CHAPTER

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BOEING Intercontinental 707

MAINTENANCE MANUAL

CHAPTER 36

PNEUMATIC

TABLE OF CONTENTS

PNEUMATIC SYSTEM - DESCRIPTION AND OPERATION

1 General

A The pneumatic system supplies high temperature compressed air for cabin air conditioning, pressurization and engine starting. The pneumatic supply duct is common to the air conditioning, pressurization and starter systems For information on starting, refer to Chapter 80

B. The main supply of high temperature compressed air is obtained from three turbocompressors, one mounted on top of each of engines No. 2, 3 and 4. An alternate or supplemental air supply is obtained by bleeding air from the intermediate compressor case of each of engines No 1, 2, 3 and 4. (See figures 1 and 2.) This engine bleed air can be used to supply either the wing thermal anti-icing system manifold or the wing pneumatic manifold Shutoff valves in the ducting control the flow of air as required.

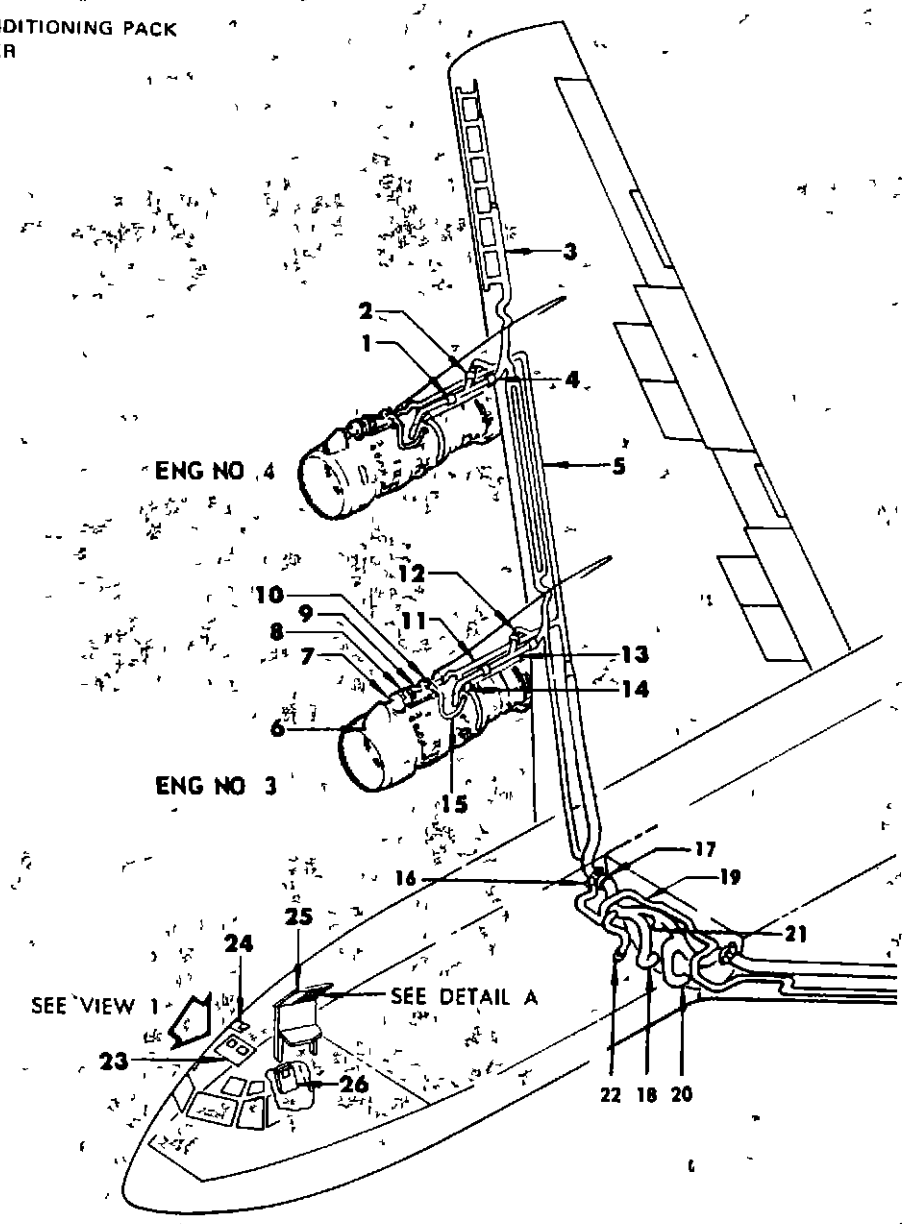
C The turbocompressor is an integral turbine and compressor unit. The turbine is driven by 16th stage engine compressor air which is ducted from the diffuser case through a pressure regulator and a shutoff valve. The turbine drives the coaxial compressor which receives fresh air from an inlet on top of the engine nacelle. The compressed air flows past a surge valve outlet and through a check valve to the wing leading edge pneumatic manifold. A low pressure pneumatic duct, to supply the engine starter, ties into the wing manifold supply duct at each engine.

D. The left and right wing manifolds are connected across the fuselage by a crossover pneumatic duct. This duct contains the valves necessary to isolate each wing manifold, deliver high temperature compressed air to the air conditioning system, and receive air from a pneumatic ground supply. A swing check valve is located outboard of each wing isolation valve to balance the pressure between the wing pneumatic manifold and the air conditioning distribution bay when the wing isolation valve is closed. A pressure takeoff from the crossover pneumatic duct provides an indication of duct pressure through an electrical system.

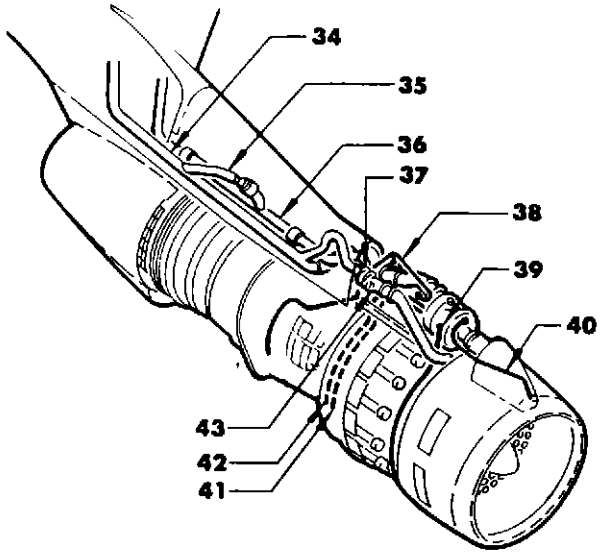
(1) A crew auxiliary heat shutoff valve allows warm air from the pneumatic manifold to be routed to the crew compartment during unpressurized flight in Passenger/Cargo Convertible Airplanes. Refer to Air Conditioning - Description and Operation, Chapter 21

E. The turbocompressor is self-regulated. Accordingly, the automatic controls are designed to provide optimum operation at the approximate cruising altitude of the airplane. In order to obtain the required pneumatic flow for engine starting, a flow control valve causes the control system to increase the airflow for this mode of operation. The flow control valve is controlled by a flow control relay, which in turn is controlled by the engine start pressure selector switch and a landing gear safety relay.

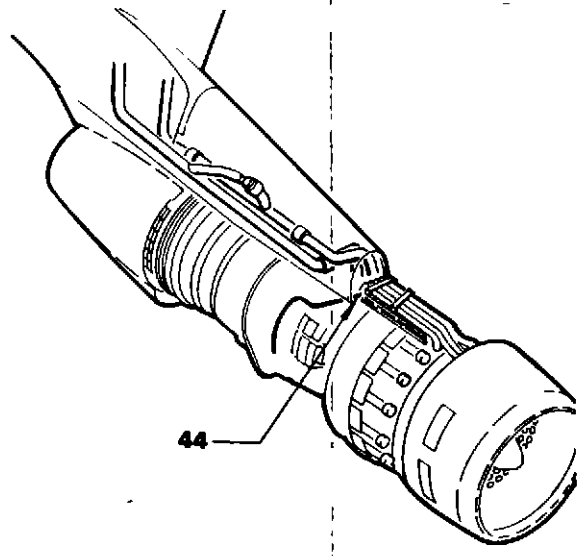
1 CHECK VALVE
2 ALTERNATE AIR SOURCE SHUTOFF VALVE
3 WING THERMAL ANTI ICE SYSTEM MANIFOLD
4 WING ANTI-ICE SHUTOFF VALVE
5 PNEUMATIC MANIFOLD
6 AIR INLET
7 COMPRESSOR
8 TURBINE
9 TURBOCOMPRESSOR SHUTOFF VALVE
10. PRESSURE REGULATOR
11 PNEUMATIC DUCT
12 VENTURI (FLOW LIMITER)
13 THERMAL ANTI ICE DUCT
14 STARTER SHUTOFF VALVE
15 ENGINE BLEED DUCT
16 SWING CHECK VALVE
17 WING ISOLATION VALVE
18 OUTLET TO RIGHT AIR CONDITIONING PACK
19 AIR PRESSURE TRANSMITTER
20 OUTLET TO LEFT AIR CONDITIONING PACK
21 OUTLET TO MAIN CABIN TEMPERATURE CONTROL VALVE
22 GROUND AIR CONNECTION AND CHECK VALVE
23 RADIO AND T-R CIRCUIT BREAKER PANEL (P5)
24 A-C BUS NO 4 CIRCUIT BREAKER PANEL (P4)
25 FLIGHT ENGINEER'S UPPER PANEL
26 J1 RELAY SHIELD - T/C FLOW CONTROL VALVE RELAY



Pneumatic System Component Location
Figure 1 (Sheet 1 of 3)

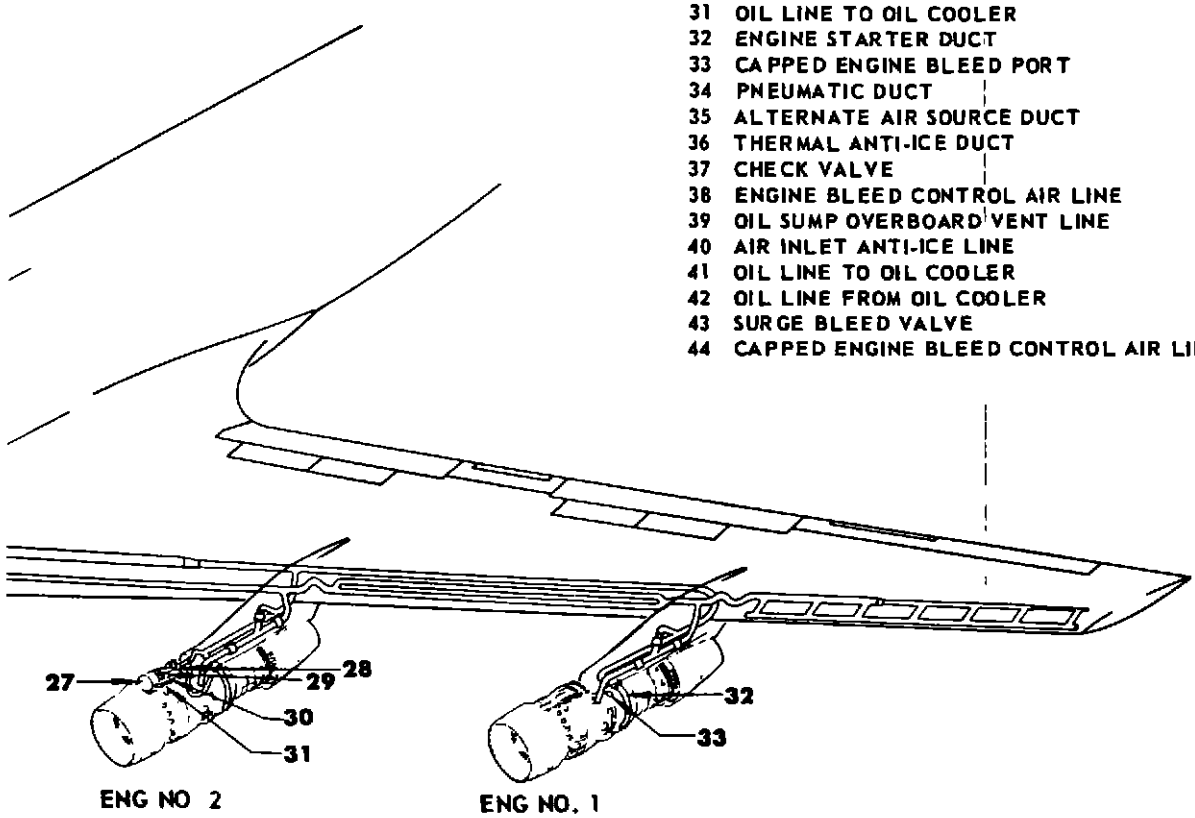


RIGHT SIDE ENGINES NO 2, 3 AND 4



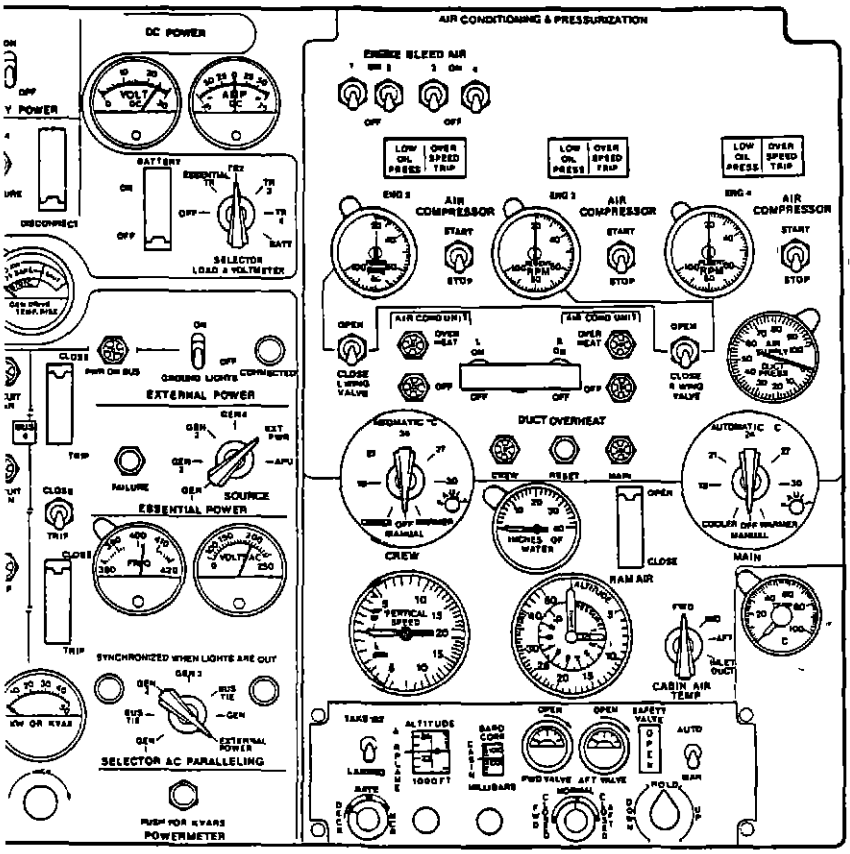
RIGHT SIDE ENGINE NO 1

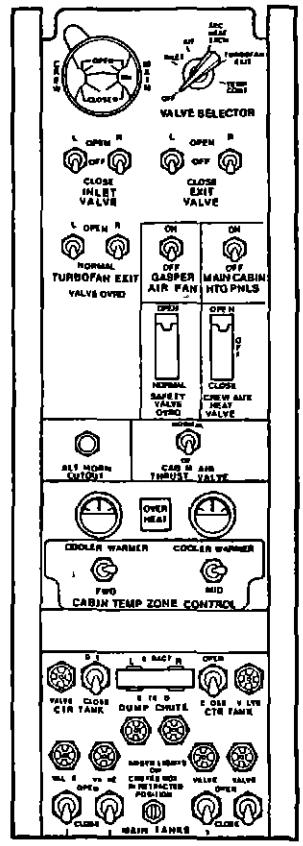
27 T/C ANTI-ICE LINE
28 SURGE VALVE EXHAUST DUCT
29 TURBINE EXHAUST DUCT
30 OIL LINE FROM OIL COOLER
31 OIL LINE TO OIL COOLER
32 ENGINE STARTER DUCT
33 CAPPED ENGINE BLEED PORT
34 PNEUMATIC DUCT
35 ALTERNATE AIR SOURCE DUCT
36 THERMAL ANTI-ICE DUCT
37 CHECK VALVE
38 ENGINE BLEED CONTROL AIR LINE
39 OIL SUMP OVERBOARD VENT LINE
40 AIR INLET ANTI-ICE LINE
41 OIL LINE TO OIL COOLER
42 OIL LINE FROM OIL COOLER
43 SURGE BLEED VALVE
44 CAPPED ENGINE BLEED CONTROL AIR LINE



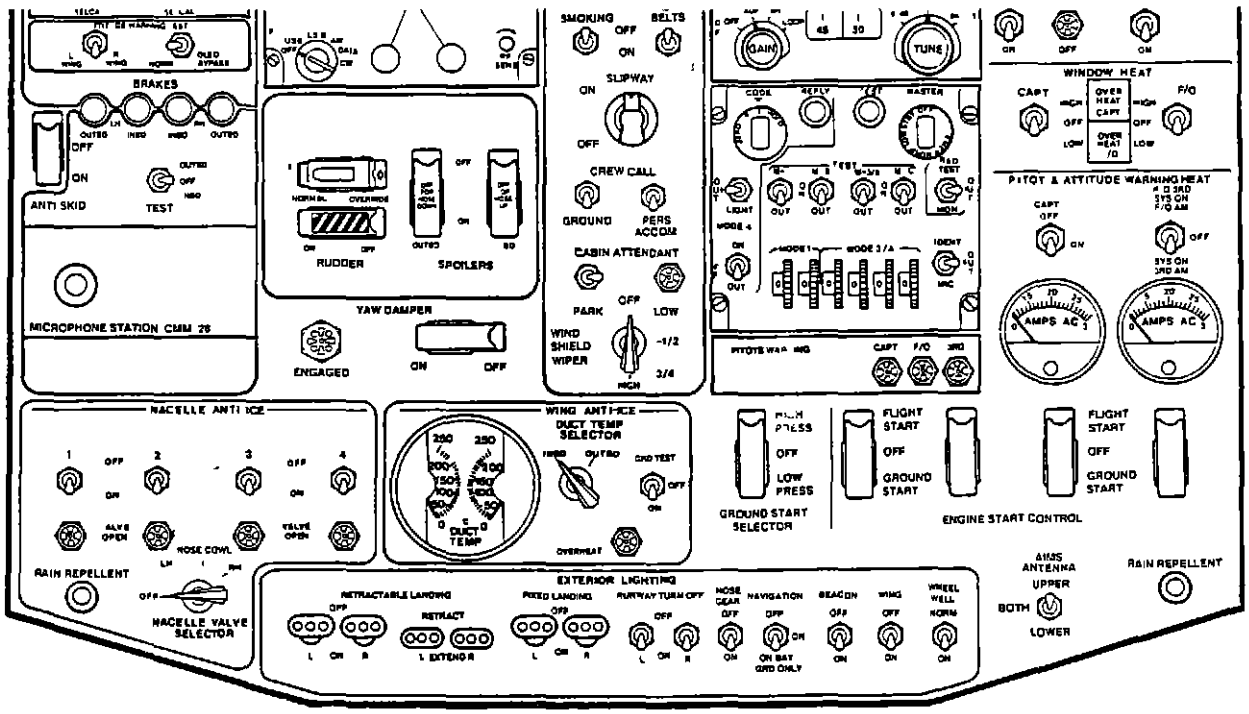
ENG NO 2

ENG NO. 1





FLIGHT ENGINEER'S UPPER PANEL



PILOT'S OVERHEAD PANEL

F All manual controls, indicators and warning lights for the pneumatic system are located on the flight engineer's panel. (See figure 1) Each turbocompressor has a "START-STOP" switch, tachometer and separate warning lights for low oil pressure and overspeed trip indications The left and right wing isolation valve switches have two positions, "OPEN" and "CLOSE." Engine bleed air is controlled by four "ON-OFF" switches, labeled "ENG 1," "ENG 2," "ENG 3" and "ENG 4 " Pressure in the high pressure manifold may be read on a gage located on the flight engineer's upper panel. The controls for the wing thermal anti-icing system and engine starting are located on the pilots' overhead panel

2 Turbocompressor (See figure 3)

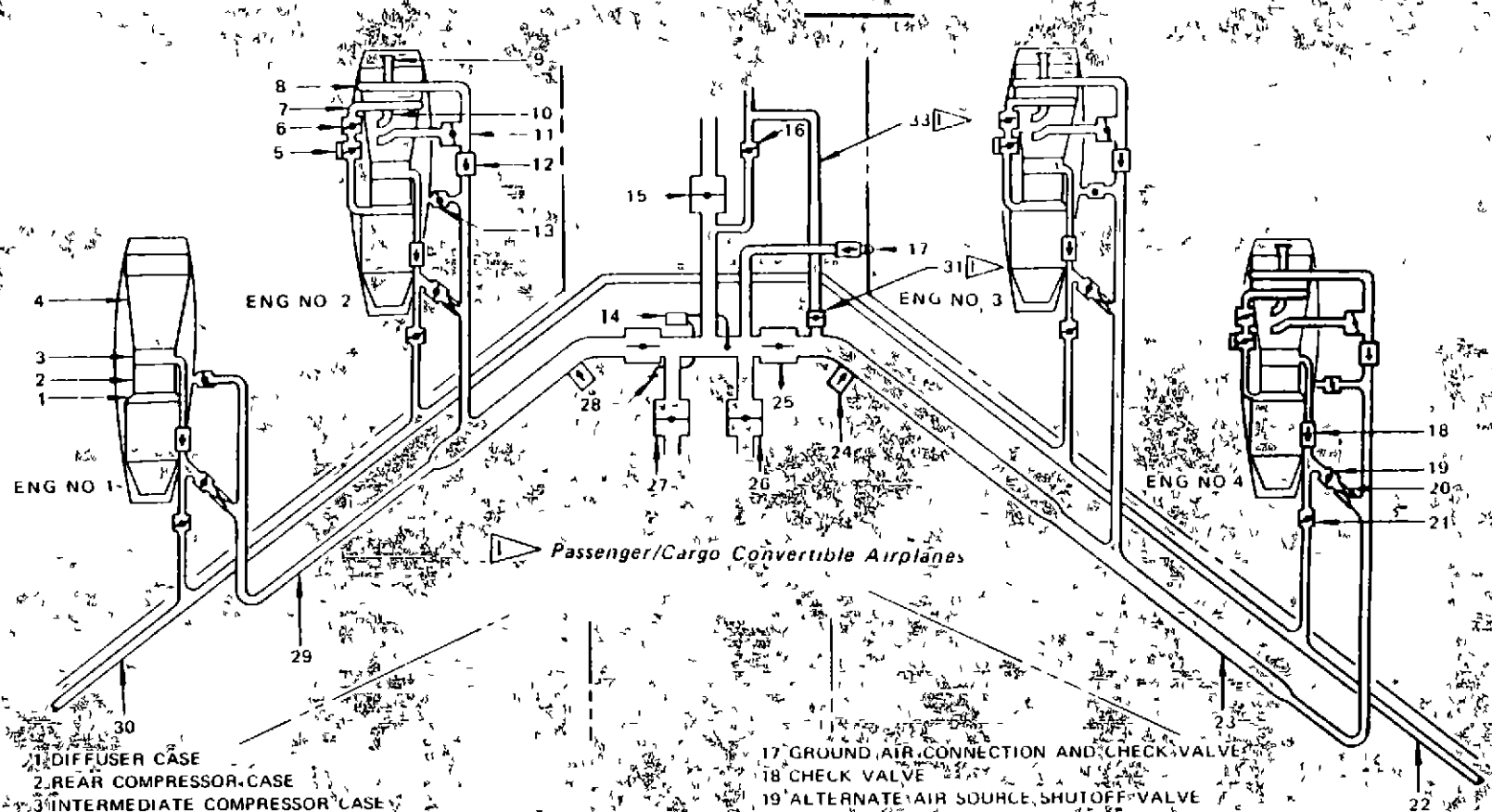
A The turbocompressor consists primarily of a radial inward flow turbine wheel with integral shaft, and a centrifugal compressor impeller. This assembly drives an oil pump assembly which consists of a spur gear oil pump, centrifugal oil pump, and a tachometer generator The spur gear oil pump supplies lubricating oil to the rotating assembly and oil under pressure to a hydraulic control system The hydraulic control system actuates a variable area nozzle at the inlet to the turbine wheel, and a surge valve in the compressor outlet duct An electrically-selected, pneumatic control system actuates the shutoff valve and the differential pressure regulator in the turbine inlet duct

B A main housing assembly provides the mounting facilities for the turbine torus, the compressor scroll and the hydraulic and pneumatic controls On the right side of the turbocompressor assembly is the oil filler neck, ground start electromagnetic valve, compressor surge bleed control assembly and the main electrical connector On the left side are the oil filter assembly and minimum oil pressure switch.

C An oil sump, beneath the main housing assembly, serves as an oil reservoir and mounting base for the unit A dipstick in the oil filler neck is marked "LEFT WING-FULL" and "RIGHT WING-FULL" to allow for the difference in oil level readings due to wing dihedral. An oil-drain plug is fitted in each end of the sump to allow for any difference in mounting of the unit The oil-drain plugs are magnetic to collect any metal particles which may be present in the oil. The oil sump is vented to atmosphere through an overboard vent line.

3 Turbocompressor Controls

A A compressor air flow controller and a speed-topping control are contained within a single housing and mounted on top of the turbocompressor The flow controller governs the speed of the



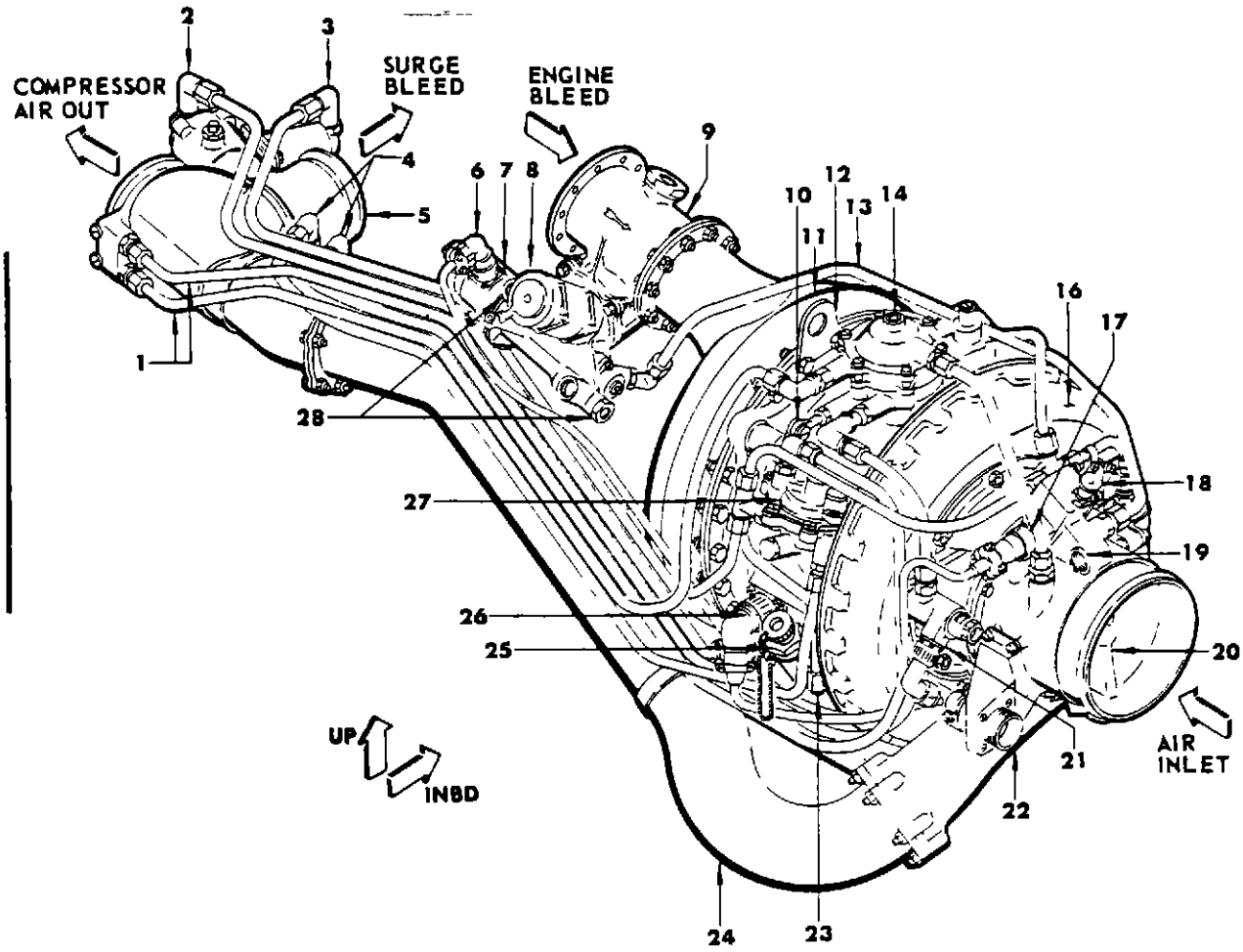
1 DIFFUSER CASE
2 REAR COMPRESSOR CASE
3 INTERMEDIATE COMPRESSOR CASE
4 FRONT COMPRESSOR CASE
5 PRESSURE REGULATOR
6 SHUTOFF VALVE
7 TURBINE
8 COMPRESSOR
9 AIR INLET
10 TURBINE EXHAUST DUCT
11 COMPRESSOR SURGE VALVE AND EXHAUST DUCT
12 CHECK VALVE
13 ENGINE STARTER SHUTOFF VALVE
14 AIR PRESSURE TRANSMITTER
15 MAIN CABIN TEMPERATURE CONTROL VALVE
16 CONTROL CABIN TEMPERATURE CONTROL VALVE
17 GROUND AIR CONNECTION AND CHECK VALVE
18 CHECK VALVE
19 ALTERNATE AIR SOURCE SHUTOFF VALVE
20 VENTURI (FLOW LIMITER)
21 WING ANTI ICE SHUTOFF VALVE
22 THERMAL ANTI ICE SYSTEM MANIFOLD
23 PNEUMATIC MANIFOLD
24 SWING CHECK VALVE
25 WING ISOLATION VALVE
26 RIGHT AIR CONDITIONING PACK SHUTOFF VALVE
27 LEFT AIR CONDITIONING PACK SHUTOFF VALVE
28 AMBIENT AIR SENSING FITTING
29 PNEUMATIC MANIFOLD
30 THERMAL ANTI ICE SYSTEM MANIFOLD
31 CREW AUXILIARY HEAT SHUTOFF VALVE
32 DELETED
33 BYPASS DUCT

Pneumatic System Schematic Diagram
Figure 2

turbocompressor to provide the desired air flow for cabin air conditioning and pressurization. The speed-topping control serves to limit the speed of the turbocompressor to a preset maximum value of 47,000 (± 1000) rpm.

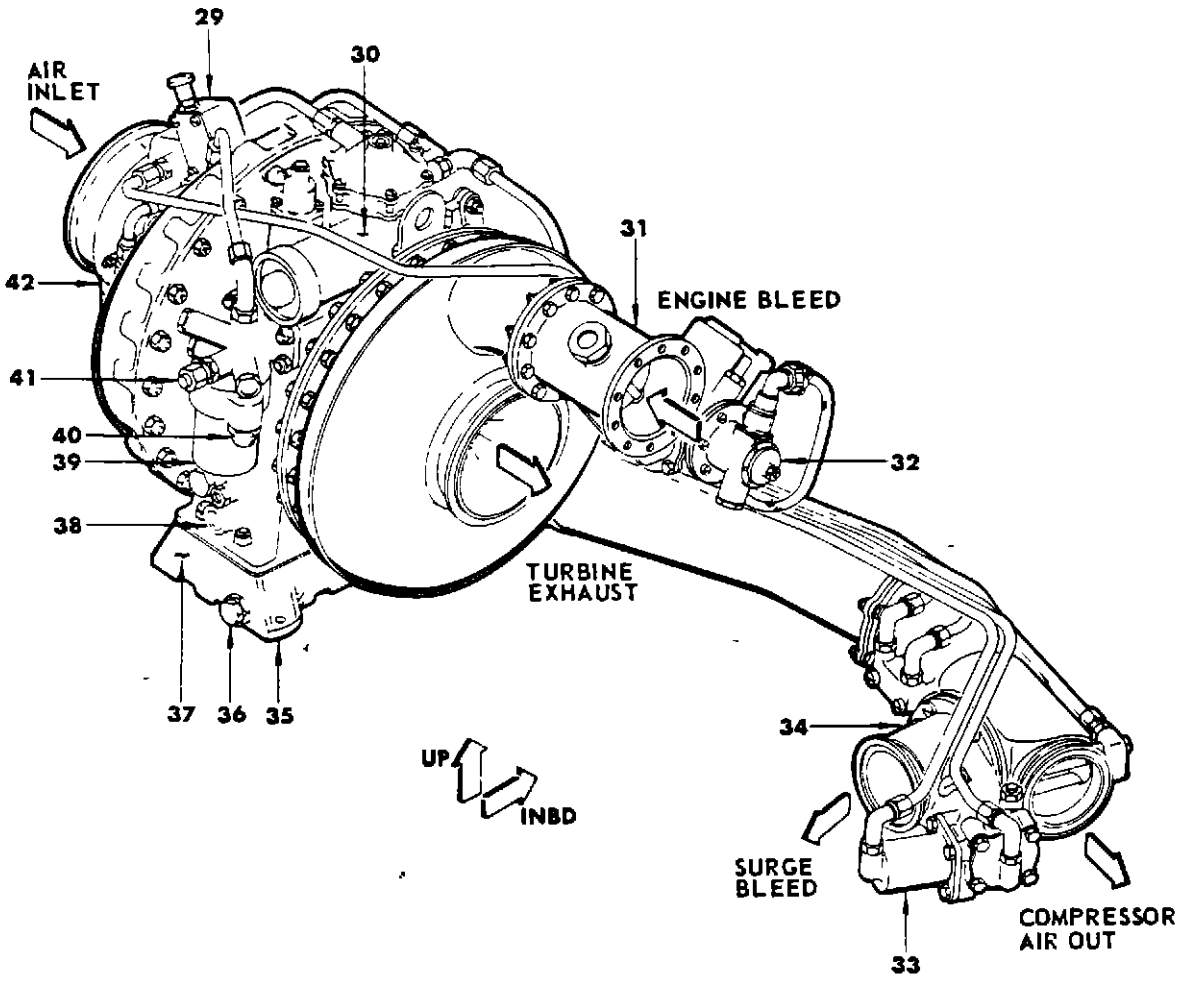
B The air flow controller consists of a pneumatic chamber divided by two diaphragms which actuate a spring-loaded piston. (See figure 4) The piston is contained in a hydraulic cylinder below the pneumatic chamber. Air pressure sensing lines connect the upper portion of the pneumatic chamber to the compressor inlet duct and the center and lower portions of the chamber to the low and high static air pressure sensing probes in the compressor outlet duct The pressure differentials, sensed through the lines and applied across the flow controller diaphragms, actuate the spring-loaded piston. An oil passage connects the hydraulic cylinder to a control oil passage which runs from the control oil pressure inlet at the filter to a turbine nozzle actuator An oil passage leading from the bottom of the hydraulic cylinder returns bleed oil to the turbocompressor oil sump The piston in the cylinder acts as a metering valve and controls oil pressure to the turbine nozzle actuator This actuator positions the turbine variable area nozzle through a mechanical linkage The turbine variable area nozzle consists of a series of vanes which can be rotated to increase or decrease air flow to the turbine Increasing or decreasing this air flow regulates the speed of the turbine and maintains the desired air weight flow

C The speed-topping control consists of a hydraulic chamber divided by a spring-loaded diaphragm which positions a hydraulic bleed valve (See figure 4) Positioning of the bleed valve is controlled by sensing the oil pressure differential across the spring-loaded diaphragm An oil passage connects the upper portion of the hydraulic chamber to the spur gear oil pump outlet The lower portion of the hydraulic chamber is connected by an oil passage to the centrifugal oil pump outlet An oil passage also connects the hydraulic bleed valve to the turbine nozzle actuator oil passage. An oil passage leading from the bottom of the bleed valve returns bleed oil to the turbocompressor oil sump. Normally, the hydraulic bleed valve of the speed-topping control is closed and the flow controller alone governs control oil pressure to the turbine nozzle actuator. When the speed of the turbocompressor reaches the preset maximum of 47,000 (± 1000) rpm, centrifugal oil pump pressure creates a large enough pressure differential across the speed-topping control diaphragm to overcome the diaphragm spring pressure and open the bleed valve Opening the bleed valve bleeds off control oil pressure to the turbine nozzle actuator which then moves toward the close position This action decreases the flow of air to the turbine which results in a decrease in turbocompressor rpm In this way, the speed-topping control superimposes speed limiting control on the air flow controller to maintain the normal maximum rpm setting



1 FLOW CONTROLLER AIR SENSING LINES
2 SURGE VALVE RETURN OIL LINE
3 SURGE VALVE CONTROL OIL LINE
4 SURGE BLEED CONTROLLER AIR SENSING LINES
5 SURGE BLEED VALVE
6 SHUTOFF VALVE ELECTRICAL CONNECTION
7 SHUTOFF VALVE SWITCHER ASSEMBLY
8 SHUTOFF VALVE ACTUATOR
9 SHUTOFF VALVE
10 VARIABLE AREA NOZZLE LINKAGE
11 TURBINE TORUS
12 HOISTING EYE
13 SHUTOFF VALVE CONTROL AIR LINE
14 AIR FLOW CONTROLLER AND SPEED TOPPING CONTROL
15 DELETED
16 COMPRESSOR SCROLL
17 OVERSPEED SWITCH ELECTRICAL CONNECTION
18 MANUAL RESET PLUNGER
19 ANTI-ICING PASSAGE INLET
20 INLET STRUT
21 GROUND START ELECTROMAGNETIC VALVE - MODE CONTROL
22 MAIN ELECTRICAL CONNECTOR
23 OIL SUMP VENT
24 COMPRESSOR OUTLET DUCT
25 OIL FILLER NECK
26 TACHOMETER GENERATOR ELECTRICAL CONNECTION
27 SURGE BLEED CONTROL
28 SHUTOFF VALVE FILTERS

Turbocompressor Component Location
Figure 3 (Sheet 1 of 2)

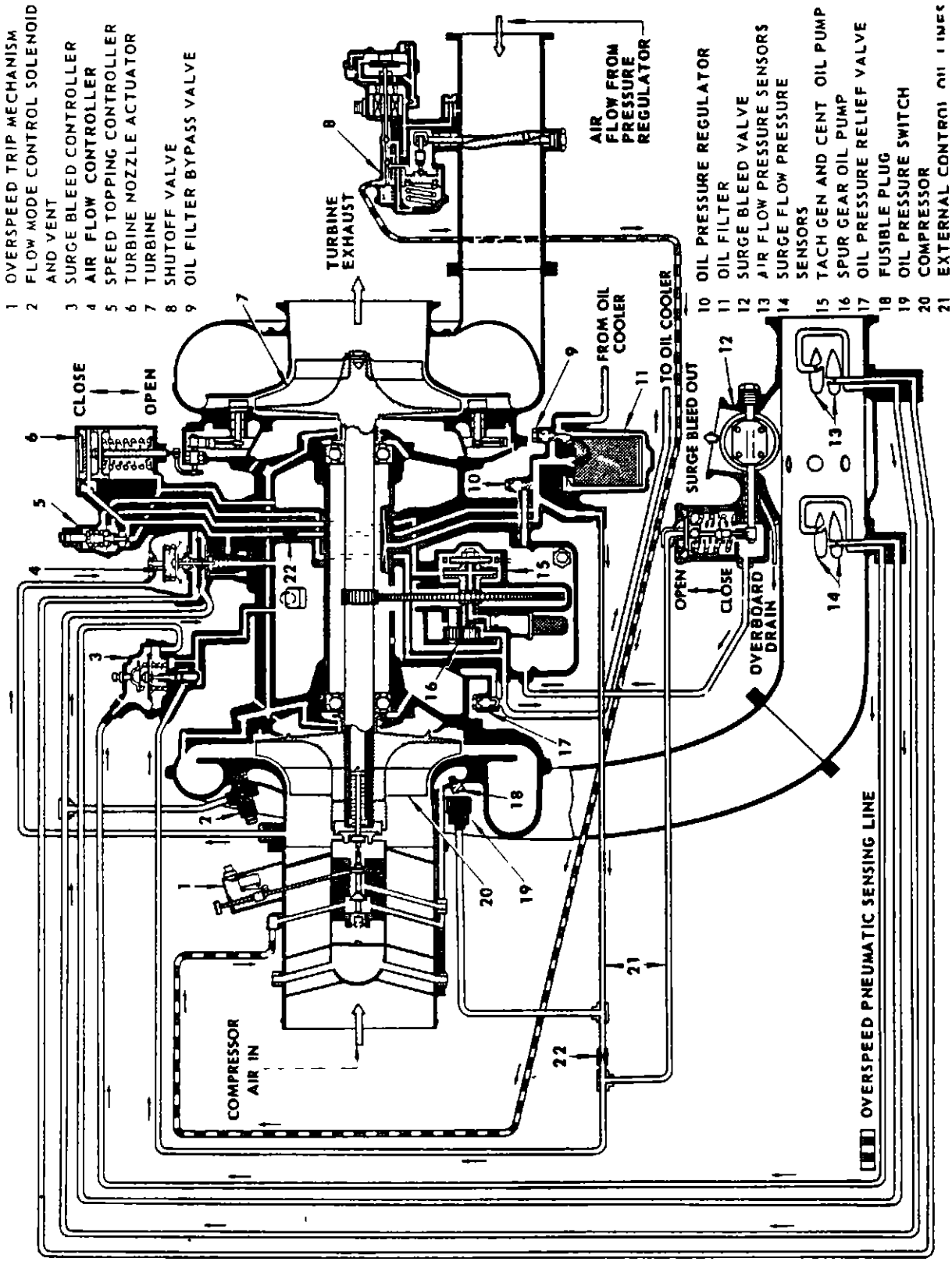


29 OVERSPEED SWITCH
30 VARIABLE-AREA NOZZLE HYDRAULIC ACTUATOR
31 SHUTOFF VALVE
32 SHUTOFF VALVE SWITCHER ASSEMBLY
33 SURGE VALVE ACTUATOR
34 SURGE BLEED VALVE
35 TURBOCOMPRESSOR MOUNTING LUG
36 OIL DRAIN PLUG
37 OIL SUMP
38 OIL COOLER CONNECTION - "OUT"
39 OIL FILTER ASSEMBLY
40 OIL COOLER CONNECTION "IN"
41 GROUND CHECK OIL PRESSURE GAGE CONNECTION
42 MINIMUM OIL PRESSURE SWITCH

Turbocompressor Component Location
Figure 3 (Sheet 2 of 2)

D. An overspeed shutoff mechanism in the compressor inlet duct serves to shut the turbocompressor down at an overspeed trip setting of 55,500 (± 1500) rpm (See figure 5.) The mechanism is essentially a spring-loaded, overspeed trip poppet valve. Mounted on top of the compressor inlet duct is a spring-loaded manual reset plunger which locks out the poppet valve and actuates an overspeed switch. The overspeed switch, in turn, energizes the closing circuit of the turbine pressure regulator and the shutoff valve. The overspeed shutoff mechanism operates to prevent overspeeding of the turbocompressor in the event of failure of the normal operating controls A flyweight device on the end of the compressor shaft contacts and opens the poppet valve when the speed of the turbocompressor reaches 55,500 (± 1500) rpm. When the poppet valve opens, the manual reset plunger is released to lock the poppet valve in the open position and close the overspeed switch When the poppet valve opens, it releases the control air pressure on the high-pressure side of a spring-loaded piston in an overspeed shutoff actuator (See figure 7) This actuator then moves a pneumatic switcher in the shutoff valve assembly to direct control air to close the shutoff valve Releasing control air pressure to the overspeed shutoff actuator in the turbine shutoff valve, as well as closing the overspeed switch to energize the closing circuit of the shutoff valve and turbine pressure regulator, ensures turbocompressor shutdown A shutoff mechanism support strut in the compressor inlet is provided with a passage through which engine bleed air is permitted to pass when heat is required for anti-icing purposes Anti-icing of the inlet strut is controlled in conjunction with the engine anti-icing system

E. The surge bleed control on the right side of the turbocompressor senses excessive momentary back pressure or pressure waves in the compressor outlet duct which could cause irregular operation of the turbocompressor. To prevent this irregular operation or surging of the turbocompressor, the surge bleed control causes a butterfly in a compressor surge valve to open. When the butterfly valve opens, sufficient air is discharged to atmosphere to relieve the back pressure and prevent buildup of a compressor surge condition. The surge bleed control consists of a pneumatic chamber divided by a spring-loaded diaphragm which actuates a hydraulic bleed valve. (See figure 4) The hydraulic bleed valve consists of a hydraulic piston contained in a cylinder. Air pressure sensing lines connect the upper and lower portions of the pneumatic chamber respectively to high and low static air pressure sensing probes in the compressor outlet duct. An oil bypass line from the surge valve actuator control oil pressure supply line is connected to the hydraulic cylinder. A return oil passage leading from the bottom of the cylinder returns bleed oil to the turbocompressor oil sump. Normally, the hydraulic bleed valve of the surge bleed control is closed and control

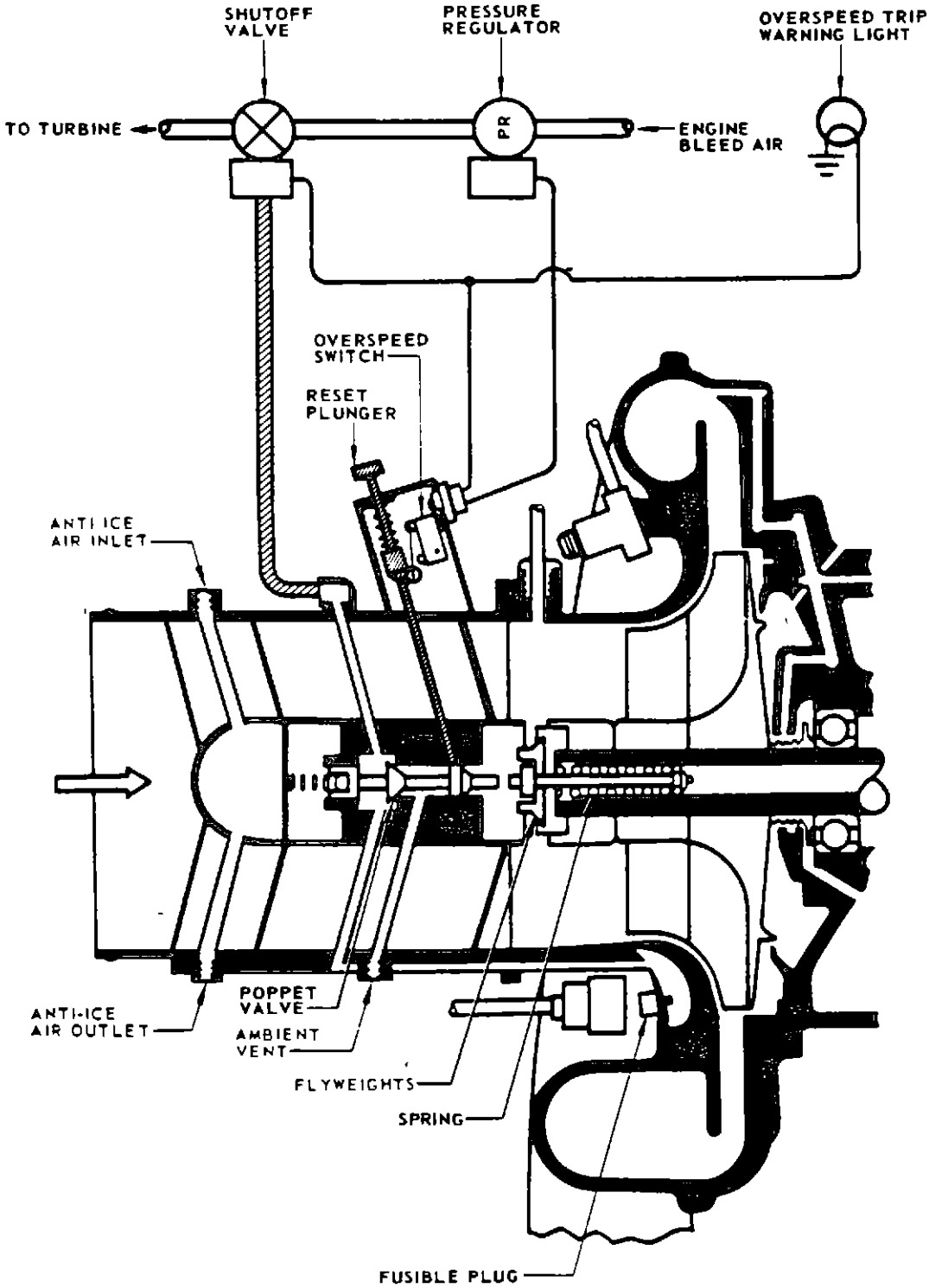


Turbocompressor Control System Schematic
Figure 4

oil pressure, acting on a spring-loaded hydraulic piston actuator in the surge valve, keeps the surge valve butterfly closed. With the butterfly valve held closed, there is no pressure discharge to atmosphere and full compressor air flow is ducted to the wing leading edge pneumatic manifold. When a surge condition exists in the outlet duct, the low static air pressure probe senses the rapid rise in pressure. At the same time, the high static air pressure probe senses a much smaller increase in pressure This pressure differential, applied across the surge bleed control diaphragm, overcomes the diaphragm spring pressure and opens the bleed valve. When the bleed valve opens, control oil pressure in the surge valve oil bypass line is decreased This decrease in pressure allows the spring in the surge valve piston actuator to push the piston up and open the butterfly valve When the butterfly valve opens, compressor air is discharged to atmosphere in an amount necessary to relieve the surge condition A restrictor in the control oil pressure supply line to the surge valve permits rapid response of the surge valve to pressure decreases in the surge bleed control oil pressure bypass line.

F. The surge valve, in the compressor outlet duct, consists of a housing containing a butterfly valve, a spring-loaded hydraulic piston actuator and an oil leakage drain (See figure 4) A control oil pressure line is connected to the top of the actuator cylinder A return oil line connects the bottom of the actuator cylinder to the turbocompressor oil sump When the surge valve opens, under the influence of the surge bleed control, compressor air is ducted to atmosphere through an outlet in the engine top fairing

G The shutoff valve, in the turbine inlet duct, controls the flow of engine bleed air to the turbine. This valve consists of a housing containing a butterfly valve which is linked to a spring-loaded, pneumatically-actuated piston. (See figure 7) A three-way system of pneumatic chambers provides pneumatic switching to the piston chamber The center chamber contains a switcher consisting of a double-ball rod. This rod is connected to, and follows the movements of, an air switching diaphragm A latching solenoid assembly, containing two spring-loaded solenoid-operated pilot valves and two permanent magnets, holds the diaphragm in either the open or close positions An inlet overpressure valve provides protection against overpressurization of the turbine by causing the diaphragm to reposition the double-ball rod air switcher which closes the butterfly valve On the opposite end of the double ball rod is a spring-loaded piston contained in a cylinder One side of the cylinder is connected to the air chamber which is sealed by the overspeed trip poppet valve, the other side is vented to atmosphere Two filter assemblies are installed in the engine bleed control air inlet to the valve assembly



Turbocompressor Overspeed Trip Control
Figure 5

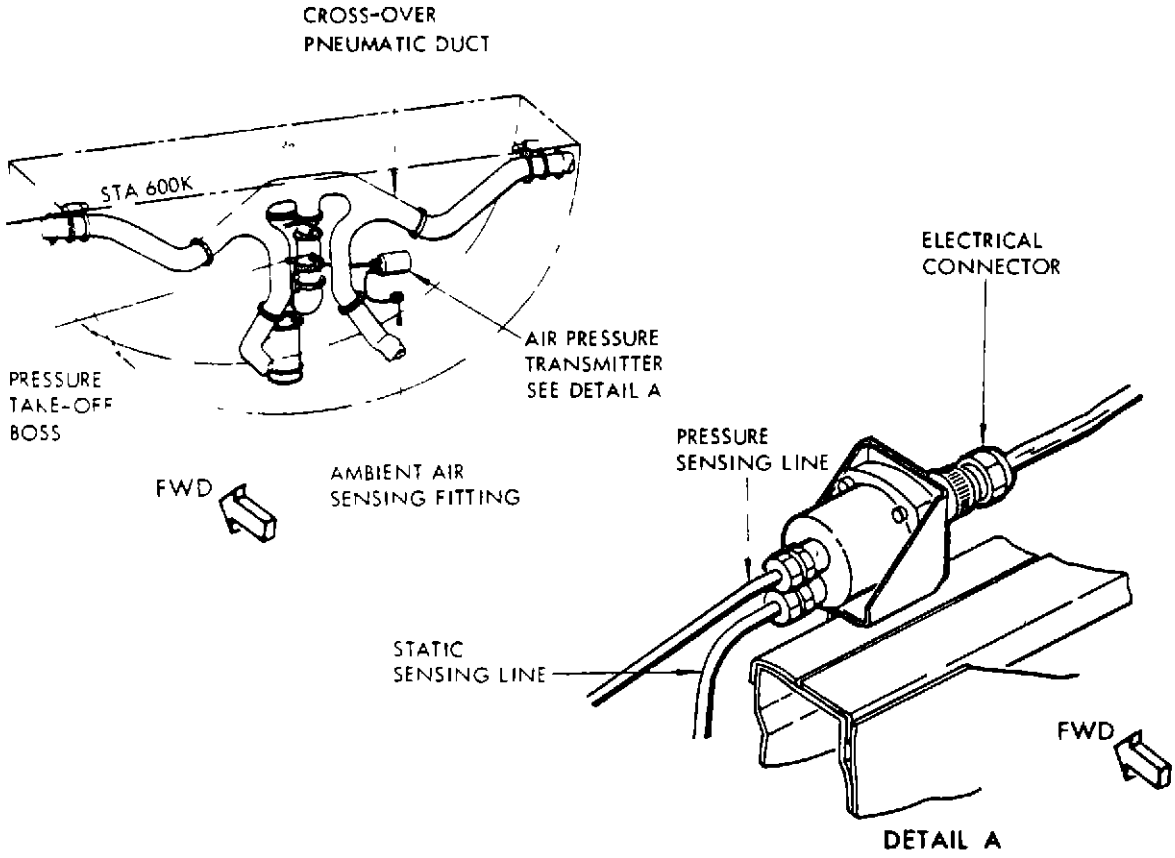
H. The differential pressure regulator, in the turbine inlet duct upstream from the shutoff valve, regulates the engine bleed air pressure to the turbine to a maximum value of 76 (± 6) psig. This valve consists of a housing containing a butterfly valve which is linked to a spring-loaded, pneumatically-actuated piston. (See figure 8.) A solenoid-operated, double-ball rod provides pneumatic switching to the piston chamber. The solenoid assembly is latched by means of two permanent magnets. A sensing selector, consisting of a housing containing a spring-loaded normally-closed metering valve, senses the downstream pressure in the turbine inlet duct. A reference pressure regulator, consisting of a housing containing a spring-loaded normally-open metering valve, regulates the pressure to the pneumatic switcher A spring-loaded ball type relief valve is located on top of the actuator piston chamber. A filter assembly is installed in the differential pressure regulator housing at the engine bleed air inlet to the regulator assembly

4 Turbocompressor Indicating and Warning Systems

A. The tachometer, which indicates turbocompressor speed in percent of maximum rpm, receives its electrical signal from a permanent magnet a-c generator driven as part of the oil pump assembly (See figure 9.)

B The air pressure gage located on the flight engineer's upper panel indicates pressure differential between the high pressure manifold pressure and ambient The gage is operated by a pressure sensitive electrical transmitter located in the air conditioning bay The system is used to monitor engine starting and for checking integrity of the high pressure ducts (See figure 6.)

C A low oil pressure warning light is located on the flight engineer's panel This light also indicates that the turbocompressor is not running. With power on the airplane a circuit is completed through a low oil pressure switch to the low oil pressure light whether the turbocompressor has been started or not When the turbocompressor is started oil pressure will build up to running pressure and will open the low oil pressure switch thus causing the light to go out The low oil pressure switch is located in the control oil pressure line The light is on any time the oil pressure is below 55 ± 10 psig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PNEUMATIC DUCT
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PRESSURE
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CONNECTOR
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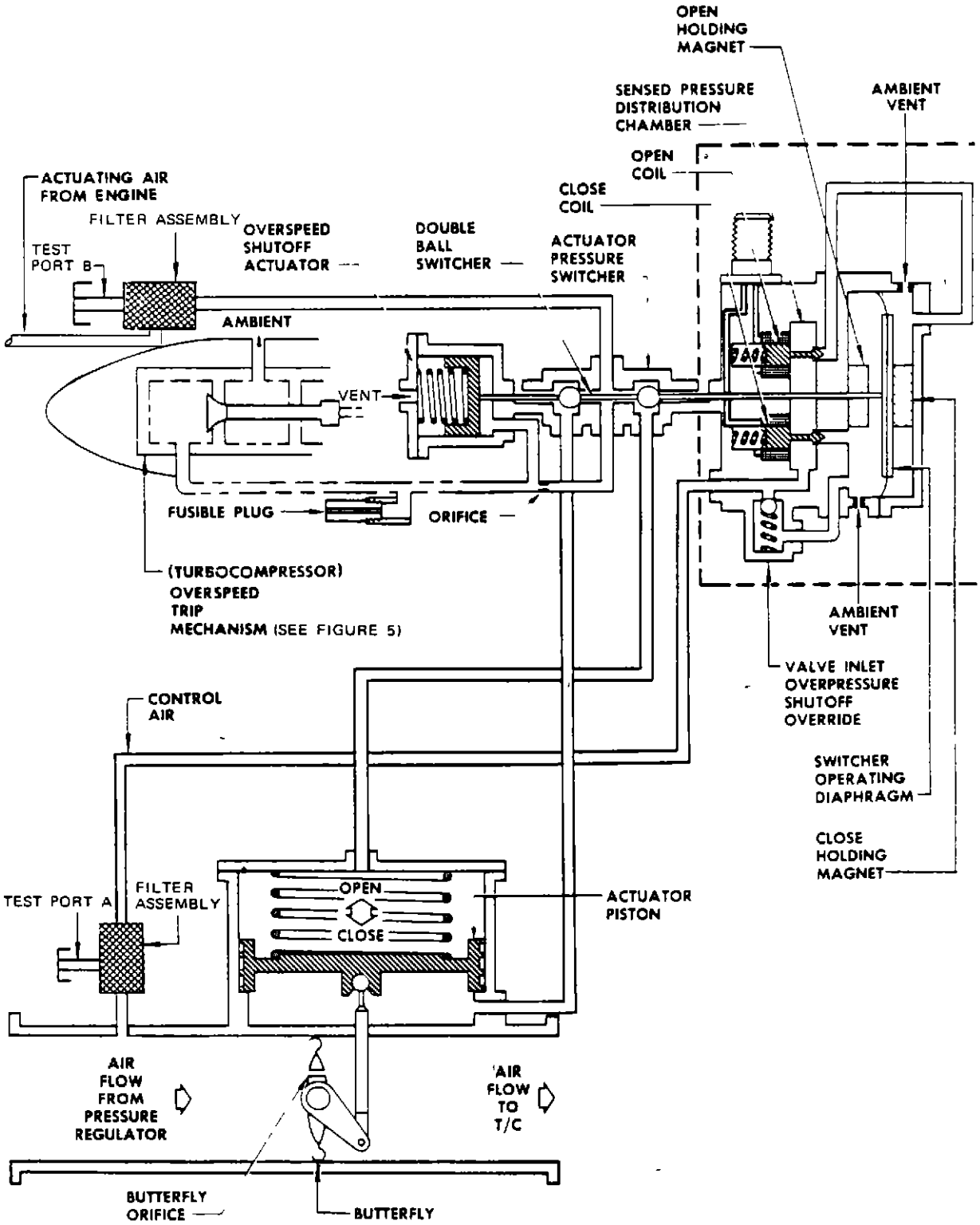


Turbocompressor Shutoff Valve Schematic
Figure 7

D. The overspeed trip warning light illuminates when the overspeed trip mechanism is actuated The overspeed switch, operated by the reset plunger, closes the circuit to the warning light. Power to the circuit is controlled by the turbocompressor "START-STOP" switch (See figure 9.)

5. Turbocompressor Oil System

A. Oil is directed, under pressure, from the spur gear pump to an external oil cooler. From the oil cooler, the oil is returned to the filter and then discharged to the various control lines and the turbocompressor bearing carrier Oil directed to the bearing carrier is discharged through spray jets against a spacer, oil pump gear drive and the shaft bearings. The oil passes through the bearings with the assistance of oil slinger rings and is then drained back into the sump through return oil passages. (See figure 4.)

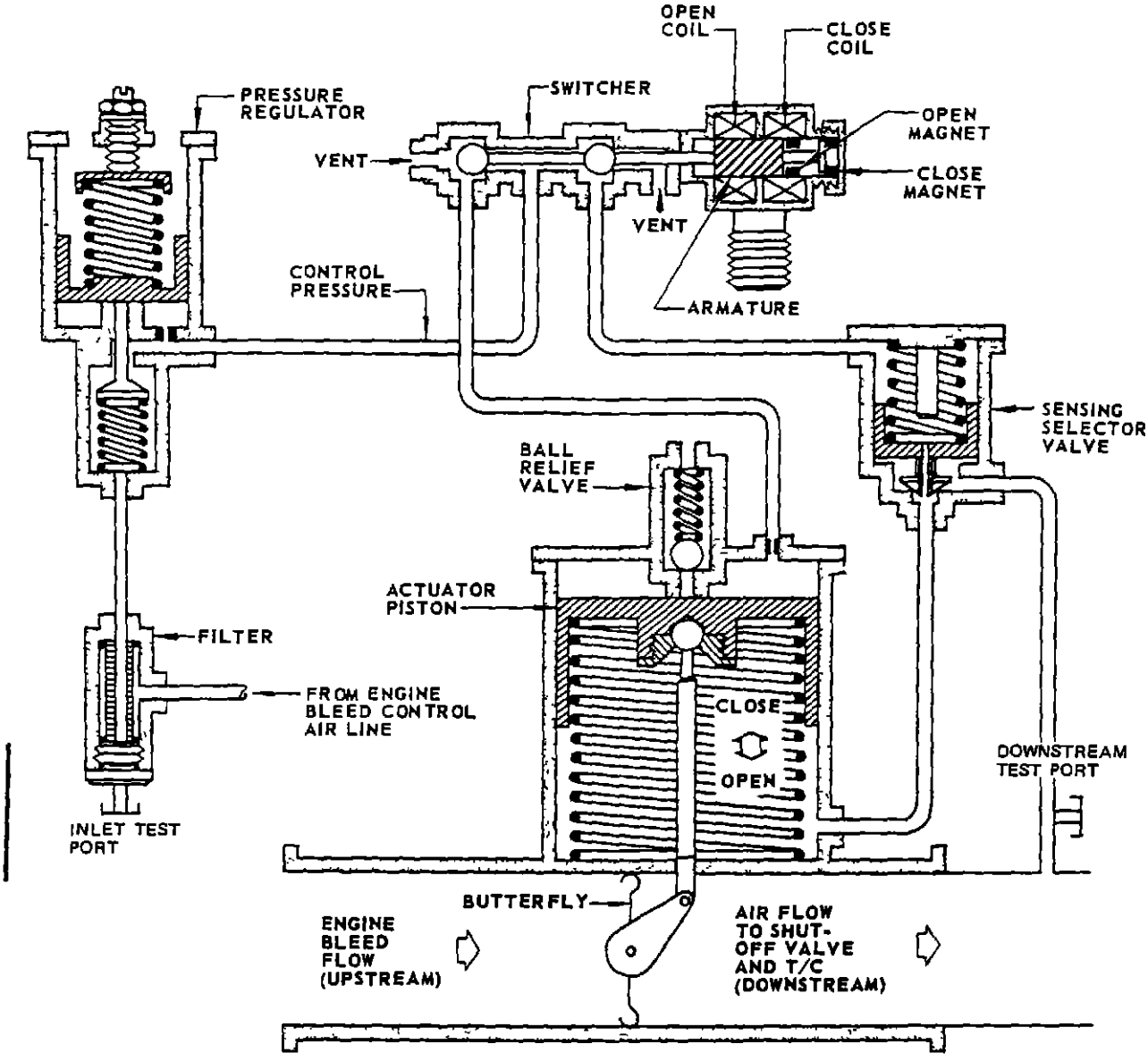
B An oil pressure regulator, located on top of the filter assembly, regulates the oil pressure to approximately 100 psig A pressure relief valve, located downstream of the spur gear oil pump outlet port, is set at 300 psig. This relief valve protects the oil system against excessive pressures during cold weather starts. An oil filter bypass valve, located at the inlet to the filter, will open if the pressure drop across the filter is greater than 20 psi.

6 Pneumatic System Valves

A. The check valve in the outlet duct from each turbocompressor is a 3-inch swing check valve The valve is placed upstream of the low pressure pneumatic duct takeoff to the engine starter This ensures that full air flow is directed to the engine starter, as required, and prevents any reverse air flow from entering the turbocompressor (See figure 2.)

B. The pneumatic duct and wing thermal anti-ice duct air shutoff valves, at each of engines 1, 2, 3 and 4, are 2-1/2 inch motor-operated butterfly valves. The valve motors operate on 115-volt, alternating current and are controlled by toggle switches on the flight engineer's and pilots' overhead panels (See figures 2 and 10.)

C. The wing isolation valves in the air conditioning distribution bay are 6-inch, motor-operated, butterfly valves The valve motors operate on 115-volt, alternating current and are controlled by toggle switches on the flight engineer's panel (See figures 2 and 11.)



Differential Pressure Regulator Schematic
Figure 8

D. The swing check valve outboard of each wing isolation valve in the air conditioning distribution bay is a 0.4-inch diameter valve. If the pressure differential between the wing pneumatic manifold and the air conditioning distribution bay exceeds 4 inches of water, the valve will open and permit flow to the manifold to balance the pressure. (See figure 2.)

E. The ground air connection check valve in the ground service connector is a 3-inch double-gate swing check valve which prevents reverse flow through the ground connector. (See figure 2.)

7. Pneumatic Ducts

A. The pneumatic system ducts are manufactured from corrosion resistant steel tubing. Expansion bellows, used between duct sections in the wing leading edge, are manufactured from stainless steel. The duct sections, in general, are coupled together by duct coupling clamps and supported by strap clamps attached to structure.

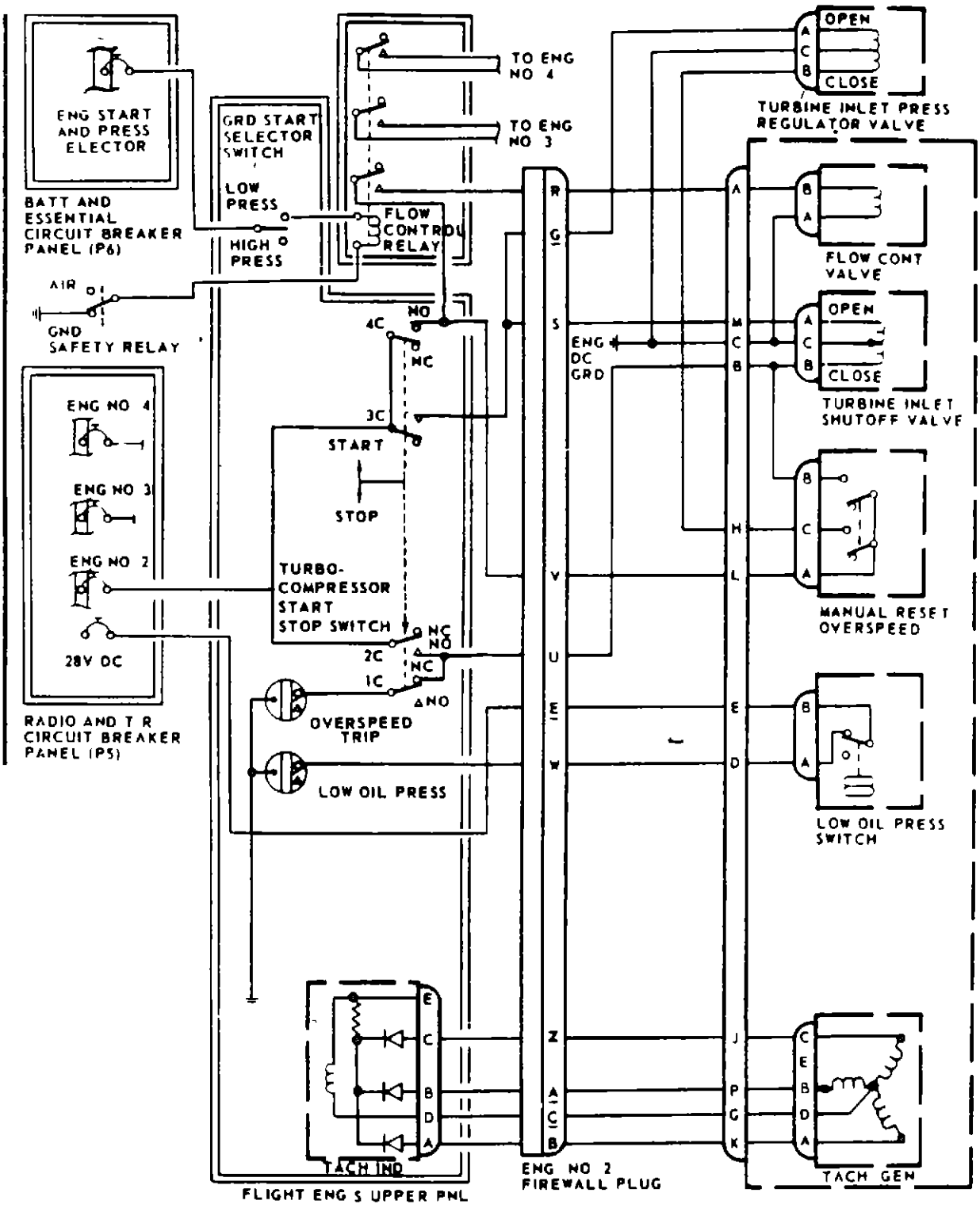
8. Pneumatic Ground Service Connector

A. The pneumatic ground service connector is located on the lower right side of the fuselage in the wing leading edge area. The connector is bolted to a mounting pan covered by an access door. The access door is hinged at the bottom and secured by a single quick-release latch.

9. Turbocompressor Operation

A. When the turbocompressor "START-STOP" switch is moved to the "START" position, and released, power is supplied to the overspeed switch and to the turbocompressor flow control valve when the flow control relay is energized. At the same time, a momentary contact directs power to energize the opening circuit of the latch type solenoid assembly in the differential pressure regulator and shutoff valve assemblies. (See figure 9.)

B. When the opening circuit to the differential pressure regulator is momentarily energized, the switcher is positioned to direct control air to the top of the actuator piston and vent the spring-loaded side to atmosphere. The permanent magnets, in the solenoid assembly, hold the switcher in this position when the solenoid is de-energized. Control air, supplied by engine bleed, is delivered to the switcher through a filter and the reference pressure regulator. This air passes through the switcher to the top of the piston chamber and pushes the piston down to open the butterfly valve. Air from the spring-loaded side of the piston is vented to atmosphere through the sensing selector valve and the switcher. (See figure 8.)



NOTE TOGGLE IS MOMENTARY IN START AND STOP POSITIONS BASIC SWITCHES ARE RELAXED WITH TOGGLE IN CENTER POSITION EXCEPT SWITCH 4 COM WHICH IS SWITCHED AS FOLLOWS NC TO COM MADE IF TOGGLE LAST MOVED TO STOP POSITION NO TO COM MADE IF TOGGLE LAST MOVED TO START POSITION

Turbocompressor Control Circuits
Figure 9

C The reference pressure regulator regulates the control pressure to the switcher This limits the inlet air pressure to the turbine to 76 (± 6) psig. The downstream sensing selector valve opens at a predetermined value and allows downstream air pressure to be sensed on the spring-loaded side of the actuator piston Sensing the downstream air pressure gives a modulating action to the butterfly (See figure 8.)

D. If the closing circuit of the normally-open differential pressure regulator is energized, through actuation of the overspeed control, the switcher is positioned to direct control air pressure through the sensing selector to the spring-loaded side of the actuator piston and vent the opposite side of the piston to atmosphere This action closes the butterfly valve (See figure 8)

E When the opening circuit to the shutoff valve assembly is momentarily energized, the open pilot valve is momentarily unseated Control air, supplied by engine bleed, passes through the inlet air filters and the switcher to the pressure distribution chamber Air from the distribution chamber passes through the momentarily unseated open pilot valve and moves the switcher operating diaphragm toward the open holding magnet This action moves the switcher to direct control air to the bottom of the piston chamber to push the piston up and open the butterfly valve Air from the spring-loaded side of the piston is vented to atmosphere through the switcher (See figure 7)

F When the closing circuit to the shutoff valve assembly is energized, the close pilot valve is momentarily unseated The control air in the distribution chamber passes through the momentarily unseated close pilot valve and moves the switcher operating diaphragm toward the close holding magnet This action moves the switcher to direct control air to the spring-loaded side of the piston chamber to close the butterfly valve Air from the bottom of the piston chamber is vented to atmosphere through the switcher The closing circuit of the shutoff valve assembly is energized by moving the "START-STOP" switch to "STOP", or through actuation of the overspeed trip control If control air pressure in the shutoff valve assembly exceeds the specified limit, the inlet overpressure valve will open and admit control air to the closing chamber This moves the switcher operating diaphragm toward the close holding magnet The diaphragm, in turn, moves the switcher to direct control air to the spring-loaded side of the piston chamber to close the butterfly valve Closing the butterfly valve shuts down the turbocompressor which remains shut down until the shutoff valve opening circuit is energized by moving the "START-STOP" switch to the "START" position (See figure 7)

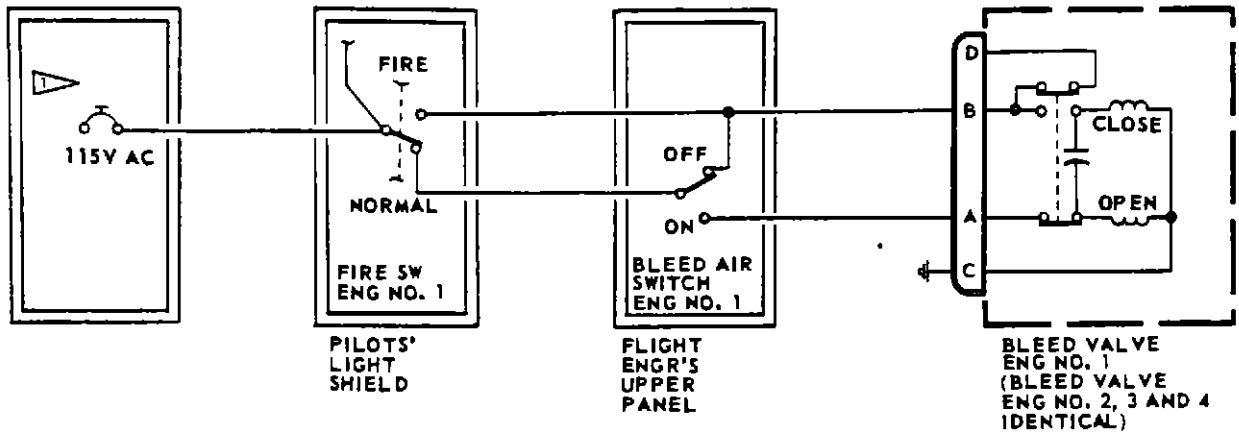
G. When the "START-STOP" switch is moved to the "STOP" position, and released, power is cut off from the overspeed switch and the turbocompressor flow control valve. At the same time, a momentary contact directs power to energize the closing circuit of the shutoff valve assembly. The shutoff valve closes and shuts down the turbocompressor. (See figure 9.)

H The compressor airflow controller and speed-topping control position the turbine variable area nozzle vanes which govern the speed of the turbocompressor assembly. (See figure 4) The ground mode flow control valve, when energized, bleeds the high static air pressure line which runs from the pressure sensing probe to the airflow controller. The resultant pressure differential across the flow control diaphragms regulates the control oil pressure to the hydraulic actuator to open the variable area nozzle vanes This ensures an adequate supply of compressed air for starting the other engines of the aircraft. The high and low pressures from the static air pressure sensing probes establish a pressure differential across one of the flow control diaphragms to lift the hydraulic piston and bleed actuator control oil back to the sump The pressure differentials, sensed through the compressor inlet air sensing line in the inlet duct and the high and low air pressure sensing lines from the downstream static pressure probes, position the hydraulic piston to govern the action of the hydraulic actuator. When compressor discharge airflow drops below the required value, the piston is moved down to close the hydraulic bleed valve and allow the hydraulic actuator to increase the opening of the variable area nozzle vanes. This increase in flow of engine bleed air to the turbine wheel increases the speed of the turbocompressor. When compressor discharge airflow is above the required value, the piston is moved up to open the hydraulic bleed valve and cause the actuator to decrease the opening of the variable area nozzle vanes. This decrease in flow of engine bleed air to the turbine wheel decreases the speed of the turbocompressor. When the speed of the turbocompressor reaches the specified limit of 47,000 (± 1000) rpm, oil pressure created by the centrifugal oil pump opens the hydraulic bleed valve in the speed-topping control. Opening of this bleed valve overrides the action of the flow controller and limits the amount of hydraulic pressure to the hydraulic actuator. This limiting of pressure results in limiting the opening of the variable area nozzle vanes, thus controlling the maximum speed of the turbocompressor

I. The surge bleed control senses a pressure differential from the high and low static air pressure probes in the compressor outlet duct that is proportional to compressor discharge airflow (See figure 4.) Normally, this pressure differential is such that the surge bleed valve

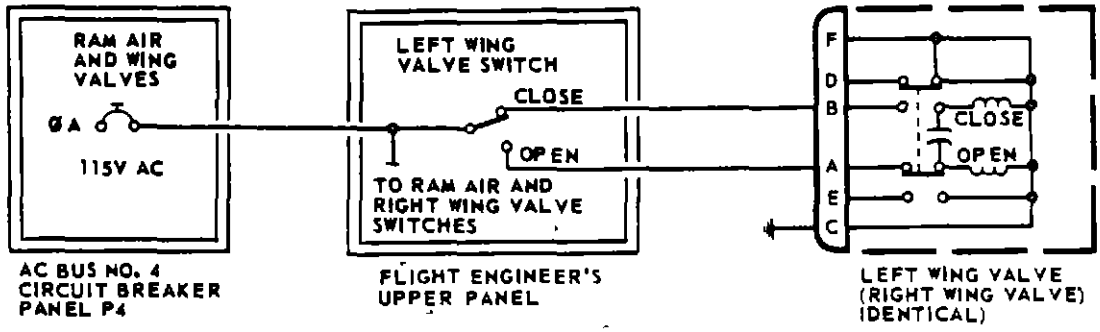
is closed. When the compressor discharge pressure approaches a surge condition, where the discharge air flow pressure rises rapidly and the flow rate is decreased, the pressure differential across the diaphragm of the surge bleed control causes the bleed valve to open With the bleed valve opened, control oil pressure decreases on the high pressure side of the piston in the surge valve actuator and allows the spring-loaded piston to open the butterfly valve When the butterfly valve opens, compressor discharge air is ducted to atmosphere in an amount necessary to relieve the back pressure wave and prevent buildup of a compressor surge condition

J The overspeed shutoff mechanism will operate to prevent overspeeding of the turbocompressor in the event of failure of the normal operating controls (See figures 5 and 7.) The flyweight device on the end of the compressor shaft will contact and open the overspeed trip poppet valve at an overspeed trip setting of 55,500 (± 1500) rpm When this occurs, the manual reset plunger is released to lock the poppet valve in the open position and close the overspeed switch Opening of the overspeed trip poppet valve permits the control air pressure on the high-pressure side of the spring-loaded piston in the overspeed shutoff actuator to escape to atmosphere The overspeed shutoff actuator, under the influence of the actuator piston spring, then moves the pneumatic switcher of the shutoff valve assembly to direct control air to close the shutoff valve Closing of the overspeed switch energizes the closing circuits to the differential pressure regulator valve and the shutoff valve and also completes the circuit to the overspeed trip warning light The manual reset plunger cannot be repositioned in flight If the overspeed shutoff mechanism is inadvertently operated on the ground, the reset plunger must be repositioned before operation of the unit can be resumed If the mechanism has operated as a direct result of turbocompressor overspeed, the turbocompressor assembly must be replaced



1 ØC FROM 115V AC BUS NO. 1 CIRCUIT BREAKER PANEL (P1) FOR ENGINES NO. 1 AND 4
ØB FROM 115V AC BUS NO. 2 CIRCUIT BREAKER PANEL (P2) FOR ENGINES NO. 2 AND 3

Engine Bleed Valve Circuit
Figure 10



Wing Isolation Valve Circuit
Figure 11

PNEUMATIC SYSTEM - TROUBLE SHOOTING

1 General

A Reference to the trouble charts and accompanying text in this section will aid in determining and eliminating the cause of turbocompressor (T/C) malfunction

B Sealed controls on the turbocompressor must not be adjusted by maintenance personnel Any trouble which is traced to a sealed control will necessitate replacement of the complete turbocompressor assembly

C Before starting detailed trouble shooting of a nonoperative or malfunctioning turbocompressor unit, proceed as follows:

(1) Check turbocompressor oil level

(2) Check power supply and visually check external circuitry for damage, loose connectors and possible shorts. If a particular circuit is suspected, carry out continuity tests as detailed under Adjustment/Test

(3) Check plumbing and ducting for damage, looseness or leaks

2 System Trouble Shooting

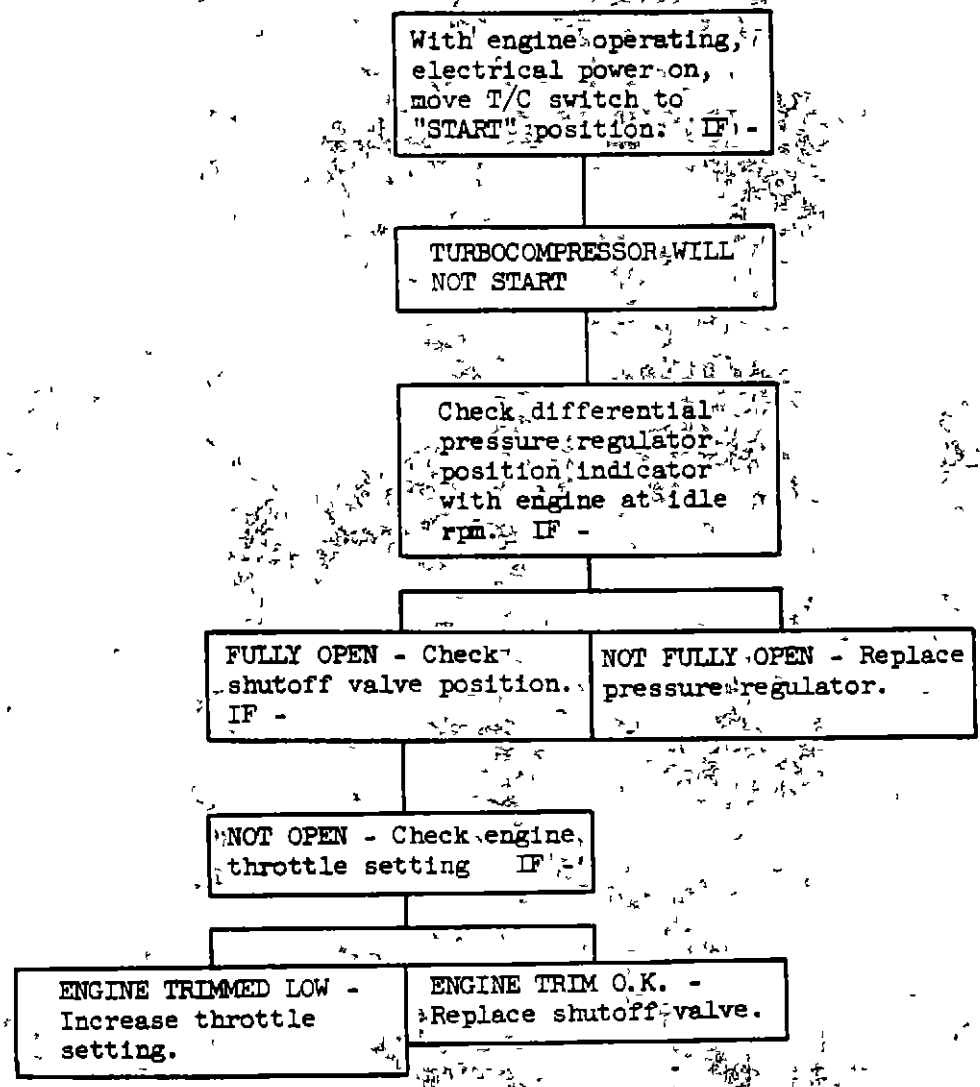
A If there is an indication that the operating turbocompressors are oscillating in phase, this is a symptom of system component failure Check for valve failure in the pneumatic system or component failure in the air conditioning system (See Chapter 21)

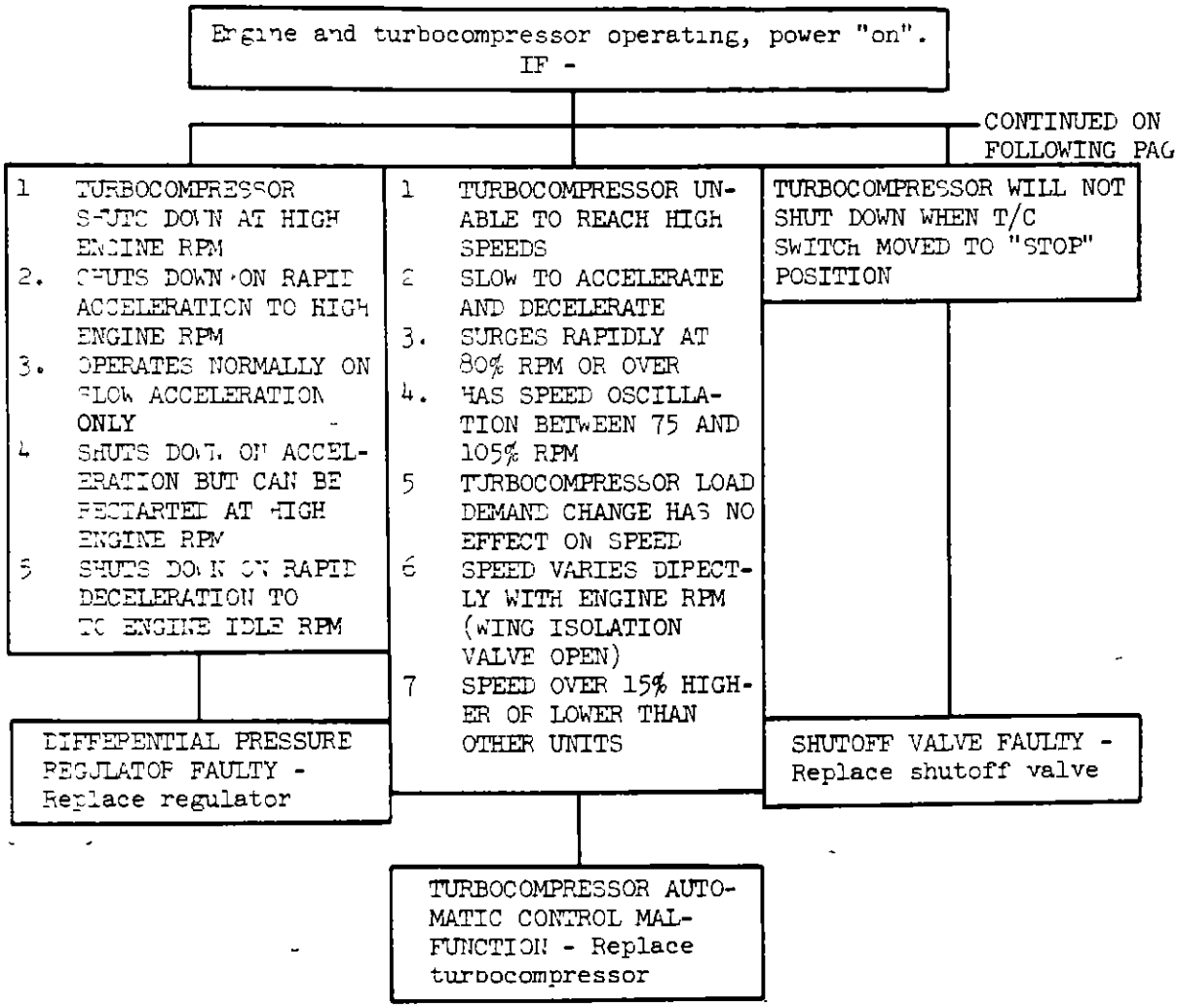
B If, with at least one turbocompressor operating or the alternate air source supplying air to the pneumatic system, a turbocompressor starts and comes up in speed before the START-STOP switch is moved to the START position, this indicates check valve failure The check valve in the turbocompressor discharge ducting has failed and is permitting the turbocompressor to be driven backwards Replace the check valve

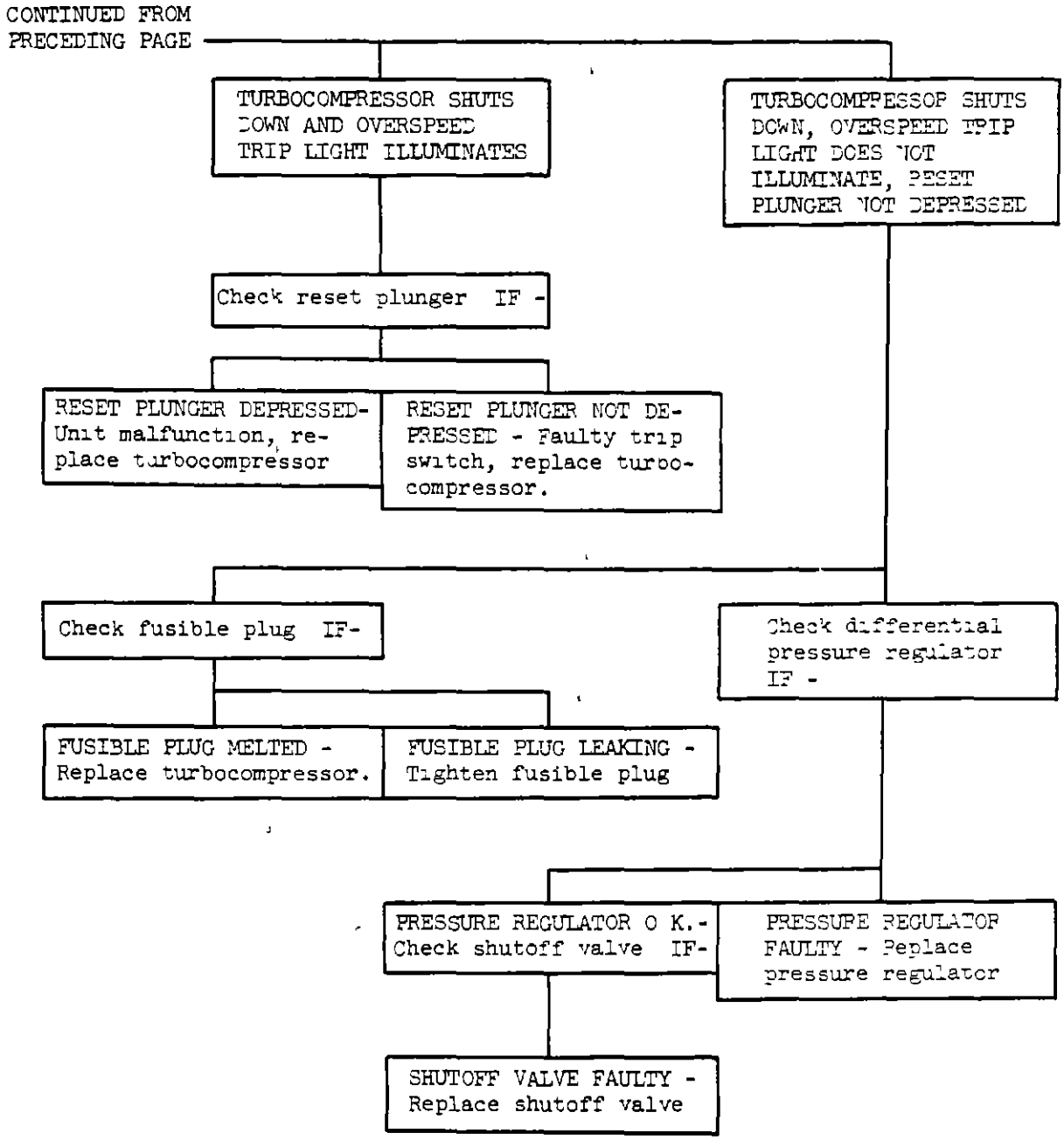
C Test set procedures have been provided to assist in trouble shooting the pneumatic system When a faulty turbocompressor shutoff valve or differential pressure regulator is suspected the applicable test set procedure should be used

(1) The test set procedures provide a method for isolating a component of the turbocompressor through the use of test ports so that a quick check of the component may be made without removing it from the airplane or having the engines running

3. Pneumatic System Trouble Charts




Engine and turbocompressor operating, power "on".
IF -
CONTINUED ON FOLLOWING PAG
1 TURBOCOMPRESSOR SHUTS DOWN AT HIGH ENGINE RPM
2. SHUTS DOWN ON RAPID ACCELERATION TO HIGH ENGINE RPM
3. OPERATES NORMALLY ON SLOW ACCELERATION ONLY
4 SHUTS DOWN ON ACCELERATION BUT CAN BE RESTARTED AT HIGH ENGINE RPM
5 SHUTS DOWN ON RAPID DECELERATION TO TO ENGINE IDLE RPM
DIFFERENTIAL PRESSURE REGULATOR FAULTY - Replace regulator
1 TURBOCOMPRESSOR UNABLE TO REACH HIGH SPEEDS
2 SLOW TO ACCELERATE AND DECELERATE
3. SURGES RAPIDLY AT 80% RPM OR OVER
4. HAS SPEED OSCILLATION BETWEEN 75 AND 105% RPM
5 TURBOCOMPRESSOR LOAD DEMAND CHANGE HAS NO EFFECT ON SPEED
6 SPEED VARIES DIRECTLY WITH ENGINE RPM (WING ISOLATION VALVE OPEN)
7 SPEED OVER 15% HIGHER OR LOWER THAN OTHER UNITS
TURBOCOMPRESSOR AUTOMATIC CONTROL MALFUNCTION - Replace turbocompressor
TURBOCOMPRESSOR WILL NOT SHUT DOWN WHEN T/C SWITCH MOVED TO "STOP" POSITION
SHUTOFF VALVE FAULTY - Replace shutoff valve


CONTINUED FROM PRECEDING PAGE
TURBOCOMPRESSOR SHUTS DOWN AND OVERSPEED TRIP LIGHT ILLUMINATES
TURBOCOMPRESSOR SHUTS DOWN, OVERSPEED TRIP LIGHT DOES NOT ILLUMINATE, RESET PLUNGER NOT DEPRESSED
Check reset plunger IF -
RESET PLUNGER DEPRESSED- Unit malfunction, replace turbocompressor
RESET PLUNGER NOT DEPRESSED - Faulty trip switch, replace turbocompressor.
Check fusible plug IF-
Check differential pressure regulator IF -
FUSIBLE PLUG MELTED - Replace turbocompressor.
FUSIBLE PLUG LEAKING - Tighten fusible plug
PRESSURE REGULATOR O K.- Check shutoff valve IF-
PRESSURE REGULATOR FAULTY - Replace pressure regulator
SHUTOFF VALVE FAULTY - Replace shutoff valve

4 Test Set Procedures

A General

(1) The following test set procedures are written to provide a maintenance level, go/no-go check of the turbocompressor shutoff valve and differential pressure regulator without removing the component from the airplane These checks require that the pneumatic system be unpressurized

B Equipment and Materials

(1) Portable Valve Actuating Test Set, AiResearch Part No 290121-3 or equivalent (See figure 101)

(2) Regulator Assembly, Test Set, AiResearch Part No 290427-1-1 or equivalent (See detail A, figure 101)

C Test Set Procedure No 1 (Turbocompressor Shutoff Valve)

(1) Gain access to turbocompressor shutoff valve by removing top fairing from engine See Chapter 71, Nacelle Forward Fairing

(2) Provide electrical power

(3) Remove shutoff valve filter retaining plug and assembly from TEST PORT A of shutoff valve (See figure 102)

(4) Install 290420-1-1 adapter in TEST PORT A of shutoff valve.

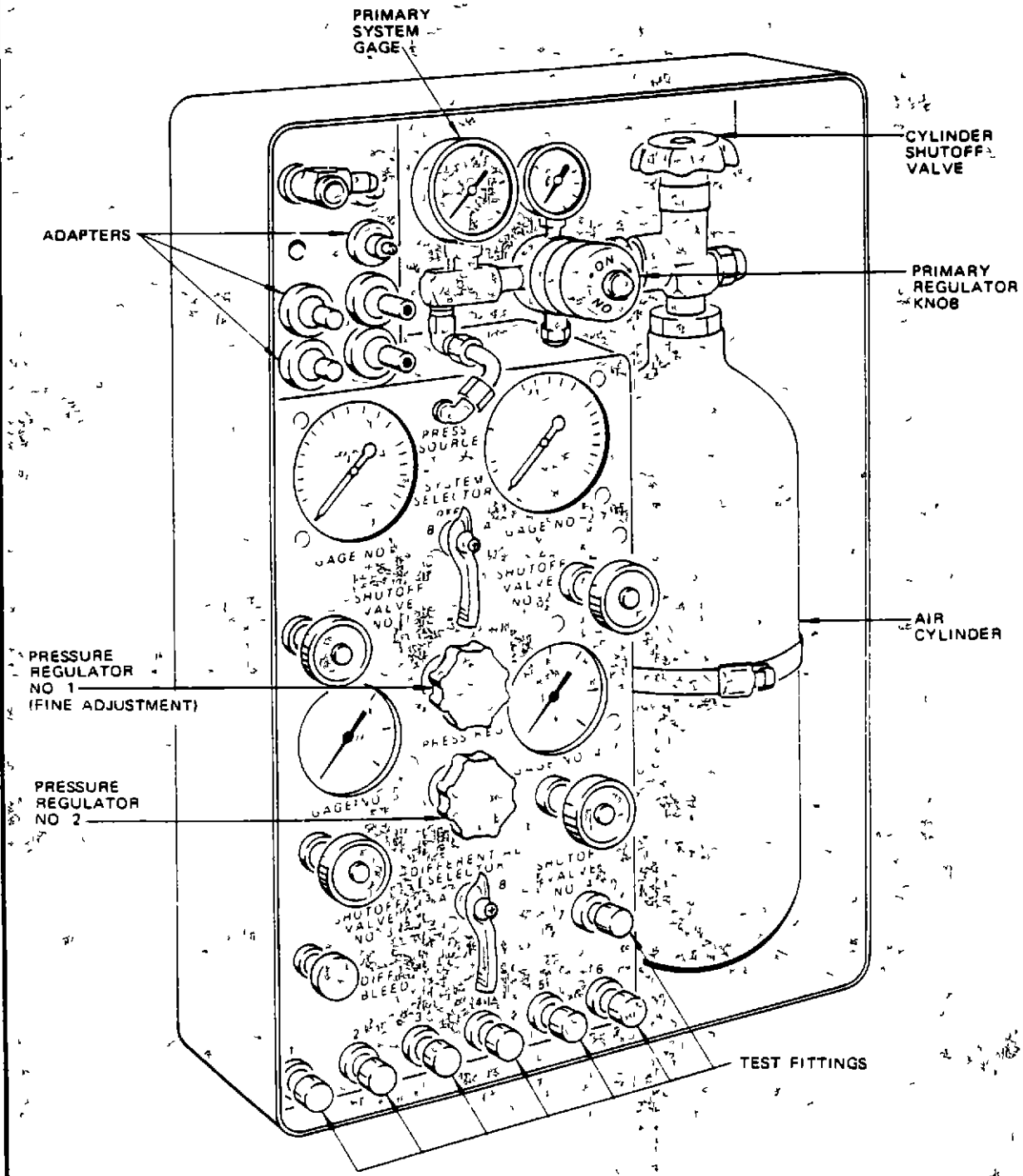
(5) Remove shutoff valve filter plug and assembly from TEST PORT B of shutoff valve

(6) Install 290221-1 adapter in TEST PORT B of shutoff valve

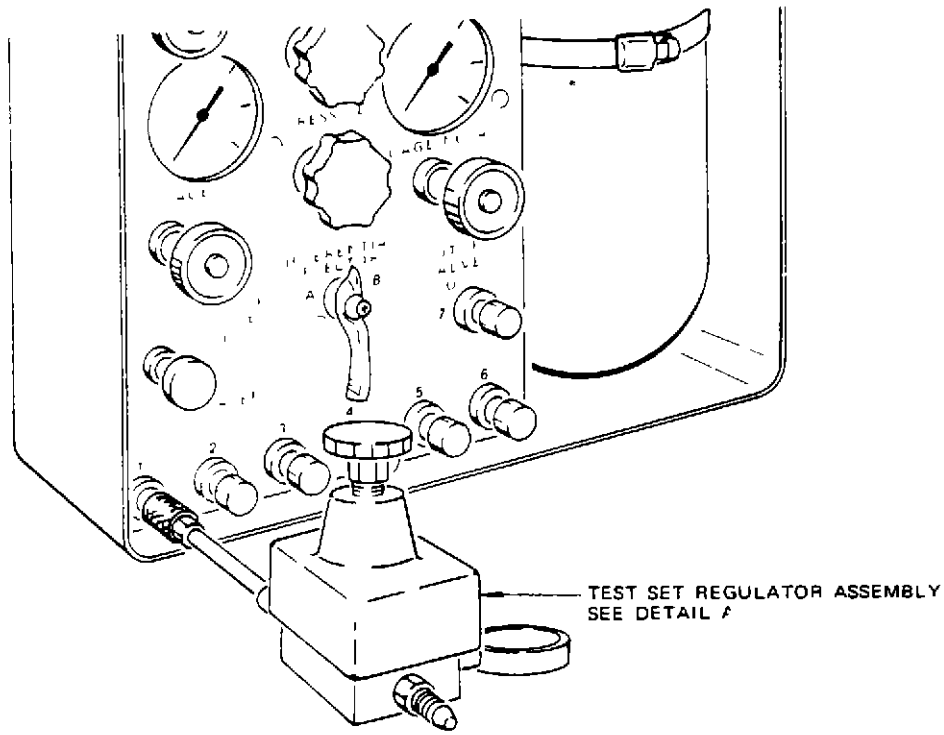
(7) Remove caps from test fittings No 1, and No 6 (See figure 101)

(8) Attach 290427-1-1 test set regulator assembly to test fitting No 1 and install cap on primary port of assembly (See detail A, figure 101)

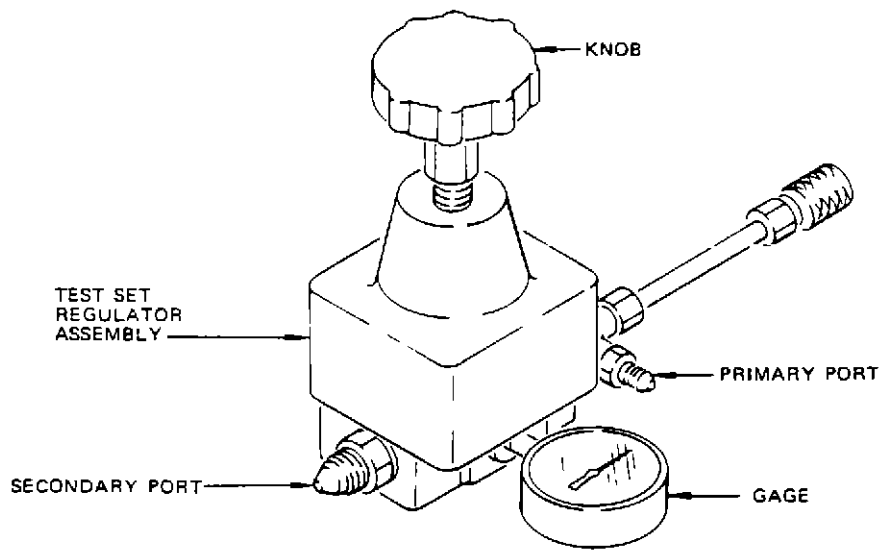
(9) Connect test hose to secondary port of test set regulator assembly and to adapter at TEST PORT B of valve.



Portable Valve Actuating Test Set
Figure 101 (Sheet 1)



VIEW 1



DETAIL A

(10) Connect test hose to test fitting No 6 and to adapter at TEST PORT A of valve

(11) Open test set cylinder shutoff valve

(12) Turn test set primary regulator knob clockwise until a reading of 35 (± 5) psig is obtained on primary system gage

(13) Place SYSTEM SELECTOR valve handle to B.

(14) Open SHUTOFF VALVE No. 2 and No 3.

(15) Turn test set regulator assembly knob clockwise until a reading of 10-11 psig is obtained on regulator assembly gage

(16) Turn pressure regulator No. 1 of portable valve actuating test set clockwise until a reading of 12 2 (± 0 1) inches of mercury is obtained on GAGE No 2.

(17) Electrically energize shutoff valve to the open position by momentarily placing the T/C START-STOP switch to START Check that turbocompressor shutoff valve butterfly is full open by observing the valve position indicator

WARNING. DO NOT RESET (PULL) OVERSPEED TRIP LATCH IF TURBOCOMPRESSOR OVERSPEED HAS OCCURED OPERATING TURBOCOMPRESSOR AFTER AN OVERSPEED COULD CAUSE TURBOCOMPRESSOR FAILURE WITH SUBSEQUENT INJURY TO PERSONNEL

(18) If turbocompressor shutoff valve butterfly does not open due to overspeed trip latch inadvertently pushed down·

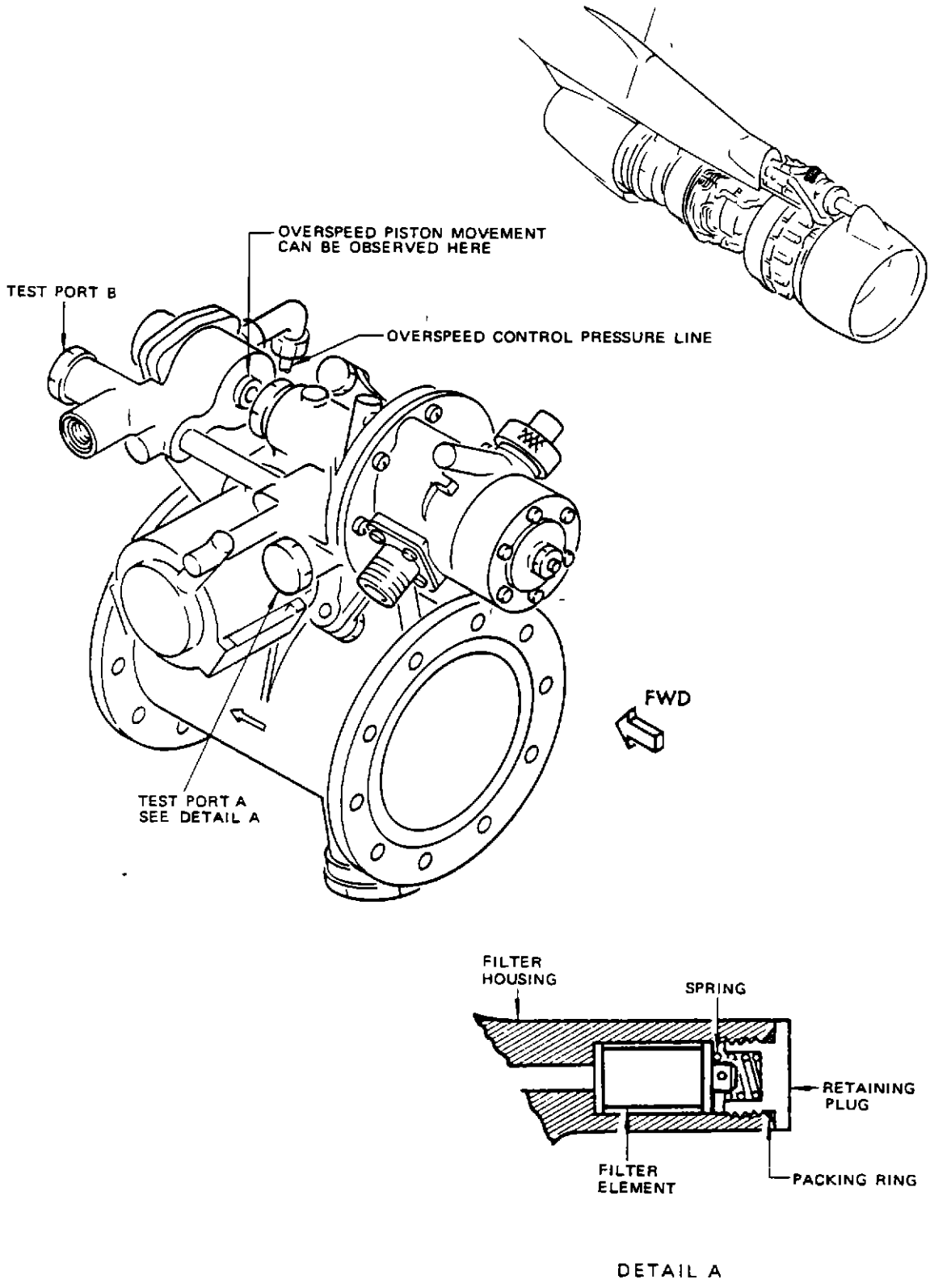
(a) Manually reset turbocompressor overspeed trip latch

(b) Verify valve solenoid is being energized electrically

(c) Disconnect the overspeed control pressure line and install MS21914-6 cap at valve fitting.

NOTE If turbocompressor shutoff valve butterfly is not open at this time, discontinue and replace valve

(19) Rotate SYSTEM SELECTOR valve handle from B to OFF and back to B. Visually check overspeed control piston for freedom of movement (See figure 102.)


OVERSPEED PISTON MOVEMENT CAN BE OBSERVED HERE
TEST PORT B
OVERSPEED CONTROL PRESSURE LINE
FWD
TEST PORT A SEE DETAIL A
FILTER HOUSING
SPRING
RETAINING PLUG
FILTER ELEMENT
PACKING RING
DETAIL A

(20) Place SYSTEM SELECTOR valve-handle to OFF

(21) Disconnect test hoses from secondary port of test set regulator assembly and test fitting No. 6.

(22) Connect test hose from TEST PORT B of shutoff valve to test fitting No 6.

(23) Connect test hose from TEST PORT A of shutoff valve to secondary port of test set regulator assembly

(24) Place SYSTEM SELECTOR valve handle to B.

(25) Turn test set regulator assembly clockwise until a reading of 12-15 psig is obtained on regulator gage

(26) Turn pressure regulator No. 1 clockwise until a reading of 24 inches of mercury is obtained on GAGE No 2

(27) Energize shutoff valve solenoid by actuating the T/C START-STOP switch Check that turbocompressor shutoff valve butterfly is full open

(28) Turn pressure regulator No. 1 counterclockwise until a reading of 12 2 inches of mercury is obtained on GAGE No 2 Check that turbocompressor shutoff valve butterfly is full closed

(29) Turn pressure regulator No. 1 clockwise until a reading of 24 inches of mercury is obtained on GAGE No 2

(30) Energize shutoff valve solenoid by actuating the T/C START-STOP switch Check that turbocompressor shutoff valve butterfly is full open

(31) Turn test set regulator assembly clockwise until it has bottomed

(32) Turn test set primary regulator knob clockwise until a reading of 140 psig (maximum) is obtained on test set regulator assembly gage

NOTE. If required limits in step (32) have been obtained component is satisfactory. If these limits have not been obtained, replace turbocompressor shutoff valve.

(33) Turn primary regulator knob and pressure regulator No 1 counterclockwise until a zero pressure indication is obtained on primary system gage

(34) Turn test set regulator assembly counterclockwise until a zero indication is obtained on regulator assembly gage.

(35) Close SHUTOFF VALVE No. 2 and No 3

(36) Place SYSTEM SELECTOR valve handle to OFF

(37) Disconnect test hoses and stow

(38) Remove adapter from valve TEST PORT A and install filter assembly and plug

(39) Remove adapter from valve TEST PORT B and install filter assembly and plug

(40) Disconnect test set regulator assembly from test fitting No 1

(41) Install caps on test fittings No 1 and No. 6

(42) Remove MS21914-6 cap from valve fitting and connect overspeed control pressure line

(43) Replace top fairing on engine See Chapter 71, Nacelle Forward Fairing

D Test Set Procedure No 2 (Turbocompressor Pressure Regulator)

(1) Gain access to pressure regulator by removing left side engine cowl panel See Chapter 71, Nacelle Forward Fairing

(2) Remove valve filter plug and assembly to create the inlet test port (See figure 103)

(3) Install 290426-1-1 adapter in the inlet test port of pressure regulator

(4) Remove cap from test fitting No 6

(5) Connect test hose to test fitting No 6 and to adapter at inlet test port

(6) Open test set cylinder shutoff valve

(7) Turn test set primary regulator knob clockwise until a reading of 35 (± 5) psig is obtained on primary system gage

(8) Place SYSTEM SELECTOR valve handle to A

(9) Open SHUTOFF VALVE No 2 and No 3.

(10) Turn pressure regulator No 1 clockwise until a reading of 20.4 inches of mercury is obtained on GAGE No 2 Check that pressure regulator butterfly is full open by observing regulator position indicator (See figure 103)

(11) Turn pressure regulator No 1 counterclockwise until a zero indication is obtained on GAGE No. 2

(12) Place SYSTEM SELECTOR valve handle to OFF

(13) Close SHUTOFF VALVE No. 2 and No 3

(14) Remove cap from test fitting No 1

(15) Attach 290427-1-1 test set regulator assembly to test fitting No 1 (See detail A, figure 101)

(16) Disconnect test hose at test fitting No 6 and connect hose to secondary port of test set regulator assembly

(17) Remove pressure regulator test port fitting to create the downstream sensing port

(18) Install 290166 adapter in the downstream sensing port of pressure regulator

(19) Connect a test hose from primary port of test set regulator assembly to adapter in downstream sensing port of pressure regulator

(20) Turn test set primary regulator knob clockwise until a reading of 55 (± 3) psig is obtained on primary system gage

(21) Place SYSTEM SELECTOR valve handle to B

(22) Turn test set regulator assembly knob clockwise until a reading of 45 (± 2) psig is obtained on regulator gage Check that pressure regulator butterfly is full open by observing pressure regulator position indicator

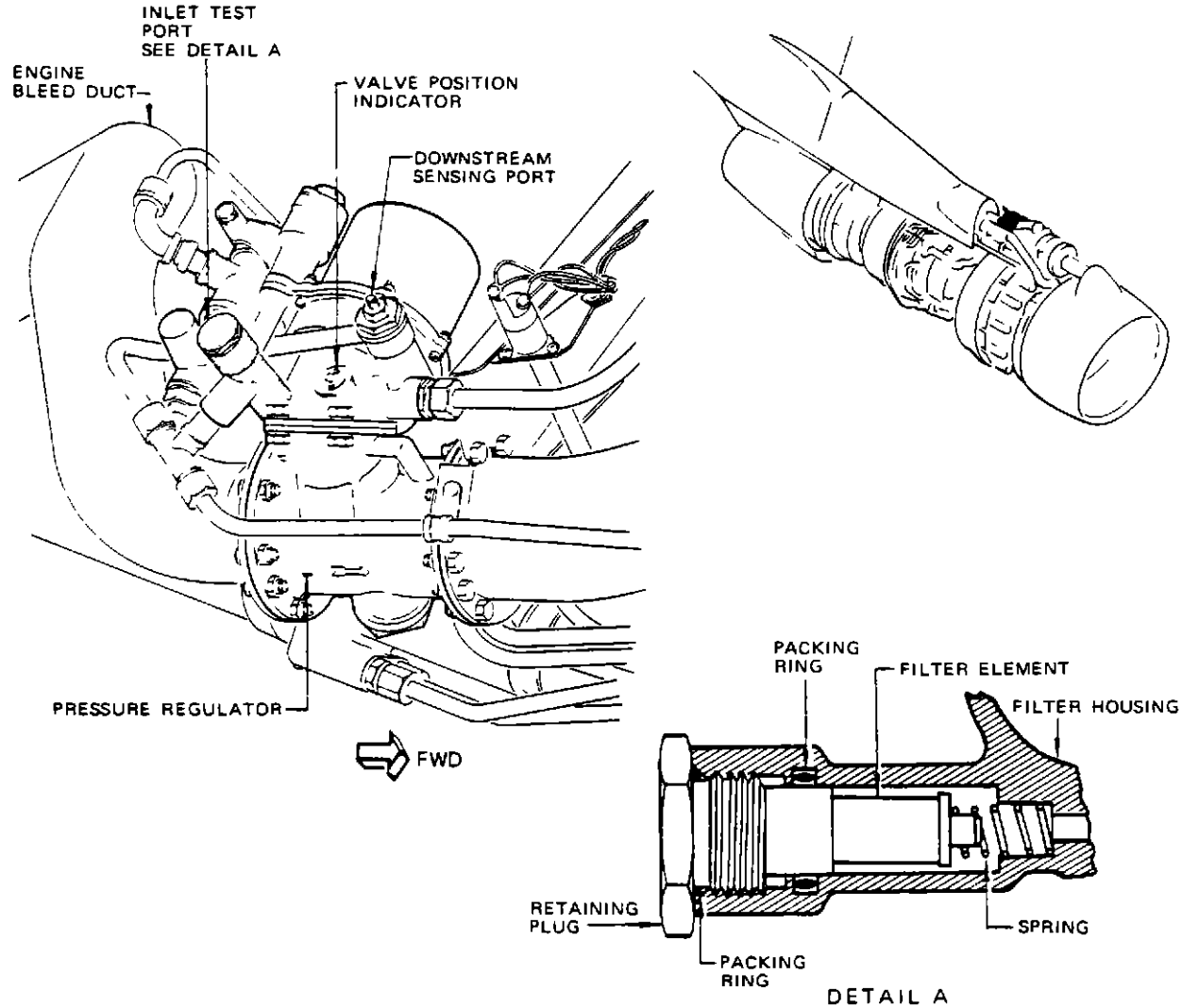
(23) Turn test set primary regulator knob clockwise until a reading of 66 (± 4) psig is obtained on primary system gage. Check that pressure regulator butterfly begins to close by observing pressure regulator position indicator.

NOTE. Check that pressure in step (22) has not increased. Adjust if necessary to correct pressure.

(24) Turn test set primary regulator knob and regulator assembly counterclockwise until a zero indication is obtained on primary system gage and regulator gage.

(25) Disconnect test hoses from the primary and secondary ports of test set regulator assembly.

(26) Connect test hose from the inlet test port of pressure regulator to primary port of test set regulator assembly.



(27) Connect test hose from downstream sensing port of pressure regulator to secondary port of test set regulator assembly.

(28) Turn test set primary regulator knob clockwise until a reading of 100 (± 3) psig is obtained on primary system gage. Check that pressure regulator butterfly is full open by observing pressure regulator position indicator.

(29) Turn test set regulator assembly knob clockwise until a reading of 82 (± 2) psig is obtained on regulator gage. Check that pressure regulator butterfly is full closed by observing pressure regulator position indicator.

(30) Slowly turn test set regulator assembly counterclockwise until a reading of 68 (± 2) psig is obtained on regulator gage. Check that pressure regulator butterfly is full open by observing pressure regulator position indicator.

NOTE. If required limits in steps (29) and (30) have been obtained component is satisfactory. If these limits have not been obtained, replace pressure regulator.

(31) Turn primary regulator knob and regulator assembly counterclockwise until a zero pressure indication is obtained on primary system gage and regulator gage.

(32) Place SYSTEM SELECTOR valve handle to OFF.

(33) Close test set cylinder shutoff valve.

(34) Disconnect test hoses and stow.

(35) Remove adapter from inlet test port and install filter assembly and plug.

(36) Remove adapter from downstream sensing port and install filter assembly and plug.

(37) Disconnect test set regulator assembly from test set fitting No. 1.

(38) Install caps on test fittings No. 1 and No. 6.

(39) Replace engine cowl panel. See Chapter 71, Nacelle Forward Fairing.

PNEUMATIC SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test Pneumatic System

A General

(1) The pneumatic system does not require adjustment Turbocompressor output is automatically adjusted by integral hydraulic and pneumatic control systems which adjust and limit speed by regulating turbine inlet nozzle opening

(2) Testing of the pneumatic system is separated into non-operating tests, operating tests and a duct leakage test

B Test Pneumatic System

(1) Equipment and Materials

(a) External electrical power supply

(b) Test Tachometer Generator and Motor Unit - Wacline 19100 or equivalent

(c) Air source capable of delivering pressures up to 45 psig at an approximate flow rate of 10 pounds per minute

(d) Air flow meter with a minimum flow range of 1.0 to 10 0 pounds per minute

(e) Air connection to mate with aircraft pneumatic ground connection - Roylon Connector 7-643-48 or 7-553-48

(f) Other equipment as required

(2) Perform non-operating tests

(a) Close "TURBOCOMP VALVE & LTS" circuit breakers on circuit breaker panel (P5)

(b) Test tachometer indication circuits

1) Connect motor-driven test tachometer generator to tachometer generator plug at turbocompressor and operate test generator at 9728 (± 100) rpm

2) Check that tachometer indicator reads 97 to 103% rpm and returns to zero without sticking when test generator is stopped.

3) Remove test generator and restore installation.

(c) Deleted

(d) Test oil pressure warning light circuit.

1) Check that "LOW OIL PRESS" warning light is illuminated

2) Move "START-STOP" switch to "STOP" position.

3) Check that corresponding "LOW OIL PRESS" warning light remains illuminated.

(e) Test differential pressure regulator and shutoff valve electrical circuits

1) Move "START-STOP" switch to "START" position.

2) Check that corresponding open coil in differential pressure regulator and shutoff valve is momentarily energized

NOTE. This is determined by listening for an audible click at the shutoff valve assembly The pressure regulator valve is normally open and will not be heard unless 28-volt dc has previously been applied to pin B of the receptacle at the pressure regulator valve

3) Move "START-STOP" switch to "STOP" position

4) Check that corresponding close coil in shutoff valve is momentarily energized

(f) Test overspeed trip warning light circuit

1) Short cable plug pin A to pins B and C at overspeed trip switch on turbocompressor and move START-STOP switch to START position

2) Check that corresponding OVERSPEED TRIP warning light illuminates

3) Check that corresponding close coil in differential pressure regulator and shutoff valve is energized and remains energized until short is removed or START-STOP switch moved to STOP position
When S O V P/N 397794 is installed check only that regulator close solenoid shall become energized

(g) Test flow control valve circuit

1) Hold START-STOP switch in START position

2) Open WATER DRAIN MAST HEATER circuit breaker on panel (P1)

3) Open then close the SAFETY & OIL COOLER RELAYS circuit breaker on radio and T-R circuit breaker panel (P5)

CAUTION FAILURE TO OPEN WATER DRAIN MAST HEATER CIRCUIT BREAKER PRIOR TO OPENING SAFETY AND OIL COOLER RELAYS CIRCUIT BREAKER CAN CAUSE HEATER TO OVERHEAT

4) Check that corresponding flow control valve solenoid is energized when circuit breaker is closed

NOTE This is determined by listening for an audible click at the flow control valve

(3) Perform operating tests

(a) Check turbocompressors for proper lubrication

(b) Operate turbocompressors as required to carry out air conditioning system tests and check that no malfunction or failure occurs
For Air Conditioning System Tests, see Chapter 21

(c) Visually check oil cooler and external oil system components and connections for leakage after turbocompressors have been run For information on turbocompressor oil cooler, see Chapter 36-1-41

(d) Check that LOW OIl PRESS warning light goes out at approximately 30% rpm

(4) Perform duct leakage test

(a) Close ENG 1 & 4 BLEED AIR & OUTBD WING ANTI-ICE VALVES circuit breaker on ac bus No 1 circuit breaker panel (P1) and ENG 2 & 3 BLEED AIR & INBD WING ANTI-ICE VALVES circuit breaker on ac bus No. 2 circuit breaker panel (P2).

(b) Close RAM AIR & WING VALVES, AUTO TEMP CONT, PACK VALVES AUX AIR ACTUATORS, CONTROL CABIN MANUAL TEMP CONTROL and MAIN CABIN MANUAL TEMP CONTROL circuit breakers on ac bus No 4 circuit breaker panel (P4)

(c) Check that ENGINE START CONTROL switches on pilot's overhead panel are positioned to OFF

(d) Check that BLEED AIR switches on flight engineer's upper panel are positioned to OFF.

(e) Check that left and right AIR COND UNIT switches are positioned to OFF.

(f) Select L WING VALVE and R WING VALVE switches to OPEN.

(g) Connect air source to aircraft pneumatic ground connection and apply 45 psig air pressure Check that leakage does not exceed 10 pounds of air per minute

NOTE: When airplane is equipped with part number 65-22777 type turbocompressor check valves, add to the maximum allowable leakage 3 5 pounds per minute for each valve.

(h) Check high pressure gage reading for accuracy (± 1 psi).

(i) Check all joints and connections with pressure applied by feeling and listening. Diffused leakage is allowable at any joint, but jet blasts are not permissible.

NOTE: Leakage past the turbocompressor check valve may cause the turbocompressor to windmill backwards. Although rotation in the reverse direction is not harmful to the turbocompressor, windmilling backwards may cause oil to be pumped from the turbocompressor out the oil sump vent. Inadequate oil supply in the turbocompressor sump may cause turbocompressor damage If oil is noticed coming from the oil sump vent, test should be stopped, oil supply replenished, and check valve replaced.

(j) Disconnect air source and external electrical power.

(k) Check ducts supplying engine bleed air to each turbocompressor visually. Check torques and shake ducts to establish that joints are secure and correctly assembled.

NOTE. With proper torques and shims the ball joints may have diffused leakage at any joint, however jet blasts are not permissible.

TURBOCOMPRESSOR - MAINTENANCE PRACTICES

1. Unit Servicing Turbocompressor

A. General

(1) Servicing of turbocompressor is confined to replenishing lubricating oil, replacing oil filter element and cleaning air filter elements as required. Lubrication instructions are contained on data plate mounted just below turbocompressor oil fill port. For access to oil fill port, see Chapter 12, "Access Doors and Panels."

B. Fill Turbocompressor Oil Sump

(1) See Chapter 12, "Oil Servicing" for recommended lubricating oils for use in turbocompressor.

(2) Remove dipstick and fill until oil level reaches corresponding full mark on dipstick. "LEFT WING FULL" on left wing installation and "RIGHT WING FULL" on right wing installation.

(3) After filling, operate turbocompressor for several minutes, recheck oil level on dipstick and add oil as necessary.

C. Drain Turbocompressor Oil Sump

(1) Remove lowest magnetic drain plug in sump.

NOTE The drain plug assemblies contain a check valve which, when plug section is removed, permits inspection of magnetic tip of plug for metal particles without loss of oil from sump.

(2) Install flexible drain unit (Tedeco part number D734 or equivalent) in oil drain connection and allow oil to drain from sump.

NOTE If a drain unit is not available, oil may be drained from sump by removing complete drain fitting. This procedure, however, is not recommended.

D Replace Turbocompressor Oil Filter

(1) Unscrew filter housing from housing cap

(2) Remove and discard packing rings and filter element

(3) Clean filter housing.

(4) Place new filter element in filter housing

(5) Place new packing ring on filter and new packing ring on filter housing

(6) Screw filter housing into filter cap

2 Removal/Installation Turbocompressor

A Remove Turbocompressor (See figure 201)

(1) Remove engine top fairing See Chapter 71, "Nacelle Forward Fairing".

(2) Remove lowest oil drain plug and drain turbocompressor oil sump

(3) Reinstall oil drain plug

(4) Disconnect main electrical connector at compressor inlet and tie back clear of unit

(5) Disconnect anti-icing line on top of compressor inlet duct and swing forward clear of inlet

(6) Remove strap clamp from aft end of flexible inlet duct Push flex duct forward and down to clear T/C inlet.

(7) Disconnect "OIL IN" line from cooler at filter Plug and cap open connections

(8) Disconnect "OIL OUT" line to cooler below filter Plug and cap open connections.

(9) Disconnect oil sump vent line Plug and cap open connections.

(10) Disconnect surge valve oil leakage drain at surge valve Plug and cap open connections.

(11) Disconnect clamps securing control air line to brackets at pressure regulator and shutoff valve.

(12) Disconnect control air line at each end of pressure regulator T-connection.

(13) Disconnect control air line at shutoff valve and remove forward section of line.

(14) Remove mounting bolts and bracket from aft shutoff valve flange.

(15) Remove mounting bolts from aft pressure regulator valve flange.

(16) Remove the three bolts attaching pressure regulator to support bracket at forward pressure regulator valve flange and remove pressure regulator and interconnecting duct as an assembly.

(17) Remove gasket at aft flange of pressure regulator and shutoff valve.

(18) Remove clamp at upper end of surge bleed exhaust duct and remove exhaust duct.

(19) Remove V-band clamps at aft end of surge bleed valve.

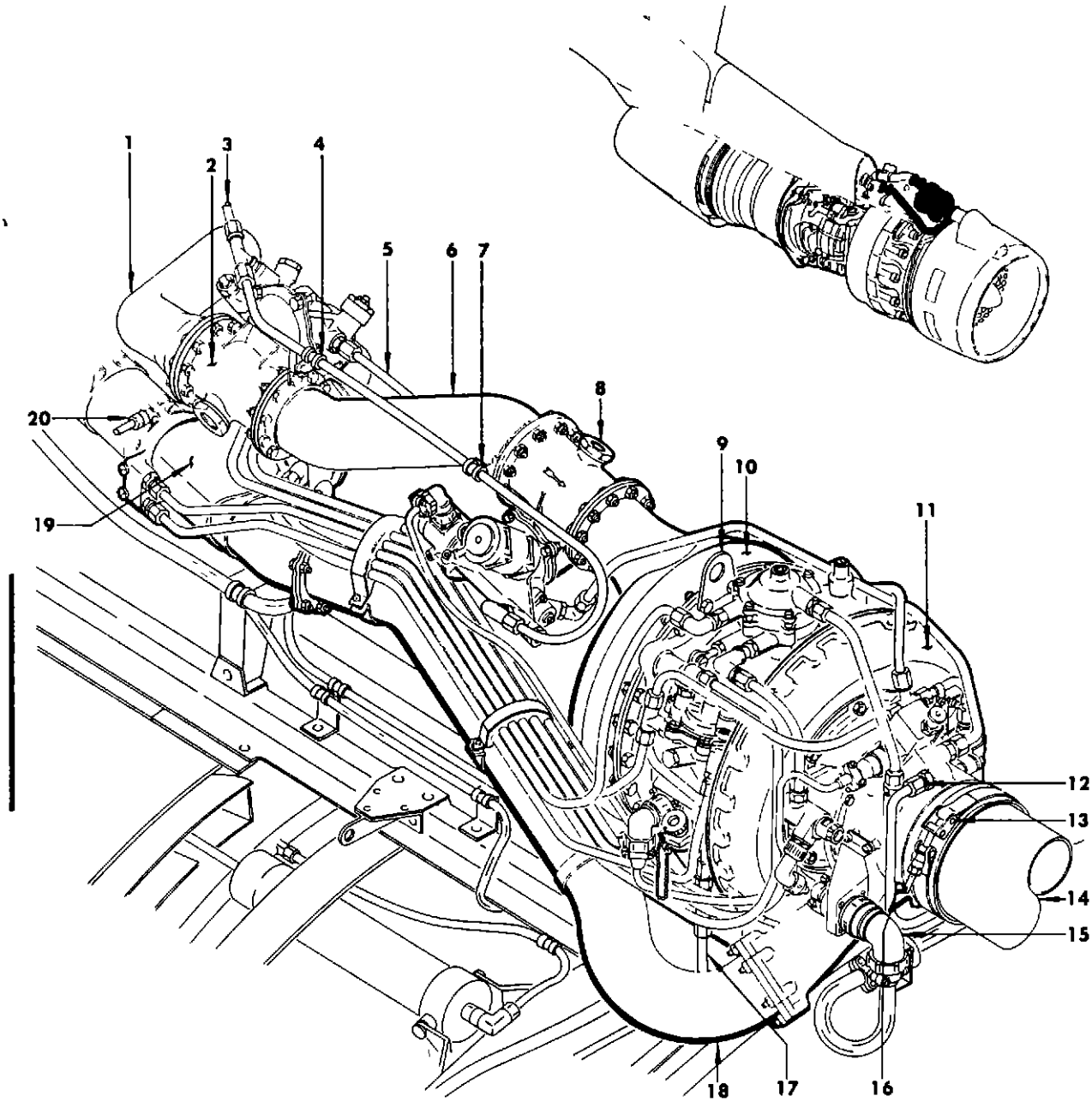
(20) Place hook of suitable crane through T/C hoisting eye and take up cable slack.

(21) Remove the four T/C mounting bolts.

NOTE The mounting bolts are secured by floating nutplates.

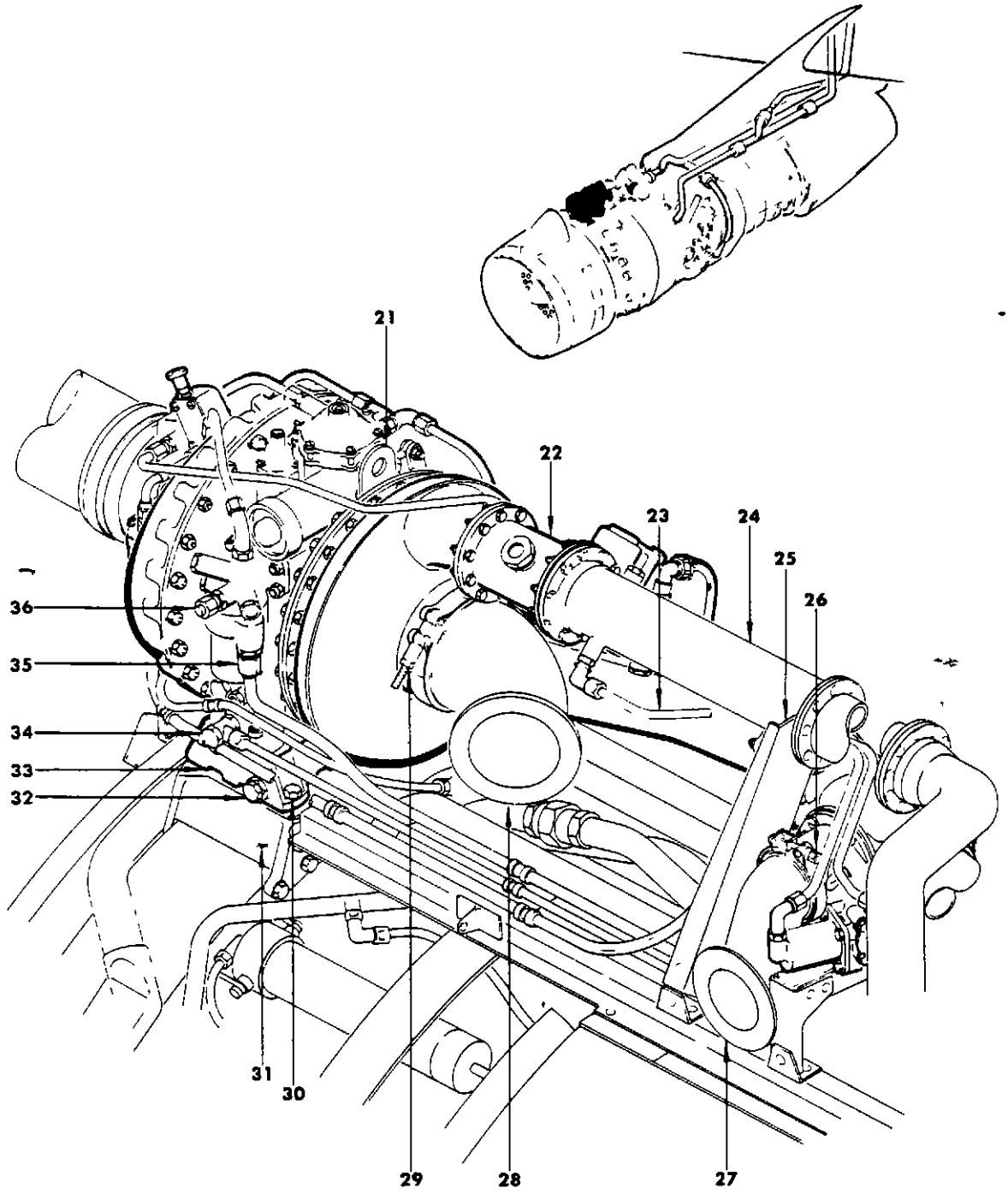
(22) Take weight of T/C with crane and guide surge bleed valve clear of pressure regulator support bracket and engine bleed duct.

(23) Support aft end of T/C by hand and guide assembly clear as it is hoisted away from engine.



1	ENGINE BLEED DUCT	11	COMPRESSOR SCROLL
2	PRESSURE REGULATOR	12	ANTI-ICING LINE
3	ENGINE BLEED CONTROL AIR LINE	13	STRAP CLAMP
4	CLAMP	14	INLET DUCT
5	SENSING LINE	15	MAIN ELECTRICAL CONNECTOR
6	INTERCONNECTING DUCT	16	FUSIBLE PLUG
7	CLAMP	17	OIL SUMP VENT LINE
8	SHUTOFF VALVE	18	PNEUMATIC DUCT
9	HOISTING EYE	19	SURGE BLEED VALVE
10	TURBINE TORUS	20	V-BAND CLAMP

Turbocompressor Installation
Figure 201 (Sheet 1 of 2)



21 HOISTING EYE
22 SHUTOFF VALVE
23 SENSING LINE
24 INTERCONNECTING DUCT
25 PRESSURE REGULATOR SUPPORT BRACKET
26 V-BAND CLAMP
27 SURGE BLEED EXHAUST DUCT
28 T/C EXHAUST DUCT
29 V-BAND CLAMP
30 T/C MOUNT BOLT
31 LEFT T/C MOUNT
32 OIL DRAIN PLUG
33 OIL SUMP
34 T/C "OIL OUT" LINE
35 T/C "OIL IN" LINE
36 GROUND CHECK OIL PRESSURE GAGE CONNECTION

B. Prepare To Install Turbocompressor

(1) Check compressor and turbine inlets and outlets for damage and foreign matter

(2) Check electrical harness and connections for damage and security

(3) Check all air and oil lines for damage, looseness or leaks

(4) Drain all inhibiting fluid or preservative oil from unit.

(5) All caps, plugs and dust covers should be replaced and left in position until turbocompressor is mounted on engine

C. Install Turbocompressor (See figure 201)

(1) Hoist unit into position using hoisting eye Care should be taken not to damage lines, ducts or electrical connectors

(2) With crane still in position, check clearance between T/C mounting lugs and mounts. Clearances shall be 0.004 inch or less. Where clearance is greater, add shims to reduce clearance to 0 004 inch or less at all points of attachment.

(3) Install the four mounting bolts and torque to 125 to 154 pound-inches.

(4) Remove crane hook from hoisting eye.

(5) Install V-band clamp at aft end of surge bleed valve and torque clamp nut to 80 to 90 pound-inches.

(6) Install surge bleed valve exhaust duct by aligning indexing pin and securing duct with clamp

NOTE. The surge bleed valve exhaust duct and surge bleed exhaust support bracket have dry-film lubricated bearing surfaces which must be kept clean and protected from mechanical damage during assembly.

(7) Position pressure regulator and interconnecting duct assembly on support bracket and install the three attaching bolts through the support bracket and forward pressure regulator valve flange.

(8) Install gasket, bracket and mounting bolts at aft shutoff valve flange.

(9) Install gasket and mounting bolts at aft pressure regulator valve flange

(10) Position forward section of control air line and connect to shutoff valve.

(11) Connect control air line at each end of pressure regulator T-connection

(12) Attach control air line clamps to brackets at pressure regulator and shutoff valve.

(13) Connect surge valve oil leakage drain.

(14) Connect oil sump vent line.

(15) Connect "OIL OUT" line to T/C spur gear oil pump outlet Torque bolt to 150 to 250 pound-inches

(16) Connect "OIL IN" line at oil filter assembly.

(17) Position flexible duct on compressor air inlet and secure with strap clamp.

(18) Connect anti-icing line to fitting on top of compressor inlet duct.

(19) Connect main electrical connector at compressor inlet

(20) Fill T/C oil sump.

(21) Operate T/C for several minutes.

(22) Recheck oil level on dipstick and add oil as necessary

(23) Replace engine top fairing See Chapter 71, "Nacelle Forward Fairing "

3. Pneumatic Shutoff Butterfly Valve and Pressure Regulating Valve

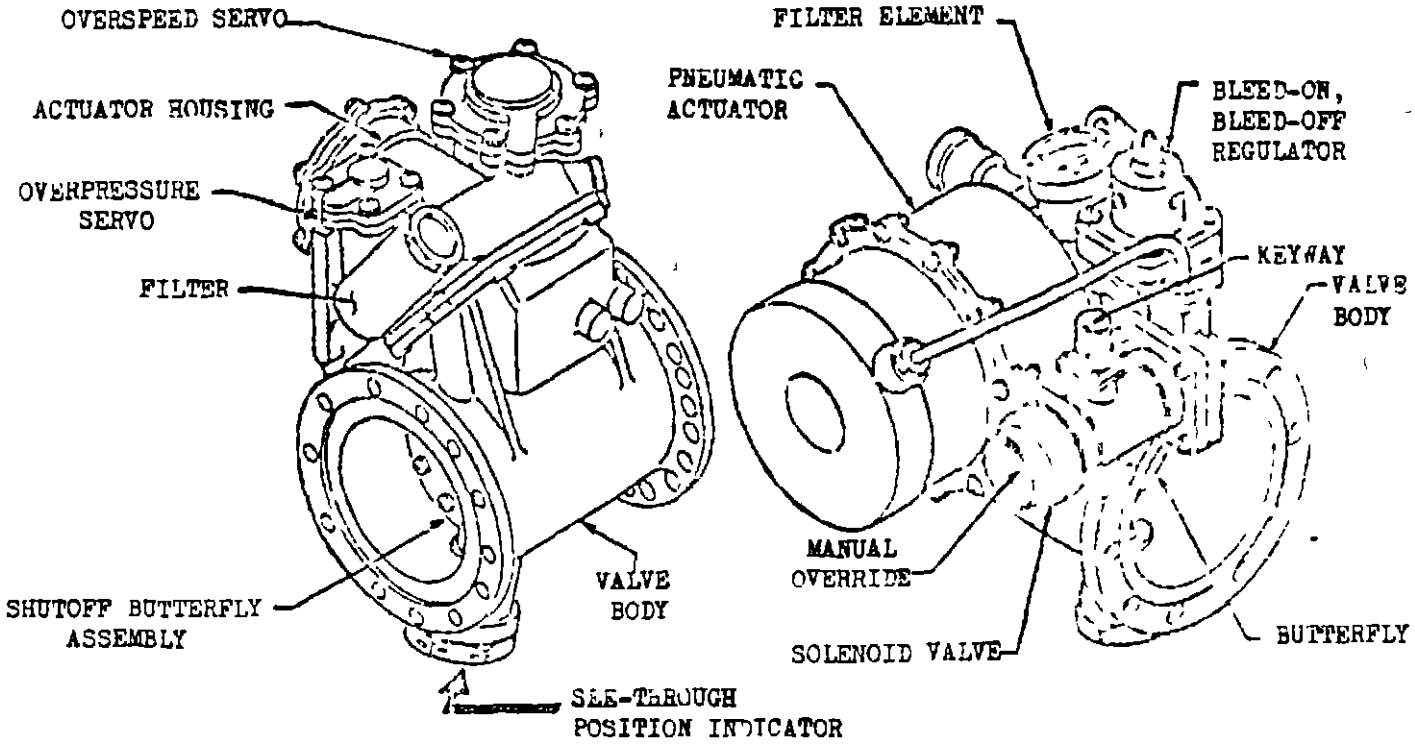
A. Turbocompressor shutoff and regulator valve variable configuration installation

(1) General

(a) A major modification is being accomplished on turbocompressor shutoff and regulator valves. Until all valves are modified, mixed configurations of valve installations may be found on an airplane.

(b) The modified shutoff valve can be identified by the AiResearch Part Number or by the presence of a quartz see-through window located on the valve body at the opposite side from the actuator housing.

(c) The modified regulator valve can be identified by the AiResearch Part Number or by the presence of a manual override button on the solenoid valve.

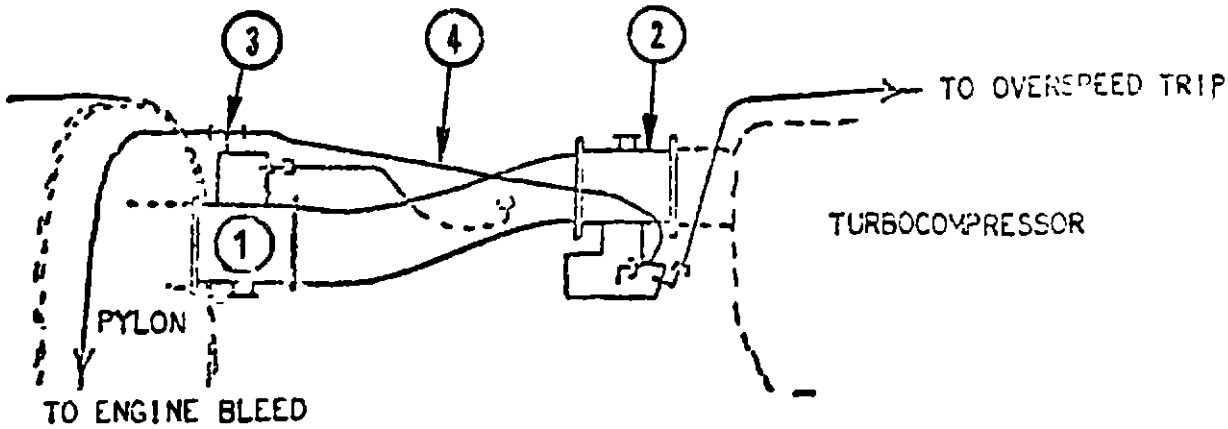


Ref: SB.AICH 21-1148 and 21-2161

Pneumatic Shutoff Butterfly Valve and Pressure Regulating Valve
Figure 201A

(2) Removal/Installation Shutoff and Regulator Valves

(a) Unmodified regulator and unmodified shutoff valves (Configuration 1) should be removed and installed per existing instructions in 36-1-2 and 36-1-32. (See figure 201B Sheet 1)



(1) UNMODIFIED REGULATOR VALVE, P/N 108940-760.

(2) UNMODIFIED SHUTOFF VALVE, P/N 122250.

(3) TEE, P/N C60W9000
NUT, P/N AN6289-6
GASKET, P/N BACG10U6
RING, BACKUP, P/N MS28777-6

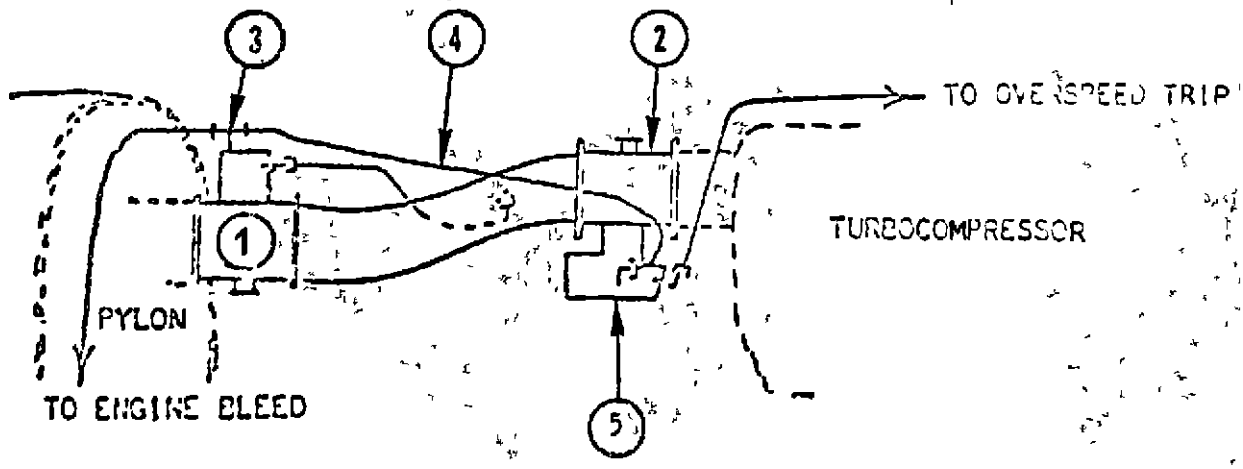
(4) TUBE ASSY, P/N 65-11687-882

(b) Modified regulator and modified shutoff valves (Configuration 2) should be removed and installed per existing instructions in 36-1-2 and 36-1-32 except for the following (See figure 201B sheet 2):

1) Engine bleed control air line (tube P/N 65-11687-882) between regulator valve tee and shutoff valve should be plugged at shutoff valve side.

2) Connect shutoff valve electrical harness and plug to dummy receptacle mounted on shutoff valve.

3) Connect regulator valve plumbing using parts indicated in figure 201B sheet 2.



(1) MODIFIED REGULATOR VALVE P/N 898304-1

(2) MODIFIED SHUTOFF VALVE P/N 397794-1

(3) TEE, P/N ER834-060604
NUT, P/N AN6289-4
GASKET, P/N BACG10U4
RING, P/N MS28777-4

(4) TUBE ASSY, P/N 65-11687-882

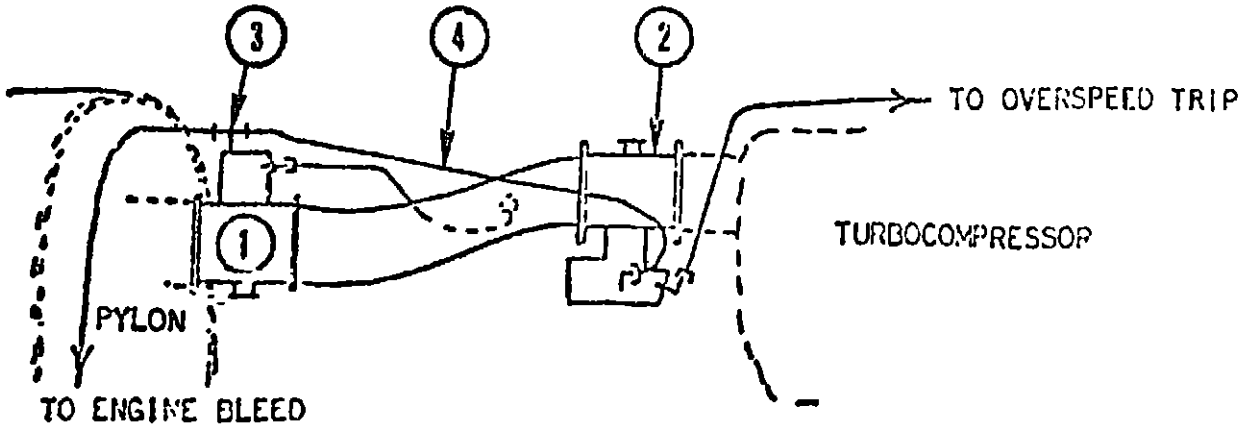
(5) PLUG, P/N MS21913J6

Ref: SB.AICH 21-1148 and 21-2161
Valve Configuration 2
Figure 201B (Sheet 2)

(c) Modified regulator valve with unmodified shutoff valve (Configuration 3) should be removed and installed per existing instructions in 36-1-2 and 36-1-32 except for the following (See figure 201B sheet 3) :

1) Engine bleed control air line (Tube P/N 65-11687-882) must be connected to regulator and shutoff valves.

2) Connect regulator valve plumbing using parts indicated in figure 201B sheet 3.



(1) MODIFIED REGULATOR VALVE P/N 898304-1

(2) UNMODIFIED SHUTOFF VALVE P/N 122250

(3) TEE P/N ER834-060604
NUT P/N 6289-4
GASKET P/N BACG10U4
RING P/N MS28777-4

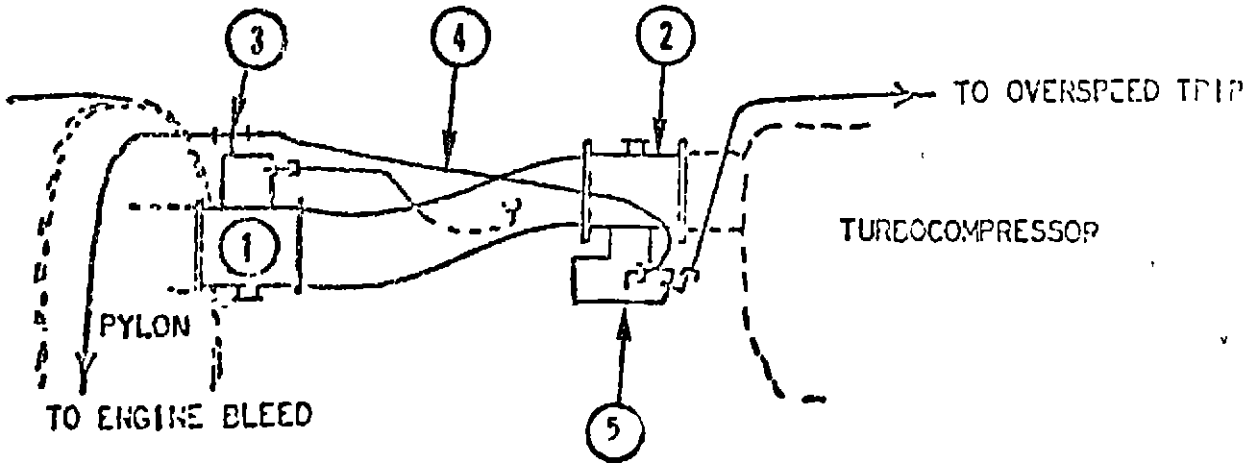
(4) TUBE ASSY P/N 65-11687-882

(d) Unmodified regulator valve with modified shutoff valve (Configuration 4) should be removed and installed per existing instructions in 36-1-2 and 36-1-32 except for the following (See figure 201B sheet 4) :

1) Engine bleed control air line (Tube P/N 65-11687-882) between regulator valve tee and shutoff valve should be plugged at shutoff valve side.

2) Connect shutoff valve electrical harness and plug to dummy receptacle mounted on shutoff valve.

3) Connect regulator valve plumbing using parts indicated in figure 201B sheet 4.



(1) UNMODIFIED REGULATOR VALVE P/N 108940-760

(2) MODIFIED SHUTOFF VALVE P/N 397794-1

(3) TEE P/N C60W9000
NUT P/N AN6289-6
GASKET P/N BACG10U6
RING, BACKUP P/N MS28777-6

(4) TUBE ASSY, P/N 65-11687-882

(5) PLUG, P/N MS21913J6

Ref: SB.AICH 21-1148 and 21-2161
Valve Configuration 4
Figure 201B (Sheet 4) SN REV. December 27, 1978

4. Removal/Installation Turbocompressor Shutoff Valve

A. Remove Turbocompressor Shutoff Valve (See figure 202.)

(1) Remove engine top fairing. See Chapter 71, "Nacelle Forward Fairing."

(2) Disconnect shutoff valve electrical connector.

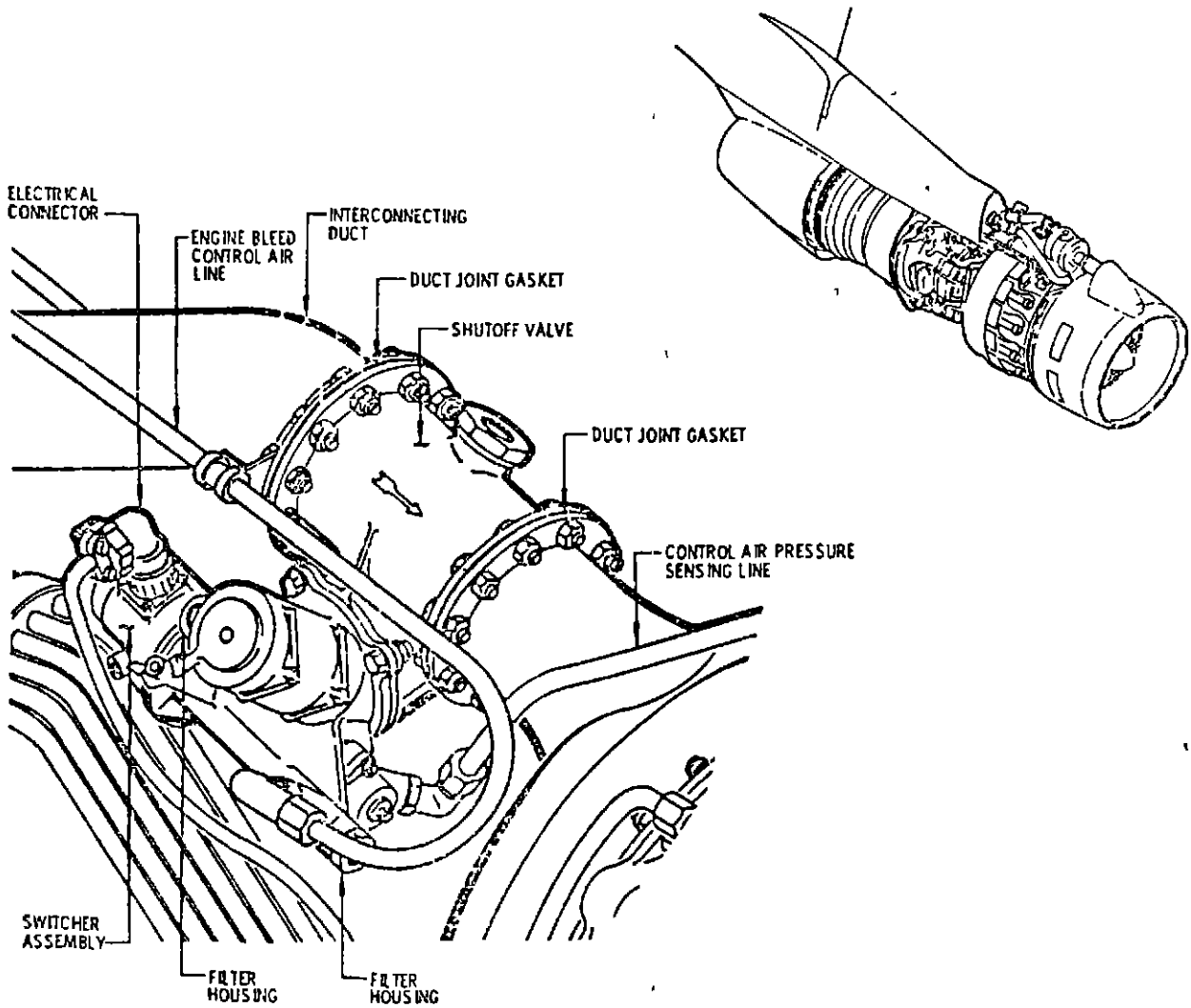
(3) Disconnect engine bleed control air line at shutoff valve.

(4) Disconnect control air pressure sensing line at shutoff valve.

(5) Remove mounting bolts and bracket from aft shutoff valve flange.

(6) Remove mounting bolts from forward shutoff valve flange.

(7) Remove shutoff valve and gaskets.



Turbocompressor Shutoff Valve Installation
Figure 202

B. Install Turbocompressor Shutoff Valve (See figure 202.)

(1) Position shutoff valve with flow arrow pointing forward.

(2) Install gasket and mounting bolts at forward flange.

(3) Install gasket, mounting bolts and bracket at aft shutoff valve flange.

(4) Connect control air pressure sensing line at shutoff valve.

(5) Connect engine bleed control air line at shutoff valve.

(6) Connect shutoff valve electrical connector.

(7) Reinstall engine top fairing.

5. Removal/Installation Shutoff Valve Filter

A. Remove Shutoff Valve Filter (See figure 203)

(1) Remove engine top fairing. See Chapter 71, "Nacelle Forward Fairing."

(2) Remove lock wire and unscrew filter retaining plug from filter housing

(3) Withdraw spring and filter element.

(4) Wash filter assembly in dry-cleaning solvent (P-S-661) and dry thoroughly.

WARNING: USE DRY-CLEANING SOLVENT IN A WELL VENTILATED AREA. AVOID BREATHING FUMES. KEEP AWAY FROM FLAME.

B Install Shutoff Valve Filter (See figure 203.)

(1) Insert filter element into filter housing with boss facing outwards.

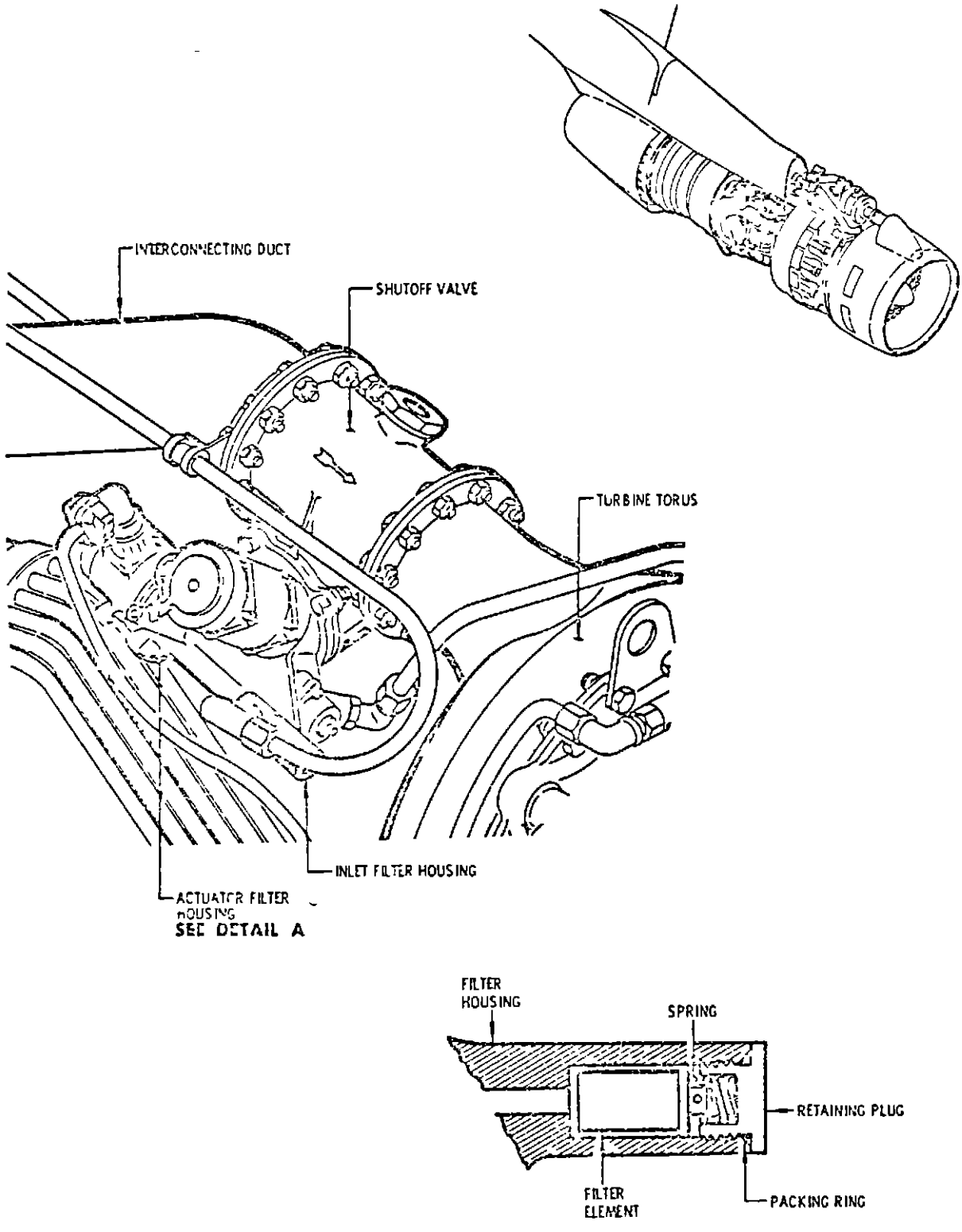
(2) Insert spring on boss of filter element.

(3) Replace packing ring on filter retaining plug.

(4) Screw retaining plug into filter housing. Ensure that filter spring is contained in inside bore of retaining plug.

(5) Tighten, then lockwire retaining plug.

(6) Reinstall engine top fairing.



DETAIL A

B3 Turbocompressor Shutoff Valve Filter Installation
Oct 15/61 Figure 203
SB Rev. December 27, 1976

PRESSURE REGULATOR - MAINTENANCE PRACTICES

Removal, Installation Pressure Regulator

A. Remove Pressure Regulator (See figure 201.)

(1) Remove engine top fairing. See Chapter 71, "Nacelle Forward Fairing "

(2) Disconnect pressure regulator sensing line.

(3) Disconnect engine bleed control air line at regulator T-connection.

(4) Disconnect pressure regulator electrical connector.

(5) Remove control air line clamp at forward valve flange

(6) Remove mounting bolts from aft pressure regulator valve flange

(7) Remove mounting bolts and bracket from forward pressure regulator valve flange.

(8) Remove pressure regulator and gaskets

B Install Pressure Regulator (See figure 201.)

(1) Position pressure regulator with flow arrow pointing forward

(2) Install gasket, bracket and mounting bolts at forward flange.

(3) Install gasket and mounting bolts at aft flange.

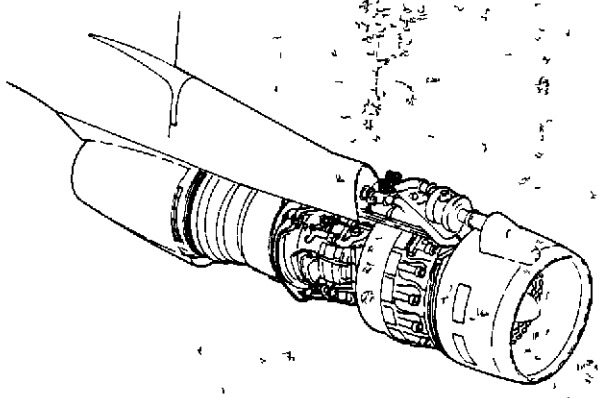
(4) Install control air line clamp at forward valve flange.

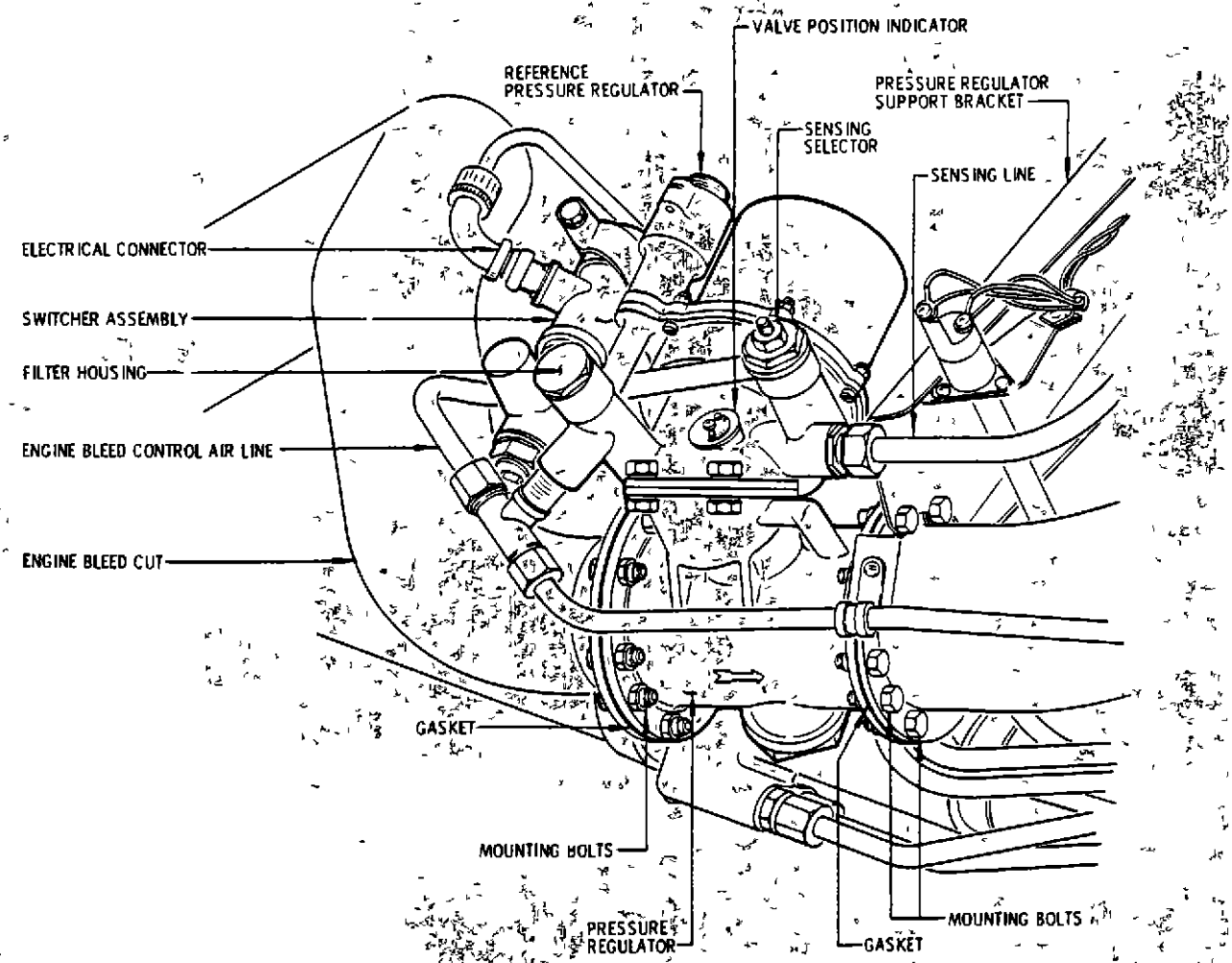
(5) Connect pressure regulator electrical connector.

(6) Connect engine bleed control air line

(7) Connect pressure regulator sensing line.

(8) Reinstall engine top fairing.





Pressure Regulator Installation
Figure 201

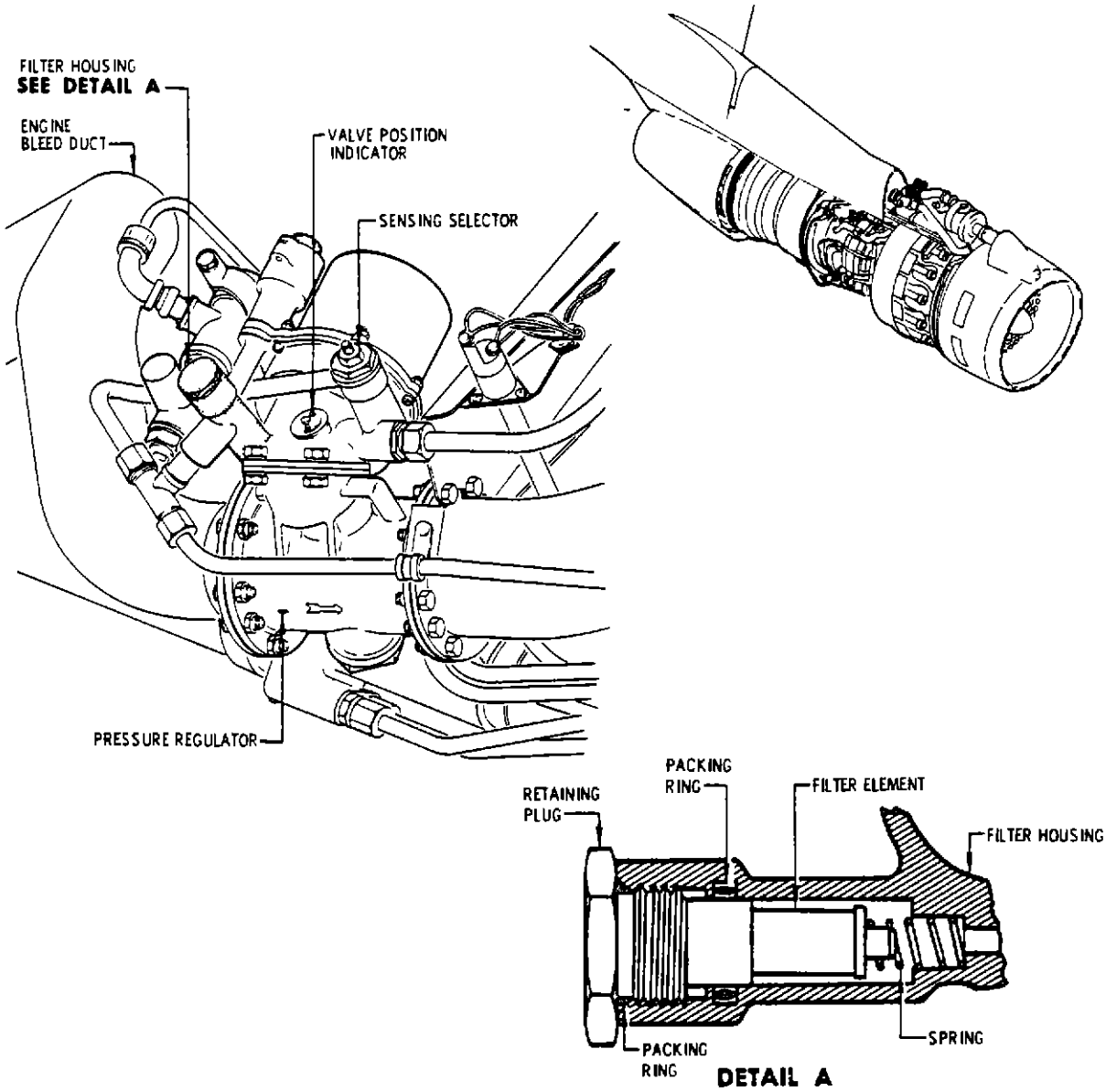
2. Removal/Installation Pressure Regulator Filter

A. Remove Pressure Regulator Filter (See figure 202.)

(1) Remove engine top fairing. See Chapter 71, "Nacelle Forward Fairing."

(2) Remove lock wire and unscrew filter retaining plug from pressure regulator filter housing.

(3) Withdraw filter element and spring.



Pressure Regulator Filter Installation
Figure 202

(4) Wash filter assembly in dry-cleaning solvent (P-S-661) and dry thoroughly.

WARNING: USE DRY-CLEANING SOLVENT IN A WELL VENTILATED AREA. AVOID BREATHING FUMES. KEEP AWAY FROM FLAME.

B. Install Pressure Regulator Filter. (See figure 202.)

(1) Remove and replace packing ring in groove of filter housing.

(2) Insert spring in deepest counterbore of filter housing.

(3) Insert filter element into filter housing with boss facing inwards, ensure that spring fits over filter element boss.

(4) Replace packing ring on filter retaining plug

(5) Screw retaining plug into pressure regulator filter housing, tighten and lockwire

(6) Reinstall engine top fairing.

TURBOCOMPRESSOR OIL COOLER - MAINTENANCE PRACTICES

1 Removal/Installation Turbocompressor Oil Cooler

A General

(1) Turbocompressor oil cooler and plumbing must be replaced with clean components when contaminated with metal particles resulting from T/C failure

CAUTION DO NOT ATTEMPT TO SALVAGE OIL COOLER BY FLUSHING. A CLEANING METHOD WHICH ASSURES REMOVAL OF EVERY PARTICLE OF FOREIGN MATERIAL MUST BE USED.

B Remove Turbocompressor Oil Cooler

(1) Disconnect oil out line. (See figure 201.)

(2) Disconnect oil in line.

(3) Move thrust reverser aft and remove phillips flathead screws along forward edge and on upper and lower ends of oil cooler

(4) Move thrust reverser forward and remove phillips flathead screws along aft of edge of oil cooler

(5) Remove oil cooler by tilting top aft and turning cooler forward edge outward to free oil cooler regulator.

C Install Turbocompressor Oil Cooler

CAUTION TAKE ALL POSSIBLE PRECAUTION TO PREVENT ANY EXTRANEOUS MATERIAL FROM ENTERING OIL COOLER. DO NOT REMOVE PLUGS UNTIL TUBING IS TO BE CONNECTED

(1) Place oil cooler in position by tilting top forward and turning cooler aft edge inward (See figure 201.)

(2) Install phillips flathead screws along aft of edge of oil cooler.

(3) Move thrust reverser aft and install phillips flathead screws along forward edge and on ends of oil cooler.

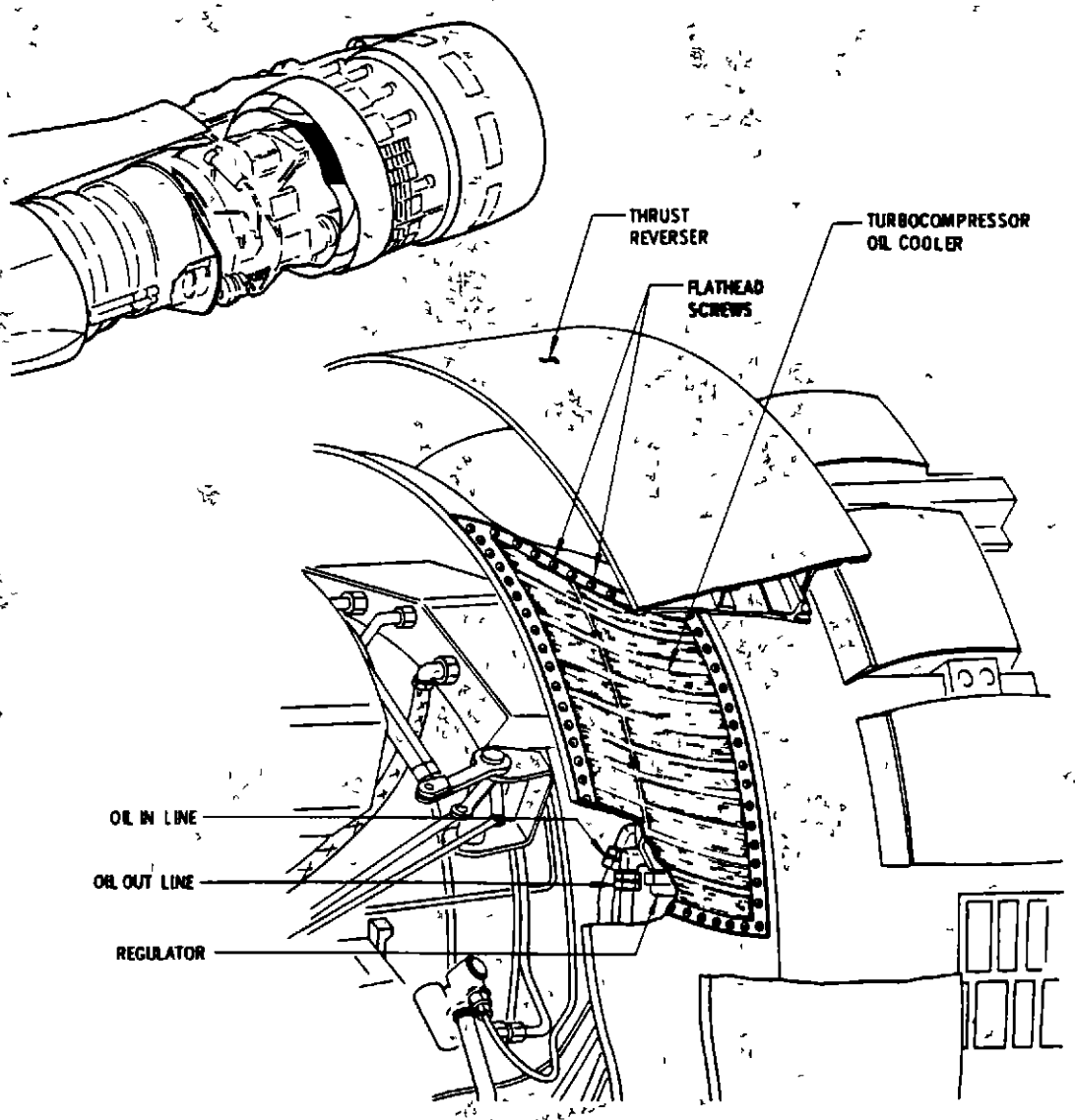
CAUTION : USE CARE TO PREVENT FOREIGN MATERIAL FROM ENTERING TUBING AND CONNECTED COMPONENTS.

(4) Connect oil out hose. (See figure 201.)

(5) Connect oil in hose

(6) Tighten oil line fittings to 240 to 360 pound-inches torque.

(7) Lockwire line connections.



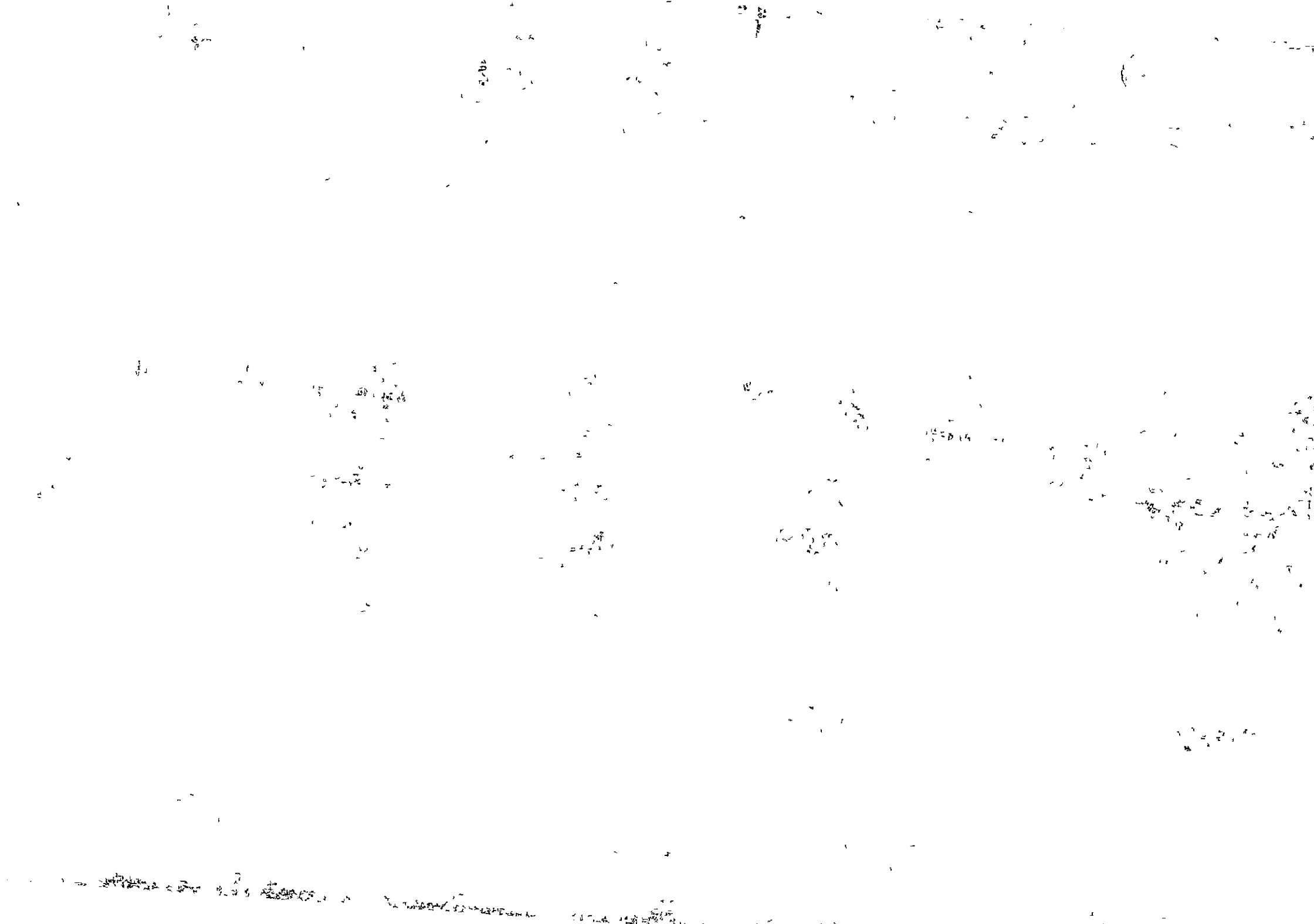
Turbocompressor Oil Cooler
Figure 201

APU - AIRPLANE PNEUMATIC SYSTEM INTERFACE - DESCRIPTION AND OPERATION

For APU - Airplane Pneumatic System Interface - Description and Operation, refer to chapter 49-00-36, page 1

APU BLEED AIR SYSTEM - DESCRIPTION AND OPERATION

For APU Bleed Air System - Description and Operation, refer to chapter 49-52-01, pages 1 and on.



PNEUMATIC DUCTS - MAINTENANCE PRACTICES

1 Removal/Installation Typical Duct Section

A Remove Typical Duct Section (See figure 201.)

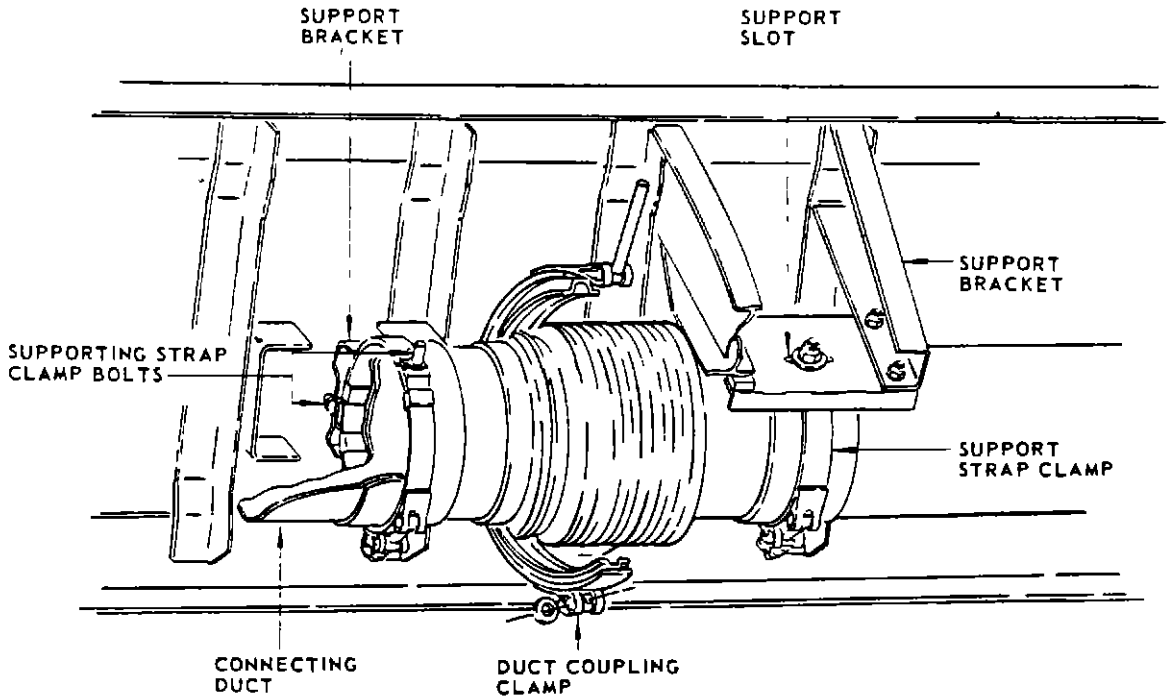
(1) Open appropriate wing leading edge access panels. See Chapter 12, Access Doors and Panels

(2) Remove lockwire and loosen duct coupling clamps at either end of duct section.

(3) Unfasten strap clamps securing duct section to support brackets.

(4) If duct section passes through seal plane using sealant at intersection, remove sealant by using wedge shaped hardwood tool and either BMS 11-7A or methyl ethyl ketone as required to free duct from seal

(5) Remove duct coupling clamps and duct section



Typical Duct Section Installation
Figure 201

B Install Typical Duct Section (See figure 201)

(1) Check new duct section for damage and foreign matter.

CAUTION NEW DUCT SECTION MUST HAVE SAME PART NUMBER AS DUCT SECTION BEING REPLACED DO NOT SUBSTITUTE ANOTHER PART EVEN IF IT IS THE PROPER LENGTH.

(2) Place new duct section in position and support loosely in strap clamps.

(3) Rotate duct section to obtain a minimum of 0.10 inch clearance on wing duct and 0.02 inch clearance on strut duct between duct and surrounding structure, tubing, and wire bundles.

(4) Install duct coupling clamps and torque to 70 to 80 pound-inches.

NOTE If installing a new 3-inch duct section outboard of number 2 engine, duct coupling clamps should be torqued to 40 to 50 pound-inches.

(5) Check that strap clamp studs are centered in support slots and torque T-bolts to 6 to 8 pound-inches.

(6) Lockwire coupling clamp nuts.

(7) If duct passes through seal plane where sealant was used on original installation, reapply sealant. Refer to, Sealing, 51-3-0.

(8) Close appropriate wing leading edge access panels.

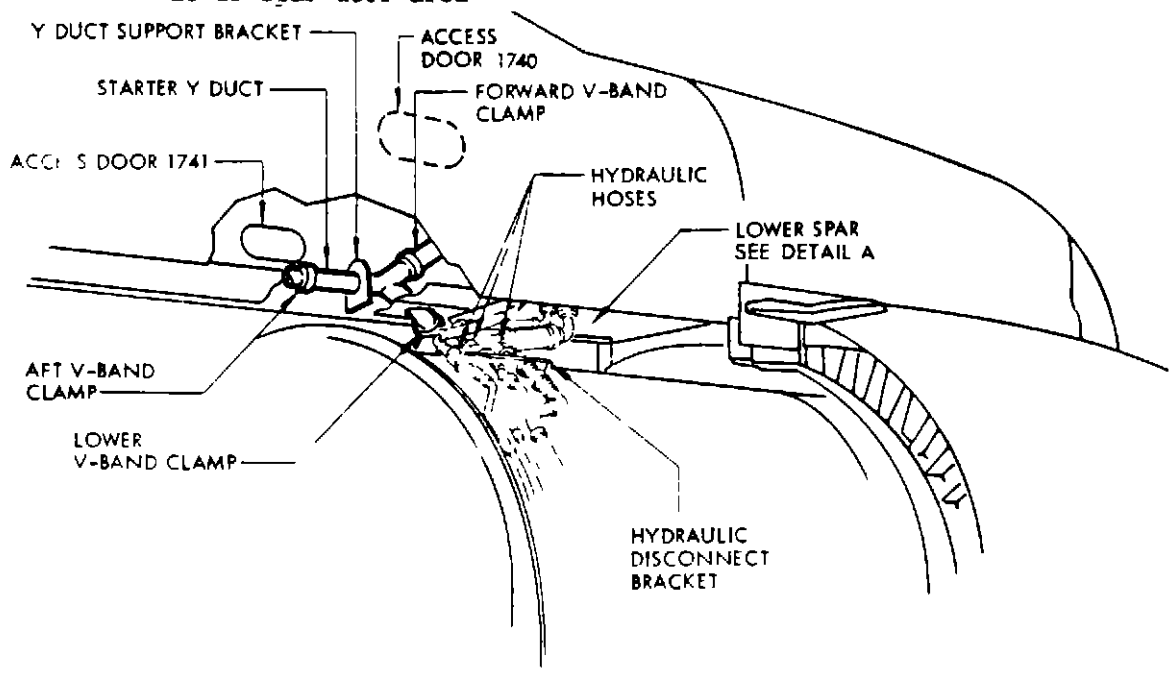
(9) For fan engine airplanes when the turbocompressor turbine discharge duct is replaced, check the fit of the seal between flange of the outer end of the duct and the nacelle fairing per 71-5-31

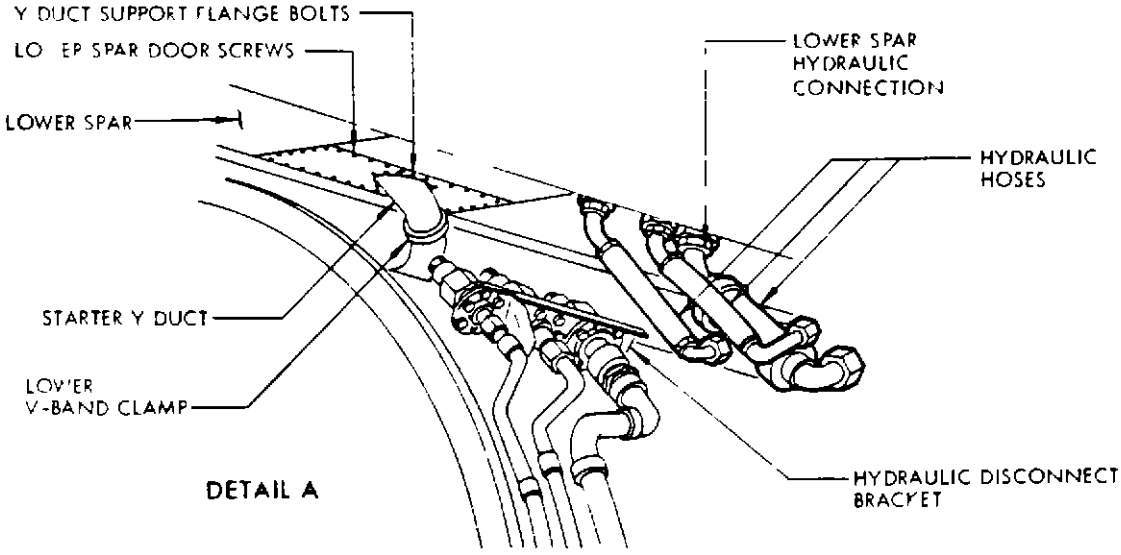
2. Removal/Installation Starter Y-Duct

A. Remove Starter Y-Duct (See Figure 202)

(1) Remove cowl panels to gain access to lower side of strut lower spar web

(2) Remove plumbing, cables and fire detector elements from the strut lower spar door area





Starter Y-Duct Installation
Figure 202

(3) Disconnect hydraulic hoses at hydraulic disconnect bracket on engine.

(4) Loosen hydraulic hoses at lower spar connection.

(5) Rotate hoses forward in order to gain access to lower spar door and lower Y-duct V-band clamp. (See figure 202, detail A.) (Retighten hose connections to prevent leakage.)

(6) Remove lower V-band clamp.

(7) Through nacelle strut access panel 1741 remove aft V-band clamp.

(8) Through the nacelle strut access panel 1740 remove the screws common to the A/C duct seal and mid spar web.

(9) Slide seal up exposing the Y-duct forward V-band clamp.

(10) Remove the forward V-band clamp

(11) Remove bolts common to lower spar door and the duct attach flanges.

(12) Remove lower spar door by removing door screws.

(13) Gain access to Y-duct support bracket through nacelle strut lower spar door opening.

(14) Disconnect and disassemble the support bracket by removing screws.

(15) Remove Y-duct through lower spar door opening.

B Install Starter Y-Duct (See figure 202.)

(1) Insert starter Y-duct through lower spar door opening

(2) Locate Y-duct in position.

(3) Through lower spar door opening install lower section of Y-duct support bracket.

(4) Insert the lower flange of the Y-duct through the lower spar door.

(5) Through the nacelle strut access panel 1741 install aft V-band clamp. Do not tighten.

(6) Through nacelle strut access panel 1740 install the forward V-band clamp. Do not tighten.

(7) Through the lower spar door opening install upper section on Y-duct support bracket

(8) Install lower spar door

(9) Install the duct attach flange bolts

(10) Install lower V-band clamps

(11) Tighten all V-band clamps

(12) Loosen hydraulic hoses at connection to lower spar and position and connect hydraulic hoses at hydraulic disconnect on engine

(13) Tighten hydraulic hoses at lower spar connection.

(14) Install nacelle strut panel 1741

(15) Install screws common to A/C duct seal and mid spar web.

(16) Install nacelle strut access panel 1740

(17) Install plumbing, cables and fire detectors previously removed from lower spar door area

(18) Install cowl panels

3 Approved Repairs Pneumatic Ducts

A General

(1) Thin-wall ducts are subject to damage as a result of improper removal or installation, mishandling or abnormal operating conditions Extremes of pressure or temperatures, may in some cases, make complete replacement of components more desirable than local repair or partial replacement

(2) Smooth dents do not require rework if they are not so deep as to restrict the airflow substantially, Smooth dents of greater depth may be removed by pulling a ball mandrel through the dented area or by the use of any applicable hydraulically or mechanically actuated expansion device Hydrostatic pressure within the allowable pressure for the particular system used in conjunction with moderate tapping with a nonmetallic hammer around the edge of the dent from the outside is an effective method for removal of some dents Methods which produce local work hardening should not be used.

(3) Shallow scratches and gouges having a depth not in excess of 10% of the duct wall thickness do not require rework provided the transition from base metal thickness is smooth and rounded.

(4) Sharp scratches and gouges can be reworked by removal of adjacent metal subject to the following restrictions.

(a) Minimum wall thickness at the bottom of a scratch or gouge after rework shall not be less than 90% of the minimum material gauge

(b) The surface roughness of the reworked area shall not exceed 40 RMS

(c) The slope of the reworked area shall not exceed a rise of 1 to 10

(d) Internal and external radii of the reworked area shall not be less than 0 12 inches

(5) Major repair procedures or replacement of sections of damaged pneumatic ducts are covered in the following Boeing document. D6-7134, Procedure for Field Repair of Damaged Pneumatic, Air Conditioning and Anti-Icing System Duct.

B Repair Turbocompressor Inlet Duct

(1) General

(a) The duct material is 6061 aluminum alloy and has a thickness of 0 040 inch.

(2) Repair simple cracks

(a) Heliarc aluminum weld the crack using 4043 filler wire

(3) Repair damaged area

(a) Cut out damaged portion of duct allowing generous corner radii.

(b) Cut a flush repair patch 0 040 inch thick of 6061 aluminum alloy to match cut out and heliarc weld to duct using 4043 filler wire

(c) Cut a reinforcement patch of the same material with 1 5 to 2 inch overlap

1) Radius corners and drill two 0 25 inch vent holes at each end in the overlap area

(d) Fit the reinforcement patch over the repair patch and tack weld to the duct

NOTE: Leave the vent holes in the reinforcement patch open

(e) Drill three or four 0 125 inch holes through both patches

(f) Heliarc weld the reinforcement patch to the duct using 4043 filler wire. Weld one end, the opposite end and then the two sides starting the side welds at the coolest end each time.

(g) Plug weld the 0.125 inch holes through the repair and reinforcement patches.

4. Adjustment/Test Duct Ball Joint

A. General

(1) The duct ball joint (located on the forward end of the engine bleed duct aft of the pressure regulator) must be free to move within required torque limits to allow for changes in stress during service. See figure 203.

B. Adjust Duct Ball Joint

(1) Test that duct ball joint is free to move (when the ten mounting bolts are torqued to 50-70 inch-pounds) with an applied load of 20-200 inch-pounds

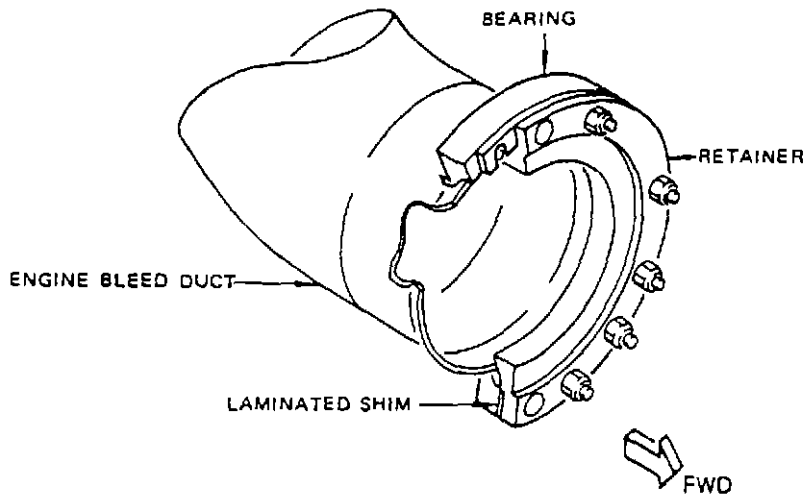
(2) If test result is not within required tolerance remove retainer

(3) Increase or decrease shim thickness as required.

(4) Install retainer and tighten the ten mounting bolts to 50-70 inch-pounds torque.

(5) Check that duct ball joint is free to move with an applied load of 20-200 inch-pounds

NOTE. With proper torque and shims the ball joints may have diffused leakage at any joint, however jet blasts are not permissible. Refer to applicable duct leakage test in Pneumatic System - Maintenance Practices, 36-0 or 36-1-0.



Duct Ball Joint
Figure 203

5. Turbocompressor Supply Ducts (TURBOFAN)

A. Installation of Turbocompressor Supply Ducts (See figure 204).

(a) Install all duct assemblies between engine bleed port and turbocompressor with bolts and clamps finger tight. All the bolts shall pass through the flanges without binding.

(b) Adjust joints for maximum gap of 0.125 inch and all axial misalignment of 0.100 inch at the connection between P/N 65-11899-64 duct and the turbocompressor shutoff valve.

(c) Torque bolts and joint clamps to correct values. Exception for (d) hereunder.

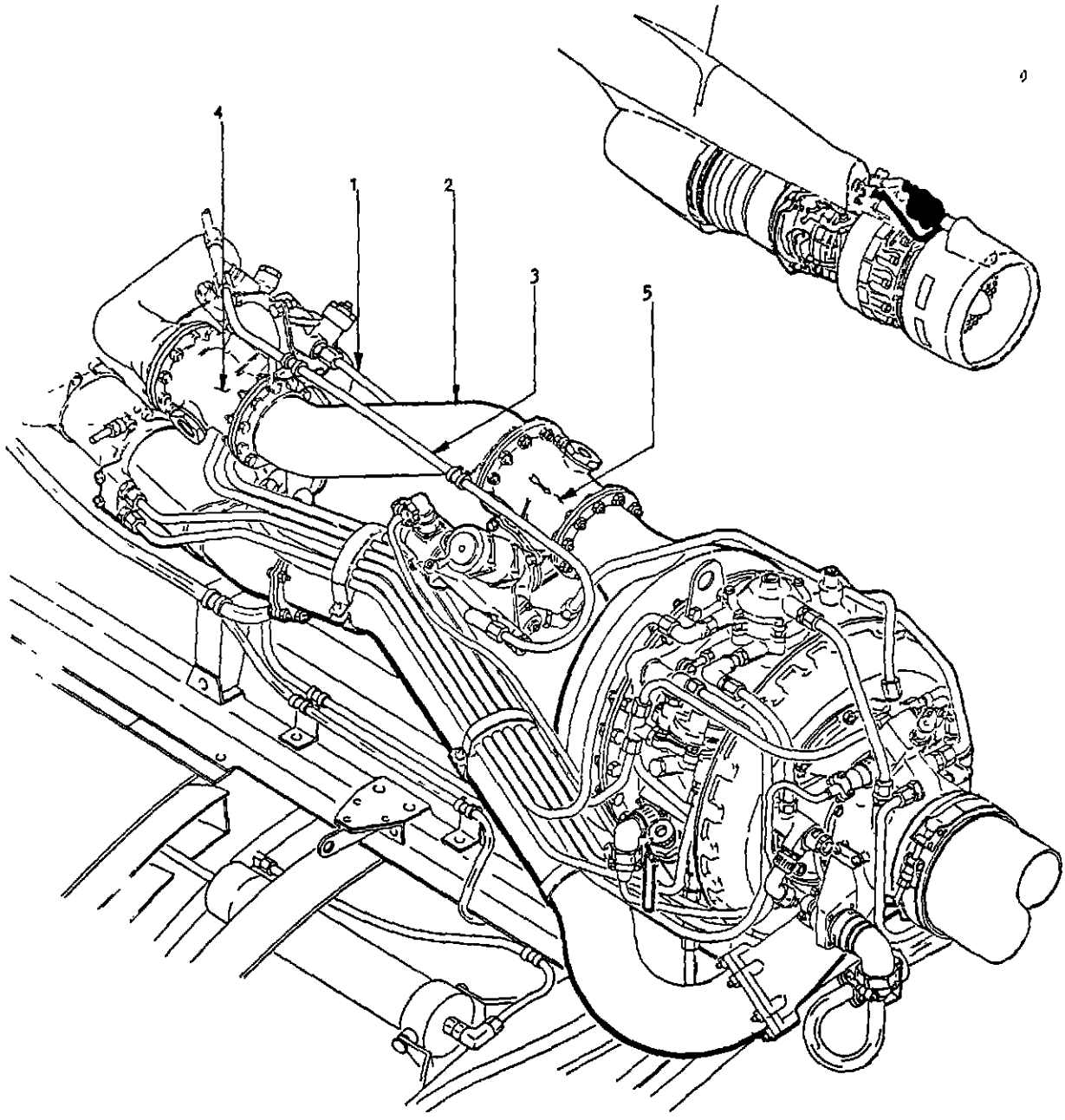
(d) Attach bracket installations as required and torque fasteners to correct values. A particular attention should be brought to the installation of the pressure regulator lower support "A" frame bracket P/N 65-42186-1, and its attach angles. One leg of the "A" frame bracket is 1/2 inch longer and should be installed to the right side of the engine, passing under 65-11899-64 duct. Attach angle, P/N 69-33677-3, should be attached to the "A" frame right leg and attach angle, P/N69-33677-800, to the left leg.

(e) Check gasket sealing between P/N 65-11899-64 duct and the turbocompressor shutoff valve as follows·

- Torque all bolts at 35 in-lbs.
- Gasket has sealed if the gap between the flanges is less than the thickness of the uncrushed seal (use feeler gage).
- If gasket has sealed, torque bolts at 65-90 in-lbs.

(f) If required, rebent the engine bleed control and sense lines (P/N 65-11687-822 and 65-11899-824) to obtain a stress free alignment with their respective ports.

(g) If the gasket does not seal, the entire turbocompressor supply duct installation, from the engine bleed port to the turbocompressor shutoff valve, should be loosened and readjusted per operations as defined in above steps (a) through (f).



1 - SENSING LINE (P/N 65-11899-824)

2 - INTERCONNECTING DUCT (P/N 65-11899-64)

3 - ENGINE BLEED CONTROL AIR LINE (P/N 65-11687-822)

4 - PRESSURE REGULATOR

5 - SHUTOFF VALVE

Turbocompressor Supply Duct Installation
Figure 204

PNEUMATIC VALVES - MAINTENANCE PRACTICES

1. Removal/Installation Outlet Duct Check Valve

   A Remove Outlet Duct Check Valve (See figure 201.)

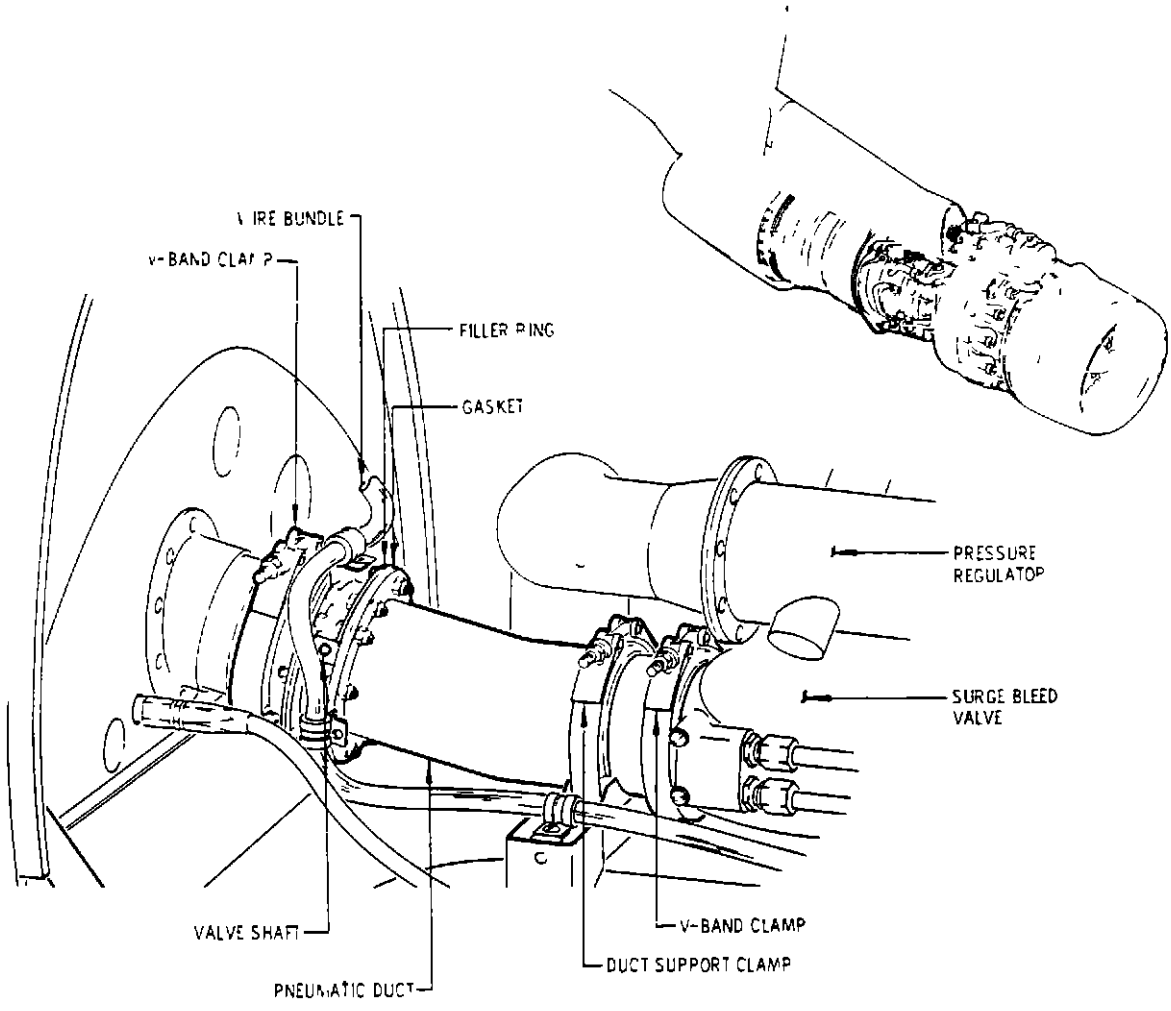
   (1) Remove engine top fairing. See Chapter 71, "Nacelle Forward Fairing."

   (2) Remove two clamps securing wire bundle to valve brackets.

   (3) Remove mounting bolts, filler rings and bracket from forward check valve flange

   (4) Remove coupling clamp from aft end of check valve.

   (5) Remove check valve and forward duct joint gasket.



Outlet Duct Check Valve Installation
Figure 201

B Install Outlet Duct Check Valve (See figure 201.)

(1) Position check valve with flow arrow pointing aft and valve shaft as near horizontal as bolt holes will allow.

(2) Install gasket, filler rings, bracket and mounting bolts on forward check valve flange leaving bolts loose

(3) Install coupling clamp on aft end of check valve and torque to 35 to 40 pound-inches.

(4) Torque mounting bolt nuts to 25 to 30 pound-inches.

NOTE. Gap between forward check valve flange gasket and duct flange should be .12 ± 04 inches prior to drawing together with bolts.

(5) Install bracket on aft check valve flange.

(6) Install two wire bundle clamps.

(7) Reinstall engine top fairing.

2 Removal/Installation Pneumatic Air Shutoff Valve

A. Remove Pneumatic Air Shutoff Valve (See figure 202.)

(1) Open engine bleed valve circuit breaker for engine No. 1 and 4 or engine No. 2 and 3 on circuit breaker panel (P1) or (P2) respectively.

(2) Remove nacelle strut access panel 1705 inboard or 1740 outboard. See Chapter 12, "Access Doors and Panels."

(3) Disconnect shutoff valve electrical connector

(4) Disconnect motor bonding strip.

(5) Remove forward and aft V-band clamps and shutoff valve.

B. Install Pneumatic Air Shutoff Valve (See figure 202.)

(1) Position shutoff valve with flow arrow pointing aft and valve shaft in the horizontal position.

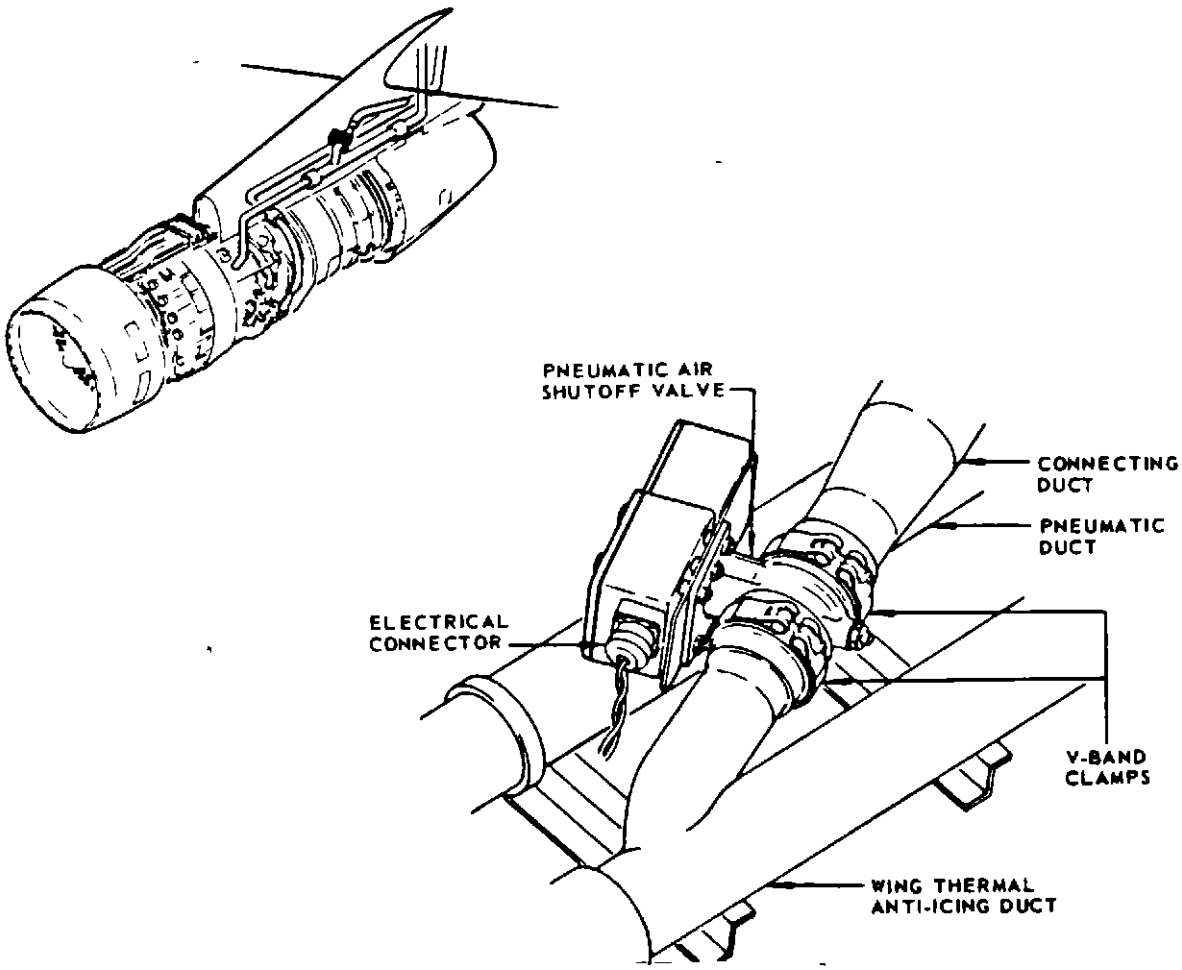
(2) Install forward and aft V-band clamps.

(3) Connect motor bonding strip.

(4) Connect shutoff valve electrical connector.

(5) Install nacelle strut access panel 1705 inboard or 1740 outboard. See Chapter 12, "Access Doors and Panels."

(6) Close appropriate engine bleed valve circuit breaker on circuit breaker panel (P1) or (P2).



Pneumatic Air Shutoff Valve Installation
Figure 202

3 Removal/Installation Wing Isolation Valve

A Remove Wing Isolation Valve (See figure 203.)

(1) Remove panels on aft end of forward cargo compartment to gain access to air conditioning distribution bay

(2) Disconnect wing isolation valve electrical connector

(3) Disconnect motor bonding strip.

(4) Remove outboard clamp

(5) Remove inboard clamp and wing isolation valve.

B Install Wing Isolation Valve (See figure 203.)

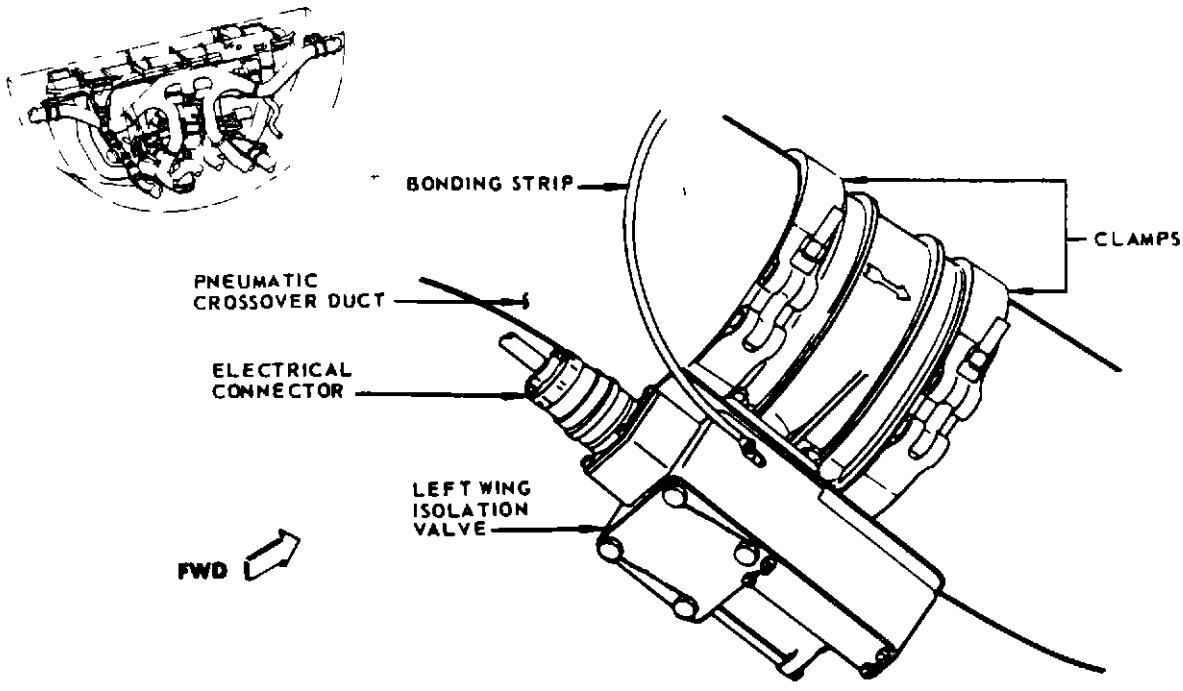
(1) Position wing isolation valve with flow arrow pointing inboard

(2) Install inboard and outboard clamps and torque to 70 to 80 pound-inches

(3) Connect motor bonding strip

(4) Connect wing isolation valve electrical connector.

(5) Reinstall panels on aft end of forward cargo compartment



Wing Isolation Valve Installation
Figure 203

4 Removal/Installation Swing Check Valve

A Remove Swing Check Valve (See figure 204)

(1) Remove panels on aft end of forward cargo compartment to gain access to air conditioning distribution bay.

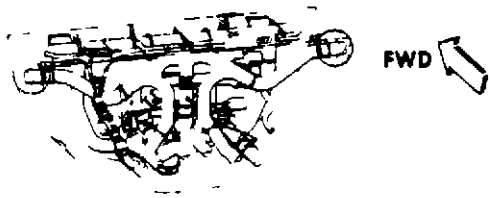
(2) Unscrew swing check valve from duct boss and remove with O-ring.

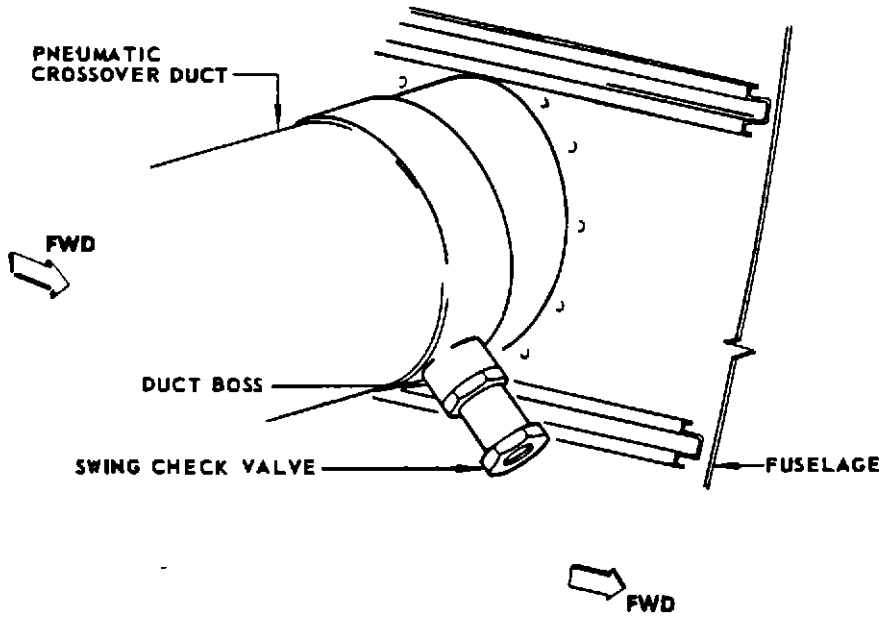
B. Install Swing Check Valve (See figure 204)

(1) Fit O-ring on swing check valve body

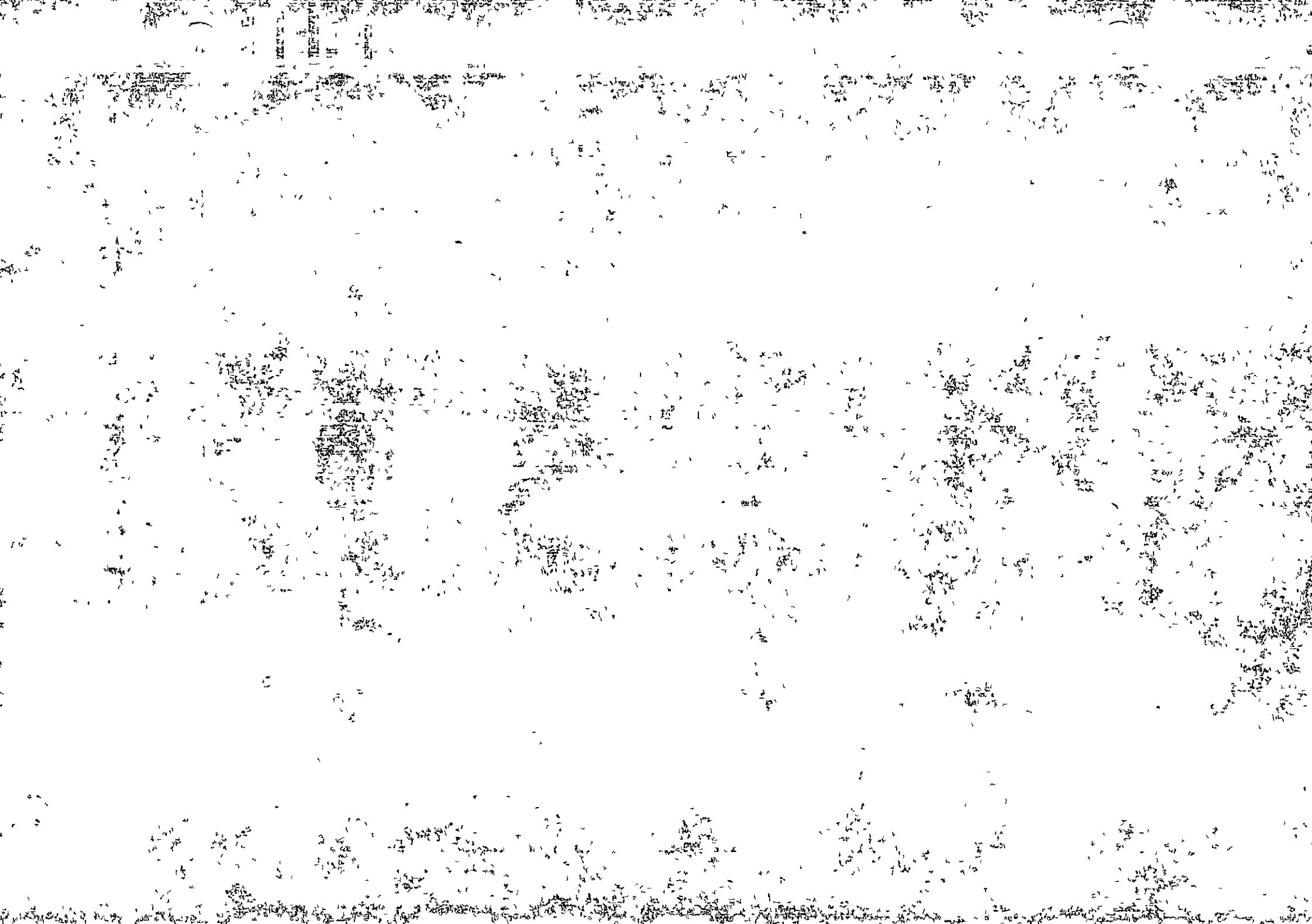
(2) Screw check valve into duct boss and tighten

(3) Reinstall panels on aft end of forward cargo compartment





Swing Check Valve Installation
Figure 204



AIR PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

1. Removal/Installation Air Pressure Transmitter

   A. Remove Air Pressure Transmitter (See figure 201.)

      (1) Open "CABIN DUCT PRESS AND FUEL TEMP" circuit breaker on 28 volt AC panel (P7).

      (2) Disconnect electrical connector.

      (3) Disconnect pressure sensing lines. Cap lines to keep out foreign material.

      (4) Remove mounting bolts (4).

      (5) Remove pressure transmitter.

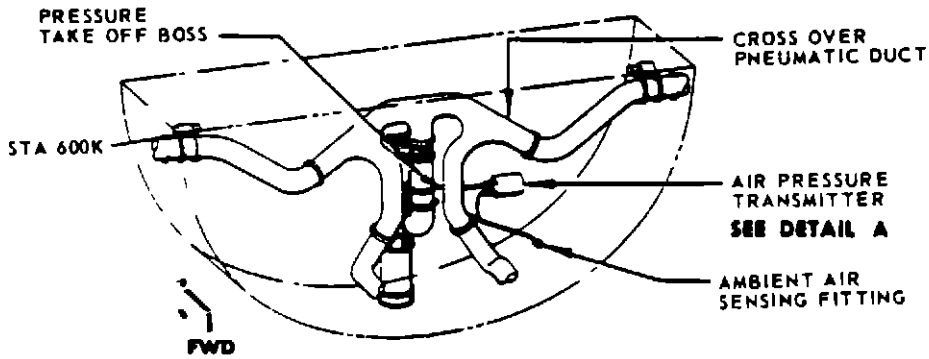
   B. Install Air Pressure Transmitter

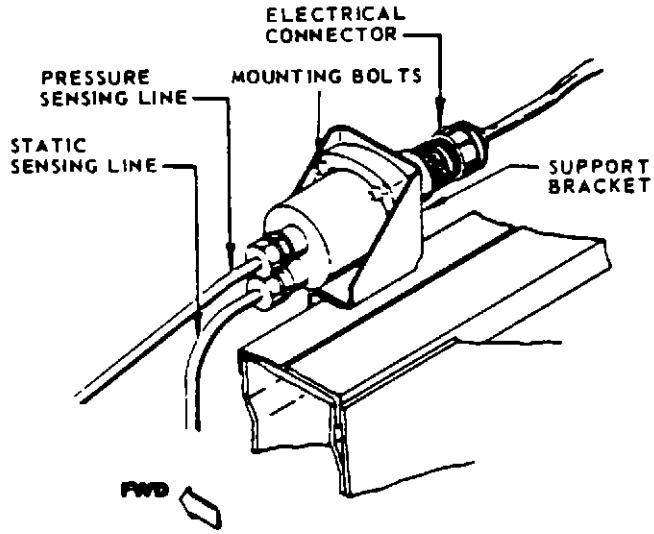
      (1) Place pressure transmitter in position on support bracket.

      (2) Install mounting bolts (4).

      (3) Connect pressure sensing lines.

      (4) Connect electrical connector.





DETAIL A

Air Pressure Transmitter Installation
Figure 201