CHAPTER 5

A. ENGINE PNEUMATIC SYSTEMS

1. General Description

a. The following engine air systems are installed by Pratt and Whitney and comprise part of the basic engine; anti-icing provisions for the engine inlet guide vanes and forward compressor case, deicing system for the engine fuel supply, and cooling and sealing air for the engine bearings. An air bleed system to balance performance between the engine high and low pressure compressors is also included with the basic engine.

b. The following systems are installed by Boeing and require an air bleed from the engine at the appropriate temperature and pressure: airplane air conditioning pack, cowling and wing anti-icing air system, generator cooling air, and CSD oil cooling air supply. An air pressure supply for the reverse actuating system is also extracted from the engine high pressure compressor.

c. Further information on the systems which use engine bleed air, but do not form part of the power plant assembly will be found in ATA 36, "Pneumatic" and Ice and Rain Protection ATA 30.

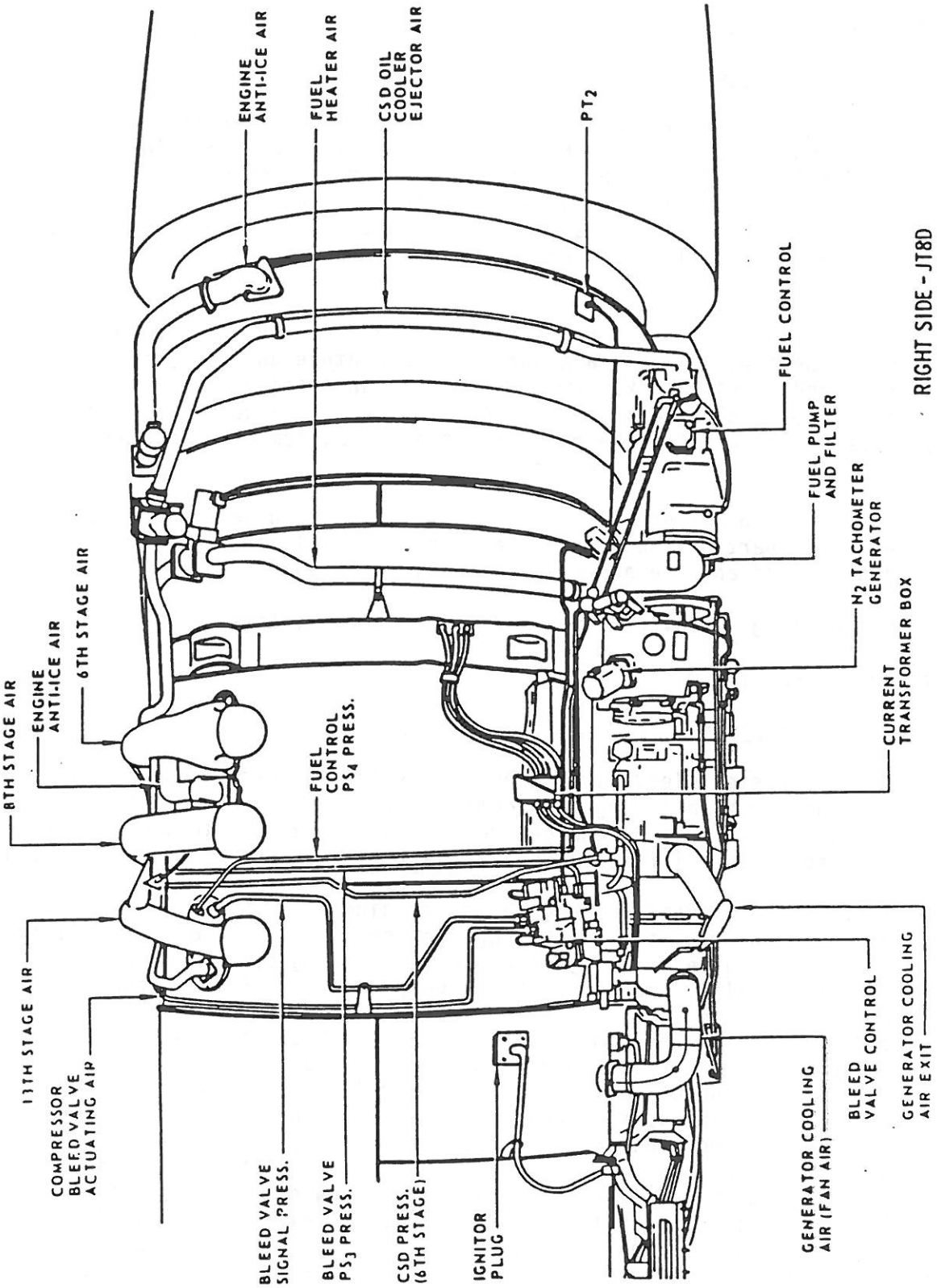
d. CSD cooling is covered in ATA 24 electrical systems.

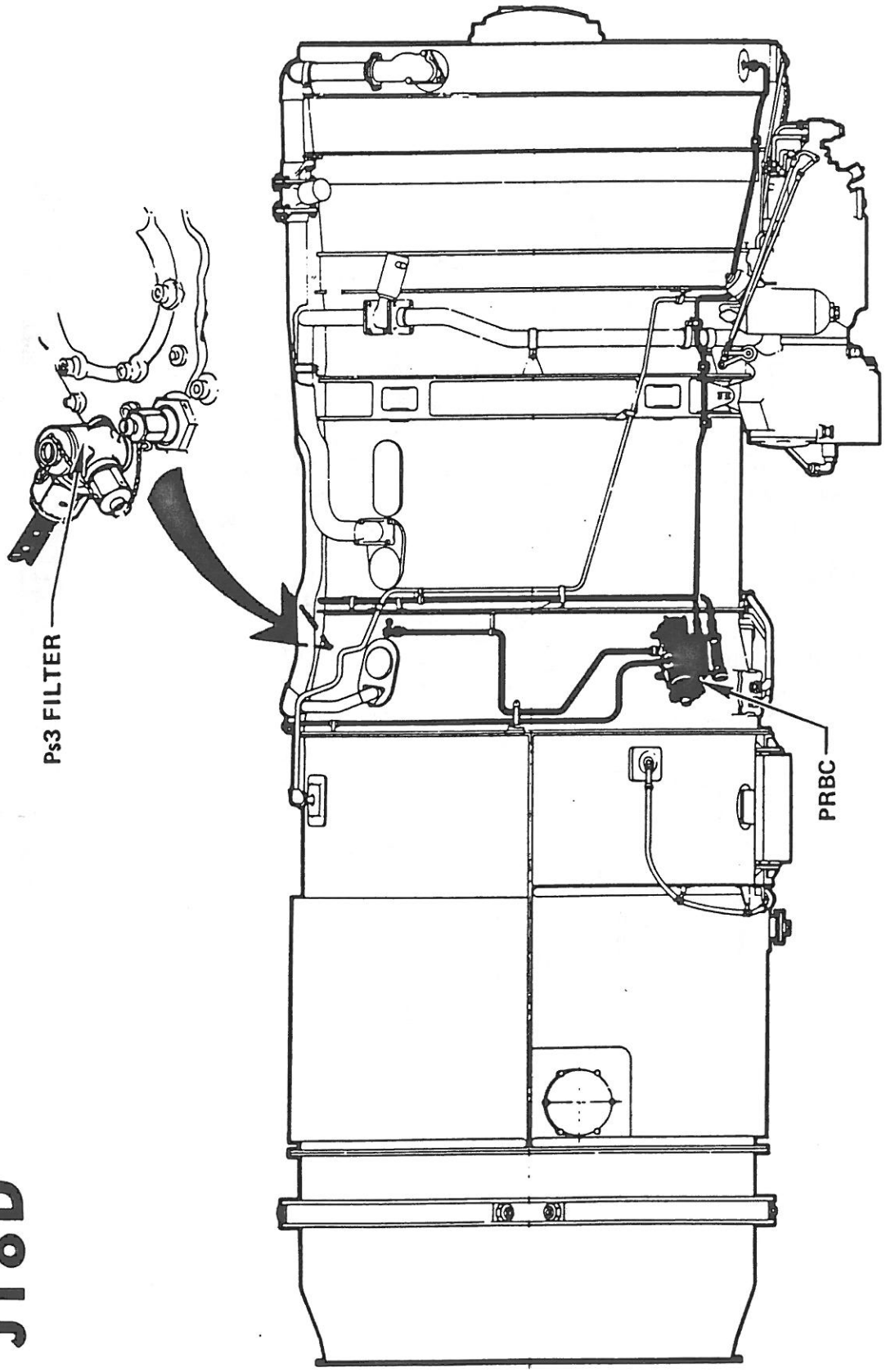
B. COMPRESSOR BLEED SYSTEM

1. General Description

a. The compressor bleed air system is designed to permit operational flexibility by allowing high compressor discharge air (13th stage), to bleed into the fan discharge duct. Two compressor bleed valves are located on the diffuser case, at the four and seven o'clock positions.

b. In the static position (engine not running), the bleed valves may be either open or closed, depending upon gravity and/or drag caused by contact of valves with cylinder walls. During periods of engine operation, high compressor discharge pressure exerted on the valve faces force the valves in to the open position. Pressure (Ps3) on one side of a diaphragm, in the pressure ratio bleed control, increases to the point where it overcomes combined (Pt2) and spring pressure forces; the poppet valves, in the control, reverse position; the muscle valve is repositioned, and Ps4 actuating air is directed to the back side of both bleed valves. This Ps4 air, acting on the larger area of the back side of the valves, is sufficient to overcome "thirteenth stage" discharge pressure acting on the valve faces, and the valves close. As the Ps3/Pt2 differential pressure decreases, the procedure is reversed. The actuating pressure (Ps4), on the back side of the valves, is reduced to ambient and internal engine pressure forces the bleed valves open.

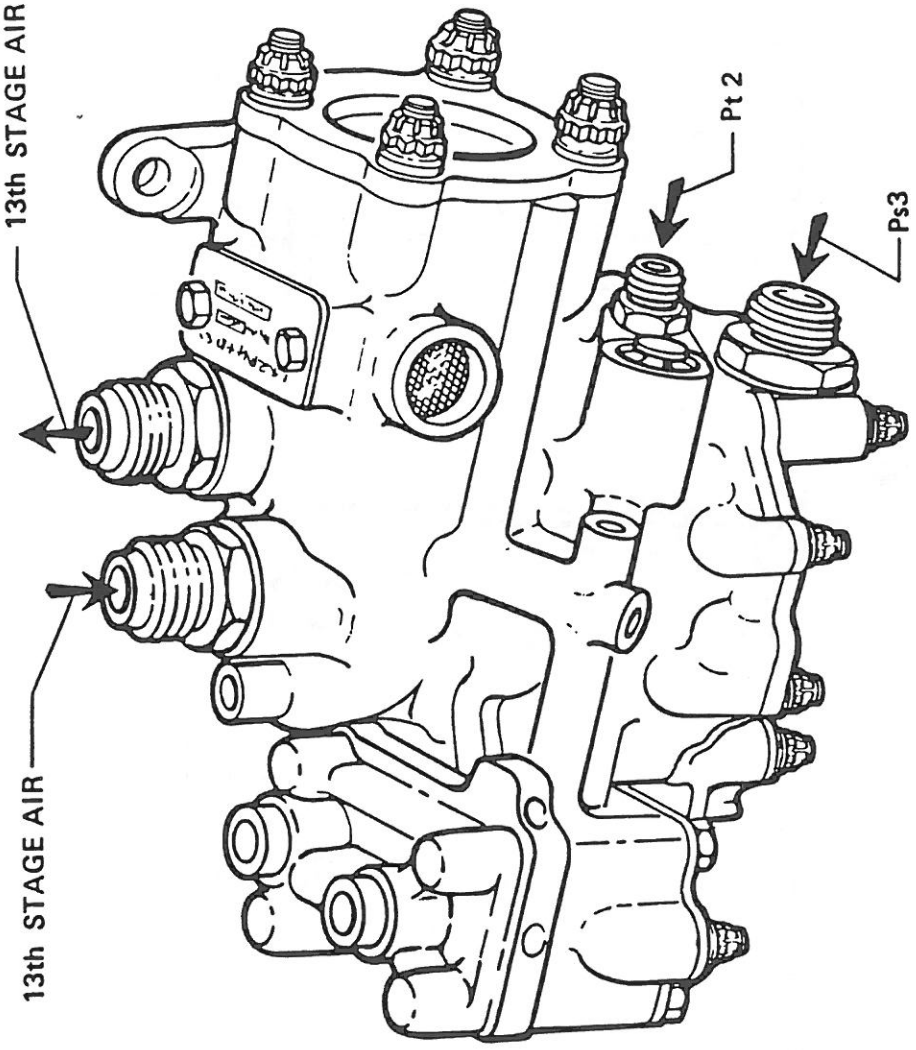

ENGINE ANTI-ICE AIR
FUEL HEATER AIR
CSD OIL COOLER EJECTOR AIR
PT2
FUEL CONTROL
FUEL PUMP AND FILTER
N2 TACHOMETER GENERATOR
CURRENT TRANSFORMER BOX
RIGHT SIDE - JT8D
8TH STAGE AIR
ENGINE ANTI-ICE AIR
6TH STAGE AIR
FUEL CONTROL PS4 PRESS.
11TH STAGE AIR
COMPRESSOR BLEED VALVE ACTUATING AIR
BLEED VALVE SIGNAL PRESS.
BLEED VALVE PS3 PRESS.
CSD PRESS. (6TH STAGE)
IGNITOR PLUG
GENERATOR COOLING AIR (FAN AIR)
BLEED VALVE CONTROL
GENERATOR COOLING AIR EXIT



ANTI-SURGE BLEED SYSTEM

JT8D

PRESSURE RATIO BLEED CONTROL



2. System Components

a. Compress Bleed Valves

Two compressor bleed valves are mounted on the diffuser case at th four and seven o'clock positions. After SB 5425 one 13th stage bleed valve on the diffuser case and three eight stage bleed valves on the rear compressor. They allow "thirteenth stage" and "eighth stage" air to bleed overboard into the fan discharge duct at low engine speeds.

b. Pressure Ratio Bleed Control

The pressure ratio bleed control is mounted on the lower right side of the engine on the fan discharge rear outer duct. It functions to provide proper scheduling of the compressor bleed valves.

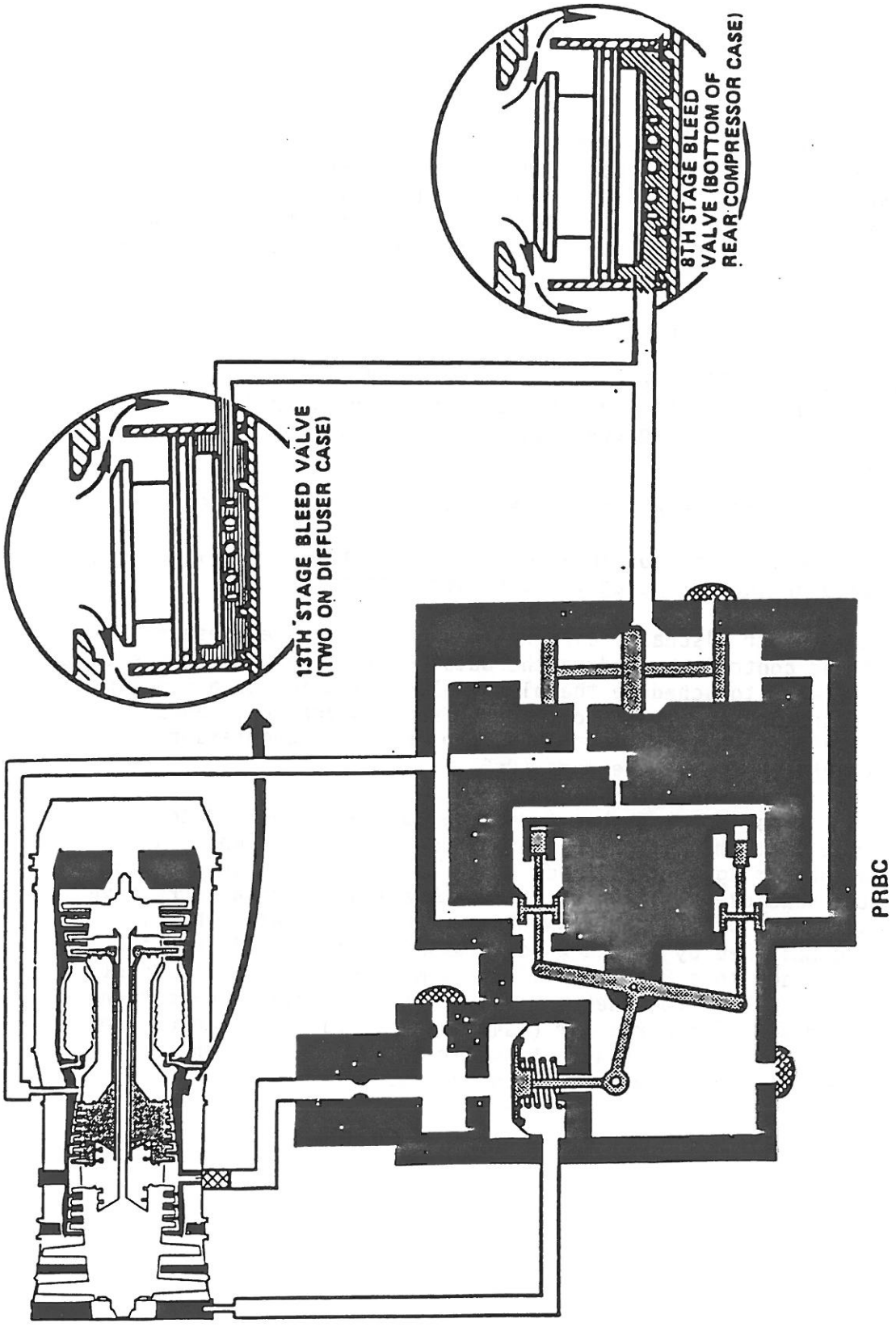
c. Description and Operation of Pressure Ratio Bleed Control

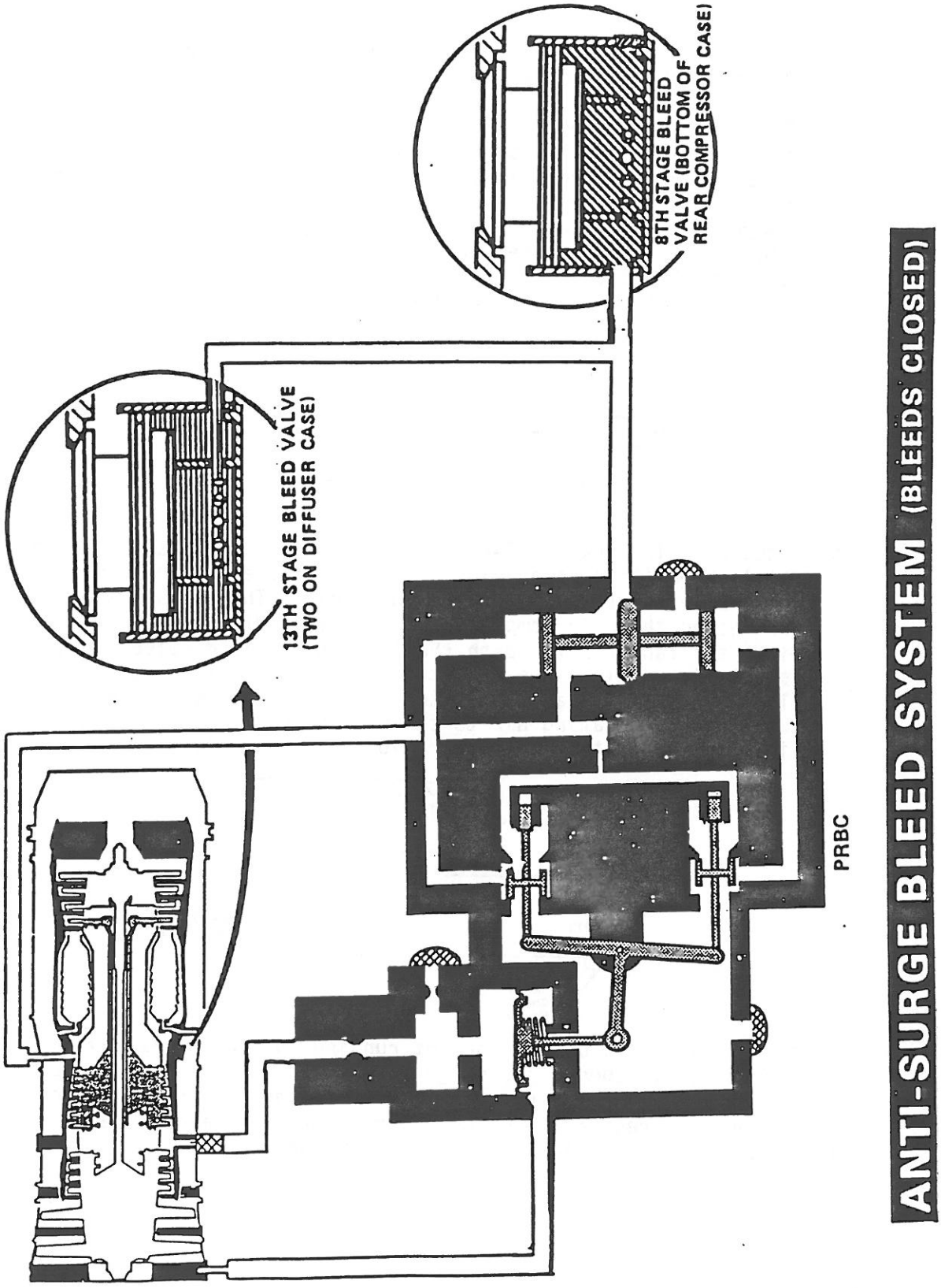
(1) The pressure ratio bleed control is located on the lower right side of the engine at the diffuser section.

(2) Compressor discharge air (Ps4) is routed to the pressure ratio bleed control mounted on the outside of the engine. This unit operates to schedule the bleed valve operation as a function of the pressure rise across the front compressor. Senses utilized are inlet total pressure (Pt2) and compressor discharge static pressure (Ps3).

(3) Ps3 is ported through a two-stage nozzle system and the resultant imput, upstream of the second nozzle, moves a diaphragm against Pt2 and spring pressure. Any change from the schedule position of the diaphragm produces a corrective action by varying the low pressure bleed valves. This is accomplished by a yoke which transmits the signal from the diaphragm to a transfer valve assembly consisting of poppet valves linked together. Movement of these valves directs high compressor discharge air (Ps4) to a "servo valve" which, in turn, moves to port actuating air to the manifold which supplies the individual bleed valves.

ANTI-SURGE BLEED SYSTEM

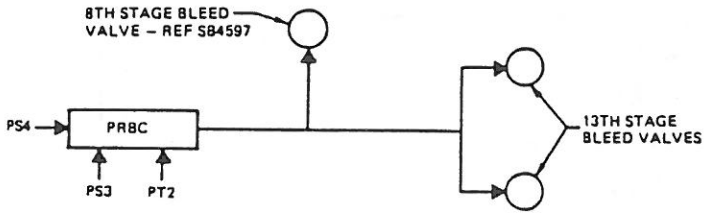




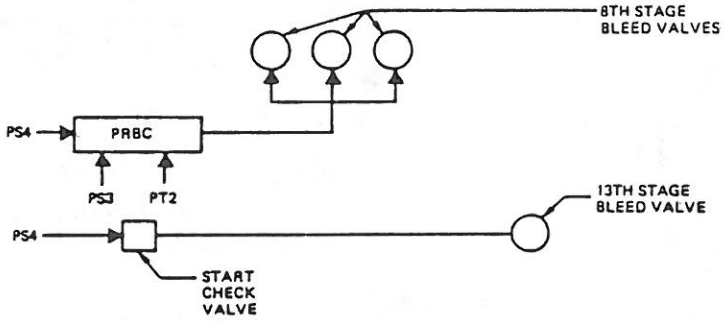
ANTI-SURGE BLEED SYSTEM (BLEEDS CLOSED)

3. In current JT8D engines this is accomplished by two basic arrangements of 8th and 13th stage bleed valves:

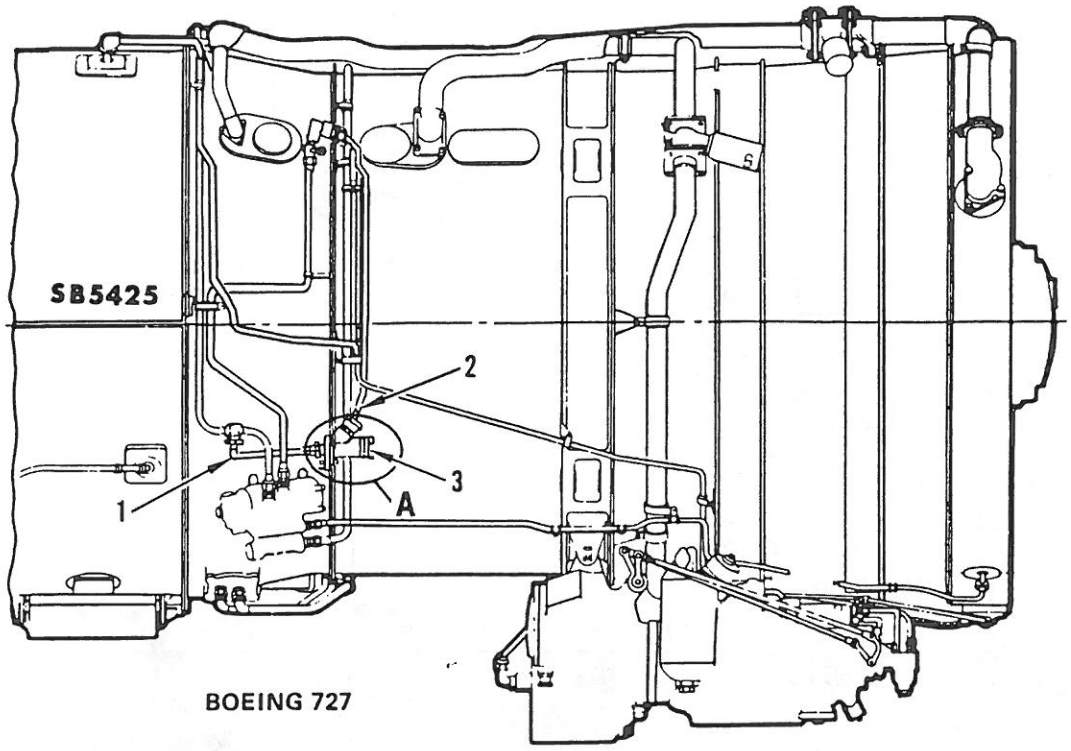
   a. Prior to P&WA SB 5425: Two 13th stage bleed valves (at four and seven o'clock positions on annulus of diffuser case) bleeds compressor discharge air (Ps4) into the fan stream. On current engines an additional, single 8th stage bleed valve on the rear compressor case (acting in unison with the 13th stage valves) bleeds 8th stage compressor air into the fan stream. Actuating air (Ps4) to the 8th and 13th stage bleed valves is interrupted by the pressure ratio bleed control.



   b. Incorporating P&WA SB 5425: One 13th stage bleed valve (at four o'clock position on annulus of diffuser case) bleeds compressor discharge air (Ps4) into the fan stream. Three 8th stage bleed valves on the rear compressor case bleeds 8th stage compressor air into the fan stream. Both the 13th stage bleed valve and the 8th stage bleed valves are actuated by Ps4 air; actuating air to the 13th stage bleed valve is interrupted by the start bleed control valve, and actuating air to the 8th stage bleed valves is interrupted by the pressure ratio bleed control.



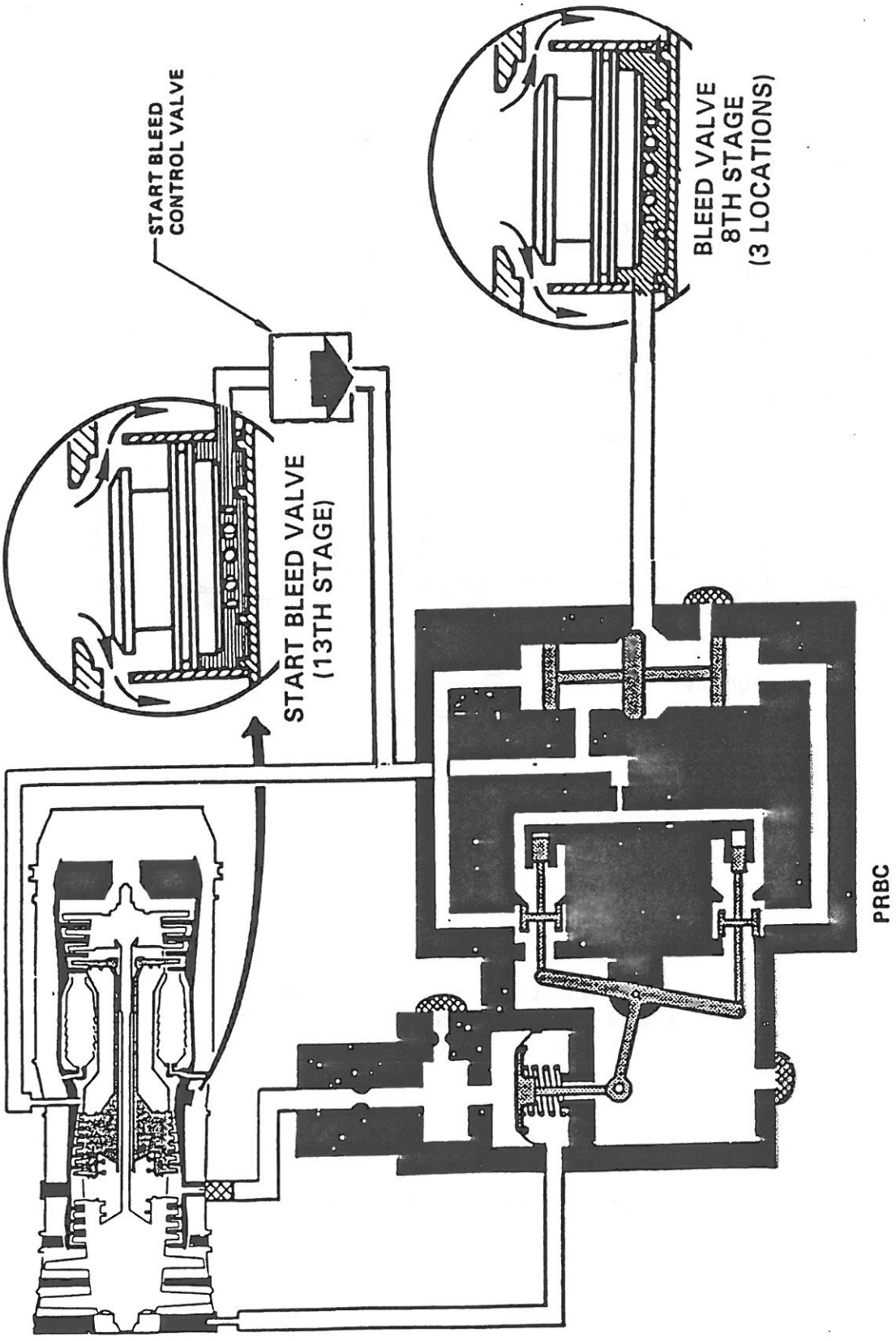
4. In the static position (engine not running) bleed valves may be either open or closed, depending upon gravity and/or drag caused by contact of the valves with the cylinder walls. During periods of engine operation, compressor discharge air pressure exerted on the valve faces acts to force valves into the open position.

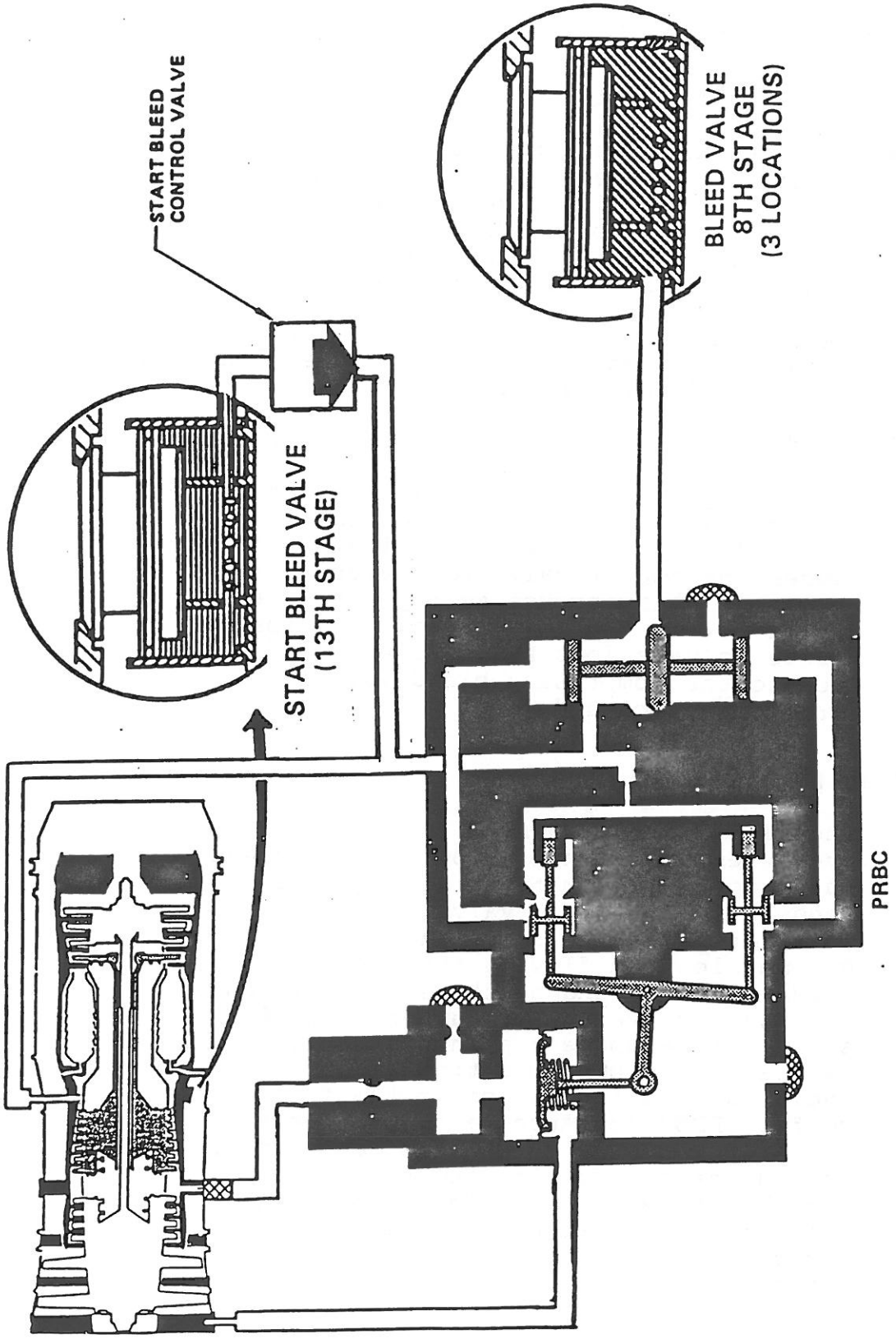


1. Bleed Control Ps4 Tube (Lower)
2. Bleed Control Ps4 Tube (Upper)
3. Start Bleed Control Valve

Start Bleed Control Valve

ANTI-SURGE BLEED SYSTEM (BLEEDS OPEN)





ANTI-SURGE BLEED SYSTEM (BLEEDS CLOSED)

ANTI-SURGE BLEED SYSTEM OPERATION

Engine Start and Idle

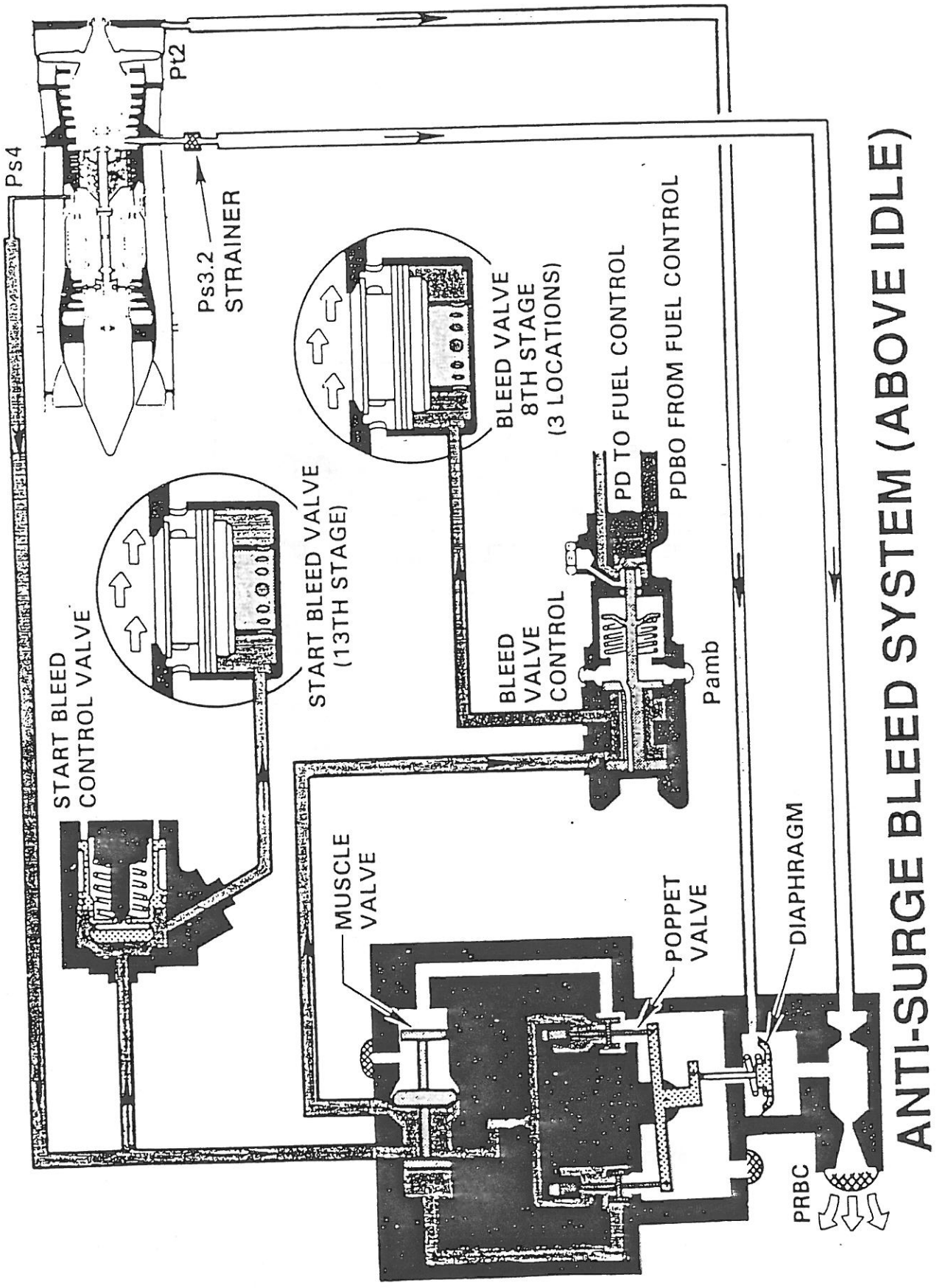
- During engine start and idle operation, the 8th stage bleed valves are open because the muscle valve in the PRBC is closed to the flow of Ps4, and is open to atmospheric vent. This allows the compressor air to push the bleed valves open. As the engine rpm increases the Ps4 pressure is sufficient to open the start bleed control valve and flow to the 13th stage bleed valve forcing it closed.

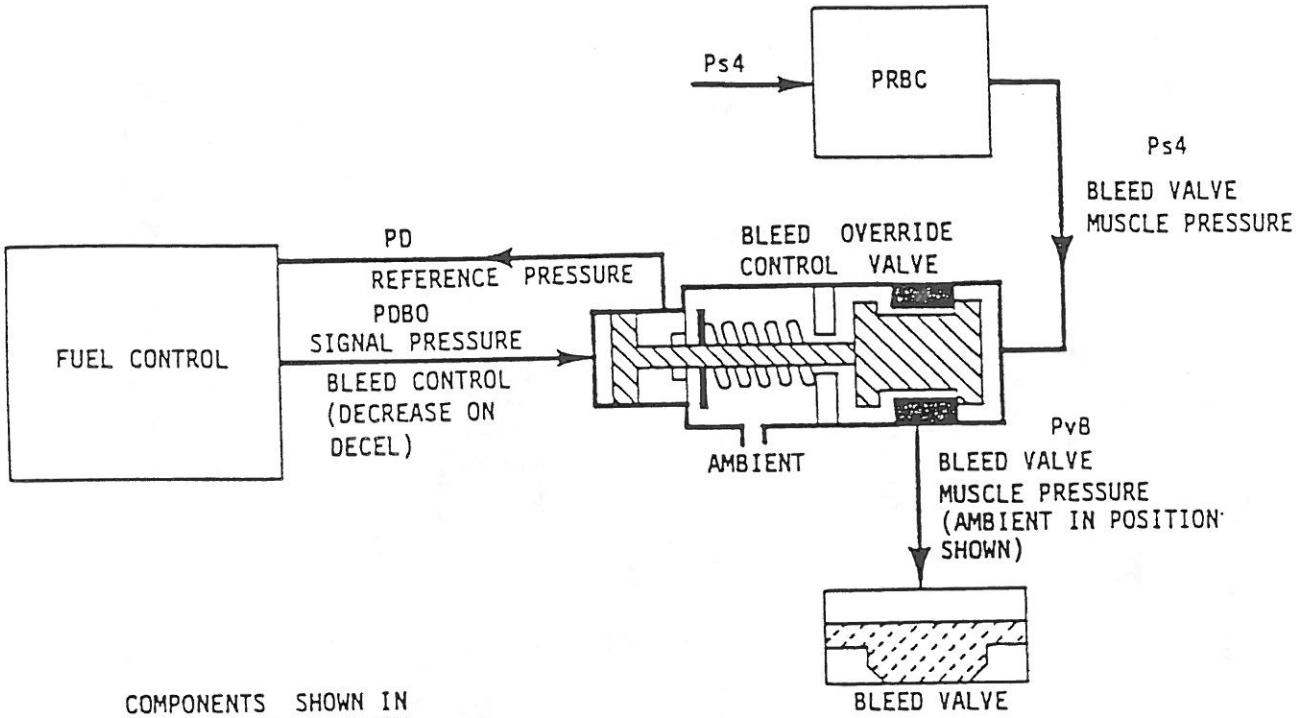
Above Idle

- As the engine is accelerated above idle the increasing Ps3.2 overcomes the combined force of Pt2 and spring. This causes the poppet valve to reverse position, allowing Ps4 to reposition the muscle valve. The repositioning of the muscle valve allows Ps4 muscle pressure to flow to the compressor bleed valves forcing them closed.

Snap Deceleration

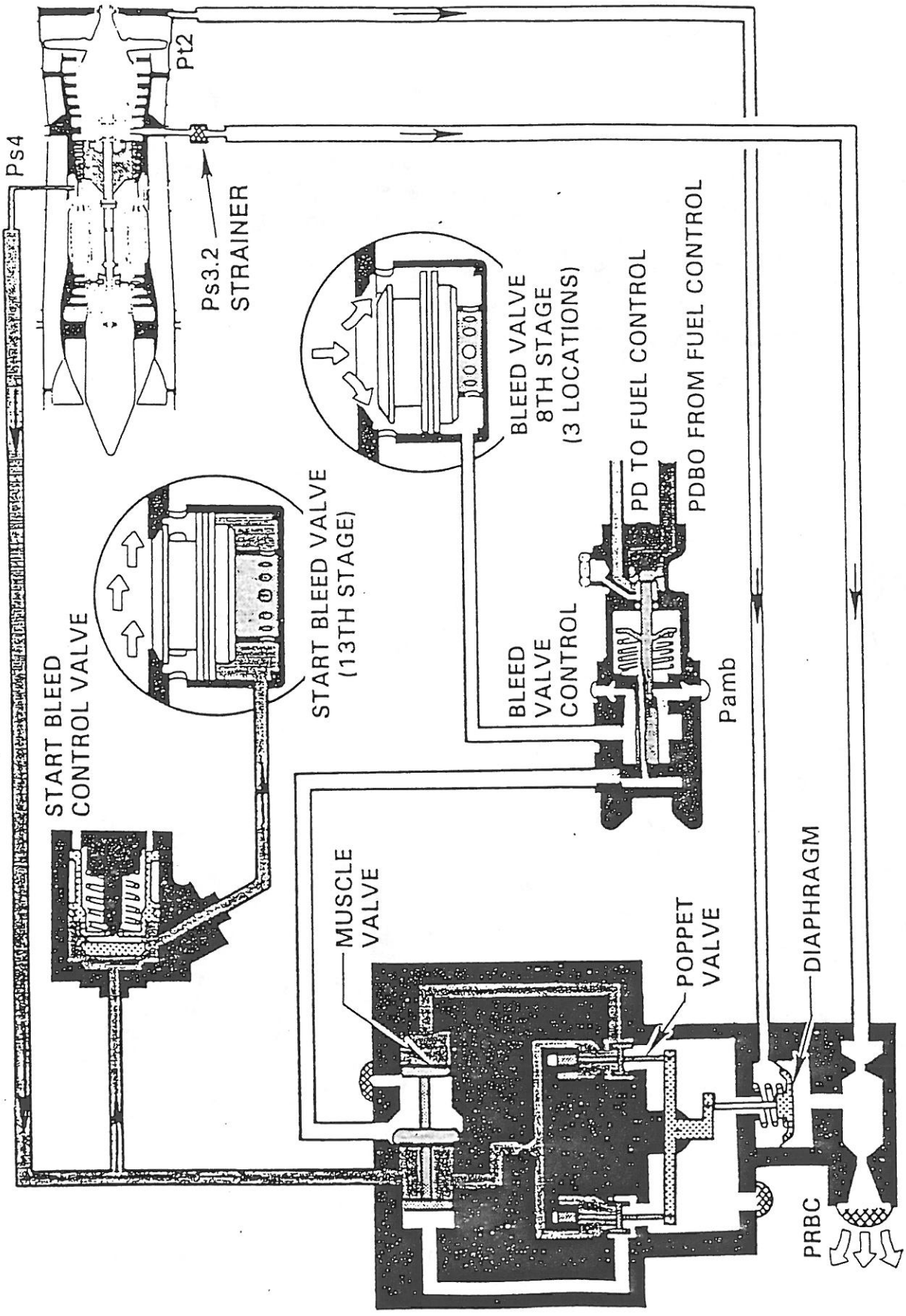
- The fuel control cuts off the high pressure fuel signal (PDBO) to the bleed valve control permitting spring force to reposition the bleed valve control transfer valve. This action prevents the Ps4 muscle from flowing through the bleed valve control, and at the same time vents the bleed valves to atmosphere. The 8th stage compressor air pushes the bleed valves to the open position. As the engine decels to idle power the fuel control PDBO pressure recovers. The Ps4 muscle pressure flow path is restored, but the engine has decelerated to low power and the Pt2 and spring force is greater than Ps3.2. Therefore, the bleed valves would remain open due to normal PRBC scheduling.


ANTI-SURGE BLEED SYSTEM (ABOVE IDLE)
Pt2
Ps4
Ps3.2 STRAINER
BLEED VALVE 8TH STAGE (3 LOCATIONS)
PD TO FUEL CONTROL
PDBO FROM FUEL CONTROL
START BLEED VALVE (13TH STAGE)
START BLEED CONTROL VALVE
BLEED VALVE CONTROL
Pamb
MUSCLE VALVE
POPPET VALVE
DIAPHRAGM
PRBC



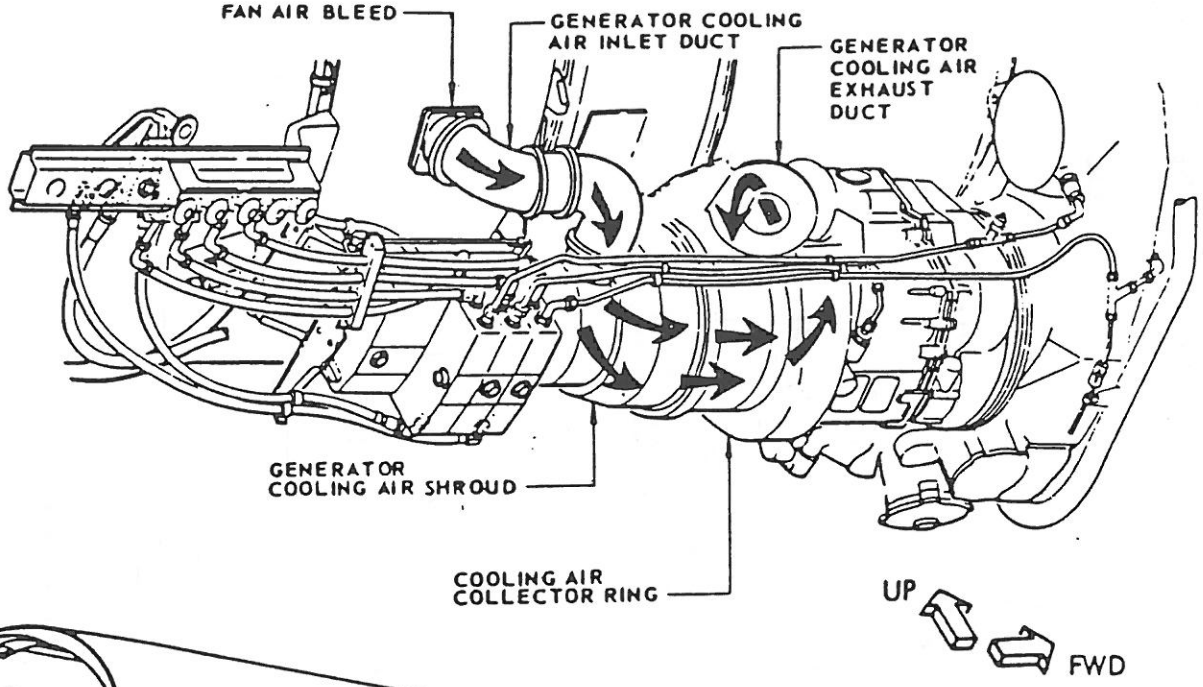
COMPONENTS SHOWN IN
DECEL OVERRIDE POSITION

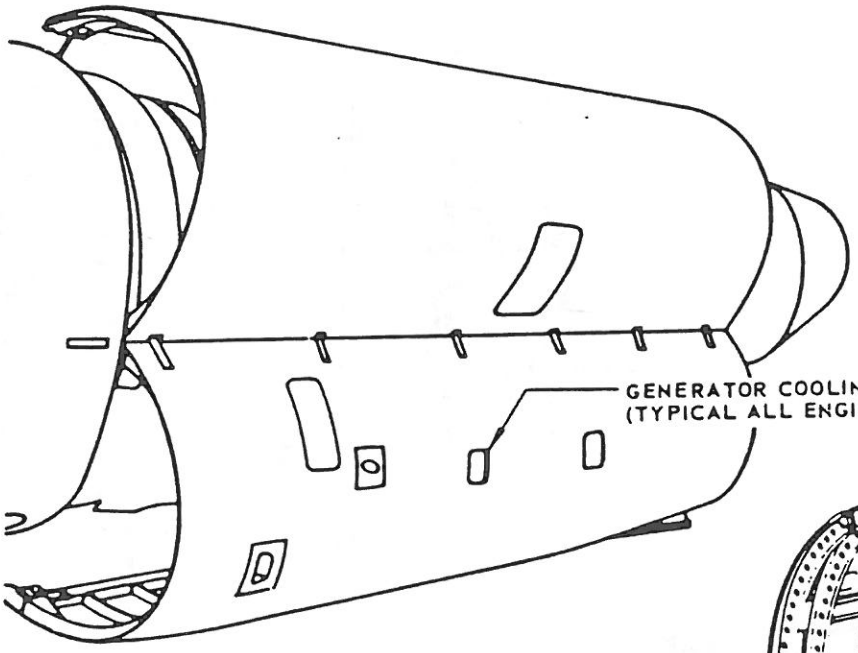
Bleed Override Control Valve – Schematic



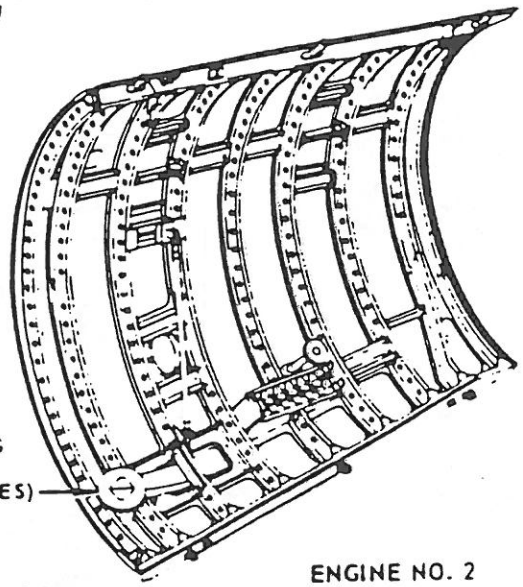
ANTI-SURGE BLEED SYSTEM

SNAP DECEL TO IDLE





TYPICAL ENGINES NO. 1 AND 3 COWL PANEL



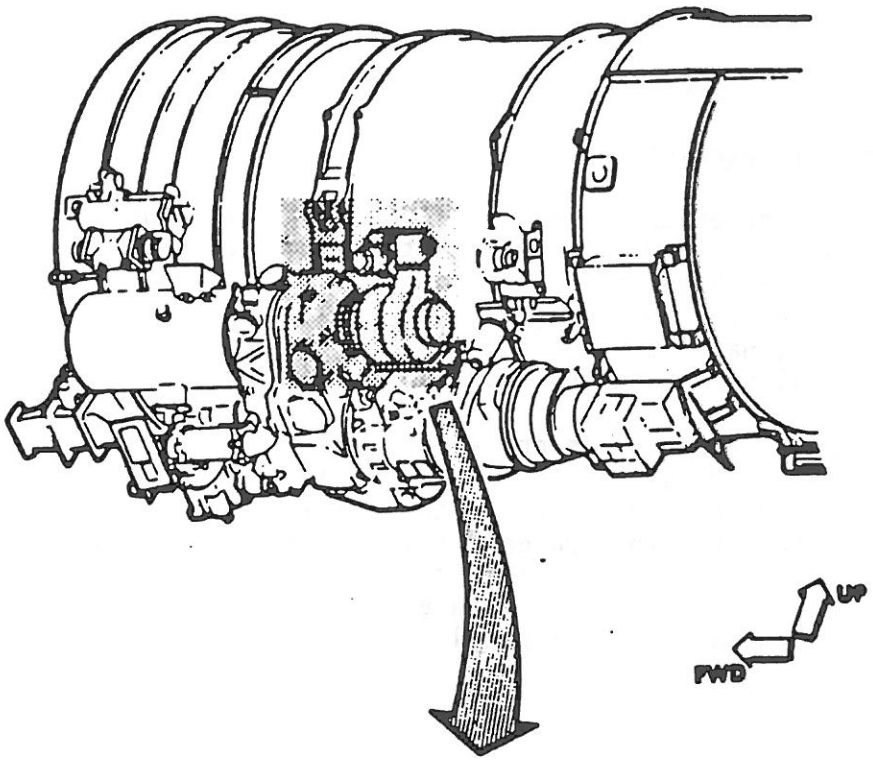
ENGINE NO. 2 COWL PANEL

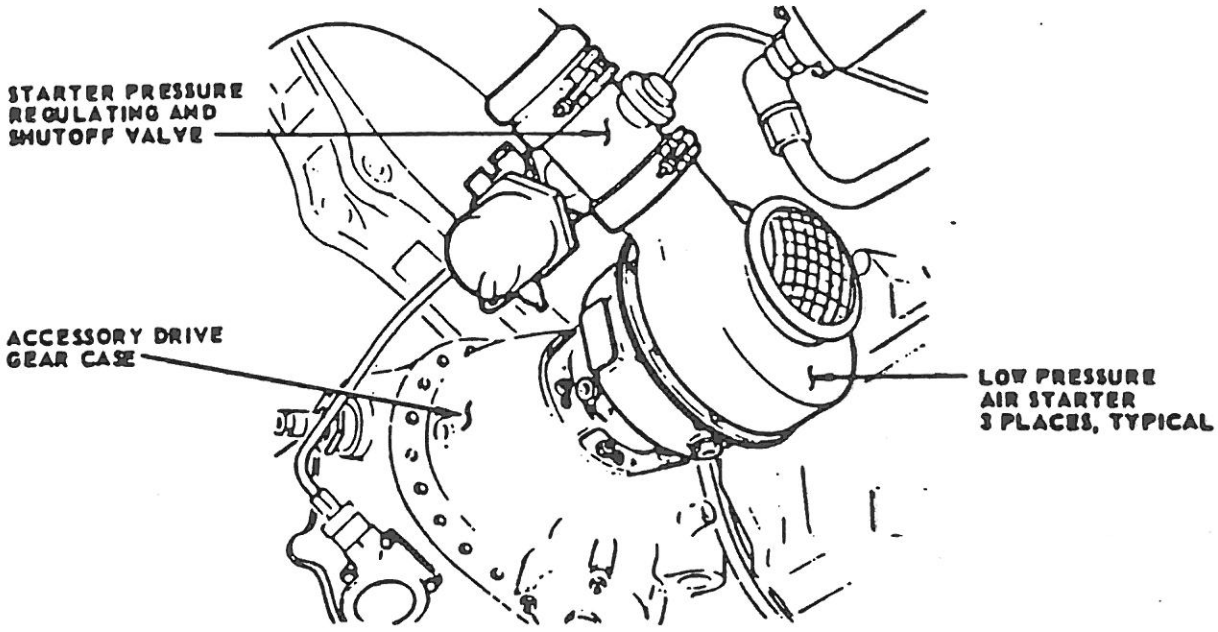
B. GENERATOR COOLING

1. General Description

a. The generator is a high speed unit that requires cooling whenever it is operating. To provide this cooling, the generator is supplied with engine bleed air. A port on the outer fan case of the engine is connected by a large duct, to a fitting on the end of the generator. An exhaust duct, attached t the generator shroud, mates with the cooling air exhaust port in the engine cowl panel.

b. When an engine is operating, low pressure fan air is forced through the large duct into the generator. The air circulates around the inside of the generator then leaves through the screened openings around the forward end of the generator casing. After leaving the generator, the air enters the generator shroud, passes through the exhaust duct and is then exhausted overboard through the exhaust port in the engine cowl panel.





PNEUMATIC STARTER SYSTEM