LIST OF EFFECTIVE PAGES

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ENGINE CONTROLS - DESCRIPTION AND OPERATION

1. General

The engines incorporate a propeller reversing system comprising a single-acting, hydraulically operated propeller controlled by a propeller governor, and with overspeed governor back-up. The propeller governor combines the functions of a normal propeller governor (CSU), a reversing (Beta) valve and a power turbine governor (Nf) into a single unit. Note that terminology used in this section is of a general nature and may thus differ slightly from that used in specific airframe manufacturer's manuals. Likewise, the percentages stated are generalized, and specific airframe installations may require different settings.

2. Description (Ref. Fig. 1)

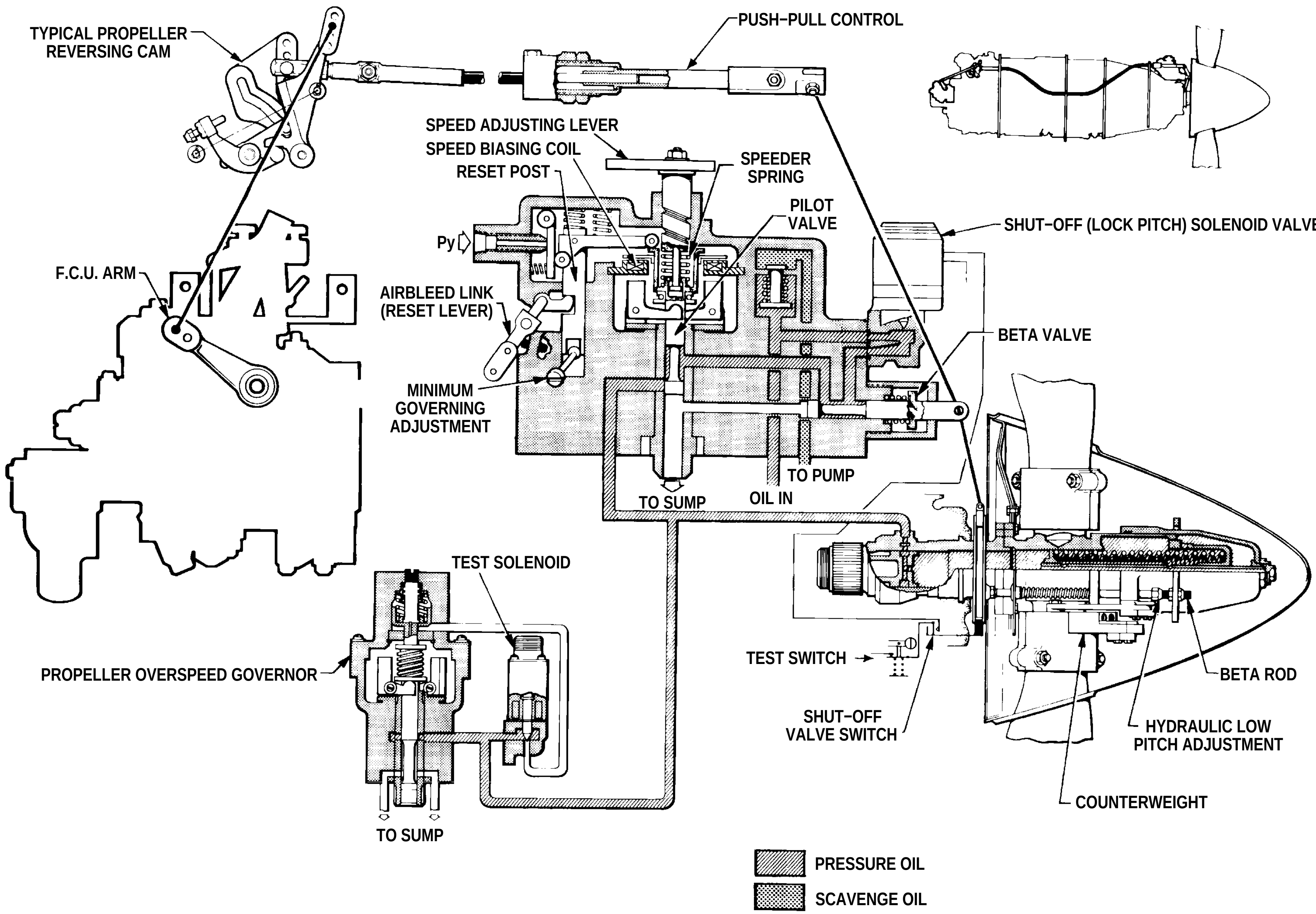
A. Propeller

The engine is normally equipped with a three-bladed metal propeller (refer to Propeller Manufacturer's Handbook), which is dowelled and bolted to the front face of the engine propeller shaft flange. The propeller assembly consists of a hollow steel spider hub which supports the propeller blades and also houses an internal oil pilot tube and the feather return springs. Movement of the propeller blades is controlled by a hydraulic piston mounted at the front of the propeller spider hub. The servo piston is connected by a link to the trailing edge of each blade root. Centrifugal counterweights on each blade and springs in the servo piston tend to drive the servo piston into the feather, or high pitch position. This tendency to movement is opposed by propeller governor oil pressure. The governor oil pressure is applied to the servo piston via passages in the governor body, an oil transfer tube to the oil transfer sleeve on the propeller shaft, then, via the hollow centerbore of the propeller shaft to the propeller hub. An increase in governor oil pressure moves the blades toward the low (fine) pitch position (increased rpm). Conversely, a decrease in governor oil pressure allows the blades to move toward high (coarse) pitch position (decreased rpm) under the influence of the feathering springs and blade centrifugal counterweights.

The servo piston is also connected by three spring-loaded sliding rods to a feedback ring mounted at the rear of the propeller. Movement of the feedback ring is transmitted by a carbon block and propeller reversing lever to the Beta valve on the propeller governor. This movement is utilized to control propeller blade angle from the normal forward fine pitch stop through to the full reverse pitch position.

B. Propeller Governor (Ref. Fig. 1)

The propeller governor (Ref. 61-20-00) performs three functions: Under normal flight conditions, the governor acts as a constant speed unit (CSU), maintaining the propeller speed selected by the pilot by varying the propeller blade pitch to match the load to the engine torque in response to changing flight conditions. During low airspeed operations, the propeller governor can be used to select the required blade angle; this mode is called Beta control. On some installations, Beta control may be restricted to ground operations, such as aircraft taxiing. While in the Beta control range, engine power is adjusted by the FCU and the power turbine (Nf) section of the propeller governor to maintain power turbine speed slightly less than the selected rpm.



Propeller Reversing System - Schematic
Figure 1

The propeller governor consists of a single-acting centrifugal governor. In forward thrust operation, the function of the governor is to boost the engine pressure oil to decrease propeller blade pitch, while the centrifugal force of the blade counterweights, assisted by the feathering springs, tends to increase the pitch angle.

The propeller governor incorporates an integral gear-type oil pump with pressure relief valve, two pivoted flyweights mounted on a rotating flyweight head, a spring-loaded pilot valve and necessary cored oil passages contained in an aluminum housing. The flyweight head is attached to a hollow driveshaft which protrudes below the housing flange. The shaft is externally splined to mate with the corresponding coupling shaft in the reduction gearbox. The spring-loaded pilot valve is installed in the driveshaft centerbore. Ports in the driveshaft and the position of the pilot valve in the shaft, control the direction of oil flow within the housing. The rotating shaft, and hence rotating flyweights, determine the position of the pilot valve while the opposing spring load on the valve is varied by the speed adjusting lever at the head of the governor. The speed adjusting lever is connected through airframe linkage to the propeller control lever in the cockpit.

A speed adjusting lever maximum stop prevents the lever from moving beyond the 100 percent position and enables the propeller to be operated at, or near to, full rated speed and the engine to develop maximum power. Moving the speed adjusting lever towards a preset feathering stop raises the pilot valve and decreases the oil pressure to the propeller servo piston. This decrease in pressure allows the piston to move, under the influence of the feathering and return springs, to rotate the propeller blades to a positive coarse pitch or feathering position regardless of governor flyweight force acting on the pilot valve.

For Post-SB1335 Engines: The propeller governor provides asynchronizing function. Magnetic pickups on the propeller shafts provide a signal to an electronic system that determines the difference in speed between the two engines and energizes a solenoid incorporated in the head of the propeller governor on the slave, right hand engine. The solenoid overrides the spring loaded pilot valve thus changing the propeller pitch setting and consequently power turbine speed.

In the event of a propeller control (speed) lever linkage failure, a spring attached to the propeller speed adjusting lever holds the lever in its last selected position or moves it against the maximum stop.

To provide the propeller governor with a sensing element, the rotating pivoted flyweights are mechanically coupled to the engine by the hollow driveshaft and accessory driveshaft in the reduction gearbox. The rotating flyweights, actuated by centrifugal force, position the pilot valve so as to cover or uncover ports in the drive gearshaft and regulate the oil flow to and from the propeller servo piston. The centrifugal force exerted by the flyweights is opposed by the force of the speeder spring. This determines the engine rpm required to develop sufficient centrifugal force on the flyweights to center the pilot valve, thereby preventing oil flow to the servo piston.

The Beta valve incorporated in the propeller governor pump output line to the pilot valve and mechanically connected to the propeller reversing lever, is designed so that forward movement of the valve will initially block off high pressure oil to the propeller servo piston, then, as forward movement continues, will dump pressure oil in the servo back into the reduction gearbox. Axial movement in the reverse direction has no effect on normal propeller control. When the propeller is rotating at a speed lower than selected by the speed adjusting lever, the governor oil pump provides pressure oil to the propeller servo, lessening the propeller pitch until the feedback ring movement pulls back the Beta valve to block off the pressure oil to the servo, thus preventing further pitch change. The pitch angle will coarsen automatically to maintain selected propeller speed as higher engine power (Ng) is selected by the pilot. The Beta control does not forcibly select reverse blade angles; very fine pitch and reverse can only occur when conditions are such that the propeller is in underspeed relative to that selected, and subject to control limitations set by individual airframe manufacturers.

The lock pitch solenoid valve (when fitted) is mounted at the front of the propeller governor and is connected by cored passages to the governor pump oil pressure line to the propeller servo piston. The solenoid is energized automatically by airframe-supplied switches at a predetermined propeller blade angle below the normal low pitch setting, and acts as a back-up system. When the solenoid is energized, the valve poppet moves to block the oil pressure line to the servo piston; this action effectively prevents oil flow to the piston chamber and prevents any further movement of the blades. However, if the engine power lever is moved to the reverse position, the lock pitch solenoid valve is de-energized by a microswitch installed in the power lever quadrant enabling the propeller governor to operate in the Beta mode. A test switch is incorporated to functionally test valve operation at maintenance activities.

The function of the Nf governor section of the propeller governor, during normal forward thrust operation, is to protect the engine against a possible power turbine overspeed in the event of a propeller governor failure. During reverse thrust operation, the Nf governor is set below the propeller governor selected speed. This acts to control propeller speed via the FCU servo system (Ref. 73-20-00), and thus reduce the power generated by the gas generator to below required setting to maintain approximately five percent less than the selected propeller speed. A yoked bell-crank, operating off the governor flyweight head, opens the Py orifice (Ref. 73-00-00, Fig. 1) as speed is increased to reduce metered fuel flow from the FCU. The speed at which the Nf governor operates is dependent on the speed selected on the governor and the position of the airbleed link reset lever. The airbleed link is normally set so that the Nf governor will control Nf at approximately six percent higher than the selected speed in its maximum position and approximately four percent lower in its minimum position. The Nf governor ‘‘droop’’ is approximately four percent; thus in maximum position the governor will commence governing at 102 percent and will fully govern at 106 percent. It should be noted that to re-set the airbleed link to its minimum position brings the yoked bell-crank into contact with the pilot valve and brings in a spring load in addition to the speeder spring which the governor flyweights must overcome to control propeller speed. This function causes propeller governed speed to increase approximately one percent more than that nominally selected.

C. Propeller Overspeed Governor (Ref. Fig. 1)

The propeller overspeed governor (Ref. Aircraft Manufacturer’s Manual) is installed in parallel with the propeller governor and mounted at the approximate 10 o’clock position on the front case of the reduction gearbox. The governor is incorporated to control any propeller overspeed condition by immediately bypassing pressure oil from the propeller servo to the reduction gearbox sump. The governor consists of conventional type flyweights mounted on a hollow, splined shaft and driven by the accessory drive gearshaft.

The hollow shaft embodies ports which are normally closed by a pilot valve installed in the shaft centerbore and held in position by the governor speeder spring. The spring tension acts in opposition to the centrifugal force of the rotating flyweights.

When an engine overspeed condition occurs, the increased centrifugal force sensed by the flyweights overcomes the spring tension, lifts the pilot valve and bypasses the propeller pitch change mechanism oil back to the reduction gearbox through the hollow, splined shaft. This permits the combined forces of the counterweights and return springs to move the blades toward a coarse pitch position, absorbing the engine power and preventing further engine overspeed. A solenoid valve, which resets the governor to a value below its normal overspeed setting, is provided to permit ground testing of the unit.

D. Starting Control Lever (Engines with Starting Control) (PT6A-27 and PT6A-28)

The starting control lever in the cockpit is connected through airframe linkages to a lever on the starting control unit; this is connected to the FCU.

E. Fuel Condition Lever (PT6A-21)

The fuel condition lever in the cockpit is connected through airframe linkages to a lever on the fuel control unit; the lever controls the position of the FCU integral fuel cut-off valve.

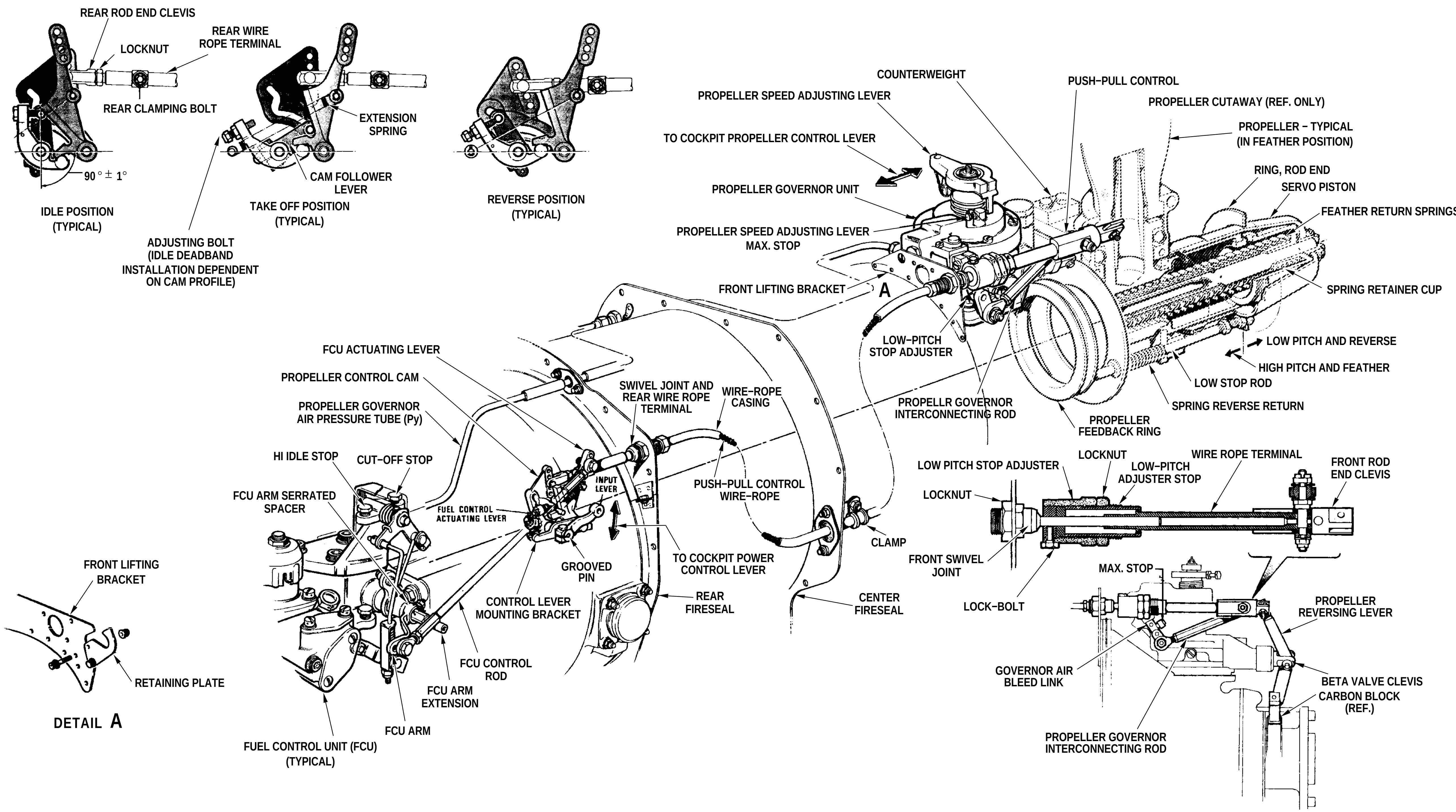
F. Power Control (Engine Power) Lever

The power control lever in the cockpit is connected through airframe linkage to the cam assembly which is mounted in front of the FCU at the rear of the engine. The power control lever controls engine power through the full range; from maximum takeoff power through to full reverse. It also selects the propeller pitch (Beta control) from reverse selection up to the constant speed rpm as selected by the cockpit propeller control (propeller speed) lever.

G. Reversing Linkage (Ref. Fig. 2)

The cam assembly, mounted at the 2 o’clock position on Flange G of the accessory gearbox, provides scheduled control movements to the FCU and starting control, the Nf governor section of the propeller governor and the propeller system. The cam assembly consists of a cam follower lever, which is connected directly to the power control lever linkage by a grooved pin, and three cam-type levers. The FCU reversing actuating lever is free mounted on the grooved pin while the propeller control cam and FCU actuating levers are free mounted on a second flat head pin. The three levers and pins are mounted on the control lever mounting bracket which is bolted to flange G.

The FCU actuating lever is spring-loaded toward idle and is connected through an adjustable interconnecting rod to the FCU control arm. In operation, movement of the power control lever moves the cam follower lever through the lever linkage. Movement of the cam follower lever causes the associated lever pin to contact the rear face of the FCU actuating lever and also slide in the slot of the propeller control cam. During normal propeller operation, from IDLE to TAKEOFF, the cam follower lever pin moves in the circumferential section of the cam slot, but imparts no motion to the propeller control cam.



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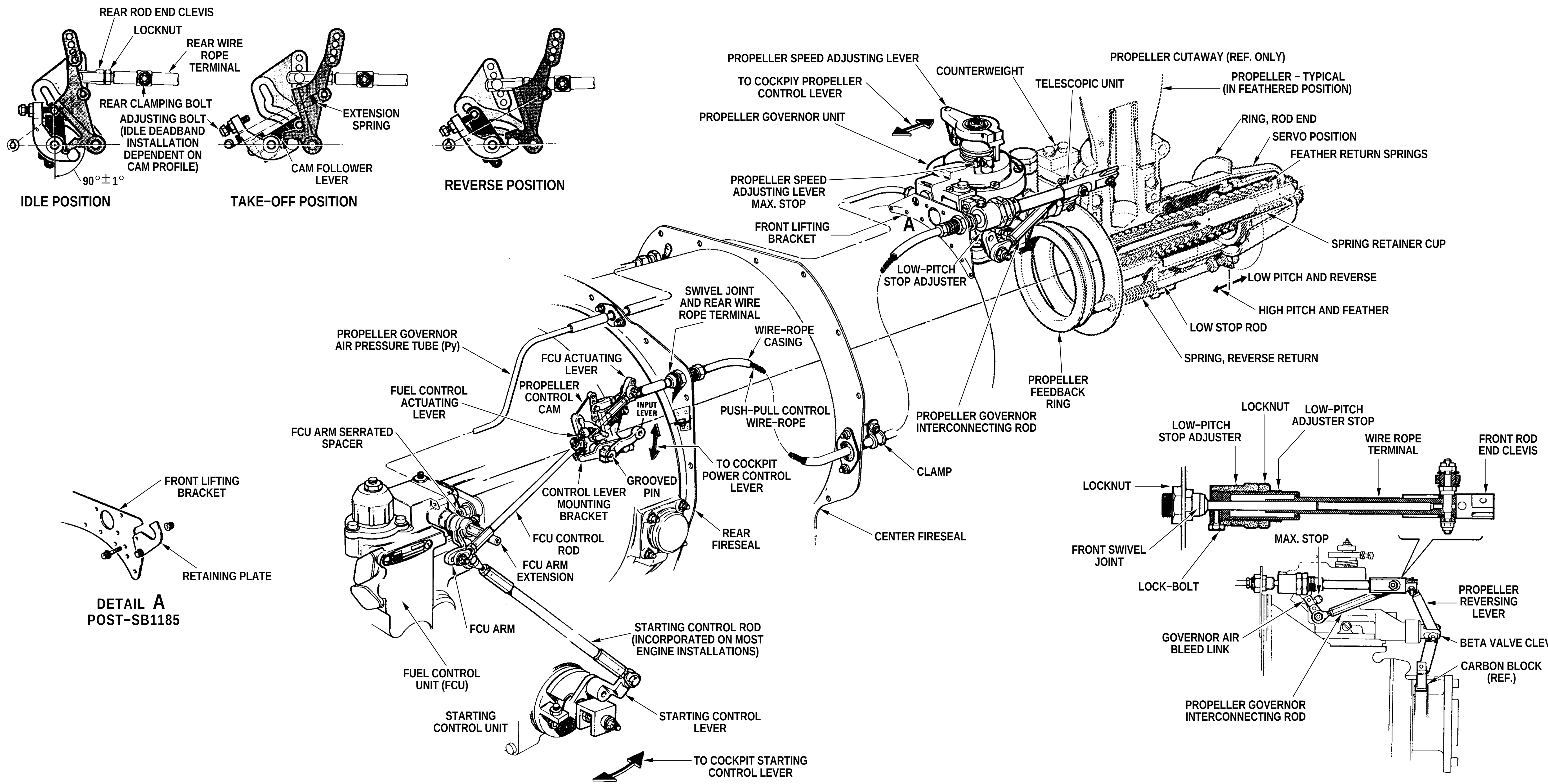
Engine Controls and Propeller Reversing System
Figure 2 (Sheet 1 of 2)



Engine Controls and Propeller Reversing System
Figure 2 (Sheet 2)

However, on selection of reverse power the lever pin moves into the radial section of the cam slot, rotating the propeller control cam and transmitting this motion forward through the push-pull wire rope to the propeller reversing lever.

An interconnecting rod bolted to the front end of the push-pull wire rope assembly connects the propeller reversing lever to the airbleed link on the propeller governor. A carbon block attached to the inner end of the propeller reversing lever provides the mechanical link between the engine reversing linkage and propeller feedback ring (Ref. Para. A.).

3. Operation

A. Propeller Governor On-Speed Cycle

During an on-speed condition in forward thrust the forces acting on the engine, propeller governor and propeller are in state of balance. With the propeller control (speed) lever set to desired rpm and the propeller blades at the correct pitch angle to absorb the power developed by the engine, the centrifugal force of the rotating flyweights balances the force of the governor speeder spring with the flyweights in the vertical position. This condition positions the pilot valve so that the valve oil ports are closed and no oil flow occurs between the governor oil pump and propeller servo piston. Oil pressure developed by the pump is then circulated back to pump inlet via the relief valve in the governor.

B. Propeller Governor Underspeed Cycle

With the propeller control (speed) lever set to the desired rpm, an underspeed condition will occur when the propeller rpm drops below the predetermined setting. The governor speeder spring tension then overcomes the reduced centrifugal force on the flyweights and pivots them inward, forcing the pilot valve downward and opening the oil ports. This allows a flow of pressure oil from the governor pump to the propeller servo piston which, in turn, overcomes the combined forces of the propeller counterweights and return springs to decrease the propeller blade pitch angle. This reduces the load and allows propeller rpm to increase; the increased rpm is sensed by the governor flyweights which force the pilot valve upward until an equilibrium between speeder spring tension and centrifugal force of flyweights is achieved, and causes the oil ports to close.

C. Propeller Governor Overspeed Cycle

In overspeed condition, the governor flyweights pivot outward to overcome the governor speeder spring tension and raise the pilot valve. This uncovers ports in the drive gearshaft and allows pressure oil in the propeller servo to flow into the reduction gearbox sump. As the propeller blade angle increases, the load on the engine increases and propeller rpm decreases. This in turn causes the centrifugal force on the flyweights to decrease, allowing the speeder spring tension to return the flyweights to the vertical position, causing the pilot valve to cover the oil ports and block the oil supply from the servo piston.

D. Propeller Overspeed Governor (Airframe Supplied)

When a propeller overspeed condition occurs, the increased centrifugal force sensed by the governor flyweights overcomes the speeder spring tension and lifts the pilot valve to bypass propeller servo oil back to the reduction gearbox sump via the governor hollow driveshaft. This allows the combined forces of the blade counterweights and the retention springs to move the propeller blades toward a coarse pitch position, thereby absorbing engine power and reducing propeller rpm. A solenoid-operated valve is incorporated to facilitate functional testing of the overspeed governor. When operated, the valve resets the governor below its normal overspeed setting.

4. Fault Isolation

For detailed fault isolation of the engine controls refer to Chapter 72-00-00, FAULT ISOLATION.