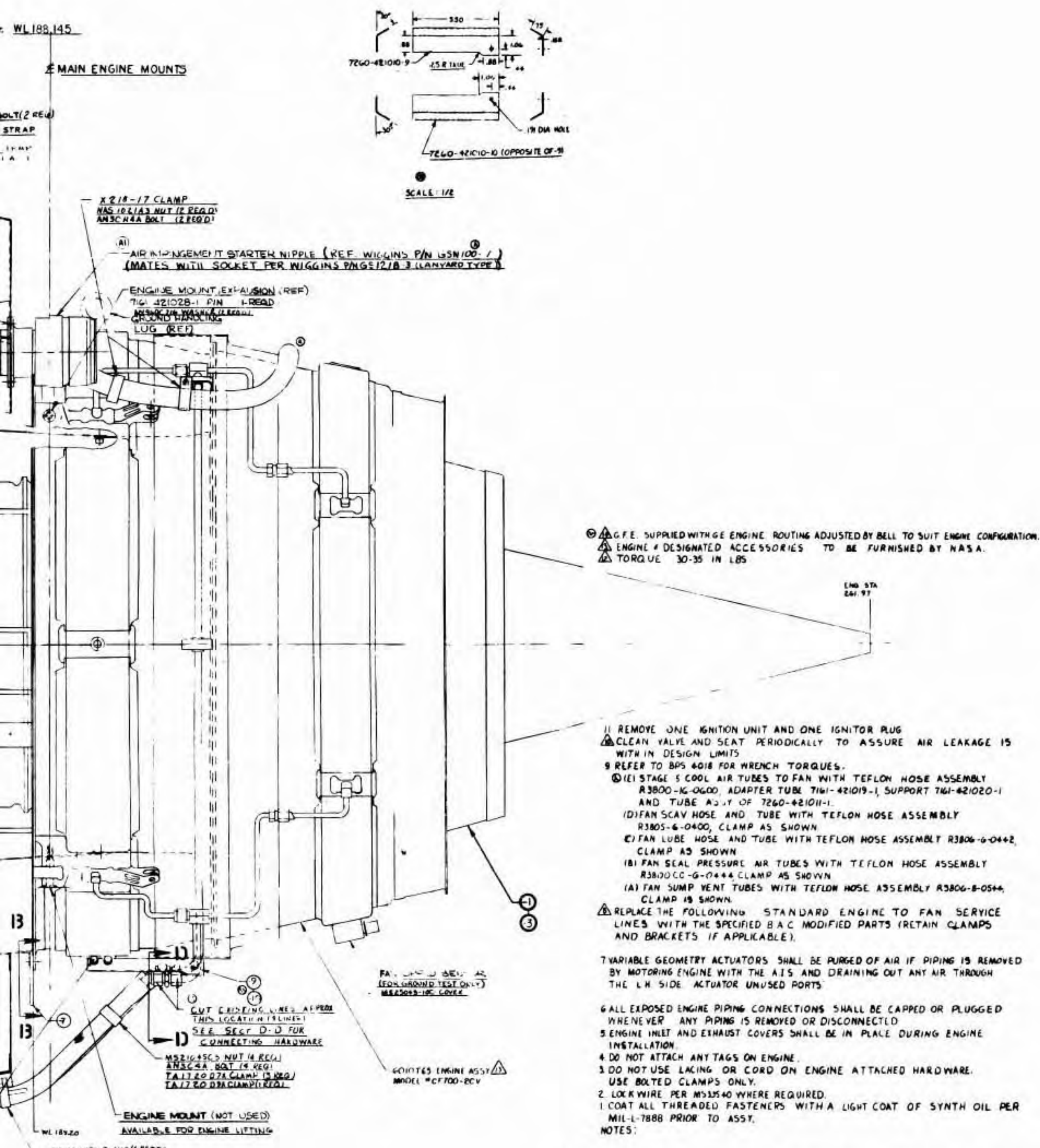
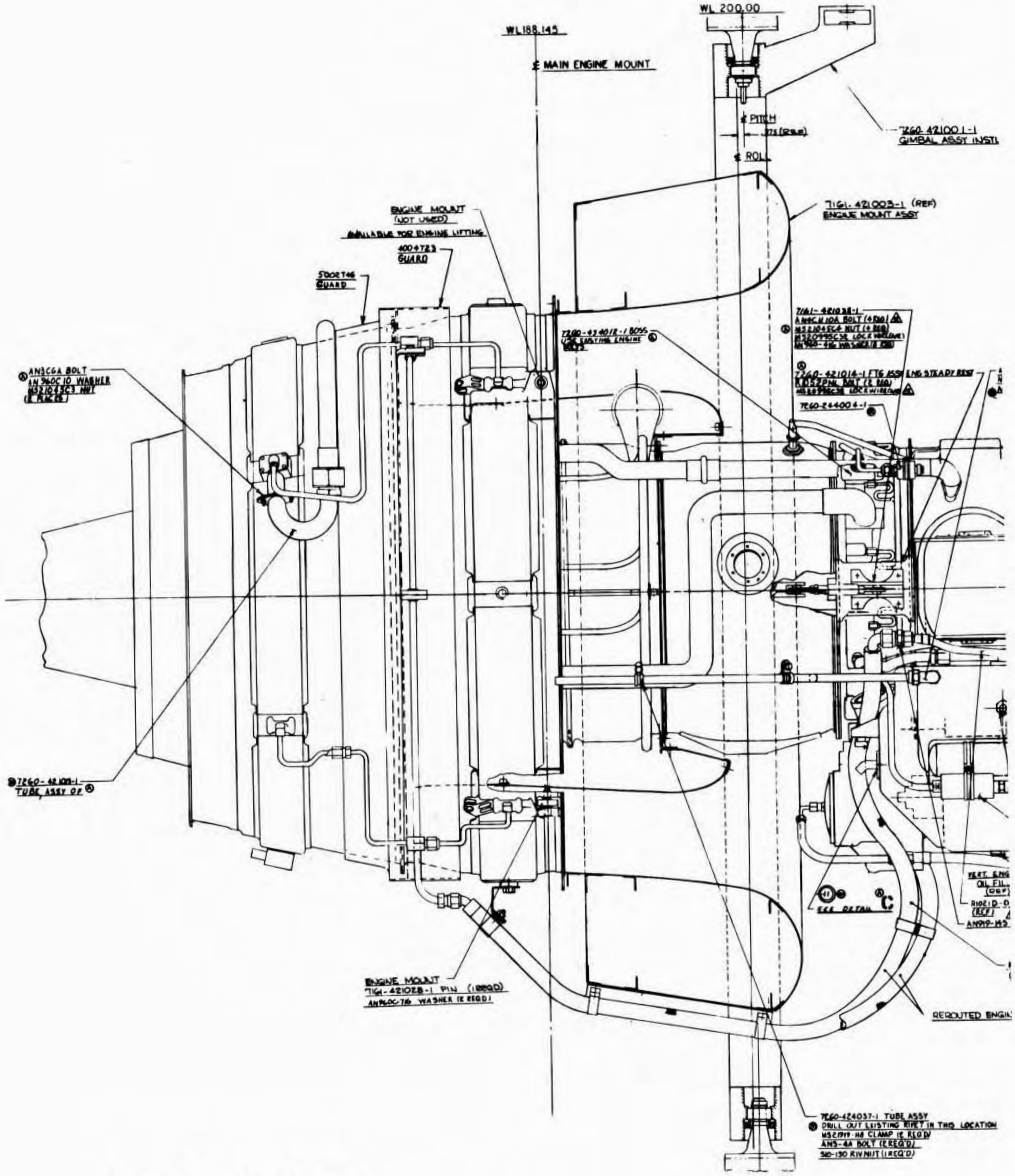



Figure 6-3. Jet Engine Schematic


WL 200.00
WL 188.145
℄ MAIN ENGINE MOUNT
℄ PITCH
℄ ROLL
7260-421001-1
GIMBAL ASSY INSTL
7161-421003-1 (REF)
ENGINE MOUNT ASSY
ENGINE MOUNT
(NOT USED)
AVAILABLE FOR ENGINE LIFTING
4004723
GUARD
5002746
GUARD
7260-424014-1 FTG ASSY ENG STEADY REST
7260-264004-1
SEE DETAIL C
REROUTED ENGI
ENGINE MOUNT
7161-421028-1 PIN (1 REQD)
AN960C-716 WASHER (2 REQD)
7260-424037-1 TUBE ASSY
DRILL OUT EXISTING RIVET IN THIS LOCATION
MS21919-H8 CLAMP (2 REQD)
AN3-4A BOLT (2 REQ'D)
510-130 RIVNUT (1 REQ'D)

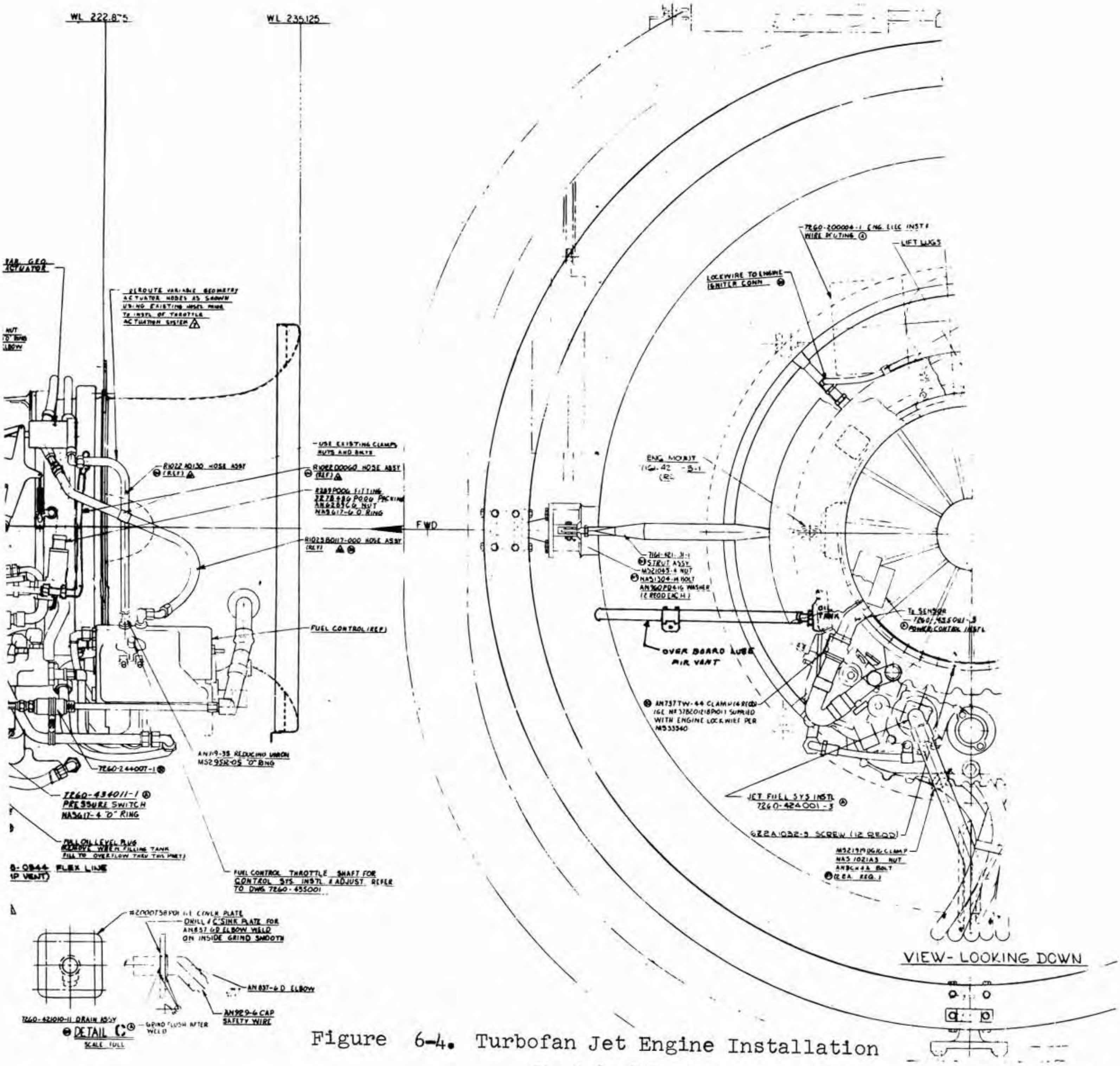



Figure 6-4. Turbofan Jet Engine Installation

**Sheet 1 of 2**

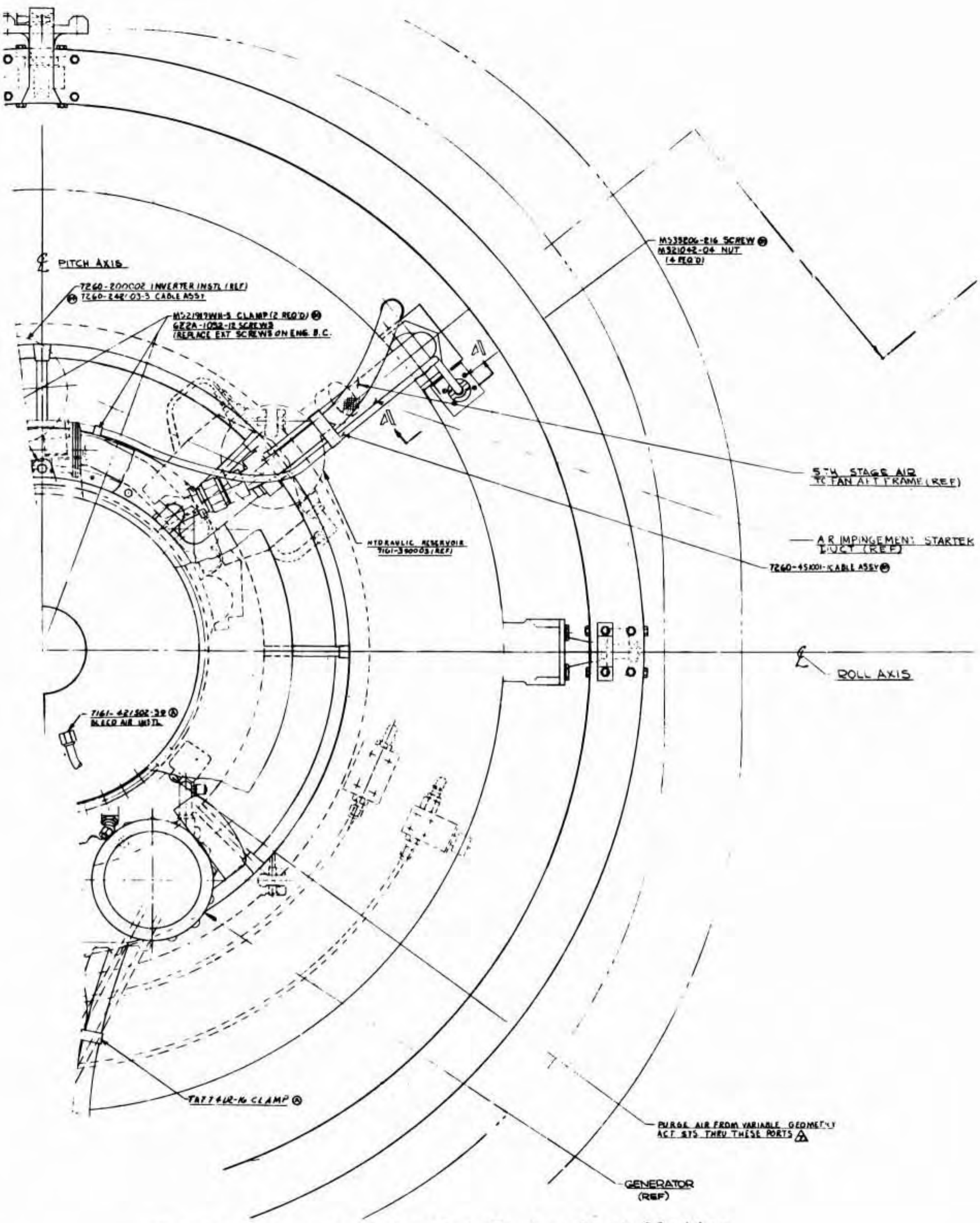



Figure 6-4. Turbofan Jet Engine Installation
Sheet 2 of 2

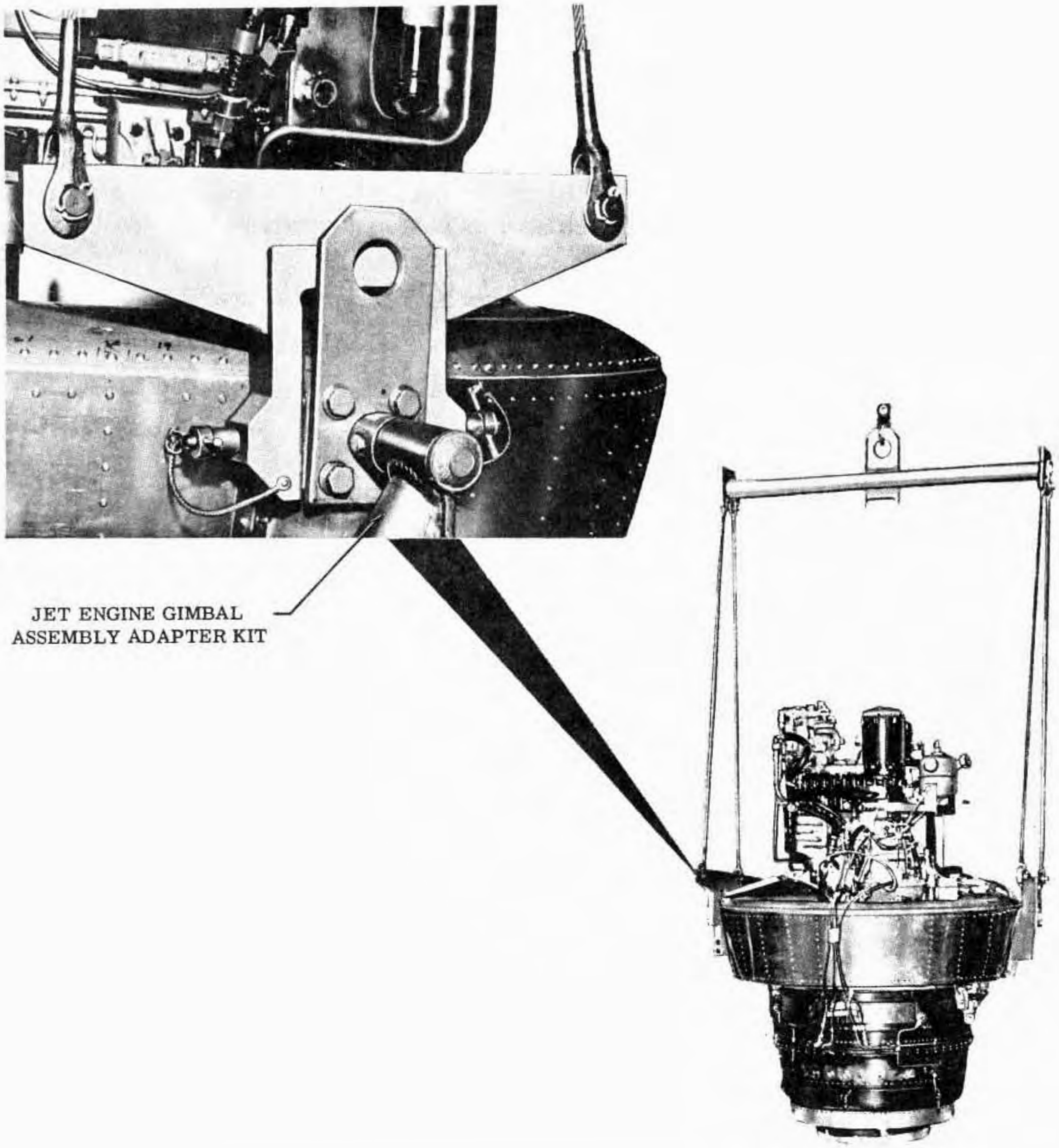



Figure 6-5 Jet Engine Vertical Hoist Sling Attachment

D. Remove slack from hoist cables, but do not take up any weight with hoist.

CAUTION

The overhead hoist is attached at this time as a precautionary measure. Attempting to raise the engine at this time will result in lifting the entire vehicle off the ground.

E. Disconnect, tag, and place dust covers on connectors P88, P125, P139, and P330. Remove the three electrical cable clamps. Remove clamps from wiring harness, as necessary, to free harness from engine. Lay harness back over gimbal ring. Identify and store clamps and mounting hardware for installation.

CAUTION

Closed loop hydraulic throttle system normally has 100 to 120 psi of hydraulic pressure trapped in system. Observe throttle system compensator, while releasing trapped pressure to zero. Piston rod should move inboard as pressure bleeds off.

F. Remove hydraulic flex lines to engine throttle acutator at actuator end. Remove all attaching clamps all the way to inner gimbal ring. Cap actuator ports with clean pressure caps. Use clean pressure plugs for flex lines.

G. Close manual fuel shut off valve. Safety wire in closed position.

NOTE

Have container ready to catch fuel draining from fuel flex line.

H. Disconnect main fuel flex line to engine at rear roll gimbal **point.** Cap and Plug disconnected fuel lines with press type cap and plug.

I. Remove engine air start adapter, part no. 7260-429013-3.

WARNING

Ensure that hydraulic system gage reads zero before opening gimbal hydraulic fittings.

J. Disconnect and cap hydraulic pressure and return flexible lines at manual shutoff valve and filter, respectively, on engine. Use clean press type caps and plugs.

K. Safety wire manual shutoff valve in closed position.

L. Disconnect yaw compensator bleed line and JP4 tank bleed air source.

M. Remove bolt and washer securing roll actuator to engine. Allow roll actuator to swing down and replace bolt and washer on actuator. Safety wire roll actuator in a position to prevent damage to actuator.

N. Check that all slack is out of engine vertical hoist sling cables.

O. Cut safety wire and remove four bolts, washers, and retaubers securing engine mount assembly to forward roll trunnion (below engine steady rest).

P. Repeat step "O" at aft roll trunnion.

CAUTION

Ensure that roll actuator is not damaged as engine is raised from vehicle.

Q. Carefully raise engine with overhead hoist so that engine mount clears forward and aft roll trunnions. Perform visual check that all lines are disconnected.

NOTE

The tail cone may be removed from the turbofan jet engine at this time if sufficient clearance is not available.

S. Raise engine until exhaust cone is clear of center body and move hoisting device and engine clear of the LLTV.

T. Reconnect stress cables and tighten to 18-inch/pounds with torque wrench.

6-23. INSTALLATION ON MAINTENANCE STAND - The turbofan jet engine is installed on the jet engine gimbal assembly adapter kit which is mounted on the parallel rail engine maintenance stand for accessory removal and buildup. This is also necessary to rotate the engine from a vertical to a horizontal attitude, or vice versa. The following procedures apply when the turbofan jet engine is supported on the jet engine vertical or horizontal hoist sling. (See figure 6-6.)

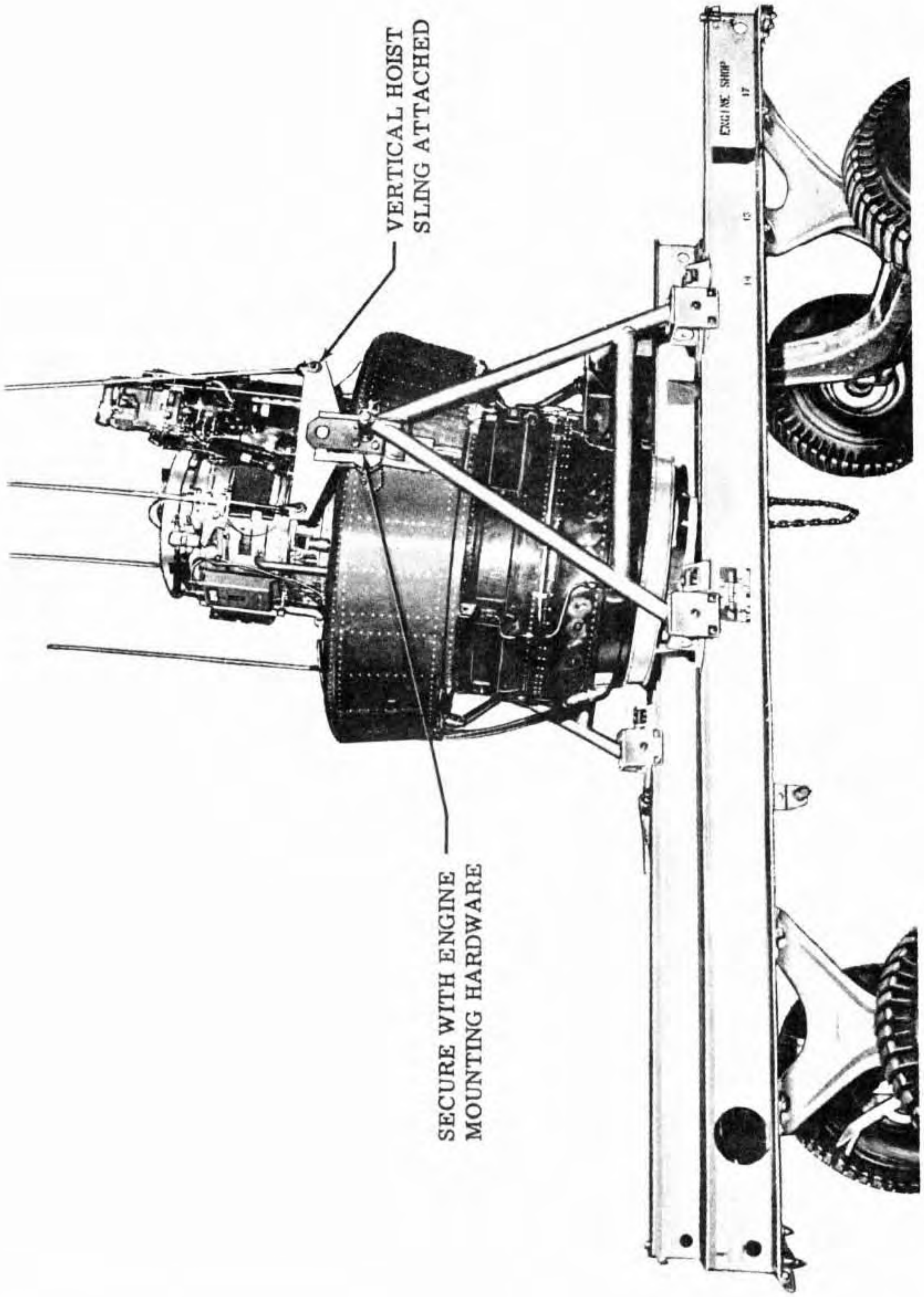



Figure 6-6 Turbofan Jet Engine Installed on Maintenance Stand

A. Position the engine between the adapters on the parallel rail maintenance stand.

B. Align the mounting points on the engine mount assembly with the trunnions on the adapter A-frames.

NOTE

Trunions must be oriented and locked in the position corresponding to the engine attitude. Lift eyes on the adapter trunnions should be up for vertical installation of engine.

C. Secure the engine mount to the adapter trunnions with bolts, nuts, and washer removed in paragraph "O" of section 22.

D. Adjust position of adapter A-frames on engine and stand rails so that engine is clear to rotate. Tighten adapters on rails.

6-24. ENGINE AIR INLET REMOVAL - The engine air inlet is removed and the forward lift adapter of the horizontal hoist sling is attached according to the following procedures before the accessories, fan inlet, and engine mount are removed. (See figure 6-7.)

A. Remove engine air inlet cover and disconnect and cap piping conncetors on $T_2$ sensor air ducts.

B. Remove the following 10/32 size screws.

1) Three located at top of throttle box.
2) Three located at inboard side of throttle box.
3) Two located at bellmouth to engine parting surface.

C. Remove clamps holding throttle limit microswitch leads to bracket on bellmouth.

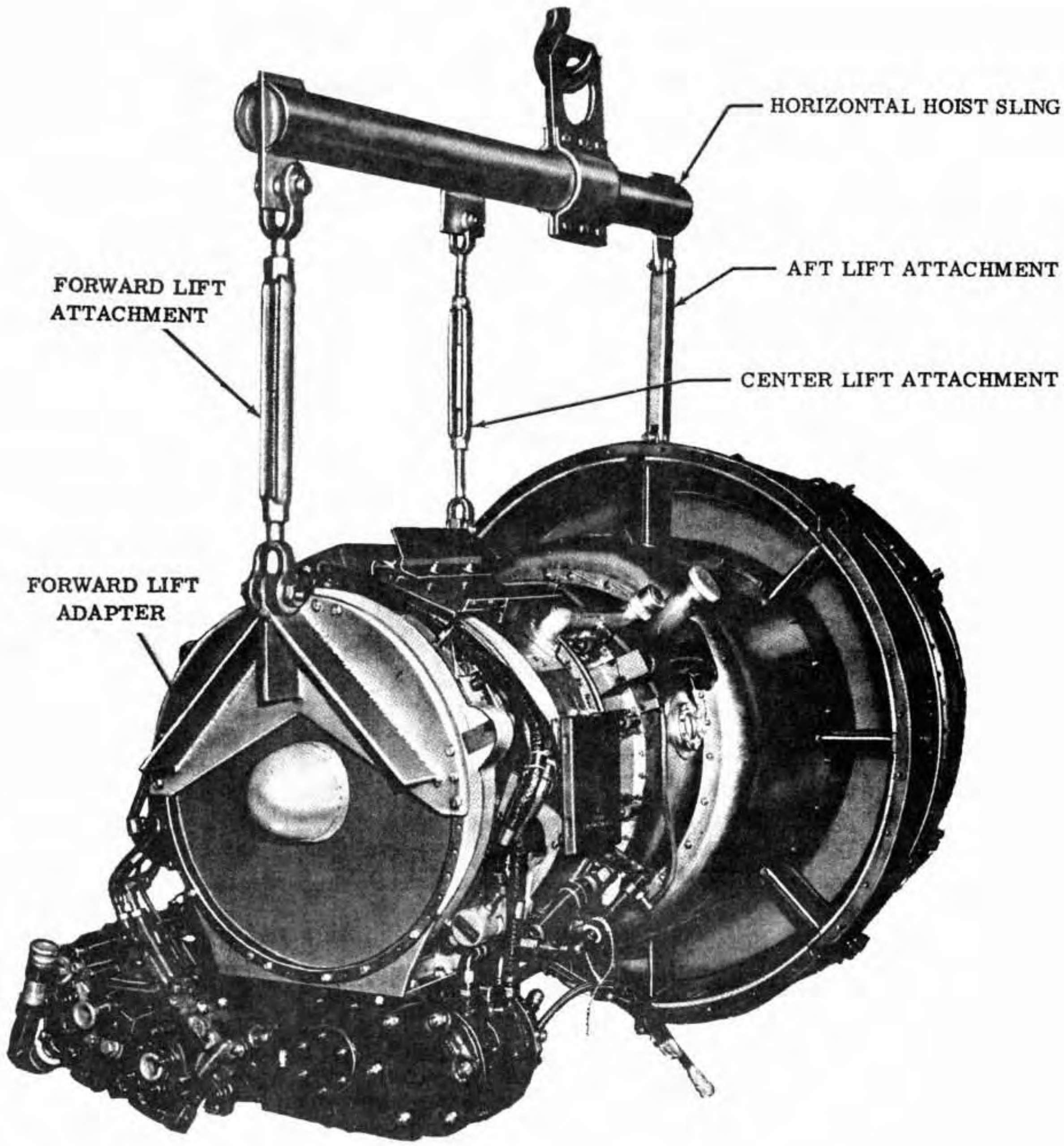



**Figure** 6-7 **Horizontal Hoist Sling Forward Lift Attachment**

D. Remove the 32 screws (10/32 size) and nuts, and 13 screws (10/32) holding the bellmouth to engine.

NOTE

Screws removed at clamp locations along parting surface are slightly longer. Note clamp position, specifically at throttle actuator mounting bracket and engine support cable bracket.

E. Identify and store mounting hardware with engine air inlet for installation.

F. Align the horizontal hoist sling forward fitting with flange on engine and secure with 10 bolts and nuts provided with jet engine horizontal hoist sling. Install lift eye bolt in engine fan case.

NOTE

The jet engine horizontal hoist sling is attached to the turbofan jet engine at this time for removal from the engine stand prior to removal of the fan inlet.

G. Install cover on compressor inlet

6-25. ACCESSORY REMOVAL - For convenience, the tail cone is removed with the turbofan jet engine vertical on the maintenance stand. The engine is then rotated and locked in the horizontal attitude for the removal procedures present in the following paragraphs. Identify and retain all mounting hardware.

WARNING

Use extreme care when rotating the engine. Use a hoist, attached to the forward lift lug on the engine to control it during rotation. Ensure that locking pin is firmly seated. Do not rotate engine with tail cone installed.

6-26. FLEXIBLE HOSES - Five flexible hoses are installed in place of the original engine lines to clear the engine mount assembly and fan inlet fairing. These lines are: (1) fan seal pressure air line, (2) fan lubrication line, (3) fan scavenge line, (4) fan sump vent line and (5) the engine fuel supply line (See figure 6-4.) Tag and remove these lines and cap and identify all fittings and openings. In addition, the flexible line from the fifth stage bleed port, which supplies pressure to the JP4 tanks, may be removed at this time. Tag and cap the line and openings. Remove clamps on engine mount and store for safekeeping.

6-27. GENERATOR - To remove, proceed as follows:

A. Note generator orientation and loosen nuts securing generator mounting adapter to upper accessory pad. Identify, tag electrical leads and disconnect from generator.

B. Carefully rotate and disengage generator from accessory drive pad and remove generator.

C. Install cover on accessory pad, using original hardware.

6-28. HYDRAULIC RESERVOIR - To remove only a damaged hydraulic reservoir, proceed as follows:

CAUTION

Cover engine and fan inlets

A. Drain reservoir by removing $\frac{1}{4}$-inch cap at base and catch fluid in suitable container. Replace $\frac{1}{4}$-inch cap.

B. Remove $\frac{1}{4}$-inch fitting and 3/8 inch fitting from forward side of reservoir.

C. Remove 3/8 inch fitting from aft side of reservoir.

D. Remove $\frac{1}{4}$-inch fitting at bottom of reservoir.

E. Remove 10/32 inch bolt and nut at support bracket at rear of reservoir.

F. Remove reservoir from mounting bracket.

6-29. Removal of the hydraulic reservoir during engine change and buildup requires performance of the following:

NOTE

Drain reservoir while engine is in vertical position on the maintenance stand.

A. Remove connector jacks, J88, J125, J139, and J330 from reservoir bracket system.

B. Disconnect and identify all electrical lines to inverter impedance until mounted above the reservoir.

C. Unsolder and identify two leads to M14 Running Time meter.

D. Remove one clamp and one bolt holding hydraulic throttle compensation unit to bracket system.

E. Remove ground leads at lower bracket.

F. Disconnect and identify all electrical leads to power relay K4.

G. Disconnect and identify electrical leads to circuit breaker CB21 on the impedance bracket.

H. Unsolder and identify leads to relay K15.

I. Disconnect and cap or plug all hydraulic lines to reservoir.

J. Remove clamp on lower bracket and clamp on top bracket.

K. Remove four 10/32 inch bolts and nuts mounting top bracket to engine.

L. Remove four 10/32 inch bolts and nuts mounting bottom bracket to engine.

M. Lift out reservoir mounting bracket.

6-30. HYDRAULIC PUMP - To remove, proceed as follows:

A. Disconnect all piping to hydraulic pump. Cap all ports and fittings.

B. Remove four nuts securing hydraulic pump to accessory pad and remove hydraulic pump.

C. Install cover on accessory pad adapter and secure with nuts removed in B.

6-31. INVERTER- To remove, proceed as follows:

A. Remove electrical leads and tag for identification.

B. Remove four 5/16-inch bolts, nuts and washers, and eight washers securing inverter mounting feet to base.

C. Remove inverter.

D. Identify and store hardware for installation.

6-32. INVERTER MOUNTING BASE - To remove, proceed as follows:

A. Remove four self-locking nuts (MS21043-3) securing forward end of base to forward flange.

B. Remove six self-locking nuts (MS21043-3) securing aft end of base of rear flange and remove inverter mounting base.

C. Identify and store hardware for installation.

6-33. TACHOMETER GENERATOR - To remove, proceed as follows:

A. Disconnect two electrical cannon plugs that are safety-wired.

B. Remove four nuts securing tachometer generator to engine oil pump and remove tachometer generator.

C. Cap tachometer generator access opening.

D. Identify and store hardware for installation.

6-34. FAN INLET REMOVAL - Removel of the fan inlet includes the removal of the engine mount assembly (outer fairing) inner bellmouth, and the support ring assembly.

A. Engine mount removal (see figures 6-8 and 6-9.)

1) Support the turbofan jet engine with the forward and aft attachments of the jet engine horizontal hoist sling.

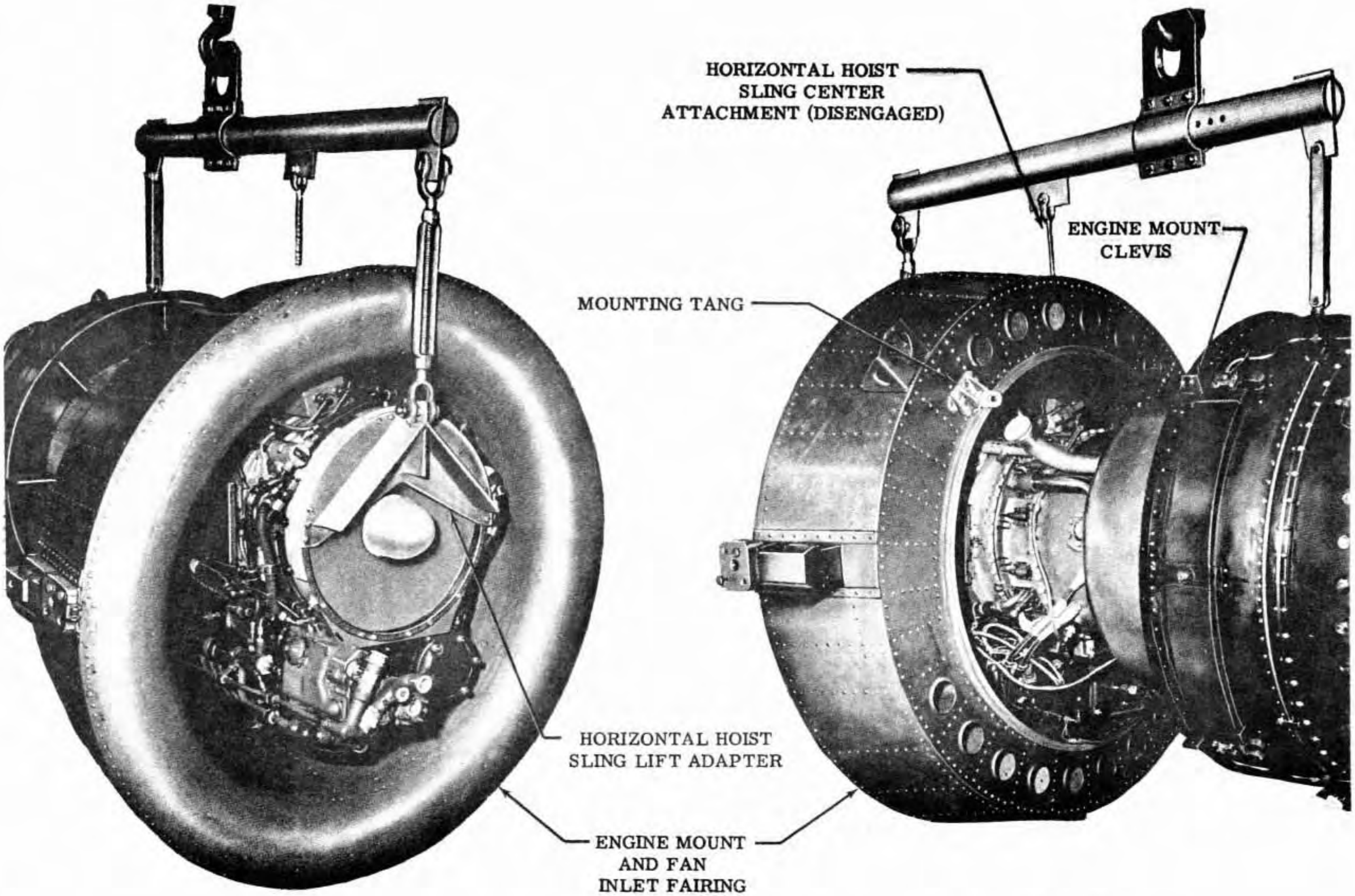
NOTE

The center attachment may be swung up out of the way for access.

2) Relieve tension on steady rest and remove screws securing steady rest mount to engine. Swing steady rest back to clear engine. Identify and store hardware for installation.

CAUTION

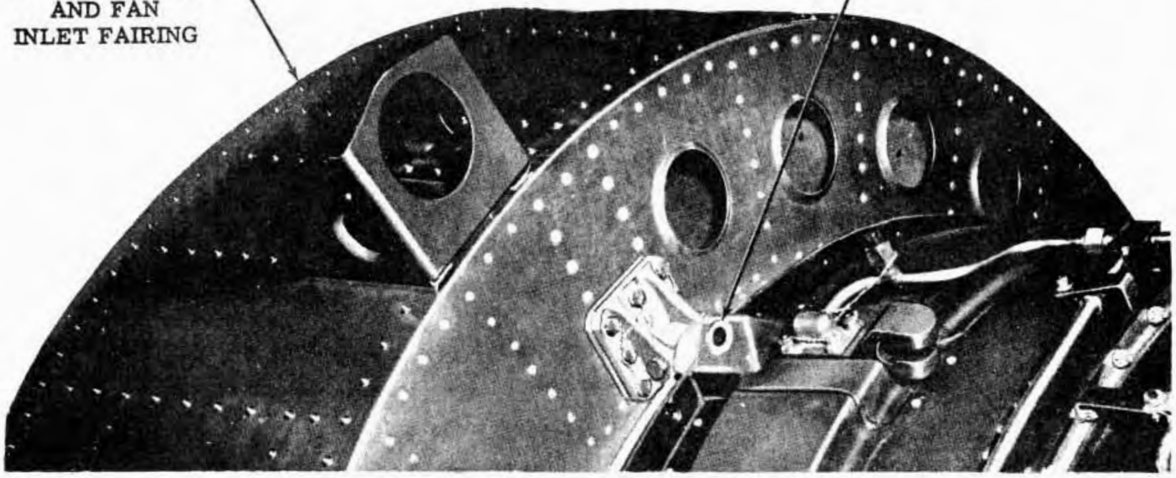
Do not allow the engine mount to drop or otherwise subject the fan inlet fairing to physical damage.



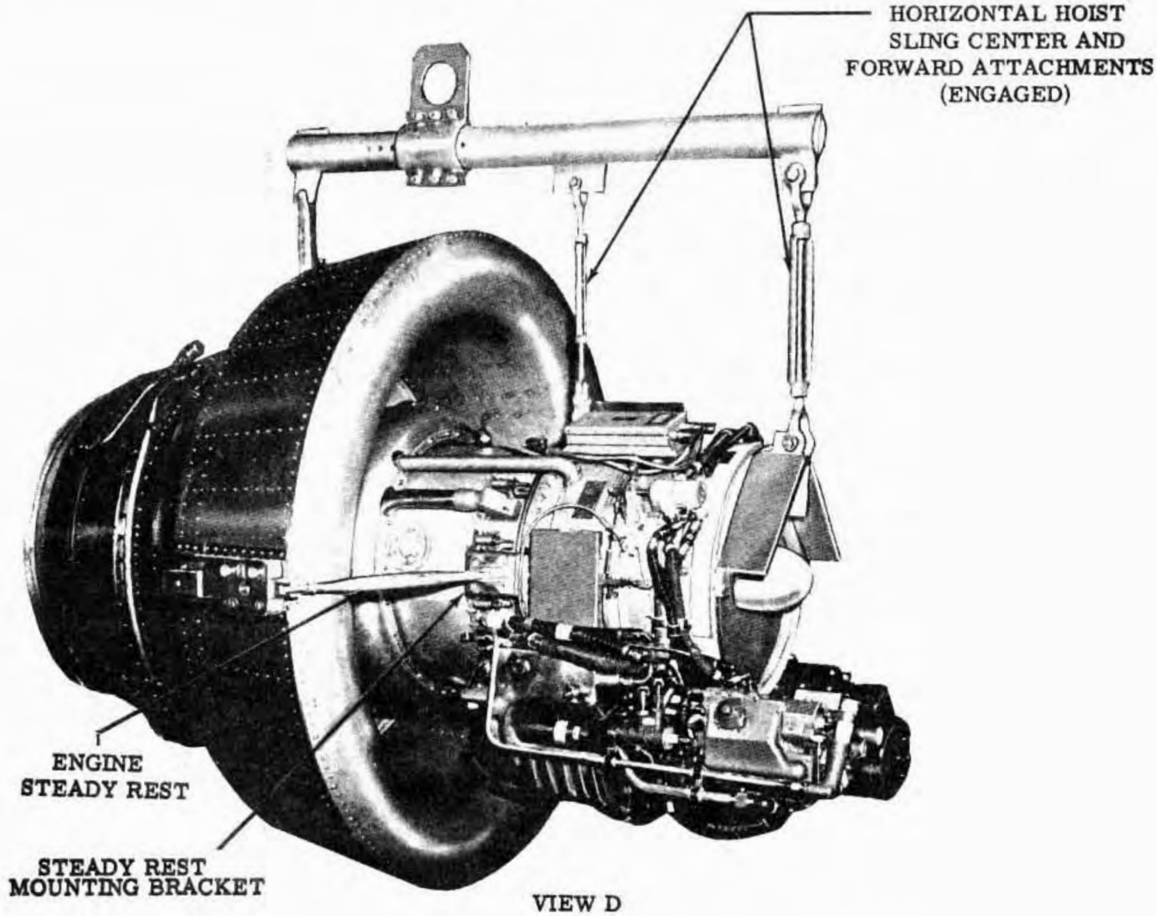

VIEW A

VIEW B

Figure 6-8. Engine Mounted On Sling




VIEW C




VIEW D

Figure 6-9. Engine Mount Assembly

3) Remove fan inlet covers and screens.

4) Remove two engine mount pins (7161-421028-1) securing engine mount tangs to clevis engine mounts.

5) Carefully move engine mount forward until it is in contact with forward attachment of jet engine horizontal hoist sling

6) Engage the center attachment of the jet engine horizontal hoist sling with the engine lift ring and tighten turnbuckle to take up load. Disengage forward sling attachment and swing it back out of the way.

7) Remove engine mount.

8) Reattach forward sling attachment

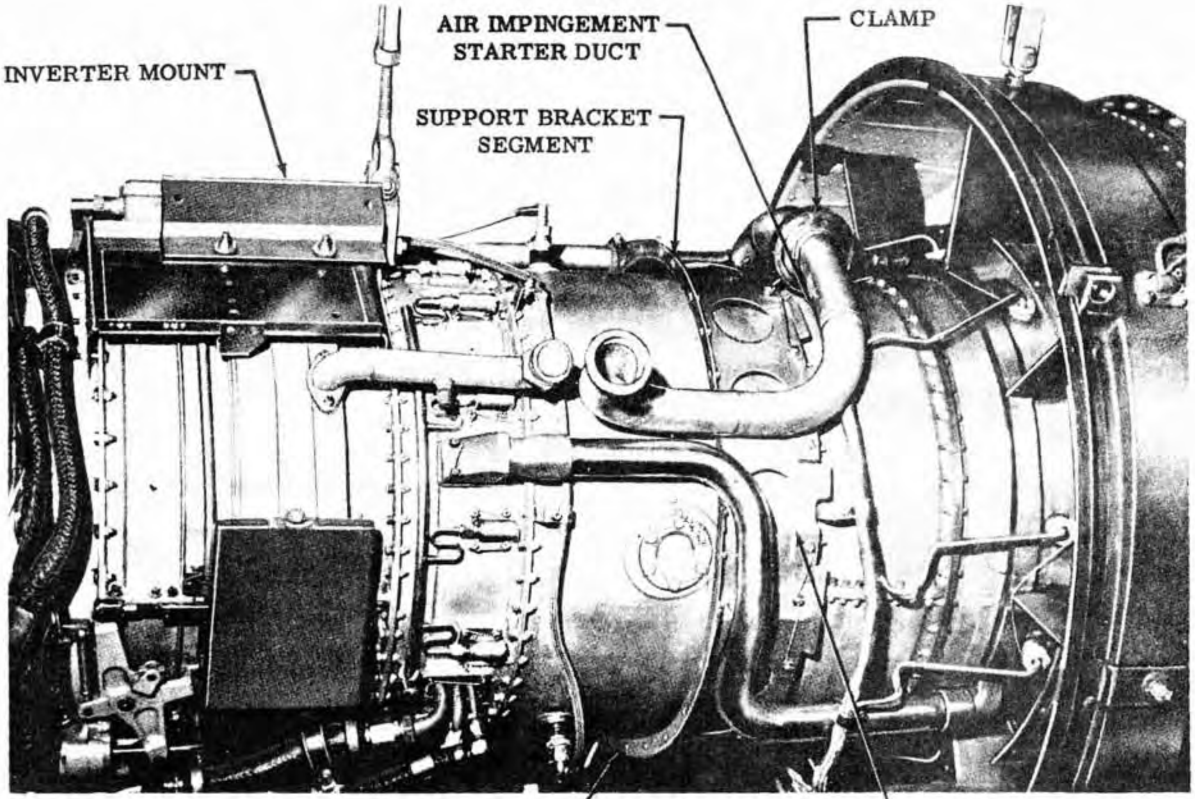
B. Inner bellmouth removal (see figure 6-10.)

1) Remove 10 screws (AN501AD10-7) and washers (AN960C10L) securing the two halves of the inner bellmouth together. Identify and store hardware for installation.

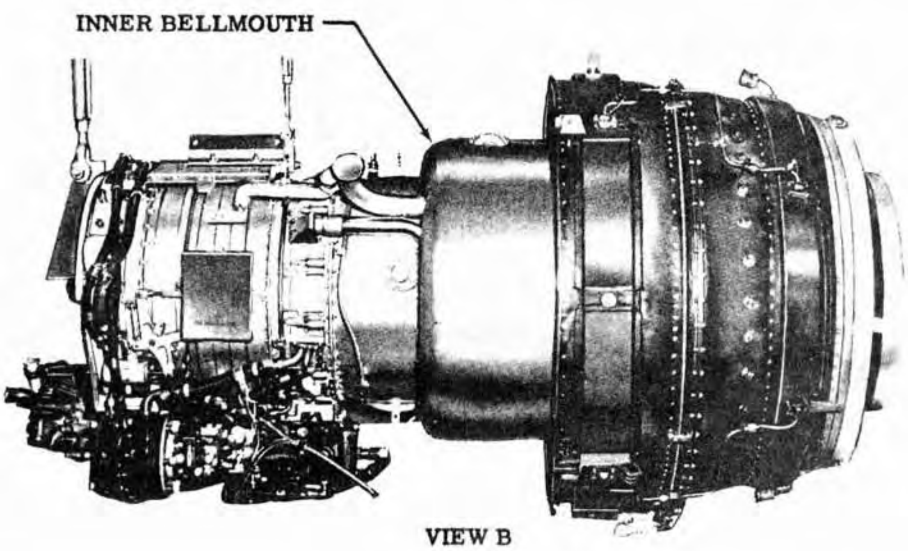
2) Remove 24 screws (AN501AD10-7) and washers(AN960C10L) securing aft end of inner bellmouth halves to engine. Identify and store hardware for installation.

3) Remove 26 screws (AN501AD10-7) and washers (AN960C10L) securing forward end of inner bellmouth halves to support ring assembly. Remove bellmouth. Identify and store hardware for installation.

4) Loosen clamps and remove air start tube assembly quick disconnect coupling. Identify and store hardware for installation.




VIEW A




VIEW B

**Figure 6-10. Support Ring and Inner Bellmouth Assembly**

C. Support ring removal (See figure 6-10.)

1) Remove six screws (AN501AD10-7) and washers (AN960C10L) securing the two halves of support ring together. Identify and store hardware for installation.

2) Remove 16 screws (AN501AD10-7) and washers (AN960C10L) securing support ring to angle brackets on engine flange. Identify and store hardware for installation.

3) Carefully remove the two halves of the support ring assembly.

4) Remove 16 angle brackets and bolts (GE Part Numbers 37B211042P101 and R105P6N) from engine flange. Identify and store angle brackets and hardware for installation.

5) Install 16 bolts (GE Part Number 327B455P012) on engine. (Draw bolts from stock.)

6) Remove theromocouple harness bracket.

7) Replace original fan seal pressure airline, fan lubrication line, fan scavenge line, fan sump vent line, and engine fuel supply line on engine.
(Consult the G. E. Technical representative for additional information.)

6-35. INSTALLATION INTO SHIPPING CONTAINER - The shipping container provided for the turbofan jet engine contains all of the necessary fittings and hardware to support the engine during storage or shipment With the engine supported on the center and aft fittings of the jet engine horizontal sling, it is positioned in the container and supported on the fittings. Replace lifting eye on fan case with manufacturer's part. Wrap the engine in moistureproof paper, with bags of desiccant, and seal the wrapping. Install the cover on the shipping container.

NOTE

The shipping support fittings may be removed from the container for attachment to the engine, for convenience. Consult the G. E. technical representative for additional information.

6-36. JP4 TANK REMOVAL

6-37. The two JP4 tanks are identical. However, their removal procedures vary slightly due to their location on the LLTV.

CAUTION

The JP4 tanks are extremely lightweight construction and will not withstand any abuse or rough handling. Do not drop or dent the tanks. Keep all caps and plugs in place after removal to prevent contamination.

6-38. PIPING CONNECTIONS - Use extreme care when disconnecting fittings to the JP4 tanks so as not to damage the tanks.

6-39. AFT TANK REMOVAL - To remove, proceed as follows:

NOTE

JP4 tanks should be completely drained before removal. Provide support while removing the JP4 tanks.

A. Remove ground wire and electrical plugs.

B. Disconnect pressurization hose assembly at top of tank and disconnect main fuel outlet hose assembly at lower side of tank at fuel filter connection.

C. Remove washer and bolt from the tank forward support arm and attachment.

D. Remove washers and bolts from each hangar and attachment fitting.

E. Disconnect upper diagonal brace and remove.

F. Raise the JP4 tank and saddle and remove from the vehicle.

G. Cap and plug all connections.

NOTE

Refer to paragraph 6-66 for installation procedures

6-40 FORWARD TANK REMOVAL - The JP4 fuel tank and saddle are removed in a similar manner as the Aft tank. However, the tank and saddle are lowered when removing them from the vehicle.

NOTE

Refer to paragraph 6-68 for installation procedures.

6-41. JET ENGINE THROTTLE CONTROL SYSTEM REMOVAL

6-42 The removal procedures are provided for the manual throttle, hydraulic actuator, cross-over valve and temperature compensator.

6-43. MANUAL THROTTLE AND ACTUATOR - To remove the manual throttle and acutator, proceed as follows:

CAUTION

The closed loop hydraulic throttle system normally has 100 to 120 psi of hydraulic pressure in the system at all times. Observe throttle temperature compensator, while releasing trapped pressure to zero. Piston rod should move inboard as pressure bleeds off. Electrical power be discontinued.

A. Remove access panel from left side of cockpit structure.

B. Remove access panel from pilot's console. See Bell drawing 7260-561001.

C. Remove bolt and washer connecting actuator to manual throttle.

D. Remove hydraulic lines to actuator and cap all ports and plug lines.

E. Remove bolt and washer from fixed end of actuator to free actuator.

F. Remove two screws holding throttle position legend plate on cover of pilot's console.

G. Remove eight screws holding cover on pilot's console.

H. Lift cover from pilot's console to provide access to throttle mounting.

I. Remove mounting bolts from throttle gear case.

J. Disconnect electrical leads to throttle and remove throttle.

6-44 CROSS-OVER VALVE - To remove the cross-over valve, proceed as follows:

A. Remove two hydraulic lines to valve. See Bell dwg.7260-435001.

B. Disconnect electrical lead Cannon plug which is safety wired.

C. Remove two lock-nuts from bolts on valve mounting bracket and remove valve.

NOTE

Refer to paragraph 6-50 for installation procedures.

6-45 HYDRAULIC ACTUATOR - To remove the jet engine-mounted hydraulic actuator, proceed as follows:

A. Disconnect hydraulic flex lines from actuator and cap all ports and plug lines.

B. Remove cotter pin, castle nut, washer, and bolt from fuel control cam and actuator piston.

C. Remove cotter pin, castle nut, washer, and bolt from actuator mounting bracket and actuator.

D. Remove actuator from engine.

6-46 TEMPERATURE COMPENSATOR - To remove the temperature compensator, proceed as follows:

A. Disconnect hydraulic lines and cap all ports and plug lines.

B. Remove bolt and mounting clamp and then remove temperature compensator.

6-47 INSTALLATION PROCEDURES

6-48 The installation procedures for replacement of the jet engine in the vehicle, mounting of accessories, installation of JP-4 fuel tanks and manual hydraulic throttle control system are basically in reverse order of removal. Instructions are provided when installation procedures vary from the removal procedures.

6-49 MANUAL THROTTLE AND ACTUATOR - The manual throttle and hydraulic actuator are installed in the reverse order of removal. (Refer to paragraph 6-43).

6-50 CROSS-OVER VALVE - The cross-over valve is installed in the reverse order of removal. (Refer to paragraph 6-44).

6-51 HYDRAULIC ACTUATOR - The jet engine-mounted hydraulic actuator is installed in the reverse order of removal. (Refer to paragraph 6-45).

6-52 TEMPERATURE COMPENSATOR - The temperature compensator is installed in the reverse order of removal. ( Refer to paragraph 6-46).

6-53 MANUAL THROTTLE CONTROL SERVICING AND ADJUSTMENT - Rigging, servicing and adjustment procedures are performed in accordance with those provided in Manual Jet Throttle System Hangar Ground Test Procedure Report Number 7260-928052.

6-54 INSTALLATION OF TURBOFAN ENGINE - The turbofan jet engine is removed from its shipping container with the jet engine horizontal hoist sling. The following procedures may be used as a guide.

A. Remove shipping container cover and open moisture-proof wrapping.

CAUTION

Use extreme care so as not to damage the engine.

B. Install lift eyebolt in engine fan case and attach the center and aft lift fittings of the jet engine horizontal hoist sling to their corresponding lift rings on the engine. Take up slack with overhead hoisting device.

C. Remove all attaching hardware securing the engine to its shipping container fittings.

D. Raise the engine clear of the shipping supports and cover the inlet and exhaust openings.

E. Install the jet engine horizontal hoist sling forward attachment fitting adapter to the engine inlet with 10 bolts and nuts provided. (See figure 6-7).

6-55 FAN INLET INSTALLATION - The fan inlet consists of the engine mount and outer fairing, the inner bellmouth, and the support ring assembly. These items are installed according to the following procedures.

A. Piping removal -- The original fan seal pressure air line, fan lubrication line, fan scavenge line, fan sump vent, and engine fuel supply lines must be removed at this time. Cap all fittings and openings, to avoid contaminating the engine, when lines are removed.

B. Support ring -- To assembly, proceed as follows:

1) Remove 16 bolts (GE Part Number 327B455P012) on engine flange and return to stock. (See figures 6-4 and 6-10 for locations).

2) Install 16 angle brackets and bolts (GE Part Numbers 37B211042P and R105P6N) on flange, using original nuts. Torque bolts to 35 to 39 pounds inches.

3) Carefully align the two halves of the support ring assembly with angle brackets and attach with 16 screws (AN501AD10-7) and washers (AN60C10L). Secure the two halves of the support ring together with six screws (AN501AD10-7) and washers (AN960C10L). Tighten all screws and lockwire.

CAUTION

When aligning the support ring assembly, ensure that cutouts and contoured areas clear engine and piping.

4) Remove cap from air impingement starter duct on engine and connect tube assembly (7161-421048-1) and secure in place with clamp. (See figure 6-4).

C. Inner bellmouth -- To assemble proceed as follows. (see figure 6-10).

1) Align the cutouts in the two halves of the inner bellmouth with engine piping and struts and position them over the support ring assembly.
2) Loosely attach the forward edge of the inner bellmouth to the support ring assembly with 26 screws (AN501AD10-7) and washers (AN960C10L).
3) Loosely attach the two halves of the inner bellmouth to each other with 10 screws (AN501AD10-7) and washers (AN960C10L).

4) Attach the aft edge of the inner bellmouth to the engine fan inlet housting with 24 screws (AN510AD10-7) and washers (AN960C10L).

5) Secure all screws and lockwire.

6-56 ENGINE MOUNT - To assemble, proceed as follows.(See figure 6-9).

A. Carefully position the engine mount and outer fairing over the inlet end of engine as far as it will go (tight against the center lift attachment).

CAUTION

Use extreme care so as not to damage or distort the fan inlet fairing.

B. Attach the forward lift fitting of the jet engine horizontal sling to the lift fitting adapter installed at the engine inlet. Tighten turnbuckle to take up load and release center lift fitting from engine.

C. Carefully position engine mount so that mounting tangs engage with clevis mounts on engine. Secure in two places with threaded engine mount pins. Lockwire engine mount pins.

NOTE

Engine steady rest attachment clevis on engine mount is at 9 o'clock, when viewed from the engine inlet, when mount is correctly positioned.

D. Install steady rest attachment in engine mount clevis.

E. Remove nuts from engine flange mounting screws and install steady rest attachment with original mounting screws. Torque screws to 44-to 48-inch/pounds.

NOTE

The steady rest turnbuckle must be aligned with the engine centerline for correct positioning of steady rest attachment on engine.

F. Engage steady rest turnbuckle with attachment clevis on engine and secure in place.

G. Adjust turnbuckle so that engine centerline is perpendicular to the engine mount. Safety wire turnbuckle.

H. Install fan inlet cover, if required.

I. Complete the air impingement starter ducting installation.

J. Install the turbofan jet engine on the maintenance stand according to the procedures presented in paragraph 6-23.

6-57 TACHOMETER GENERATOR - The tachometer generator is installed in the reverse order of removal. (Refer to paragraph 6-33).

6-58 INVERTER MOUNTING BASE - The inverter mounting base is installed in the reverse order of removal. (Refer to paragraph 6-32) Torque mounting bolts at forward flange to 20 to 25 inch pounds and mounting bolts at aft flange to 44 to 48 inch pounds.

6-59 INVERTER - The inverter is installed in the reverse order of removal. (Refer to paragraph 6-31).

6-60 HYDRAULIC PUMP - The hydraulic pump is installed in the reverse order of removal. (Refer to paragraph 6-30).

6-61 HYDRAULIC RESERVOIR - The hydraulic reservoir is installed in the reverse order of removal. (Refer to paragraphs 6-28 and 6-29).

6-62 GENERATOR - The generator is installed in the reverse order of removal. (Refer to paragraph 6-27).

6-63 FLEXIBLE HOSES - The five items of piping, removed in paragraph 6-26, are replaced with flexible hoses as shown in figure 6-4. Prior to installation, the flexible hoses should be flushed with trichlorethylene, or similar solvent, and air dried to ensure against contaminating the engine.

6-64 ENGINE AIR INLET INSTALLATION - The engine air inlet bellmouth and automatic throttle control mounting bracket are installed with the engine in the horizontal attitude on the maintenance stand.

A. Remove forward lift attachment fitting, if not previously accomplished, and remove air inlet protective cover.

B. Align the $T_2$ air sensor piping on the engine air inlet bellmouth with engine piping and position the engine air inlet bellmouth on engine.

C. Align the serrations of the throttle arm of the throttle control unit with the missing tooth of spline shaft of the engine throttle. Tighten clamping nut.

D. Secure the engine air inlet bellmouth to the engine with the screws removed in paragraph 6-24.D. Torque to 6 to 8-inch pounds and safety as required.

NOTE

The lowest mounting screws are threaded into a tapped plate and do not require nuts.

E. Install engine air inlet cover, if required.

F. Attach the overhead hoisting device to the forward engine lift fitting and take up slack.

CAUTION

The hoist is used to control the engine during rotation from horizontal to vertical on the maintenance stand.

G. Remove locking pin on engine gimbal adapter A-frame and rotate the engine to the vertical position. Install locking pin and disengage the overhead hoist.

H. Install exhaust cone on engine tail pipe.

6-65 INSTALLATION INTO LLTV - The turbofan jet engine is installed into the LLTV in essentially the reverse order of removal.(Refer to paragraphs 6-20 and 6-22). Ensure that sufficient slack is left in the electrical harness at the gimbal crossovers to enable maximum gimbal movement with no strain on the harness. Instructions for installation and mechanical adjustment of the automatic throttle control unit are provided in paragraph 6-49 through 6-53.

6-66 JP-4 TANK INSTALLATION - The two JP-4 tanks are identical. However, their installation details vary due to their location on the LLTV. The following paragraphs provide the procedures for installing the tanks and saddles on the LLTV.

CAUTION

The JP-4 tanks are extremely lightweight construction and will not take any abuse or rough handling. Do not drop or dent the tanks. Keep all caps and plugs in place to prevent contamination.

6-67 AFT TANK INSTALLATION - To install the aft tank, proceed as follows:

A. Raise the JP-4 tank and saddle up and over the frame and lower into position and align the hangers with attachment fittings on the structure (radial hanger forward).

B. Install a bolt through each hanger and attachment fittings; use a washer on either side of attachment fitting as a spacer; and secure with a washer and nut. Tighten finger tight.

C. Install the forward tank support arm between the forward hanger and its attachment point on the structure below the tank hanger. Secure in the same manner previously described.

D. Tighten all attachments.

E. Connect plumbing, ground wire and electrical connectors.

6-68 FORWARD TANK INSTALLATION - The forward JP-4 tank and saddle is installed in a manner similar to the aft tank. However, the radial hanger is pointed aft and its support arm hangs downward from the center body structure.

6-69 PIPING CONNECTIONS - Use extreme care when connecting fittings to the JP-4 tanks so as not to damage the tanks and applying the torques specified on the approved check list.

6-70 JET ENGINE ADJUSTMENTS

6-71 Refer to Jet Engine Functional Ramp Test Procedure, Report Number 7260-928058, for adjustments on jet engine.

6-72 JET ENGINE AND JP-4 FUEL TANKS SERVICING

6-73 Refer to section II of this manual for general servicing procedures for the jet engine and fuel tanks.

SECTION VII

## SECTION VII
## ROCKET PROPULSION

### 7-1 DESCRIPTION

7-2 The rocket system, Figure 7-1, provides the means of maneuvering the vehicle to commanded flight attitudes, and also provides lift control during lunar simulation flight.

### 7-3 ATTITUDE CONTROL ROCKETS

7-4 Two sets of eight attitude control rockets (18) with separate fuel lines provide redundancy. Two motor-operated isolation valves (14) permit the pilot to select the Standard, Test, or Both sets of attitude rockets for flight operation or to isolate one set of attitude rockets in the event of failure of either system and effect a safe landing. The valves are controlled by manual operation of the attitude rockets Test- Standard - Both selector switch in the cockpit. Both sets of rockets may be automatically selected by pilot movement of the hand controller to any hard stop position in the event of difficulty in maintaining attitude control, or by avionics system when switching to Backup in an emergency. Each rocket chamber has an associated solenoid value (17) to control the flow of propellant and a variable orifice hand value (16) to provide ground adjustment of the rocket thrust between 30 and 90 pounds. A guarded attitude control system switch marked ACS-SAFE (figure 1-15) inhibits or arms the attitude control rocket system.

### 7-5 LIFT ROCKETS

7-6 Two lift rockets provide a variable lift thrust nominally equal to one-sixth of the vehicle weight when the remaining five-sixths of the weight is supported by the jet engine system (simulated lunar gravity). Two motor-operated tank isolation valves (19) controlled by the Rocket Propellant switch (figure 1-15) provide isolation capability of the lift system should a leak occur, and shutdown redundancy in event the lift rockets (24) fail to shut down on command by the normal control lever (T-handle, figure 1-14). The throttle valve (22) varies propellant flow such that the lift thrust is proportional to throttle valve crank angle position. This valve is electrically controlled from the cockpit through the T-handle. A friction control knob at the base of the lift rocket T-handle may be rotated clockwise to increase on the T-handle shaft so that the lever will remain in any position. The check valves (23) retain propellant in lines to minimize thrust response time and are matched to minimize thrust imbalance. High pressure refief valves (15) prevent pressure buildup in propellant lines due to thermal expansion and decomposition of residual hydrogen peroxide in fuel lines.

## 7-7 ROCKET INSTRUMENTATION

7-8 Pressure transducers monitor all 16 attitude control rocket chamber pressures for: (1) the stuck valve malfunction detection circuit (activates stuck valve warning light (figure 1-18) and is monitored in telemetry van) and (2) for in-flight ground monitoring. Two pressure transducers monitor both lift rocket chamber pressures for cockpit display and ground monitoring. A third lift rocket transducer supplies signals for the T/W avionic computer, the $H_2O_2$ - remaining computer, and for activating the automatic jet throttle for lunar simulation.

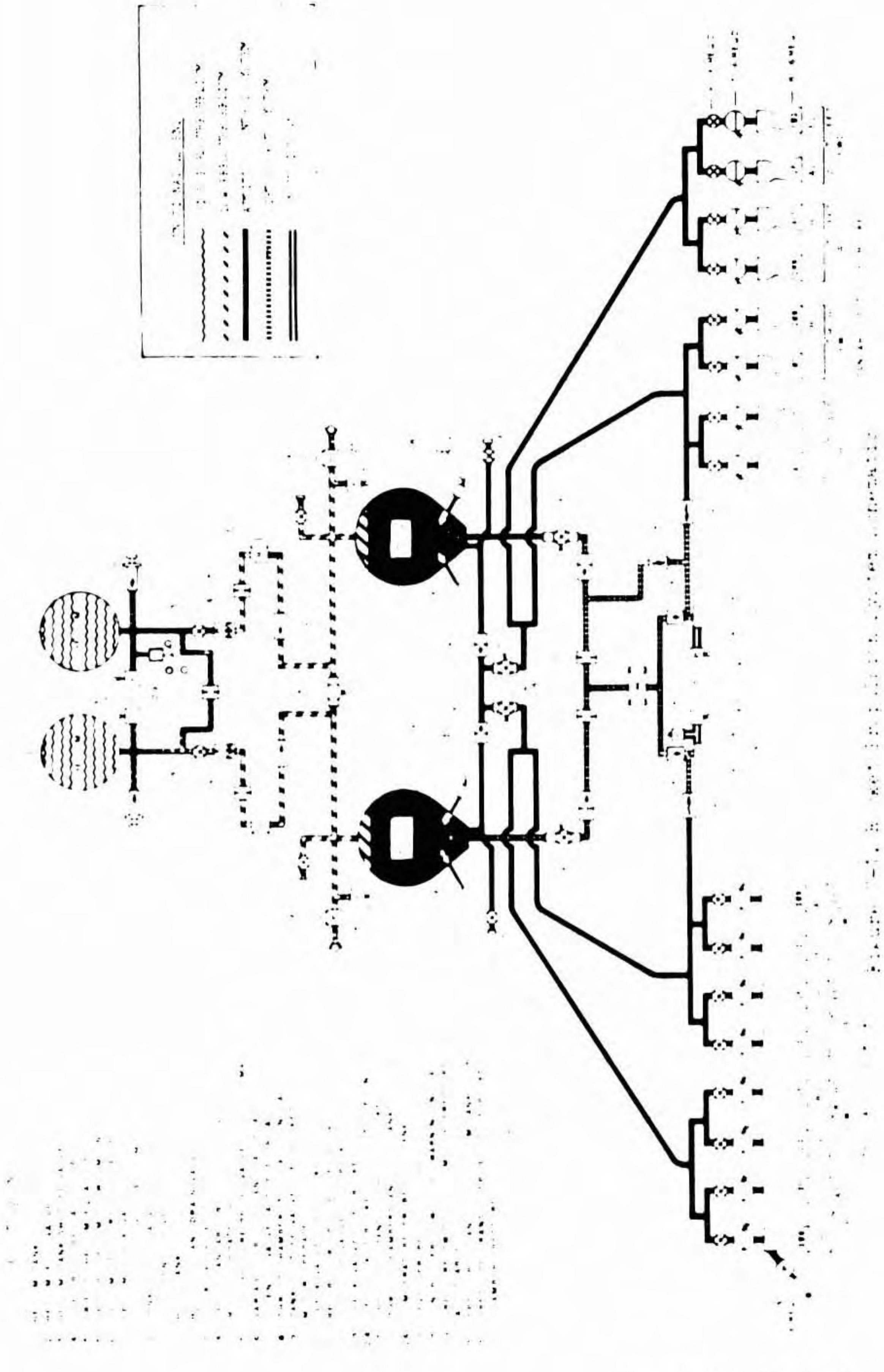
7-9 There are sixteen 90-pound thrust attitude control rockets and two 500-pound thrust lift motors. Decomposition of the 90 percent concentration of hydrogen peroxide ($H_2O_2$) in catalyst packs in each rocket chamber produces superheated steam and oxygen. The high pressure of these gases escaping at the rocket nozzle provides the propulsive force. See figure 7-2.

7-10 Stainless steel lines carry the $H_2O_2$ monopropellant from its two tanks to the thrust chambers. The $H_2O_2$ tanks have a common manifold and mount on the right and left sides of the vehicle main frame. Connecting tubing is symetrical in length and size to provide equal flow from each propellent tank. On/off flow control in the Lift Rocket system is by motor operated shutoff valves. The Lift Rocket Control system consists of a pilot-operated T-handle, a rheostate, a remote throttling position control box, a rotary actuator and a throttle valve. Propellant flow from the propellent tanks is balanced by orifices in the lines.

7-11 The two separate attitude control systems are isolated by motor operated shutoff valves controlled by the pilot operated selector switch. Variable orifice valves and solenoid valves control the thrust of each of the 16 attitude control rockets. Either the "Test" or "Standard", or both systems may be selected for attitude control in the pitch, roll, and yaw axes. Thrust levels are preset by adjustment of variable orifice valves. The on/off solenoid valves provide rapid pulsing operation.

7-12 The propellent system is operated by high pressure helium gas. The common manifold on the two pressure source tanks provides separate or common pressurization of the two $H_2O_2$ propellent tanks. The helium system also has filters, orifices, and regulators.

7-13 Safety features are built into the system in various check valves, relief valves, motor operated valves, and orifices.



7-14 In the helium system rapid pressure transfer between tanks is restricted by an orifice in case of rupture of one section of the high pressure system. Normal serviced pressure is 4000 psig at ambient. temperature of 70° F to 100° F. Downstream of the helium source tanks, two helium regulators provide redundant sources of 495 psig propellent pressure supply. Due to the high flow rate capability, each helium regulator is restricted by an orifice at the regulator inlet. The orifice prevents overpressurization of the $H_2O_2$ tank in the event of complete failure of the helium regulator.

7-15 The $H_2O_2$ tanks are protected from overpressurization by individual relief valves which start opening at about 540 ± 20 psig. The situation occurs when a helium regulator fails to restrict pressures below this level.

7-16 The attitude rocket tubing and lift rocket tubing is protected from trapped pressure buildup by high pressure relief valves which vent on extreme thermal fluid expansion pressures above 650 psig. These relief valves vent the raw $H_2O_2$ into the lift rocket chamber where it is decomposed into less harmful products.

7-17 The $H_2O_2$ tanks are isolated from each other with check valves in the manifold inlet lines to both lift rockets and attitude rocket systems. These valves prevent transfer of propellent from tank to tank during operations.

7-18 The tanks are connected between the pressurization inlet ports by a manifold tubing arrangement. This tubing is normally operational but can be restricted by closing a cockpit actuated motor operated valve, thus making the two tanks completely separate.

## 7-19 INSTALLATION AND REMOVAL

## 7-20 GENERAL

7-21 These procedures are for typical equipment and are for guidance in both removal and installation of units similar to those described.

A. Install $H_2O_2$ tubing and units by routing shown on blue print 7260-460001.

B. Lightly lubricate male fittings with a drop of Flurolube LG-160 before torquing fittings. (Since lubricant is detrimental to rocket operation, avoid getting it into tubing or on wetted surfaces.)

C. Keep components in plastic containers when not actually mounted.

D. Keep caps on openings of components.

E. Support units as required when connecting and torquing them.

F. After clamping tubing in place and making fittings hand tight, verify that installation agrees with drawing by unit indentification and orientation. Also, check flow direction where applicable.

G. When a subsystem is assembled and checked, torque fittings to valves given. Where torque values are not given, refer to tables 7-1, 7-2 (O-ring and gasket seals), and 7-3.

7-22 $H_2O_2$ Tank - (Right tank, attitude starboard, outboard, figure 7-3).

A. Hand tighten shoulder bolts (NAS 1304-7) with washers (AN 960 PD 416) attaching forward and aft trunnion and tank support tube assemblies to main support ring at two points. Refer to Bell drawing 7260-460003.

B. Hand tighten three bolts (AN 4H7A) with bushings (7260-152006-5) attaching forward and aft trunnion and tank support tube assembly to upper corners of center body. Engage both $H_2O_2$ tank trunnions with the tank support trunnions.

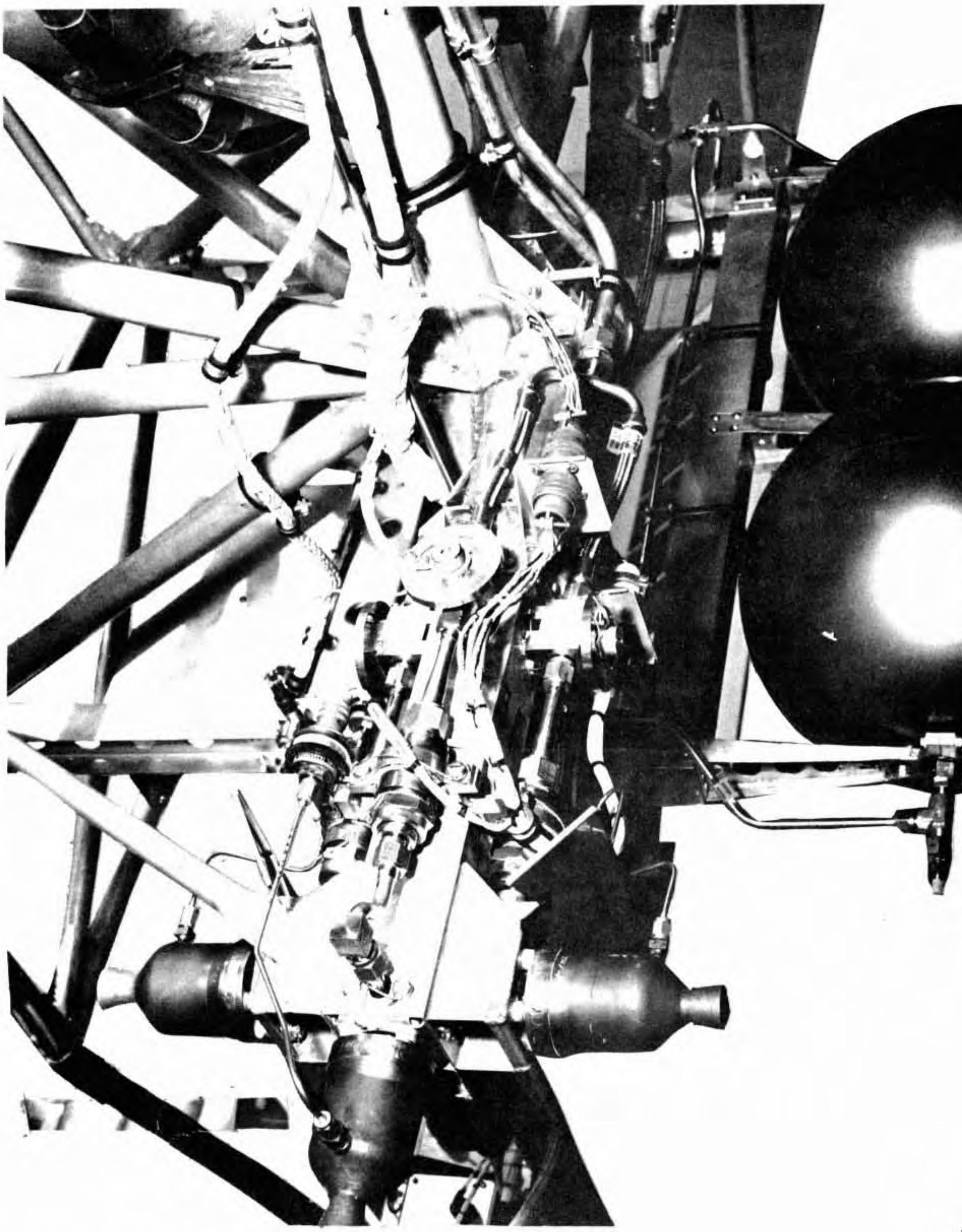


Figure 7-2 Helium Tanks and Typical Attitude Rocket Cluster

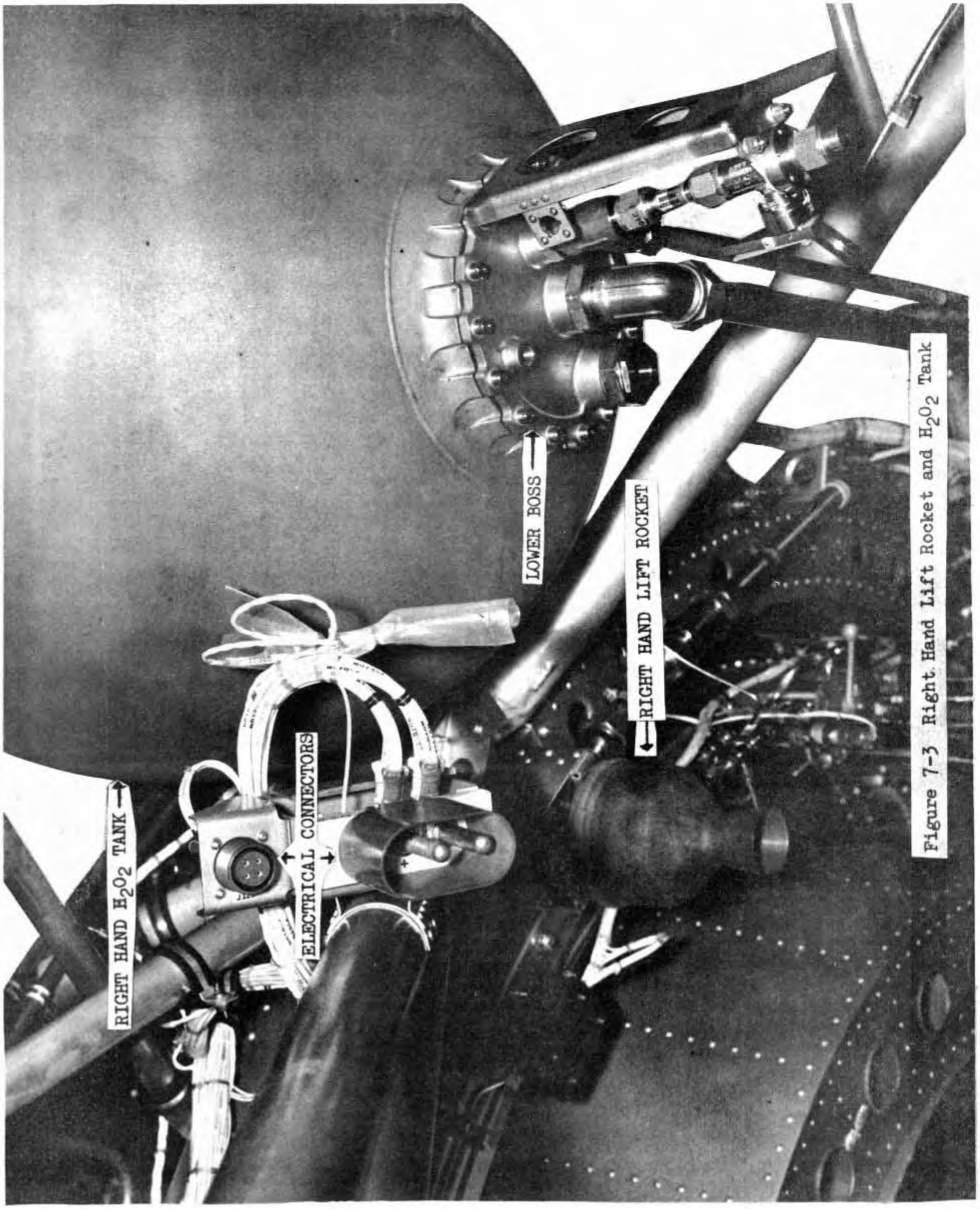



Figure 7-3 Right Hand Lift Rocket and $H_2O_2$ Tank

TABLE 7-1. TORQUE VALUES FOR FLARED TUBE FITTINGS

| TUBING OD INCHES | WRENCH TORQUE FOR TIGHTENING AN818 NUT (IN. LB) ALUMINUM ALLOY TUBING FLARE AND 10061 (SINGLE) OR AND 10078 | | STEEL TUBING FLARE AND 10061 | | ALUMINUM ALLOY TUBING (FLARE AND 10078) FOR USE IN OXYGEN LINES ONLY | | HOSE END FITTINGS AND HOSE ASSEMBLIES (IN. LB) MS28740 AN6292 | |
|---|---|---|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |
| 1/8 | - | - | - | 50 | - | - | - | - |
| 3/16 | - | - | 90 | 100 | - | - | 70 | 100 |
| 1/4 | 40 | 65 | 135 | 150 | - | - | 70 | 120 |
| 5/16 | 60 | 80 | 180 | 200 | 100 | 125 | 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 | - | - | - | - | - | - |

TABLE 7-2

TORQUE VALUES FOR BULKHEAD TUBE FITTING

| TUBE SIZE | FITTING THREAD SIZE | TORQUE LIMITS (INCH-POUNDS) MIN | MAX |
|---|---|---|---|
| 1/8 | 5/16-24 | 40 | 50 |
| 3/16 | 3/8-24 | 70 | 80 |
| 1/4 | 7/16-20 | 110 | 130 |
| 5/16 | 1/2-20 | 140 | 160 |
| 3/8 | 9/16 | 220 | 250 |

| TUBE SIZE | FITTING THREAD SIZE | MIN | MAX |
|---|---|---|---|
| 1/2 | 3/4 | 270 | 320 |
| 5/8 | 7/8 | 350 | 450 |
| 3/4 | 1-1/16 | 500 | 700 |
| 1 | 1-5/16 | 700 | 900 |

## TABLE 7-3

### TORQUE VALUES FOR STEEL NUT-BOLT (SCREW) COMBINATIONS

| BOLTS AND SCREWS | BOLTS AND SCREWS |
|---|---|
| AN3 through AN20<br>AN42 through AN49<br>AN73 through AN81<br>AN173 through AN186<br>AN502 AN525<br>AN509<br>Bell Std. 6Z1 | MS20004 through MS20024<br>(NAS144 through NAS158)<br>(NAS172)<br>NAS333 through NAS340<br>NAS464 (Shear)<br>NAS583 through NAS590 |

| NUTS | | NUTS | |
|---|---|---|---|
| TENSION | SHEAR | TENSION | SHEAR |
| AN256<br>AN310<br>AN315<br>AN361 (NAS1024)<br>AN362 (NAS1023)<br>AN363 (NAS1021)<br>AN365 (NAS1021)<br>AN366 (NAS1023)<br>AN373 (NAS1024) | AN320<br>AN364 (NAS1022) | AN256<br>AN310<br>AN315<br>AN361 (NAS1024)<br>AN362 (NAS1023)<br>AN363 (NAS1021)<br>AN365 (NAS1021)<br>AN366 (NAS1023)<br>AN373 (NAS1024) | AN320<br>AN364 (NAS1022) |

| NUT BOLT SIZE | TORQUE LIMITS IN.LB | | TORQUE LIMITS IN.LB | | TORQUE LIMITS IN.LB | | TORQUE LIMITS IN.LB | |
|---|---|---|---|---|---|---|---|---|
| | MIN | MAX. | MIN | MAX. | MIN | MAX. | MIN | MAX. |
| 8-36 | 12 | 15 | 7 | 9 | | | | |
| 10-32 | 20 | 25 | 12 | 15 | 25 | 30 | 15 | 20 |
| 1/4-28 | 50 | 70 | 30 | 40 | 80 | 100 | 50 | 60 |
| 5/16-24 | 100 | 140 | 60 | 85 | 120 | 145 | 70 | 90 |
| 3/8-24 | 160 | 190 | 95 | 110 | 200 | 250 | 120 | 150 |
| 7/16-20 | 450 | 500 | 270 | 300 | 520 | 630 | 300 | 400 |
| 1/2-20 | 480 | 690 | 290 | 410 | 770 | 950 | 450 | 550 |
| 9/16-18 | 800 | 1,000 | 480 | 600 | 1,100 | 1,300 | 650 | 800 |
| 5/8-18 | 1,100 | 1,300 | 660 | 780 | 1,250 | 1,550 | 750 | 950 |
| 3/4-16 | 2,300 | 2,500 | 1,300 | 1,500 | 2,650 | 3,200 | 1,600 | 1,900 |
| 7/8-14 | 2,500 | 3,000 | 1,500 | 1,800 | 3,550 | 4,350 | 2,100 | 2,600 |
| 1-14 | 3,700 | 5,500 | 2,200 | 3,300 | 4,500 | 5,500 | 2,700 | 3,300 |
| 1 1/8-12 | 5,000 | 7,000 | 3,000 | 4,200 | 6,000 | 7,300 | 3,600 | 4,400 |
| 1 1/4-12 | 9,000 | 11,000 | 5,400 | 6,600 | 11,000 | 13,400 | 6,600 | 8,000 |

C. Hand tighten bolt (NAS 501H10A-13) tith washer (AN960 PD 1016) attaching aft support trunnion to tank aft trunnion.

D. Torque trunnion and tank support assembly mounting bolts. Lockwire three bolts at upper corners of center body.

NOTE

Gap between forward tank trunnion shoulder and mount should be 0.050 to 0.150 inches. Washers (7260-460003-67) may be used on bolt (NAS 501H10A-13) to adjust the gap.

E. Install and torque fittings on piping to upper and lower tanks bosses (figure 7-3).

1) $\frac{1}{2}$-inch fittings to 270 to 320 inch pounds (upper and lower),

2) 1-inch fittings to 700 to900 inch pounds (lower).

F. Torque bolt (NAS 501H10A-13)in aft trunnions to 100 ± 10 inch pounds and lockwire.

G. Connect propellent level sensor to LLTV main wiring harness. It is usually necessary to remove the mount and retainer to attach the electrical connector to the probe connector.

H. Install left $H_2O_2$ tank in a similar manner.

7-23 HELIUM TANK - (figure 7-2) See Bell drawings 7161-460114 and 7260-471009.

A. Verify that plug is installed in pressure port of helium tank.

(7-23)(A)

NOTE

Hardware removed in step B will be used for reassembly in step C.

B. Remove nuts, bolts, and washers securing lower fittings to three support brackets and remove lower fittings.

C. Position helium tanks so that mounting trunnions are seated into support assemblies with plugged pressure ports outboard. Torque lower fittings on support brackets.

NOTE

Center bracket allows for tank expansion. Shims for brackets may be required.

D. Remove plug from ports and connect high-pressure piping to helium tanks. Torque $\frac{1}{2}$-inch bushings to 270 to 320 inch pounds, and 3/8-inch fittings to 220 to 250 pounds.

7-24 LIFT ROCKET (figure 7-3) See Bell drawing 7260-460003).

7-25 Two identical lift rockets are on brackets attached to main structural ring of center body.

A. Match lift chambers to minimize net thrust difference throughout throttle range of 100 to 500 pounds thrust. Select two chambers by the following criteria:

1) Thrust versus chamber pressure data within a 5-pound thrust band through 250 to 350 pounds thrust range.
2) Chamber pressure versus propellent feed pressure curves most closely matched.

(7-25) B. Hand tighten four bolts (NAS 1304-8H) with washers (AN 960 PD 416) into rocket mounting brackets (from top).

C. Place three insulators (7161-460113-5) and four washers (AN 960 PD 416) below mounting bracket on each of four bolts. Alternate insulators and washers as shown on dwg. 7260-460003.

D. Align rocket engine piping with output in bracket (7260-460001-1) and hand tighten four bolts into rocket engine.

E. Hand tighten $H_2O_2$ line to rocket engine inlet.

F. Torque mounting bolts to 20-inch pounds and lockwire. Torque tubing fittings to values on table

G. Connect chamber pressure transducer to pressure taps on each lift rocket chamber and torque to values on table

7-26 <u>ATTITUDE CONTROL ROCKETS</u> (See Bell drawing 7161-470020)

7-27 Sixteen identical attitude control rockets are mounted in clusters of four. One cluster is attached to each of four mounting beams (figure 7-2).

A. Hand tighten eight bolts (AN3-4A/-5A), with washers (AN 960 960 PD 10), and nuts (MS 21045-C3) attaching the bracket on a cluster with the bracket on a mounting beam. (See Bell drawing 7260-460003).

B. Hand tighten $H_2O_2$ piping fittings on the variable orifice inlet ports.

<u>NOTE</u>

Use 7260-460051-1 fittings in locations listed on the blue print to facilitate tubing fit.

(7-27) C. Torque mounting bolts to 20-inch pounds and lockwire.

D. Torque piping fittings to 450 to 500-inch/pounds for ½-inch flare fittings, and 270 to 300-inch/pounds for 3/8-inch flare fittings.

E. Connect electrical harness to LLTV main harness (figure 7-3).

F. Dress and secure electrical harness along support beam.

7-28 <u>LIFT ROCKET CONTROL SYSTEM</u> (Figure 7-4, see Bell dwg. 7260-541001).

7-29 The removal procedures are provided for the T-handle, throttle valve, rotary actuator and remote throttling position control box.

7-30 <u>T-HANDLE</u> - To remove the lift rocket T-handle, proceed as follows:

<u>CAUTION</u>

Electrical power should be disconnected prior to removal of T-handle.

A. Disconnect electrical wiring to positioning rheostat.

B. Remove six mounting screws from T-handle mounting bracket and front portion of pilot's console.

C. Remove four mounting screws from T-handle mounting bracket and side portion of pilot's console.

7-31 <u>ROTARY ACTUATOR AND THROTTLE VALVE</u> - To remove these components together as a unit, proceed as follows:

WARNING

$H_2O_2$ lines to components to be removed must be cleared of $H_2O_2$. Circuit breaker CB 28 must be pulled.

A. Disconnect $H_2O_2$ tubing from throttle valve. Plug and cap lines and ports.

B. Remove six mounting bolts and washers from mounting plate.

C. Disconnect electrical connector to rotary actuator.

D. Remove rotary actuator and throttle valve still on mounting plate as a unit.

7-32 REMOTE THROTTLING POSITION CONTROL BOX - To remove this component, proceed as follows:

A. Cut safety wire and remove electrical connector.

B. Loosen wing nut and remove control box.

7-33 PIPING

7-34 Refer to paragraph 3-10 for rocket system piping installation.

7-35 CHECKING AND ADJUSTMENT ROCKET COMPONENTS.

7-36 HELIUM REGULATOR

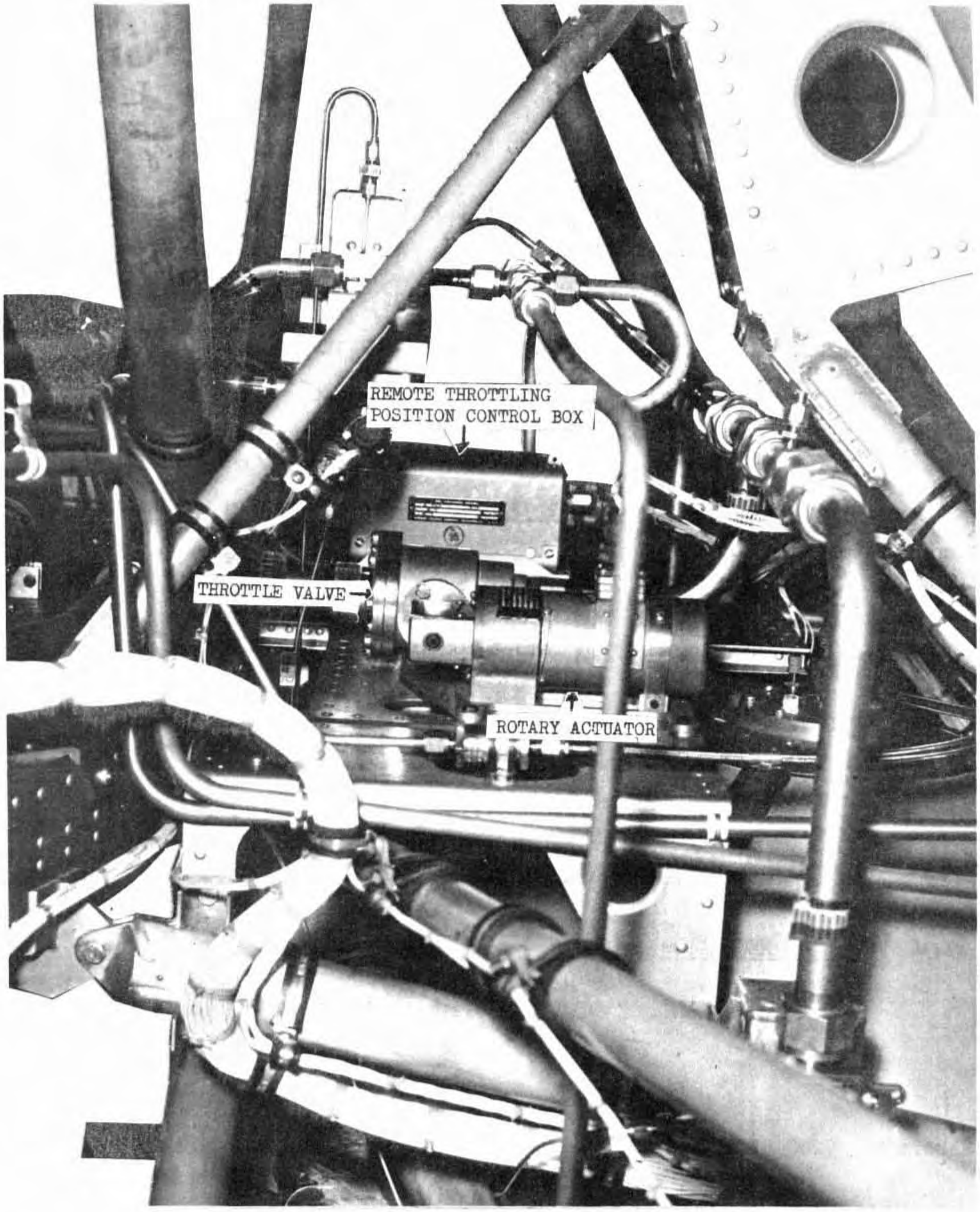



Figure 7-4. Lift Rocket Control Components

7-37 The helium pressure regulator (7260-472120) provides 495 psig pressure to the propellant tanks through the network shown in figure 7-5. The regulators normally pressurize both propellant tanks via the open helium crossover valve.

7-38 LOCKUP PRESSURE - Measure the lockup pressure of each regulator separately with the helium crossover valve closed. Individual regulator lockup pressures shall be within 5 psi of each other. If an unbalance of approximately 20 psi exists, extreme differential in helium tank pressures will occur during lift rocket firing. The higher pressure regulator will meet the flow demand, but it may cause helium tank pressure differences as high as 700 psi after a relatively short time of thrust operation.

7-39 The small orifice between the tanks will not allow equalization of pressure for nearly one minute for this extreme pressure differential.. Also, the HELIUM LOW pressure warning will trigger early if pressure on the right regulator is high, or will trigger late if pressure on the right regulator is low.

7-40 PRESSURE DIFFERENTIAL - The regulator lockup pressure differential can not be determined by the E/P cart gage readings unless the accuracy of those gages are known, except when no pressure differential exists (regardless of gage readings). After recording the regulator lockup pressure readings indicated on the E/P cart gages, open the helium crossover valve. Observe the E/P cart gages and record values. With no change in the E/P cart gage readings, the pressure differential is zero and the test gage should read 495 ± 5 psig. Use a 0-800 psi test gage with 0.5% accuracy to measure the system lockup pressure. Refer to LLTV Rocket Propulsion 30-Day Functional & Static Leakage Test, Report Number 7260-931013 for additional details on this procedure.

7-41 ADJUSTMENT - Compress the spring guide on the top of the regulator slightly to relieve spring tension as the body section is adjusted. Screw the body inward to increase regulation pressure; outward to lessen pressure. The adjustment can be made under pressure.

NOTE

Compress the spring guide using a suppressor with a center opening. This provision will allow the tube on the center spring guide to pass through.

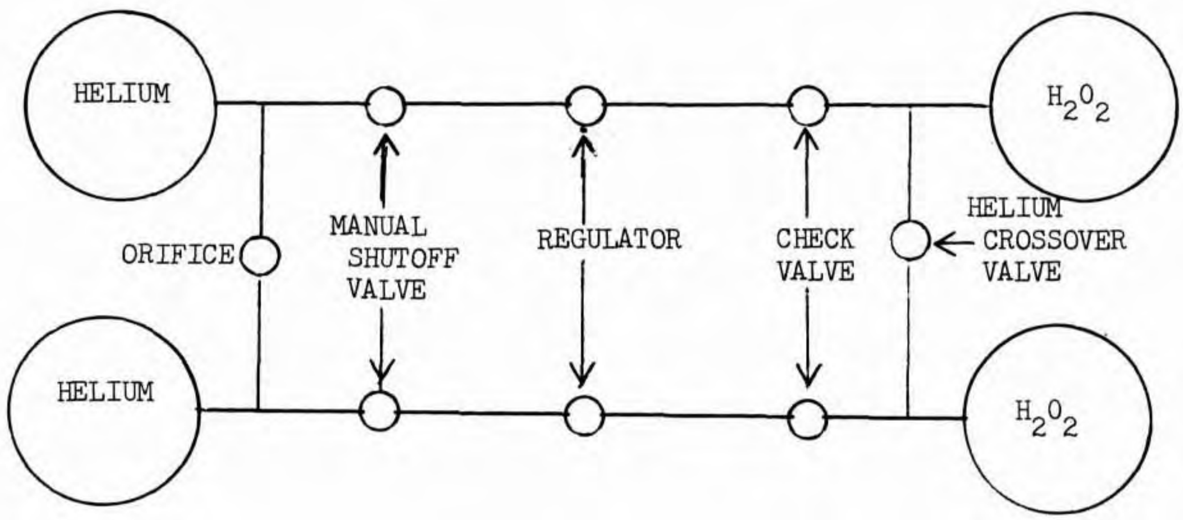



Figure 7-5. Helium Pressurization System Diagram

CAUTION

The following mechanical adjustments to the rocket controls are necessary before pressure testing the system.

7-42 ATTITUDE ROCKET CLUSTER VARIABLE ORIFICE VALVE

A. Pressurize the system to 500 psig with the adjustment lock bolt tightened.

B. Loosen the allen screw which retains the knurled handle on the stem of the variable orifice valve (7161-472110-3 to allow the pressure to move the stem to the most extended position. Push the knurled knob toward the valve body,then tighten the allen screw to keep this position.

C. Loosen the main adjustment lock and tab and move the variable orifice valve to a angular setting equal to the desired thrust (i.e. $90^{\circ}$ = 90 lb thrust). This setting is approximate and shall be verified by firing the rocket engines. Safety wire the bolts if there is a possibility of them loosening prior to thrust adjustments. After live firing thrust adjustments are made DO NOT disturb the orifice setting. Torque stripe can be used to verify the settings have not been disturbed.

7-43 LIFT ROCKET (See Bell drawing 7260-541001).

NOTE

Both electrical and mechanical adjustments are required on the lift rocket control system.

A. Adjust the control potentiomenter.

(7-43)(A) 1) Adjust the NAS 428-3 and -10 bolt and AN315-3 nut on the 7260-541001-15 throttle control to restrick the the throttle stick travel to 40 degrees (from fully down to fully up.) Use calibration fixture to make angular settings.

2) Apply 28 VDC power to the unit through CB 28.

CAUTION

Ensure that the lift rocket propellant valves are closed when pressure is on the vehicle. Otherwise, pressure will exhaust through the lift rockets when the throttle valve opens during these procedures.

3) Move the throttle slowly upward through the 40 degree range. The drive shaft on the rotary actuator (7260-541004) should rotate clockwise (as seen from the output shaft side) only. The relationship of the throttle to the 7260-541015-1 rheostat is correct if the actuator moves at any respositioning of the throttle, but does not reverse direction, during the upward motion of the T-handle. (The rheostat stacked on the controller rheostat is a telemetry transducer.) Also, the throttle/rheostat relationship may be verified by checking the octal display. A steady increase in the reading as the throttle moves upward indicates correct adjustment. A loss of octal signal indicates incorrect adjustment (the rheostat wiper arm is off the rheostat windings.)

(7-43) B. If the rotary actuator reverses direction between fully on and fully off throttle position, adjust the relationship of the rheostat gear to the throttle gear by the following procedure:

1) Move the throttle upward. Mark the tooth on the rheostat gear which engages the throttle gear with a pencil lead when the rheostat wiper arm first touches the rheostat windings after crossing the winding cap.
2) Lower the throttle handle completely and lock it.
3) Remove the rheostat from the retainer hole. Rotate the gear and re-engage the marked tooth in the throttle gear.
4) Compensate any minor error in position by slightly rotating the potentiometer case. (This method allows the rheostat electrical connections to be exposed for rework.)

C. Adjust the variable orifice throttle valve.

NOTE

This ball type valve has a passage machined into the valve ball. No marking shows shaft position versus valve position. The motor driven rotary is connected by coupling flange 7260-9541001-11,013 with three bolts and allows ± 5 degrees of adjustment. The flange has 36 splines which mate with the 36-tooth serrated shaft on the rotary actuators to give 360 degree adjustment in 10 degree increments.

(7-43)(C) 1. Adjust the 7260-472060 throttle valve to shut off completely as the valve is driven clockwise by the rotary actuator. Flange bolts may have to be removed. Find the shutoff position by pressurizing the $H_2O_2$ system to about 100 psig and rotating the throttle valve manually clockwise to the off position.

2) Drive the actuator fully to the off position with the throttle stick and connect the 7260-541001 couplings.

NOTE

Coupling -13 may have to be removed completely. Be sure that the shaft lock screws are tightened in the flange coupling upon reassembly.

D. Actuate the throttle several times and verify the following:

1) Gas flow starts after about two degrees of throttle stick travel upward.
2) Gas flow increases rapidly as the throttle is opened.
3) Gas flow stops as the throttle is closed at <u>any speed</u>. Adjust the actuator coupling angular setting if exceeding slow or fast actuations do not always close the throttle valve. The throttle valve has a 10 degree shutoff band built in. Slight gas leakage is acceptable through valve seat, see blue print specifications. Operational check with $H_2O_2$ propellant is advisable.

7-44 FUNCTIONAL CHECKOUT

7-45 The following equipment will enable testing of functional and and static leaks in components and tubing.

A. Electrical and Pneumatic Test Cart (E&P Cart).

B. 28 VDC Power Supply.

C. 110 VAC, 400 $H_z$ Power Supply.

D. 4000 psig Helium Source

E. 2000 psig Nitrogen Source

7-46 The 30-Day Functional & Static Leakage Test, 7260-931013, describes use of this equipment. Two other procedures which are not presently used, because they were published for acceptance testing, also use the equipment. They are the ground test procedures; Hanger Operational Text 7260-928056 and Ramp Functional Text 7260-928063.

7-47 ELECTRICAL AND PNEUMATIC TEST CART (E/P)

7-48 The E/P test cart is used for functional testing of the LLTV Rocket system and is used for servicing the vehicle Helium supply prior to vehicle rocket system operations. The cart filters and regulates an inlet gas supply of 0-4500 psig to provide pressurization of the LLTV Helium system and both $H_2O_2$ tanks. With an external 28-volt, d-c supply and four electrical cables mounted in the cart, individual control of the 16 attitude rocket solenoid valves is provided by the cart. Individual switches on the cart control panel provides selection of each solenoid.

7-49 E & P CART

NOTE

The helium tank may be serviced directly from the Helium Gas Supply Truck which has built in regulation equipment.

7-50 LLTV HELIUM TANK SERVICING

A. Check that both helium tank and $H_2O_2$ tank regulators are backed off fully counterclockwise.

B. Close the inlet source valve.

C. Close the helium tank supply valve.

D. Close the common $H_2O_2$ tank supply valve.

E. Close both $H_2O_2$ tank supply valves.

F. Close the $H_2O_2$ tank vent valves.

G. Open the helium tank vent valve.

H. Remove the helium outlet port cap and attach the helium supply line. Attach the supply service manifold to the line and close the manifold hand valve. (Do not attach maniford to vehicle service port.) Attach Kellum safety grip to the cart hook.

I. Attach the helium source supply line to inlet port A on the E&P cart, and attach the Kellum safety grip to the cart hook. Attach the supply line and Kellum safety grip to the service truck helium supply.

J. Connect helium tank temperature monitoring box.

CAUTION

Throughout servicing, monitor Helium tank surface temperature. If necessary, cool the tank surface to maintain temperature below $150^{\circ}$ F up to 3800 psi and below $110^{\circ}$ F from 3800 to 4000 psi.

K. Apply pressure to the source line (4500 psig max) using the servicing truck valves. Tighten connections if leaks are observed.

(7-50) L. Open the inlet source valve.

CAUTION

Do not open the inlet source valve if source pressure gage shows greater than 4500 psig. Burst disc will rupture in E&P Cart.

M. Open the helium system service valve to apply pressure to the helium regulator.

N. Slowly open the regulator valve and note audible gas flow from helium vent, then close the vent valve.

O. Continue pressurizing the vehicle service line and E&P cart system to 4500 psig.

NOTE

The regulator controls the pressure indicated on the helium tank gage.

P. When the system is pressurized check for leaks by shutting off the inlet source valve and noting pressure decay.

NOTE

The helium regulator has a built in relief valve which may cause pressure loss.

Repair leaks as soon as possible. If repair is not practical and leakage is minimal and not a hazard to operations, repair at a practical time.

Q. Open the servicing manifold hand valve slowly and purge the service lines prior to attaching the helium tank schraeder valves.

(7-50) R. Close the manifold hand valve and attach the manifold to the tanks.

S. Back out the regulator and vent any pressure from the cart system.

T. Check that the vehicle helium manual shutoff valves are closed and schraeder valves on the helium tanks are open.

U. Open the inlet source valve closed in step P.

V. Bring the helium tanks to pressure using the regulator.

W. When pressurization is complete, close the helium tank servicing schraeder valves.

X. Close the source valve on the supply truck.

Y. Back out the regulator to zero.

Z. Disconnect and store the helium servicing line and manifold, and cap and plug open ports (if not needed for continued tests or topping off helium tank pressure).

AA. Shut off helium source supply valve on truck.

AB. Loosen the fitting on the helium supply line from the source truck and allow the pressure to release. Disconnect the fitting and cap and plug the opened ports.

AC. Disconnect the helium supply line from the E&P cart and cap and plug the open ports.

AD. Close the E&P cart inlet source valve.

## 7-51 LLTV $H_2O_2$ Tank Pressurizing

A. Check that both helium tank and $H_2O_2$ tank regulators are backed off fully counterclockwise.

B. Close the inlet source valve, and disconnect $H_2O_2$ pressure transducers.

C. Close the helium tank supply valve.

D. Close the common $H_2O_2$ tank supply valve.

E. Open both $H_2O_2$ tank supply valves.

F. Open both $H_2O_2$ tank vent valves on the E&P cart.

G. Close the helium tank vent valve.

H. Remove the $H_2O_2$ tank port caps and install the $H_2O_2$ tank service lines as necessary.

I. Install the helium source supply line to the inlet port A on the E&P cart and attach the Kellum safeth grip to the cart hook. Attach the supply line and Kellum safety grip to the service truck helium supply.

J. Apply pressure to source line (4500 psig max) using the servicing truck valves. Tighten connections if they leak.

K. Open the inlet source valve.

CAUTION

DO NOT OPEN THE INLET SOURCE VALVE IF THE SOURCE PRESSURE GAGE SHOWS MORE THAN 4500 PSIG.

L. Open the common $H_2O_2$ tank supply hand valve.

M. Open the $H_2O_2$ tank vent valve.

N. Open the LH/RH tank $H_2O_2$ supply valves and increase the regulator setting to purge the cart. When the cart is purged close the vents.

O. Increase pressure on the plugged service lines to 600 psi and check the fittings for leaks (tighten as necessary).

P. Shut off the inlet source valve and observe an unusual pressure loss.

NOTE

The regulator has a built in relief system and may vent.

(7-51) Repair any leaks as soon as possible. If the repair is not practical and leakage is minimal and not a hazard, repair at a practical time.

Q. With the inlet source valve shut off, vent the system by backing off the regulator to zero psi as indicated on the $H_2O_2$ tank gages.

R. Open the inlet source valve.

S. Remove the service line plugs. Using the regulator, purge the lines before installation on the $H_2O_2$ tank manual vent valve outlet port, or other fitting if directed.

T. Open the vehicle $H_2O_2$ tank manual vent valves.

U. Pressurize the $H_2O_2$ tanks as necessary for tests using the regulators.

V. When pressurizing work is complete, back out the regulator to zero psig and open the LH and RH $H_2O_2$ tank vent valves on the cart.

W. Close the helium supply truck shut off valves.

X. Loosen the fitting on the helium supply line to allow pressure to release. Disconnect the fitting and cap and plug the opened ports.

Y. Disconnect and store the helium supply line from the E&P cart.

Z. Close the E&P cart inlet source valve.

AA. Disconnect the $H_2O_2$ tank service lines. Cap and plug the open ports and store the lines in the E&P cart.

7-52 SOLENOID VALVE OPERATION

7-53 A. Set all switches on the E&P cart to OFF.

B. Pull the circuit breaker on the E&P cart.

C. Remove the vehicle electrical connector to the solenoid valves at the connector on the attitude control cluster. Attach the E&P cart cable marked for that location to the connector.

D. Tie the cable to the ship structure to relieve strain on the connectors.

E. Plug the 28 VDC leads from the E&P cart into the emergency DC outlet of the ground power supply box and apply power.

F. Push in the circuit breaker on the cart and observe the red ON lamp.

G. During tests do not apply power to solenoids for more than ten minutes at a time without a cooling period for the solenoid valve.

H. When testing is complete, shut off the 28 VDC supply and pull the circuit breaker on the E&P cart. Disconnect the cables from the ship and store them in the cart.

I. Attach the vehicle electrical connectors.

SECTION VIII

# SECTION VIII

# COCKPIT INSTRUMENTATION

# MAINTENANCE

## 8-1. SCOPE OF SECTION

8-2. This section provides a functional description and maintenance instructions for the Engine and Fuel indicators, Rocket System indicators, Flight Instruments, and Annunciator Panel indicators. The maintenance instructions includes operational checkout, trouble-shooting, removal and installation, adjustments, and test equipment.

## 8-3. DESCRIPTION AND LEADING PARTICULARS

8-4. A complete list and brief description of all cockpit instruments and indicators is presented in table 1-2, section I of this manual.

## 8-5. ENGINE AND FUEL INDICATORS

8-6. A brief description of the JP4 Tank Pressure, Oil Pressure, Exhaust Gas Temperature (EGT) and Percentage RPM indicators is presented. A functional analysis of associated circuitry is also provided.

8-7. JP4 TANK PRESSURE INDICATOR CIRCUIT - The JP4 Tank Pressure Indicator circuit contains two cockpit-mounted indicators, two fuel tank pressure transducers, two calibration potentiometers and two current limiting resistors (figures 8-1 and 8-2). Each JP4 Tank Pressure indicator is scaled to indicate from 0 to 50 psig with major division marks at 10 psig intervals and fine graduations at 1 psig intervals. A zero correction adjustment is front-mounted on the indicator. The DC input

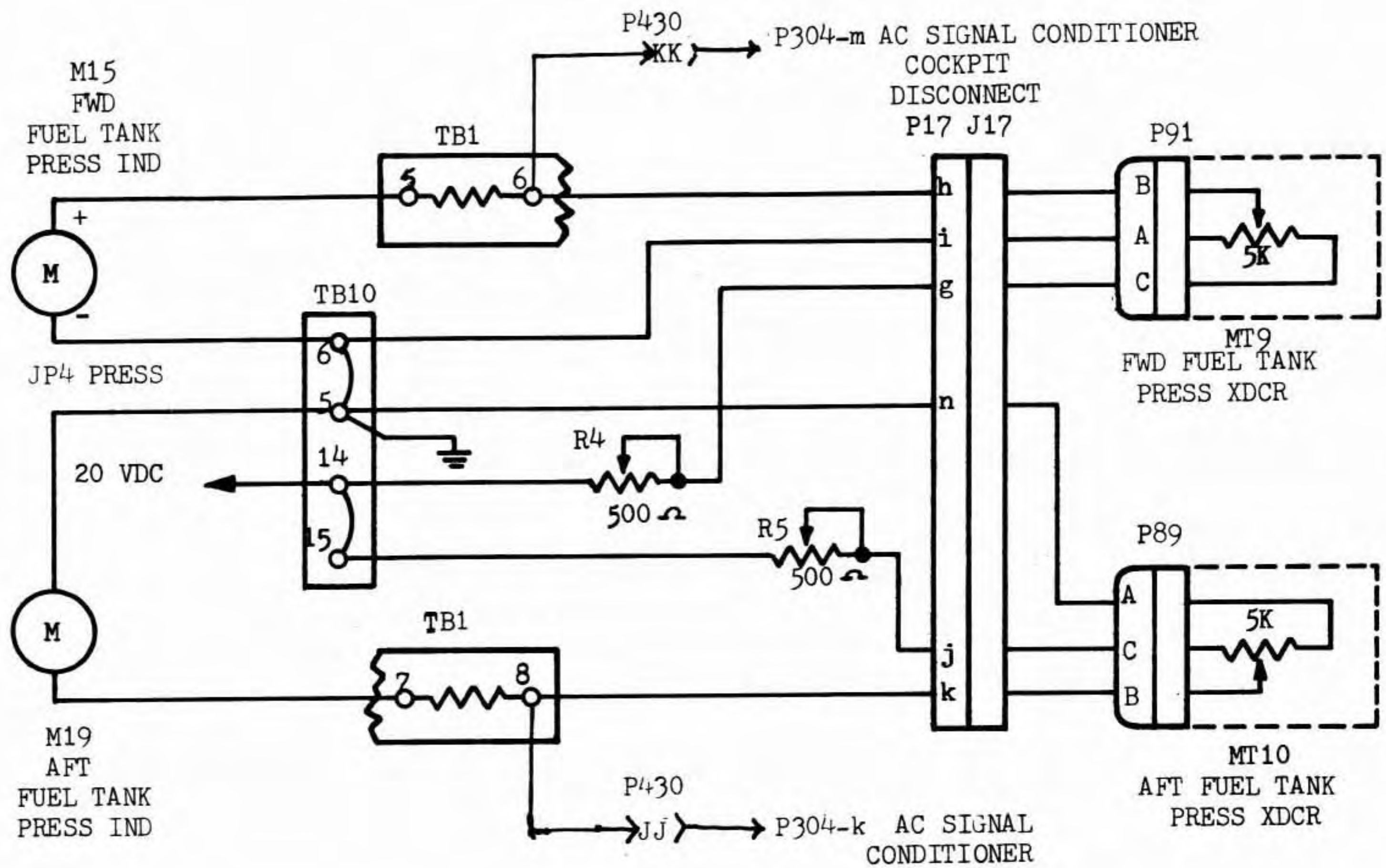



Figure 8 - 1. JP 4 Tank Indicators Schematic Diagram

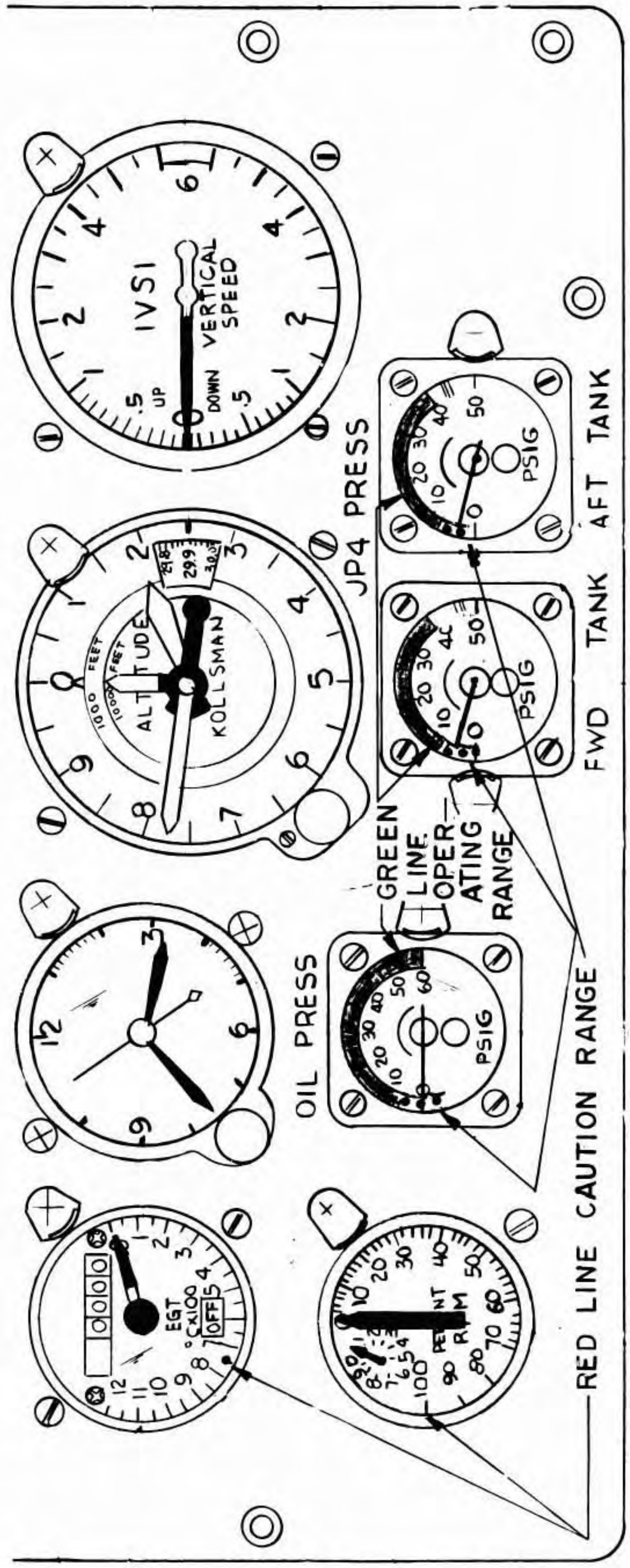



Figure 8-2. Pilot Instrument Panel - Bottom Portion

current values to obtain related indications are shown in table 8-1. An increasing tank pressure pushes the movable contact of the transducer resistive element toward the more positive voltage at pin c. An increased voltage is tapped and applied to the Fuel Tank Pressure indicator through the current limiting resistor (R8/R9), resulting in an up-scale deflection of the indicator needle. The voltage from the transducers is also routed to the AC Signal Conditioner for telemetry processing. Refer to section X. Calibration procedures for the JP4 pressure transducers are provided in paragraph 8-42.

8-8. OIL PRESSURE INDICATOR CIRCUIT - The Oil Pressure Indicator circuit contains a 100-microampere meter calibrated for a range of 0 to 60 psig, a calibration potentiometer, a current limiting resistor and an oil pressure transducer (see figures 8-2 and 8-3). The indicator is scaled with major division marks at 10 psig intervals and fine graduations at 2 psig intervals. A zero correction adjustment is front-mounted on the indicator. The DC input current values to obtain corresponding oil pressure psig values are shown in table 8-2. The Oil Pressure Indicator and the JP4 Pressure Indicator circuits are identical in operation. Calibration procedures are presented in paragraph 8-46.

TABLE 8-1. DC CURRENT VERSUS INDICATION

| DC Current (Microamperes) | Indication (psig) |
|---|---|
| 20 | 10 |
| 40 | 20 |
| 60 | 30 |
| 80 | 40 |
| 100 | 50 |

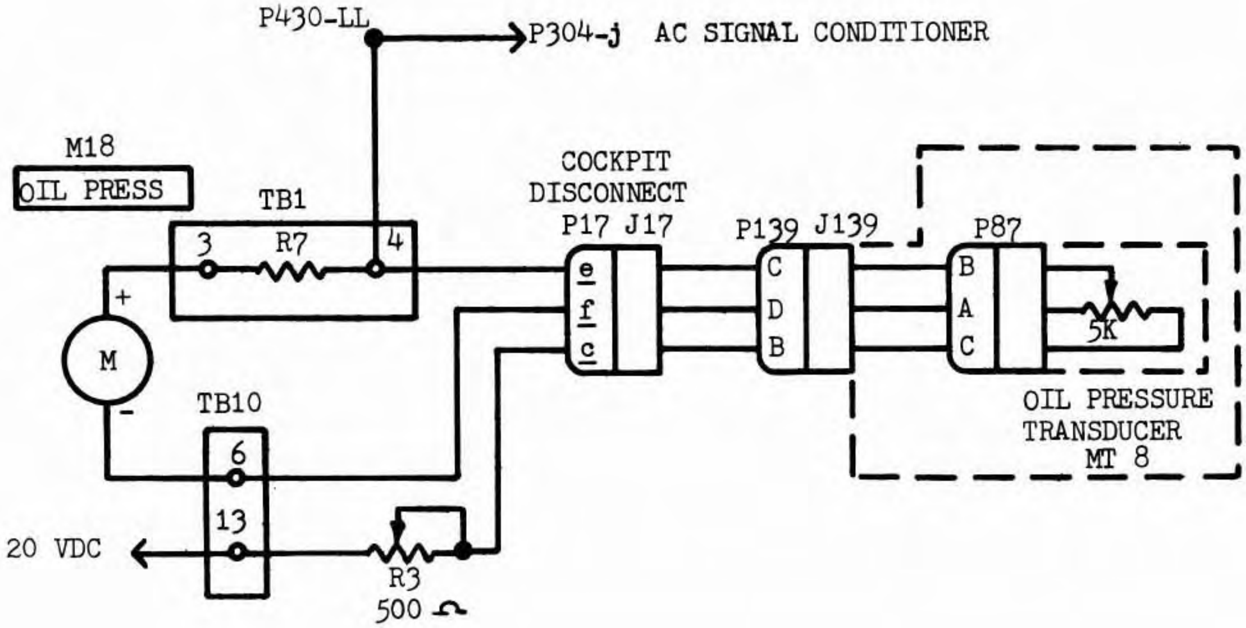



Figure 8-3. Oil Pressure Indicator Circuit - Schematic Diagram

TABLE 8-2. DC CURRENT VERSUS OIL PRESSURE INDICATION

| DC Current (Microamperes) | Indication (psig) |
|---|---|
| 16.6 | 10 |
| 33.3 | 20 |
| 50.0 | 30 |
| 66.7 | 40 |
| 83.3 | 50 |
| 100.00 | 60 |

8-9. EGT INDICATOR CIRCUIT - The EGT Indicator circuitry contains an EGT indicator and a thermocouple unit. The EGT indicator consists of a digital readout, a 5K-ohm potentiometer, a Power Failure indicator and a temperature gage (figures 8-2 and 8-4). The digital readout provides EGT readings in 2°C increments. The temperature gage is calibrated for a maximum of 1200°C in 50°C increments. The input voltage versus temperature equivalents are provided in table 8-3. The potentiometer is used to retransmit a voltage analog of the EGT to the DC Signal Conditioner for telemetry transmission.

TABLE 8-3. INPUT VOLTAGE VERSUS EGT INDICATION*

| Input Voltage (Millivolts) | Temperature Degrees C |
|---|---|
| 8.13 | 200 |
| 16.40 | 400 |
| 24.91 | 600 |
| 33.30 | 800 |
| 41.31 | 1000 |
| 48.89 | 1150 |

*Substract 0.05 mv/deg of ambient temperature in degrees "C" from each input voltage.

8-10. PERCENT RPM INDICATOR CIRCUIT - The Percent RPM Indicator circuitry consists of an engine-mounted tachometer generator and the Tachometer indicator. The indicator dial is calibrated in percent of RPM in 2% increments up to 100%. A smaller dial also on the indicator is calibrated in 1% increments up to 10% (figures 8-2 and 8-5).

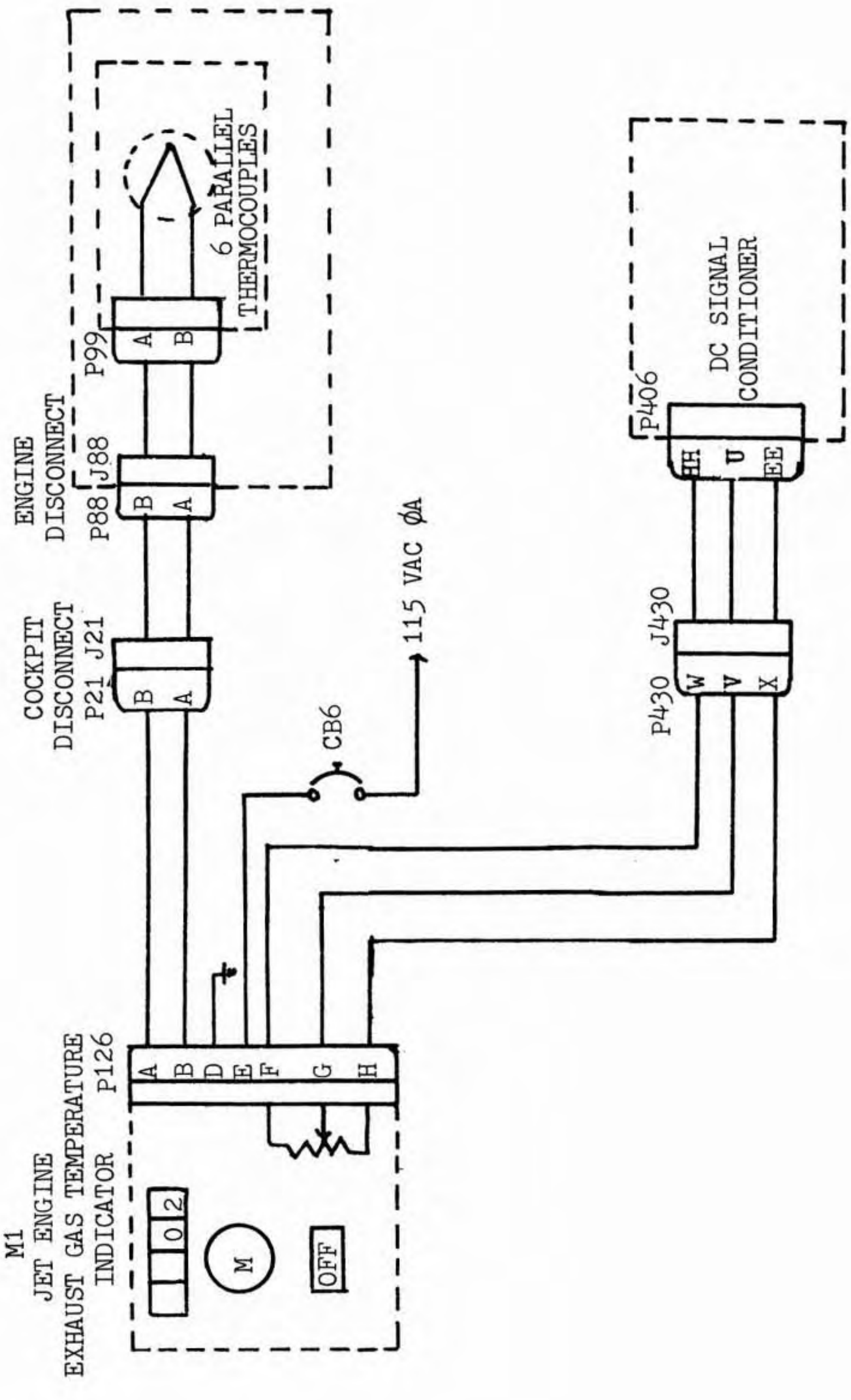



Figure 8-4. Exhaust Gas Temperature Indicator Circuit, Cabling Diagram

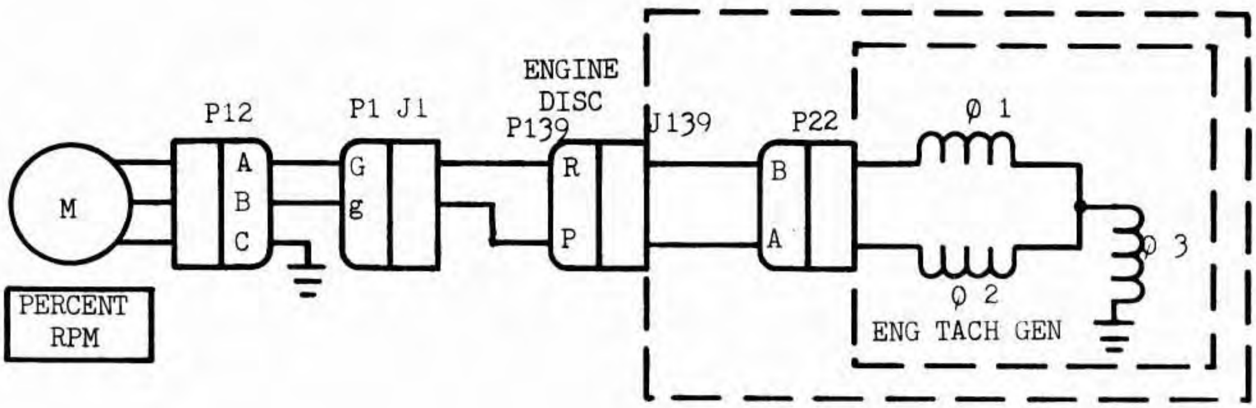



Figure 8-5. Percent RPM Indicator Circuit - Schematic Diagram

8-11. ROCKET SYSTEM INDICATORS

8-12. The Rocket System indicators consist of a Helium Source Pressure, an $H_2O_2$ Tank Pressure, a Lift Rocket Chamber Pressure and an $H_2O_2$ Remaining indicator. A brief description and functional analysis is presented to these indicators and associated circuitry.

8-13. HELIUM SOURCE PRESSURE INDICATOR CIRCUIT - The Helium Source Pressure Indicator circuit consists of a dual needle voltmeter, and two helium tank pressure transducers (figures 8-6 and 8-7). The indicator contains a center and a perpherical needle for left and right helium tank pressures. The center needle is marked with an R so that when the needle is top dead center the R is upright. The perpherical needle is marked so that an L is upright under the same condition. The indicator dial is calibrated up to 4500 psia, with major divisions at 1000-psi points, and minor divisions every 200 psi on scale. A zero correction adjustment is on rear of indicator. Table 8-4 provides a list of voltage input versus pressure indicator values. Analog voltages are also routed from the transducers to the AC Signal Conditioner.

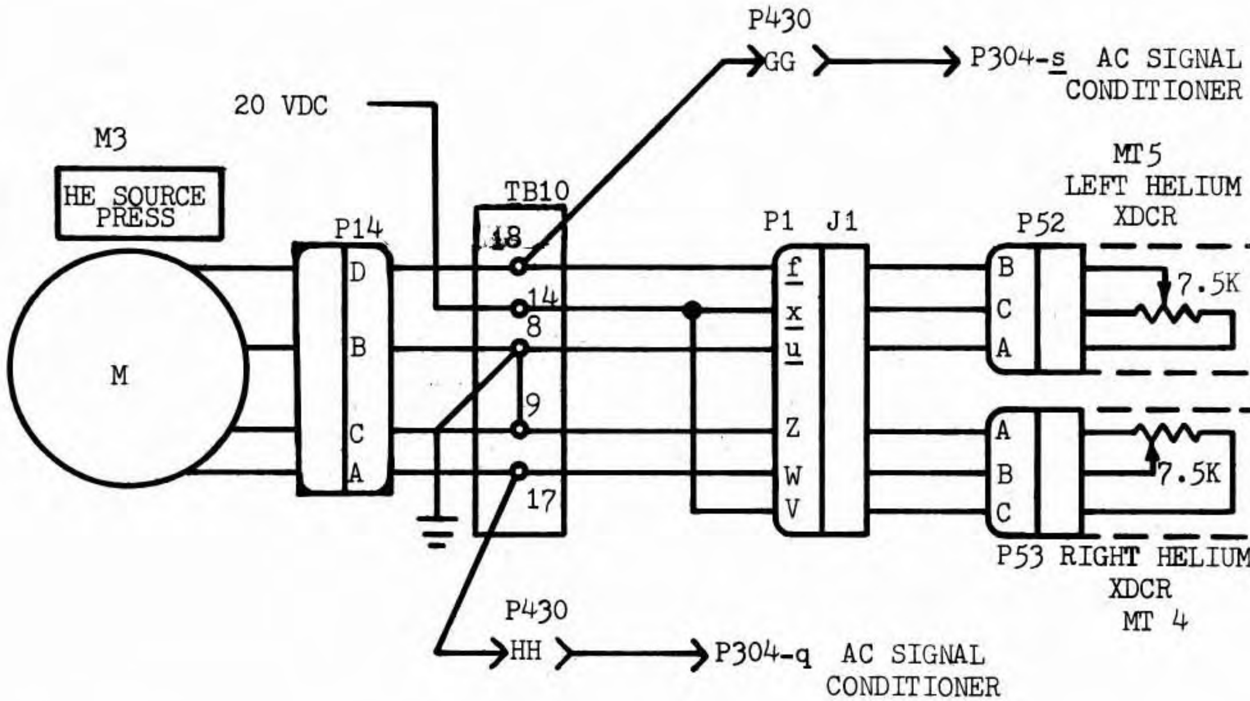



Figure 8-6. Helium Source Pressure Indicator Circuit - Schematic Diagram

TABLE 8-4. VOLTAGE INPUT VERSUS HELIUM PRESSURE INDICATION

| Voltage Input | Pressure |
|---|---|
| 2.182 | 500 |
| 4.276 | 1000 |
| 6.400 | 1500 |
| 8.498 | 2000 |
| 10.62 | 2500 |
| 12.80 | 3000 |
| 15.07 | 3500 |
| 17.45 | 4000 |
| 20.00 | 4500 |

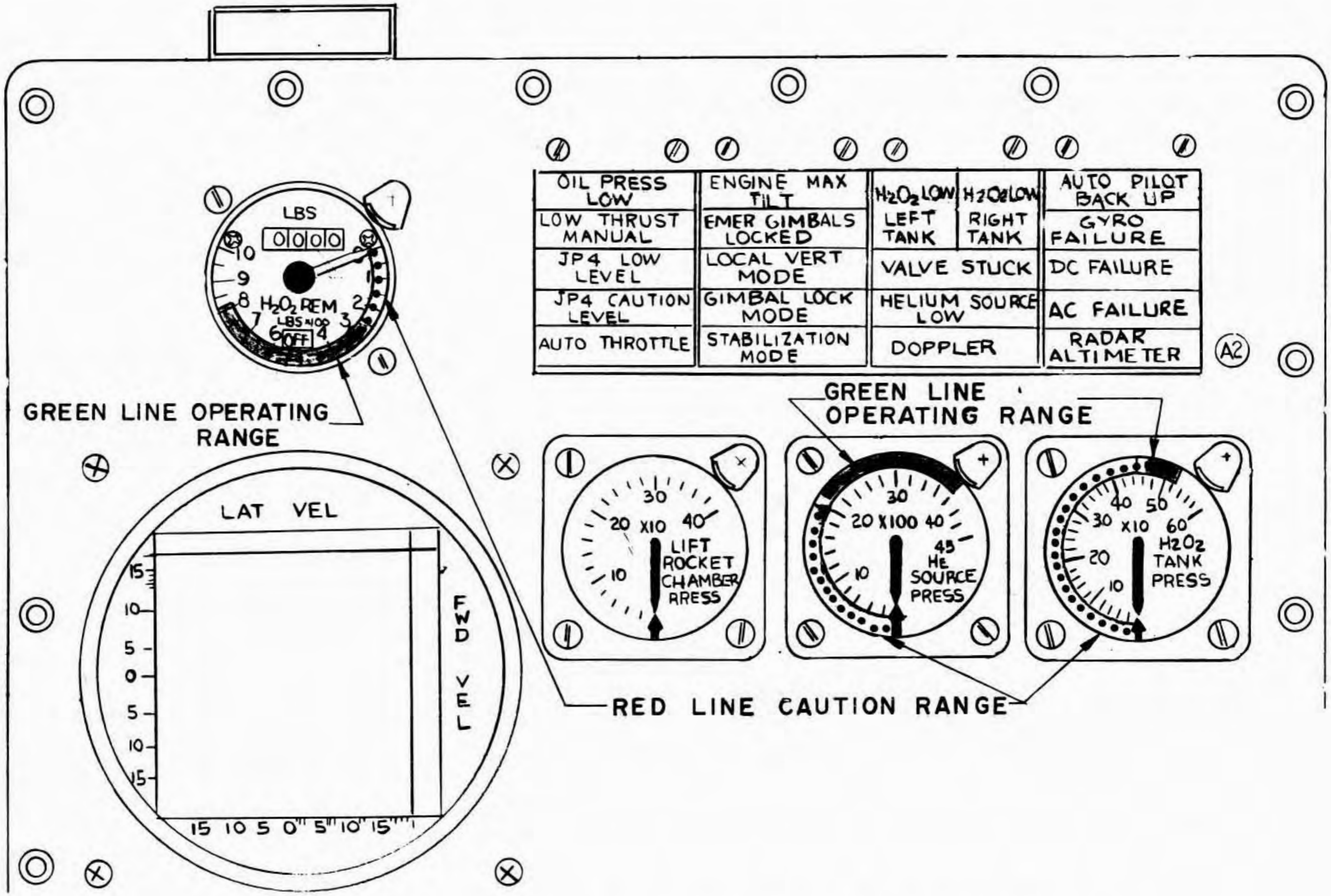



Figure 8-7. Pilot Instrument Panel - Top Portion Including Annunciator Lights

8-14. <u>$H_2O_2$ TANK PRESSURE INDICATOR CIRCUIT</u> - The $H_2O_2$ Tank Pressure Indicator circuit is almost identical to the Helium Source Pressure Indicator circuit (figures 8-7 and 8-8). The dial is calibrated up to 600 psia in 100 psia major increments, and minor divisions of 20 psi. The input voltages for $H_2O_2$ tank pressure indications are presented in table 8-5.

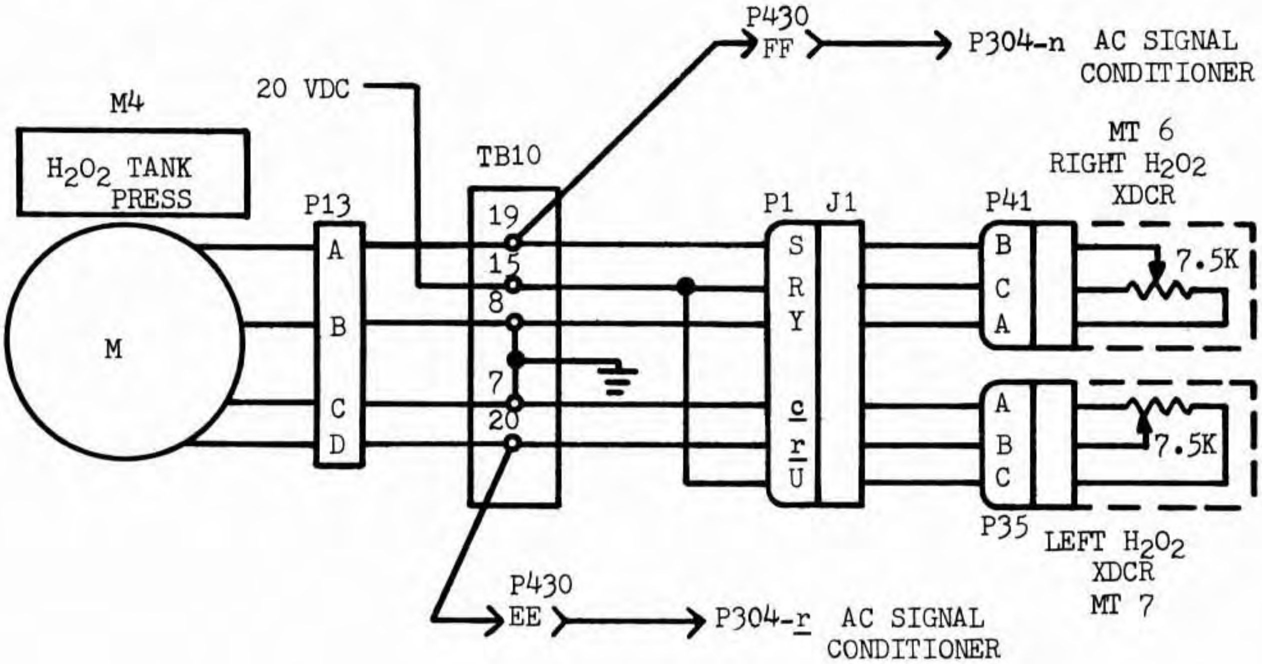



Figure 8-8. $H_2O_2$ Tank Pressure Indicator Circuit, Schematic Diagram

8-15. <u>LIFT ROCKET CHAMBER PRESSURE INDICATOR CIRCUIT - This circuit is</u> also almost identical to the Helium Source Pressure Indicator circuit (figures 8-7 and 8-9). The dial is calibrated up to 400 psia in 100 psia major increments, and minor divisions of 20 psi. The input voltage for rocket chamber pressure indications are presented in table 8-6.

TABLE 8-5. VOLTAGE INPUT VERSUS $H_2O_2$ PRESSURE INDICATION

| Voltage Input | Pressure psi |
|---|---|
| 2.786 | 100 |
| 5.476 | 200 |
| 8.143 | 300 |
| 10.86 | 400 |
| 13.69 | 500 |
| 16.71 | 600 |

TABLE 8-6. VOLTAGE INPUT VERSUS ROCKET CHAMBER PRESSURE INDICATION

| Voltage Input | Pressure |
|---|---|
| 1.40 | 50 |
| 2.75 | 100 |
| 4.063 | 150 |
| 5.361 | 200 |
| 6.645 | 250 |
| 7.948 | 300 |
| 9.248 | 350 |
| 10.575 | 400 |

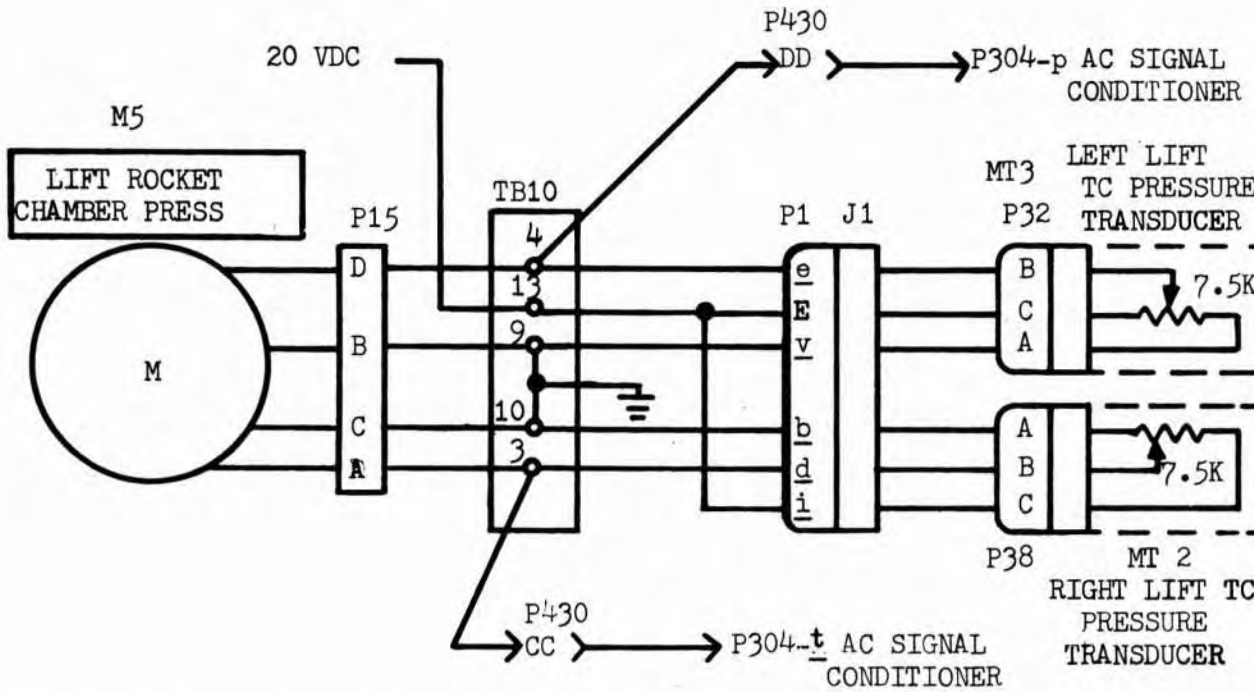



Figure 8-9. Lift Rocket Chamber Pressure Indicator Circuit, Schematic Diagram

8-16. $H_2O_2$ FUEL REMAINING INDICATOR CIRCUIT - An input voltage from the fuel level detector located in the Attitude Control System Monitor Electronics is routed to the $H_2O_2$ Fuel Remaining indicator. This indicator contains a digital readout, calibrated in 2-pound increments, a larger dial calibrated in 50-pound increments up to 1000 pounds, a Power Failure indicator, and a 5K-ohm retransmitting potentiometer (figures 8-7 and 8-10). The analog voltage representing $H_2O_2$ fuel remaining is retransmitted to the DC Signal Conditioner for telemetry processing. The voltage inputs versus pounds of $H_2O_2$ fuel remaining are provided in table 8-7.

TABLE 8-7. VOLTAGE INPUT VERSUS $H_2O_2$ FUEL REMAINING

| Voltage Input | Fuel Remaining (pounds) |
|---|---|
| -10 | 0 |
| - 8 | 200 |
| - 6 | 400 |
| - 4 | 600 |
| - 2 | 800 |
| 0 | 1000 |

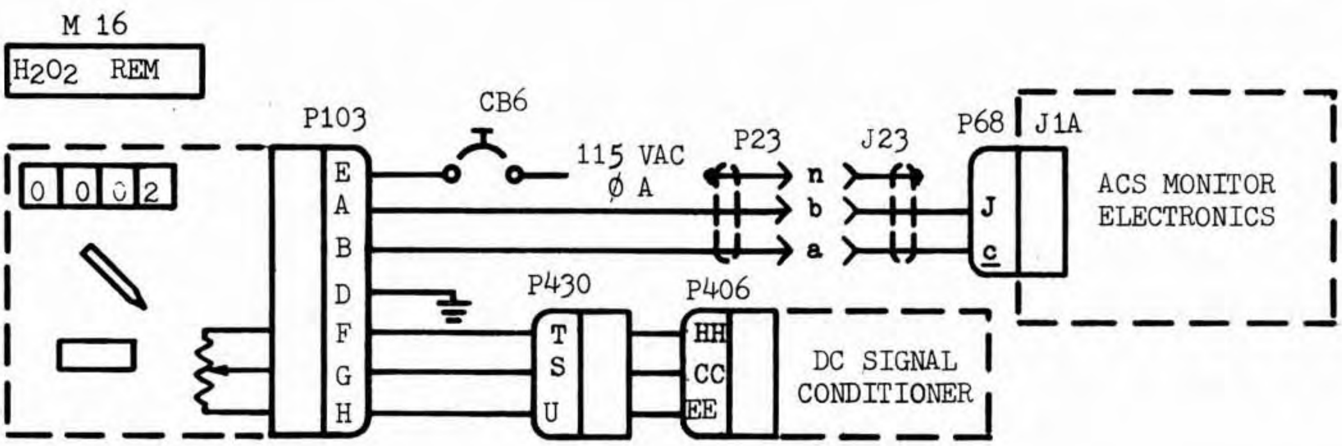



Figure 8-10. $H_2O_2$ Fuel Remaining Indicator, Cabling Diagram

## 8-17. FLIGHT INSTRUMENTS

8-18. The flight instruments mounted on the Pilot's Console consist of an Attitude indicator, an Altitude/Altitude Rate indicator, a Horizontal Velocity indicator, a Thrust/Weight indicator, a Barometric Altimeter, a Wind Velocity indicator, and an Inertial-Lead Vertical Speed indicator. A Wind Direction indicator is mounted in the cockpit ceiling. Description of the indicators and associated circuitry is presented.

8-19. ATTITUDE INDICATOR - The Attitude indicator is a 3-axes ball which indicates vehicle pitch, yaw, and roll (figure 8-11). The vertical and horizontal needles, in conjunction with ball movement, portray yaw and pitch, respectively. A zero set synchro or control differential transformer provides course setting for the indicator. The Attitude indicator receives input signals from the Attitude Gyro package and ACS Primary Electronics (figure 8-12). Refer to section XI for detailed descriptions of the Avionics system.

8-20. ALTITUDE/ALTITUDE RATE INDICATOR - Altitude signals and altitude rate signals from the radar assembly drive the servo systems in the indicator. As the indicator points are driven by the servo system, signals from retransmitting potentiometers are routed to the DC Signal Conditioner for telemetry processing (figures 8-11 and 8-13). Altitude is indicated in 5-foot increments up to 1000 feet on one vertically-calibrated scale. The rate of altitude change is in 2 feet-per-second increments, with a maximum descending and ascending rate of 50 feet-per-second indicated on the other vertically-calibrated scale.

8-21. HORIZONTAL VELOCITY INDICATOR - Signals derived from the Doppler radar provide inputs to the indicator servo systems. Longitudinal velocity is indicated by the horizontal needle on the vertically-calibrated FWD VEL scale. Lateral velocity is indicated by the vertical needle on the horizontally-calibrated LAT VEL scale. Increasing and decreasing velocity for both scales are in major increments of 5 fps with finer graduations in 1-fps increments (figures 8-7 and 8-14). The range of the scale is selected by the X1-X10 Horiz Vel switch located on the mounting box assembly, thus providing 0-20 fps and 0-200 fps scale velocities. As the indicator needles are moved by the servo motor, retransmitting potentiometers provide analog voltage inputs to the DC Signal Conditioner for telemetry processing.

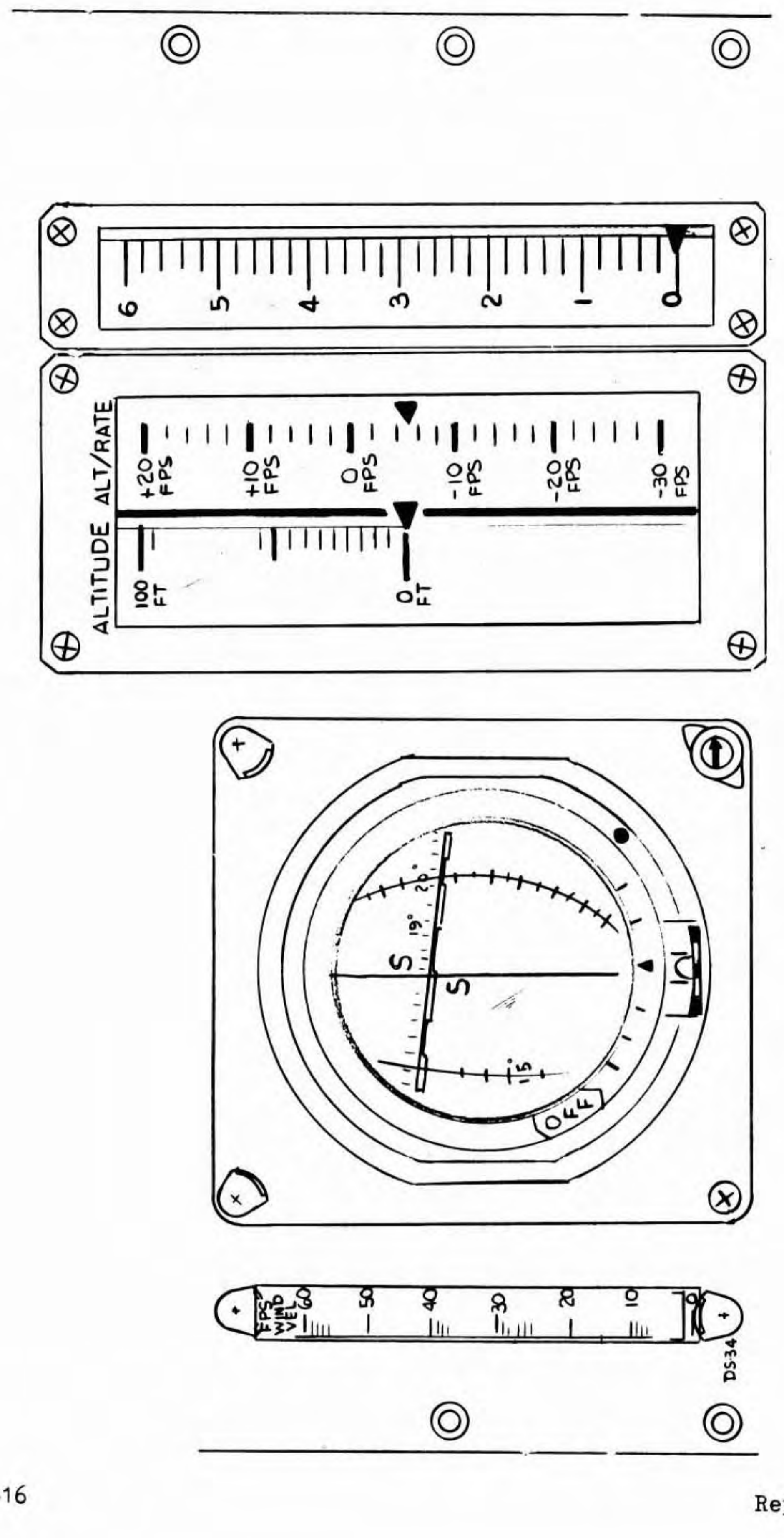



Figure 8-11. Pilot Instrument Panel - Middle Portion

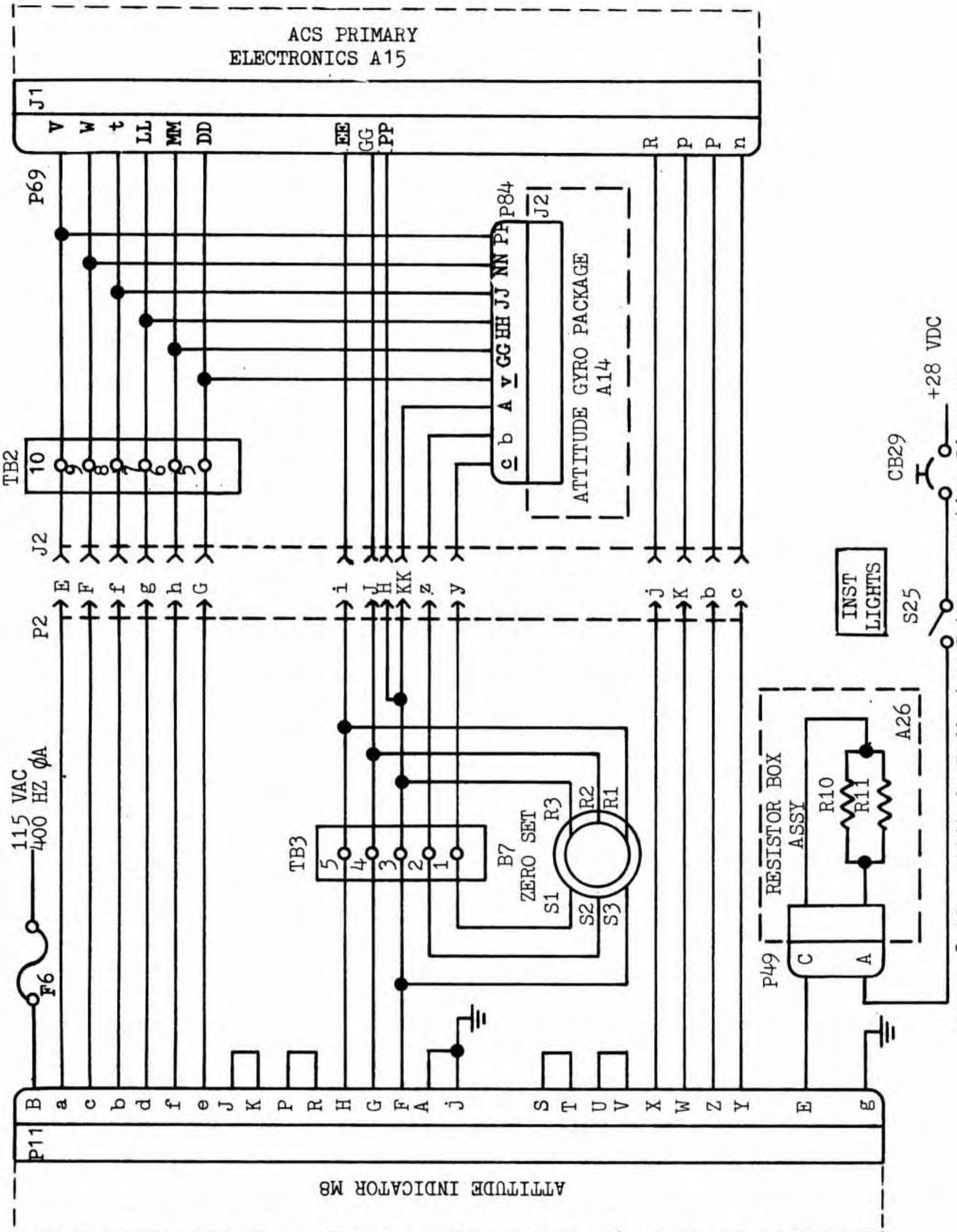



Figure 8-12. Attitude Indicator Interconnection Diagram

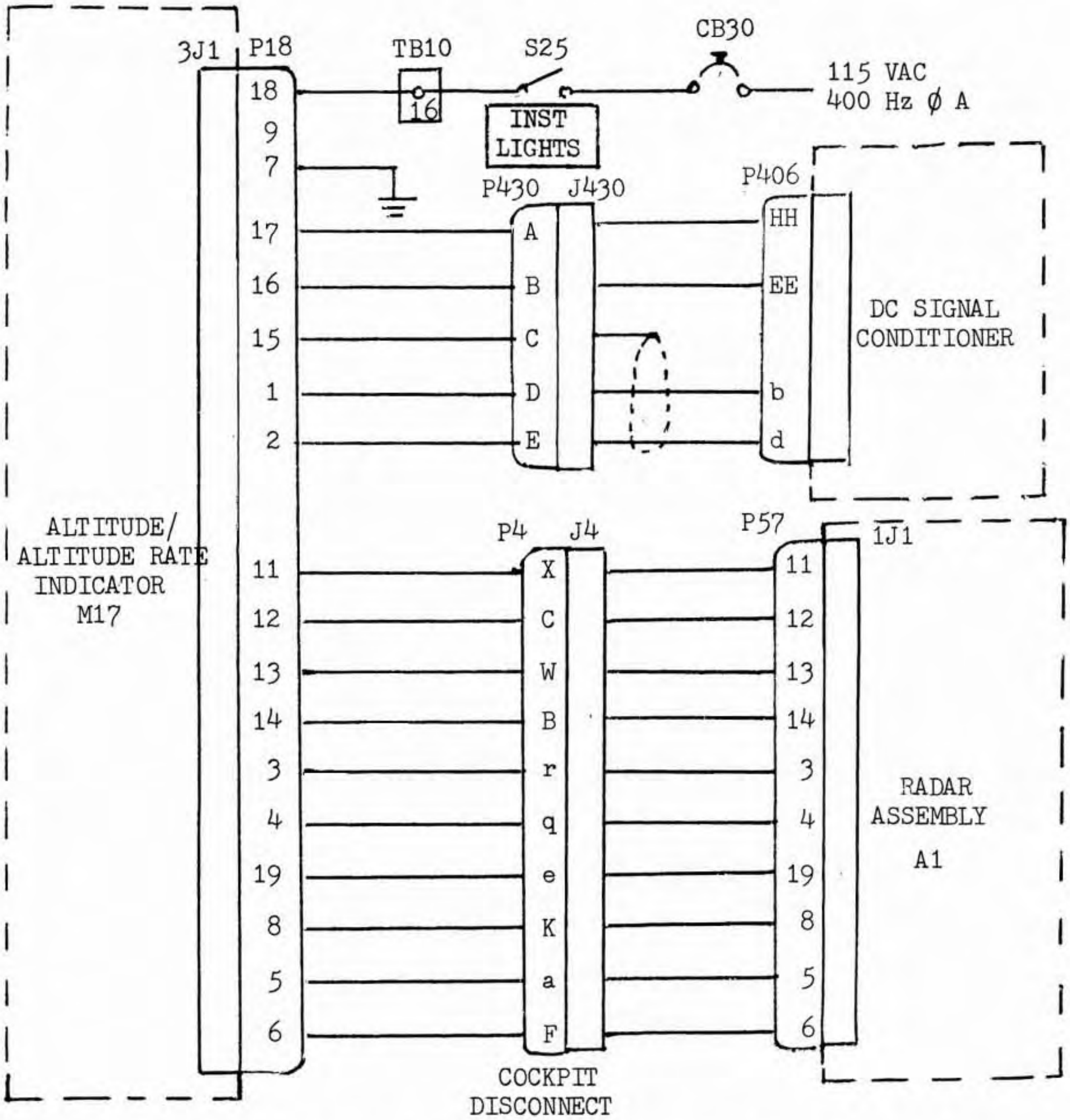



Figure 8-13. Altitude/ Altitude Rate Indicator Cabling Diagram

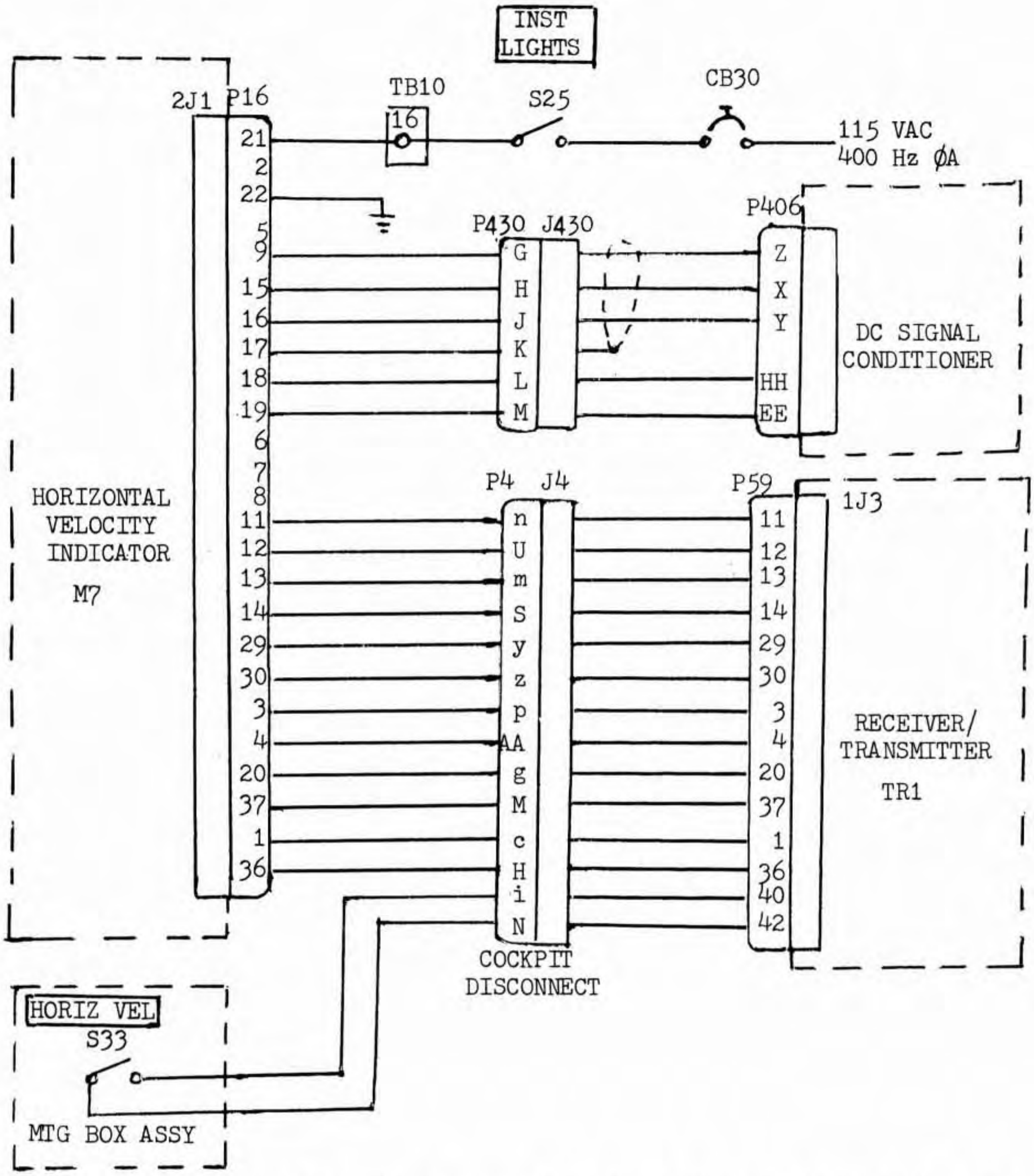



Figure 8-14. Horizontal Velocity Indicator Cabling Diagram

8-22. THRUST/WEIGHT INDICATOR - The Drag Compensation system provides reference and signal voltages for the Indicator Servo system (figures 8-11 and 8-15).

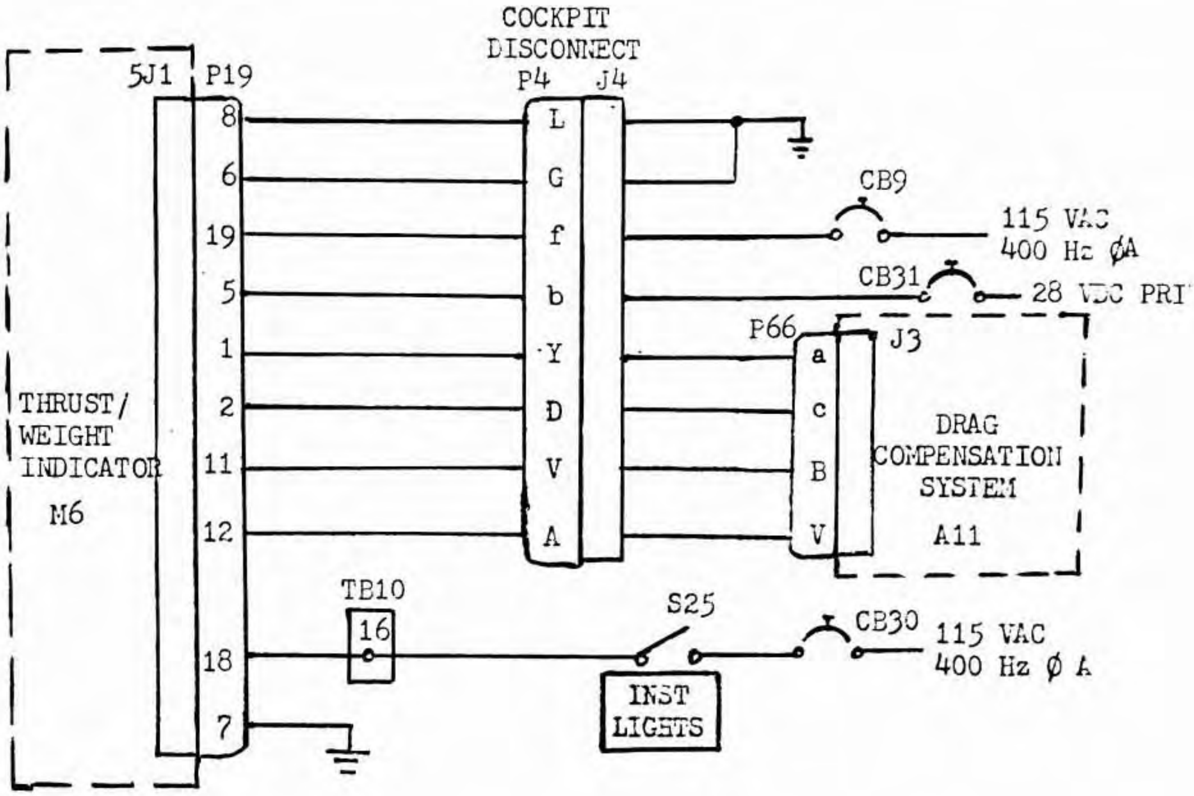



Figure 8-15. Thrust/Weight Indicator Cabling Diagram

As the servo drives the indicator pointer, normal acceleration, which is body-axis referenced, is displayed on the vertically-calibrated scale as lunar gravity. The scale is calibrated in major divisions of 1-G up to 6 lunar gravities. An indication of lunar gravity is obtained during Lunar Simulation flight mode.

8-23. BAROMETRIC ALTIMETER - A standard barometric altimeter is mounted on the Pilot's Console (figure 8-2). A control knob provides manual setting of the ambient pressure. Altitude is displayed by using three pointers to indicate hundreds, thousands and tens of thousand on the dial, which is marked 0 through 9 with 50-foot minimum division marks. The rear of the indicator is exposed to the atmosphere for operation without a Pitot system.

8-24. WIND VELOCITY INDICATOR CIRCUIT - The Wind Velocity Indicator circuit consists of a 500-microampere meter, a special amplifier, a 15-volt power supply, and an externally-mounted anemometer (figures 8-2 and 8-16). The voltage generated by the anemometer is directly coupled to an AC amplifier, which has a gain of 3. The amplified AC is then rectified and the DC routed to the Wind Velocity indicator and the DC Signal Conditioner. The vertical dial on the indicator is calibrated in feet-per-second in 10 fps major division marks and finer graduations of 5 fps up to 85 fps maximum indication. Refer to paragraph 8-50 for adjustment procedures.

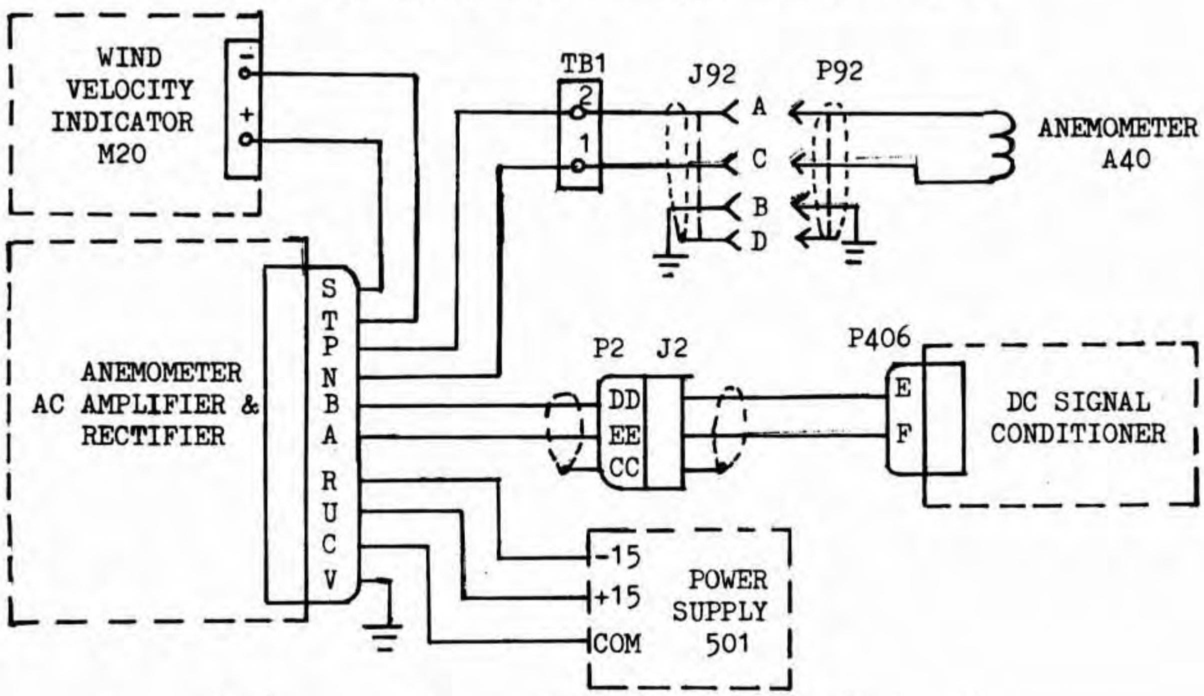



Figure 8-16. Wind Velocity Indicator Circuit, Wiring Diagram

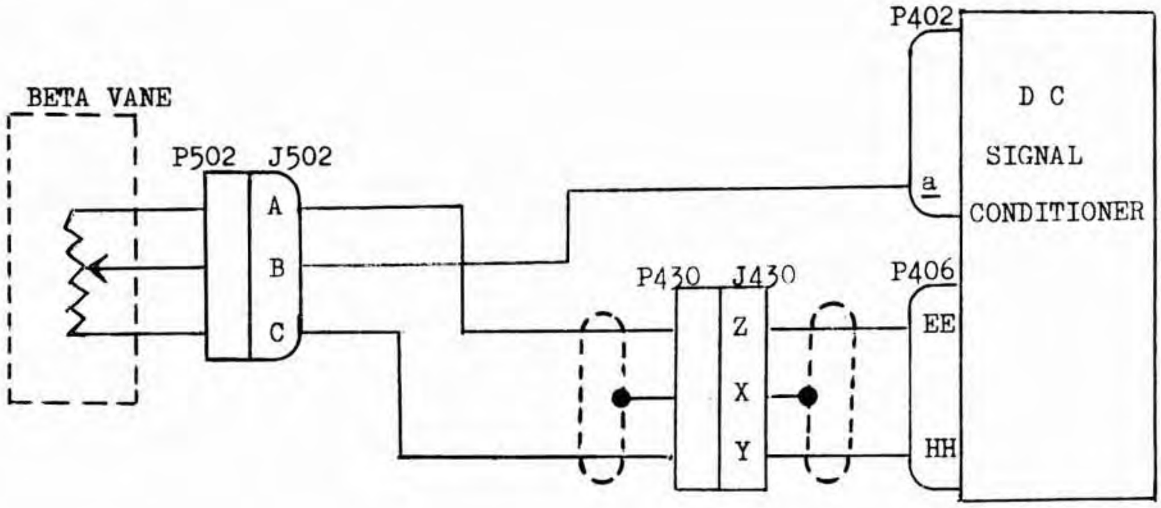



Figure 8-17. Wind Direction Indicator (Beta Ind.) Circuit, Wiring Diagram

8-25. WIND DIRECTION INDICATOR (BETA IND.) - A boom-mounted vane is coupled to a 15K - ohm potentiometer which drives a meter mounted at the top of the Pilot Console. Although the vane is free to rotate 360 degrees, the indicator is scaled to indicate its position over ± 90 degrees. This signal is also routed to the DC Signal Conditioner for telemetry processing.

8-26. INERTIAL-LEAD VERTICAL SPEED INDICATOR - This indicator is a self-contained unit (figure 8-2) designed to indicate vertical velocity immediately as its inertial mass is affected by vehicle acceleration. The dial is non-linearily calibrated for an up or down movement in 100 feet-per-minute (fpm) divisions up to 6000 fpm.

8-27. WIND DIRECTION INDICATOR - An externally-mounted wind vane is mechanically coupled through the cockpit ceiling to the directional pointer on the Wind Direction indicator. A 5K-ohm potentiometer is inserted in this mechanical linkage to provide an input signal to the

DC Signal Conditioner for telemetry processing (figure 8-18).

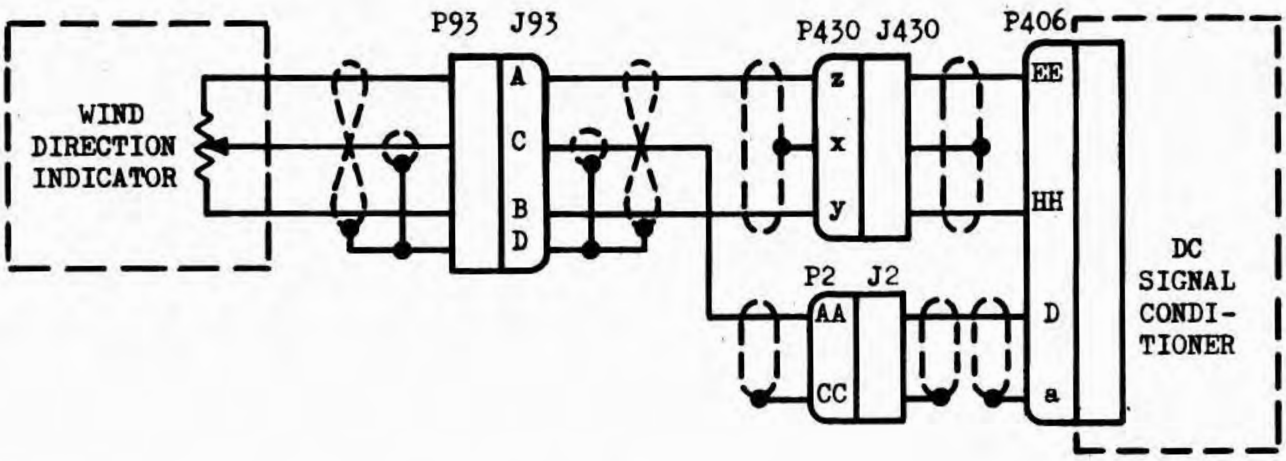



Figure 8-18. Wind Direction Indicator, Cabling Diagram

8-28. AC AND DC VOLTMETERS - Installed below the Pilot's Console (figure 1-7) is an AC voltmeter for display of primary AC power. In conjunction with the AC Power Check switch (figure (1-7), phase A and C can be checked. Located near the AC voltmeter is a DC voltmeter for display of DC power, which is primary DC or during backup mode of operation is emergency DC.

8-29. CLOCK - Installed in the Pilot's Console (figure 8-2) is an 8-day mechanical clock for display of mission time.

8-30. ANNUNCIATOR WARNING INDICATORS - Mounted on the Pilot's Console (figure 8-7) are 21 indicators; 14 are red warning indicators, 4 are amber caution and 3 are green condition indicators. A discussion is provided in paragraphs 8-31 through 8-34. Refer to table 1-5 for a complete list of indicators. Circuit analysis is best presented by use of typical indicator diagrams, to prevent repetition of common components.

8-31. The Annunciator indicators require the application of a signal to pin 1 of the indicators to turn on the lamp. The type of signal and device to activate the indicator is listed in table 8-8. A typical indicator circuit requiring a pressure switch is shown in figure 8-19. As a specific indicator is activated, a similar signal is routed to the DC Conditioner for telemtry processing.

8-32. The Oil Pressure Low Indicator circuit (figure 8-19) is typical of the indicators listed in paragraph 8-31, except the $H_2O_2$ indicator, which is a dual indicator. Whenever the oil pressure is below 15 $\pm$ 2 psig the Oil Pressure switch closes and grounds pin 1 of DS1. With circuit breaker CB3 normally closed the indicator illuminates. The same ground is also applied to the one of the inputs of the master warning control box (figures 8-20 and 8-21). The Annunciator indicator and the master warning control box can both be tested by placing Warning Light Test switch S19 in the test position.

8.33. MASTER WARNING CONTROL BOX - In addition to providing the driver circuit for the DC Failure indicator, the master warning control box also provides an amplifier channel to drive the Master Warning indicator which is located above the Pilot's Console, and an audio oscillator to provide an audible warning to the pilot, whenever one of the red warning indicators is illuminated.

8.34. A simplified block diagram is provided in figure 8-20. See Bell drawing 7260-301721 for schematic of the amplifiers. With a red warning indicator activated, (table 8-7) a similar input is routed to the appropriate input terminal board. The terminal board diodes and resistors route the input to the master warning indicator driver amplifier channel and to the audio oscillator trigger stages. The ground inputs require an inverter stage and then become common with the positive input.

| Indicator | Input Required | Activated By | Illumination |
|---|---|---|---|
| Oil Pressure Low | Ground | Pressure Switch | Red |
| Low Thrust Manual | Ground | Limit Switch | Red |
| JP4 Low Level | Ground | Fuel Sensor Switch | Red |
| JP4 Caution Level | Ground | Fuel Sensor Switch | Amber |
| Auto Throttle | + 28 VDC | Lunar Sim Relay | Green |
| Engine Max Tilt | + 28 VDC | Relay Contacts | Red |
| Emerg. Gimbals Locked | + 28 VDC | Hydraulic Pressure Relay Contacts | Red |
| Local Vert. Mode | + 28 VDC | Relay Contacts | Amber |
| Gimbal Lock Mode | + 28 VDC | Gimbal Lock Switch | Green |
| Stabilization Mode | + 28 VDC | Relay Contacts | Green |
| $H_2O_2$ Low Left Tank | Ground | Sensor/Relay Driver | Red |
| $H_2O_2$ Low Right Tank | Ground | Sensor/Relay Driver | Red |
| Valve Stuck | Ground | Relay Contacts | Red |
| Helium Source Low | Ground | Pressure Switch | Red |
| Doppler | + 28 VDC | Receiver/Transmitter | Amber |
| Auto Pilot Backup | + 28 VDC | Primary/Backup Switch and Monitor Relays | Red |
| Gyro Failure | Ground | Monitor Relays | Red |
| DC Failure | + 28 VDC | Master Warning Control Box Relay Driver | Red |
| AC Failure | + 28 VDC | AC Power Switch | Red |
| Radar Altimeter | + 28 VDC | Radar Assembly | Amber |
| Hardover | + 28 VDC | Hand Controller/Relays | Red |

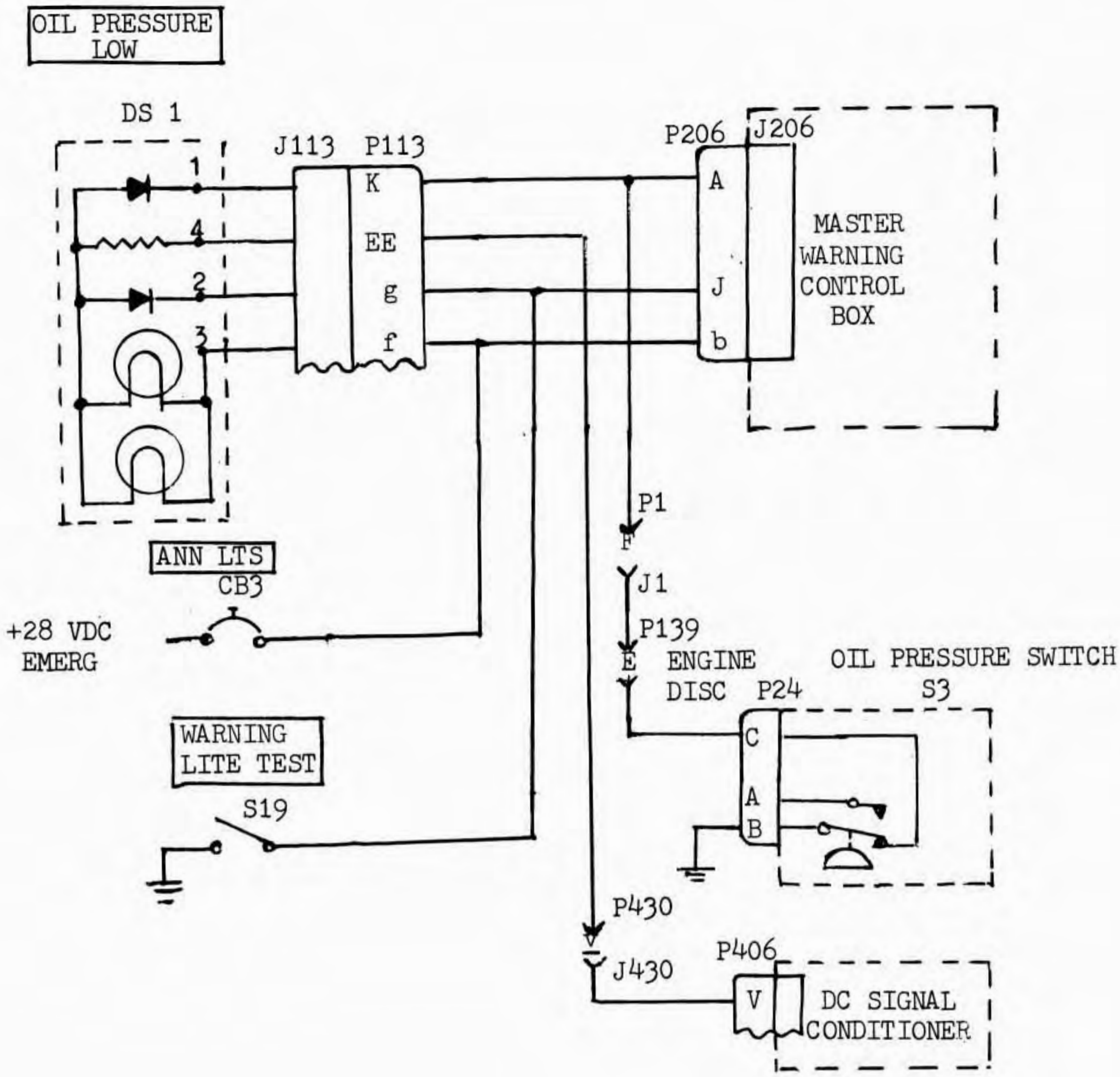



Figure 8-19. Typical Annunciator Indicator Circuit, Schematic Diagram

8-35. COCKPIT INSTRUMENTATION OPERATIONAL CHECKOUT

8-36. The operational checkout of instruments and indicators in the cockpit is provided in table 8-9. The annunciator lights are checked by placing the Warning Light Test switch in the light test position.

TABLE 8-9. COCKPIT INSTRUMENTATION
OPERATIONAL CHECKOUT PROCEDURES

| Indicator | Procedure |
|---|---|
| Altimeter, Barometric | Check ambient pressure reading |
| Wind Velocity | Check ground level wind velocity reading. |
| Wind Direction | Check wind direction indication. |
| Exhaust Gas Temperature | Check ambient temperature reading. |
| JP4 Tank Pressure | Check pressure indication as tanks are serviced. |
| $H_2O_2$ Tank Pressure | Same as previous item. |
| Helium Source Pressure | Check pressure indication as tanks are serviced. |
| $H_2O_2$ Fuel Remaining | Use $H_2O_2$ Set switch to increase/decrease indicator reading. Check ind when rkt used. |
| Oil Pressure | Check indication as jet engine is started. |
| Percent RPM | Check indication as jet engine is started. |
| Lift Rocket Chamber Pressure | Check indication as lift rockets are fired. |
| Altitude Indicator | Follow paragraphs 1.8 through 1.8.2 of Avionics System Preflight Report No. 7260-931006 |
| Altitude/Altitude Rate | Preflight 7260-931009 |
| Horizontal Velocity | Preflight 7260-931009 |
| Thrust/Weight | Checked only during flight. |
| Inertial-Lead Vertical Speed | Checked only during flight. |
| Voltmeters, AC and DC | Check for reading with power on. |
| Clock | Check for time indication. |
| Hardover | Follow paragraphs 4.1.2.30 through 4.1.2.30.7 of Avionics Preflight 7260-931050. |

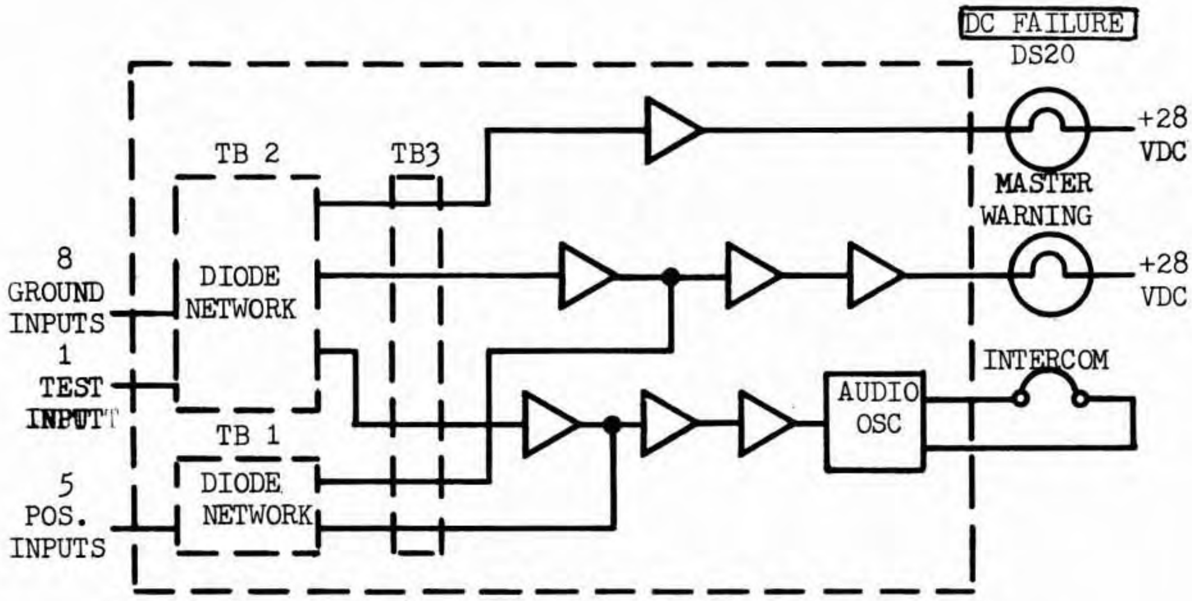



Figure 8-20. Master Warning Control Box, Block Diagram

8-37. COCKPIT INSTRUMENTS TROUBLE ANALYSIS

8-38. Failure of the cockpit instruments and associated circuitry does not indicate an inherent failure, as the systems they monitor, e.g., fuel, oil and altitude, may be the basic source of trouble. When limited to just the indicators and associated circuitry, the various diagrams will assist in troubleshooting. For additional assistance, refer to paragraph 4.2.6.4 fo Failure Mode Analysis Report Number 7260-950014.

8-39. REMOVAL AND INSTALLATION

8-40. The simplicity of removal and installation requires only the removal or connection of rear-mounted connectors, as required, and the removal or installation of mounting screws and washers from the indicator and cockpit instrument panel.

8-41. ADJUSTMENTS

8-42. The adjustment procedures for those indicators requiring adjustment peculiar to the LLTV are provided. Adjustments procedures for the following GFE instruments are not described: Thrust/Weight, Altitude/Altitude Rate, Horizontal Velocity and Attitude indicators. Refer to Cockpit and Data Systems Hangar and Ramp Ground Test Procedures, Report Number 7260-928057, for procedures to check the calibration of the cockpit instruments.

8-43. JP4 TANK PRESSURE INDICATOR CIRCUIT

8-44. Paragraphs 8-45 and 8-46 provide the test equipment required, and step-by-step procedures to adjust the forward and aft JP4 Tank Pressure Indicator circuits.

8-45. TEST EQUIPMENT REQUIRED - A test gage (0-200 psi) and a pressure test cart are required.

8-46. STEP-BY-STEP PROCEDURE - Perform the following steps in the indicated order.

NOTE

Power must be applied to the vehicle.

A. With pressure test cart, pressurize transducer in 10-pound increments.
B. Measure pressure with test gage.
C. Read JP4 Tank Pressure indicator; adjust appropriate rheostat (R4/R5) for reading to correspond to test gage readings (figure 8-1).

8-47. OIL PRESSURE INDICATOR CIRCUIT

8-48. Paragraphs 8-49 and 8-50 provide the test equipment required, and step-by-step procedures to adjust the Oil Pressure Indicator circuit.

8-49. TEST EQUIPMENT REQUIRED - A test gage (0-200 psi) and a pressure test cart are required.

8-50. STEP-BY-STEP PROCEDURE - Perform the following steps in the indicated order.

NOTE

Power must be applied to the vehicle.

A. With pressure test cart, pressurize transducer in 10-pound increments.
B. Measure pressure with test gage.
C. Read Oil Pressure indicator; adjust R3 (figure 8-3) as required for reading to correspond to test gage readings.

8-51. WIND VELOCITY INDICATOR CIRCUIT

8-52. Refer to Cockpit and Data Systems Hangar and Ramp Ground Test Procedures, Report Number 7260-928057, for procedures to check the calibration and adjustment of the Wind Velocity indicator.

SECTION IX

SECTION IX

ELECTRICAL SYSTEM

MAINTENANCE

## 9-1. SCOPE OF SECTION

9-2. This section provides a description, functional analysis and maintenance instructions for the LLTV Electrical system. The maintenance instructions include troubleshooting analysis, service and testing, adjustments, removal and installation procedures, test equipment, and vehicle power transfer procedures.

## 9-3. DESCRIPTION AND LEADING PARTICULARS

9-4. The Primary Power system consists of a 28-volt, 200-ampere, DC generator (figure 9-1) driven by the jet engine, a 400-hertz, 3-phase inverter (figure 9-2), a DC voltage regulator (figure 9-3), AC and DC external power receptacles (figure 7-3), and AC and DC distribution lines. The Secondary Power system consists of battery control relays, a 28-volt battery (figure 9-3), an emergency 400-hertz AC inverter, two 800-hertz, AC inverters, and AC and DC distribution lines. Circuit breakers, located in the cockpit (figure 1-4) and on the aft equipment rack (figure 9-3), used in both systems, isolate defective equipment and assure power to the aft equipment. Refer to Bell drawing No.7260-200001. for detailed electrical information.

9-5. Electrical wiring is separated, where practical, into four bundles. AC primary circuits run along the top of the left hand outboard structure and primary DC and low level circuits run along the bottom. Emergency circuits run along the right hand outboard structure, AC along the top

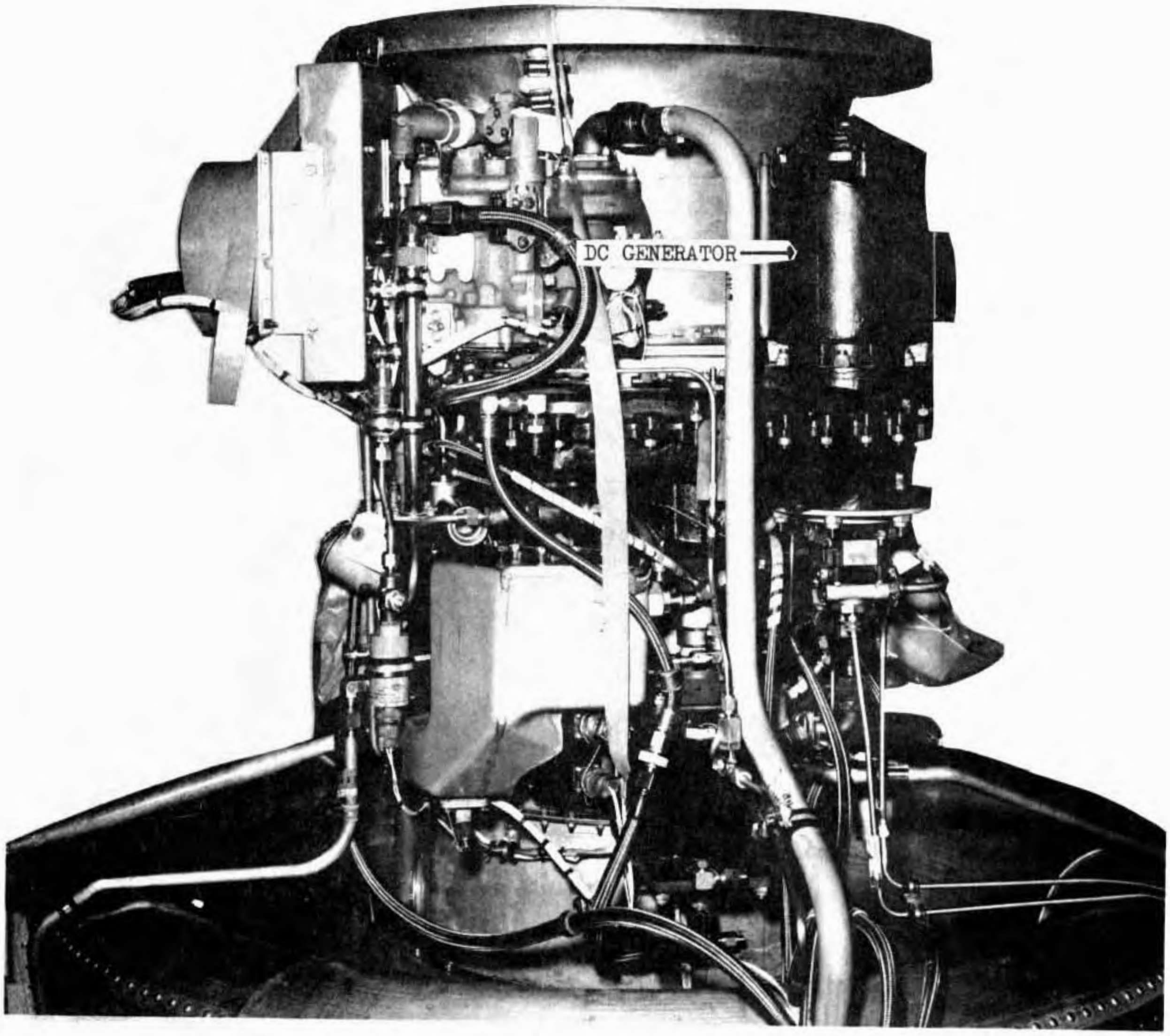



Figure 9-1 28-Volt D-C Generator

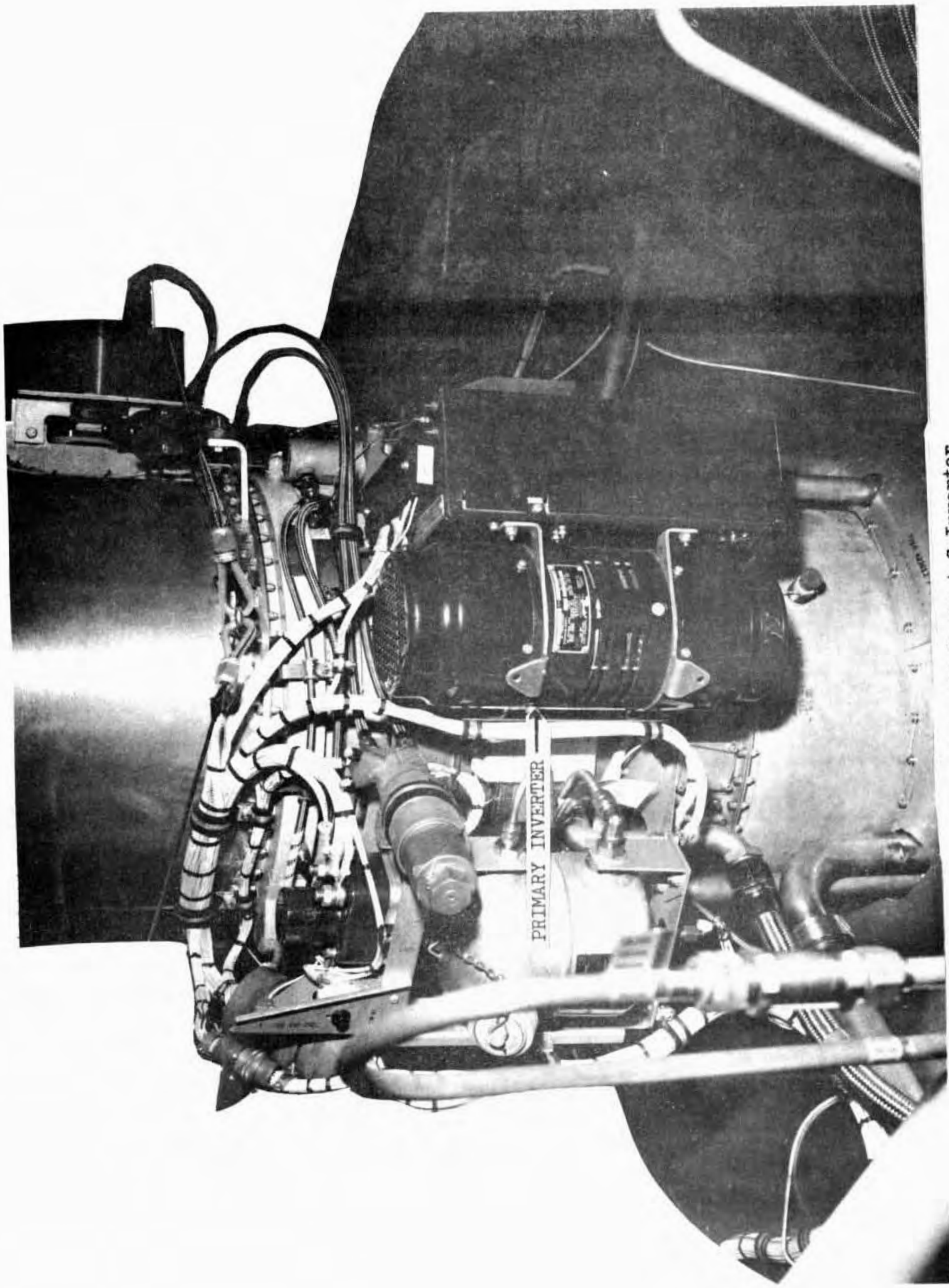



Figure 9-2 400-Hertz A-C Inverter

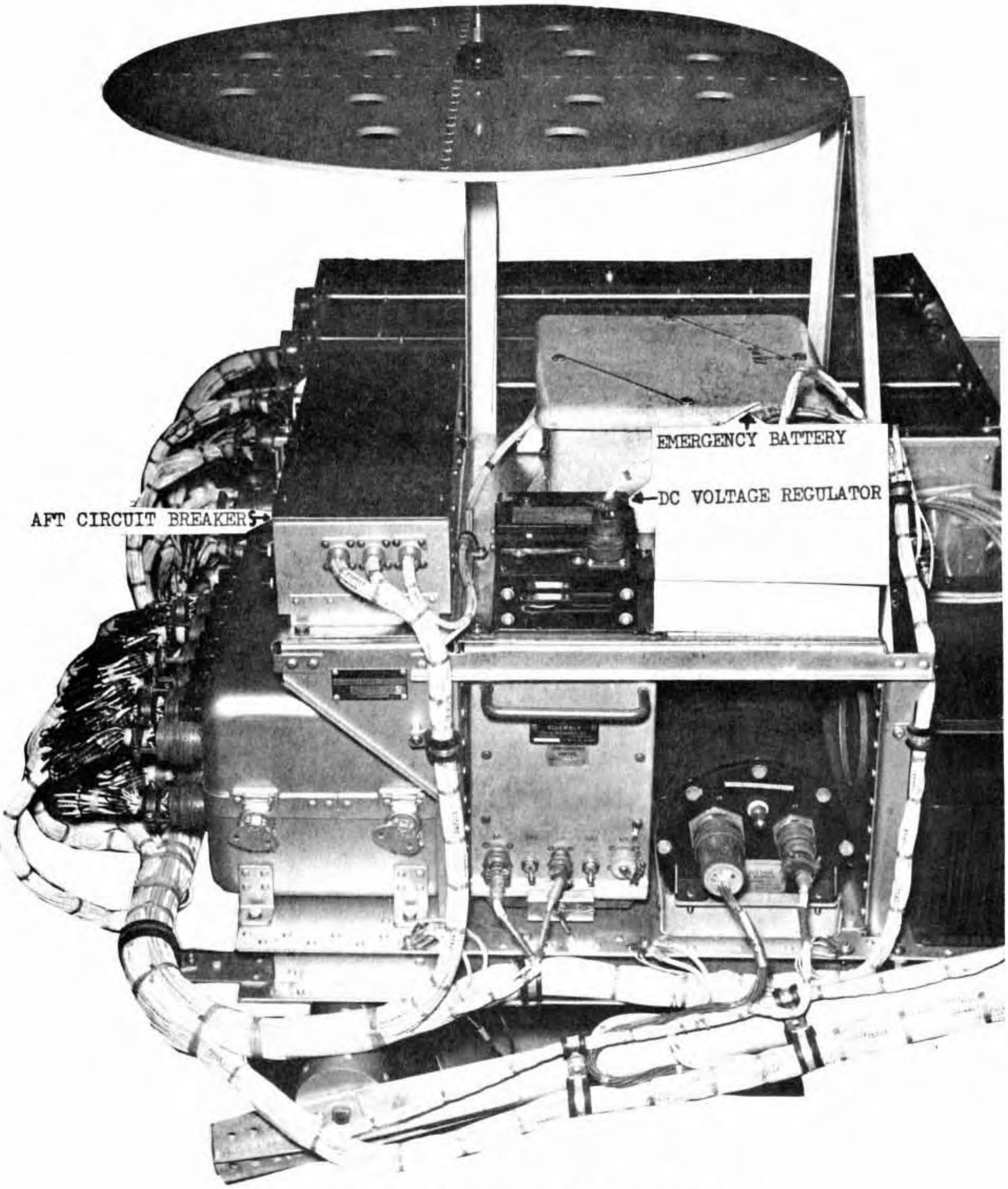



Figure 9-3. Aft Equipment Rack, Starboard Side

and DC along the bottom.

## 9-6. FUNCTIONAL ANALYSIS

9-7. Analysis of the LLTV Electrical system is presented for the normal or primary AC and DC power operation and then for emergency or backup operation.

## 9-8. PRIMARY POWER SYSTEM

9-9. The source of DC power for the Primary system is a 28 VDC generator which is mechanically driven by the jet engine. The generator is controlled by the cockpit DC Power switch (figure 1-3) which turns it on and off, the DC voltage regulator which automatically adjusts generator output level, and the DC Over/Under Voltage circuit which automatically shuts off the generator should the output vary more than 28 $\pm$ 4 vdc. The 28 VDC Primary Generator drives a 115v, 400-hertz inverter which supplies AC power. Control of the inverter is accomplished by the cockpit AC Power switch and the AC Over/Under Voltage circuit. The AC Over/Under Voltage circuit automatically drops the inverter from the line if the AC voltage exceeds the limits of 115 $\pm$ 15 vac. In the event primary AC voltage falls below 100 volts or above 130 volts, avionics will automatically switch to Rate Backup, select and fire both sets of rockets, and select Emergency Gimbals Locked mode of jet engine control. AC Failure, Auto Pilot Backup and Emergency Gimbals Locked indicators will illuminate. If the DC generator output voltage decreases below 24.0 volts or increases above 32 volts, avionics will automatically switch to Rate Backup and select Emergency Gimbals Locked engine control. Both sets of rockets will be selected but only the Standard set will fire. AC Failure, Auto Pilot Backup, and Emergency Gimbals Locked indicators will illuminate.

9-10. The DC Power switch (figure 1-3), located on the Pilot's Control Console, applies the 28-volt DC generator output through the voltage regulator to the DC distribution line. The DC Power switch is a momentary action switch that is latched closed as long as the primary DC is applied to the DC Volts sensor. The AC Power switch (figure 1-3) is the same type of switch and is latched closed as long as the Phase A and Phase C AC volt sensors provide a latching input to the AC Power switch. See figure 9-4 for DC and AC power distribution. Primary DC power is routed through the de-energized contacts of the battery relay to the emergency DC distribution line. The emergency 400-hertz inverter and two 800-hertz inverters provide 28 volts, AC during operation of the Primary Power system.

9-11. BACKUP POWER SYSTEM

9-12. The Battery Power switch (figure 1-3) is placed in the ON position to enable the emergency battery relay to energize if primary DC power is lost. The emergency battery provides 28 volts, DC, to essential systems for flight safety and to the 400-hertz, 28-volt, AC emergency inverter and the 800-hertz inverters to provide 28 volts, AC, to essential systems for flight safety.

9-13. CIRCUIT BREAKERS

9-14. The circuit breakers accessible to the pilot are listed in table 1-2 and shown in figure 1-4. The circuit breakers on the aft equipment rack are listed in table 9-1.

9-15. TROUBLE SHOOTING ANALYSIS

9-16. Failure of any given circuit breaker removes DC and AC and sometimes both DC and AC from the various equipment. The symptoms due to a

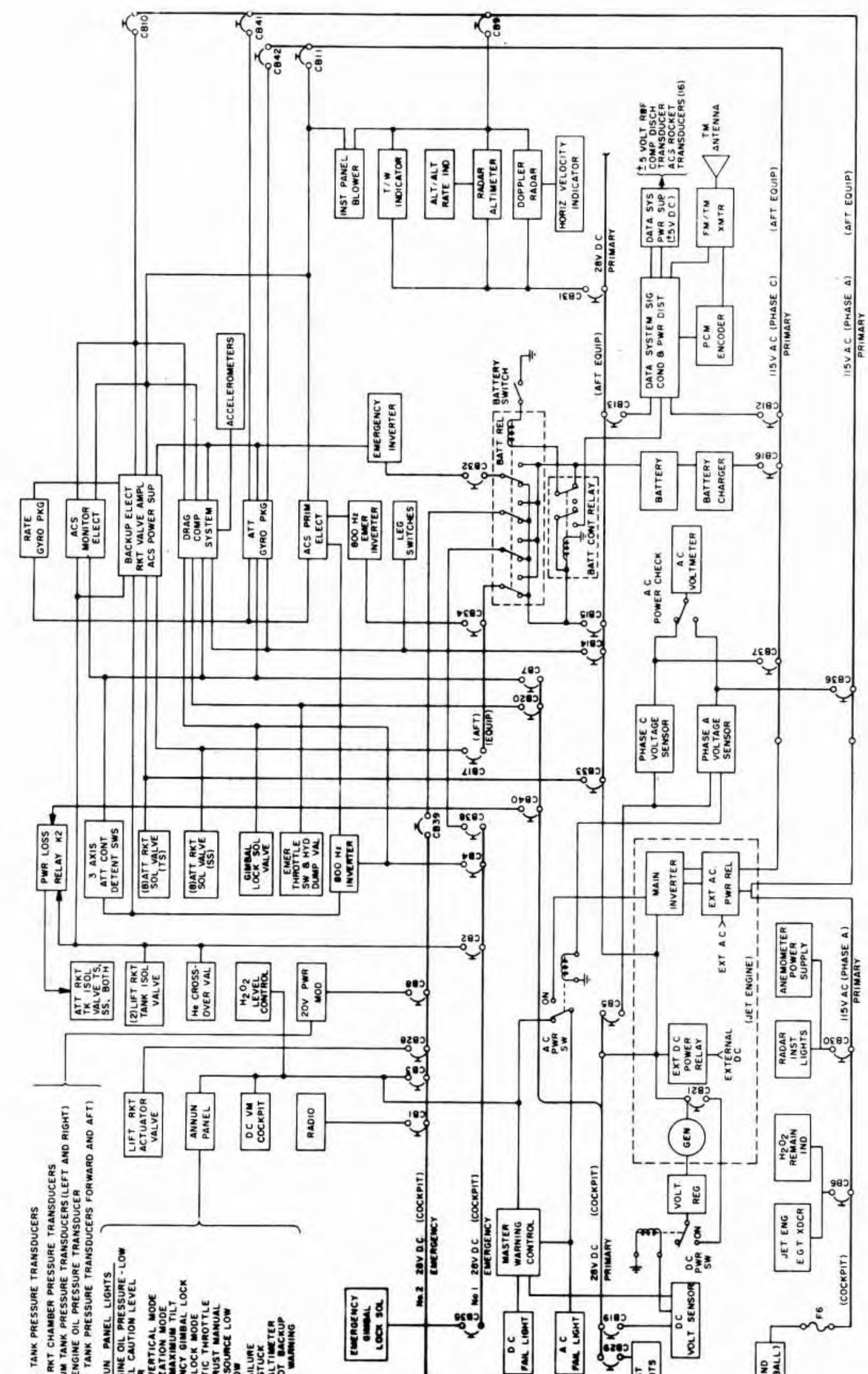



Figure 9-4. LLTV Electrical Power Distribution Diagram

circuit breaker failure are varied but can be determined, in part, by an analysis of figure 9-4. However, as gross symptoms are also exhibited by individual equipment failure, not traceable to circuit breaker failure, each trouble must be individually analyzed by the use of tables 1-2 and 9-1 in conjunction with figure 9-4. For example, a failure of circuit breaker CB15 or CB21 results in the system using the emergency battery. However, if circuit breaker CB15 opens there is still primary 115 volts, AC available. Observation of vehicle system operation and warning indicators is the primary source of information to perform troubleshooting analysis at the electrical system. Voltage checks and continuity checks are required to further isolate defective circuits.

9-17. SERVICE AND TESTING

9-18. Servicing and testing of the emergency battery is performed by the battery shop in accordance with approved procedures. Quality assurance personnel shall monitor battery use and condition and maintain the MSC 772 historical record on each battery.

9-19. VEHICLE POWER TRANSFER PROCEDURE

9-20. The step-by-step procedures and equipment requirements are provided in paragraphs 9-21 through 9-27.

9-21. EQUIPMENT REQUIREMENTS

9-22. The following equipment is required to perform vehicle power transfer.

A. Rectifier Cart
B. Ground Power Distribution Box
C. Truck-mounted Auxiliary Power Unit (APU)

(Items A–C: Refer to Vehicle Preflight Checklist 7260-931005)

TABLE 9-1. AFT EQUIPMENT CIRCUIT BREAKERS

| Dwg Desig. NBR | Title | Bus | Function |
|---|---|---|---|
| CB9 | Radar | 115-volt Primary | Radar Altimeter, doppler radar, instrument panel blower, and T/W indicator |
| CB10 | ∅ A ACS | 115-volt Primary | ACS monitor electronics, ACS power amplifier, Attitude Gyro |
| CB11 | ∅ C ACS | 115-volt Primary | Instrument panel blower, ACS monitor electronics, ACS power amplifier, ACS primary electronics, Attitude Gyro |
| CB12 | ∅ C Inst | 115-volt Primary | Data system |
| CB16 | Battery Charge | 115-volt ∅ A Primary | Battery charge |
| CB13 | 28 v DC Norm.Inst. | 28-volt Primary | Data system |
| CB14 | DC Norm. ACS | 28-volt Primary | Drag compensation, Attitude Gyro package, leg switches |
| CB15 | DC Emergency | 28-volt Primary | Emergency bus feed battery control relay |
| CB31 | Radar | 28-volt Primary | Radar altimeter, doppler and T/W indicator |
| CB17 | Emergency Attitude Rockets | 28-volt Emergency | Rocket valve supply |
| CB32 | Emergency Inverter | 28-volt Emergency | Emergency inverter |

TABLE 9-1. AFT EQUIPMENT CIRCUIT BREAKERS (Continued)

| Dwg Desig. NBR | Title | Bus | Function |
|---|---|---|---|
| CB34 | DC Emergency ACS | 28-volt Emergency | ACS primary electronics Emergency power |
| CB33 | Norm Attitude Rockets | 28-volt Normal | Rocket valve power amplifier |
| CB36 | Phase A Volt Monitor | 115-volt Primary | Phase A voltage sensor |
| CB37 | Phase C Volt Monitor | 115-volt Primary | Phase C voltage sensor |
| CB38 | Forward DC Emergency | 28-volt Emergency | CB2, CB4, CB35 Fwd emergency bus protection |
| CB39 | Forward DC Emergency | 28-volt Emergency | CB1, CB3, CB28 Fwd emergency bus protection |
| CB41 | Attitude Gyro | 115-volt Primary ∅ A | Attitude Gyro |
| CB42 | Attitude Gyro | 115-volt Primary ∅ | Attitude Gyro |

9-23. STEP-BY-STEP PROCEDURES

9-24. To accomplish vehicle power transfer, perform the step-by-step procedures provided in paragraphs 9-25 through 9-27.

9-25. POWER STATUS - Preliminary steps are as follows:

A. Vehicle operative from Rectifier Cart Set at 28.5 volts.

B. S-2 on Ground Power Distribution Box in ON (over ride) position.

C. Truck-mounted auxiliary power unit (APU) started and running for 5 - 10 minutes to warm up. The APU DC Load switch shall be "OFF" at this time and voltage adjusted to 30 volts NO LOAD.

9-26. <u>GROUND RECTIFIER TO TRUCK-MOUNTED APU</u> - To transfer power from ground rectifier to the truck-mounted APU, proceed as follows:

A. Insert DC cord to truck APU into the available 28-volt plug (J2 or J3) of Ground Power Distribution Box.

B. Hold AC Power switch in vehicle cockpit in ON position manually until after power has been transferred back to the rectifier unit.

C. Turn the APU Load switch to ON position.

D. Turn down the voltage of ground rectifier to that voltage where it is supplying less than 50 amperes. Then turn the rectifier unit OFF and remove its cordage from the Ground Power Distribution Box.

E. Power transfer complete, vehicle may now be transferred to ramp.

9-27. <u>TRUCK-MOUNTED APU TO GROUND RECTIFIER</u> - To transfer power from the truck-mounted APU to the ground rectifier, proceed as follows:

A. The cockpit AC Power switch is still being held in ON position.

B. Insert the cord from the ground rectifier into the available 28-volt plug (J2 or J3) of the Ground Power Distribution Box. Also, connect the ground inverter cordage into J1.

C. Turn the ground rectifier ON and increase its voltage until its ammeter reads approximately 50 amps.

D. Turn the truck APU Load switch to OFF and disconnect its cord from the Ground Power Distribution Box.

E. Start the ground inverter by closing S-1 (Ground Power Distribution Box).

F. The AC Power switch need not be held beyond this point in time and can be released.

G. Reset the ground rectifier voltage at 28.5 volts.

H. Place S-2 of the Ground Power Distribution Box in its OFF position.

I. Power Re-transfer complete.

9-28. REMOVAL PROCEDURES

9-29. The removal procedures for the major components of the LLTV electrical system are provided in paragraphs 9-30 through 9-41.

9-30. EMERGENCY BATTERY

9-31. To remove the emergency battery, proceed as follows:

A. Cut safety wire on four bolts (AN3H-10A), located on battery case cover. See Bell drawing 7260-202003.

B. Remove four bolts and washers (AN970-3) from cover and remove cover.

CAUTION

When removing battery electrical connections do not short terminals together with tools.

C. Disconnect electrical connections from battery terminals.

D. Remove battery wedges and lift battery by lacing tape from case. See Bell drawing 7260-200006.

9-32. DC VOLTAGE REGULATOR

9-33. To remove the DC voltage regulator, proceed as follows:

A. Disconnect electrical connector P55.

B. Remove four screws (MS51957-44) and washers (AN960PDS) from regulator case holding bracket.

C. Remove DC voltage regulator from aft equipment rack.

9-34. DC GENERATOR

9-35. Refer to paragraph 6-25 for removal procedures for the DC generator. See Bell drawing 7161-202001.

9-36. PRIMARY INVERTER AND MOUNTING BASE

9-37. Refer to paragraphs 6-29 and 6-30 for removal procedures for the primary inverter and its mounting base. See Bell drawing 7260-200002.

9-38. EMERGENCY INVERTER AND HEAT SINK

9-39. To remove the emergency 400-hertz inverter and heat sink, proceed as follows:

A. Disconnect electrical connector P72 from the emergency inverter.

B. Remove four bolts (AN3-6A) and washers (AN960PD10) holding inverter and heat sink to bracket mounted on aft structure. See Bell drawing 7260-153502.

C. Remove eight screws (AN507-1021-6) holding heat sink to inverter to separate the two components. See Bell drawing 7260-153503.

D. Clean thermal joint compound from heat sink and inverter.

9-40. 800-HERTZ INVERTERS

9-41. The removal procedures for both inverters are essentially similar and differ only due to installation location. Access to the mounting screws for the inverter mounted in the cockpit is accomplished by removal of the access panel in the pedestal. See Bell drawing 7260-561004. To remove either inverter, proceed as follows:

A. Remove electrical wires to inverter.

NOTE

If service loop is long enough for installation of new inverter, the wires can be cut. Otherwise remove potting compound and unsolder connections.

B. Cut safety wire from mounting screws.

C. Remove four screws (MS352276-261) and washers (AN960PD10L) from inverter and mounting plate. See Bell drawing 7260-200006.

D. Clean thermal joint compound from inverter and mounting plate.

9-42. INSTALLATION PROCEDURES

9-43. The installation procedures for the major components of the LLTV electrical system are provided in paragraphs 9-44 through 9-54.

9-44. EMERGENCY BATTERY

9-45. The emergency battery is installed in the reverse order of removal. Refer to paragraph 9-30.

9-46. DC VOLTAGE REGULATOR

9-47. The DC voltage regulator is installed in the reverse order of removal. Refer to paragraph 9-32.

9-48. DC GENERATOR

9-49. The DC generator is installed in the reverse order of removal. Refer to paragraph 6-25.

9-50. PRIMARY INVERTER AND MOUNTING BASE

9-51. The primary inverter and mounting base is installed in the reverse order of removal. Refer to paragraphs 6-29 and 6-30.

9-52. EMERGENCY INVERTER AND HEAT SINK

9-53. Apply thermal joint compound to base of the emergency inverter and then proceed to install in the reverse order of removal. Refer to paragraph 9-38.

9-54. 800-HERTZ INVERTERS

9-55. Apply thermal joint compound to base of the inverter and then proceed to install in the reverse order of removal. Refer to paragraph 9-40.

9-56. GENERATOR AND REGULATOR CHECK AND ADJUSTMENT

9-57. The equipment required, preliminary procedures and step-by-step procedures are provided in paragraphs 9-58 through 9-64.

9-58. EQUIPMENT REQUIRED

9-59. A drive stand capable of delivering 3570 to 6000 RPM, and a test harness (figure 9-5) is required to check and adjust the DC generator and voltage regulator.

9-60. PRELIMINARY PROCEDURE

9-61. Remove the DC generator and DC voltage regulator in accordance with procedures provided in paragraphs 6-25 and 9-32, respectively.

9-62. STEP-BY-STEP PROCEDURE

9-63. To check and adjust the DC generator and regulator, proceed as follows:

A. Mount the generator on a drive stand capable of delivering 3750 to 6000 RPM.

B. Connect the voltage regulator as shown in figure 9-5 using wire lengths and gages indicated.

C. Run up the generator to 4200 RPM and close the switch to the regulator.

NOTE

If the voltmeter shows that the generator is not excited, increase RPM until the generator is excited, then reduce RPM to 4200.

D. Adjust the voltage regulator for a voltmeter reading of 28.0 volts.

E. Install the DC generator and voltage regulator in the reverse order of removal. Refer to paragraphs 6-25 and 9-32, respectively.

9-64. An alternate procedure for adjusting generator voltage without removal from vehicle is as follows:

A. Adjust the regulator with the jet engine running at approximately 48 percent RPM.

B. Set the voltage to 28.0 volts on the cockpit DC voltmeter.

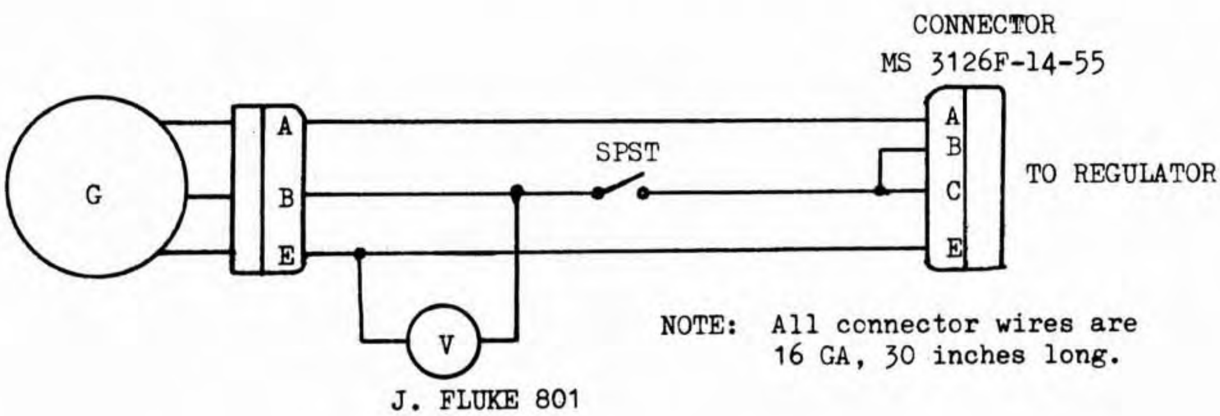



Figure 9-5. DC Generator and Regulator Adjustment Connections, Cabling Diagram

SECTION X

# RADIO, RADAR AND TELEMETRY MAINTENCE

## 10-1 SCOPE OF SECTION

10-2 The section provides a functional and general description, and maintenance instructions for the radio communication equipment, radar equipment, and instrumentation and telemetry equipment. The maintenance instructions include operational check out, troubleshooting, installation and removal, adjustments and test equipment.

## 10-3 DESCRIPTION AND LEADING PARTICULARS

10-4 The radio communication equipment consists of a UHF transceiver, an antenna, and an intercommunication control box and amplifier. The radar equipment consists of a receiver/transmitter, two antennas, a radar assembly, a high voltage power supply, an altitude/altitude rate indicator and a horizontal velocity indicator. The instrumentation and telemetry equipment consists of a PCM encoder, an FM transmitter, an antenna, an AC/DC signal conditioner, a positive and negative 5-volt power supply, various sensors and transducers, and a positive 20-volt power module. The sensors, transducers and power module are also functional components of other systems.

## 10-5 RADIO COMMUNICATION EQUIPMENT

10-6 Located on the left console in the cockpit, is the TR31, UHF transceiver, which provides the pilot with communications to the ground. The UHF transceiver control panel provides a 4-channel frequency selector control, an audio volume control, an on-off control and a squelch control. See figure 1-14. The four UHF frequencies are 233.6, 235.4, 236.6, and 239.5 megahertz. An amplifier and control box, C823A/AIC-10, (figure 1-14), provides impedance matching between 9 ohm headsets and 150 ohm tranceiver output. For detailed maintenance instructions on the UHF transceiver, refer to Cubic Corporation manual UHF Transceiver Cubic Model TR31.

10-7 RADAR EQUIPMENT

10-8 The radar equipment provides altitude and altitude rate signals, and horizontal velocity signals to the respective indicators. Refer to paragraphs 8-20 and 8-21 for a description of the indicators. The indicators provide similar signals from internal potentiometers to the AC/DC Signal Conditioner.

10-9 RADAR ALTIMETER - Radar signals are transmitted to and received from the ground by the radar assembly (Ryan 602A, figure 10-1) and two antennas (figure 10-2). The received radar signals are processed by the radar assembly and an altitude and an altitude rate signal is routed to the Altitude/Altitude Rate Indicator M17. The similar type signals. are provided to the AC/DC Signal Conditioner from potentiometers contained in the indicator. Refer to Ryan Support Manual Model 602 Radar Altimeter, Report Number 60264-1 for detailed maintenance instructions on the radar assembly and indicator.

10-10 DOPPLER RADAR - Radar signals transmitted and received by Receiver/Transmitter Model TR-1 (Ryan 547A, figure 10-2) provide forward and lateral velocity signals by measurement of the doppler shift in the transmitted versus received signals. The forward (horizontal) velocity and lateral (drift) velocity signals are routed for display on the Horizontal Velocity Indicator M7. Equivalent signals are provided to the AC/DC Signal Conditioner from potentiometers contained in the indicator. Refer to Ryan Support Manual Model 547 Doppler Velocity Sensor, Report Number 54764-1 for detained maintenance instructions on the indicator and TR-1 receiver/transmitter.

## 10-11 INSTRUMENTATION AND TELEMETRY EQUIPMENT

10-12 Instrumentation of the LLTV through the use of 27 transducers, 7 potentiometers, various switches, sensors, and miscellaneous devices provides input signals to the AC/DC Signal Conditioner. See figures 10-3 and 10-4. A total of 63 channels of analog voltage data and 29 bits of digital data is provided to the PCM Encoder (figure 10-1). Refer to Teledyne Systems Operation and Maintenance Manual, PCM Telemetry System Model CT-77A for detailed maintenance instruction on the encoder. The output of the encoder is routed to FM/TM Transmitter TR-2 for transmission to the TM van. See figure 10-1.

## 10-13 INSTRUMENTATION AND TELEMETRY BLOCK DIAGRAM ANALYSIS

10-14 A general functional block diagram analysis is provided in paragraphs 10-15 to 10-21. A discussion of the 63 channels of analog voltage data preceeds the analysis of the 29 bits of digital data. The discussion is supported by a block diagram (figure 10-4) and table 10-1.

## 10-15 ANALOG VOLTAGE INSTRUMENTATION

10-16 Channels 1 through 53 and 58 through 67 (refer to table 10-1) are used to provide analog voltage data. A comparison of figure 10-4 and table 10-1 provides identification of the analog voltage source

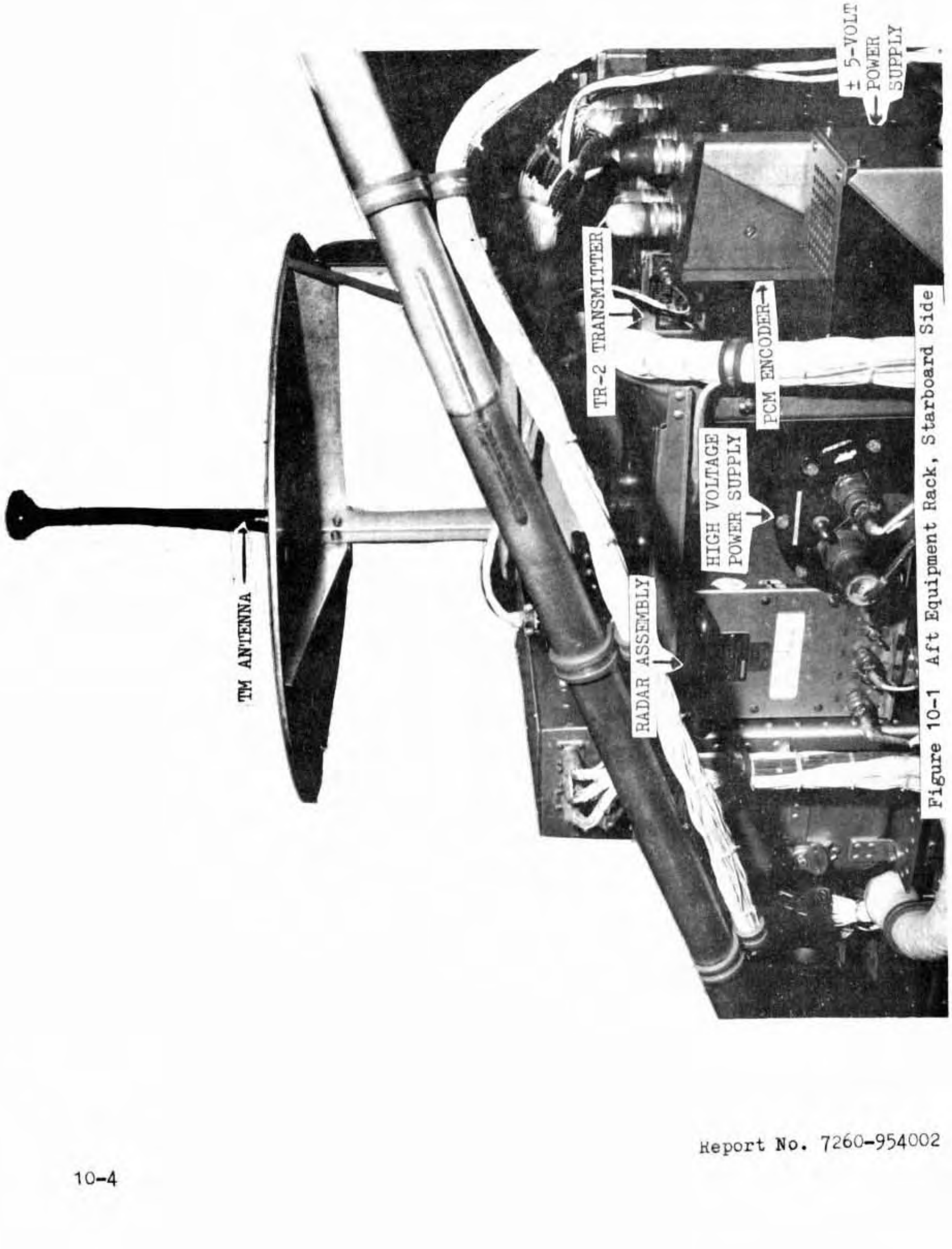



Figure 10-1 Aft Equipment Rack, Starboard Side

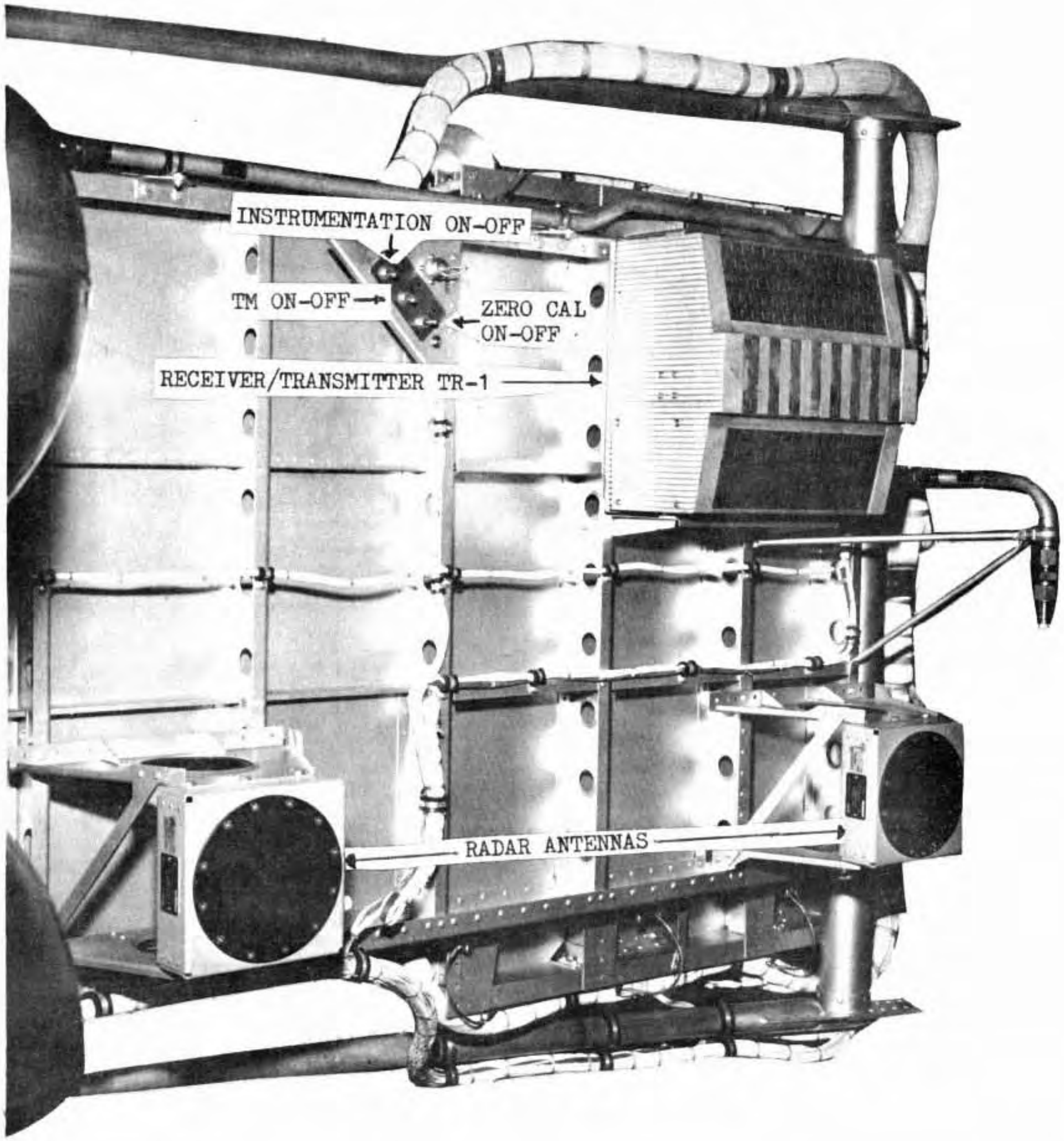





Figure 10-2. Radar Receiver/Transmitter Model TR-1

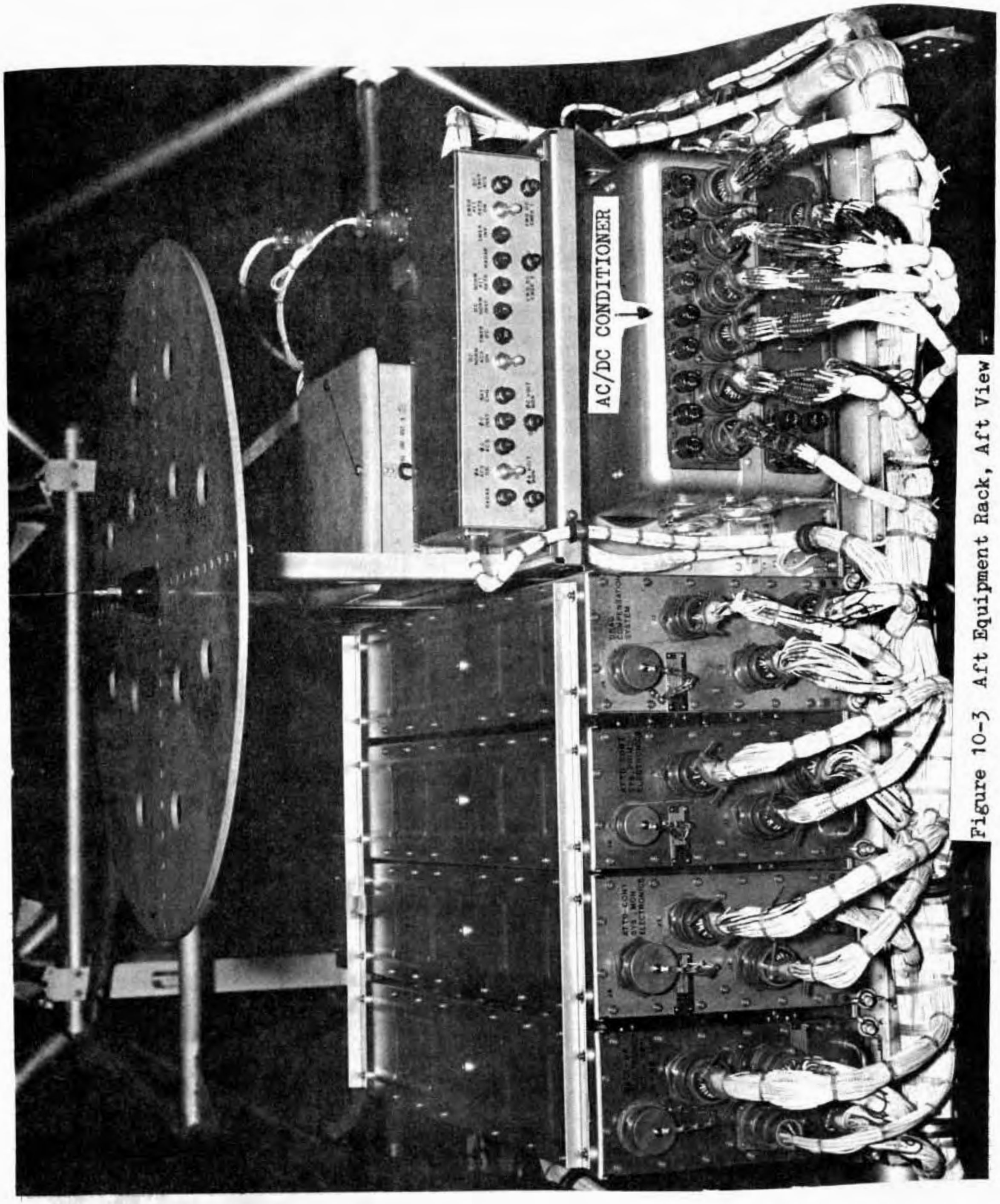



Figure 10-3 Aft Equipment Rack, Aft View

either to a component or system level. All analog voltages are routed to the AC/DC Signal Conditioner prior to processing by the PCM Encoder. The circuitry for the analog voltage sources common to the cockpit instrument panel is provided in section VIII of this manual. Table 10-1 provided the wiring information for analog signals routed from the Avionics system, and other signal sources in addition to the sources common to the cockpit instruments.

10-17. DIGITAL DATA INSTRUMENTATION

10-18. Channels 54 through 57 (refer to table 10-1) are used to provide the 29 bits of digital data. A comparison of figure 10-4 and table 10-1 provides identification of the digital source either to a component level or system level. The digital sources common to the annunciator panel indicators are routed through the indicators prior to the AC/DC Signal Conditioner. Table 10-1 provides the wiring information for digital signals routed from other sources in addition to the sources common to the annunciator panel indicators.

10-19. AC/DC SIGNAL CONDITIONER

10-20. The control relays for the instrumentation and telemetry systems are located in the DC Signal Conditioner. Control switches for these relays are mounted on the underside of the aft equipment platform. See figure 10-2. The positive and negative 5-volt power supply outputs are routed to the DC Signal Conditioner to provide power to the attitude rocket transducers, the compressor discharge and accumulator pressure transducers. The positive and negative 5 volts are also routed through the DC Signal Conditioner to the PCM Encoder input. See figure 10-5. The attitude rocket transducer output, (channels 27 through 42) are routed through the DC Signal

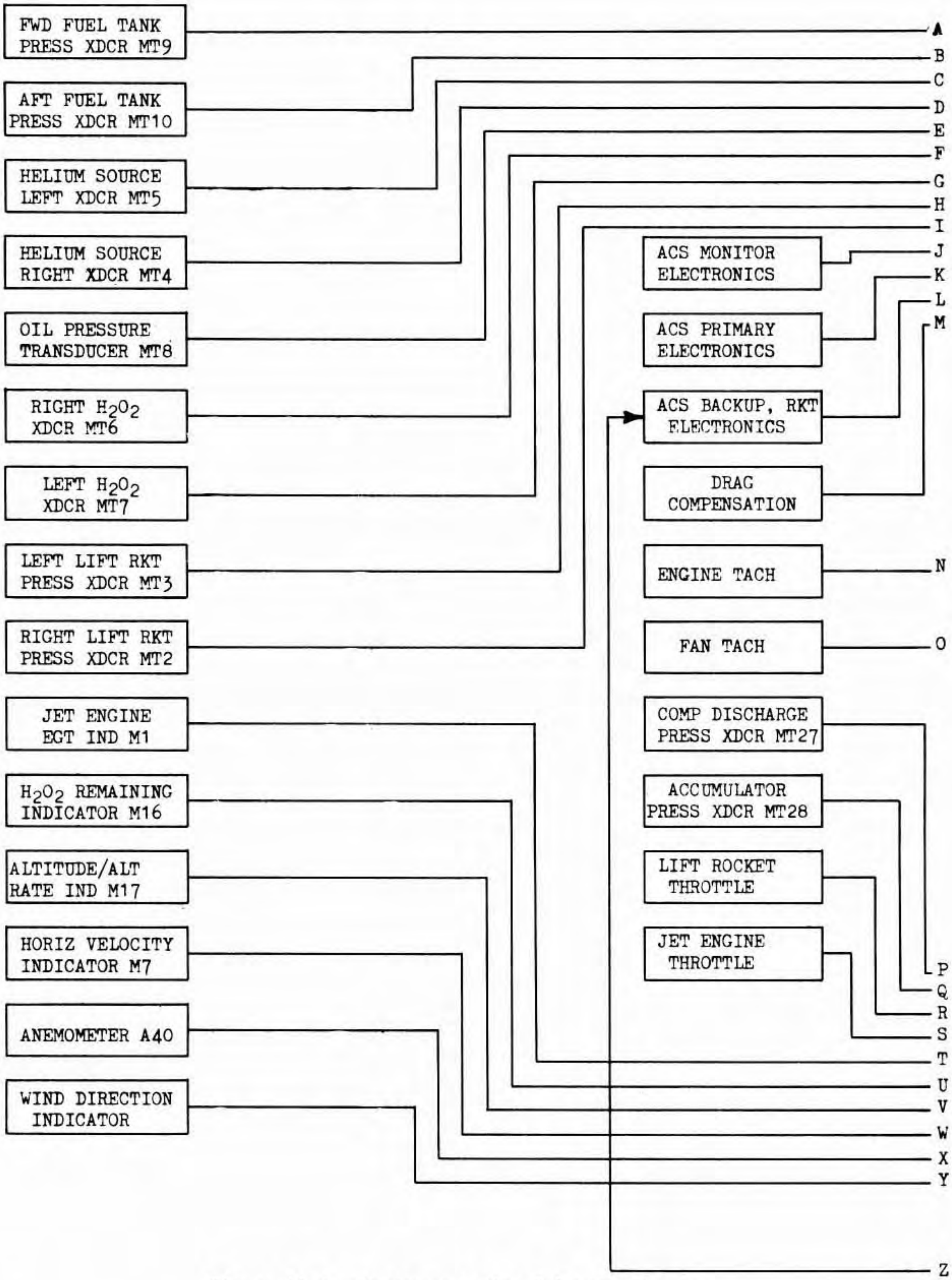



Figure 10-4. Instrumentation Telemetry System Block Diagram, Sheet 1 of 2

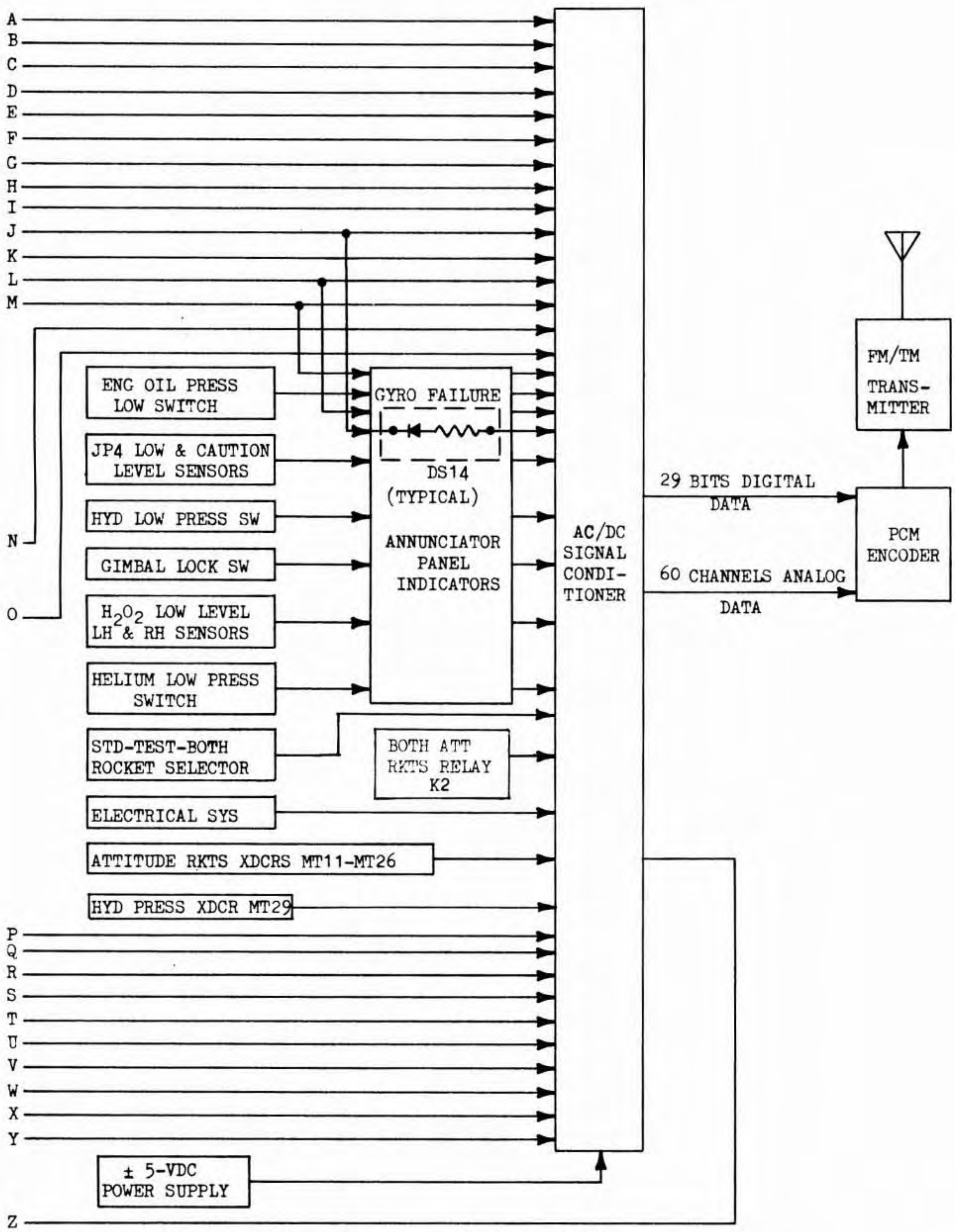



Figure 10-4. Instrumentation Telemetry System Block Diagram, Sheet 2 of 2

Table 10-1. Telemetry Instrumentation Channels Wire List

| Chan | Signal | Source | Conn-Pin | Interconn | AC/DC Conditioner Input | AC/DC Conditioner Output | PCM Encoder Input | PCM Encoder Output |
|---|---|---|---|---|---|---|---|---|
| 1A | Vehicle Pitch Attitude | Primary Elec | P69-r | NA | P304-b | P303-G | P418-1 | P413-10 |
| 1B | | | | | | P303-N | P418-2 | |
| 2A | Vehicle Roll Attitude | Primary Elec | P69-CC | NA | P304-a | -E | -3 | |
| 2B | | | | | | -c | -4 | |
| 3A | Vehicle Yaw Attitude | Primary Elec | P69-FF | NA | P304-c | -F | -5 | |
| 3B | | | | | | -M | -6 | |
| 4A | Vehicle Pitch Velocity | Primary Elec | P69-m | NA | P304-e | -H | -7 | |
| 4B | | | | | | -P | -8 | |
| 5A | Vehicle Roll Velocity | Primary Elec | P69-N | NA | P304-d | -Z | -9 | |
| 5B | | | | | | -U | -10 | |
| 6A | Vehicle Yaw Velocity | Primary Elec | P69-k | NA | P304-f | -a | -11 | |
| 6B | | | | | | -V | -12 | |
| 7A | Ax Error Signal | Drag Compen. | P66-K | NA | P304-K | -b | -13 | |
| 7B | | | | | | -W | -14 | |
| 8A | Helium Source Left Hand | Xdcr MT 5 | P52-B | P1-f/TB10- | P304-s | -J | -15 | |
| 8B | | | | 18/P430-GG | | -R | -16 | |
| 9A | Helium Source Rt Hand | Xdcr MT 4 | P53-B | P1-W/TB10- | P304-q | -n | -17 | |
| 9B | | | | 17/P430-HH | | -r | -18 | |
| 10A | Jet Eng Pitch Attitude | Drag Compen | P66-Z | NA | P304-N | -K | -19 | |
| 10B | | | | | | -L | -20 | |
| 11A | Jet Eng Roll Attitude | Drag Compen | P66-G | NA | P304-P | -d | -21 | |
| 11B | | | | | | -e | -22 | |
| 12A | Ax Pitch Acceleration | Drag Compen | P66-i | NA | P304-g | -p | -23 | |
| 12B | | | | | | -u | -24 | |
| 13A | Ay Roll Acceleration | Drag Compen | P66-j | NA | P304-h | -B | -25 | |
| 13B | | | | | | -A | -26 | |
| 14A | Az Yaw Acceleration | Drag Compen | P66-J | NA | P304-H | -C | -27 | |
| 14B | | | | | | P303-D | P418-28 | |
| 15A | Altitude | Alt/Alt Rate | P18-1 | P430-D | P406-b | P405-E | P418-29 | |
| 15B | | Indicator M11 | | | | -h | -30 | |
| 16A | Altitude Rate | Alt/Alt Rate | P18-2 | P430-E | P406-d | -F | -31 | |
| 16B | | Indicator M11 | | | | -T | -32 | |
| 17A | Drift Velocity | Hor Velocity | P16-16 | P430-J | P406-Y | -X | -33 | |
| 17B | | Indicator M7 | | | | -G | -34 | |
| 18A | Horizontal Velocity | Hor Velocity | P16-15 | P430-H | P406-X | -Y | -35 | |
| 18B | | Indicator M7 | | | | P405-H | P418-36 | P413-10 |

Table 10-1. Telemetry Instrumentation Channels Wire List (Continued)

| Chan | Signal | Source | Conn-Pin | Interconn | AC/DC Conditioner Input | AC/DC Conditioner Output | PCM Encoder Input | PCM Encoder Output |
|---|---|---|---|---|---|---|---|---|
| 19A | Lift Rkt Throttle Pos | Throttle Pot | NA | P430-w | P406-BB | P405-D | P418-37 | P413-10 |
| 19B | | R2 | | | | P405-R | -38 | |
| 20A | Rate Command Pitch | Primary Elec | P69-F | NA | P403-e | P404-FF | -39 | |
| 20B | | | | | | -u | -40 | |
| 21A | Rate Command Roll | Primary Elec | P69-G | NA | P403-M | -GG | -41 | |
| 21B | | | | | | -CC | -42 | |
| 22A | Rate Command Yaw | Primary Elec | P69-g | NA | P403-p | -p | -43 | |
| 22B | | | | | | -y | -44 | |
| 23A | Jet Eng Throttle Pos | Throttle Pot | NA | P430-AA | P406-DD | -C | -45 | |
| 23B | | R11 | | | | -J | -46 | |
| 24A | Compressor Disch Press | Xdcr MT 27 | P460-B | P330-K | P402-B | -BB | -47 | |
| 24B | | | | | | P404-AA | -48 | |
| 25A | Lift Rkt Press L. Hand | Xdcr MT 3 | P32-B | P1-e/TB10-4 | P304-p | P303-X | -49 | |
| 25B | | | | P430-DD | | P303-S | -50 | |
| 26A | Lift Rkt Press R. Hand | Xdcr MT 2 | P38-B | P1-d/TB10-3 | P304-t | P303-Y | -51 | |
| 26B | | | | P430-CC | | P303-T | P418-52 | |
| 27A | Att Rkt Press $B_s$ | Xdcr MT 15 | 1P441-B | 1P440-H | P402-Z | P404-Z | P419- 1 | |
| 27B | | | | | | -g | - 2 | |
| 28A | $F_s$ | Xdcr MT 16 | 1P442-B | 1P440-C | P402-Y | -Y | - 3 | |
| 28B | | | | | | -f | - 4 | |
| 29A | $B_t$ | Xdcr MT 17 | 1P443-B | 1P440-K | P402-X | -X | - 5 | |
| 29B | | | | | | -e | - 6 | |
| 30A | $F_t$ | Xdcr MT 18 | 1P444-B | 1P440-L | P402-a | -a | - 7 | |
| 30B | | | | | | -h | - 8 | |
| 31A | $G_s$ | Xdcr MT 20 | 3P442-B | 3P440-C | P402-c | -c | - 9 | |
| 31B | | | | | | -j | -10 | |
| 32A | $C_t$ | Xdcr MR 21 | 3P443-B | 3P440-K | P402-d | -d | -11 | |
| 32B | | | | | | -x | -12 | |
| 33A | $C_s$ | Xdcr MT 19 | 3P441-B | 3P440-H | P402-b | -b | -13 | |
| 33B | | | | | | -i | -14 | |
| 34A | $G_t$ | Xdcr MT 22 | 3P444-B | 3P440-L | P402-L | -t | -15 | |
| 34B | | | | | | -w | -16 | |
| 35A | $A_s$ | Xdcr MT 11 | 2P441-B | 2P440-H | P402-F | -F | -17 | |
| 35B | | | | | | -U | -18 | |
| 36A | Att Rkt Press $E_s$ | Xdcr MT 12 | 2P442-B | 2P440-C | P402-E | P404-E | P419-19 | |
| 36B | | | | | | P404-M | P419-20 | P413-10 |

Table 10-1. Telemetry Instrumentation Channels Wire List (Continued)

| Chan | Signal | Source | Conn-Pin | Interconn | AC/DC Conditioner | | PCM Encoder | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Input | Output | Input | Output |
| 37A | Att Rkt Press $E_t$ | Xdcr MT 14 | 2P444-B | 2P440-L | P402-C | P404-C | P419-21 | P413-10 |
| 37B | | | | | | -V | -22 | |
| 38A | $A_t$ | Xdcr MT 13 | 2P443-B | 2P440-K | P402-D | -D | -23 | |
| 38B | | | | | | -L | -24 | |
| 39A | $D_t$ | Xdcr MT 25 | 4P443-B | 4P440-K | P402-K | -K | -25 | |
| 39B | | | | | | -T | -26 | |
| 40A | $H_t$ | Xdcr MT 26 | 4P444-B | 4P440-L | P402-G | -G | -27 | |
| 40B | | | | | | -P | -28 | |
| 41A | $D_s$ | Xdcr MT 23 | 4P441-B | 4P440-H | P402-H | -H | -29 | |
| 41B | | | | | | -R | -30 | |
| 42A | Att Rkt Press $H_s$ | Xdcr MT 24 | 4P442-B | 4P440-C | P402-J | -J | -31 | |
| 42B | | | | | | P404-S | P419-32 | |
| 43A | JP4 Pressure Aft Tank | Xdcr MT 10 | P89-B | P17-k/TB1-8/P430-JJ | P304-k | P302-D | P419-33 | |
| 43B | | | | | | -L | -34 | |
| 44A | JP4 Pressure Fwd Tank | Xdcr MT 9 | P91-B | P17-h/TB1-6/P430-KK | P304-m | -H | -35 | |
| 44B | | | | | | -N | -36 | |
| 45A | Fan RPM | Fan Tach | P332-A | P330-A | P304-A | P302-A | -37 | |
| 45B | Low | | P332-B | P330-B | P304-B | P302-E | -38 | |
| 46A | Thrust/Weight Computer | Drag Compen | P66-g | NA | P403-N | P404-q | -39 | |
| 46B | | | | | | -n | -40 | |
| 47A | + 5 Volt Calibrate | +5 VDC P.S. | P464-3 | NA | P401-r | -HH | -41 | |
| 47B | | | | | | -DD | -42 | |
| 48A | - 5 Volt Calibrate | -5 VDC P.S. | P464-6 | NA | P401-m | -s | -43 | |
| 48B | | | | | | P404-r | -44 | |
| 49A | Gas Gen RPM | Engine Tach | P331-C | P330-C | P304-C | P302-J | -45 | |
| 49B | Low | | P331-D | P330-D | P304-D | P302-K | -46 | |
| 50A | $H_2O_2$ Tank Press L. Hand | Xdcr MT 7 | P35-B | P1-r/TB10-20/P430-EE | P304-r | P303-q | -47 | |
| 50B | | | | | | P302-P | -48 | |
| 51A | Exhaust Gas Temperature | EGT Ind M1 | P126-G | P430-V | P406-U | P405-v | -49 | |
| 51B | | | | | | P405-BB | -50 | |
| 52A | $H_2O_2$ Tank Press R. Hand | Xdcr MT 6 | P41-B | P1-S/TB10-19/P430-FF | P304-n | P303-f | -51 | |
| 52B | | | | | | P302-R | P419-52 | |
| 53A | Ay Error Signal | Drag Compen | P66-H | NA | P304-J | P303-g | P410- 1 | |
| 53B | | | | | | P303-j | P410- 2 | P413-10 |

Table 10-1. Telemetry Instrumentation Channels Wire List (Continued)

| Chan | Signal | Source | Conn-Pin | Interconnections | AC/DC Conditioner Input | AC/DC Conditioner Output | PCM Encoder Input | PCM Encoder Output |
|---|---|---|---|---|---|---|---|---|
| 54-1 | JP4 Caution Level | Tank Sensors A28 and A29 | P50-A Fwd P54-A Aft | P1-X/TB10-1/ P1-C/TB10-1/ P113-L/DS2-1/ DS2-4/P113-BB/P430-s | P406-y | P405-n | P416-49 | P413-10 |
| 54-2 | JP4 Low Level | Tank Sensors A28 and A29 | P50-C Fwd P54-C Aft | P1-a/TB10-2/ P1-T/TB10-2/ P113-M/DS3-1/ DS3-4/P113-AA/P430-r | P406-GG | P405-U | P416-48 | |
| 54-3 | $H_2O_2$ Low Level RH | Right Sensor A34 | P127-A &C | P42-A&C/P17-x&w/P7-A&C (A32 P8-E/P113-X/DS13-4/DS13-6/ P113-t/P430-j | P406-v | P405-x | P416-47 | |
| 54-4 | $H_2O_2$ Low Level LH | Left Sensor A33 | P143-A &C | P36-A&C/P17-X&Y/P5-A&C(A31) P6-E/P113-W/DS13-1/DS13-5/ P113-w/P430-f | P406-w | P405-g | P416-46 | |
| 54-5 | Low Auto Throttle Signal Cutoff | Aft Limit Sw | NA | P330-F | P402-u | P405-f | P416-45 | |
| 54-6 | Low Auto Throttle Clutch Disengage | Low Thrust Limit Sw | NA | P139-F/P113-N/DS11-1/DS11-4 P113-DD/P430-u | P406-p | P405-p | P416-44 | |
| 54-7 | Helium Source Low | Helium Low Press Sw S42 | P48-A | P1-K/P113-Z/DS12-1/DS12-4/ P113-u/P430-i | P406-u | P405-z | P416-43 | |
| 54-8 | Doppler | TR1 Rx/Tx | P59-39 | P4-k/P113-j/DS4-1/DS4-4/ P113-FF/P430-g | P406-g | P405-m | P416-42 | |
| 54-9 | Attitude Rkt Test | Rkt Test-Std-Both Sw S6D | Pin 44 | P430-F | P406-c | P405-K | P416-41 | |
| 55-1 | Stablization Mode | Drag Compen | P101-HH | P113-P/DS6-1/DS6-4/P113-p/ P430-n | P406-W | P405-r | P416-38 | |
| 55-2 | Local Vertical | Drag Compen | P101-CC | P113-A/DS5-1/DS5-4/P113-m/ P430-m | P406-B | P405-t | P416-36 | |
| 55-3 | Emerg Gimbals Locked | Hyd Low Press Sw S5 | P26-A | K6/J205-D & F/P113-S/DS8-1/ DS8-4/P113-n/P430-k | P406-e | P405-s | P416-21 | P413-10 |

Table 10-1. Telemetry Instrumentation Channels Wire List (Continued)

| Chan | Signal | Source | Conn-Pin | Interconnections | AC/DC Conditioner Input | AC/DC Conditioner Output | PCM Encoder Input | PCM Encoder Output |
|---|---|---|---|---|---|---|---|---|
| 55-4 | Attitude Rocket Std | Rkt Test-Std-Both Sw S6D | Pin 45 | P430-N | P406-j | P405-L | P416-34 | P413-10 ↓ |
| 55-5 | Stuck Valve | Backup Elec | P109-p | P23-h/P113-Y/DS15-1/DS15-4/P113-v/P430-h | P406-x | P405-y | P416-19 | |
| 55-6 | [illegible] | Backup Elec | P109-c | NA | P406-h | P405-u | P416-33 | |
| 55-7 | Auto Throttle | Drag Compen | P101-r | P2-p/Lunar Sim relay/P113-U/DS10-1/DS10-4/P113-CC/P430-t | P406-AA | P405-AA | P416-24 | |
| 55-8 | Jet Eng Maximum Tilt | Drag Compen | P101-x | P2-V/P113-R/DS7-1/DS7-4/P113-r/P430-q | P406-FF | P405-FF | P416-32 | |
| 55-9 | Gimbal Lock Mode | Gimbal Lock Switch S21 | J70-E | TB10-11/P113-T/DS8-1/DS8-4/P113-q/P430-p | P406-f | P405-w | P416-27 | |
| 56-1 | Direct Latch Pitch | Monitor Elec | P68-D | NA | P403-g | P405-EE | P416-16 | |
| 56-2 | Direct Latch Yaw | Monitor Elec | P68-F | NA | P403-f | P405-HH | P416-14 | |
| 56-3 | CB 7 Trip | CB7 | NA | P430-Y | P406-k | P405-P | P416-13 | |
| 56-4 | Backup Gyro Failure | Monitor Elec | P68-F | P1-t/P113-b/DS14-1/DS14-4/P113-HH/P430-d | P406-N | P405-q | P416-12 | |
| 56-5 | CB15 Trip | Batt Relay | NA | NA | P402-f | P405-N | P416-11 | |
| 56-6 | Hor Vel Scale Range | Hor Velocity Indicator M7 | P16-9 | P430-G | P406-Z | P405-i | P416-10 | |
| 56-7 | Emerg AC Power Loss | Emerg Inv | P72-G | TB2-4 | P302-S | P302-T | P416-9 | |
| 56-8 | [illegible] | Backup Elec | P109-b | NA | P402-j | P404-m | P416-8 | |
| 56-9 | Oil Pressure Low | Oil Press Sw | P24-C | P139-E/P1-F/P113-K/DS1-1/DS1-4/P113-EE/P430-V | P406-V | P405-V | P416-7 | |
| 57-1 | Direct Latch Roll | Monitor Elec | P68-K | NA | P402-k | P404-k | P416-2 | |
| 57-2 | Hardover Both | Relay Ka | NA | NA | P304-T | P304-U | P416-1 | ↑ P413-10 |

Table 10-1. Telemetry Instrumentation Channels Wire List (Continued)

| Chan | Signal | Source | Conn-Pin | Interconnections | AC/DC Conditioner Input | AC/DC Conditioner Output | PCM Encoder Input | PCM Encoder Output |
|---|---|---|---|---|---|---|---|---|
| 58A<br>58B | $H_2O_2$ Pounds Remaining | $H_2O_2$ Rem Ind M16 | P103-G | P430-S | P406-CC | P405-CC<br>P405-M | P410-11<br>P410-12 | P413-10 |
| 59A<br>59B | Jet Eng Oil Press | Xdcr MT 8 | P87-B | P139-C/P17-e/TB1-4/P430-LL | P304-j | P302-F<br>P302-M | P410-13<br>P410-14 | |
| 60A<br>60B | Wind Velocity | Aneomometer | P92-A & C | TB1-1/P2-DD | P406-E | P405-B<br>P405-W | P410-15<br>P410-16 | |
| 61A<br>61B | Wind Direction | Wind Dir Ind | NA | P93-C/P2-AA | P406-D | P405-GG<br>P405-b | P410-17<br>P410-18 | |
| 62A<br>62B | Accumulator Pressure | Xdcr MT 28 | P465-B | NA | P402-N | P405-S<br>P405-DD | P410-19<br>P410-20 | |
| 63A<br>63B | Az Error Signal | Drag Compen | P66-A | NA | P304-L | P303-h<br>P303-k | P410-21<br>P410-22 | |
| 64A<br>64B | Hydraulic Pressure | Xdcr MT 29 | J466-B | NA | P402-S | P404-N<br>P404-EE | P410-23<br>P410-24 | P413-10 |
| 65 | He Tank Temp. | Thermistor | NA | NA | J406-K&L<br>J406-H&J | | P404-v<br>P404-W | |
| 66 | Angle of Attack | Boom | J502-B | NA | J402-U | | P401-a<br>P404-P | |
| 67 | Side Slip | Boom | J502-D | NA | J402 A-A | | P403-m<br>P404-R | |

Conditioner to the Backup Electronics and to the PCM Encoder input. Channels 15 through 19,23, 24, 46, 51, 58, 60, 61, 62, and 64 are also routed through without conditioning to the PCM Encoder. These are analog voltage signals which are within the negative to positive voltage limits acceptable by the PCM Encoder. Channels 54-1 through 54-9, 55-1 through 55-9, 56-1 through 56-6 and channels 56-8, 56-9 and 57-1 are routed to J407 of the DC component module assembly (see schematic diagram, Bell drawing 7206-242032). Channels 20 through 22 are also routed to J407. The component plugged in J407 functions as a voltage divider to the various inputs. The component plugged in J408 provides a common ground connection for various channels.

10-21. The AC power and DC power control relays are located in the AC Signal Conditioner. The remaining channels, 1 through 14, 25, 26, 43, 44, 45, 49, 50, 52, 53, 56-7, 57-2, 59 and 63 are routed to the AC Signal Conditioner. These channels are internally routed to J305, J306, and J307 as shown in figure 10-5. Channel 45 is routed to J305 which contains demodulator circuits to convert the fan tach a-c signal to an acceptable d-c voltage level. Channel 49 is routed to J307, which contains voltage dividers and zener diode limiters. The channel 49 (engine tach AC) signal is limited and then routed to J306, which contains demodulator circuits similar to J305 to convert the engine tach a-c signal to an acceptable d-c voltage level. All other channels are also routed to J307 and from the voltage dividers are routed to output connectors J302 or J303, except 57-2 which is routed out J304, and to the PCM Encoder input. The 63 channels of analog data and 29 bits of digital data are converted from parallel inputs to a 9-bit binary coded word for each input and formatted as serial data to the telemetry transmitter TR-2.

10-22. OPERATIONAL CHECKOUT

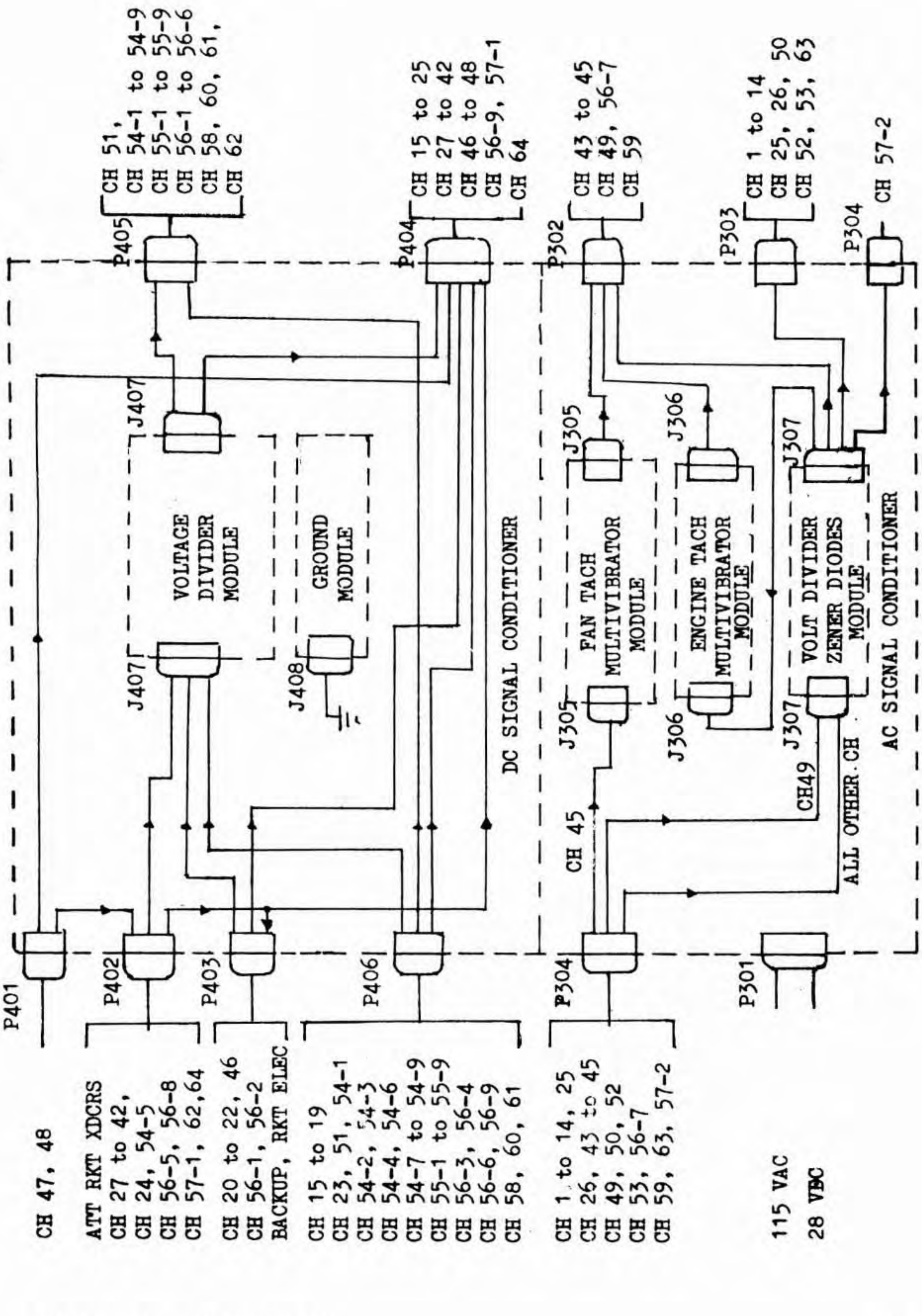



Figure 10-5 AC/DC Signal Conditioner, Block Diagram

10-23. Limited operational checkout procedures are provided for the radio communications equipment and radar equipment. Operational checkout of the instrumentation and telemetry equipment is accomplished by following the procedures provided in Section VIII of this manual and Cockpit and Data Systems Ground Test Procedures, Report Number 7260-928057.

10-24. RADIO COMMUNICATIONS

10-25. In order to check operation of the radio communications equipment, perform the procedures outlined in the following documents:

A. To apply power to the LLTV, perform Part A of the LLTV Preflight Checklist, Checklist Number 7260-931005.

B. To perform communications check, perform Part B-4 of the LLTV Instrumentation Preflight Checklist, Checklist No.7260-931007.

10-26. RADAR EQUIPMENT

10-27. In order to check operation of the radar equipment, perform the procedures outlined in the following documents:

A. Part A of the LLTV Preflight Checklist, Checklist Number 7260-931005.

B. LLTV Radar Systems Preflight Checklist, Checklist Number 7260-931009.

10-28. INSTRUMENTATION

10-29. In addition to the references provided in paragraph 10-23, the LLTV Instrumentation Preflight Checklist, Checklist Number 7260-931007 provides instrumentation checkout procedures.

10-30. TROUBLESHOOTING PROCEDURES

10-31. The number of signal channels to be checked precludes a specific troubleshooting procedure for each channel. Troubleshooting of the telemetry transmitter, the PCM encoder, the UHF transceiver, intercomm, and radar equipment is accomplished by performing procedures outlined in the maintenance and support manuals previously referenced. The requirement to locate a trouble in a telemetry channel indicates a failure of a specific channel to meet the standards of the Cockpit and Data Systems Ground Test Procedures, Report Number 7260-928057. A general troubleshooting technique is provided rather than channel by channel procedural techniques. A volt-ohmmeter is in most cases the only test equipment used.

10-32. A failure to obtain the desired encoder output for channels whose signal source is common with the flight instruments or annunciator panel indicators is analyzed by the following steps:

A. Check instruments or indicator for inoperable channel.

B. Use push-to-test switch when annunciator indicators are involved.

C. Failure of encoder output and instrument or indicator, indicates common trouble. Use Table 10-2 to check wiring and signal source, with volt-ohmmeter.

10-33. A failure to obtain the desired encoder output for other channels is analyzed by the following steps:

A. Check input signal to AC/DC Signal Conditioner for inoperable channel.

B. Use volt-ohmmeter and table 10-1 to check wiring and signal cource.

10-34. INSTALLATION AND REMOVAL

10-35. Installation and removal of most of the radio, radar and telemetry equipment requires only standard procedures for accomplishment. The following procedures are provided for the equipment requiring special instructions.

10-36. UHF TRANSCEIVER TR-31

10-37. The installation and removal procedures for the UHF transceiver TR-31 are provided in paragraphs 10-38 and 10-39.

10-38. INSTALLATION - To install the UHF transceiver, proceed as follows:

A. Attach the adapter bracket to the TR-31 transceiver.
B. Position the TR-31 in accordance with Bell drawing 7260-561001.
C. Connect coaxial cables P202 and P201.
D. Connect the control differential transformer, (CDX).
E. Attach the TR-31 mounting bracket and the CDX by nine screws.

10-39. REMOVAL - To remove the UHF transceiver, proceed in reverse order of paragraph 10-38.

10-40. PCM ENCODER

10-41. The installation and removal procedures for the PCM Encoder are provided in paragraphs 10-42 and 10-43.

10-42. <u>INSTALLATION</u> - To install the PCM encoder, proceed as follows:

A. Move aft equipment platform 4-inches to the rear to provide installation working space.
B. Install encoder with four mounting bolts.
C. Connect electrical connectors.

10-43. <u>REMOVAL</u> - To remove the PCM encoder, proceed in reverse order of paragraph 10-42.

10-44. <u>TELEMETRY TRANSMITTER TR-2</u>

10-45. The installation and removal procedures for the telemetry transmitter are provided in paragraphs 10-46 and 10-47.

10-46. <u>INSTALLATION</u> - To install the telemetry transmitter, proceed as follows:

A. Remove the PCM encoder in accordance with paragraph 10-43.
B. Install the transmitter with four bolts to mounting plate.
C. Connect electrical connectors P1, P2 and P3.

10-47. <u>REMOVAL</u> - To remove the telemetry transmitter, proceed as follows:

A. Remove the PCM encoder in accordance with paragraph 10-43.
B. Removal of the PCM encoder is now accomplished in reverse order of paragraph 10-46.

10-48. <u>ADJUSTMENT PROCEDURES</u>

10-49. The adjustment of the instrumentation and telemetry system is accomplished by following the procedures provided in Section VIII of this manual and Cockpit and Data Systems Ground Test Procedures, Report Number 7260-928057, except for Channel 56-7.

10-50. EMERGENCY AC POWER LOSS CHANNEL 56-7 ADJUSTMENT

10-51. Paragraph 10-52 lists the test equipment required and paragraph 10-53 provides step-by-step procedures to adjust channel 56-7.

10-52. TEST EQUIPMENT REQUIRED - The following ground support equipment and test equipment are required:

A. Power cart or truck
B. Octal box
C. Variable 26-volt, 400 hertz, a-c power source.
D. AC voltmeter

10-53. STEP-BY-STEP PROCEDURE - To adjust the emergency AC power loss channel, proceed as follows:

A. Remove wire X16A20 from terminal board TB2-4.
B. Apply external power to vehicle.
C. Place all circuit breakers ON, except CB20 and 28.
D. Apply variable a-c power source to wire X16A20 and ground.
E. Vary a-c power source and observe octal box indication for a change in state of channel 56-7 at 22 ± 2 volts a-c indication on a-c voltmeter.
F. Adjust R301 so that channel 56-7 changes state when voltage drops below 22 ± 2 volts as indicated by a-c voltmeter.
G. Replace wire X16A20 to terminal board TB2-4.
H. Remove test equipment and external power.