

CHAPTER 3

PROPELLERS FOR TURBO-PROPELLER AIRCRAFT

Objectives

1. The aim of this Chapter is to provide the Aircraft Technician (P) with information to cover the Skill and Knowledge Specifications (SAKS) for assembly, installation, and removal of turbo propellers. When you have studied this Chapter you should understand the function of:

- Propeller hub and blade assembly.
- Pitch change piston, eyebolt and link assembly.
- Oil tubes.
- Cylinder assembly.
- Pitch lock assembly.
- Slip ring and bush gear housing.

Also, you should be able to explain:

- The need for a ground fine pitch angle.
- The operation of the propeller governor unit.
- The operation of the pitch change mechanism.
- The safety devices necessary in this propeller system.

Introduction

2. When an in-use propeller is damaged or life expired, the quickest aircraft turn-round time is achieved by removing the used propeller from the aircraft and fitting a serviceable propeller of identical type. The amount of work involved in this activity will depend upon the type of propeller and the state in which it is supplied.

Assembled propellers are bulky and difficult to transport over long distances. Because of this, they are often delivered to the user in a dismantled state. This enables the propeller to be packed into a comparatively small case that is easy to handle and transport. It follows, therefore, that an A Tech P must be able to assemble a propeller, supplied in a dismantled state, in addition to fitting it to a propeller shaft when assembled.

3. In this Chapter we shall deal with general details about hydraulically operated propellers. However, before dealing with these let us consider, in a general way, information that is applicable to handling most propellers.

Handling Precautions

4. Whether they are supplied assembled or in a packed state, a considerable amount of handling and lifting may be necessary before the propeller is finally fitted onto the propeller

shaft. General rules for lifting and using slings are to be found in AP3402; mandatory instructions covering the use of slings are to be found in AP3158 Vol 2 leaflet H22 and in AP2817A Vol 1 and 6.

5. The rules and instructions for handling propellers can be summarized as follows:

- Wear correctly fastened overalls so that nothing will catch on the items being handled.
- Before lifting heavy items, prepare a safe and accessible place to receive the part.
- Ensure that the floor area is cleared of obstructions, grease, oil and water.
- When using a crane or a block and tackle, the lift is to be supervised by an NCO.
- When moving heavy items where a crane cannot be used, obtain adequate assistance.
- When a number of persons are lifting a heavy item, only one person is to give instructions.
- When heavy parts of a propeller (such as the pitch change mechanism (PCM)) are placed on a bench they must be made secure so that they cannot roll off and cause damage or injury to personnel.
- When testing the operation of newly assembled propellers do not allow oil to spill onto the floor or the test bench. If oil leaks are apparent, catch the oil in a drip tray and reduce the oil pressure. Finally, remove all traces of oil from the propeller and work bench.
- Before fitting slings to the assembled propeller ensure that they are the correct slings for the job and in a serviceable condition.
- Fit the sling so that it does not damage the propeller parts.
- When lifting a propeller in readiness for fitting to an aircraft, the lift will often start with the propeller lying horizontally. It is usual to sling by two blades so that they straddle the vertical centre line. The upper blades lift clear but the lower blade(s) must be protected from scraping along the floor as the propeller is lifted.
- Never rest a propeller on the spinner back plate or on the cooling fan.

6. When the propeller is supported by the sling it may be necessary to fit the spinner back plate. This is a task undertaken whilst the propeller is suspended and extreme care is needed to avoid working underneath the suspended load.

7. The principle of producing thrust is the same for all propellers, but the requirements of a turbo-propeller engine differ from those of a reciprocating piston engine, particularly when a single turbine is used.

8. Normally, when a piston engined aircraft uses a variable pitch propeller, the propeller will have a fine pitch stop and a coarse pitch stop for single engined aircraft, with the addition of a *feathering* facility for most multi-engined aircraft. Propeller braking may or may not be included according to operational requirements.

Some turbo-propeller aircraft without a free turbine engine will require a propeller with blades which can be turned into the plane of rotation to produce a zero angle of attack for engine starting; such a propeller is described in the following notes. It provides the following:

- A ground fine pitch of zero angle for engine starting.
- A flight fine pitch angle which equates with the fine pitch setting of a piston engined aircraft.
- Feathering ability.

The propeller is designed for constant speed operation in the normal range between 'flight fine pitch' and coarse pitch. It is hydraulically operated by engine oil that has been increased in pressure by the spur gear pump in a mechanically governed control unit.

Hydraulic Fixed Cylinder Propeller

9. This propeller has four blades each secured into the hub by the blade bearing assembly. The pitch change mechanism consists of a fixed cylinder inside which a piston is moved by governor oil pressure. The piston is linked to the blade roots by eye-bolts and operating links so that axial movement of the piston causes each blade to turn around its axis as illustrated in Fig 5.3.1.

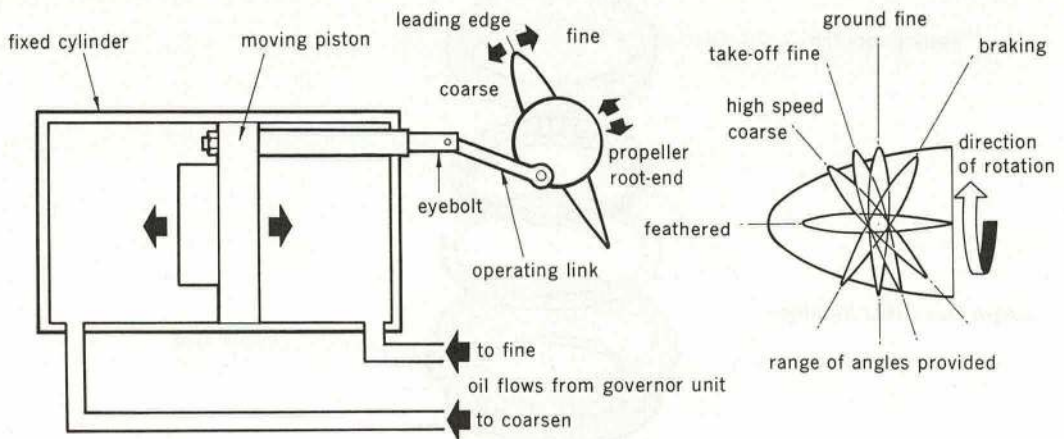


Fig 5.3.1. Principle of operation (fixed cylinder turbo-propeller)

10. The propeller consists of:

- Four alloy blades, with operating pins, held into the hub by a taper roller bearing assembly.
- Hub and driving centre.
- Oil tubes.
- Pitch lock mechanism.
- Pitch change mechanism.

The Propeller Blade

11. Each blade is machined to shape from duralumin forgings. The root end is bored and screw threaded with a left-hand thread to accept a special large diameter retaining bolt that is used to secure a taper roller bearing assembly onto the shank of the blade (Fig 5.3.2). Two steel bushes are shrunk onto the blade shank for location of the top and bottom races of the taper roller bearing and, when the bearing is assembled onto the blade, the special retaining bolt is locked by a serrated segment which is secured to the bottom race. Finally, the operating pin is secured to the blade root. The fitting is located by a dowel and held in position by set bolts.

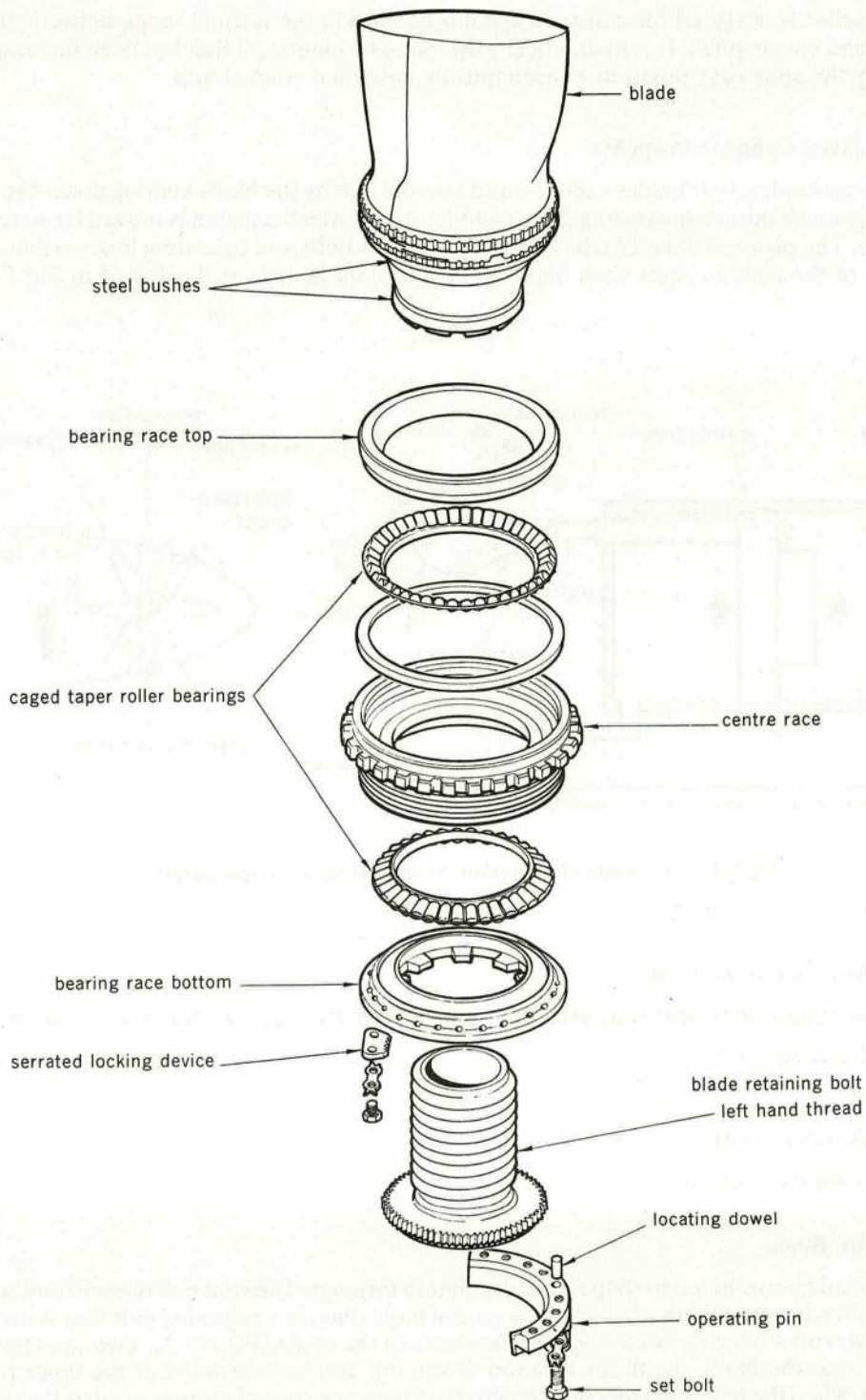


Fig 5.3.2. Blade root assembly

12. **Blade bearing assembly.** The bearing assembly consists of a centre race housing sandwiched between two rings of caged taper rollers which seat on the top and bottom race respectively. The bearing is pre-loaded by the retaining bolt which is screwed into the root of the blade on a left-hand thread. The centre race housing is of cylindrical construction with two races machined in its bore, one race for each of the two taper roller bearings. Externally the centre race housing is screw threaded to match the thread in the hub shell and a slotted flange enables the assembled blade to be screwed into the blade socket and secured there. When the blade has been fitted to the hub, the slotted flange of the centre race housing is locked to the cylinder back plate.

13. **Anti-icing.** The propeller blades are de-iced by electrically heated over-shoes that are fitted into recesses machined along the leading edge of each propeller blade. The overshoes contain electrical heater elements which receive an electrical supply through slip rings at the rear of the propeller hub and feed cables attached to the blade shank.

14. **Blade markings.** All propeller blades are painted with approved safety markings which enable the blade to be seen when the propeller is spinning. In addition, each blade carries identification marks and relevant information such as:

- The blade serial number.
- The blade position number.
- The maker's crest.
- The drawing number.
- Aero-dynamic correction figures.
- The master station (blade angle checking station).

The Hub and Driving Centre

15. **The hub shell.** The shell is machined from an alloy steel forging and consists of four short sockets with internal buttress threads which accept the propeller blades and their bearing assemblies (Fig 5.3.3). The blade sockets are spaced with 90° between centres and, for balance purposes, they are numbered to match the position numbers marked on each blade. The shell is bored through its front and rear face to fit the hub driving centre, which is a hollow sleeve fitted at right angles to the blade sockets.

16. **The driving centre.** The driving centre is bolted into the hub shell to provide the means for mounting the propeller onto the propeller shaft. It is splined internally to match the propeller shaft, and the front cone support is shrunk into the bore immediately in front of the internal splines. At the rear, the bore of the driving centre is tapered to seat on the rear cone (which is an engine part fitted to the rear of the propeller shaft). The front of the driving centre bore is screw threaded for the transfer sleeve housing.

A flange at the rear of the driving centre provides a mounting for the de-icing power supply slip ring and an attachment for the propeller lifting lug. Provision is made for oil sealing the bore between the rear of the splines and the rear cone seating.

17. **Attachment to shaft.** The assembled propeller is secured to the propeller shaft between two cones; the front cone is a propeller part and the rear cone is an engine part. The propeller retaining nut is cylindrical in shape, screw threaded in the bore with a buttress thread to match that of the propeller shaft. Forward of the threaded portion, the bore of the nut is splined to fit a special spanner which is provided in the propeller tool kit. Once fitted, the propeller retaining nut is locked by the pitch lock unit.

The Oil Tubes

18. The pressure oil that operates the pitch change mechanism is fed through two concentric oil tubes, which are propeller parts, screwed into an adapter in the bore of the propeller shaft

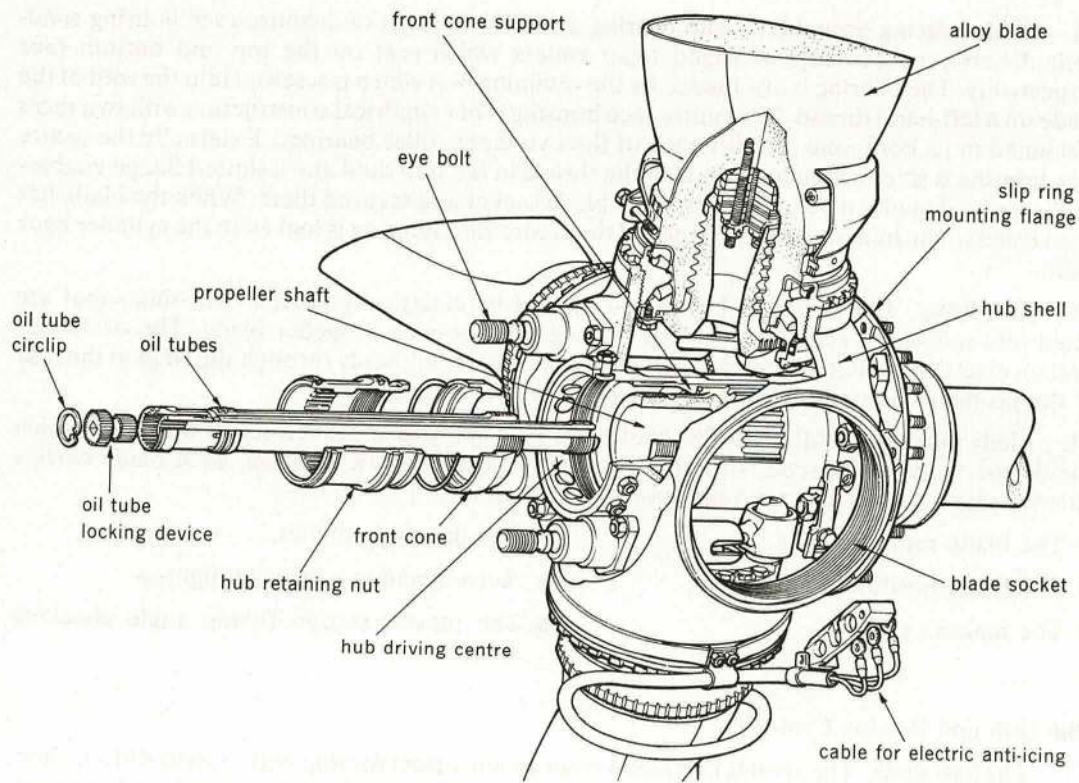


Fig 5.3.3. Propeller hub assembly

(Fig 5.3.3). The inner tube screws in on a left-hand thread and provides an oilway for the coarse pitch oil flow. The outer oil tube has a right-hand thread and carries the fine pitch oil flow. At the front end, both oil tubes are splined to match a special locking device which is used also when fitting or removing the oil tubes. Once fitted, the oil tubes are secured in position by the externally splined locking device which engages the splines in the bores of the tubes locking them together. A circlip fits into a groove in the bore of the outer oil tube and secures the assembly in the locked position. The front ends of the oil tubes terminate in a transfer sleeve housing which secures the cylinder backplate (Fig 5.3.4).

Fitted in from the front of the pitch change cylinder is the pitch lock assembly (Fig 5.3.5) which extends into the bore of the transfer sleeve housing to lock the propeller nut and mate with the front end of the pitch change oil tubes. Oil transfer sleeves in the pitch lock assembly complete the oilways to the pitch change piston and provide for oil return to the scavenge system.

Surrounding the pitch change oil tubes is a third and larger diameter oil tube, which provides an oil passage for the oil flow to operate the pitch lock mechanism.

The Pitch Change Mechanism

19. The pitch change mechanism for this type of propeller consists of:

- A cylinder backplate and transfer sleeve housing.

- A fixed cylinder enclosing a piston and pitch stops.
- Pitch lock and oil sleeves.
- Blade operating link assembly.

20. **The cylinder backplate.** The disc shaped backplate provides a mounting for the pitch change cylinder. This backplate fits in front of the propeller hub and it has four clearance holes to permit movement of the operating link assembly for the blades. It is secured to the hub by the transfer sleeve housing which screws into the hub and is locked by the washer as shown in Fig 5.3.4.

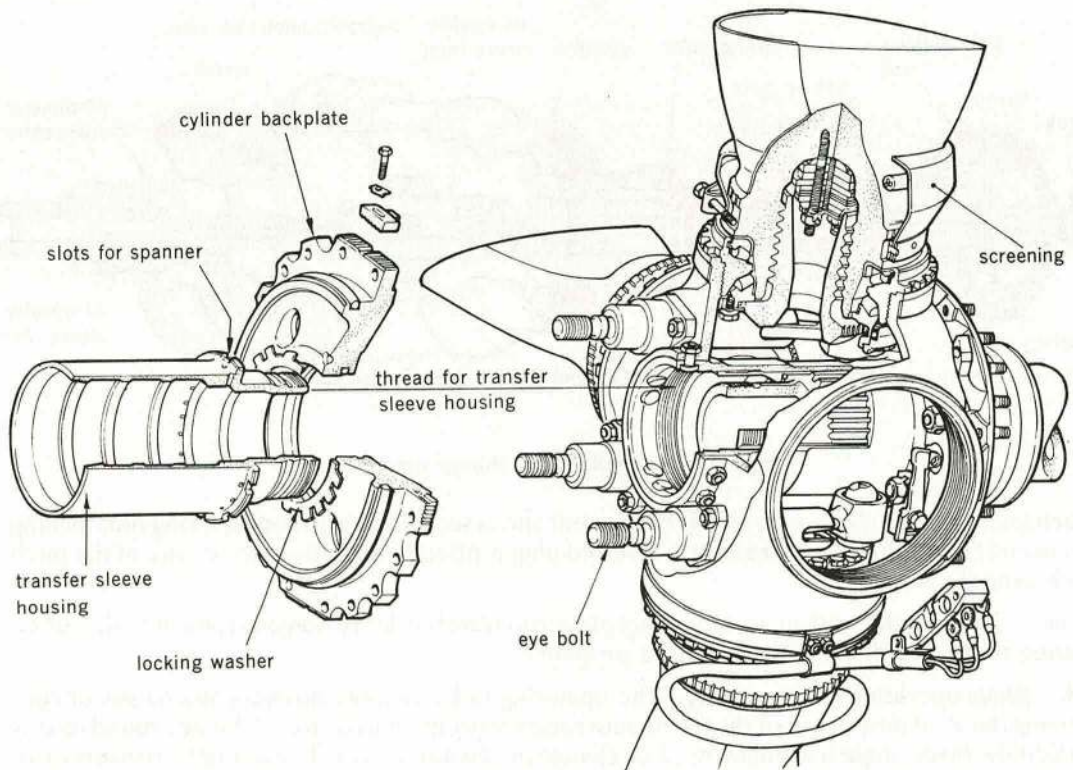


Fig 5.3.4. Attaching the cylinder backplate

21. **Transfer sleeve housing.** One end of the sleeve is screwed into the hub so that the sleeve surrounds the front end of the oil tubes. The sleeve flange which secures the cylinder backplate against the front of the hub, has slots to accept the spanner used for fitting or removing the sleeve housing. A ring of holes is drilled through the wall of the sleeve, just in front of the external flange. These holes transfer governor pressure oil to the rear side of the pitch change piston which slides upon the outer surface of the sleeve.

22. **The cylinder.** The shaped cylinder is flanged and drilled at the rear for mating with, and bolting to, the cylinder backplate (Fig 5.3.5). The cylinder provides a working surface for the pitch change piston and a shoulder towards the front forms one part of the ground fine pitch stop (see later). The front of the cylinder is bored to obtain access to the propeller retaining nut and to permit fitting of the pitch lock mechanism discussed in para 24. The mouth of the bore is screw threaded internally to match the lock retaining nut and the pitch change cylinder is sealed by the

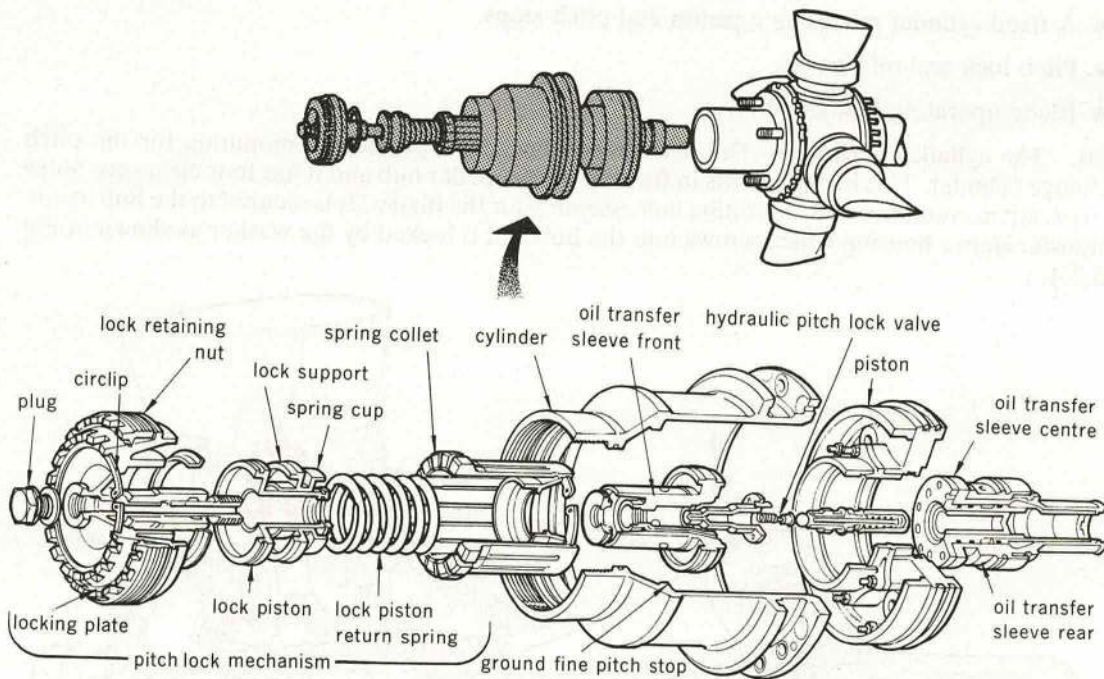


Fig 5.3.5. Propeller pitch change mechanism

pitch lock cylinder cover which beds onto a seal and is secured in position by a ring nut, locking plate and circlip (Fig 5.3.5). Finally, a screwed plug is fitted to the hole in the centre of the pitch lock cylinder cover.

Note. The cylinder, piston, cylinder backplate and transfer sleeve housing remain undisturbed during routine removal and fitting of a propeller.

23. **Blade operating link assembly.** The operating link assembly provides the means of converting the axial movement of the piston into rotary movement to turn each blade around its axis so that the blade angle is changed by pitch change piston movement. The assembly consists of an eyebolt sleeve, eyebolt and an operating link (Fig 5.3.6). Each eyebolt fits inside an eyebolt sleeve which provides a working surface in the bushed hub shell. The front end of each eyebolt is secured to the pitch change piston and its rear end is attached to the front of an operating link by a pivot or link pin. The bushed rear end of each operating link fits snugly over a pin attached to the root end face of a propeller blade. Slots in the rear of each eyebolt and sleeve allow for articulation of the operating link caused by the radial movement of the blades as the pitch change piston moves forward and backwards in its cylinder.

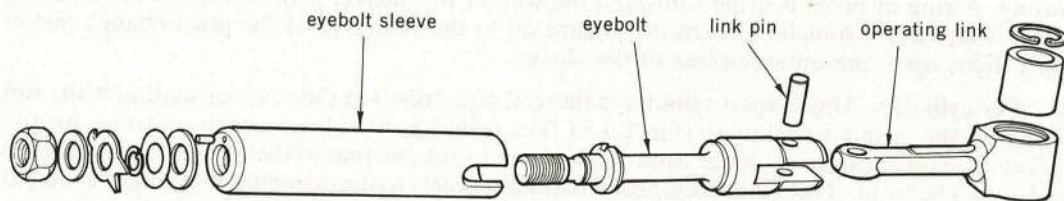


Fig 5.3.6. Blade operating link assembly

Pitch Lock Mechanism

24. The pitch lock mechanism is necessary to cater for the two fine pitch positions of 'flight fine pitch' and 'ground fine pitch'. It acts as a safety device designed to prevent the propeller from inadvertently over-running the flight fine pitch position to the detriment of flight safety.

25. **Principle of operation.** The pitch change piston (Fig 5.3.7) is fitted with two pitch stops — the flight fine pitch stop and the ground fine pitch stop. The flight fine pitch stop provides a normal fine pitch angle, whereas the ground fine pitch stop does not arrest the piston movement until the propeller blades turn into the plane of rotation to attain *zero pitch angle*. To obtain a zero blade angle it follows that the pitch change piston must move *beyond* the flight fine pitch position and, to achieve this, the flight fine pitch stop must be withdrawn or rendered ineffective whenever ground fine pitch is required. Therefore, the flight fine pitch stop is a flexible arrangement which requires a support to maintain it in the flight fine pitch stop position. When the support shown in Fig 5.3.7 is withdrawn, the flight fine pitch stop can move down flush with the level of the pitch lock cylinder and the oil pressure acting upon the pitch change piston can now move it forward into the ground fine position. The pitch lock assembly fits inside the pitch change cylinder and the transfer sleeve housing where it connects with the oil tubes to complete the oilways to the PCM.

26. **Hydraulic lock valve.** The pitch lock mechanism houses a valve called the 'hydraulic lock valve' (Fig 5.3.8). This is a spring-loaded ball valve opened by fine pitch oil pressure and closed by a spring. In the event of an oil supply failure the hydraulic lock valve closes and acts like a non-return valve to trap coarse pitch oil in the pitch change cylinder. The oil trapped in the cylinder prevents centrifugal twisting movement (CTM) from turning the propeller blades towards fine pitch without affecting the feathering ability of the propeller.

27. The principle of constant speeding for this propeller is similar to that explained in Chap 1 of this Section (for hydraulic propellers) where the angle of the blade is controlled by a mechanical governor that is sensitive to engine speed and load. The governor is always in one of three positions:

- Under speed
- On speed
- Over speed

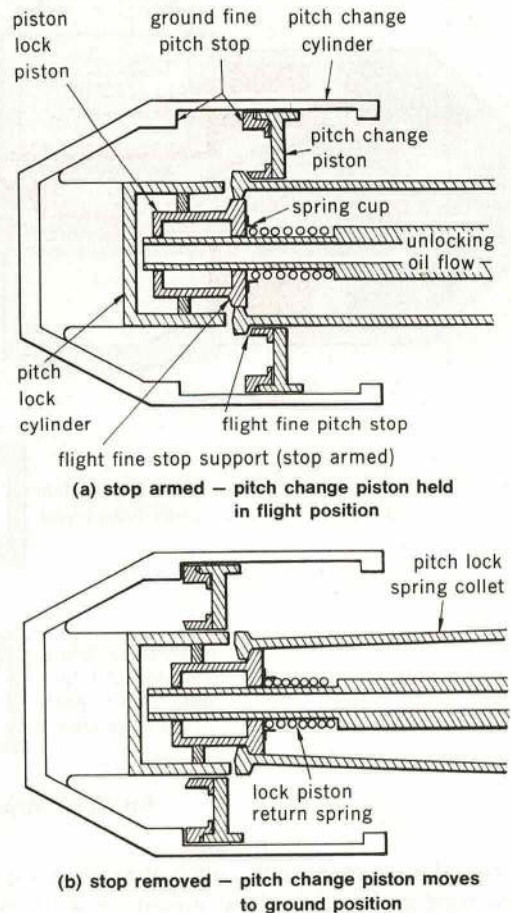


Fig 5.3.7. Principle of pitch lock mechanism

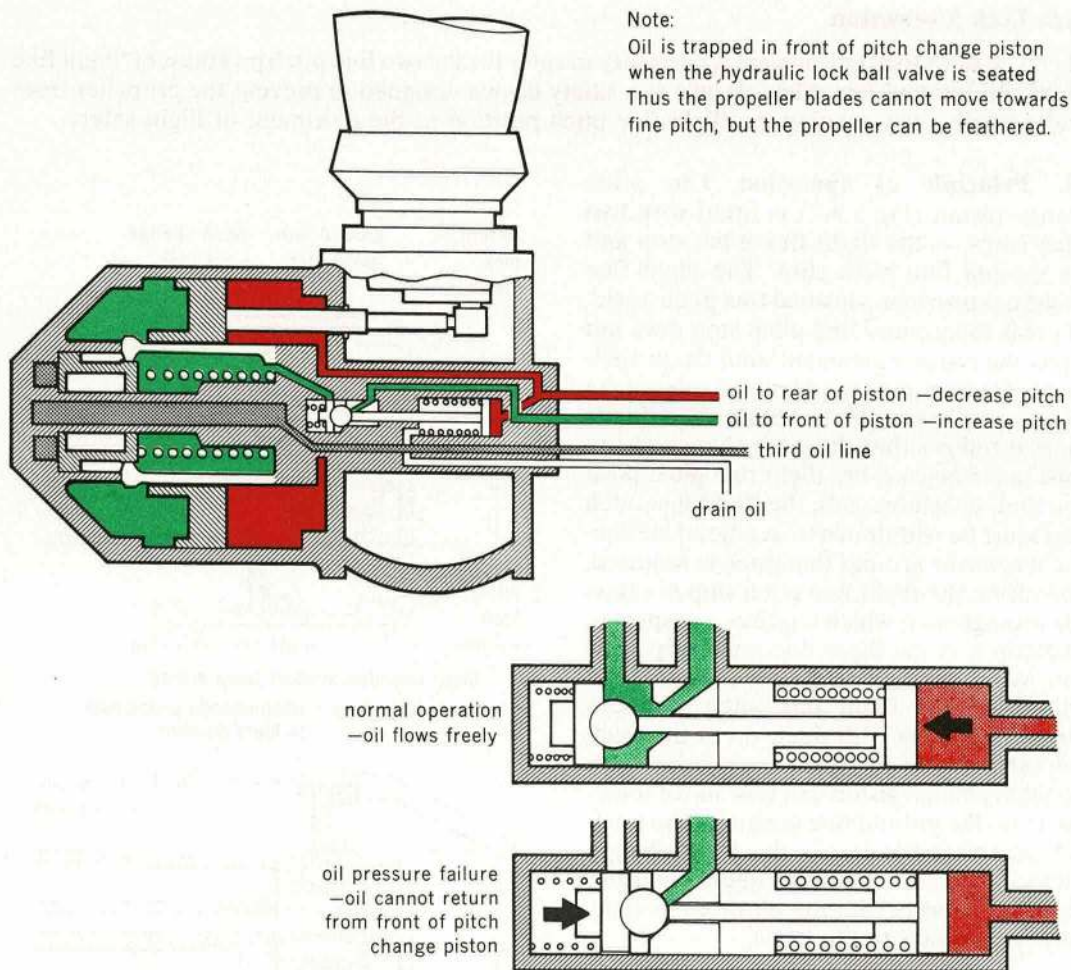


Fig 5.3.8. Hydraulic lock valve

Forward movement of the pitch change piston turns the propeller blades towards fine pitch and rearward movement of the piston turns the blades towards coarse pitch until the 'On speed' condition is established.

28. **Ground idle.** In addition to the normal constant speed and feathering range we have seen that this propeller extends the fine pitch range to include a ground fine pitch position which is necessary to reduce the load imposed upon the engine during starting and ground idling. A mechanical stop is fitted to prevent the propeller from entering the ground fine pitch range when the aircraft is in flight. This stop is the 'flight fine pitch stop' and it is strongly spring-loaded into the safe for flight 'flight fine' pitch stop position. To enable either flight fine pitch or ground fine pitch to be selected, pitch selection levers are provided. These levers (one for each propeller) are fitted to the main control pedestal in the aircraft cockpit. They are called 'fine pitch stop levers' and they provide the two stop positions required for flight fine or ground fine. The lever positions are:

- **Stop armed.** This is the flight fine pitch position and the stop lever is at the front of the quadrant (Fig 5.3.9a).

- **Stop removed.** This is the ground fine pitch position and the stop lever is at the rear of the quadrant (Fig 5.3.9b).

To prevent inadvertent loss of propulsive thrust, the pitch stop levers are mechanically inter-connected with the throttle lever so that when all throttle levers are advanced towards open (for max or cruise power) the pitch stop levers must move into the stop armed position. Thus always when the aircraft is flying the flight fine pitch stop is armed.

29. **Propeller control.** There is no separate propeller control selector for this engine/propeller combination. Instead of a separate propeller control lever, the gover-

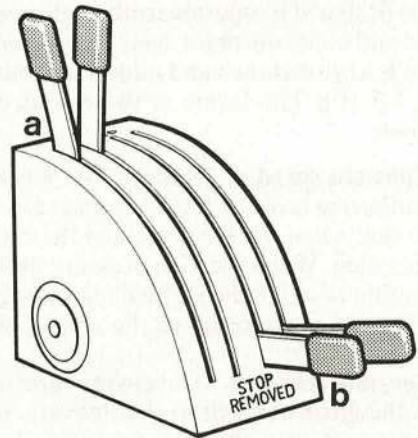


Fig 5.3.9. Pitch stop selector levers

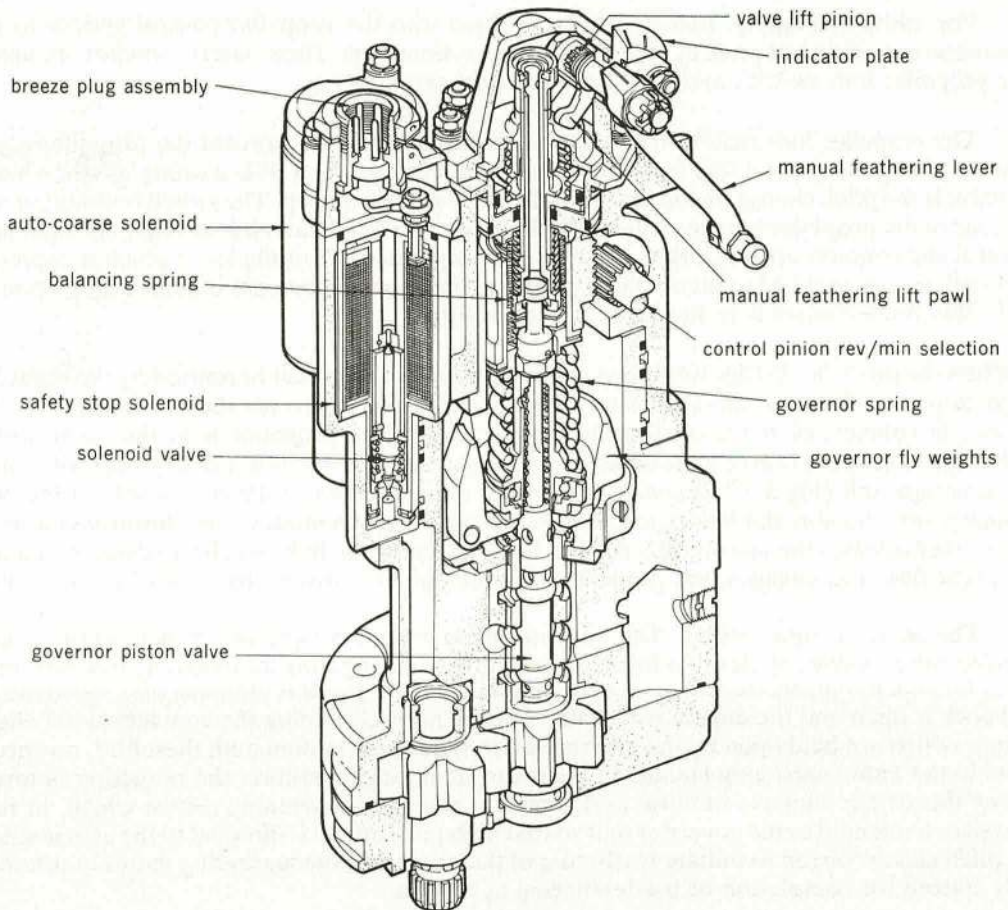


Fig 5.3.10. Controller unit

nor is designed to operate from engine control inter-connections. At the top of the governor is a lever and mechanism for selecting either constant speed operation or feather, whilst below this there is a normal rack and pinion rev/min selector which varies the value of the governor spring (Fig 5.3.10). The levers at these control points are linked into the engine control system as follows:

- **Constant speed or feather.** The lever at the top of the governor unit is called the manual feathering lever. It is inter-connected with the high pressure shut-off cock (HP cock) control so that when the HP cock is at the run or 'shut-off' position, the governor is set for constant speeding. When the high pressure fuel cock control lever is moved beyond fuel shut-off to the feather position the manual feathering lever pawl mechanically lifts the governor piston valve to direct pressure oil to the coarse pitch side of the pitch change piston.
- **Rev/min selection.** The engine throttle control is linked to a normal rack and pinion control in the governor unit so that movement of the throttle control acts through inter-connecting linkage to vary the load imposed upon the governor spring to act as a rev/min selector.

Safety devices

30. For additional safety, two switches are fitted into the propeller control system to give automatic coarsening of pitch in certain emergency situations. These safety switches are named 'the propeller hub switch', and 'the torque switch' respectively.

31. **The propeller hub switch.** The purpose of this switch is to prevent the propeller blades from attaining the ground fine position when the aircraft is flying. It is a safety device which is effective if the pitch change piston overruns the flight fine pitch stop. The switch is mounted onto the rear of the propeller hub immediately behind number one blade; it is strongly spring-loaded towards the contacts open position. It is closed by a pivoted operating lever which is depressed by a striker cam attached to number one propeller blade and it becomes effective only when the flight fine pitch control is in the 'stop armed' position.

When the propeller blades turn to an angle slightly finer than that permitted by the flight fine pitch stop (stop failure), the striker on number one blade depresses the operating lever and closes the contacts of the propeller hub switch. When the propeller is in the 'stop armed' condition, closing the hub switch contacts energizes an 'electro-hydraulic safety stop' solenoid in the governor unit (Fig 5.3.10) and high pressure oil is directed to the coarse side of the pitch change piston, turning the blades towards coarse pitch. As the blades move towards coarse the cam striker releases the operating lever and the contacts of the hub switch will open and, unless the flight fine stop engages, the propeller will hunt slightly around the flight fine position.

32. **The engine torque switch.** The purpose of the engine torque switch is to automatically coarsen the propeller blades of a failed engine, thus reducing drag immediately a power loss is felt. The switch is positioned in an 'auto-coarsening circuit' and it is effective only when the HP fuel cock is open and the engine is running. During normal running the contacts in the engine torque switch are held open by the pressure oil in the torque system and, therefore, no current flows in the auto-coarsening circuit. In the event of an engine failure, the reduction in torque allows the switch contacts to close and complete the auto-coarsening circuit which, in turn, energizes a solenoid in the governor unit so that high pressure oil is directed to the coarse side of the pitch change piston to initiate feathering of the propeller; the feathering motor is automatically started for completion of the feathering operation.

Removing a Propeller (Turbine Engine)

33. **Preparation.** *Adequate preparation* smooths the way for a skilled operation carried out in a professional manner. Therefore:

- Collect together the tools necessary for the job. As we saw earlier, these are usually provided in a propeller tool kit designed for use with a particular propeller; it is important to collect the correct kit (Fig 5.3.11).
- The aircraft must be positioned so that lifting tackle can be used and then secured to prevent movement.
- Position sufficient platforms and steps to give safe and easy access to the propeller without obstructing its removal.
- Obtain a supply of cleaning material, and containers suitable for catching any oil which drains from the propeller hub.

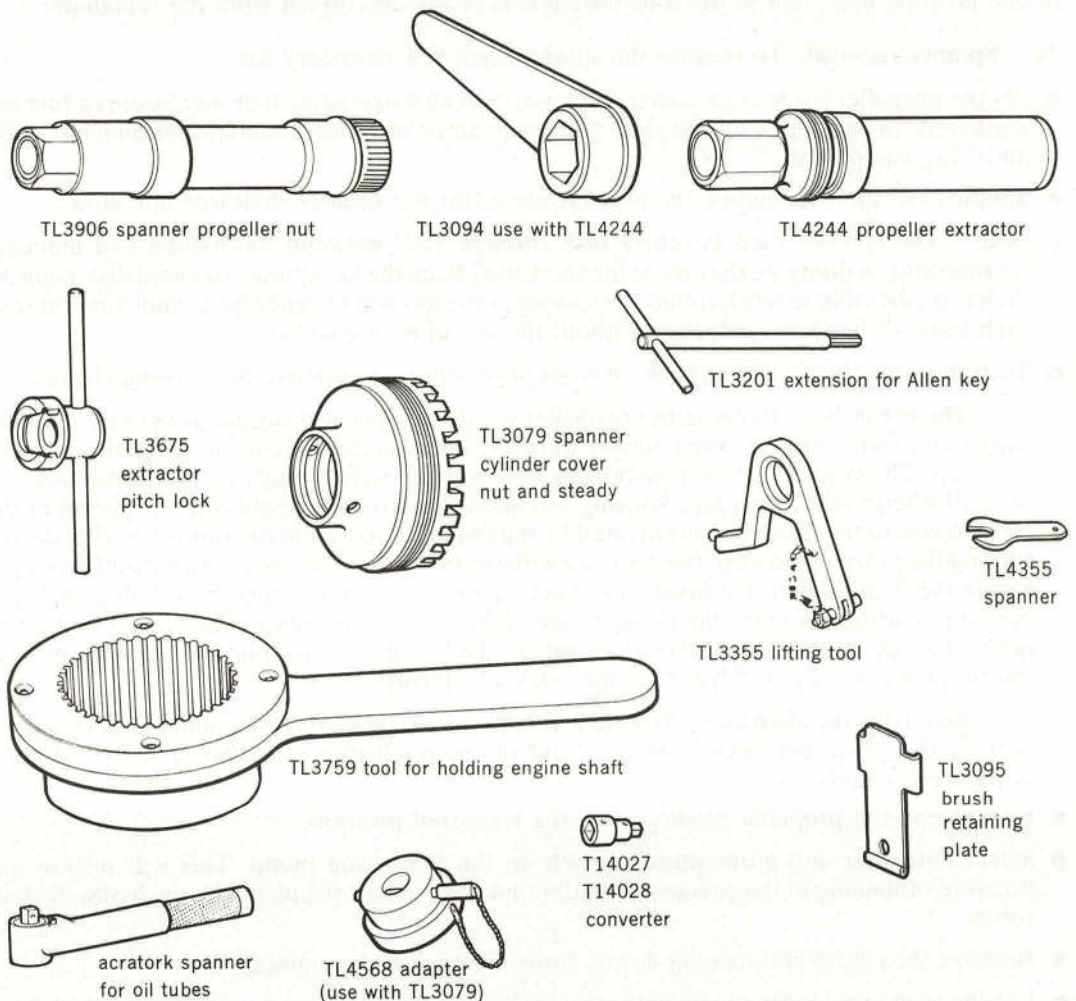


Fig 5.3.11. Example propeller tool kit

- Collect the necessary Air Publications and procedure cards covering propeller removal.
- Provide adequate stowage space for the propeller and its parts.
- Ensure that suitable lifting equipment is available.
- Record the propeller type and serial number for subsequent documentation.

34. **Manually changing pitch.** The pitch angle of the blades may need altering to facilitate the removal work; therefore, consult the relevant APs and procedure cards as the work progresses. When the blades are to be turned manually it is important that torque is applied to all blades simultaneously. Torque is applied to the blades by using suitable turning clamps, one fitted to each blade. This is a difficult operation and care is needed to avoid causing damage; the anti-icing equipment is particularly vulnerable.

35. **The spinner.** The spinner shell carries electrical anti-icing equipment and it must be fitted in the correct position to ensure electrical contact. To ensure that the spinner shell can be fitted in one position only, one of the four fasteners is positioned off-set from the remainder.

36. **Spinner removal.** To remove the spinner shell it is necessary to:

- Set the propeller blades to a coarse pitch position approximately half way between fine and feathered. In this position, the shell will come away with less possibility of damage to the anti-icing equipment.
- Support the spinner, unlock the four fasteners, lift the spinner shell free and stow.

Note. The spinner shell fasteners turn through 180° between the locked and unlocked position and, in doing so, they force the shell away from the backplate. To avoid distorting the shell it is advisable to work round the spinner, turning each fastener by a small amount until each fastener has been unlocked without the use of excessive force.

- Turn the propeller blades into the feathered position and remove the turning clamps.

37. **The brush box.** Because the propeller needs an electrical supply to operate the anti-icing equipment, the electrical supply must be disconnected when the propeller is to be removed. The contact between stationary and moving parts is made by the 'brush box', an item attached to the brush gear housing and making electrical contact with the propeller slip ring. Access to the brush box is obtained by removing a panel from the spinner backplate and turning the propeller to align the aperture with the brush box. Two readily accessible set-bolts secure the brush box to the brush gear housing and, after unscrewing these bolts, the brush box can be withdrawn through the aperture in the spinner backplate (Fig 5.3.12). Take care not to damage the brushes and immediately fit the brush retaining plate which is supplied in the propeller tool kit and listed on the relevant SP card.

38. **Removing the pitch lock.** To gain access to the propeller retaining nut, it is necessary to remove the pitch lock unit from the front of the pitch change cylinder. A logical work sequence is as follows:

- Ensure that the propeller blades are in the feathered position.
- Select unfeather and momentarily switch on the feathering pump. This will release any pressure remaining in the coarse pitch oil trapped in front of the piston by the hydraulic lock valve.
- Remove the circlip and locking device from the pitch lock retaining nut.
- Use the tools provided in the flight tool kit to unscrew the pitch lock retaining nut (which has a left-hand thread). As the retaining nut unscrews, the pitch lock unit will be partially withdrawn from the transfer sleeve housing.

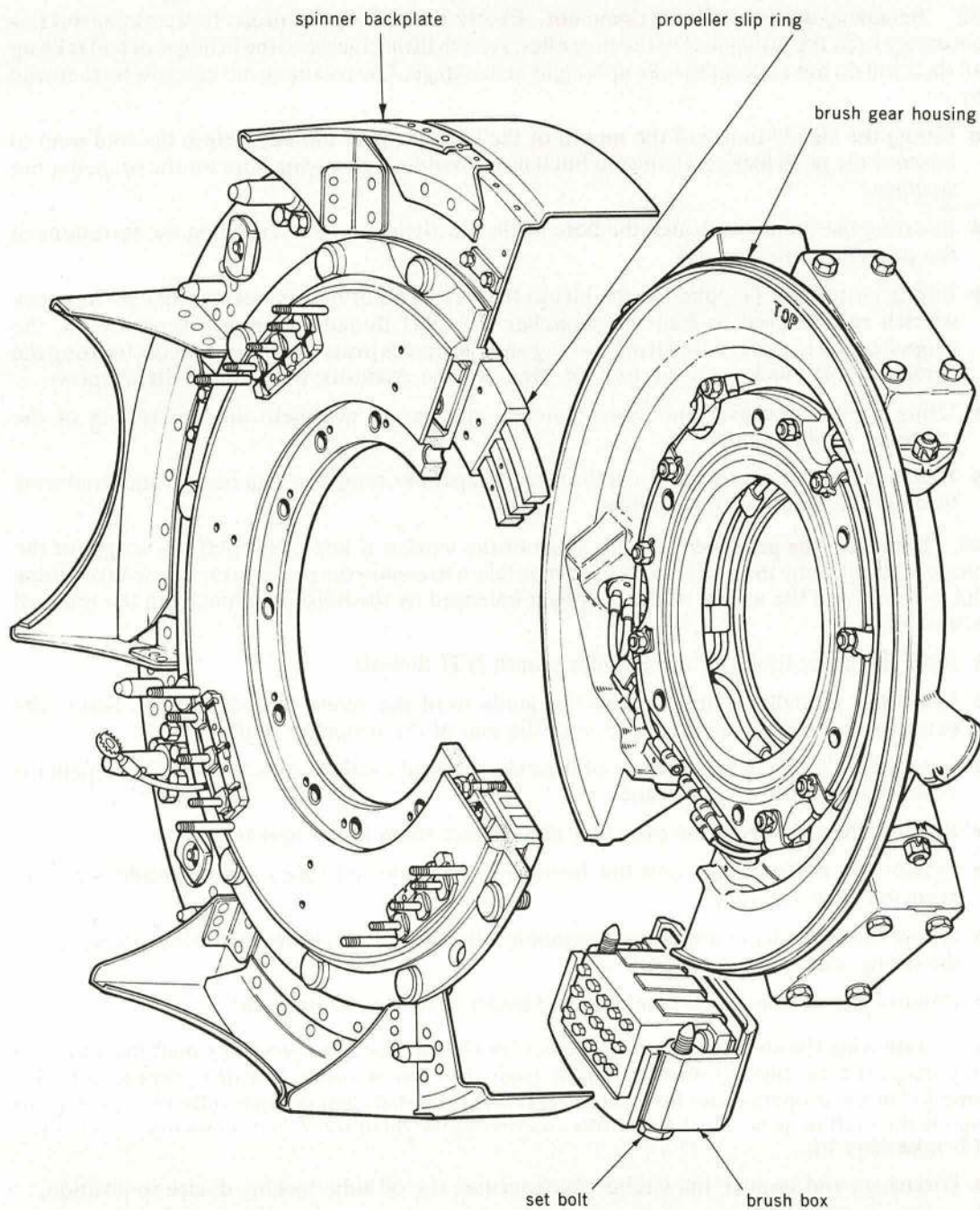


Fig 5.3.12. Removing the brush box

- After removal of the nut, an extractor is used to complete the removal of the pitch lock unit. This extractor carries its own tommy bar and attaches to the centre of the pitch lock cylinder cover.

39. **Removing the propeller retaining nut.** Before unscrewing the propeller retaining nut it is necessary to fit the lifting tool to the propeller. Attach lifting tackle to the lifting tool and take up all slack but do not attempt to take up weight at this stage. The retaining nut can now be removed by:

- Fitting the steady tool into the mouth of the cylinder (LH thread); this is the tool used to unscrew the pitch lock retaining nut but it now provides a steadying bore for the propeller nut spanner.
- Inserting the spanner through the bore of the steadying tool and engaging the serrations of the propeller retaining nut.
- Fitting an adapter (supplied in the kit) to the outer end of the spanner so that an Acratork wrench can be used to free the propeller nut (RH thread). During this operation, the propeller must be prevented from turning and the blades protected from damage by using the blade support block from the tool kit. Remove the Acratork wrench and the adapter.
- Using a more compact and easily handled spanner to complete the unscrewing of the propeller retaining nut.
- Removing the steady tool and withdrawing the spanner complete with the nut and front cone through the mouth of the cylinder.

40. **Removing the propeller.** At this stage of the work it is important that the weight of the propeller is taken by the hoist but care must be taken to ensure the propeller is not, in turn, lifting the engine. With the weight of the propeller balanced by the hoist, continue with the removal work and:

- Refit the guide tool into the cylinder mouth (LH thread).
- Insert the propeller extractor into the guide until the screw threads engage. Screw the extractor in until it makes contact with the end of the propeller shaft.
- Use a suitable spanner on the end of the extractor and continue to turn until the propeller is pulled forward off the rear cone.
- Remove the tools from the propeller and replace them in the tool kit.
- Protect the shaft threads and the forward ends of the oil tubes whilst withdrawing the propeller from the shaft.
- Secure the propeller to a stand or acceptable alternative and remove the lifting tackle; return the lifting tool to the tool kit.
- Remove the hub rear seal complete and attach it to the old propeller.

41. **Removing the oil tubes.** During removal of the oil tubes, the propeller shaft must be held to prevent it from turning when torque is applied to the oil tubes. For this purpose, a tool is supplied in the propeller tool kit to fit the splines of the shaft and provide sufficient leverage to enable the shaft to be held by hand whilst unscrewing the oil tubes. When removing the oil tubes, it is necessary to:

- Disengage and remove the circlip which secures the oil tube locking device in position.
- Move the locking device forward until its front serrations clear the outer tube but its rear serrations remain engaged with those of the inner oil tube. In this position, the locking device becomes a part of the tool used for unscrewing the oil tube.
- Fit an item called a 'converter' into the bore of the locking device to enable an Acratork spanner to be used for unscrewing the oil tube. When fitting the converter and the spanner, it is important that the locking device does not re-engage the outer oil tube.

- Unscrew the inner oil tube which has a left-hand thread.
- Remove the locking device from the inner tube and engage it with the splines of the outer oil tube. Use the converter and the Acratork spanner to unscrew the outer oil tube which has a right-hand thread.
- Remove the propeller shaft holding tool and return it to the tool kit.

42. **Brush gear housing.** The brush gear housing is the propeller part that is secured to the engine casing. It fits behind the propeller and surrounds the propeller shaft to provide an important link in the transmission of electrical power between the generator and the propeller. It is secured to the engine casing by six cap screws, and removal of the brush gear housing requires the following work to be done:

- Disconnect the electrical supply lines by separating the Breeze type sockets.
- Support the brush gear housing and, by using an Allen key, unscrew the six retaining screws. Remove the brush gear housing, ensuring that it is complete.
- Refit and secure the brush box to the housing. Remove the brush retaining plate and replace it in the tool kit.
- Ensure that the brush gear housing, complete with brush box, is labelled so that it remains with its original propeller.

43. **Protective treatment.** After a propeller has been removed, the propeller shaft must be protected by suitable blanks or wrappings. The old propeller must be cleaned and protected by suitable into-corrosion materials, labelled with the relevant information and prepared for return into the repair network.

Installing a Propeller (Turbine Engine)

44. Fitting a propeller is work which requires the operator to display an adequate knowledge of the subject of propellers coupled with a high degree of manual skill. Flight safety depends upon the integrity of the completed work.

45. **Preparation.** General preparation is described in para 33. However, certain items require individual attention and their preparation is described in the following paragraphs.

46. **Preparing the propeller.** It is assumed that the propeller is in the assembled condition and ready to be fitted to the engine shaft. Before doing so, however, the following preliminary work must be done:

- Ensure that the propeller is the correct type and record the serial number.
- Check the propeller, seals and components against a master list to ensure that the unit is complete.
- Remove all protective wrappings and preservatives where necessary. Clean the propeller and its component parts.

47. When the propeller has been cleaned, it should be given a general survey for condition and items, such as the following, should be checked:

- The splines in the hub bore and the cone seats must be clean and free from burrs.
- The blades should be examined for surface damage including damage to the anti-icing overshoes which must be checked for proper adhesion.
- Electrical cables require careful examination to ensure that the coverings and connections are in a sound condition.
- Visible oil seals must be in good condition.

- The exterior of the pitch lock unit must be free from burrs.
- All screw threads and splines must be clean and free from burrs.

Any damage found, however slight, must be reported to the person in charge who will decide upon remedial action.

48. Before offering this type of propeller to the propeller shaft, it is necessary to fit the brush gear housing to the engine casing to provide the link needed in the electrical supply between generator and propeller.

49. **Fitting the brush gear housing.** To avoid damage to the brushes, the brush box should be removed (see para 37). The brush gear housing should be examined to confirm that the mounting bushes are complete and properly fitted. When satisfied with the condition of the housing, offer it up to the engine reduction gear casing and carefully align the Breeze plug connections with the aircraft electrical supply sockets. Secure the brush gear housing in position with the six cap screws and spring washers. Tighten the screws by using an Allen key and the extension supplied in the tool kit. Finally, connect the electrical supply cables but do not re-fit the brush box.

50. **Checking cone fit and hub switch tracking.** Before the final mounting of the propeller, it is necessary to establish the fit of the propeller support cones and the accuracy of the hub switch track against the slip rings. To carry out this work, the propeller must be mounted onto the propeller shaft and the retaining nut tightened, but the oil tubes are not fitted and the oil seals are removed from the driving centre. To complete these tests, it is necessary to:

- Fit the lifting tool to the propeller, attach a sling and prepare to lift the propeller.
- Degrease and dry the cone faces and seatings.
- Apply an even thin coat of engineer's marking blue to the conical contact surfaces of the propeller cones. The blue must be applied evenly to cover the whole of the inclined surface area of the cones; care is needed because too much blue or uneven application will provide a false marking transfer pattern.
- Dust the slip rings of the brush gear housing with french chalk, lightly covering the whole area.
- Smear a little engine oil onto the propeller shaft and place the rear cone in position.
- Lift the propeller and carefully mount it on the propeller shaft.
- Fit the front cone/hub nut assembly and tighten the nut.
- Remove the propeller lifting tackle so that the propeller can be turned by hand.
- Turn the propeller blades around their axis through the flight fine position towards ground fine pitch. This action ensures that the cam plate striker on No 1 blade has moved the operating lever and the hub contact switch is in contact with the slip rings.
- Rotate the propeller shaft through not less than one revolution to allow the hub switch to mark the french chalk on the slip ring.
- Turn the propeller blades back into the feathered position. Refit the slinging equipment and remove the propeller from the shaft (paras 39 and 40).
- Check the tracking of the hub switch by examining the mark left in the french chalk on the slip ring. Report the result of your examination to the NCO i/c.
- Examine the cone and cone seating for transfer of marking blue. A uniform marking covering an estimated 80% of the contact surface is required. If the contact is very poor, the cone(s)

should be changed but small high spots can be removed by using an oil stone (subject to re-test).

- When these tests provide a satisfactory result, remove all traces of french chalk and marking blue in readiness for final fitting of the propeller.

51. **Fitting the oil tubes.** The first part of the final installation is to fit the oil tubes into the propeller shaft. The bore of the shaft must be spotlessly clean and the screwed ends of the oil tubes lubricated with engine oil. The tools used for fitting the oil tubes are the same as those used for removal and, in general, fitting is the reverse of removal (para 41). However, if after correctly torque loading the oil tubes the locking device will not engage, it may be necessary to remove the inner oil tube and fractionally tighten the outer oil tube by a part of a serration. Refit and tighten the inner oil tube, fit the locking device and its securing circlip. Return the tools to the tool kit.

52. **Final installation of the propeller.** The work involved in slinging the propeller and the equipment used is the same as that used for propeller removal and the test fit. However, for the final fit you must:

- Lubricate the propeller shaft with oil and lightly coat the face of the cone with grease (*see* SP cards).
- Fit the shaft seal in front of the rear cone and insert the distance piece, bevel end first, into the rear bore of the driving centre.
- Protect the propeller shaft and the oil tubes from damage whilst lifting and mounting the propeller on the shaft.
- Lubricate the face of the front cone and fit the cone, oil seal and propeller retaining nut to the retaining nut spanner.
- Carefully insert the assembly through the mouth of the pitch change cylinder and the transfer sleeve housing until the nut engages the thread on the end of the propeller shaft (RH thread). Tighten as far as possible by hand.
- Screw the steady tool into the mouth of the pitch change cylinder and then fit the extension lever to the spanner and tighten the propeller nut until hand tight; slacken off slightly and then re-tighten. Before removing the lever extension give the lever a number of sharp blows with a four pound hammer.
- Remove the lever extension and replace it by the torque wrench adapter. Use the Acratork spanner to set the final tightness torque of the propeller retaining nut (*see* SP cards — but typically 900 to 1000 lb ft).
- Remove the tools and inspect the propeller generally for correct fitting.

53. **Fitting the pitch lock unit.** The propeller blades must be in the feathered position before you carry out the following work:

- Remove and prepare for final assembly those items illustrated in Fig 5.3.13.
- Apply a film of clean engine oil to the pitch lock unit and insert the lock through the mouth of the pitch change cylinder. Push the lock unit in as far as it will go and rotate it slightly to ensure that its serrations engage with those of the propeller retaining nut. This engagement is important because it provides the locking for the propeller nut.
- Smear the rubbing ring with grease and insert it into the mouth of the pitch change cylinder so that the tabs locate in the slots in the bore. Push the ring in until it contacts the pitch lock cylinder cover.
- Lubricate the pitch lock retaining nut with clean engine oil and screw it into the bore of the

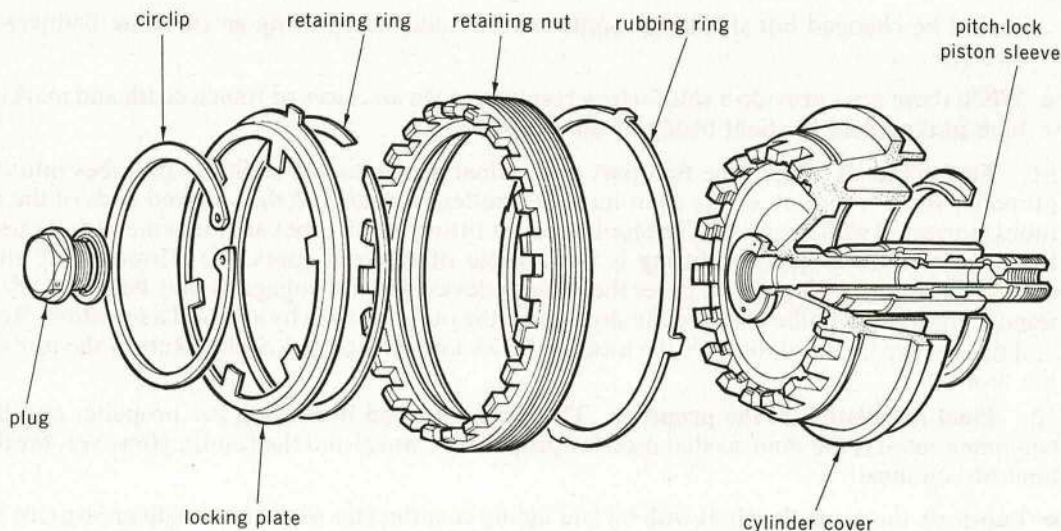


Fig 5.3.13. Pitch lock securing assembly

pitch change cylinder (LH thread) and tighten to approximately 220 lb ft. Fit the spring retaining ring into its groove in the pitch lock cylinder cover.

- Engage the tabs of the locking plate in the slots of both pitch lock cylinder cover and its retaining nut. Secure in position by fitting the circlip.

54. In an emergency, the pitch lock retaining nut can be fitted without the use of a torque spanner by marking and measuring the final movement of the nut. To tighten the nut by this method, it is necessary to:

- Fit the pitch lock and tighten the nut to the hand-tight position. Oscillate the nut on its thread to ensure that it is moving freely and re-tighten to the hand-tight position.
- Make a suitable grease pencil mark on the cylinder and the nut to identify the hand-tight position of the nut.
- Make a second pencil mark on the cylinder $\frac{1}{8}$ in (two-tenths on a rule) on the tightening side of the first mark.
- Tighten until the mark on the nut is aligned with the second mark on the cylinder and the tightness of the nut will be satisfactory.
- Complete the locking as detailed in para 53.

55. **Fitting the brush box.** Fit the brush box to the brush gear housing and torque the setbolts to 120 lb ft \pm 5 lb ft; remove the brush retaining plate and refit the access panel to the spinner backplate.

56. **Fitting the spinner.** When offering up the spinner, the propeller blades need to be positioned mid-way between fine pitch and feather. Identify the 'master' lock peg and slot and then:

- Lubricate the pegs and guide pins with a little grease and dust the rubber ring with french chalk.
- Ensure that the four attachments are in the 'unlocked' position; align the master lock peg with its offset slot and offer the spinner to the backplate.

- Lock the spinner carefully by turning each fastener only a little at a time until the spinner has been pulled evenly onto the backplate and each fastener has been locked without using undue force.
- Remove all tools from the work face, visually examine the propeller assembly and, if all appears well, record and sign for the completed work.

Testing a Newly Fitted Propeller

57. Newly fitted propellers require static feathering and unfeathering tests before the engine is started (*see Propeller AP*). When the static tests have been completed and the propeller proved satisfactory, comprehensive engine running tests are carried out to ensure that the propeller systems, both electrical and hydraulic, are functioning correctly. These tests are detailed in the relevant Aircraft and Engine Air Publication Volume I.

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