ENGINE

Jet engines produce thrust by accelerating air. It is the product of the mass of the air times the increase in velocity that determines thrust output. To generate a given amount of thrust, a small volume of air can be accelerated to a very high velocity, or a relatively large amount can be accelerated to a lower velocity. In a turbojet engine, incoming air is compressed, mixed with fuel, combusted and exhausted at a high velocity. In a turbofan engine, only a portion of incoming air is combusted. The hot air then drives the fan which accelerates a large volume of air at a lower velocity. This air is bypassed around the engine core and is not mixed with fuel or combusted. The relation of the total mass of bypassed air, to the amount of air going through the combustion section, is known as the bypass ratio. The bypass ratio of the Citation 525A engine is 3.3 to 1.

The FJ44-2C, developed for the Citation 525A by Williams International, is a medium-bypass turbofan engine rated at 2400 pounds static thrust (sea level). A concentric shaft system supports the fan and turbine rotors. The inner shaft connects the fan (N_1) and the axial boost stage of the low pressure compressor at the front of the engine to the two rear low pressure turbines. The outer shaft connects the high pressure centrifugal compressor (N_2) and the forward (high pressure) turbine. All intake air passes through the fan. Immediately aft of the fan the airflow is divided by a concentric duct. Most of the total airflow is bypassed around the engine core through the outer bypass duct and is exhausted at the rear. Air entering the inner duct passes through a single-stage axial intermediate pressure (IP) compressor. The high pressure air then passes through a diffuser assembly and moves aft to the combustion section. The primary part of the combustion section is the combustion chamber, which is of a folded annular design. Fuel is introduced through a manifold to a rotating fuel slinger, which atomizes and uniformly delivers the fuel to the primary combustion zone. A stationary ("start") fuel nozzle is also provided to improve cold and high altitude start characteristics.

NOTE

"Start" nozzle fuel is used by the engine at an approximate rate of 9 pounds per hour and is reflected in the fuel flow indications.

The mixture is ignited initially by two capacitive-discharge, single-output exciters which are located at the one o'clock position on the engine. Each exciter output is connected to an igniter plug that extends into the primary zone of the combustor. After start, combustion becomes self-sustaining, however the igniters are capable of continuous operation at all points of the engine operating envelope. The hot gases expand and travel rearward through the high pressure turbine. The power generated by this turbine is transmitted by the outer shaft to turn the N_2 compressor. Only a small part of the energy available in the hot, high pressure air is absorbed by the high pressure turbine. As the expanding gases move rearward, they pass through a set of guide vanes and enter the two-stage, low-pressure turbine. A greater portion of the remaining energy is extracted there and transmitted by the inner shaft to the forward-mounted fan. The hot gases then exhaust into the atmosphere. The turbofan is in effect two interrelated powerplants. One section is designed to produce energy in the form of high velocity, hot air. The other utilizes some of this air to provide the power to drive the fan. The fan of the FJ44-2C, pumping a high volume of cool low-velocity air, produces over half of the total thrust.

The N_1 (fan) and N_2 (turbine) shaft speed outputs to the cockpit indicators are magnetic

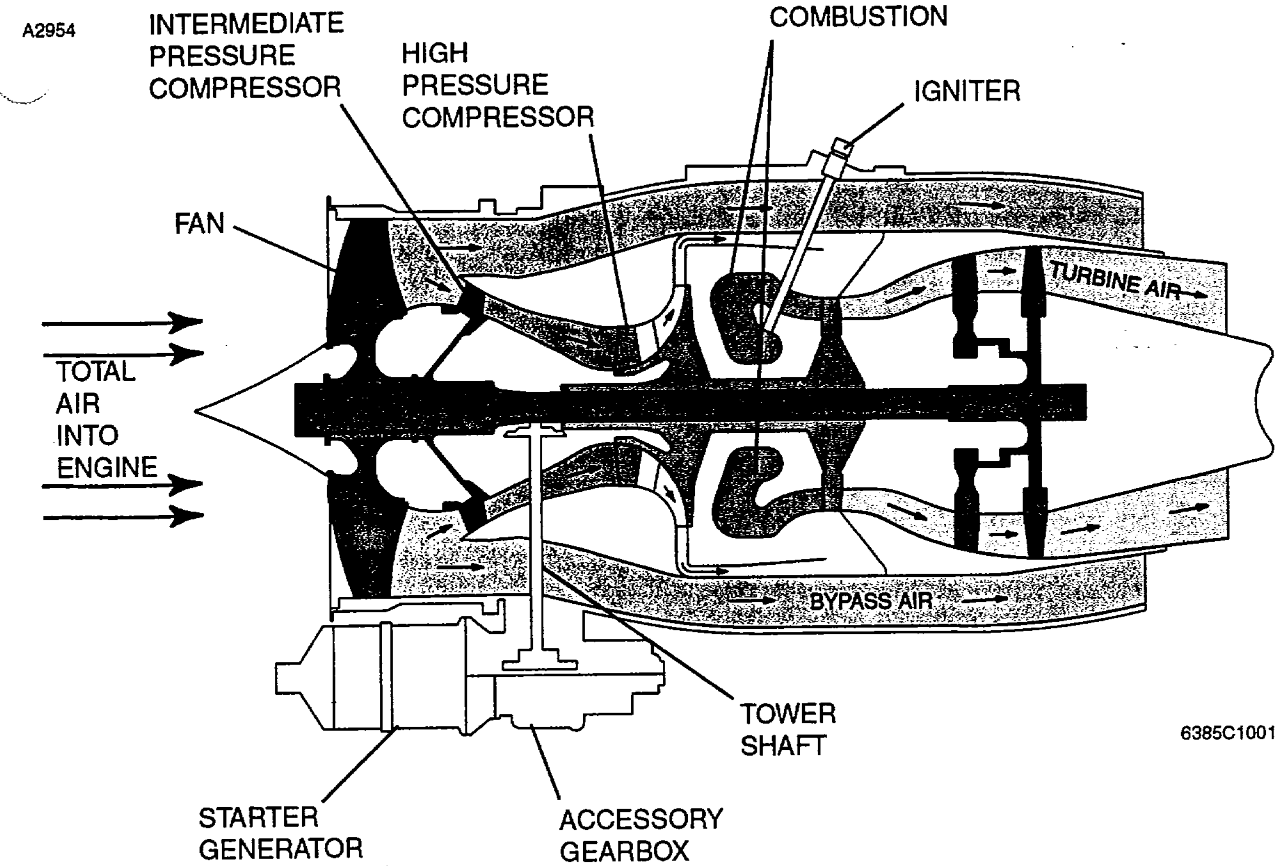


Figure 2-1 Engine Airflow

sensors. DC electrical power is required for their operation. Circuit breakers for the left engine indicators are located on the left circuit breaker panel and circuit breakers for the right engine are located on the right panel.

An engine synchronizer system provides automatic N_1 fan or N_2 turbine RPM matching of the right (slave) engine to the left (master) engine. The synchronizer will continuously monitor the engine speeds and adjust the slave engine speed setting as required. The actuator has a range capability of 3 percent of fan RPM and 3 percent of turbine RPM. A rotary FAN-OFF-TURB switch on the pedestal actuates the engine synchronizer system. FAN position synchronizes N_1 RPM and TURB position synchronizes N_2 RPM. OFF position deactivates the system and drives the actuator to the center of its range before stopping. An indicator light adjacent to the synchronizer switch comes on when the system is turned on. A turbine out-of-sync condition is generally more noticeable in the cockpit and a fan out-of-sync condition is usually more noticeable in the area of the rear seats.

IGNITION SYSTEM

Each engine incorporates dual exciter units and two igniters. The exciter units convert battery or generator input to high voltage Direct Current (DC), store it momentarily until a given energy level is reached, and allow it to discharge in spark form through the igniters. System wiring is such that malfunction of one igniter or exciter will not affect normal operation of the other.

Cockpit control consists of two-position RH and LH ignition switches. In NORM, function is automatic during start or during engine anti-ice operation. Moving the throttle to IDLE after depressing the start button activates ignition until it is terminated automatically at approximately 45 percent turbine RPM (N_2). Continuous ignition occurs any time the respective engine anti-ice switch is in either the ENG ON or ENG/WING position or the ignition switch is ON.

A small green light above each ignition switch illuminates whenever one or both exciters are receiving electrical power. If one igniter should fail, ignition will still be available from the remaining igniter. If the ignition light does not illuminate when ignition is selected, or should be automatically provided, check the applicable ignition system circuit breaker on the left circuit breaker panel.

CAUTION

IF THE IGNITER CIRCUIT BREAKER IS PULLED, DO NOT ATTEMPT TO RESET THE CIRCUIT BREAKER UNTIL THE START HAS BEEN ABORTED.

ACCESSORY GEARBOX

The starter/generator, fuel pump, fuel control, hydraulic pump, and oil pump are driven by the accessory gearbox mounted below the engine. Power to drive the gearbox is transmitted from the N_2 section through the tower shaft and a series of bevel gears. Lubrication is provided by the engine oil system.

OIL SYSTEM

The system provides cooled, pressurized oil for lubrication and cooling of engine bearings and accessory drive gears and bearings. An integral tank on each engine has a capacity of approximately 2.0 U.S. quarts of usable oil.

Oil is drawn from the tank by the pressure element of the three-element pump mounted on the accessory gearbox. It passes through a screen at the tank exit and through a screen and magnetic chip collector at the pump inlet, and then through the pump enroute to the main oil filter and the fuel/oil cooler.

From the cooler, which is a fuel-oil heat exchanger, it passes through filters before being routed to the engine bearings and accessory gearbox. A poppet-type pressure regulator valve maintains a steady pressure by bypassing oil back to the tank, when required.

Circulated oil is returned to the tank by the pump's two scavenge elements. Oil from bearings 1, 2, and the tower shaft gravity drains into the accessory gearbox where it is picked up by one element. The other element scavenges from the rear bearing cavity (bearings 3 and 4).

A filter bypass is provided in the gearbox housing. As differential pressure across the filter approaches the 25 to 30 PSID range, the valve opens to ensure oil flow to the engine even if the filter element becomes completely clogged. An impending bypass indicator assembly is paralleled with the filter and bypass valve. A button extends to provide visual indication of impending bypass. The indicator is actuated at 15 PSID which is a minimum of 10 PSI prior to bypass. A thermal lockout prevents actuation caused by high oil pressure caused by cold oil.

An oil filler port with dipstick and sight gage is provided at the 10 o'clock position of the left engine and the two o'clock position of the right of the engine. This enables convenient left or right engine oil reservoir level checks and oil addition.

Cockpit indicators receive inputs from the pressure transducer and the temperature sensor which are located just downstream of the oil cooler.

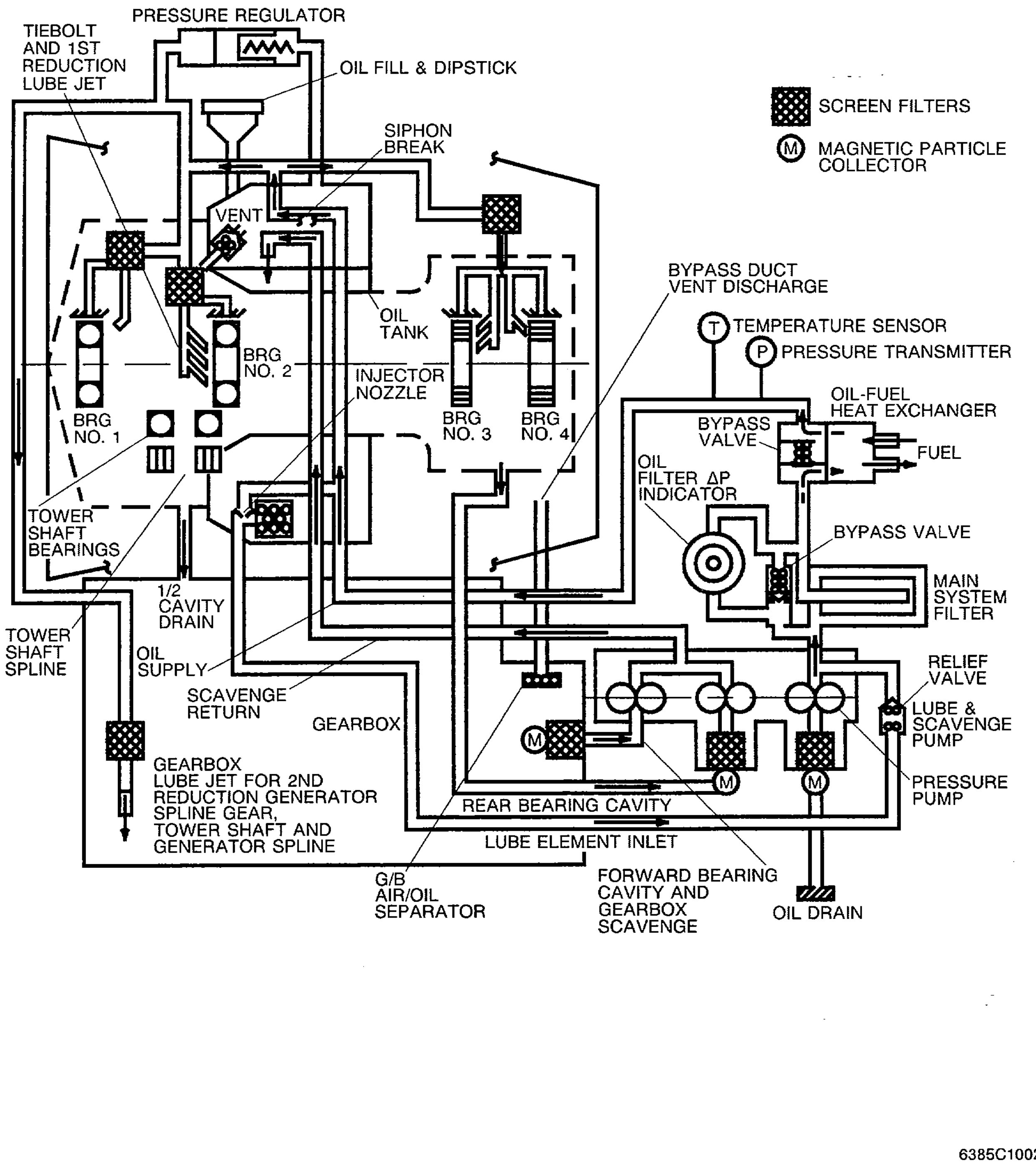
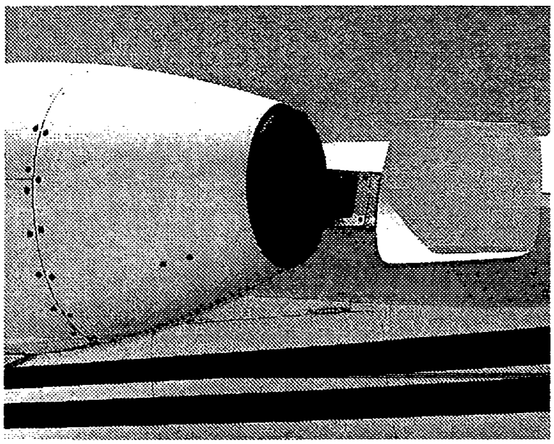


Figure 2-2. Engine Oil System Schematic

THRUST ATTENUATOR SYSTEM

Description and Operation

The thrust attenuators consist of vertical "paddles" which, when deployed, insert themselves aft of the engine into the exhaust gas stream, providing a reduction of the forward thrust of the engines. When stowed, the attenuators streamline themselves along the engine pylon aft of the nacelle.



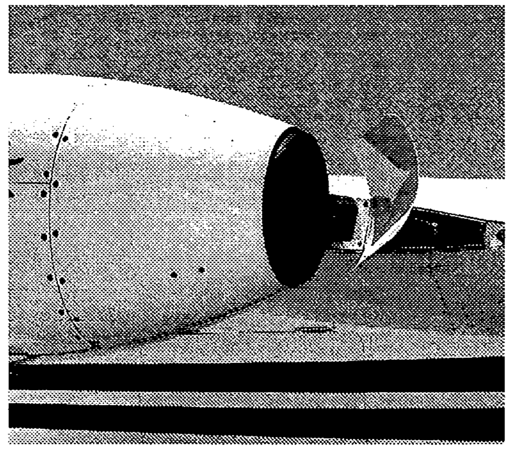


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Figure 2-3. Thrust Attenuator In Stowed and Deployed Positions

Normal Operation

The thrust attenuator system is designed for two-position automatic operation; stowed during flight and deployed when the engines are running on the ground with the throttles in idle position. The attenuators are deployed and stowed by hydraulic pressure. The hydraulic pressure is supplied to the thrust attenuator actuators by two positive displacement engine-driven pumps. The attenuators are activated to the deployed position when the throttle is brought to the idle position on engine start, when the landing gear squat switch is closed. The squat switch provides a ground enabling the attenuators to deploy. In flight the squat switch ground is not available, removing the circuit which is required for deployment. When the throttles are advanced out of idle position the attenuators retract. On landing, when the throttles are brought to idle and the squat switches close, the thrust attenuators automatically operate to the deployed position.

Operation of the attenuators is automatic as long as the thrust attenuator STOW/AUTO/TEST switch is in the AUTO position. When the switch is in the STOW position the thrust attenuators are locked in the stowed position and will not operate.

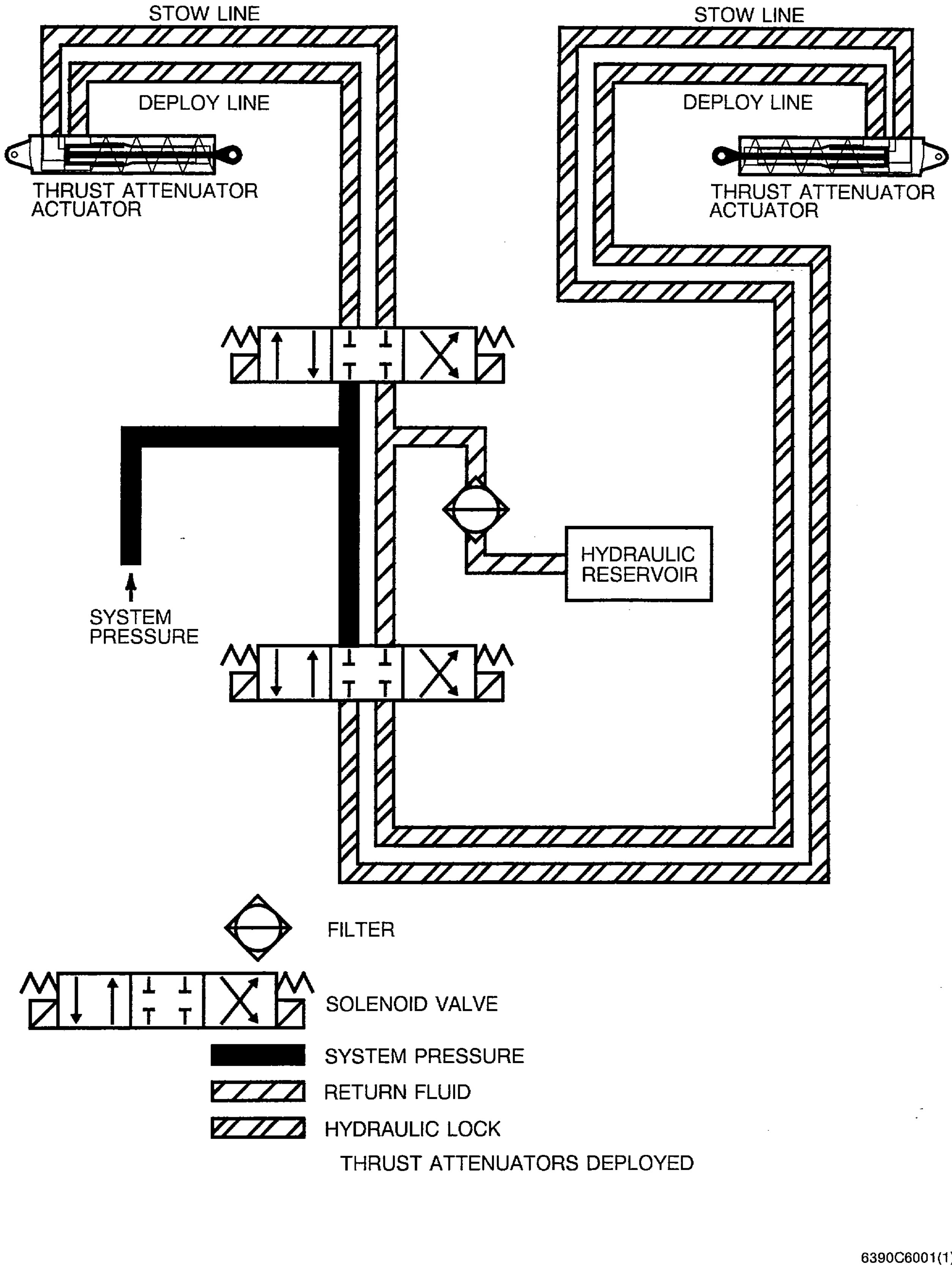

Figure 2-4. Thrust Attenuator Hydraulic System Schematic (Sheet 1 of 3)

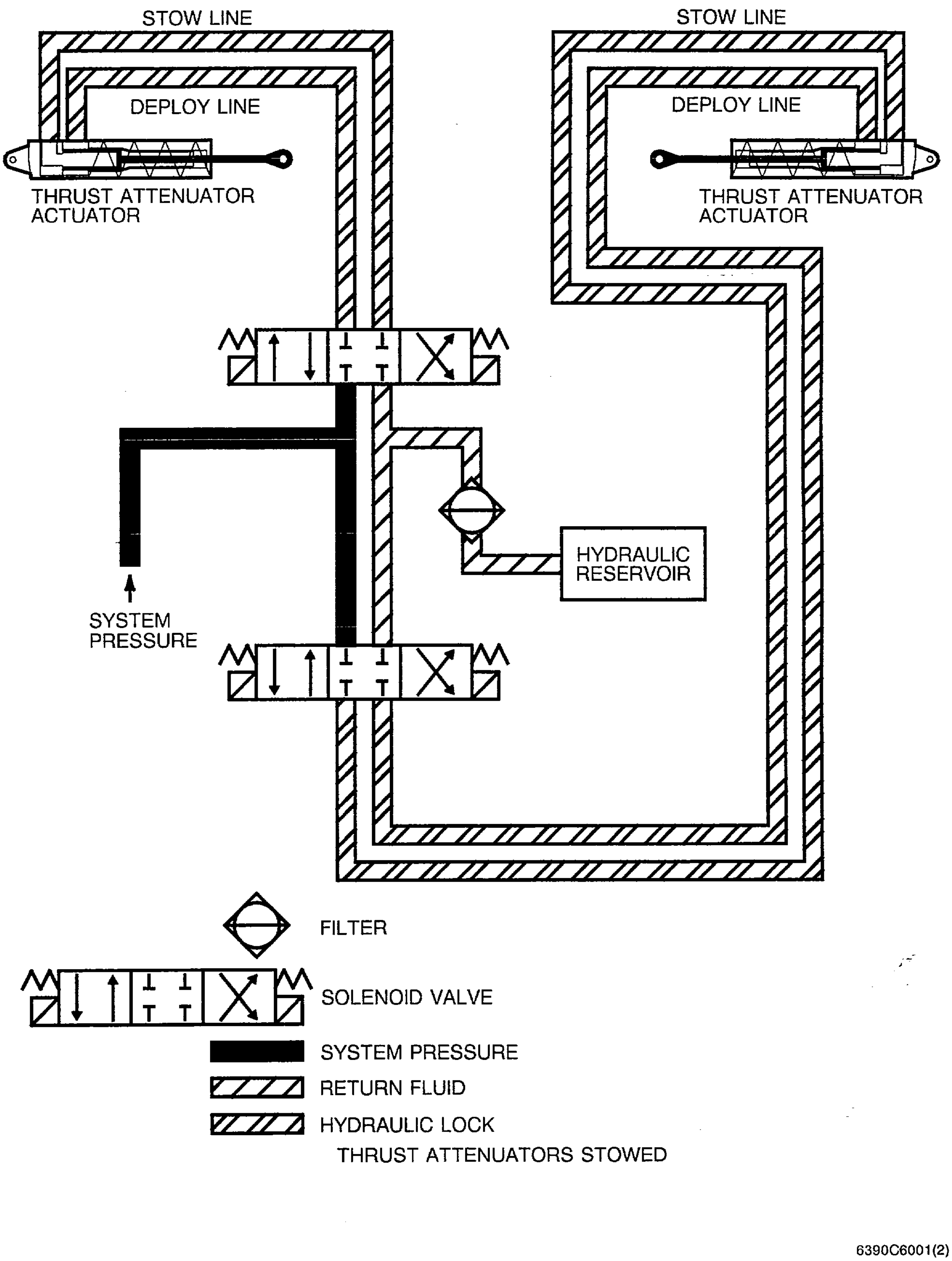

Figure 2-4. Thrust Attenuator Hydraulic System Schematic (Sheet 2 of 3)

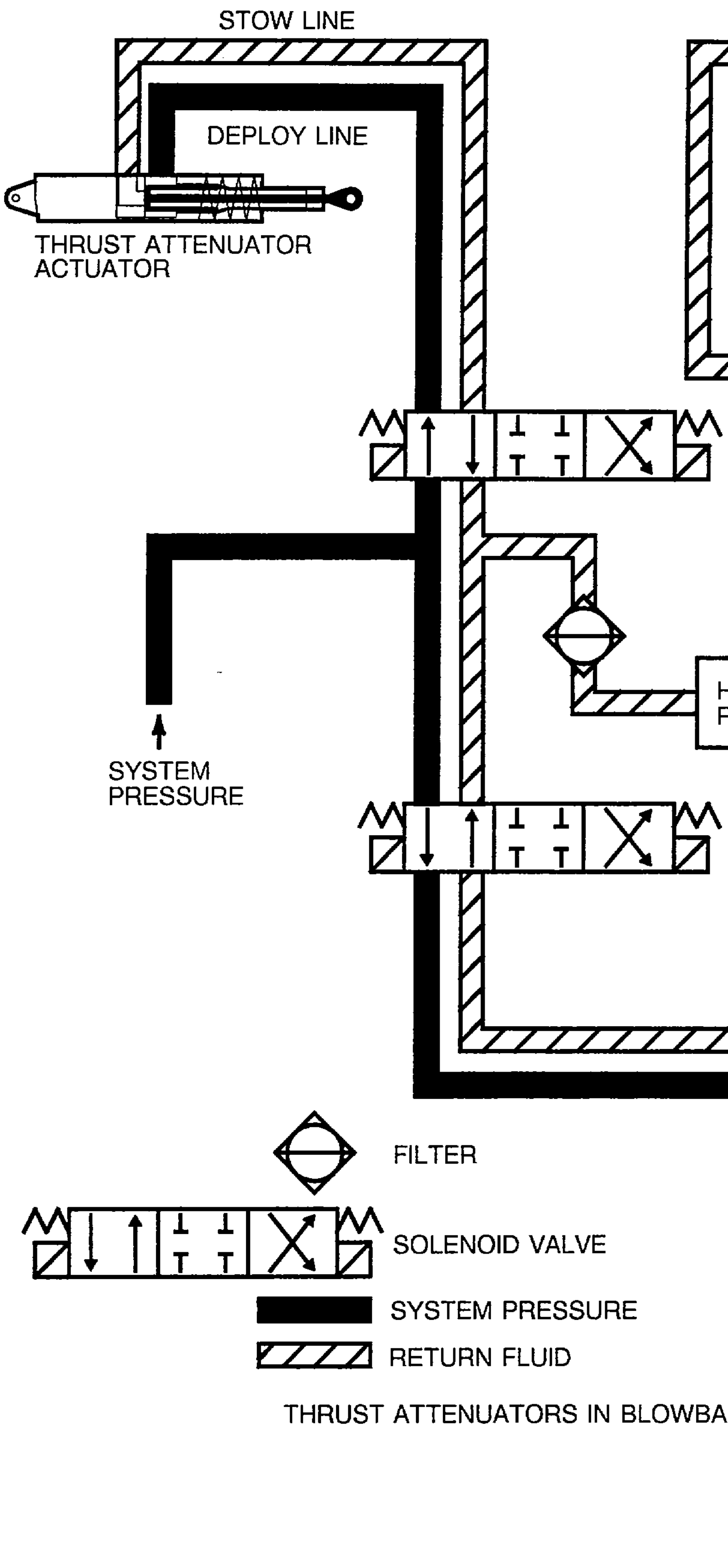

Figure 2-4. Thrust Attenuator Hydraulic System Schematic (Sheet 3 of 3)

A hydraulic lock holds the attenuators in the deployed and stowed positions. There is no mechanical lock in the system. The system is fail safe in that a hydraulic failure in the system could conceivably result in deployment of the attenuators in flight, however, the actuator design of the system is such that in conditions of high airspeed and/or high thrust the attenuators will blow back and only a small loss in available thrust will result. When an unlocked thrust attenuator condition occurs, whether intentionally or due to a malfunction, the ATTEN UNLOCK, LH and/or RH annunciator on the annunciator panel will illuminate. Deployment of the Thrust attenuators in flight will also illuminate the MASTER CAUTION RESET annunciator. If an unintentional deployment should occur in flight, or if deployment is not desired on the ground, placing the STOW/AUTO/TEST to the STOW position will stow the attenuators and hold them in the stowed position. Holding the thrust attenuator STOW/AUTO/TEST switch to the test position on the ground will test the thrust attenuator master caution circuit and illuminate the MASTER CAUTION RESET annunciator.

If the STOW position is selected on the THRUST ATTENUATOR STOW/AUTO/TEST switch, located on the throttle quadrant, the white ATT STOW SELECTED annunciator on the center instrument panel will illuminate in order to remind the pilot that the STOW position has been selected.

The white HYD PRESS ON annunciator will illuminate during both the deploy and the stow cycle. When the paddles have reached the stowed or the deployed position the HYD PRESS ON annunciator will extinguish.

FIRE PROTECTION

Engine fire detection consists of a closed-loop sensing system and detector control unit which illuminates the respective red ENG FIRE warning light on the cockpit glare shield (and sound the respective "LEFT" or "RIGHT ENGINE FIRE" aural warning if the airplane is equipped with the voice warning system) if a fire or overheat condition is present. The warning light, under a transparent, spring-loaded guard, also serves as a firewall shutoff switch.

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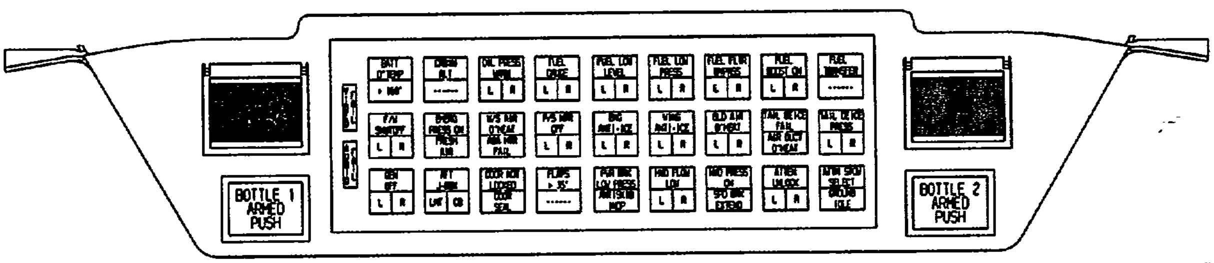

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Figure 2-5 Fire Detection Indicating Lights

Lifting the guard and depressing the warning light simultaneously closes the respective firewall fuel and hydraulic valves, deenergizes the starter/generator and arms the two extinguishing bottles, which are filled with $CBrF_3$ (Halon 1211). Firewall shutoff and extinguisher arming are indicated by illumination of the respective FUEL LOW PRESS, HYD PRESS LOW, F/W SHUT OFF and GEN OFF annunciator panel lights and both white BOTTLE ARMED lights.

Once armed, either bottle may be discharged to the selected engine by pushing the BOTTLE ARMED light. The light will go out as the light is pushed. System plumbing is such that both bottles can be directed to the same engine if necessary.

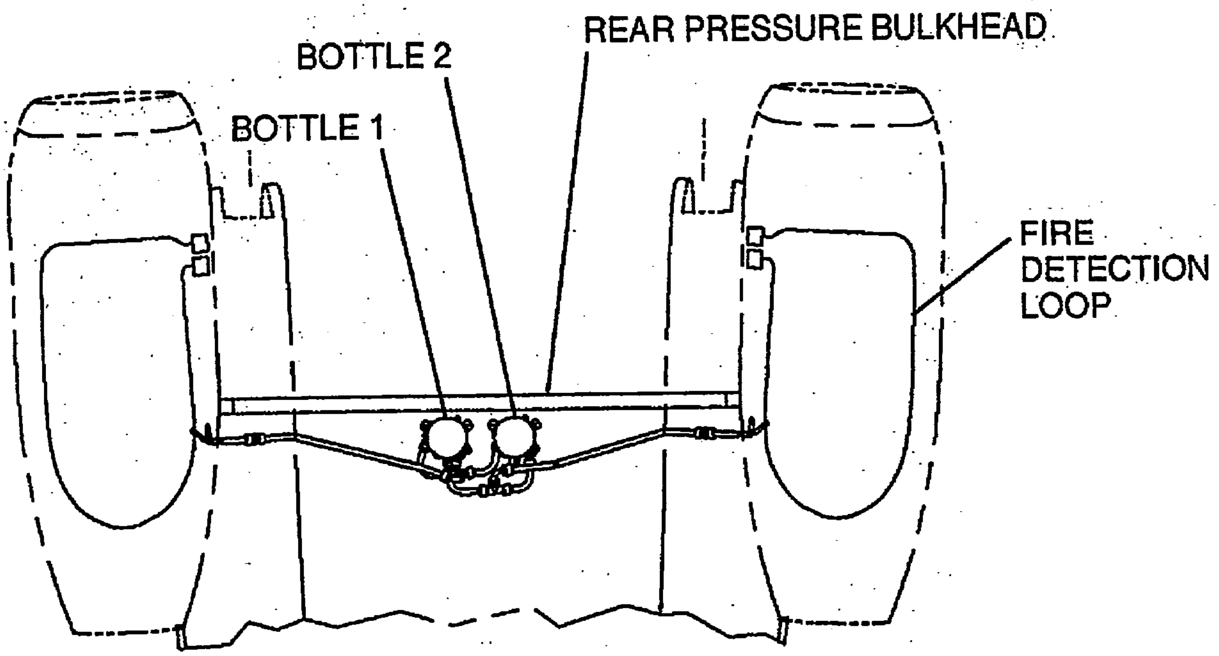

Figure 2-6 Engine Fire Extinguishing System

Function of the lights and continuity of the sensor and detector control units is checked by placing the rotary TEST selector in the FIRE WARN position and observing illumination of both red lights. Depressing either fire light will then illuminate both BOTTLE ARMED lights. If the airplane is equipped with the voice warning system, that system will also test. Since the BOTTLE ARMED lights will come on each time the system is tested or initially activated regardless of quantity of extinguishing medium, it is necessary to check proper bottle servicing on the pressure gages in the tailcone compartment during preflight inspection.

All test, detection and extinguishing features are electrically powered from the main Direct Current (DC) buses requiring either external power, the battery switch in BATT, or a generator on the line for operation.