Abdulla Aljunibi

PROPELLER PITCH CONTROLS

To control the RPM

Introduction: general information about PROPELLER PITCH CONTROLS

fixed-pitch propellers were given blade angles designed to provide:

- acceptable performance during both takeoff and cruise.

Ground adjustable propellers:

- gave the operator the ability to set the propeller pitch prior to flight

These units were not adjustable during flight, but:

- provided the means whereby the pitch could be set to enhance either cruise or takeoff operations

Automatic propellers:

- changed pitch during flight without any direct input from the pilot

the automatic propellers provided a:

- lower pitch setting for takeoff and climb and a higher pitch for cruise

but

- lacked the precise controllability preferred by pilots: لكنه يفتقر إلى إمكانية التحكم الدقيقة التي يفضلها الطيارون

Controllable-pitch propellers provided the means:

- whereby the pilot could tailor the pitch of the propeller to best suit the flight based on altitude, speed, engine rpm, economy, etc.
- يمكن للطيار تصميم درجة المروحة لتناسب الرحلة على أفضل وجه بناء على الارتفاع والسرعة ودورة في الدقيقة للمحرك

Electrically controlled propellers made available the option for pilots to:

- select a variety of fixed-pitch positions in addition to constant-speed operations.

Technicians must understand the:
- relationship between :

1, propeller pitch
2, rpm
3, manifold absolute pressure (MAP)
4, propeller performance

For any single revolution of the propeller:
- the amount of air displaced (directionally moved) depends on the ; blade angle, which determines the quantity or mass of air moved by the propeller

the blade angle becomes a suitable means of adjusting the load on the propeller that is:
- subsequently transferred to the crankshaft to control engine rpm
- The load get transmitted to the crankshaft so RPM may increase or decrease (my own explanation)

If the blade angle is increased:
- more load is placed on the engine
- tending to slow it down unless extra horsepower is applied

If the blade angle is decreased:
- less load is placed on the engine
- tending to speed it up unless less horsepower is applied.

For the same throttle setting, a reduction of engine rpm will:
- increase the MAP as less air is pulled from the manifold and consumed by the cylinders.
- meaning: Reducing engine RPM increases Manifold Absolute Pressure (MAP) as less air is drawn into the cylinders, affecting engine performance.

propellers, which are rotating airfoils, the force of:
- lift becomes thrust

Increasing propeller blade angle:
- increases the ;

1, angle of attack (AoA)
2, produces more lift (thrust)
3, produces more drag (torque bending force)

this action increases the horsepower required to:
- turn the propeller at any given rpm.

Simply stated, it takes more horsepower to :
- drive a higher pitch propeller at the same rpm than it does to drive a lower pitch propeller, other conditions being equal.

engine rpm can readily be controlled by:

- increasing or decreasing the blade angle

The blade angle is also an excellent method of adjusting:

- the AoA of the propeller

On constant-speed propellers, the blade angle is commonly:

- adjusted to provide the most efficient AoA at all engine and airplane speeds

Lift versus drag curves, which are drawn for propellers as well as wings, indicate that:

- the most efficient AoA is a small one varying from 2° to 4° positive

The actual blade angle necessary to maintain this small:

- AoA varies with the forward speed of the airplane.
- This is due to a change in the relative wind angle or relative airflow (RAF) applied to the propeller blade, which varies with aircraft speed. Refer to Figures 1-6 and 1-10.

Fixed-pitch and ground-adjustable propellers are designed for best efficiency at:

- one rotation and forward speed.

In other words:

- they are designed to fit a given airplane and engine combination at a preferred flight parameter.

A propeller may be used that provides the maximum propeller efficiency for one of the following:

1, takeoff

2, climb

3, cruising

4, high speeds

But : can only choose 1 of they above

Any change in these conditions results in:

- lowering the efficiency, to some degree, of both the propeller and the engine constant-speed propeller:

- keeps the blade angle adjusted for maximum efficiency for most conditions encountered in flight.

During takeoff, when maximum power and thrust are required:

- the constant-speed propeller is at a low propeller blade angle or pitch

The low blade angle keeps the AoA:

- small and efficient with respect to the relative wind or RAF

At the same time, it allows the propeller to :

- handle a smaller mass of air per revolution

This light load allows the engine to turn at :

- a higher rpm and convert the maximum amount of fuel into heat energy in a given time

The high rpm also creates:

- maximum thrust

Although the mass of air handled per revolution is small,:

- the engine rpm is high
- the slipstream velocity (air coming off the propeller) is high

with the low airplane speed:

- the thrust is maximum

After takeoff, as the speed of the airplane increases:

- the constant-speed propeller changes to a higher angle or blade pitch the higher blade angle in combination with the higher airspeed keeps the AoA:

- small and efficient with respect to the RAF

The higher blade angle:

- increases the mass of air handled by the propeller per revolution

This decreases the engine:

- rpm, reducing fuel consumption and engine wear, and keeps thrust at a maximum for that operation

Climb:

For climb after takeoff the power output of the engine is reduced by the:

- pilot to climb power

This is accomplished by decreasing the:

- manifold absolute pressure by ;
- reducing the throttle opening and increasing the blade angle to lower the engine rpm using the propeller control.

- the torque (horsepower absorbed by the propeller) is reduced;

to match the;

- reduced power of the engine.

The AoA is again kept small by:

- the increase in blade angle and forward speed of the aircraft

Cruse

At cruising altitude when the airplane is in level flight and less power is required than is used in takeoff or climb:

- engine power is once more reduced by lowering the manifold pressure, leaning the mixture, and increasing the blade angle to decrease the rpm

this reduces:

- torque to match the reduced engine power

The AoA is still:

- small because the blade angle has been increased to correspond with the increase in airspeed

The constant-speed propeller has a;

- propeller control lever, often on the center pedestal between the throttle and the mixture control.

Single engine airplanes with constant-speed propellers may use a :

- push-pull cable
- instead of a lever to control propeller pitch

vernier feature that allows the pilot to:

- precisely set rpm by slowly rotating the control knob in the appropriate direction,

1, clockwise to increase rpm
2, counter clockwise to decrease rpm

Figure 3-2. Push-pull type controls for throttle (T), propeller (P),

Figure 3-1. Throttle; propeller; and mixture controls of twin engine aircraft.

The two extreme positions for the propeller control are:

- increase rpm or low pitch (full forward)
- decrease rpm or high pitch (full aft)

The propeller knob is directly connected to the propeller governor and, by;

- moving the control, adjusts the tension on the governor speeder spring.

On applicable models, this control can also be used to :

- feather the propeller by moving the knob into the feathering position

The two main engine instruments used for setting power with the constant-speed propeller are the:

- tachometer
- the manifold pressure gauge

During cruise operations, revolutions per minute (rpm) is controlled by the:

- propeller control
- manifold pressure is set using the throttle control.

PROPELLER GOVERNOR

propeller governor is an:

- engine rpm sensing device with a high pressure oil pump

In a constant-speed propeller system, the governor responds to a:

1, change in engine rpm

2, by directing oil under pressure to the propeller hydraulic cylinder or by releasing oil from the hydraulic cylinder, depending on system design

The change in oil volume in the hydraulic cylinder:

- changes the blade angle and maintains the engine rpm

The governor is set for a:

- specific rpm through the use of the propeller control, which compresses or releases tension on the governor speeder spring.

A propeller governor is used to sense:

- propeller/engine speed and normally provides pressurized oil to the propeller to reduce blade pitch

Fundamental forces, some already discussed, are used to control blade angle variations required for constant-speed propeller operation

These forces are:

1, Centrifugal twisting moment (CTM):

- move the blade into low pitch.

2, Propeller governor:

oil on the propeller piston side of the governor moves the blades to :

- low pitch

This balances is :

- against the propeller blade counterweights

The latter moves the blades toward :

- high pitch.

3, Propeller blade counterweights:

- always move the blades toward high pitch

4, Pneumatic pressure against the propeller piston:

- pushes toward high pitch

5, Springs:

- push in the direction of high pitch and feather.

6, Aerodynamic twisting moment (ATM):

- moves the blades toward high pitch.

All of the forces listed are not equal in terms of magnitude.

The most powerful force is the :

- governor oil pressure acting on the propeller piston.

The piston is connected mechanically to :

- the blades:

1, the piston moves, the blades are rotated in proportion to change pitch angle.

2, By removing the oil pressure from the governor:

- the other forces can force the oil from the piston chamber and move the propeller blades in the other direction.

GOVERNOR MECHANISM

The engine driven single acting propeller governor (constant-speed control) receives oil from:

- the engine's lubricating system and boosts that pressure to that required to operate the pitch changing mechanism

It consists of a :

1, gear pump to:

- increase the pressure of the input oil from the engine

2, pilot valve :

- controlled by flyweights in the governor
- to direct the flow of oil through the governor to and from the propeller,
- it's a relief valve system that regulates the operating oil pressures in the governor.

3, Flyweight

4, A spring called the speeder spring :

- opposes the governor flyweight's ability to fly outward when turning

The tension on this spring can be adjusted by :

- moving the propeller control on the control quadrant

The tension of the speeder spring sets the maximum rpm of the engine in the:

- constant-speed mode

As the engine/propeller rpm is increased to the maximum set point (maximum speed) of the governor:

- the governor flyweights overcome the tension of the speeder spring and move outward

This action moves the pilot valve in the:

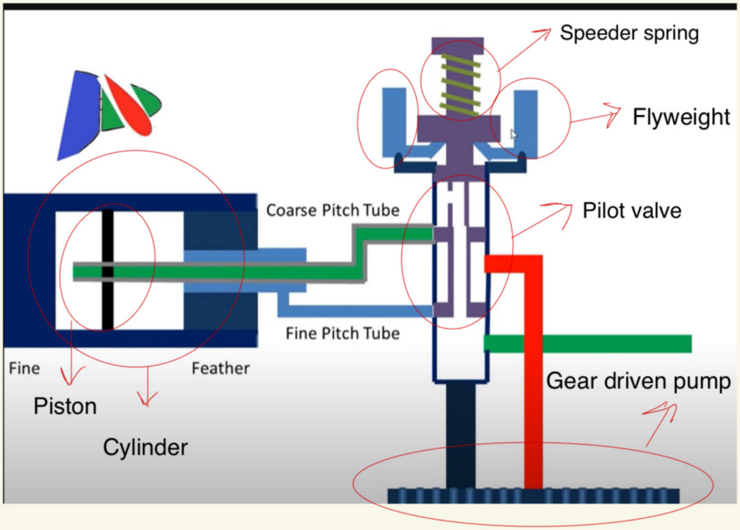
- governor to release oil from the propeller piston
- to allows the counterweights on the propeller blades to increase blade pitch,
- which will increases the load on the engine,
- slowing it down to return the rpm to the on speed rpm

The governor regulates the:

- flow of oil to or from the propeller piston
- to maintain the proper blade angle,
- ensuring constant-speed operation by balancing control forces in the engine.

The position of the pilot valve, with respect to the propeller governor metering port:

- regulates the quantity of oil that flows through this port to or from the propeller



In addition to boosting the engine oil pressure to produce :

- one of the fundamental control forces,

the governor :

- maintains the required balance between control forces by metering to, or draining from, the propeller piston the exact quantity of oil necessary to maintain the proper blade angle for constant-speed operation

A speeder spring:

- opposes the action of the governor flyweights which sense propeller speed

If the flyweights turn slower than the tension on the speeder spring:

- they move inward; this is an under speed condition

To accelerate the engine/propeller combination:

- the blade angle (pitch) must be decreased

the process:

- Additional oil flows into the propeller and acts on the piston to:
- decrease blade pitch or blade angle
- speeding up the engine until it reaches the on speed condition where the force on the governor flyweights and the tension on the speeder spring are returned to a balanced condition.

This balance of forces can be disturbed by the:

1, aircraft changing attitude (climb or dive)
2, the pilot changing the tension on the speeder spring with the propeller control (i.e., if the pilot selects a different rpm)
3, by the pilot moving the throttle control.

Before discussing the on speed, under speed, and over speed operations

it must be mentioned that the propeller governing systems tries to:

- maintain an on speed condition.

This is established when the:

- mechanical forces between speeder spring tension and flyweight action are equal.

When the engine is running at low rpm, such as start up, warm up, taxiing, final approach, etc., the governor attempts to:

- lower propeller pitch to elevate engine rpm until the on-speed condition is attained.

However, when the propeller blades are against their physical low pitch stops:

- they are unable to further reduce pitch to gain rpm

In such operating conditions, the propeller acts like a :

- fixed-pitch unit and remains against the low pitch stop until :
- the rpm is increased and the on speed rpm is reached or exceeded

Should the governor encounter an over speed condition: meaning to operate and change the pitch

- the pilot valve will be shifted within the governor
- to increase the blade pitch in order to reduce rpm until the on speed condition is established.

1, ON SPEED CONDITION

When the engine is operating at the rpm set by the pilot using the cockpit control:
- the governor is operating "on speed."

In an on speed condition, the centrifugal force acting on the governor's flyweights is:
- balanced by the tension exerted by the speeder spring
- and the pilot valve is neither directing oil to or from the propeller hydraulic cylinder

In the on speed condition, the forces of the governor flyweights and the tension on the speeder spring are :
- equal; the propeller blades are not changing pitch.

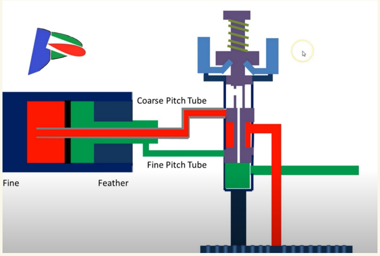
If something happens to unbalance these forces, such as:
- if the aircraft dives or climbs,
- or the pilot selects a new rpm range by moving the propeller control (changes tension on the speeder spring),
- or the pilot changes throttle setting

then these forces are unequal and:
- an under speed or over speed condition will result

The governor, as a speed sensing device, causes the propeller to :
- respond to under speed and over speed conditions by returning to the set rpm regardless of the aircraft attitude or throttle setting.

The speeder spring propeller governing range is limited to about:
- 200 rpm

Beyond this rpm:
- the governor cannot maintain the correct rpm.



2, UNDER SPEED CONDITION

When the engine is operating below the rpm set by the pilot using the cockpit control:

- the governor is operating in an under speed condition.

In this condition:

- the arms of the flyweights tilt inward
- because there is not enough centrifugal force acting on the flyweights to overcome the force of the speeder spring

The pilot valve, forced down by the speeder spring:

- measure or meters oil flow to decrease propeller pitch and raise engine rpm

inc

To maintain a constant speed:

- the governor senses the decrease in speed and ;
- increases oil flow to the propeller; this will
- moving the blades to a lower pitch and allowing them to maintain the same speed

The oil then flows through

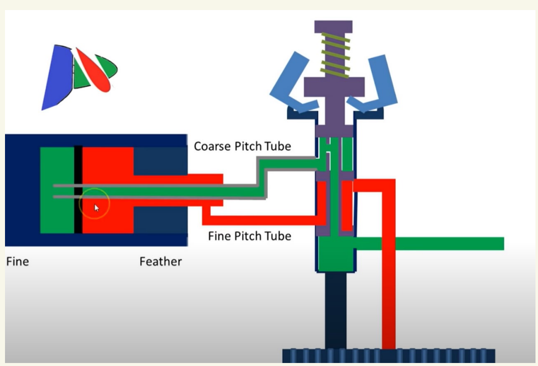
- the valve port and into the propeller piston

causing the blades to ;

- move to a lower pitch (a decrease in load).

the propeller governor will be in an under speed condition when

- the engine is operated at low power settings.
- This occurs whenever the engine rpm is below the operating range of the propeller governor
- Not feathering



3, OVER SPEED CONDITION

When the engine is operating above the rpm set by the pilot using the cockpit control or the redline adjustment of the governor:

- the governor is operating in an over speed condition.

In an over speed condition:

- the centrifugal force acting on the flyweights is greater than the speeder spring force.

The flyweight arms;

- tilt outward and raise the pilot valve.

The pilot valve then;

- measure or meters oil flow to increase propeller pitch and lower engine rpm

When the engine speed increases above the rpm for which the governor is set: note

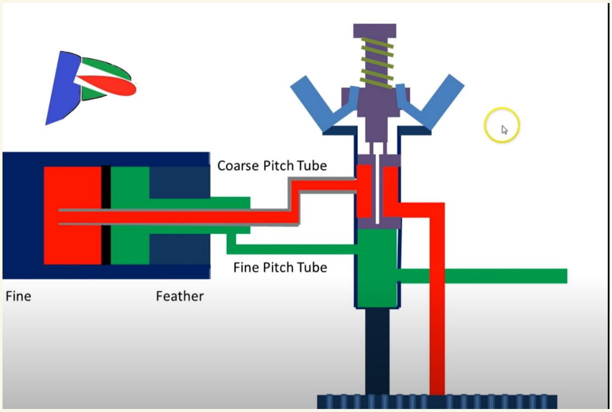
- that the flyweights move outward against the force of the speeder spring,
- raising the pilot valve.

This opens the propeller governor metering port:

- allowing governor oil to flow from the propeller piston

At this point the counterweights on the blades:

- increase pitch angle, which slows the engine rpm.



CONSTANT-SPEED PROPELLER OPERATIONS

My statement

Hartzell constant-speed, non-feathering propeller is a :

- propeller system manufactured by Hartzell that maintains a constant rotational speed and does not have the ability to feather its blades.

HARTZELL CONSTANT-SPEED, NON-FEATHERING PROPELLERS

Hartzell propellers can be classified by:

- aluminum hub (compact) and steel hub.

They combine:

- low weight
- simplicity in design
- rugged construction. Strong construction

In order to achieve these ends, the hub is made as :

- compact as possible ; مضغوط قدر الإمكان
- utilizing aluminum alloy forgings for most of the parts

The hub shell is made in:

- two halves, bolted together along the plane of rotation

This hub shell carries the:

- pitch change mechanism and blade roots internally.

The hydraulic cylinder, which provides power for:

- changing the pitch

is mounted at the front of the:

- hub

The propeller can be installed only on:

- engines with flanged mounting provisions

One model of non-feathering aluminum hub constant-speed propeller utilizes:

- oil pressure from a governor to move the blades into high pitch (decrease rpm).

The centrifugal twisting moment of the blades tends to:

- move them into low pitch (increase rpm) in the absence of governor oil pressure.

This is an exception to most of the aluminum hub models and feathering models

Most of the Hartzell aluminum and steel hub models use:

- centrifugal force acting on blade counterweights to increase blade pitch and governor oil pressure for low pitch.

The steel hub contains a:

- central "spider," that supports aluminum blades with a tube extending inside the blade roots.
- The blades are mounted on the hub spider for angular adjustment

Blade clamps connect the:

- blade shanks with blade retention bearings

hydraulic cylinder is mounted on the:

- rotational axis connected to the blade clamps for pitch actuation.

The centrifugal force (pulling the blades from the hub) generated by:

- the blades during high rpm operations,
- amounting to as much as 25 tons
- is transmitted to the hub spider through blade clamps and then through bearings

The propeller thrust and engine torque is:

- transmitted from the blades to the hub spider through a bushing inside the blade shank.

In order to control the pitch of the blades:

- hydraulic piston cylinder element is mounted on the front of the hub spider

The piston is attached to the blade clamps by means of a sliding:

- rod and fork system for non-feathering models
- a link system for the feathering models.

The manufacturer's specifications and instructions must be:

- consulted for information on specific models

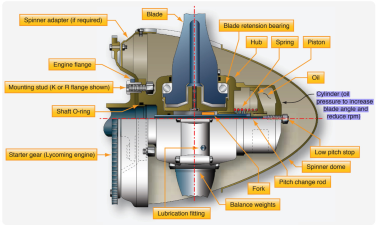


Figure 3-9. Constant speed, non-feathering propeller.

CONSTANT-SPEED FEATHERING PROPELLERS

The feathering propeller utilizes a:

- single oil supply from a governing device to hydraulically actuate a change in blade angle

While the propeller is operating, the following forces are constantly present:

1) spring force,
2) propeller blade counterweight force,
3) centrifugal twisting moment (CTM) of each blade
4) blade aerodynamic twisting moment (ATM).

The spring and counterweight forces attempt to rotate the blades to a :

- higher blade angle ; heigh pitch

The centrifugal twisting moment of each blade is generally working to ;

- lower blade angle. ; low pitch

Blade aerodynamic twisting force is usually :

- very small in relation to the other forces
- can attempt to increase or decrease blade angle ; low or high pitch

The summation of the propeller forces is ;

- toward higher pitch

and is opposed :

- by a variable force toward lower pitch

The variable force is:

- oil under pressure from a governor
- with an internal pump that is mounted on and driven by the engine.

The oil from the governor is supplied to the:

- propeller and hydraulic piston through a hollow propeller shaft

Increasing the volume of oil within the piston and cylinder:

- decreases the blade angle and increases propeller rpm.

If governor supplied oil is lost during operation; engine does not work properly

- the propeller increases pitch and feathers

Feathering occurs because the summation of internal propeller forces causes the :

- oil to drain out of the propeller until the feather stop position is reached.

Normal inflight feathering is accomplished when the:

- pilot retards the propeller condition lever past the feather detent

my statement: moving a control in the cockpit to a position that's beyond where the propeller blades usually stop to reduce drag. This action might be needed in certain situations during flight.

This permits control oil to:

- drain from the propeller and return to the engine sump.

Engine shutdown is normally accomplished during the feathering process

Normal inflight unfeathering is accomplished when:

- the pilot positions the propeller condition lever into the normal flight (governing) range and restarts the engine

my statement:

- When a pilot wants to "unfeather" the propeller during flight:

1. They move a lever to put the propeller blades back in the normal position for flying. (governor)

2. Then they restart the engine.

This process gets the propeller ready to help the airplane fly like it normally does.

As engine speed increases:

- the governor supplies oil to the propeller and the blade angle decreases

Decreasing the volume of oil :

- increases blade angle
- decrease propeller rpm.

By changing blade angle:

- the governor can vary the load on the engine and maintain constant engine rpm (within limits), independent of where the power lever is set.

The governor uses engine speed sensing mechanisms that permit it to:

- supply or drain oil as necessary to maintain constant engine speed (rpm)

Most of the steel hub Hartzell propellers and many of the aluminum hub units are:

- full feathering

These feathering propellers operate similarly to the:

- non-feathering ones except the feathering spring assists the counterweights to increase the pitch of the blades.

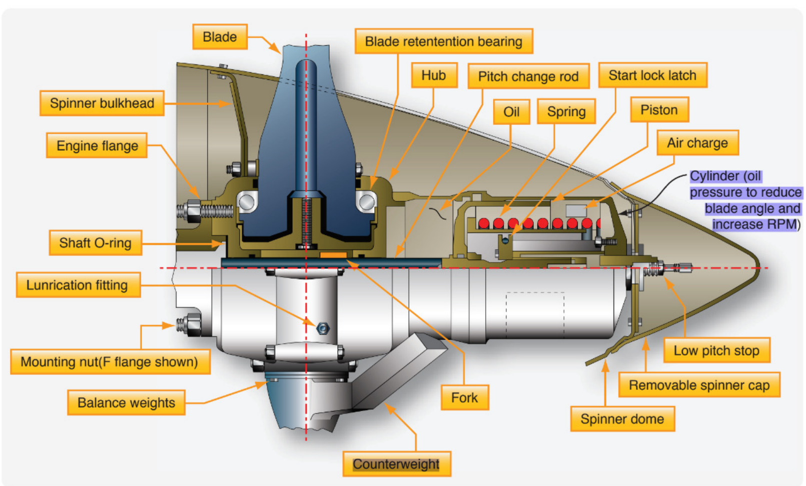


Figure 3-10. Constant speed, feathering propeller.

UNFEATHERING:

Unfeathering can be accomplished by any of several methods, as follows:

1, Start the engine:

How It Works:

- When the engine starts, it sends oil to the propeller, which adjusts the propeller blades to reduce their angle (pitch). This process helps the propeller come out of the feathered position and back to its normal position for flying

Possible Issue:

- can cause some vibration in the aircraft.

2, air pressure and governor

Provide an accumulator connected to the governor with a :

- valve to trap a pneumatic oil charge when the propeller is feathered

but released to the propeller:

- when the propeller or rpm control is returned to normal position.

This system is used with:

- training aircraft because it :
- unfeathers the propeller in a very short time and promptly starts the engine windmilling.

3, unfeathering pump

Provide an unfeathering pump that provides:

- pressure to force the propeller back to low pitch quickly using engine oil.

Normal inflight unfeathering is accomplished when the pilot :

- positions the propeller control lever into the normal flight (governing) range

This causes the governor to:

- disconnect the propeller oil supply from the return drain and reconnects it to the governed oil supply line from the governor.

At that instant, there is no oil available from the engine oil pump to the governor because:

- the engine is not rotating

therefore:

no governed oil is available from the governor for controlling the propeller blade angle and rpm.

As the engine is started:

- its speed increases, the governor supplies oil to the propeller, and the blade angle decreases

As soon as the engine is operating,:

- the governor starts to unfeather the blades

Soon thereafter:

- windmilling takes place, which speeds up the process of unfeathering

In general, restarting and unfeathering of propellers can be classified as:

- reciprocating engine restart unfeathering
- turboprop restart unfeathering
- accumulator unfeathering.

When reciprocating engine restarting is used to unfeather the propeller:

- the engine takes a little longer to rotate fast enough to provide oil pressure to the governor and then to the propeller

This delay can cause:

- vibration as the propeller is unfeathered.

Many aircraft use an :

- accumulator to provide stored pressure to quickly unfeather the propeller.

Special unfeathering systems are available for certain aircraft where

- restarting the engine is difficult

or

- for training purposes.

The system consists of an

- oil accumulator
- connected to the governor
- through a valve

The air or nitrogen pressure in one side of the accumulator:

- pushes a piston to force oil from the other side of the accumulator through the governor to the propeller piston
- to move the propeller blades from feather to a lower blade angle

The propeller then begins to :

- windmill and permits the engine to start.

When an unfeathering pump is used:

- activated by the pilot after positioning the propeller control correctly, sends oil pressure to the propeller to swiftly bring it back to its standard position for flight.

AUTOFEATHERING SYSTEM

An auto feather system is used normally only during:
1, takeoff
2, approach
3, landing

It feathers the propeller automatically if :
- power is lost from an engine.

The system uses a:
- solenoid valve to dump oil pressure from the propeller cylinder
- this allows the propeller to feather

if two torque switches sense low torque from the engine
- This system typically has a Test-Off-Arm switch that is used to operate the system

HAMILTON STANDARD HYDROMATIC PROPELLERS

A hydromatic propeller has a :

- double acting governor

that uses :

- oil pressure on both sides of the pitch change

piston located in the :

- dome of the propeller hub

The hydromatic governors are similar in ;

- construction and principle of operation as in other constant speed systems.

The major difference is in :

- the pitch changing mechanism.

In the hydromatic propeller:

- no counterweights are used on the propeller blades
- the moving parts of the mechanism are completely enclosed

Oil pressure and the centrifugal twisting moment (CTM) of the blades are used together :

- to move the blades to a lower pitch angle

The main advantages of the hydromatic propeller are the:

- large blade angle range
- the feathering and reversing features

This propeller system is a :

- double acting hydraulic propeller
- design in which the hydraulic pressure (engine oil pressure) on the piston dome is used against governor oil pressure on the opposite side of the piston.

HAMILTON STANDARD PROPELLER CONTROL

HYDROMATIC ON SPEED CONDITION

A governor uses :
1, flyweight assembly
2, speeder spring
3, pilot valve
4, oil pressure boost pump
5, valves
is used to provide :
- constant speed operations of the Hamilton Standard propeller

Boosted oil pressure is sent to the :
- inboard section of the piston and ordinary engine oil pressure to the outboard surface of the piston.

When the engine is on speed:
- the pilot valve is positioned so that oil does not enter or exit the propeller dome.

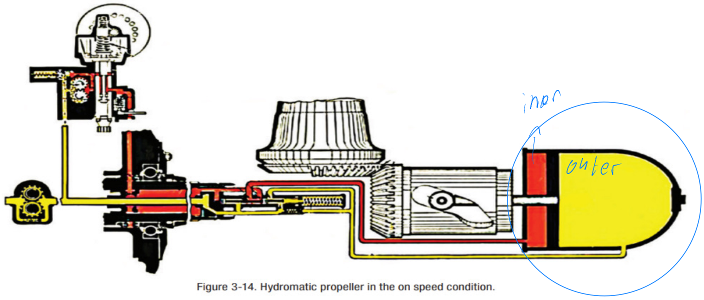


Figure 3-14. Hydromatic propeller in the on speed condition.

OVER SPEED CONDITION

High pitch

To increase propeller pitch, as during an over speed condition:

1, boosted oil pressure from the oil pump within the governor is directed to the inboard side of the piston

2, while oil from the outboard section of the dome is allowed to drain back to the engine

- This action increases propeller pitch.

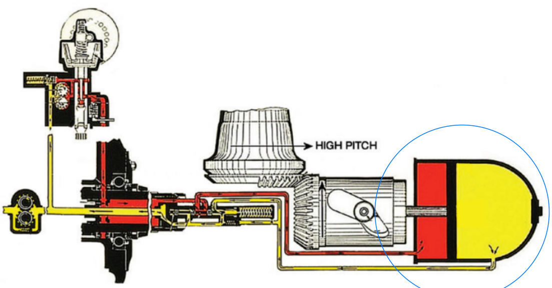


Figure 3-16. Hydromatic propeller in the over speed condition.

HYDROMATIC UNDER SPEED CONDITION

Low pitch

To reduce propeller pitch:

1, the pilot valve moves so that oil acting on the inboard surface of the piston is allowed to drain from the dome.

2, Engine oil pressure directed to the outboard section of the dome, along with the CTF generated by the propeller blades

- this action decrease propeller pitch.

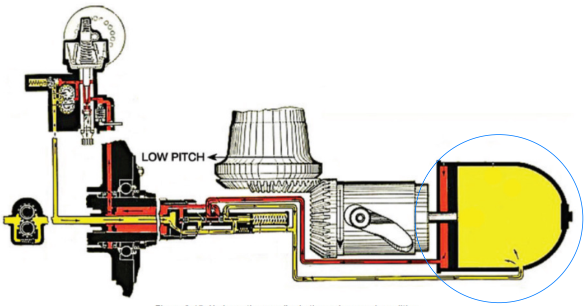


Figure 3-15. Hydromatic propeller in the under speed condition.

Feathering and unfeathering

Feathering and unfeathering the Hamilton Standard propeller are achieved through the

- use of an auxiliary oil pump.

This unit is typically driven by an
1, electric motor
And:
2, delivers oil pressure at levels greater than those generated by the oil boost pump within the governor.

Electrical switches and holding coils are

- incorporated into the feathering and unfeathering operations; يتم دمجهم

TURBOPROP ENGINES AND PROPELLER CONTROL SYSTEMS

Turboprop engines are used with many :

- single engine aircraft
- twin engine aircraft
- commuter aircraft

Smaller turboprop engines, such as the Pratt and Whitney PT-6, are normally installed on

- single and twin engine designs
- the power ranges from 500 to 2000 shaft horsepower.

The turboprop propeller is operated by a :

- gas turbine engine
- through a reduction gear assembly.

It has proven to be an :

- extremely efficient power source.

The combination of propeller, reduction gear assembly, and turbine engine is referred to as a:

- turboprop power-plan

the turboprop engine produces thrust indirectly because :

- the compressor and turbine assembly furnishes torque to a propeller;
- producing the major portion of the propulsive force that drives the aircraft.

The turboprop fuel control and the propeller governor are connected and operate in :

- coordination with each other.; بتناسق

The power lever directs a signal from the cockpit to the fuel control for :

- a specific amount of power from the engine.

The fuel control and the propeller governor together establish the :

1, correct combination of rpm
2, fuel flow
3, propeller blade angle to create sufficient propeller thrust to provide the desired power

Simultaneously managing these parameters becomes a complicated process.

The propeller control system is divided into two types of control:
1, for flight operation
2, for ground operation

1, For flight operations: (alpha range)
the propeller blade angle and fuel flow for any given power lever setting are:

- governed automatically according to a predetermined schedule.

Below the “flight idle” power lever position, the coordinated rpm blade angle schedule becomes :

- incapable of handling the engine efficiently.

My statement:

- When the power lever is below the "flight idle" position, the engines aren't running fast enough to handle flying the plane efficiently.

2, beta range (ground operations)
In the beta range of the throttle quadrant:

- the propeller blade angle is not governed by the propeller governor
- but is controlled by the power lever position

When the power lever is moved below the start position:

- the propeller pitch becomes negative to provide reverse thrust for rapid deceleration of the aircraft after landing.

A characteristic of the turboprop is that changes in power are not related to engine speed, but to there:

- turbine inlet temperature

During flight

- the propeller maintains a constant engine speed:

This speed is known as the :

- 100 percent rated speed of the engine
- it is the design speed at which most power and best overall efficiency can be obtained

Power changes are effected by changing the :

- fuel flow.

Ex :

An increase in fuel flow causes an :

- increase in turbine inlet temperature
- So there will be a corresponding increase in energy available at the turbine.

In this case :

- The turbine absorbs more energy and transmits it to the propeller in the form of torque

The propeller, in order to absorb the increased torque:

- increases blade angle, thus maintaining constant engine rpm with added thrust.

REDUCTION GEAR ASSEMBLY

REDUCTION GEAR ASSEMBLY

The function of the reduction gear assembly is to:

- reduce the high rpm from the spinning turbine to a propeller rpm that can be maintained without exceeding the maximum propeller tip speed (normally around the speed of sound)

Most reduction gear assemblies use a:

- planetary gear reduction system.

Mounting pads are available for:

- propeller governor(s)
- oil pump
- and other accessories

A propeller brake is often :

- incorporated into the gearbox

The propeller brake is designed to:do 2 things

1, prevent the propeller from wind milling when it is feathered in flight
2, decrease the time for the propeller to come to a complete stop after engine shutdown.

TURBO-PROPELLER ASSEMBLY

TURBO-PROPELLER ASSEMBLY

The turbo-propeller provides an :

- efficient and flexible means of using the power of the engine at any condition in flight (alpha range).

For the ground handling and reversing (beta range) the propeller can be operated to provide either

- zero

or

- negative thrust. Low thrust may also be available in beta.

The major subassemblies of the propeller and associated control network are the:

1, cylinder and piston assembly composing the dome
2, hub
3, pitch change mechanism
4, low pitch stop assembly
5, over speed governor
6, pitch control unit
7, auxiliary pump
8, feather and unfeather valves
9, torque motor
10, spinner
11, de-ice timer
12, beta feedback assembly
13, and propeller electronic control

Modern turboprop engines use:

- dual Full Authority Digital Engine Control (FADEC) to control both engine and propeller.

The spinner assembly is a:

- cone shaped configuration that mounts on the propeller and encloses the dome and barrel to reduce drag.

ELECTRICALLY CONTROLLED PROPELLERS

Where most controllable pitch propellers utilize :

- hydraulically operated governors and pitch change mechanisms

some propellers use:

- electrical motors to control propeller blade pitch.

Electrically controlled propellers share many features with the hydraulically controlled models, such as:

- constant speed operation
- feathering and unfeathering
- reversing

Electrically controlled propellers also include

- capabilities not incorporated in the hydraulically controlled systems.

Components composing the electrically controlled propellers include the:
1, motor
2, motor brake
3, gearbox
4, the propeller hub and blades
5, slip rings and brushes
6, governor
7, related switches and controls.

The pilot controls the propeller using a:
- switch in combination with a propeller control lever.

The main switch has four positions:
1, off
2, increase rpm
3, decrease rpm
4, automatic.

1, The off position :
- de-energizes the system.

The propeller remains in its :
- current pitch position unless the feather switch or reverse pitch switch are activated.

2/3, The increase rpm and decrease rpm positions are:
- spring loaded and make contact as long as the pilot holds the switch in the desired mode.

The pilot must hold the switch in the increase or decrease rpm position to ;
- activate the system

Once the switch is released
- it returns to the off position and the propeller is locked into a new pitch angle.

In such operations, the propeller acts like a :
- fixed pitch propeller that has the ability to vary pitch settings

In the event of an electrical failure:
- the propeller pitch will remain in the position it was in when the power failure occurred.
- This feature is due to the spring loaded motor brake

4, When the control switch is placed in the automatic position:

engine driven propeller governor is incorporated.
The engine and the governor are connected

The governor uses switches to :
- increase and decrease pitch to maintain constant engine rpm

As the automatic position is a continuous mode of operation, the pilot does not need to:
- hold the switch in this position once selected.

the units associated with the electric propellers use a
1, flyweight
2, speeder spring arrangement.

on speed
When the governor is on speed:
- flyweight action and speeder spring are in balance
- no electrical signal is sent to the brake and motor

under speed
When the governor is in an under speed condition:
- the governor activates the pitch change motor to reduce propeller pitch
- until the governor returns to the on speed condition.

over speed
if the governor is in the over speed condition:
- the governor sends a signal to the pitch change motor to increase rpm
- until the engine returns to the on speed rpm

The governor control lever is normally located :

- adjacent to the throttle in a fashion similar to hydraulically operated governors

Full forward on the governor control lever provides :

- low pitch

the control is moved aft, the propeller will :

- increase pitch to maintain a lower on speed rpm

Electrically controlled propellers have :

- feathering capabilities
- reverse pitch capabilities