SECTION II

ENGINE

2-1. ENGINE.

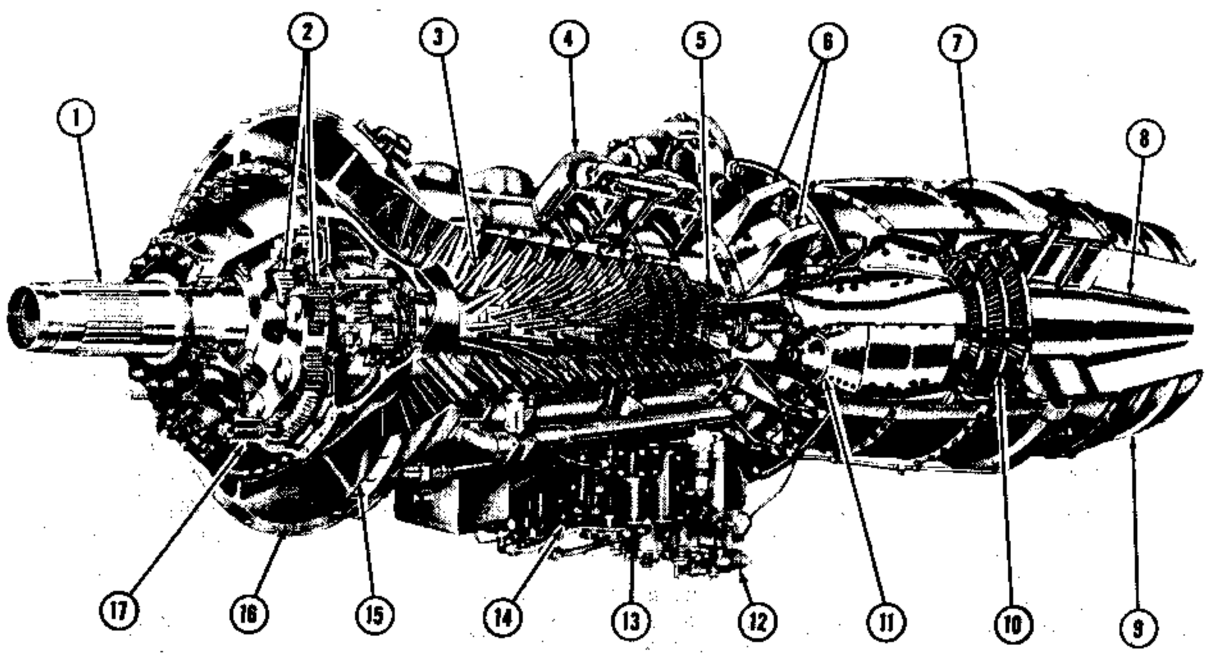
2-2. GENERAL DESCRIPTION. *(See figures 2-1 through 2-3.)* Airplanes 1 through 4 and 6 through 14 are powered by four Pratt & Whitney T34-P-3A engines, and airplanes 5 and 15 and subsequent are powered by four Pratt & Whitney T34-P-7W engines. The engines are housed in conventional semimonocoque nacelles, and are accessible through quick-opening orangepeel-type cowling. Each engine is a multistage, axial-flow, single-compressor gas turbine which produces thrust by driving a propeller at the front and discharging high-velocity gases through a nozzle at the rear. Each engine is capable of developing a static takeoff power of 6000 equivalent shaft horsepower (ESHP). A 13-stage, axial-flow compressor produces a maximum compression ratio of approximately 6.7 to 1. To facilitate starting and to prevent compressor stall at low power conditions, overboard air bleeds are provided at the sixth and seventh compression stages. These air bleed ports are automatically actuated and are open for starting and low power ground operation. Additional air bleed ports, located at the compressor discharge, provide high-pressure heated air for wing anti-icing and de-icing, and engine inlet and oil cooler anti-icing. The pressurized air is ducted aft for empennage boot de-icing, and may be used for starting other engines. The high-pressure heated air may also be used for air conditioning and pressurizing the airplane in an emergency (GTU's inoperative). The burner section contains eight combustion cones. Spark igniters are installed in the No. 2 and No. 7 cones for starting purposes. Combustion gases from the burner section enter the turbine section to provide turbine driving energy. The turbine has three expansion stages beyond which the high-velocity gases discharge through the tailpipe. Power from the turbine is transmitted to the compressor and propeller reduction gearing through a single shaft. To prevent an inoperative engine from windmilling either after feathering in flight or while the airplane is parked on the ground, a self-contained engine brake is incorporated on the starter drive shaft. The brake may also be used below 45 percent rpm to reduce the time required to shut down an engine on the ground. The engine incorporates negative torque control (NTC) to reduce asymmetric thrust by automatically suppressing windmilling drag from an inoperative engine before feathering the propeller.

2-3. The principal components of the engine are the nose section, air inlet section, compressor section, accessory section, combustion section, turbine section, and exhaust section. The engine and its accessories, except the oil tank and related components normally installed in the nacelle, make up the demountable power plant *(see figure 2-3)*. The demountable power plant consists of the engine, engine mount, engine accessories, tailpipe extension, and shroud. All T34-P-3A and T34-P-7W demountable power plants, except those which have been specifically adapted for inboard positions by the installation of the alternator, are interchangeable between nacelle positions.

2-4. ENGINE CONTROLS AND INSTALLATIONS. Engine controls and installations discussed in paragraphs 2-5 through 2-60 include those controls, switches, indicators, and installations that relate to the functions of maintenance personnel at the pilots' and systems engineer's stations (see paragraphs 2-61 through 2-85). For additional information on engine controls and indicators, see Sections III through X of this handbook and refer to the volume for *Instruments, Handbook Maintenance Instructions.*

2-5. ENGINE FUEL CONTROL.

2-6. The engine fuel control system receives fuel under boost pump pressure from the main fuel system through a firewall shutoff valve. The fuel is routed through strainers to the 2-stage engine-driven fuel pump, where its pressure is increased to the required pressure. From the engine-driven pump, fuel is routed to the fuel control unit, which includes a filter. The fuel control unit turns the fuel flow on or off through an integral shutoff valve (by movement of the propeller condition lever), and regulates engine power output by controlling fuel flow (by the position of the power lever). The fuel control unit meters fuel to the



1. Propeller Shaft
2. Reduction Gearing
3. First-Stage Axial Flow Compressor
4. Bleed Air Manifold
5. Thirteenth-Stage Axial Flow Compressor
6. Engine Vibration Isolator Mounting Pads
7. Turbine Case
8. Turbine Exhaust Cone
9. Turbine Exhaust Extension Outer Duct
10. Three-Stage Turbine Rotor
11. Combustion Chamber
12. Fuel Pressurizing And Dump Valve
13. Fuel Pump
14. Fuel Control
15. Air Inlet Strut
16. Annular Air Inlet
17. Negative Torque Control Switch Actuating Piston

Figure 2-1. Engine — Cutaway View — Typical

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engine according to a prescribed schedule for all operating conditions, without causing excessive turbine temperature or permitting fuel flow to fall below the minimum required to sustain combustion. From the fuel control unit, the regulated flow passes through the fuel flow transmitter to the pressurizing and dump valve. The pressurizing and dump valve diverts fuel to the engine primary and secondary fuel manifolds.

2-7. The gear-type fuel pump has two pumping stages. During normal operation, the first stage acts as an engine-driven boost pump which increases fuel pressure to the inlet of the second stage by approximately 25 psi. The second stage increases the pressure to approximately 500 psi. Either stage has adequate capacity to maintain limited power if the other stage fails.

2-8. The amount of fuel metered by the fuel control unit is a function of power lever position, engine speed, compressor inlet temperature, and combustion chamber pressure. Sensing units continuously monitor these operating conditions to regulate fuel flow to the engine.

2-9. The pressurizing and dump valve, located between the fuel control unit and the nozzle manifolds, diverts all fuel through the engine primary fuel manifold at low-pressure flow during engine starting. As the engine starts, the pressurizing valve, through higher pressure flow, opens an additional passage to the engine secondary fuel manifold. At engine shutdown, the loss of pressure allows the dump valve to open, thus draining both engine fuel manifolds overboard.

2-10. POWER LEVERS AND FRICTION LOCK.

2-11. Two banks of four power levers each, located on the control pedestal, are mechanically linked to the engine fuel control units and to the propeller circuits to control power output by coordinating fuel flow with propeller rpm. A friction-type power lever lock is actuated by a lever, placarded POWER LOCK, located to the right of the pilot's power levers. The power levers also control propeller reversing. Each power lever actuates a water-alcohol injection switch during advancement to MAX POWER (takeoff) position, and actuates the landing gear warning switch when re-

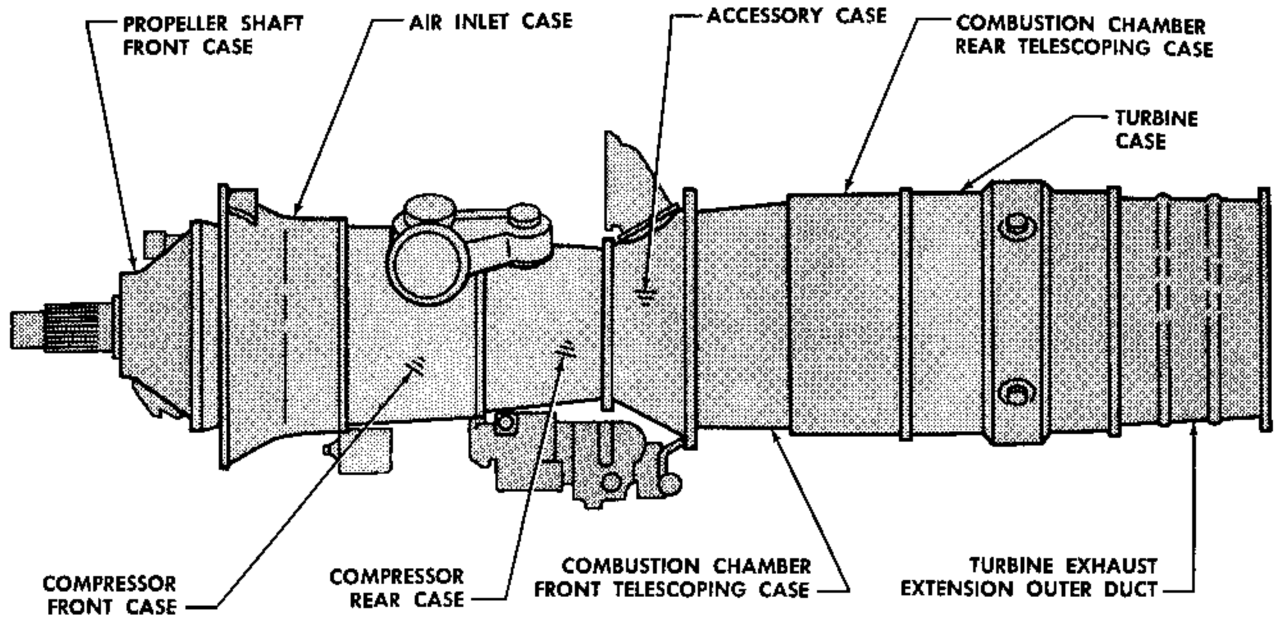


Figure 2-2. Engine Sections

tarded to the FLIGHT idle position. The takeoff warning horn switch is actuated by the No. 1 or No. 3 power lever at slightly above FLIGHT idle. The power lever, through mechanical linkage, also actuates the synchronizer circuits to set the desired synchronization speed of the propellers throughout the FLIGHT range. In the GROUND range, the power lever, through mechanical linkage, actuates the propeller circuits to create a pitch change signal to either the feather motor or the clutches to set the propeller blade angle. The engine is controlled by fuel governing.

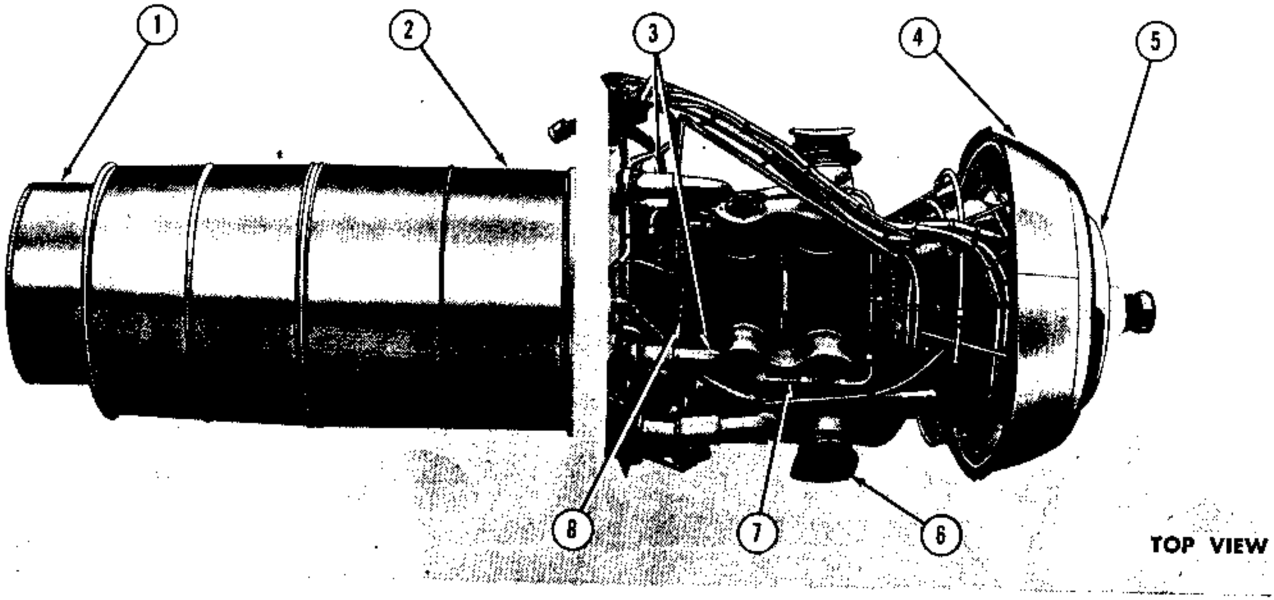
2-12. GROUND IDLE SPEED SWITCHES. Two ground idle speed switches, one for the No. 1 and No. 4 engines, and one for the No. 2 and No. 3 engines, are installed on the pilots' overhead electrical panel. The switches provide two ranges of idle speed for ground operation, HI IDLE and LOW IDLE. The switches are spring loaded to the HI IDLE position. When a power lever is retarded to the GROUND idle position and the respective ground idle speed switch is momentarily actuated to the LOW IDLE position, a 28-volt d-c circuit is completed to energize a solenoid on the fuel control unit to change the ground idle stop to the low idle position; engine speed then drops to approximately 55.5 percent (6000) rpm. When the power lever is advanced to or above the FLIGHT idle position, or is moved to REVERSE, a cam mechanically actuates a mechanism on the fuel control unit to change the ground idle stop to the righ idle position or 90.9 percent (10,000) rpm. When the power lever is again retarded to the GROUND idle position or taken out o REVERSE, engine speed will be maintained at 90. percent (10,000) rpm until the ground idle speed switc is again actuated to the LOW IDLE position.

Note

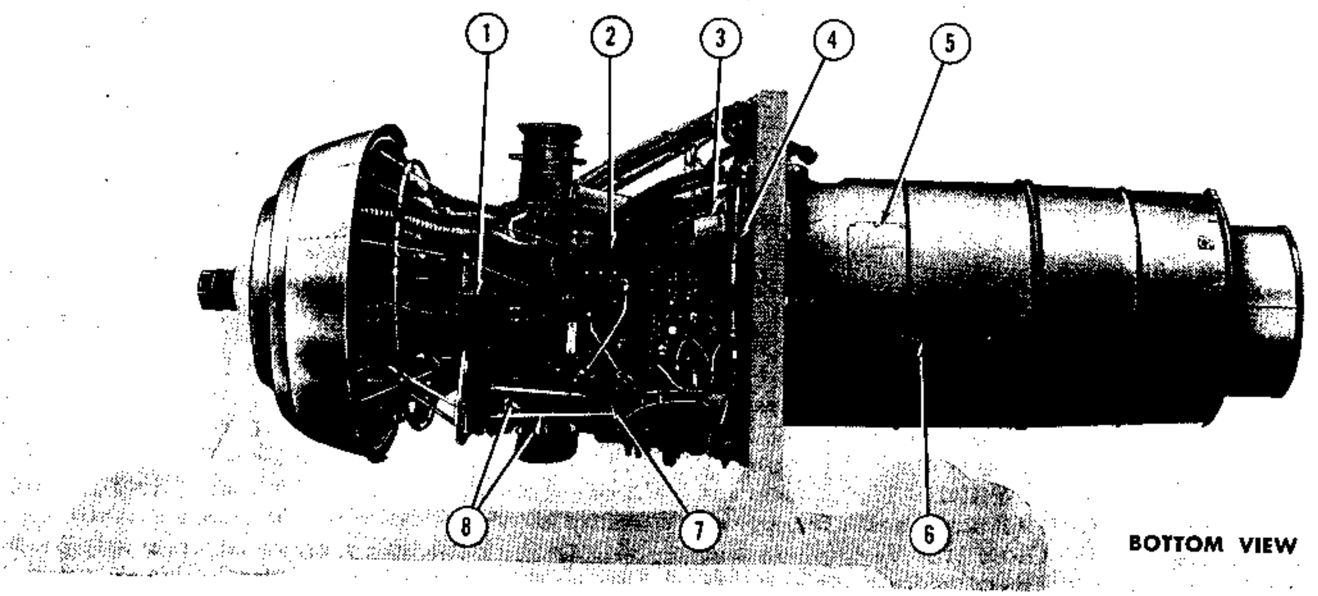
When the engines are shut down from high idle rpm, the engines will accelerate to 90.9 percent (10,000) rpm upon starting. If the engines are shut down from low idle rpm, the engines will not accelerate above 55.5 percent (6000) rpm upon starting, unless the power lever is advanced to or above the FLIGHT idle position or is placed in REVERSE.

2-13. NEGATIVE TORQUE CONTROL.

2-14. A dual negative torque control (NTC) is ir stalled on each engine to automatically provide a increase pitch (decrease rpm) signal whenever a cond tion of negative torque (propeller driving the turbine exists. If a condition of negative torque is sensed b the NTC, the propeller pitch circuit is actuated to sta the propeller toward feather position. The propelle will continue toward feather position until a blad angle is reached where negative torque is less than tha required to actuate the circuit. The system will no drive the propeller completely to feather. If engin power is restored before feathering, normal propelle operation is automatically restored. The NTC syster is automatic during operation in the flight range, syn



1. Exhaust Extension
2. Engine Shroud
3. Engine Bleed Air Pipes
4. Cowl Nosering
5. Propeller Spinner Afterbody Fairing
6. Overboard Bleed Air Manifold Joint
7. Acceleration Bleed Air Manifold
8. Alternator Mounting Pad



1. Ignition Exciter
2. Fuel Pump
3. Vibration Isolator
4. Fire Extinguisher Spray Ring
5. Combustion Section Access Door
6. Combustion Chamber Fuel Drain Hose
7. Fuel Control Unit
8. Fuel Control Pushrods

Figure 2-3 (Sheet 1 of 2). Engine—Typical

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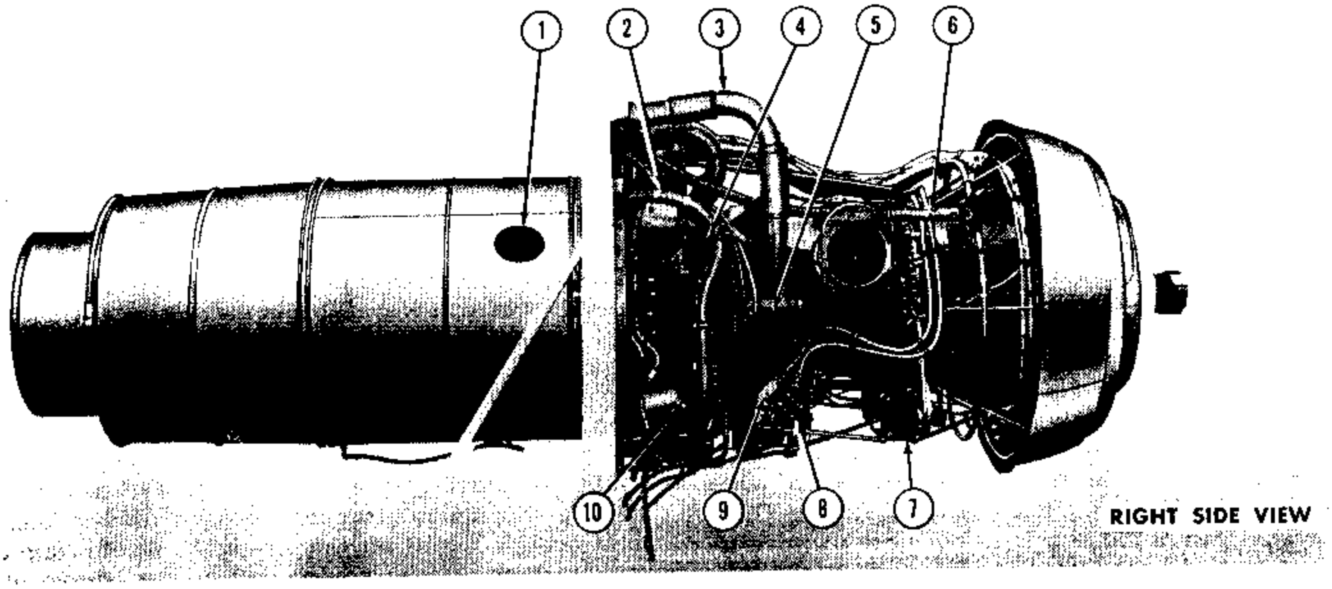
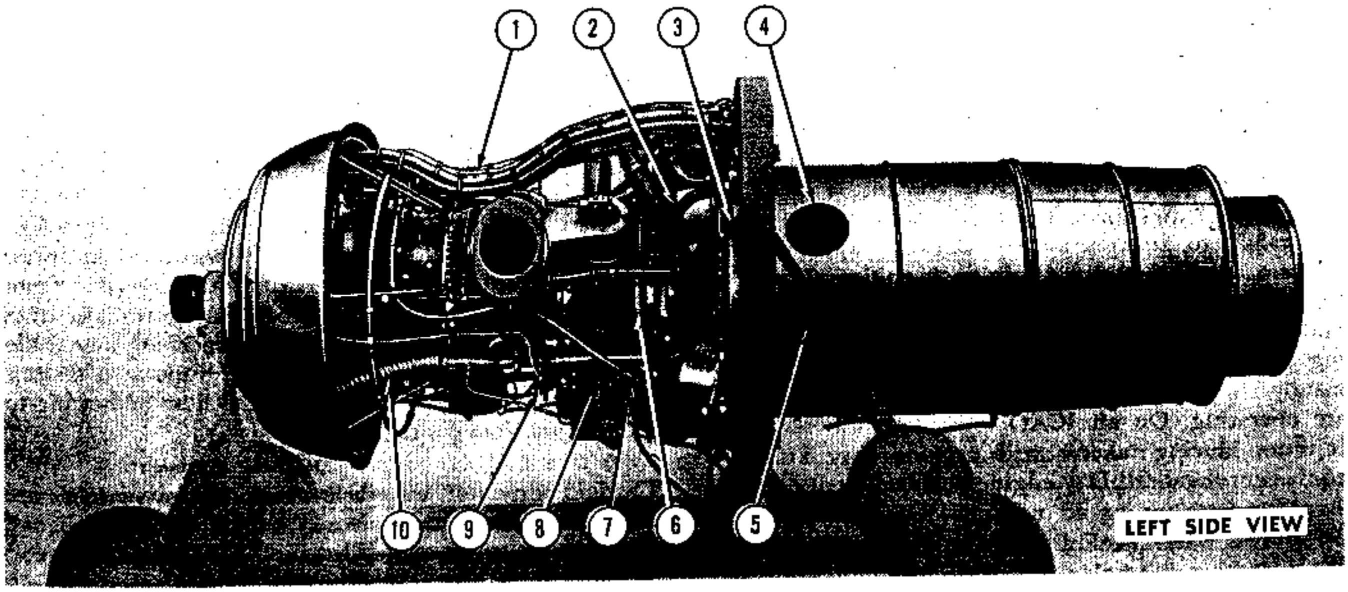


1. Shroud Cooling Port
2. Oil Supply Hose
3. Starter Supply Pipe
4. Engine Brake Actuator
5. Air Turbine Starter
6. Fire Extinguisher Supply Hose and Spray Ring
7. Engine Control Gear Box
8. Propeller Coordinator
9. Flight Low-Pitch Stop Latch Switch
10. Tachometer Generator



1. Engine and Propeller Control Conduits
2. Oil Return Hose
3. Oil Tank Vent Hose
4. Shroud Cooling Port
5. Alternator Cooling Air Exhaust Port (Covered On Outboard Installations)
6. Ignition Compositor
7. Oil Breather Hose
8. Fuel Supply Hose
9. Cowl Anti-Icing Control Valve
10. Cowl Anti-Icing Supply Hose

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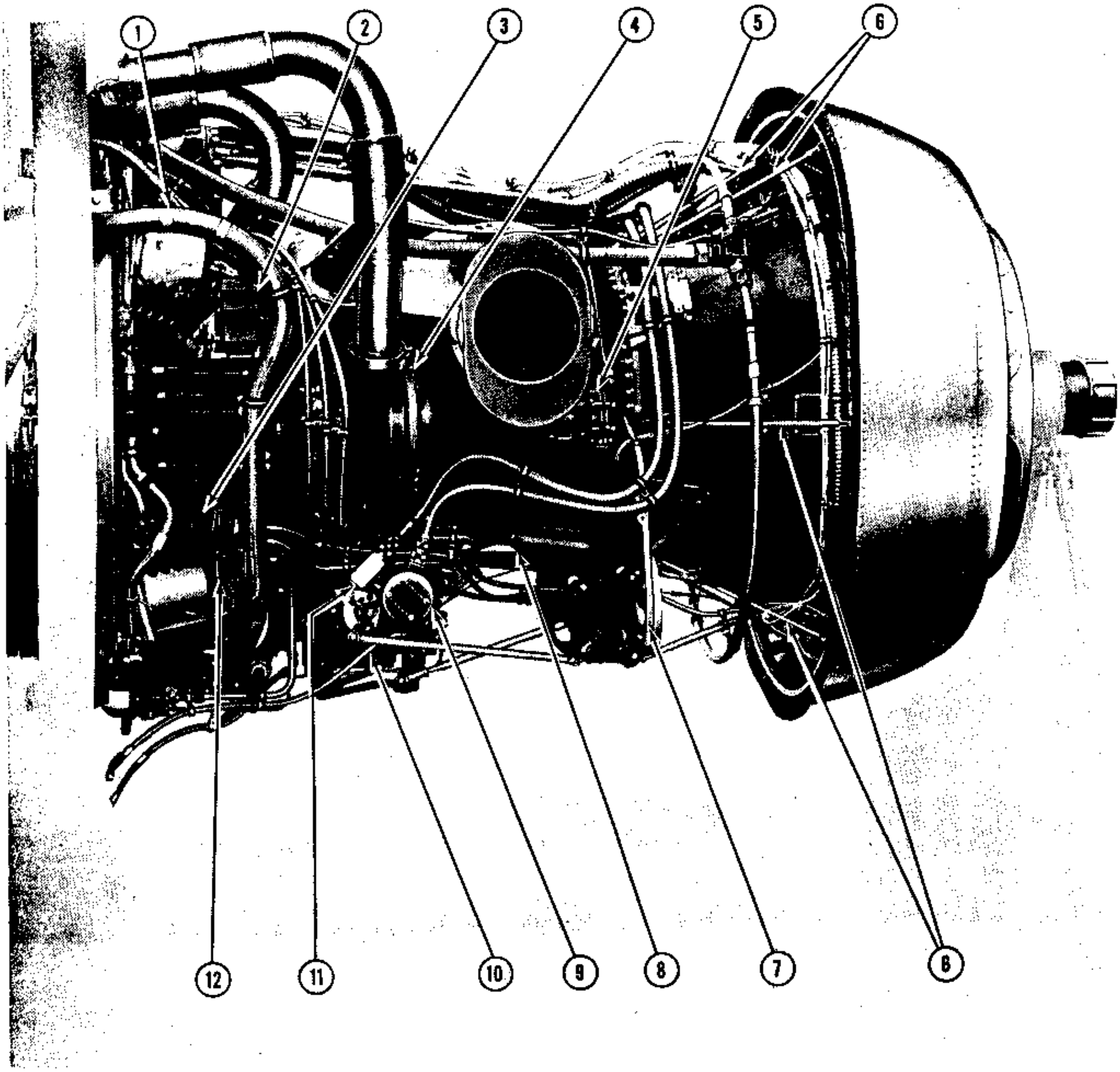
Figure 2-3 (Sheet 2 of 2). Engine—Typical



1. Oil Inlet from Tank
2. Engine Brake Actuator
3. Fuel Flow Transmitter
4. Pneumatic Starter
5. Compressor Overboard Air Bleed Control
6. Cowl Nose Ring Support Struts
7. Engine Controls Bracket
8. Engine Inlet Guide Vane Anti-icing Air Tube
9. Propeller Coordinator
10. Propeller Coordinator Seal Drain
11. Propeller Flight Low-Pitch Stop Latch Switch
12. Tachometer Generator

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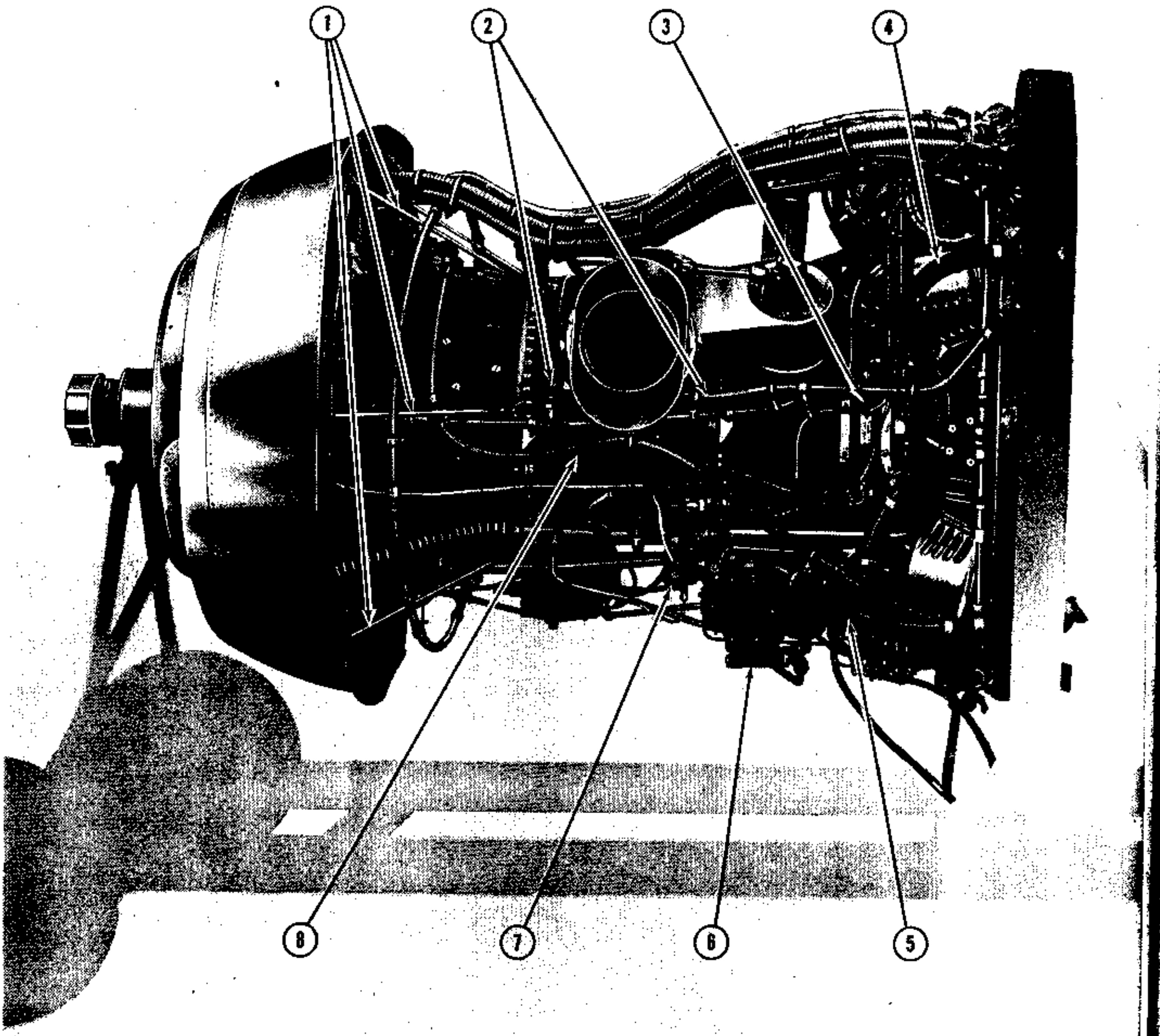
Figure 2-10 (Sheet 1 of 5). Engine Buildup—Right Side



1. Cowl Nose Ring Strut Support Assembly
2. Oil Tank Vent Hose and Lines
3. Ignition Compositor
4. Oil Return to Tank Hose
5. Fuel in Hose
6. Fuel Pump
7. Engine Cowl Anti-Icing Air Valve
8. Engine Breather Hose

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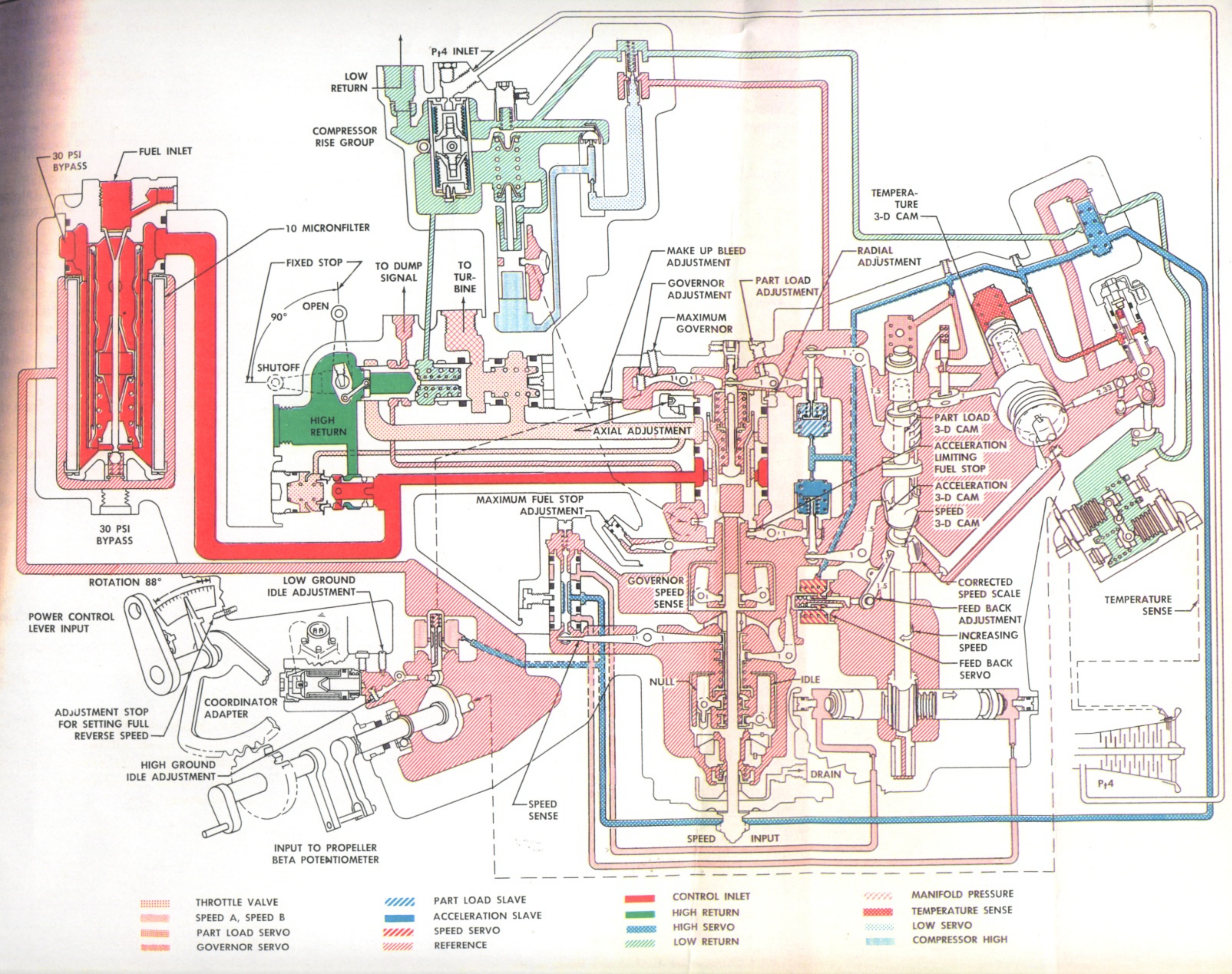
Figure 2-10 (Sheet 2 of 5). Engine Buildup—Left Side



LOW RETURN
P$_t$4 INLET
COMPRESSOR RISE GROUP
30 PSI BYPASS
FUEL INLET
10 MICRONFILTER
FIXED STOP
TO DUMP SIGNAL
TO TURBINE
OPEN
90°
SHUTOFF
HIGH RETURN
30 PSI BYPASS
MAKE UP BLEED ADJUSTMENT
GOVERNOR ADJUSTMENT
MAXIMUM GOVERNOR
PART LOAD ADJUSTMENT
RADIAL ADJUSTMENT
TEMPERATURE 3-D CAM
AXIAL ADJUSTMENT
PART LOAD 3-D CAM
ACCELERATION LIMITING FUEL STOP
ACCELERATION 3-D CAM
SPEED 3-D CAM
MAXIMUM FUEL STOP ADJUSTMENT
ROTATION 88°
LOW GROUND IDLE ADJUSTMENT
POWER CONTROL LEVER INPUT
GOVERNOR SPEED SENSE
CORRECTED SPEED SCALE
FEED BACK ADJUSTMENT
INCREASING SPEED
FEED BACK SERVO
TEMPERATURE SENSE
COORDINATOR ADAPTER
ADJUSTMENT STOP FOR SETTING FULL REVERSE SPEED
HIGH GROUND IDLE ADJUSTMENT
NULL
IDLE
DRAIN
P$_t$4
SPEED SENSE
SPEED INPUT
INPUT TO PROPELLER BETA POTENTIOMETER
THROTTLE VALVE
SPEED A, SPEED B
PART LOAD SERVO
GOVERNOR SERVO
PART LOAD SLAVE
ACCELERATION SLAVE
SPEED SERVO
REFERENCE
CONTROL INLET
HIGH RETURN
HIGH SERVO
LOW RETURN
MANIFOLD PRESSURE
TEMPERATURE SENSE
LOW SERVO
COMPRESSOR HIGH