THE PRATT & WHITNEY PT6
TURBOPROP
CHAPTER 19
P 670 TO 676

PT6 Engine

The PT6 engine is made by Pratt & Whitney of Canada.

Engine horsepower ratings range from 475 hp up to around 2,000 hp, … … … … depending on the model.

Rated rpm is around 38,000 rpm and a gearbox is needed to reduce propeller rpm down to a usable range of around 2,000 rpm to 2,300 rpm.

The PT6 is a free turbine engine, … meaning that the power turbine and the compressor turbine are not mechanically connected.

Gas flow from the compressor turbine is used to turn the free, (power), turbine. (air coupled)

The free turbine drives the propeller through a gearbox.

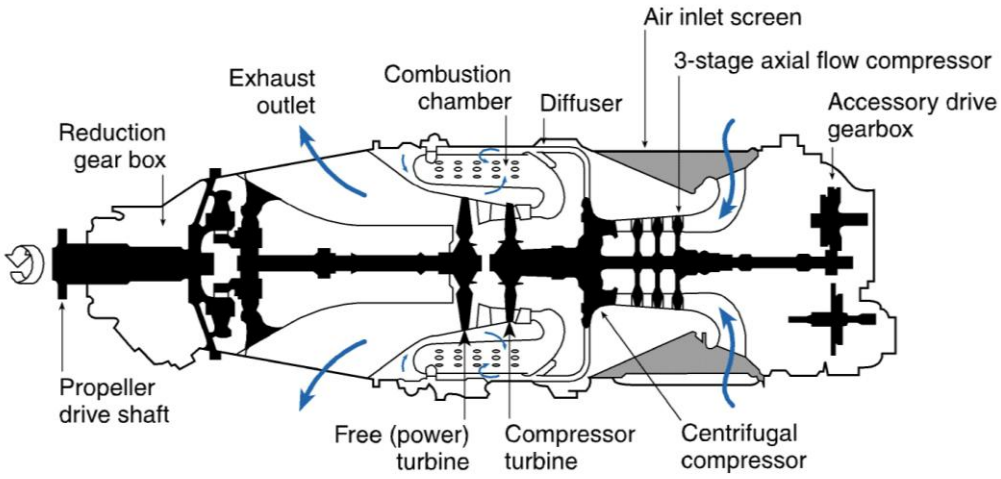
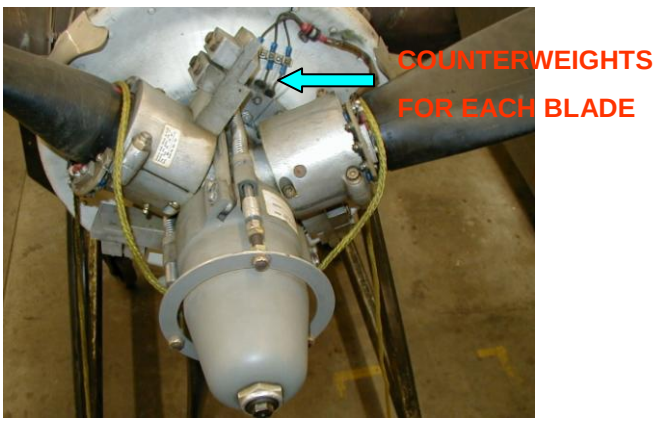


Figure 19-36. *The Pratt & Whitney of Canada PT6 free-turbine turboprop engine*

The "PT6" Propeller

1. A "Hartzell" propeller with 3 to 6 blades is typical, … depending on power produced.
2. The later models use propeller blades with a composite blade construction, … others are made out of an aluminum alloy.
3. The propeller used is the counterweight steel hub version having an internal feathering spring.
4. The counterweights and spring are used to drive the propeller blades to high pitch and/or feather.
5. Oil pressure drives the propeller blades into low pitch and reverse thrust.



No Beta "Oil" Tube

The PT6 uses a more "conventional" propeller & control setup than the Garrett TPE331 engine.

Instead of a long oil carrying "beta" tube with a sliding sleeve, (PPC):-

The PT6 engines that have reverse thrust use a "beta valve" that is controlled by the power lever and gets feedback from:-

1. Beta rods.
2. Feedback ring.
3. Carbon block

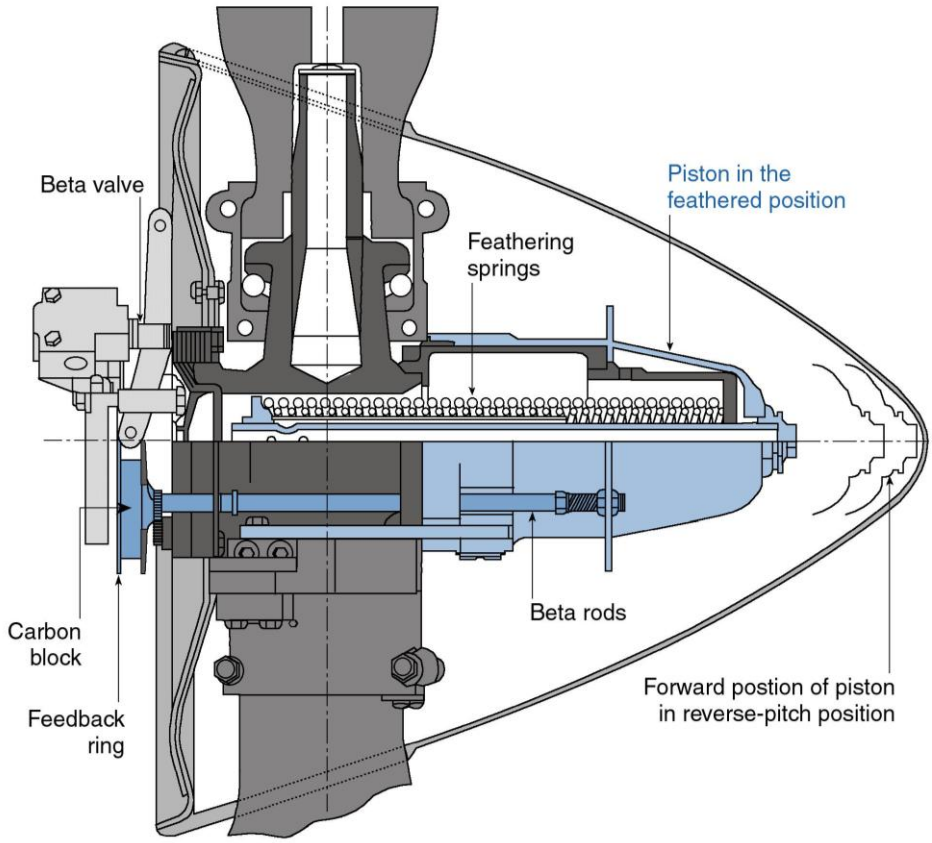
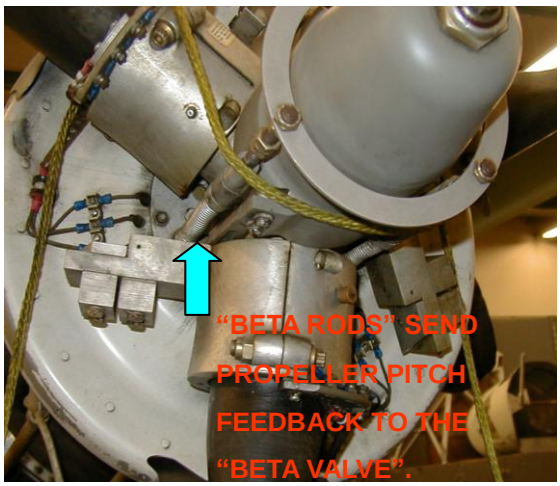
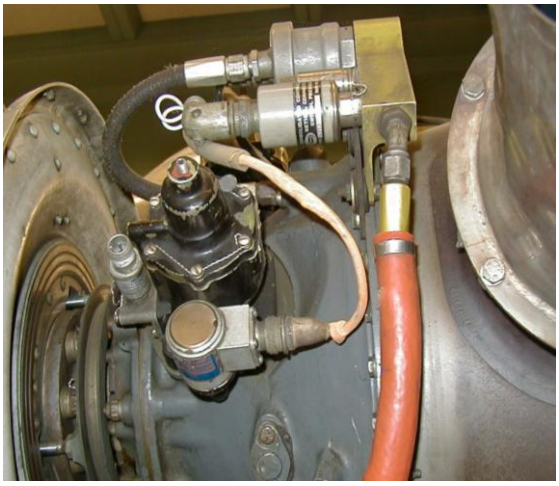


Figure 19-37. *Hartzell steel-hub propeller for a PT6 turboprop engine*



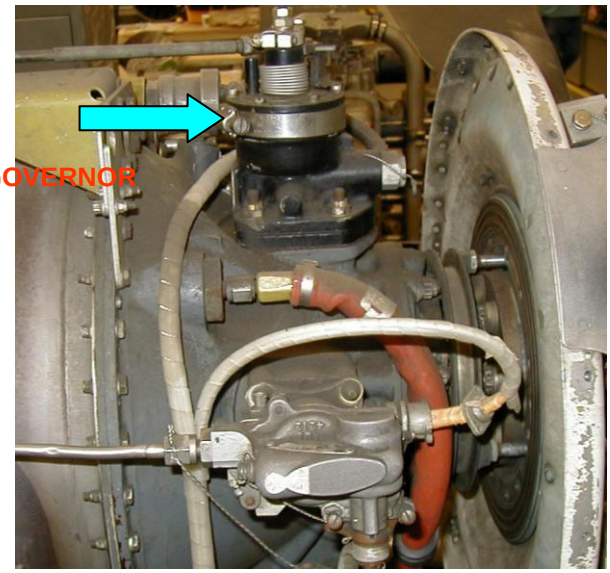


Propeller Pitch Control

1. Governor oil pressure is used to drive the propeller into low pitch and reverse thrust.
2. Propeller counterweights & spring are used to drive the propeller into high pitch and feathering.
3. Alpha mode - the propeller is controlled by the propeller governor. (Flight)
4. Beta mode - the propeller is controlled by a separate "beta valve" circuit built into some propeller governor. (on reversing props)

   During ground operation - (beta), the beta valve sets the "propeller pitch". (50% to 80%).

   Beta is called underspeed since the prop governor is not controlling the engine rpm.



PT6 Engine Controls

Today - most "PT6" installations have three cockpit control levers per engine.

1. Power control lever
2. Propeller control lever
3. Condition lever

If engine has reverse thrust, that control is built into the power lever.

Note:- some installations have a fourth control lever - "emergency control".

On non reversing propellers -

The "condition lever" functions may be incorporated into the "power lever".

The "Power" Lever

Sets engine power in both beta and alpha modes.

Attaches to the engine fuel control unit. (FCU)

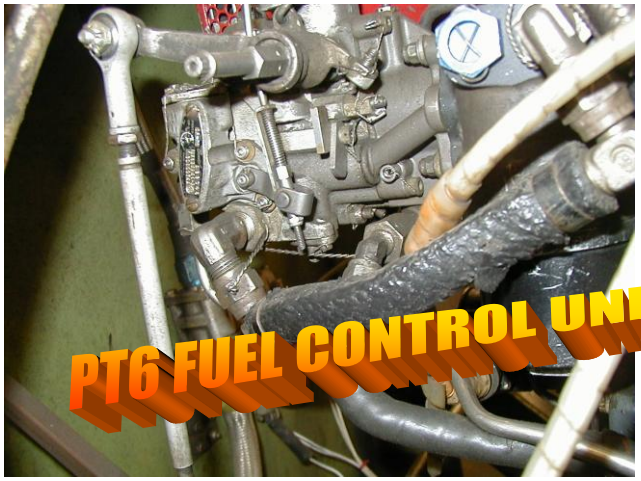
May also be attached to a "beta" propeller pitch control valve. (if it has reverse

thrust)

Effective from full reverse power, … through idle, … up to max power.

Reverse thrust sets both power and blade angle proportional to "power lever" movement.

Reverse thrust is obtained from the "beta valve" setting through a "beta control cam" mechanical linkage.



Fuel control metering is by metered air controlled by flyweights that move a main metering valve. Note the power lever input into the speeder spring, (12).

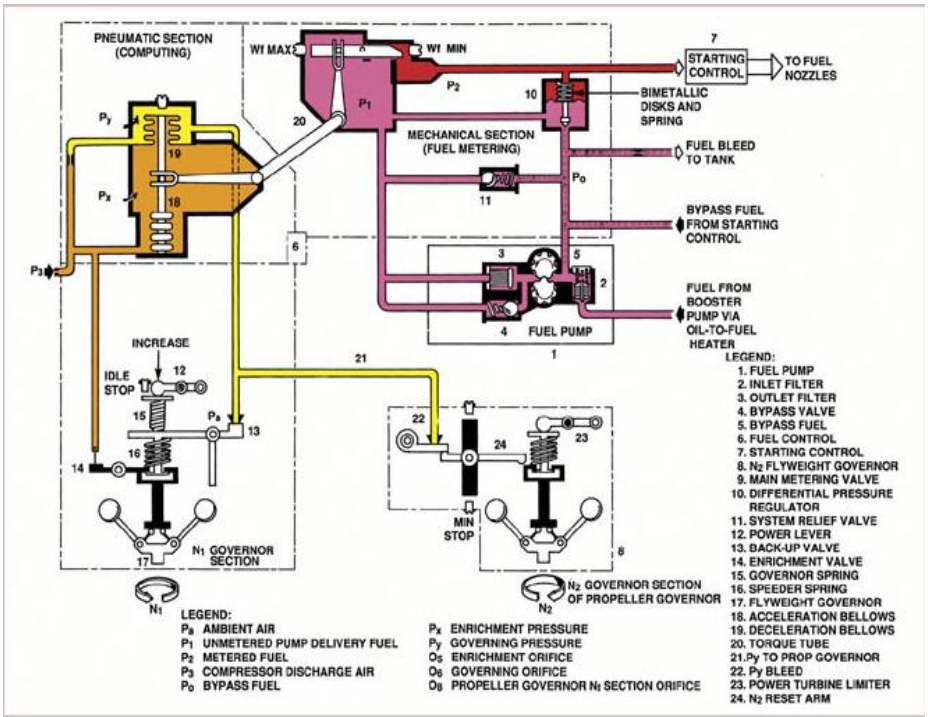


FIG 07-05

Aircraft Gas Turbine Powerplants

Propeller Control Lever

Connects to the "propeller governor".

Used to set blade angle in "alpha mode".

Used to "feather" propeller at maximum decrease position with a "lift rod".

In "beta mode", the "power lever" is used to set the propeller blade angle with the "beta valve". (on a reversing prop)

Condition Control Lever

May also be called a "start lever".

Normally the "third control" lever after power and propeller control, (if it is installed).

This control is installed on engines with "reverse thrust" propellers.

Condition lever has three positions

1. Engine shut off
2. Low idle, … 50% rpm (ground operation)
3. High idle, … 80% rpm (flight operation)

On PT6 engines without reverse thrust, the condition lever control may be incorporated in the power lever, … like on our "king air".

Not Found on All Installations

Emergency power lever

Not found on all PT6 engine installations.

Used in case of fuel control failure on the pneumatic side.

The normal pt6 fuel control operation uses bleed air metering from pneumatic bellows.

The bellows air circuit can fail, … emergency power lever bypasses the bellows control to give "crude" emergency engine control.

Some Installations have Four Separate Control System.

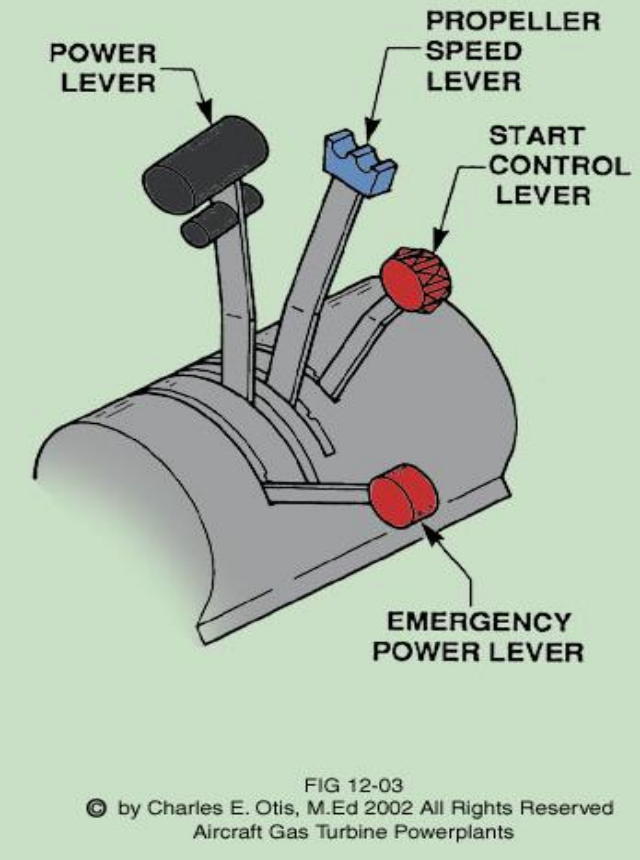


FIG 12-03

Aircraft Gas Turbine Powerplants

PT6 "Propeller" Control

The three propeller control circuits are:

1. Beta control valve for ground operation, … controlled by the power lever in "beta mode". (for taxi & ground use with reversing props).
2. Propeller governor for automatic pitch control during "alpha mode". (approximately 80% to 100%)
3. A preset overspeed propeller governor is used for automatic propeller overspeed protection, if the "propeller governor" fails. (power turbine)

Note:-

PT-6 turboprops also have a "FCU" N1 compressor turbine governor that will reduce engine fuel flow if a propeller overspeed of 105% or greater occurs.

The Two PT6 Prop Governors

Beta valve & prop governor *** overspeed governor

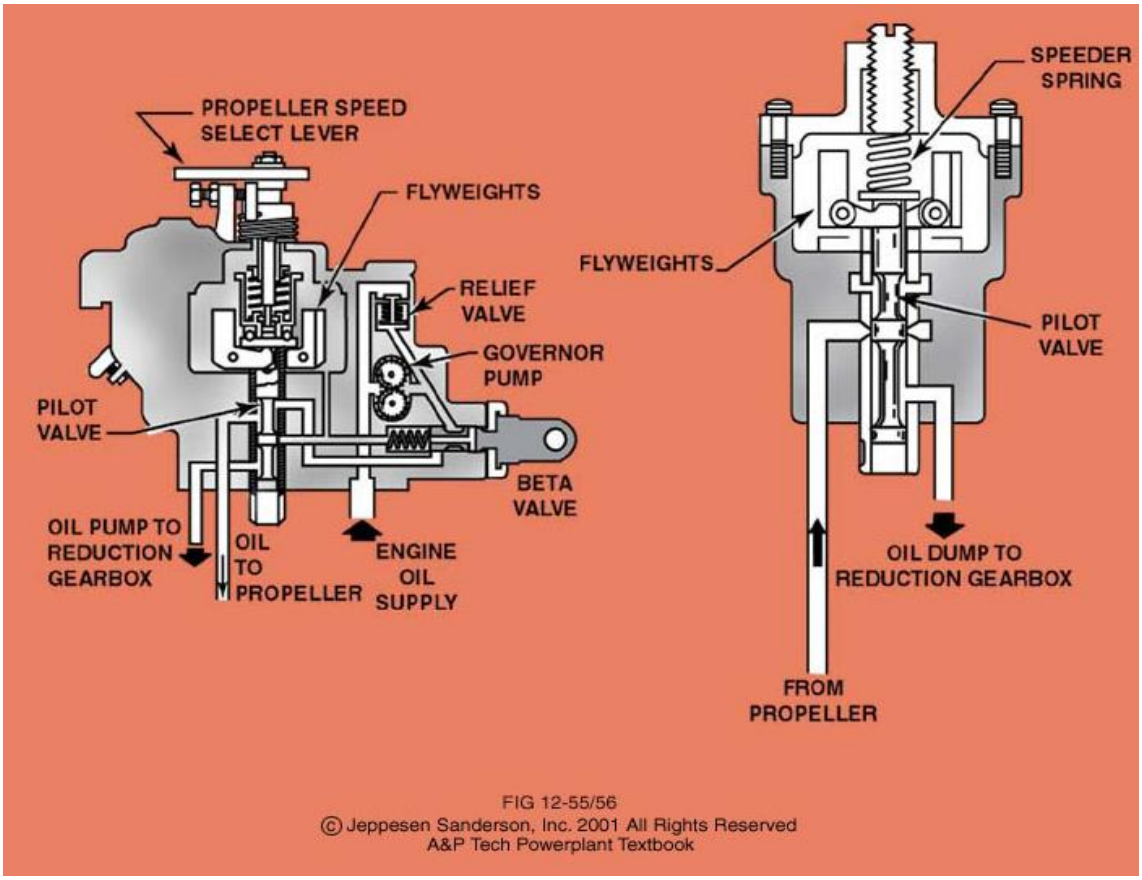


FIG 12-55/56

A&P Tech Powerplant Textbook

"Beta" Operation

"Beta" is the ground mode operation between 50% and approximately 80% of rated power.

During "beta", … the propeller governor is in an underspeed condition and does not control rpm.

In "beta", … when the power lever is advanced, … the "beta valve" controls propeller pitch by "dumping oil" and increasing blade angle.

In "beta", … as the power lever is advanced, fuel flow is also increased to the engine by the engine fuel control unit.

The fuel control and the beta valve are mechanically linked together.

In "Beta" Mode

Propeller has a feedback ring connected to a carbon block to give blade position feedback to a "beta" valve during ground operation.

A follow up linkage connects the propeller piston to the beta valve to give proportional propeller control.

As engine rpm is increased with the power lever,

The propeller governor comes on speed and takes over from the beta valve.

When the propeller governor takes over from the beta valve, … that is alpha mode. (starts around 80%)

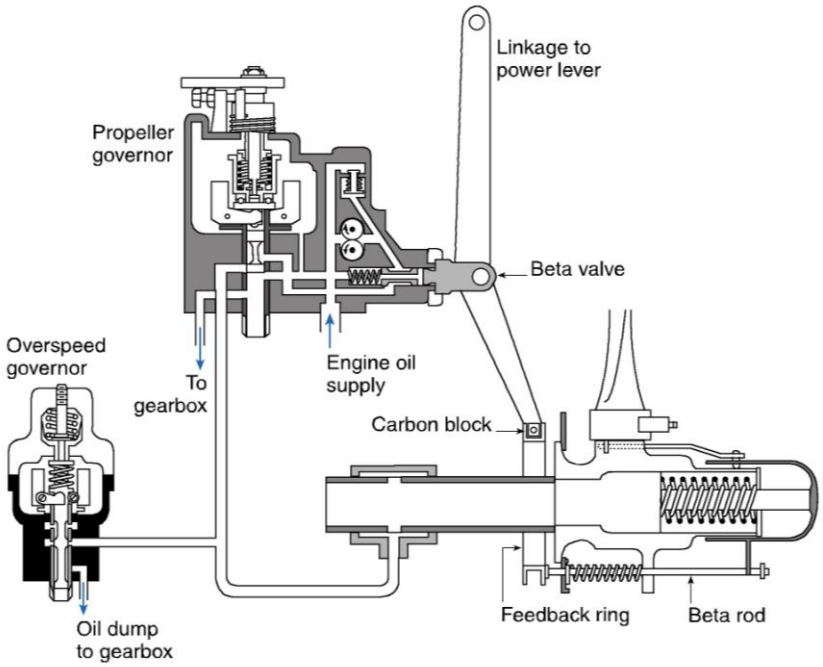


Figure 19-39. *Beta operation of the PT6 propeller*

Alpha Mode

Alpha mode is the flight mode.

In alpha mode the propeller rpm is high enough for the propeller governor to be on speed. (80-100%).

During alpha mode,

… the power lever controls engine power.

… propeller governor controls blade pitch.

Unlike the garrett - engine speed may be less than 100%.

The flyweights & speeder spring inside the propeller governor modulate a pilot

valve that controls oil pressure to maintain the preset blade angle. (propeller pitch can be set by the pilot).

A lift rod inside the propeller governor allows for the quick dumping of propeller oil pressure to feather the propeller, …with prop. spring and C/W.

"Alpha" Summary

During alpha conditions, (flight),

Alpha happens - when the flyweights in the propeller governor come up to operational speed. (engine speed approx. 80% or above).

Governor takes over propeller pitch control from the "beta valve" in alpha mode, … around 80%.

The pilot valve in the "propeller governor" is positioned by the "flyweights" & "speeder spring" and controls the oil pressure going to the propeller.

The propeller governor sets the propeller rpm while the power lever sets the engine power.

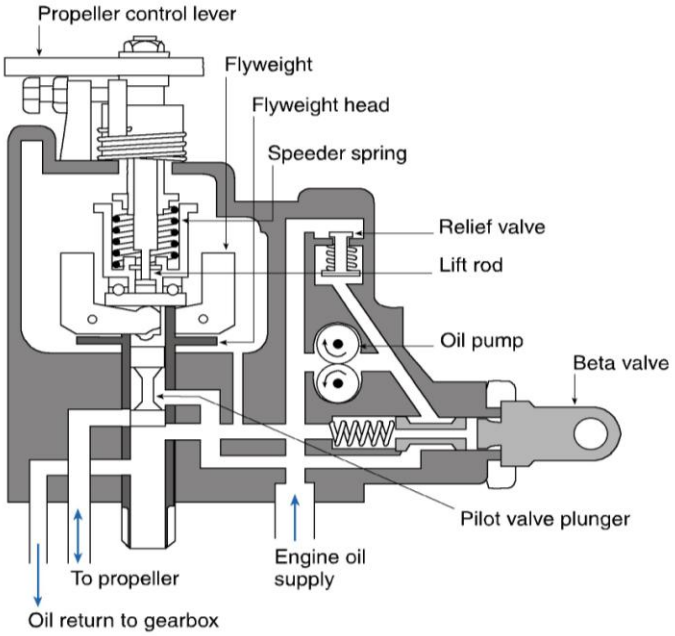


Figure 19-38. *Flyweight governor used to control PT6 propeller speed*

The Final Assembly

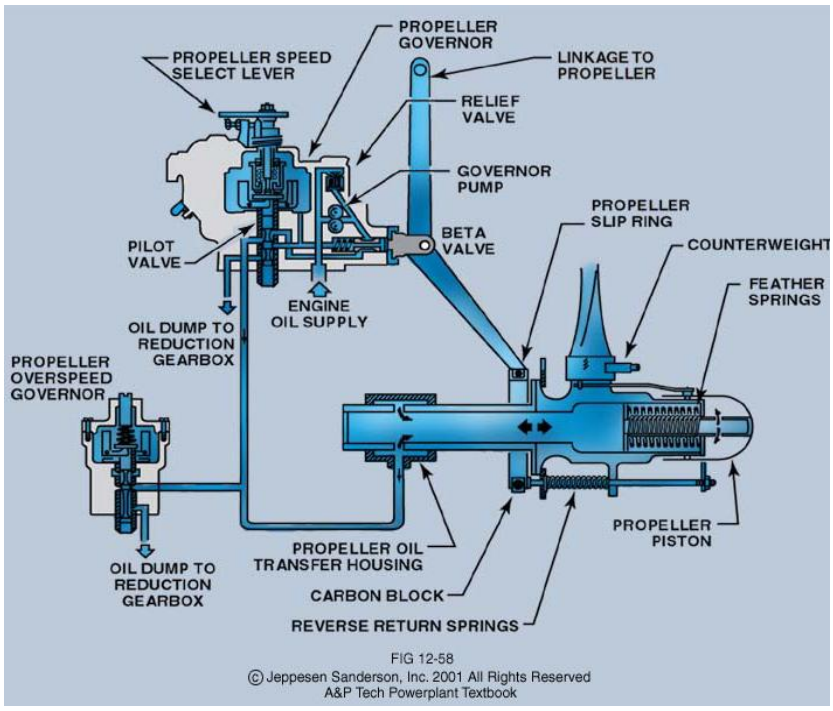


FIG 12-58

A&P Tech Powerplant Textbook

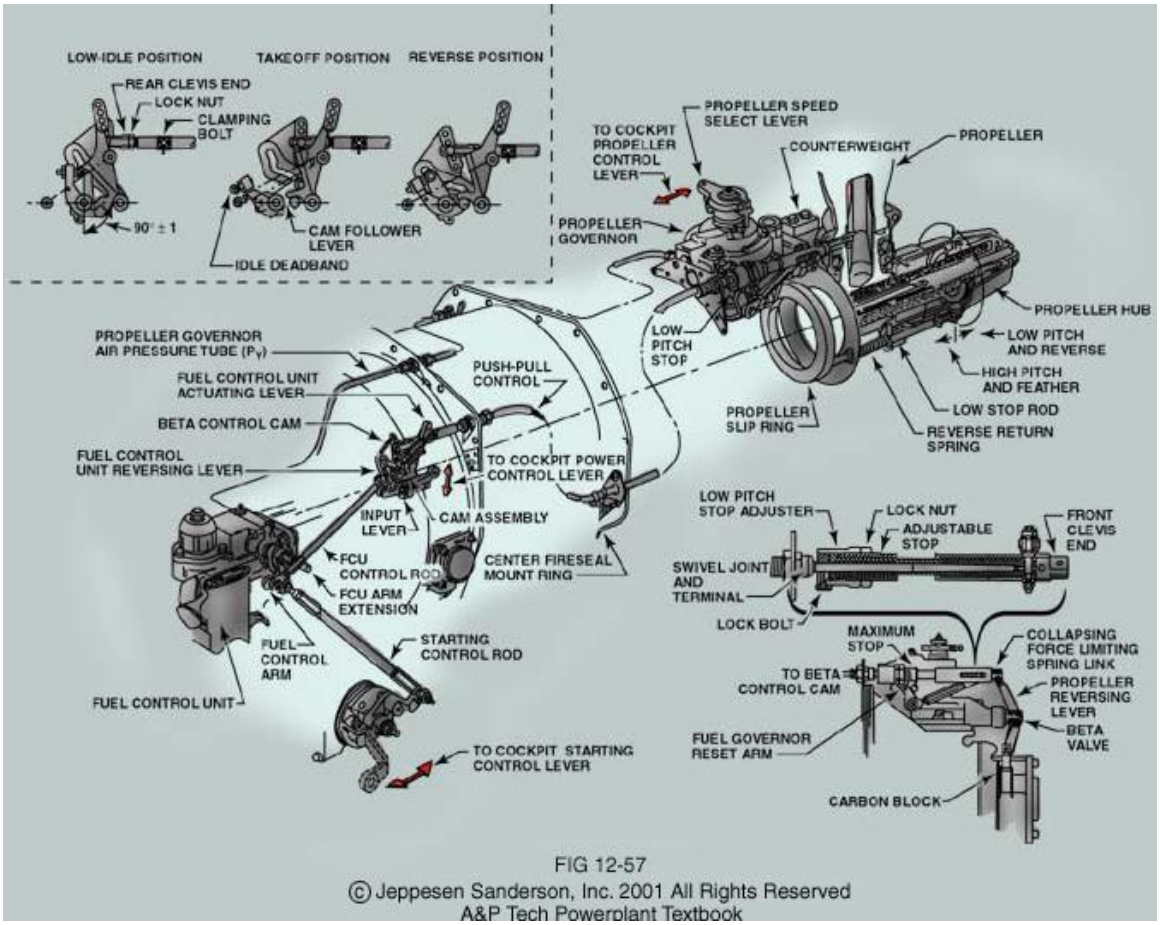


FIG 12-57

A&P Tech Powerplant Textbook

Other PT6 Propeller Systems

Some installations have

Auto ignition.

Auto feather.

Both of the above work on torque meter oil pressure signals.

If the oil pressure drops below a predetermined value.

First, … auto ignition is turned on.

If torque sensing still senses a dropping of engine torque, ……..

The auto feather valve opens letting the propeller blades drive to the feather position.

What We Learned

What a free turbine is.

The PT6 engine has two prop governors and one beta control.

A separate compressor turbine governor is used to protect for engine overspeed that is independent of the propeller governors.

PT6 engine fuel metering is by flyweights and pneumatic pressure bellows that control the fuel valve.

There is no "beta" tube as on the Garrett TPE331 engine, … a beta valve setup is used instead.

There is no one standard engine control configuration for all the pt6 engines, … there are 1, 2, 3, & 4 lever control systems.

Open Book Project

1. Explain free turbine.
2. What are the three different governors used on a pt6 engines.
3. Explain beta mode operation with a reversing propeller on a pt6 engine.
4. Explain alpha mode operation of a pt6 engine.