Aerolineas Argentinas

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CHAPTER 80 - STARTING

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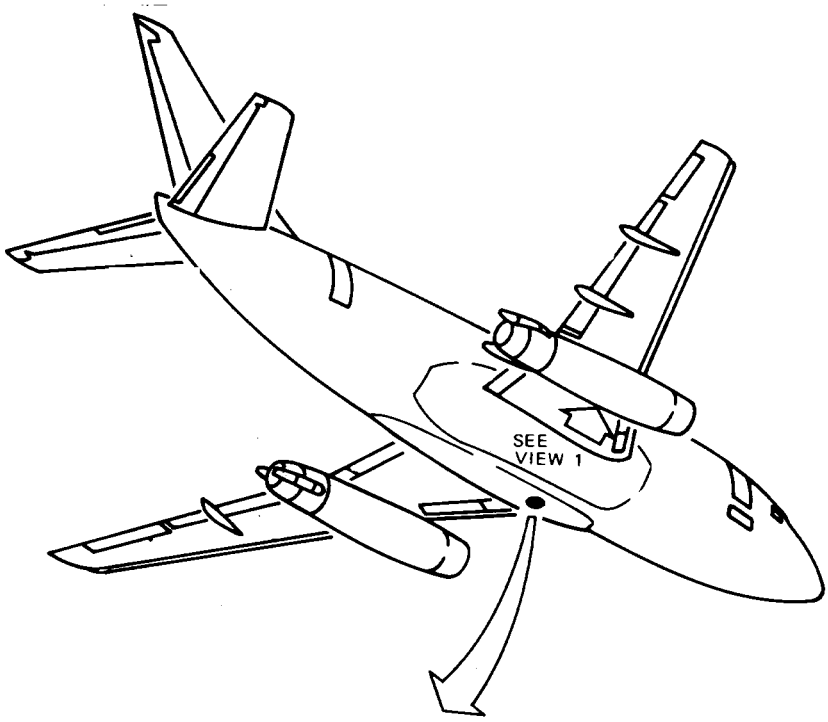
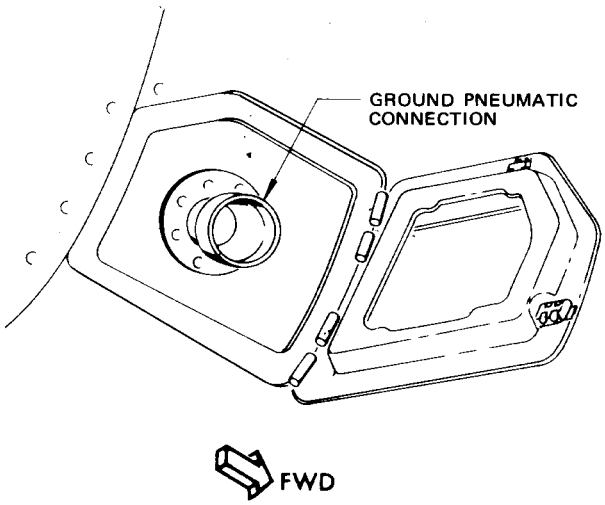
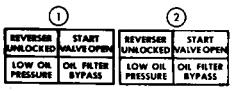
PNEUMATIC STARTING SYSTEM - DESCRIPTION AND OPERATION

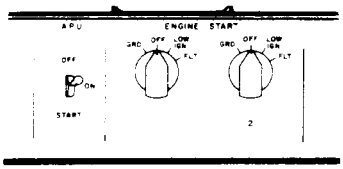
1. General
   A. The pneumatic starting system provides means for rotating the engine to the rpm range where starting can be accomplished when fuel and ignition are supplied.
   B. With air pressure in the pneumatic manifold, actuating the engine start switch will supply electrical power to open the starter valve. Low pressure air acts on the turbine blades of the pneumatic starter causing it to rotate. Rotation of the starter is transmitted to the N2 compressor through the accessory drive gear system. When the engine has accelerated to starting speed, application of fuel and ignition, by advancing the start lever, results in the engine starting. For engine start procedure, refer to AMM Chapter 71, Power Plant. At starter cutout speed, electrical power is interrupted mechanically, the starter valve closes, and the starting cycle is ended.
   C. The system consists of two pneumatic starters, two starter valves, and the associated pneumatic plumbing. It is controlled by two start switches, located on the forward overhead panel. For component location, see Fig. 1.
   D. The pneumatic starting system can use low pressure air from three separate sources. Normally, the engines are started with bleed air from the auxiliary power unit (APU). Secondly, the low pressure air can be obtained from a ground source through the ground pneumatic connection (Fig. 1). The third source of low pressure air is the cross-bleed air from an operating engine. The cross-bleed starting is not desirable because the operating engine must operate at approximately 80% power setting to develop adequate air pressure for starting the other engine.
2. Pneumatic Starter
   A. The pneumatic starter (Fig. 2) is a lightweight turbine-type air motor which converts the kinetic energy of compressed air into starting torque sufficient to accelerate the engine to starting speed. Low pressure air and electrical power are required for starter operation. The starter will continue to assist the engine until electrical power is removed.
   B. The starter consists of a scroll assembly, turbine wheel, reduction gear assembly, engaging mechanism and an output shaft. The starter is fitted with a start valve to control the inlet airflow. When the valve is open, it admits air to the inlet connection on the starter scroll assembly; the air then passes through the starter vanes of the scroll assembly and is directed radially inward through the turbine wheel imparting high-speed rotation. Exhaust air from the turbine wheel then passes through an air outlet screen.





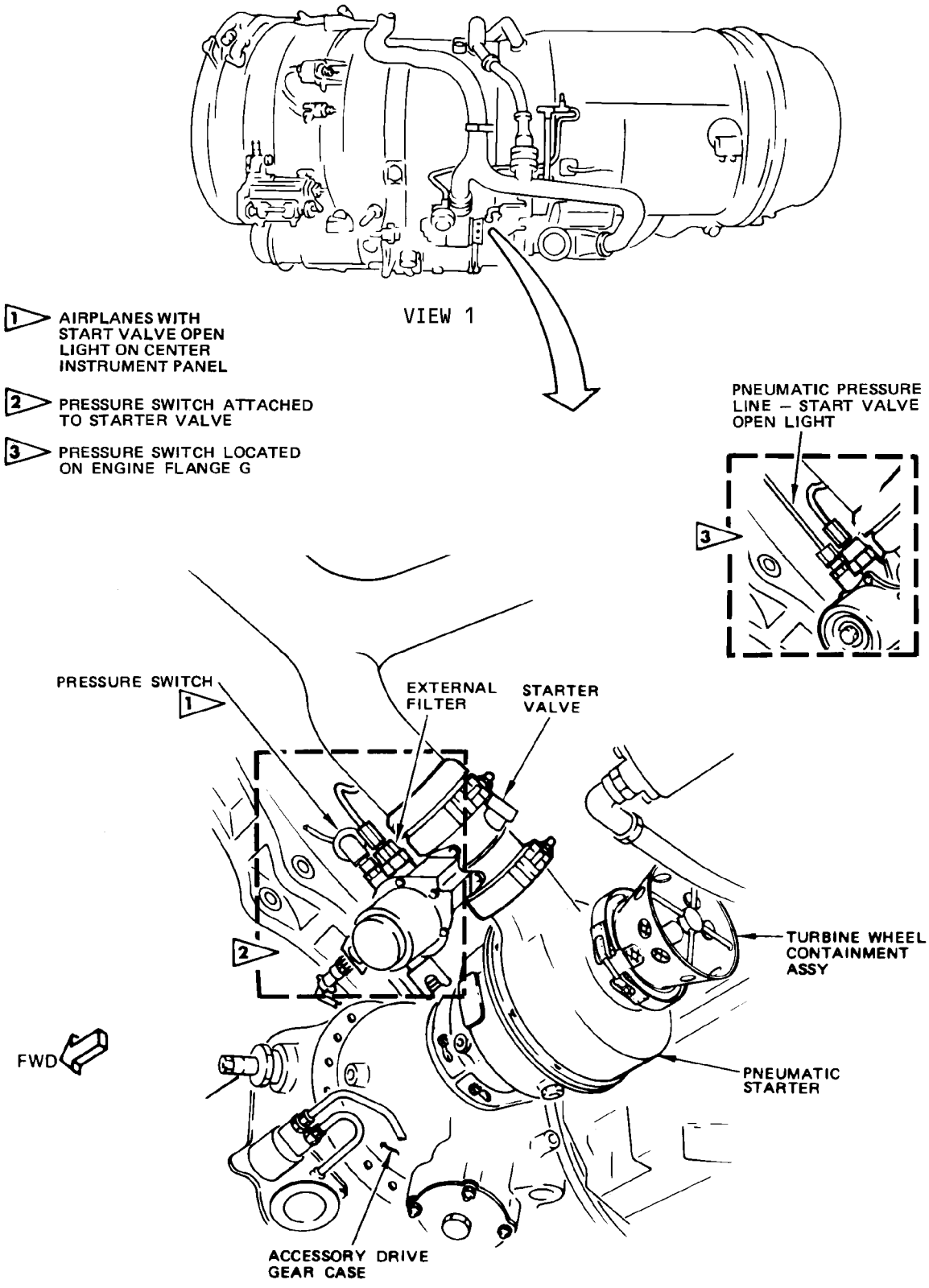


CENTER INSTRUMENT PANEL
AR LV–LIU AND ON



FORWARD OVERHEAD PANEL

Pneumatic Starting System Component Location
Figure 1 (Sheet 1)



Pneumatic Starting System Component Location
Figure 1 (Sheet 2)

C. The reduction gear train translates the high speed, low torque of the turbine wheel into low speed, high torque. This output is transmitted through a pawl and ratchet engagement mechanism to the output shaft. From the starter output shaft the cranking torque is transmitted to the N2 compressor by way of the accessory drive gears. A clutch mechanism provides engagement of the reduction gear train with the output shaft for engine starting. When the speed of the output shaft exceeds the speed of the internal gear hub, the clutch mechanism overruns, thus providing automatic disengagement. The pneumatic starter is mounted on the accessory drive gear case beneath the engine.

3. Starter Valve (Fig. 3)

A. The starter valve controls airflow to the pneumatic starter during engine starting. The valve is pneumatically operated and solenoid-controlled. It consists essentially of two assemblies, a valve body assembly with lever-operated butterfly valve, and a piston-type pneumatic actuator assembly. The valve is located in the pneumatic duct to the starter. It is attached to the duct and starter inlet flange by clamps (Fig. 3).

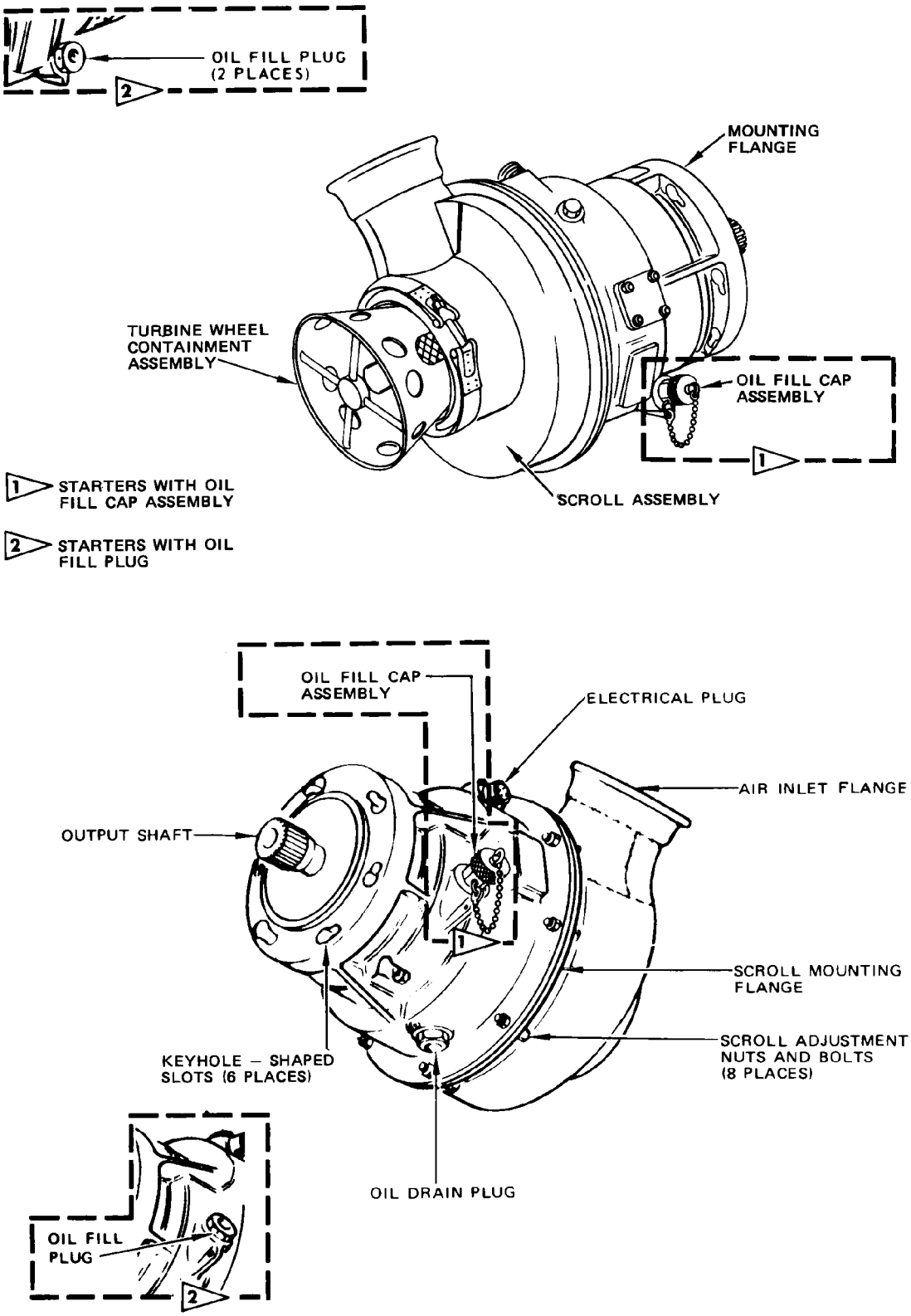
B. Valve P/N 898172-1-1 (AiResearch)

(1) Valve inlet pressure is directed through a pressure port, filter, and orifice, into a ball-type solenoid-actuated switcher and through the pneumatic switcher to chamber B. With solenoid de-energized, chamber A is vented and inlet pressure in chamber B keeps the butterfly closed. With solenoid energized, the ball closes the vent, and inlet pressure is ported to chamber A and to the actuator of the pneumatic switcher. The pneumatic switcher closes off inlet pressure to chamber B and connects that chamber to sensing selector.

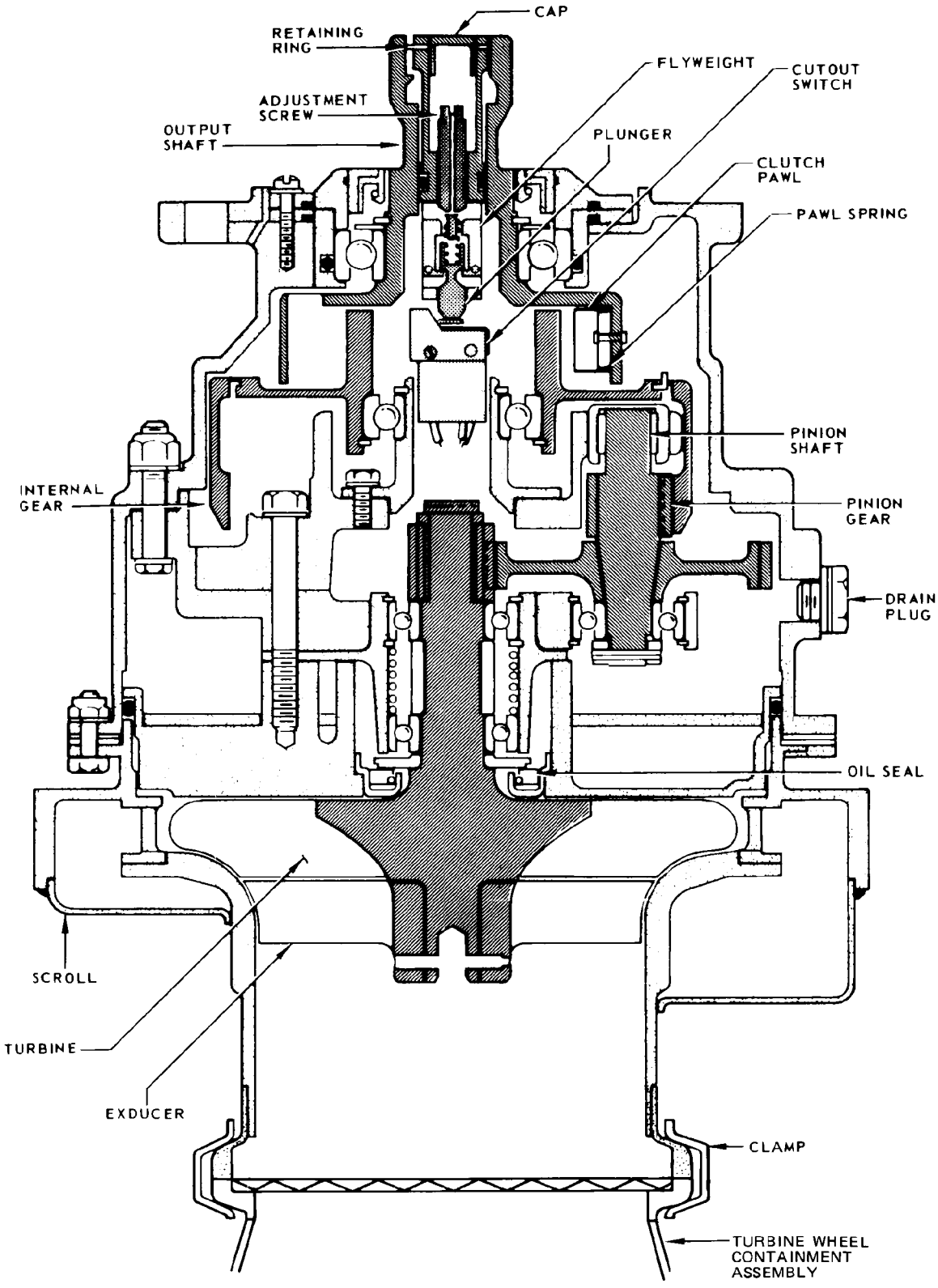
(2) As chamber B vents through the bleed orifice, pressure differential across the actuator piston moves the butterfly toward open position. At inlet pressures lower than set valve (36 ±5 psig), sensing selector remains closed and keeps the butterfly in fully open position. When inlet pressures equal or exceed set valve, bleedoff reference regulator opens to maintain a constant reference pressure in chamber A, and the sensing selector opens to direct downstream pressure to chamber B. This modulates the butterfly position to maintain the desired downstream pressure.

(3) When solenoid is de-energized, pneumatic switcher and chamber A are quickly vented and upstream pressure is ported to chamber B or closing side of the actuator, causing rapid closing of the butterfly. As downstream pressure drops, sensing selector closes, chamber B pressure rises, assisting the torsion spring in closing the valve completely.

(4) An additional pneumatic bleed located on the upstream side of the butterfly vane directs hot air onto the solenoid switcher and pneumatic switcher housings to prevent icing and to reduce moisture during cold weather operation.



Pneumatic Starter
Figure 2 (Sheet 1)



Pneumatic Starter
Figure 2 (Sheet 2)

C. Valve P/N 2680337 (Parker)

(1) Valve inlet pressure is felt on the upstream side of the butterfly vane and directed through a pressure port, filter, and orifice, into the control portion of the unit. Pressure in the control is directed through a 3-way solenoid-actuated switcher to the regulator control servo. The control servo consists of a poppet-diaphragm combination and includes a spring preset at the control pressure. The control servo has the capacity to open a large variable orifice with its poppet.

(2) The variable orifice (when open) is larger than the fixed orifice installed in the inlet sensing line. The variable orifice poppet opens and closes with small changes in downstream pressure. The downstream pressure is felt on the control servo through the downstream sensing passage. The control servo will amplify changes in the downstream pressure to allow a larger pressure change to be felt on the primary diaphragm used for butterfly positioning. The amplified pressure signal is used to open the butterfly when downstream pressure is low (i.e., below 46 ±5 psig). The spring in the primary diaphragm area is used to close the butterfly when downstream pressures are above the control pressure (i.e., above 46 ±5 psig).

D. Valve P/N 2730426 (Parker Hannifin) on preferred installation plus airplanes POST-SB 80-1002

(1) Valve opening is initiated by energizing the solenoid. The energized solenoid moves the 3-way poppet to close the vent to ambient and allow control air to pass through an orifice and into the opening side chamber of the actuator diaphragm. The control air pressure exerts a force on the actuator diaphragm and overcomes the spring closure force thereby opening the butterfly. A slow-opening rate is achieved by restricting the flow of high pressure air by the upstream orifice.

(2) When upstream pressure is not available at the actuator diaphragm, a compression spring exerts a closing force on the actuator diaphragm to move or hold the butterfly in the closed position. The open side of the diaphragm is vented to ambient through the open passage to the 3-way solenoid positioned valve to prevent any force during the shutoff operation.

(3) A downstream pressure sense port is provided for systems utilizing a pressure switch for indicating valve open and close positions (Fig. 1 and 3).

E. The solenoid switcher can be operated by the manual override button when the solenoid malfunctions (Fig. 3). The valve also incorporates a second override feature that requires opening the engine left cowl panel CSD servicing access door and turning the valve butterfly position indicator with an allen wrench (Fig. 3). A hole forward of the CSD servicing access door in the cowl panel provides access to the valve manual override button.

4. Operation

A. Other controls used in conjunction with the starting system are the air conditioning control switches, wing thermal anti-ice control switches and the start levers. Refer to AMM Chapter 21, Air Conditioning, AMM Chapter 28, Fuel, AMM Chapter 30, Ice and Rain Protection, AMM Chapter 36, Pneumatics, AMM Chapter 49, Airborne Auxiliary Power Unit, and AMM Chapter 74, Ignition, for integration of these systems with AMM Chapter 80, Starting.

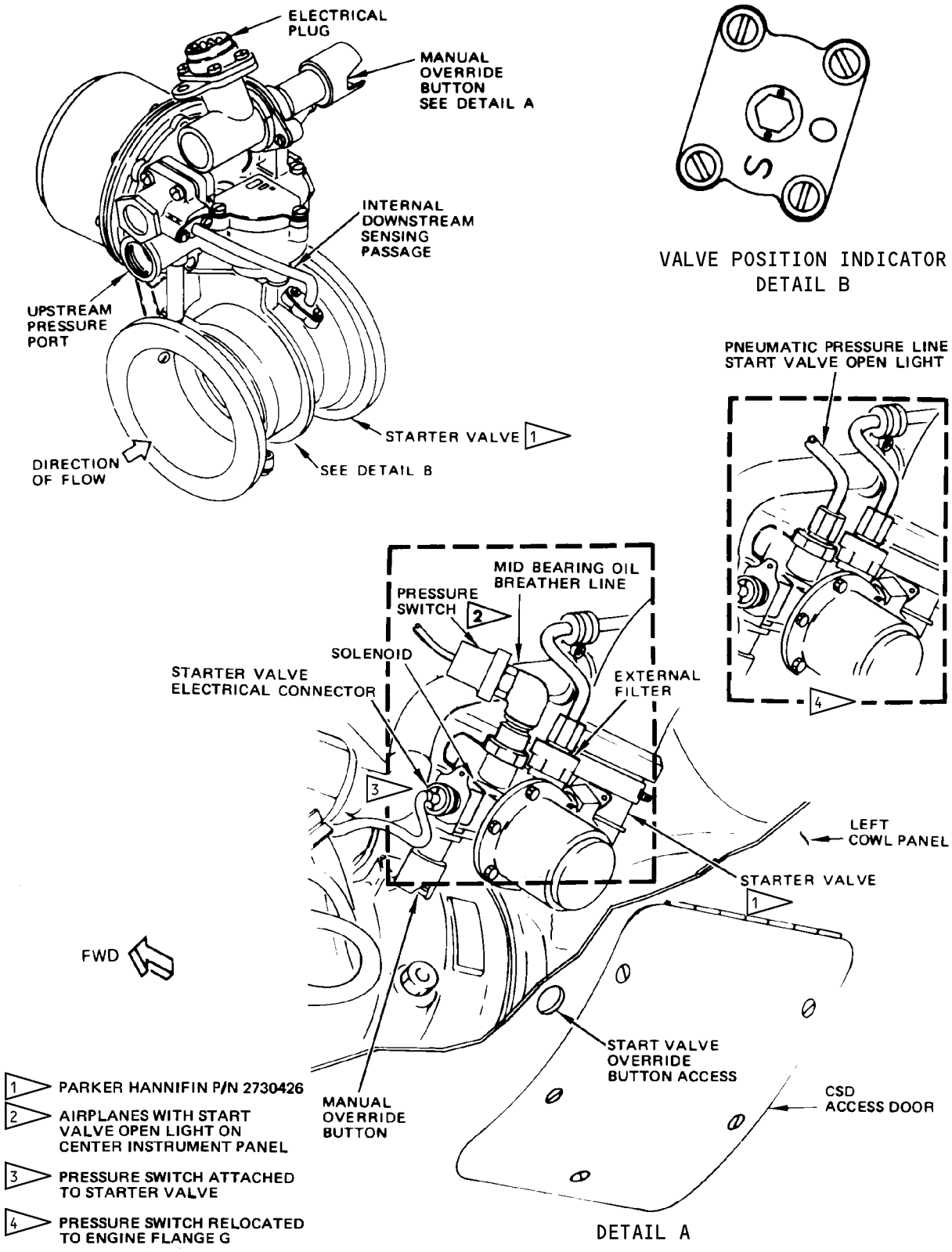
B. Engine starting can be performed in the following ways:
(1) Using auxiliary power unit (APU).
(2) Using ground air source.
(3) Using bleed-air from the other engine.

C. Starter valve inlet pressure limits:

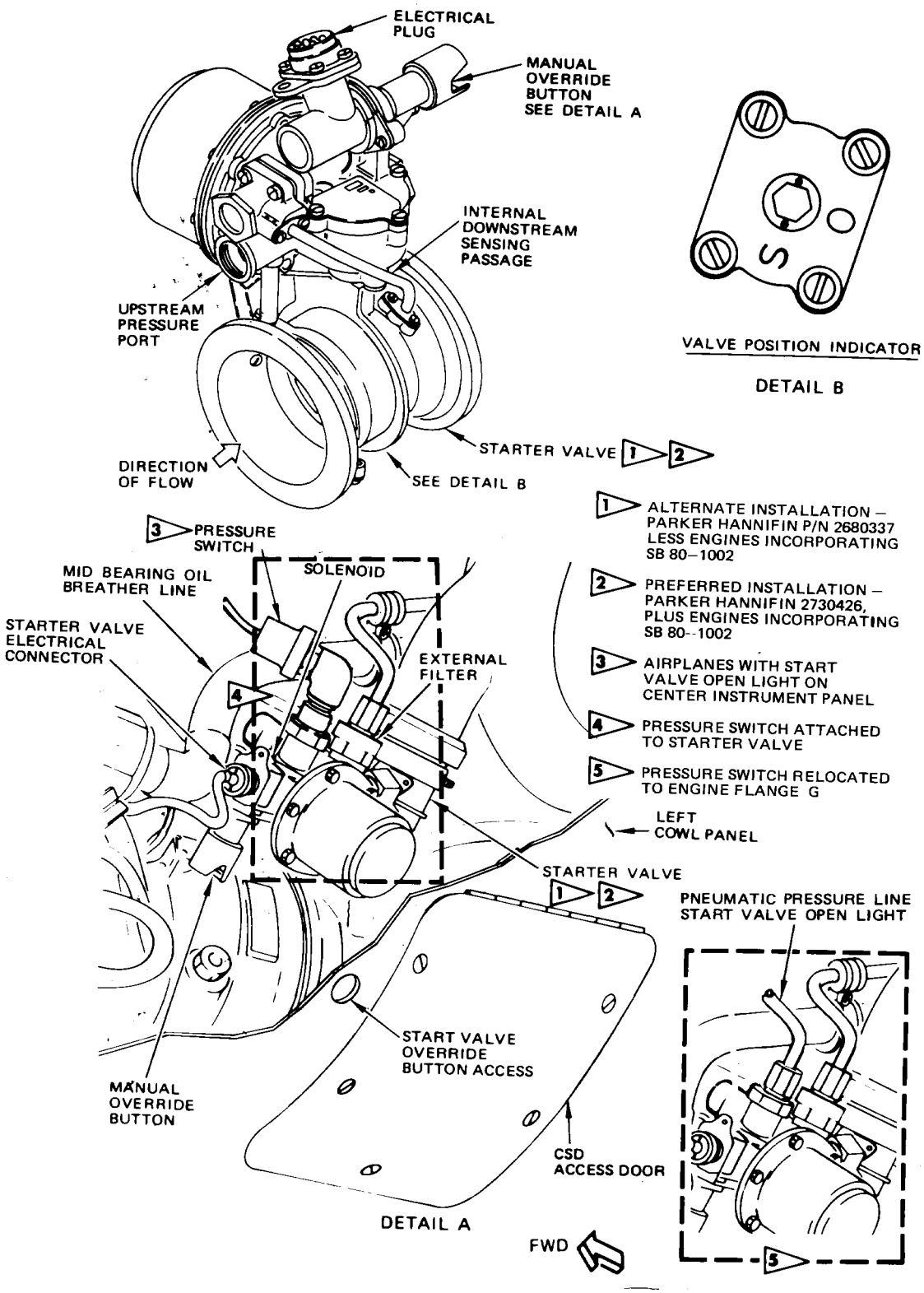
D. Electrical power for the starting system is obtained from the 28-volt dc battery bus (Fig. 5). The system is controlled by two start switches, one for each engine. The start switches are four-position rotary switches, located on the forward overhead panel (Fig. 4). The four positions are: GRD start, OFF, LOW IGN, and FLT start. The switches are momentary in ground start position.

E. AR LV-LIU and on;
A START VALVE OPEN light is provided for each engine, located on the center instrument panel. Once a switch is positioned to ground start, a holding solenoid in the switch is energized and holds the momentary contacts closed. When the starter cutout switch opens at cutout speed, the holding solenoid is de-energized, and the start switch returns to off position. In all other positions the switch will remain as positioned until another selection is made (Fig. 5).

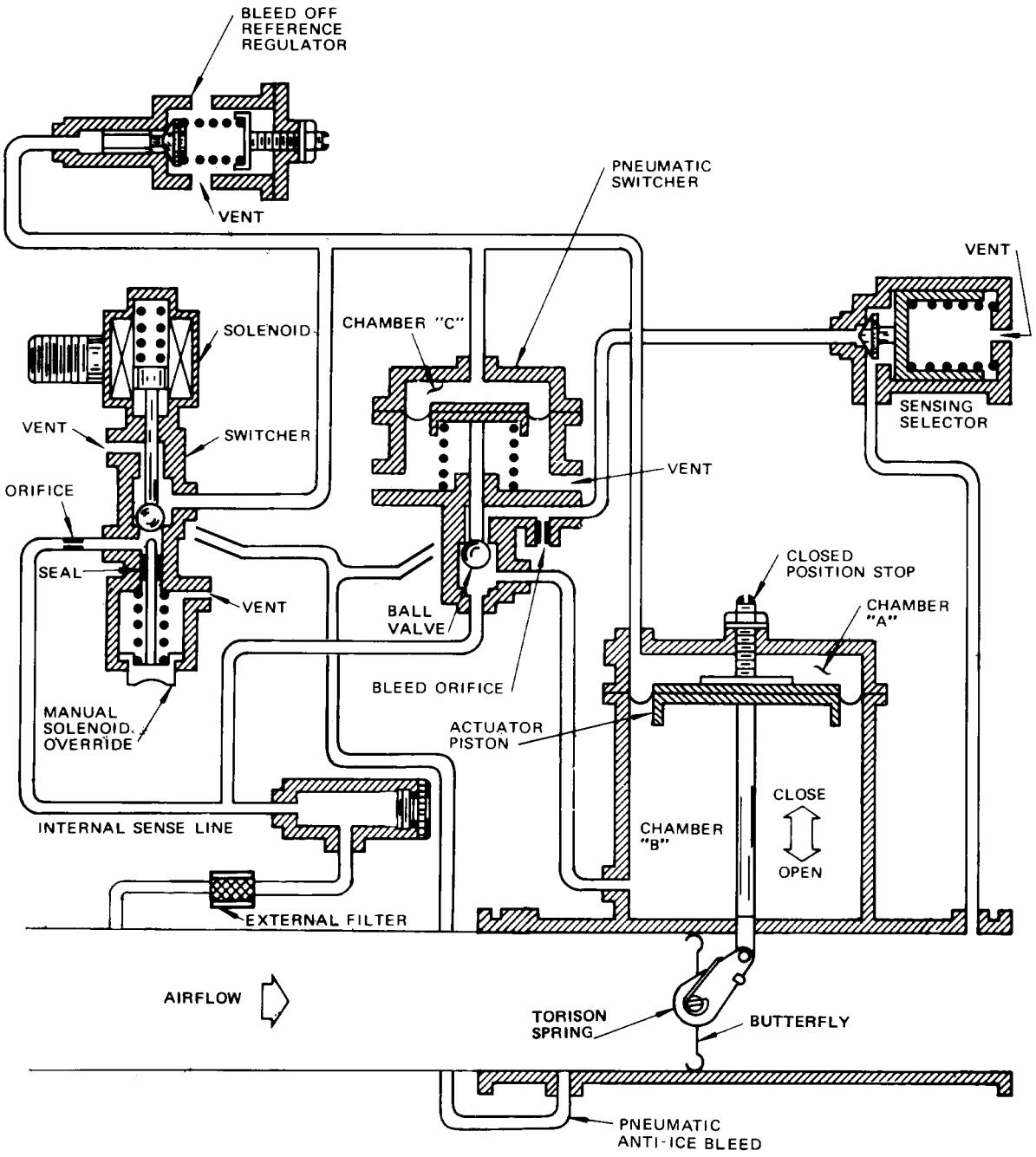
AIR SOURCE FOR PNEUMATIC STARTING	CONTROL CABIN GAGE READINGS PRIOR TO VALVE OPENING	
	MINIMUM PSIG	MAXIMUM PSIG
Onboard APU	30.0	53.0
Ground Cart (Mobile Type)	30.0	55.0
Other Ground Supply (Permanent Type)	30.0	48.0
Cross-Bleed from Other Engine	30.0	48.0



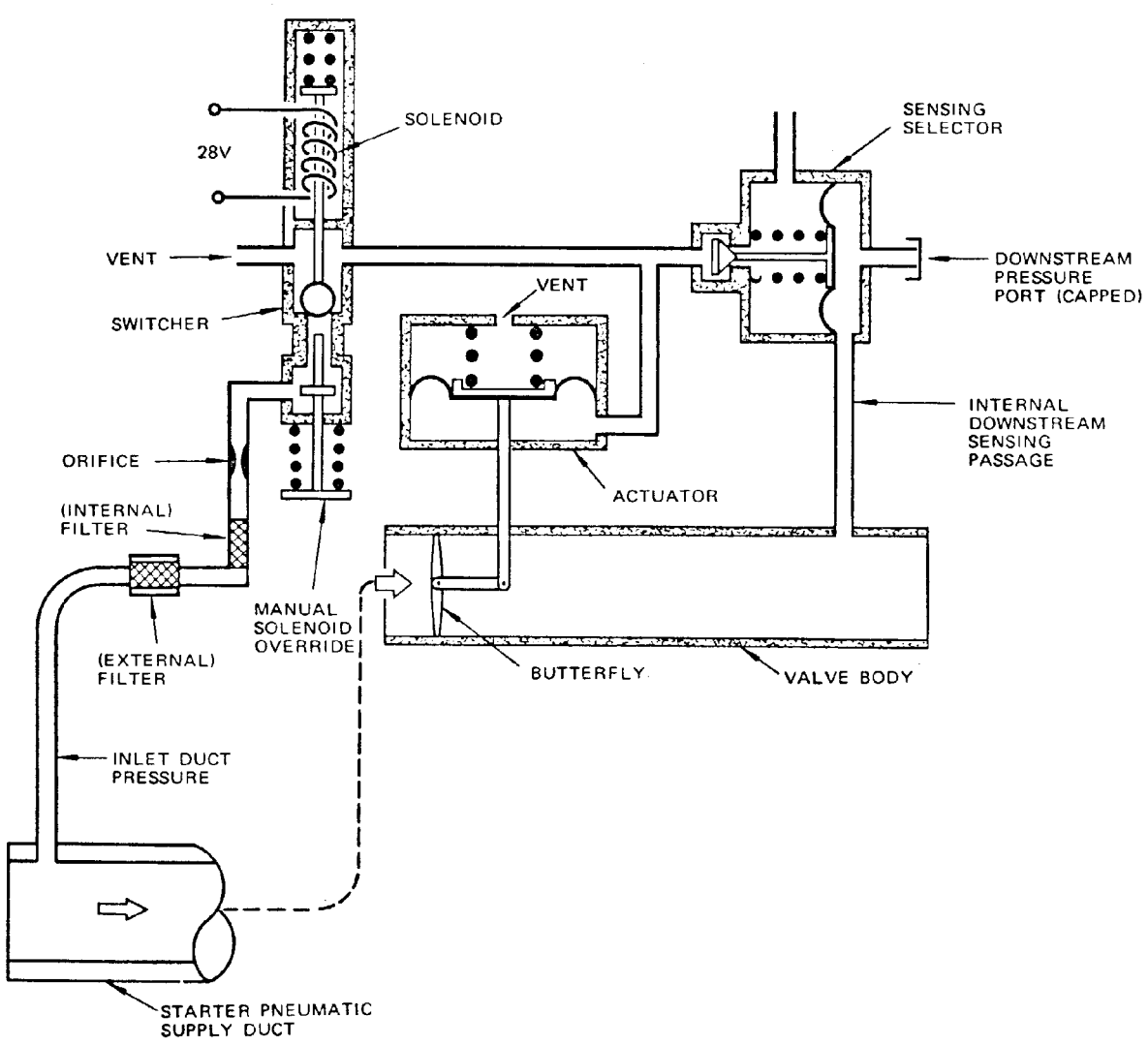
Starter Valve
Figure 3 (Sheet 1)



Starter Valve
Figure 3 (Sheet 2)

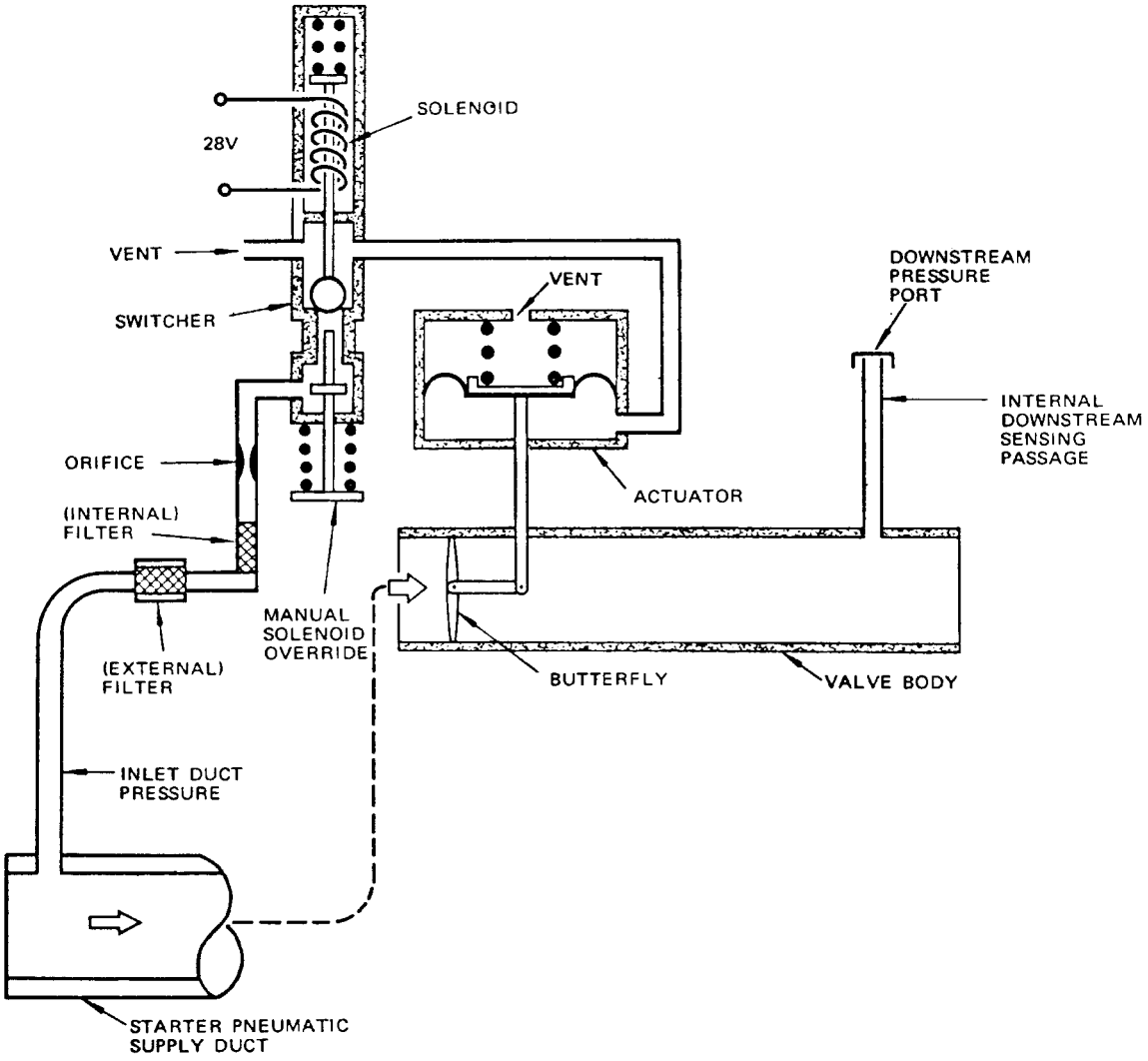


Starter Valve
Figure 3 (Sheet 3)



PARKER HANNIFIN VALVE P/N 2680337
LESS ENGINES INCORPORATING SB 80-1002

Starter Valve
Figure 3 (Sheet 4)



Starter Valve
Figure 3 (Sheet 5)

F. The pneumatic starter duty cycles are as follows:
   (1) For normal starting, the duty cycle is 30 seconds (maximum) on and 60 seconds off.
   (2) For slow starting engine, the duty cycle can be extended to a maximum of 60 seconds on at speeds up to starter cutout speed (35 to 40% N2 rpm), and 60 seconds off. The extended duty cycle can be repeated once and then a 5-minute cooling period must be observed between extended duty cycle starts.
   (3) For motoring the engine, the duty cycle is 2 minutes on and 5 minutes off.
   (4) With the APU operating at governed speed, the APU bleed valve switch is positioned to ON. This opens the APU bleed valve and supplies compressed air to the starter valves. When the applicable engine start switch is positioned to GRD start, electrical power is supplied to the starter valve solenoid to open the valve, and through the normally closed contacts of the starter cutout switch, to energize the start switch holding solenoid.
   (5) AR LV-LIV and on;
   When pressure appears downstream of the start valve the start valve pressure switch actuates and energizes the START VALVE OPEN light, indicating that the valve has opened (Fig. 5).
   (6) When compressed air is supplied to the starter, the starter begins rotating the N2 compressor of the engine. The rotation of the N2 compressor causes rotation of the N1 compressor and the turbines. When the engine has accelerated to between 15 and 17% N2 rpm (15% minimum), fuel and ignition are supplied by advancing the start lever to the IDLE detent. Engine light up occurs within 20 seconds after the start lever movement. The starter continues to assist the engine until starter cutout speed is attained. At cutout speed (35 to 40% N2 rpm), the centrifugally operated cutout switch opens and interrupts electrical power to the start switch holding solenoid. The start switch returns to OFF position, interrupting power to the starter valve, and the valve closes. The closing of the starter valve is evidenced by sudden increase in pneumatic duct pressure which can be observed by monitoring the dual pressure indicator on the forward overhead panel and a closing sound shall be audible from the starter valve solenoid (Fig. 4).
   (7) AR LV-LIU and on;
   Closing of the start valve will be further verified by the START VALVE OPEN light on the center instrument panel being extinguished (Fig. 1). For engine starting and shutdown procedures, refer to AMM Chapter 71, Operating Procedure.

CAUTION: IF START VALVE LIGHT REMAINS ILLUMINATED, SHUT ENGINE DOWN IMMEDIATELY. CONTINUED ENGINE OPERATION WITH START VALVE LIGHT ILLUMINATED MAY RESULT IN DAMAGE DUE TO STARTER DISINTEGRATION. DO NOT EXCEED THE RECOMMENDED STARTER DUTY CYCLE. FOR STARTER DUTY CYCLE REFER TO PAR. 4.E. SHOULD THE ENGINE FAIL TO START AND ACCELERATE NORMALLY, DO NOT ATTEMPT ANOTHER STARTING OPERATION UNTIL THE ENGINE HAS COMPLETELY STOPPED ALL ROTATION. (ALLOW APPROXIMATELY 30 SECONDS AFTER THE TACHOMETER READS ZERO). IF ENGINE START WAS ABORTED DUE TO HUNG START, CHECK POSITION OF TURBOFAN VALVE (AMM 21-52-0) AND AIR CLEANER PURGE VALVE (AMM 21-12-0). VALVES MUST BE IN CLOSED POSITION BEFORE ATTEMPTING ANOTHER START.

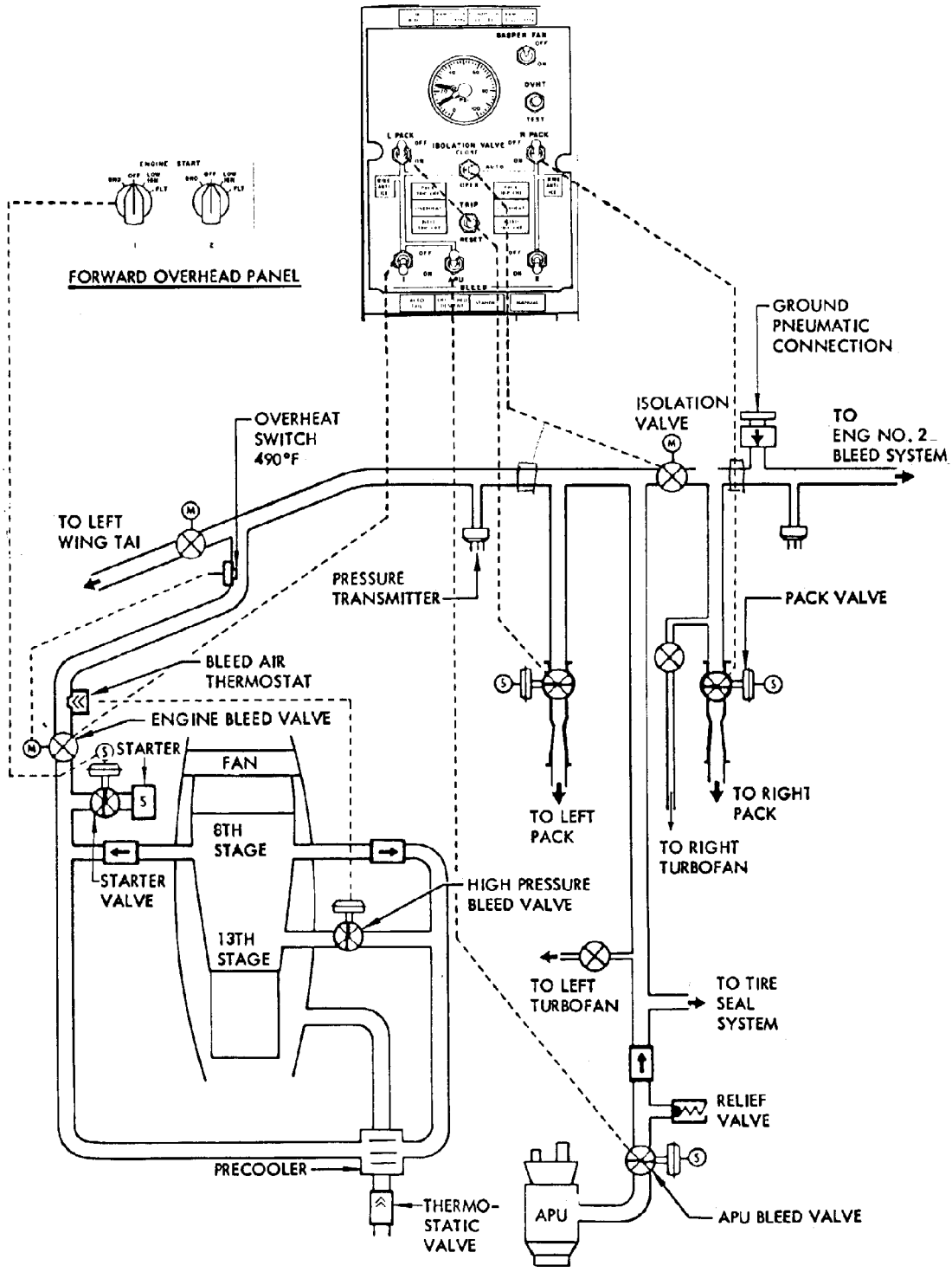
(8) A manual override button on starter valve permits opening the valve if it fails to open electrically. When the override button is actuated, the valve solenoid is overridden, and the valve opens pneumatically. The valve manual override button must be released when the N2 tachometer indicator reads 35 to 40% rpm. The valve then closes, and the starting cycle is terminated.

CAUTION: IF THE MANUAL OVERRIDE BUTTON IS NOT RELEASED WHEN THE N2 TACHOMETER INDICATES 42% RPM, THE STARTER WILL OVERSPEED AND CAN BE SEVERLY DAMAGED. THE INTERPHONE SHALL BE USED FOR COMMUNICATIONS WITH THE CONTROL CABIN.

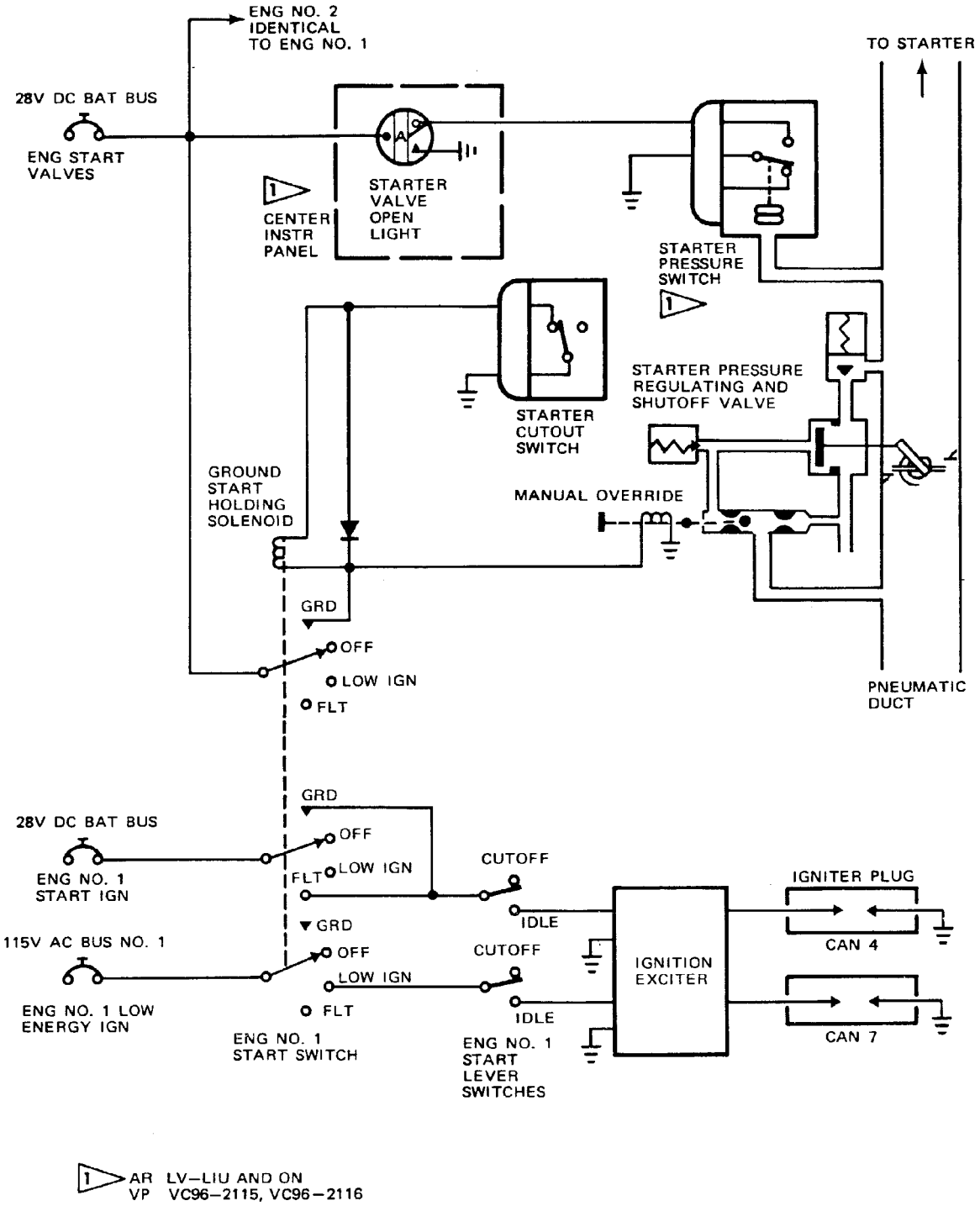
NOTE: For access information to the manual override button, refer to par. 3.

G. Engine Starting Using External Air Source

(1) This type of engine starting is dependent upon having external low pressure air source connected to the ground pneumatic connection. The procedure for starting is the same as using the APU except that bleed air valve for the applicable engine must be opened manually (AMM Chapter 36) if ac power is not available.



Pneumatic Starting System Flow Diagram
Figure 4



Pneumatic Starting System Circuit
Figure 5

H. Engine Starting Using Engine Cross-Bleed Air

(1) When necessary, cross-bleed starting of the second engine can be accomplished by using 8th-stage bleed air from the operating engine. Adequate pressure for cross-bleed starting is provided when the operating engine is operating at approximately 80% N2 rpm. The procedure for starting is the same as using the APU.

I. Motoring the Engine

(1) The starter can be used for motoring an engine. Motoring of the engine can be required to clear the engine of trapped fuel, to bleed the engine fuel control, or to prime the constant speed drive. Refer to AMM Chapter 71, Power Plant for motoring procedures.

CAUTION: DO NOT EXCEED THE RECOMMENDED PNEUMATIC STARTER DUTY CYCLE. FOR STARTER DUTY CYCLE, REFER TO PAR. 4.E.

PNEUMATIC STARTING SYSTEM - TROUBLESHOOTING

1. General
   A. In troubleshooting the pneumatic starting system, the engine bleed air valves and air conditioning isolation shutoff valves must be in the open position. A check should be made (switches on forward overhead panel) to assure valves are open prior to attempting to motor engine. If any valves are closed, ac electrical power is required to open the valves.
2. Troubleshooting Charts

2. Trouble Shooting Charts

Check that engine rotates freely; attempt to motor engine. Refer to Chapter 71, Power Plant - General. IF -

CONTINUED ON FOLLOWING PAGE

N2 COMPRESSOR DOES NOT ROTATE.

Make audible check of starter rotation. IF -

NOT OK - Check for pressure in pneumatic duct. Dual pressure indicator on forward overhead panel. IF -

OK - Replace starter and/or trouble shoot engine, refer to Chapter 72, Engine.

NOT OK - Trouble shoot pneumatic system; refer to Chapter 36, Pneumatics.

OK - Check that START VALVE OPEN light is illuminated. Check that start valve butterfly indicator on valve is in open position.
IF -

NOT OK - Try to open starter valve using manual override on valve. IF -

OK - Replace starter.

VALVE DOES NOT OPEN - Replace starter valve.

VALVE OPENS - Disconnect electrical valve and check for power and ground.
IF -

NO POWER - Disconnect electrical connector on starter and check for power and ground. IF -

OK - Replace starter valve.

NO POWER - Repair and/or replace start switch.

OK - Replace starter.

Pneumatic Starting System - Troubleshooting
Figure 101 (Sheet 1)

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N2 COMPRESSOR DOES NOT ATTAIN 35 TO 40% RPM.

Check for adequate pressure in pneumatic duct. (30 psi minimum on forward overhead panel dual pressure indicator, prior to opening start valve). IF –

NOT OK – Trouble shoot Pneumatic system, refer to Chapter 36.

OK – Check that starter valve butterfly position indicator is fully open or modulating. IF –

NOT OK – Replace starter valve.

OK – Replace starter.

STARTER FAILS TO SHUT DOWN WHEN N2 COMPRESSOR ATTAINS 35 TO 40% RPM.

Release start control switch to OFF. IF –

STARTER DOES NOT SHUT DOWN – Replace starter valve.

STARTER SHUTS DOWN – Replace starter.

Pneumatic Starting System – Troubleshooting
Figure 101 (Sheet 2)

CONTINUED FROM
PRECEDING PAGE

START VALVE OPEN LIGHT DOES NOT COME ON WHEN VALVE BUTTERFLY IS OPENED.

Press to test bulb. IF –

OK – Check for power and ground at pressure switch. IF –

OK – Replace pressure switch.

START VALVE OPEN LIGHT DOES NOT GO OFF WHEN VALVE BUTTERFLY IS CLOSED.

Disconnect pressure switch electrical connector from receptacle at engine flange.

LIGHT REMAINS ON – Check for shorts in wiring and connectors.

LIGHT GOES OFF – Replace pressure switch.

Pneumatic Starting System – Troubleshooting
Figure 101 (Sheet 3)

PNEUMATIC STARTER - MAINTENANCE PRACTICES

1. Preservation of Starter
   A. General
      (1) The pneumatic starter should be preserved if it is going to be out of service for a prolonged period of time.
   B. Equipment and Materials
      (1) Corrosion Preventive Compound, MIL-C-8188, Grade A
   C. Prepare Starter for Preservation
      (1) Drain all lubricating oil from starter oil sump by removing oil fill and drain plugs and allowing starter oil sump to drain completely.

          WARNING: PROLONGED CONTACT OF LUBRICATING OIL WITH SKIN MAY CAUSE DERMATITIS, OIL WILL STAIN CLOTHING AND SOFTEN PAINT. SKIN MUST BE THOROUGHLY WASHED AFTER CONTACT AND SATURATED CLOTHING MUST BE REMOVED IMMEDIATELY. PAINTED SURFACES ON WHICH OIL HAS BEEN SPILLED SHOULD BE CLEANED IMMEDIATELY.

   D. Preserve Starter
      (1) Replace oil drain plug and refill starter oil sump using approximately 150 cubic centimeters of corrosion preventive compound. Replace oil fill plug.
      (2) Rotate starter slowly in all directions so that all internal surfaces are thoroughly coated with corrosion preventive compound. Manually turn starter output shaft several revolutions in both directions.
      (3) Remove oil fill and drain plugs and allow corrosion preventive compound to drain.
      (4) Replace starter oil fill and drain plugs and tighten securely.
      (5) Cover all openings and connections on unit with protective plugs and covers, and wipe all oil, grease, or dirt from external surfaces.
2. Depreservation of Starter
   A. General
      (1) A replacement starter must always be depreserved prior to being installed on an engine.
   B. Equipment and Materials
      (1) Lubricating Oil, MIL-L-7808, or P&WA Specification No. 521 (See P&WA Service Bulletin No. 238.)
   C. Depreserve Starter
      (1) Remove oil fill and drain plugs and allow preventive compound to drain. Replace oil drain plug.

(2) Fill starter oil sump with 150 cubic centimeters of lubricating oil.

WARNING: PROLONGED CONTACT OF LUBRICATING OIL WITH SKIN MAY CAUSE DERMATITIS, OIL WILL STAIN CLOTHING AND SOFTEN PAINT. SKIN MUST BE THOROUGHLY WASHED AFTER CONTACT AND SATURATED CLOTHING MUST BE REMOVED IMMEDIATELY. PAINTED SURFACES ON WHICH OIL HAS BEEN SPILLED SHOULD BE CLEANED IMMEDIATELY.

(3) Replace oil fill plug and rotate starter in all directions so that all internal surfaces are thoroughly coated with lubricating oil.
(4) Remove lubricating oil fill and drain plugs and allow starter oil sump to drain completely. Starter must be held in horizontal position with drain hole down for complete draining.
(5) Clean drain plug thoroughly, install new drain plug gasket, install drain plug, tighten to 75 pound-inches torque and lockwire.
(6) Refill starter oil sump with 350 cubic centimeters of lubricating oil.

CAUTION: UNLESS COMPATIBILITY OF OIL IS ASSURED, DO NOT MIX BRAND NAME OILS. DO NOT REFILL STARTER OIL SUMP WITH OIL USED TO FLUSH OUT CORROSION PREVENTIVE COMPOUND.

(7) Install new fill plug gasket, install fill plug, tighten to 90 pound-inches torque and lockwire.

PNEUMATIC STARTER - REMOVAL/INSTALLATION

1. General
   A. The pneumatic starter should be preserved if not in service for a prolonged period of time. It is necessary to depreserve a replacement starter prior to installation (Ref Maintenance Practices).

      CAUTION: EXTREME CARE MUST BE EXERCISED TO PREVENT FOREIGN MATERIAL FROM ENTERING THE STARTER.

2. Equipment and Materials
   A. Lubricating Grease - BMS 3-24 (Aeroshell Grease No. 16)
3. Prepare Starter for Removal (Fig. 401)
   A. Open engine left removable cowl panel (Ref 71-11-11 R/I).
   B. Disconnect electrical plug from starter.
   C. On airplanes with the pressure switch, for the start valve open light, attached to the starter valve; remove the starter valve (Ref 80-11-21 R/I). On airplanes with the pressure switch, for the start valve open light, located on the engine flange G; remove the starter valve (Ref 80-11-23 R/I).
   D. Remove starter turbine wheel containment assembly (Ref 80-11-41 R/I).
4. Remove Starter (Fig. 401)
   A. Loosen nuts attaching starter to accessory drive gear case enough to allow rotation of starter on gear case pad.

      NOTE: Starter mounting flange has keyhole-shaped slots that allow for removal and installation without removing nuts from studs on accessory drive gear case. One starter mounting stud is inaccessible and will not have a nut installed.

   B. Rotate starter clockwise so that large end of keyhole-shaped slots in mounting flange will pass over heads of nuts. Remove starter.
   C. Cover all openings and connections with protective covers or plugs.
5. Prepare Starter for Installation
   A. Remove all shipping plugs, covers, and caps from starter.
   B. Perform depreservation of starter (Ref MP).
   C. Fit starter to engine drive pad to determine starter position. Check that lubricating oil drain plug is low enough to ensure complete draining and that there is still access to electrical receptacle.
   D. Determine whether starter scroll will have to be rotated to align starter air inlet with air supply duct.

      NOTE: Scroll assembly may be rotated as necessary to make connection with air supply duct.

E. If rotation of starter scroll assembly is necessary, loosen eight nuts securing scroll clamping flange to gear housing assembly, rotate scroll assembly as necessary and torque nuts to 35 to 45 pound-inches.

6. Install Starter (Fig. 401)
   A. Coat starter output shaft splines with lubricating grease.
   B. To ensure good electrical bond, clean mating surface of starter flange and attaching studs and nuts with a general purpose cleaning solvent. Apply with nonmetallic brush or cloth applicator and wipe dry with lint-free gauze or cloth.
   C. Install new gasket on engine starter pad of accessory drive gear case.
   D. Position starter to align large end of keyhole-shaped slots in mounting flange with studs on engine drive pad. Rotate starter counterclockwise to seat nuts firmly in small end of slots.

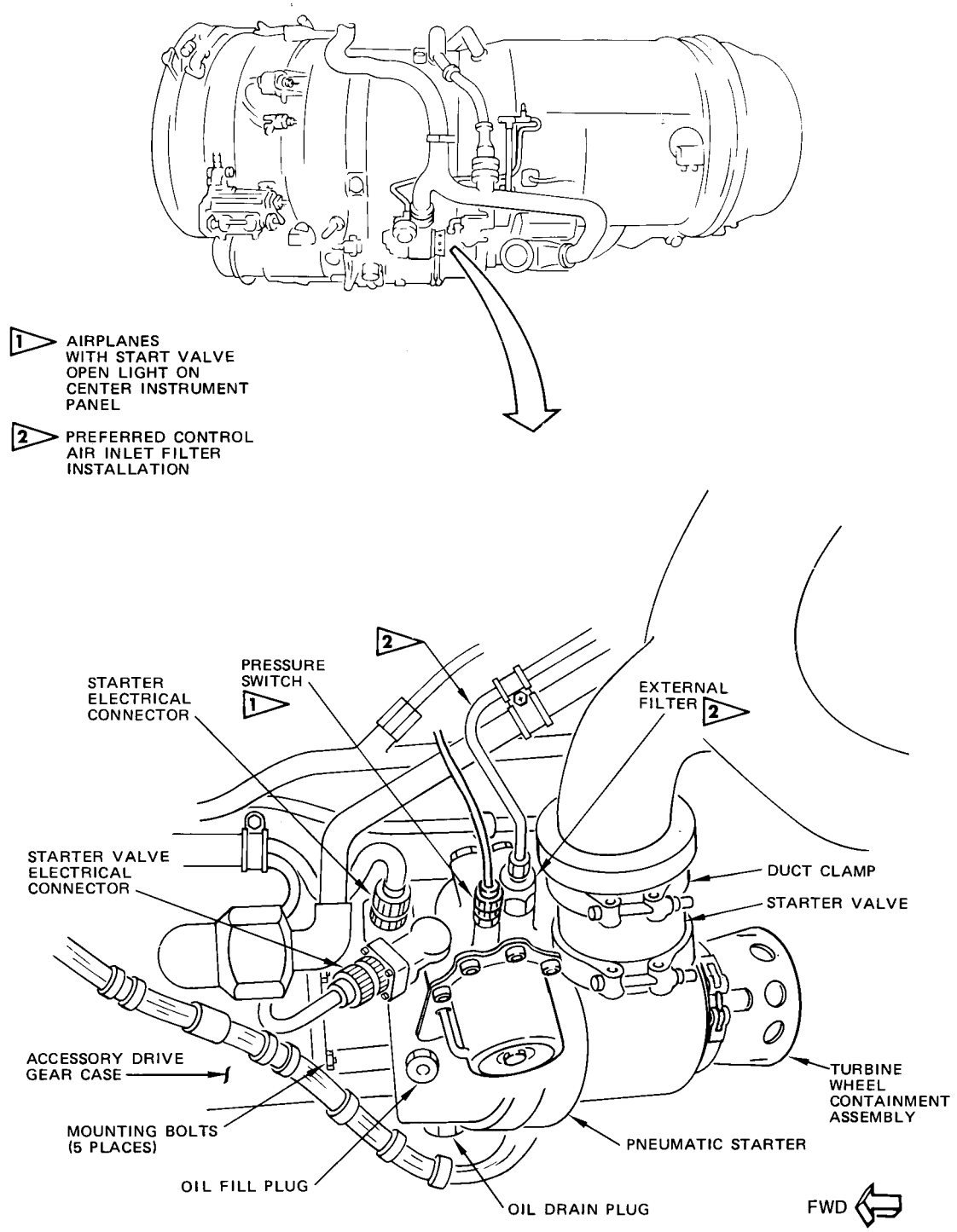
      CAUTION: MAKE CERTAIN THAT SPLINES OF STARTER OUTPUT SHAFT ARE PROPERLY ENGAGED WITH COUPLING IN ENGINE ACCESSORY DRIVE PAD.

   E. Tighten attaching nuts. Inaccessible stud will not carry a nut.

7. Restore Airplane to Normal Configuration
   A. Connect electrical plug and lockwire.
   B. Install starter valve (Ref 80-11-21, Removal/Installation).
   C. Install starter turbine wheel containment assembly (Ref 80-11-41, Removal/Installation).

      CAUTION: STARTER IS FACTORY ADJUSTED AND NO ADJUSTMENT OTHER THAN ROTATION OF SCROLL ASSEMBLY IS PERMISSIBLE IN THE FIELD.

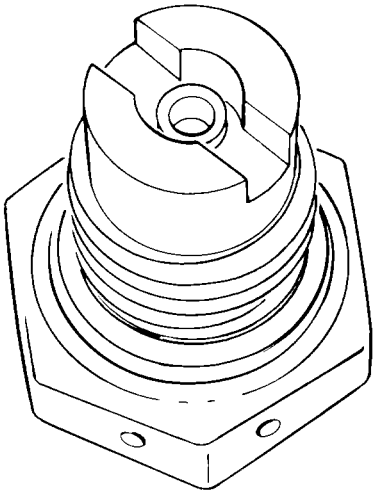
   D. After installation is completed, perform engine motoring procedures for functional test (Ref Chapter 71, Operating Procedure).
   E. Close engine cowl panel.



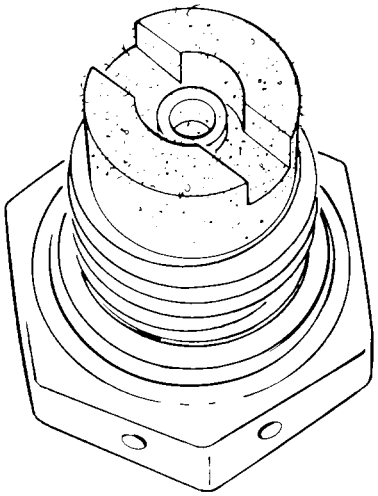
Pneumatic Starter Installation
Figure 401

PNEUMATIC STARTER - INSPECTION/CHECK

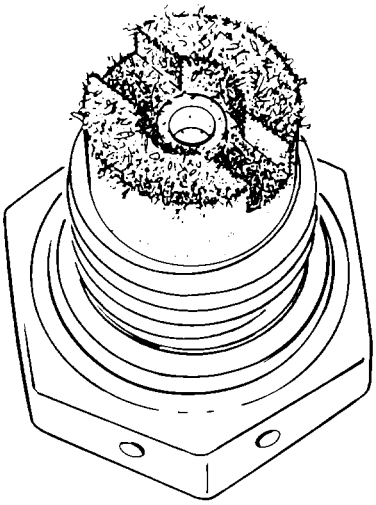
1. General
   A. Inspection and check of the starter shall include, but is not limited to, the requirement of this section. The inspection and check requirements are inspection prior to installation and periodic inspection.
2. Inspection/Check
   A. Prior to Installation
      (1) Visually check for damaged incurred during handling, storage, or shipment. There shall be no evidence of damage.
      (2) Check for engagement clutch operation as follows:
         (a) Grip starter output shaft of the spline and manually apply a sharp torque in the direction opposite to the rotation arrow on the identification plate (clockwise). Relatively large resistance should be felt, this indicates that the reduction gears and turbine wheel assembly are being driven opposite to the normal direction of rotation.
         (b) Manually apply a sharp torque in the direction of rotation arrow (counterclockwise). Relatively light resistance should be felt and ratcheting shall occur, this indicates the engagement clutch is free to operate.
      (3) Visually check that all required lockwire is installed and secure.
   B. Periodic Inspections
      (1) Visually check for security of mounting. There shall be no evidence of looseness.
      (2) Visually check pneumatic connections for security and leakage. Pneumatic connections shall be secure and there shall be no evidence of leakage.
      (3) Visually check exhaust duct area for damage. Check turbine wheel assembly for broken or chipped blades or other indications of damage. Replace starter if evidence of damage.
      (4) Visually check for lubricating oil leakage. There shall be no evidence of leakage.
      (5) On starters with magnetic drain plug, remove magnetic portion (9/16 inch hexagon) of drain plug and inspect for presence of metal particles (Fig. 601). Presence of metal, either minor or major is unacceptable. If major metal is present internal failure is indicated and starter should be replaced. If minor metal is present, flush starter as follows:
         (a) Drain lubricating oil and service starter (Ref 12-13-41).



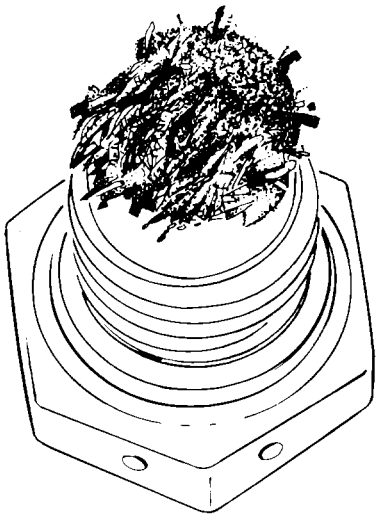
CLEAN
ACCEPTABLE



NORMAL FUZZ
ACCEPTABLE



MINOR METAL
NOT ACCEPTABLE



MAJOR METAL
NOT ACCEPTABLE

1-12A-1231

Start Magnetic Plug
Figure 601

(b) Motor starter for 90 seconds followed by five minutes off for cooling, followed by an additional 30 seconds motoring and five minutes cooling.

NOTE: If cold air (38C (100F) max) is used at starter inlet, there is no time limitation for motoring. However, excessive motoring will shorten service life of starter gears and bearings.

(c) Drain lubricating oil and recheck magnetic drain plug. Service starter if plug has normal-to-minor metal (Ref 12-13-41).

NOTE: If minor metal reappears at next check replace starter at first opportunity.

(d) Check lubricating oil level, reservice as required.

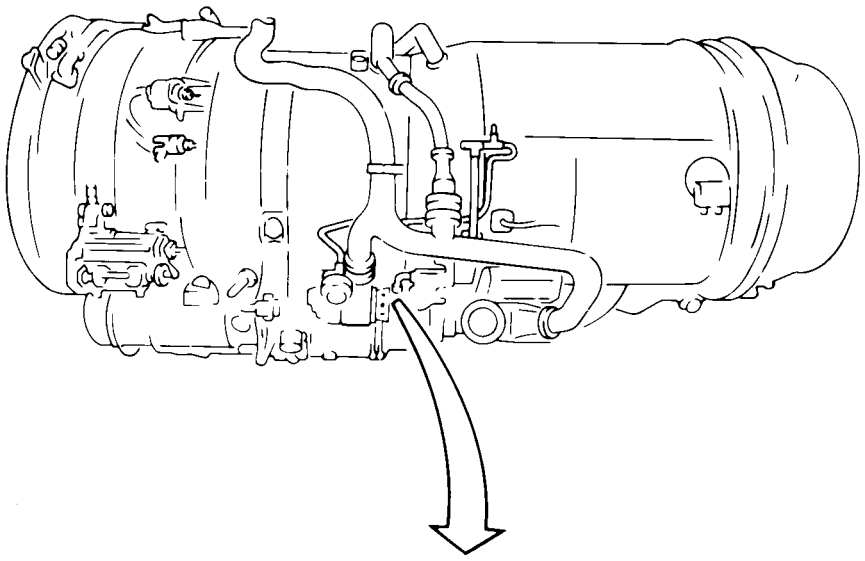
(6) On starters without magnetic drain plug, drain and examine lubricating oil.

(a) If metal particles exist, replace starter (Ref 80-11-11 R/I).

(b) If drained oil is free of metal particles, refill with new lubricating oil. (Ref 12-13-41).

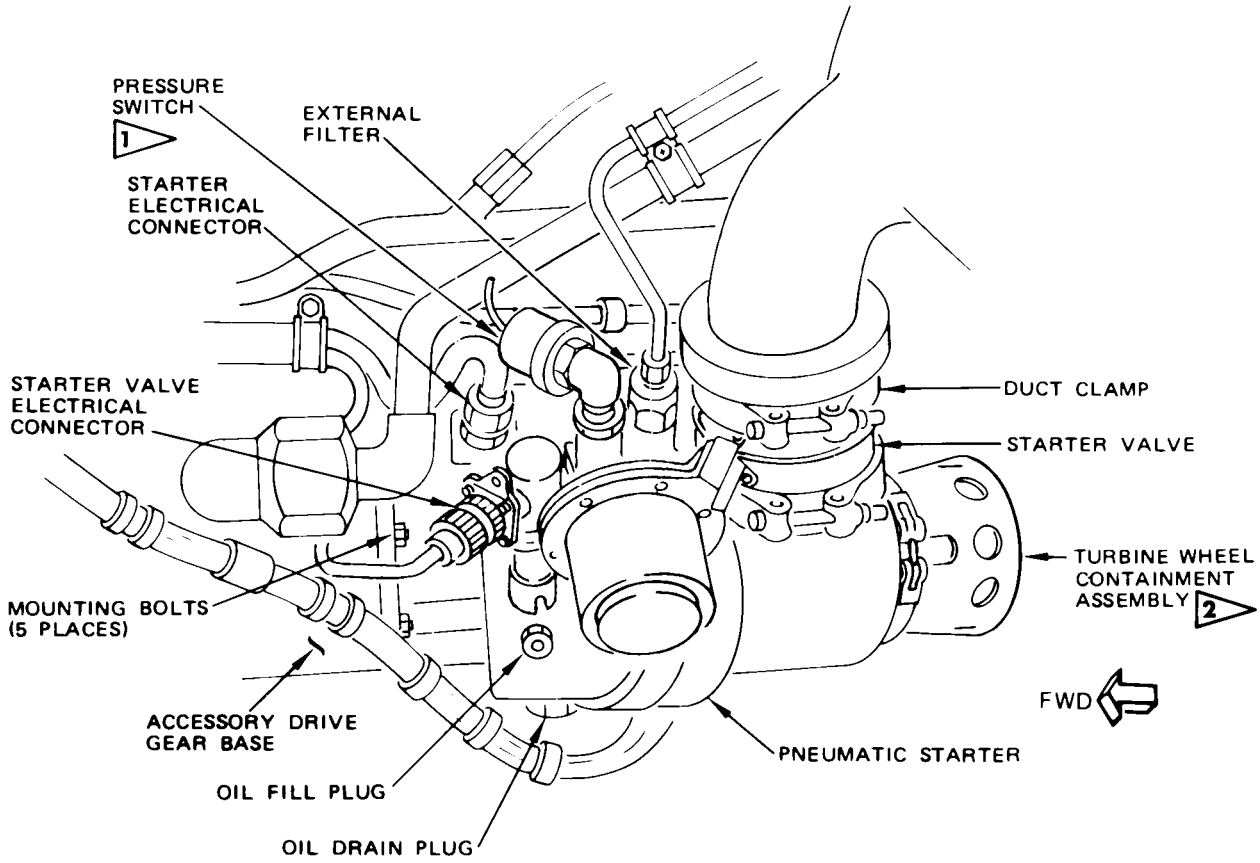
STARTER VALVE - REMOVAL/INSTALLATION

1. Prepare Starter Valve for Removal
   A. Open engine left removable cowl panel (Ref Chapter 71, Power Plant).
   B. Disconnect electrical plug from starter valve.
   C. Loosen valve pressure switch, if installed.
   D. Disconnect filter line from starter valve.
   E. Remove filter from starter valve.
2. Remove Starter Valve (Fig. 401)
   A. Open clamp holding starter valve to air supply duct.
   B. Open clamp holding starter valve to starter and remove valve but keep valve supported.
   C. On start valves having downstream pressure switch, hold pressure switch and turn valve until free of switch threads. This procedure presents twisting of the pressure switch electrical leads and eliminates removal of the pressure switch.
   D. If new starter valve is to be installed, remove manual override button guard and save for use on replacement valve.
3. Prepare Starter Valve for Installation
   A. Remove shipping covers and caps from all openings of the starter valve.
   B. Install manual override button guard.
   C. Prior to installation of clamps, clean valve flanges and mating surfaces with a general purpose cleaning solvent. Apply with nonmetallic brush or cloth applicator and wipe dry with lint-free gauze or cloth.
   D. On start valves having downstream pressure switch, hold pressure switch and thread and tighten valve onto switch.
4. Install Starter Valve (Fig. 401)
   A. Position valve between the air supply duct and pneumatic starter and install clamps. Orient the valve so that the electrical plug will be approximately 1/4 to 1/2 inch from the 1-1/4 inch diameter midbearing oil breather line.
5. Restore Airplane to Normal Configuration
   A. Connect electrical plug to starter valve.
   B. Install new filter.
   C. Connect filter line to filter.
   D. Close engine cowl panel.
   E. An operational check is performed by either motoring or starting engine in normal manner (Ref Chapter 71, Power Plant - General).



1 AIRPLANES WITH START VALVE OPEN LIGHT ON CENTER INSTRUMENT PANEL

2 AIRPLANES WITH STARTER TURBINE WHEEL CONTAINMENT ASSEMBLY



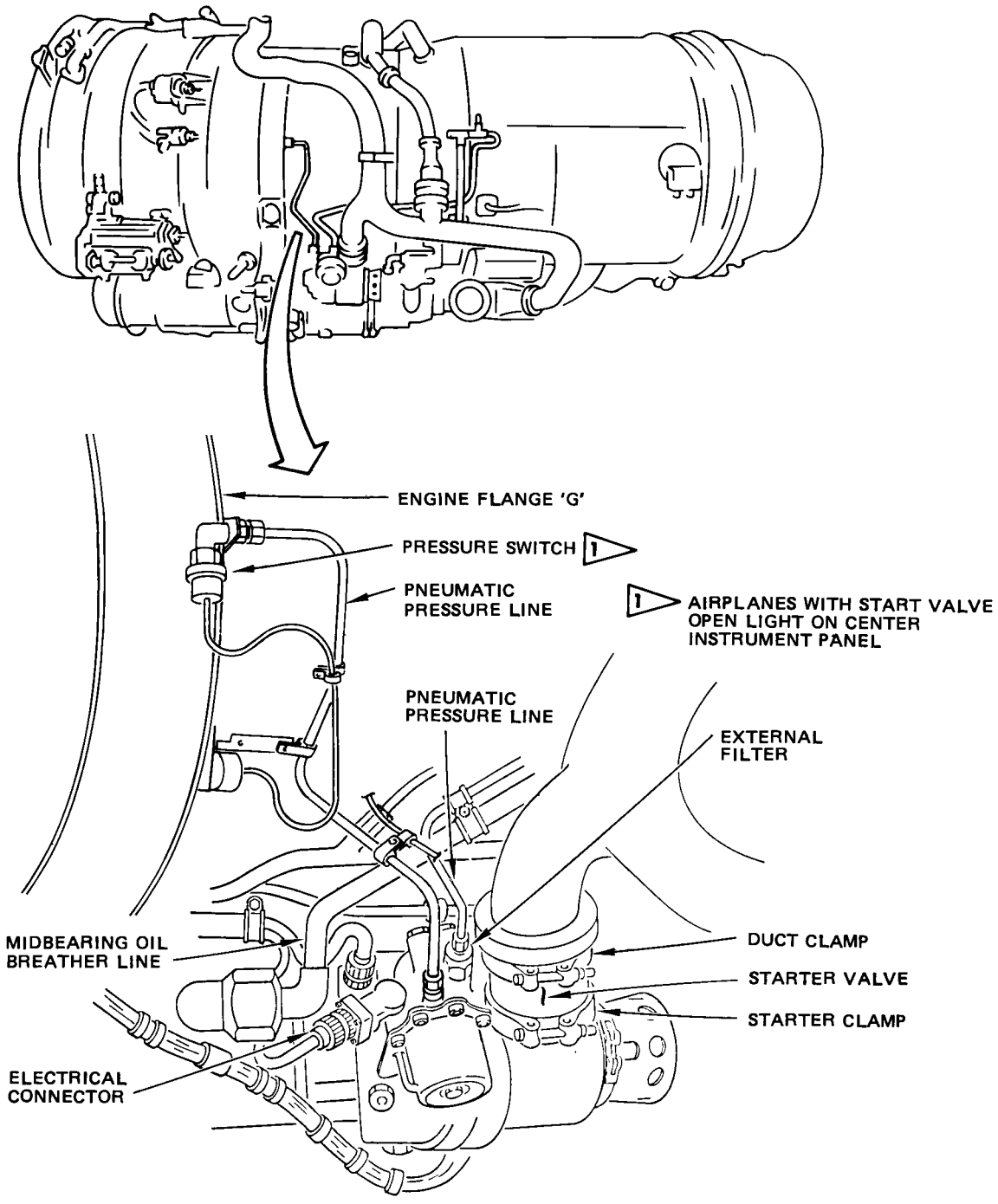
Starter Valve Installation
Figure 401

EFFECTIVITY
Starter valve open light pressure switch attached to starter valve

450457

STARTER VALVE - REMOVAL/INSTALLATION

1. Prepare Starter Valve for Removal
   A. Open engine left removable cowl panel (Ref Chapter 71, Power Plant).
   B. Disconnect pressure line (starter valve open pressure switch) from fitting on starter valve.
   C. Disconnect electrical plug from starter valve.
2. Remove Starter Valve (Fig. 401)
   A. Open clamp holding starter valve to air supply duct.
   B. Open clamp holding starter valve to starter and remove valve. Be sure start valve is supported when lower clamp is removed.
3. Prepare for Starter Valve for Installation
   A. Remove shipping covers and caps from all openings of the starter valve.
   B. Prior to installation of clamps, clean valve flanges and mating surfaces with a general purpose cleaning solvent. Apply with nonmetallic brush of cloth applicator and wipe dry with lint-free gauze or cloth.
4. Install Starter Valve (Fig. 401)
   A. Position valve between the air supply duct and pneumatic starter and install clamps. Orient the valve so that the electrical plug will be approximately 1/4 to 1/2 inch from the 1-1/4 inch diameter midbearing oil breather line.
5. Restore Airplane to Normal Configuration
   A. Connect electrical plug to starter valve.
   B. Connect pressure line (start valve open pressure switch) to fitting on starter valve.
   C. Install new filter.
   D. Connect filter line to filter.
   E. Close engine cowl panel.
   F. An operational check is performed by either motoring or starting engine in normal manner (Ref Chapter 71, Power Plant - General).



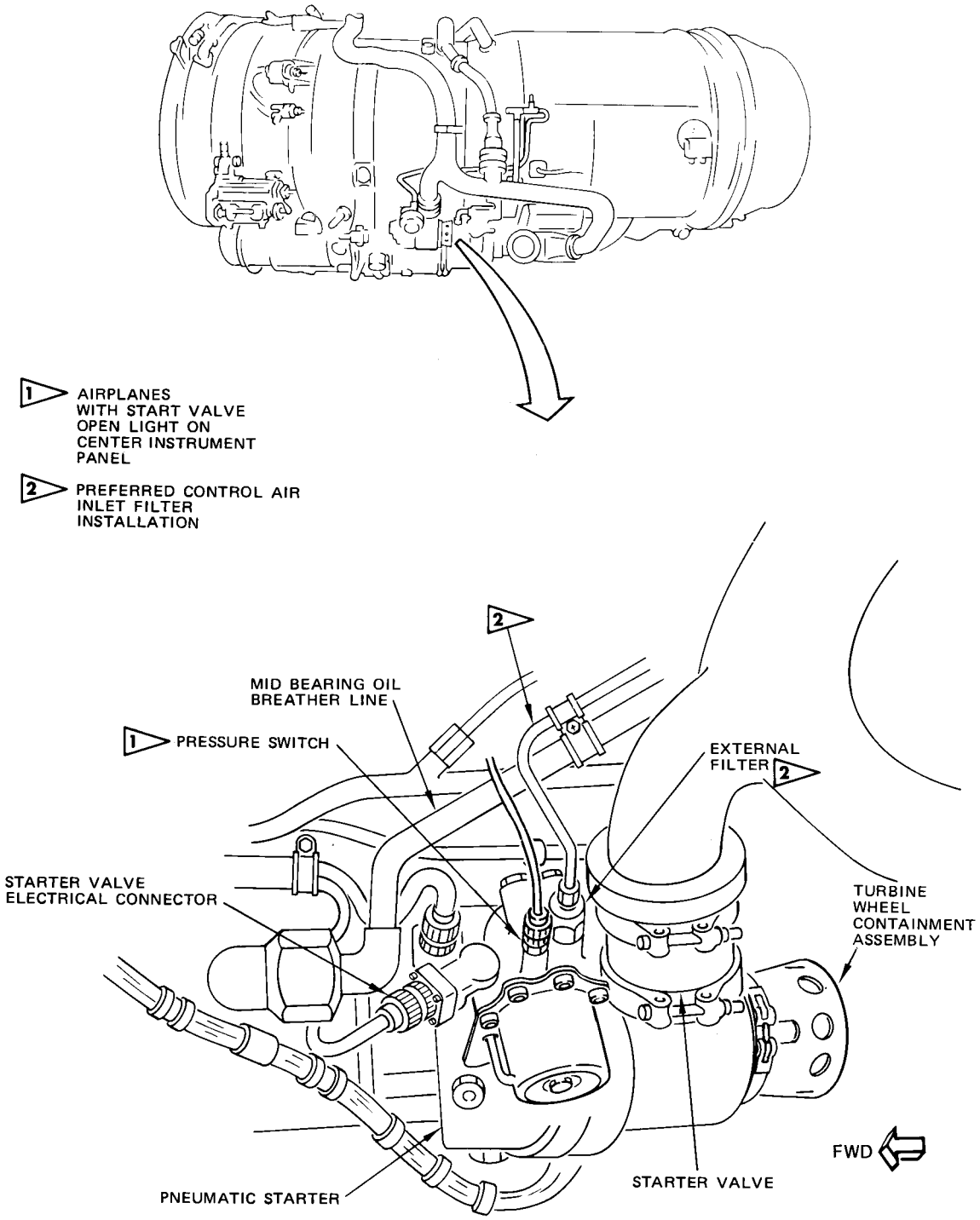
Starter Valve Installation
Figure 401

STARTER VALVE FILTER - REMOVAL/INSTALLATION

1. Remove Starter External Valve Filter
   A. Open the engine left removable cowl panel (AMM 71-11-11/401).
   B. Disconnect pneumatic line from filter.
   C. Remove filter from start valve.

      NOTE: The Hydraulic Research 11-10865 filter cannot be disassembled and therefore must be cleaned in a sonic cleaning tank or by reverse flushing with solvent. The Mectron 22103 filter can be disassembled and cleaned by normal cleaning procedures. The internally mounted finger-type filter found on early units is self-cleaning, therefore, removal is not required.

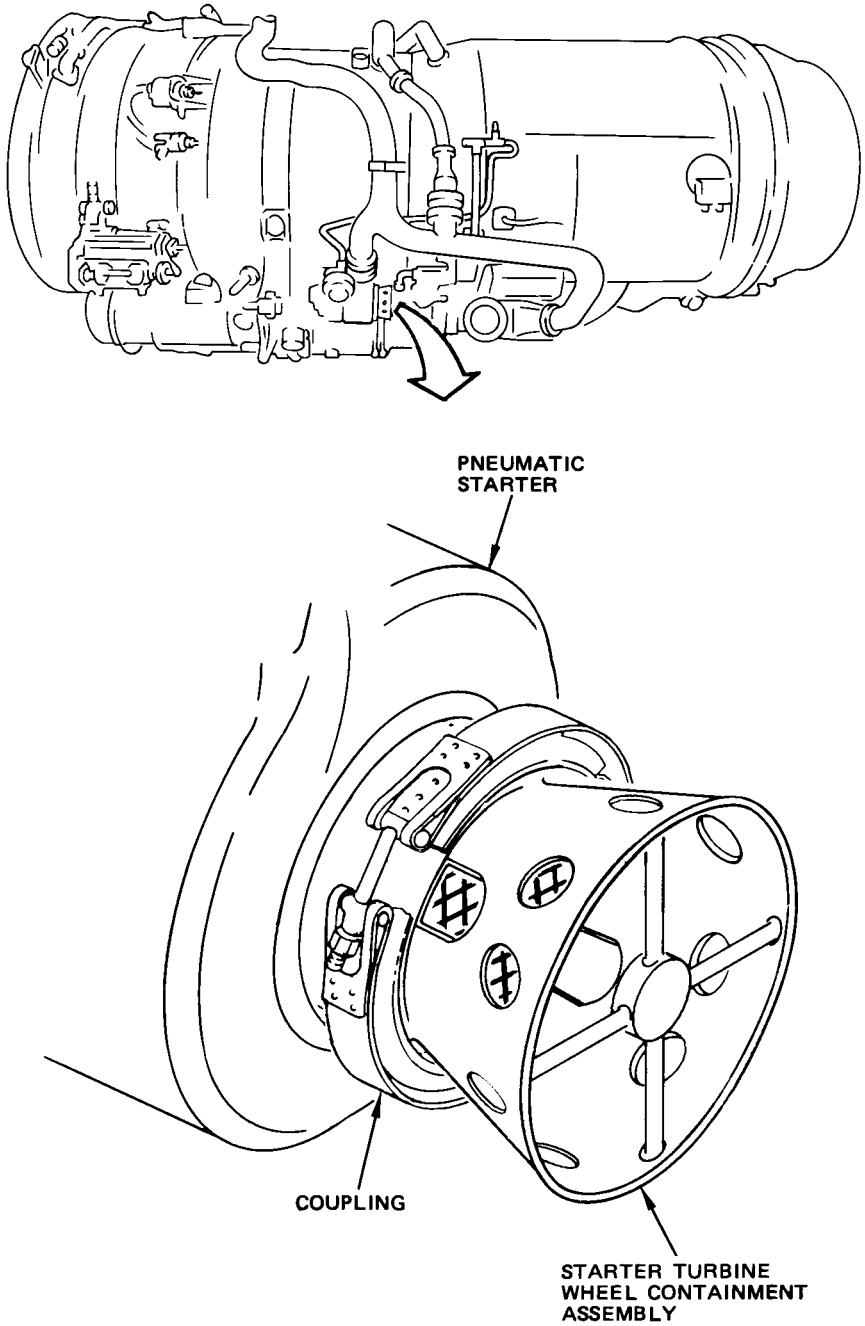
2. Install Starter Valve Filter
   A. Install filter in start valve.
   B. Connect pneumatic line to filter.
   C. Close the engine left removable cowl panel (AMM 71-11-11/401).



Starter Valve Filter Installation
Figure 401

STARTER TURBINE WHEEL CONTAINMENT ASSEMBLY - REMOVAL/INSTALLATION

1. Remove Starter Turbine Wheel Containment Assembly (Fig. 401)
   A. Open engine cowl panel to gain access to left side of engine accessory drive gear case (Ref Chapter 71, Power Plant).
   B. Remove coupling and containment assembly.
2. Install Starter Turbine Wheel Containment Assembly (Fig. 401)
   A. Position containment assembly on starter housing air outlet with coupling.
   B. On airplanes with 357797 coupling, secure containment assembly to starter by tightening coupling nut 25 to 40 lb-in. Install lockwire. On airplanes with BACC10GY-400 coupling, secure containment assembly to starter by tightening coupling nut 45 to 55 lb-in.
   C. Close engine cowl panel (Ref Chapter 71, Power Plant).



Starter Turbine Wheel Containment Assembly Installation
Figure 401