CHAPTER 10

TAIL ROTOR

TABLE OF CONTENTS

ILLUSTRATIONS

INTRODUCTION

The tail rotor is a two-bladed controllable pitch rotor located on the right side of the tail fin, driven by the output shaft of 90° gear box. Hub is a delta hinge mounted to gearbox shaft to provide equalization of thrust on advancing and retreating blade. (Unequal thrust caused by dissymmetry of lift). Assembly incorporates preconning to relieve loads on yoke. Control linkage provides equal pitch change to both blades simultaneously. Tail rotor counteracts torque of main rotor and provides heading control. Tail rotor flight controls are covered in Chapter 11, "Flight Controls." The rate of rotation (approximately 1,600 rpm) provides for quieter operation.

GENERAL

The tail rotor system consists of three basic sub-assemblies: the tail rotor hub assembly, the tail rotor blades, and the tail rotor pitch change mechanism.

Tail rotor blades are attached to a yoke that is part of the tail rotor hub. The tail rotor hub is composed of a trunnion that is splined to the tail rotor mast and a flex-beam yoke attached to the trunnion by bearings. The pitch-change mechanism connects between the tail rotor flight controls and the tail rotor blades to provide a collective change in thrust.

The tail rotor system is illustrated in (Figure 10-1).

HUB ASSEMBLY

The tail rotor hub assembly consists of the following major components: (Figure 10-2)

- Trunnion
- Yoke Assembly
- Trunnion bearings
- Bering Housing
- Blade attachment bearings
- Blades
- Pitch Horns

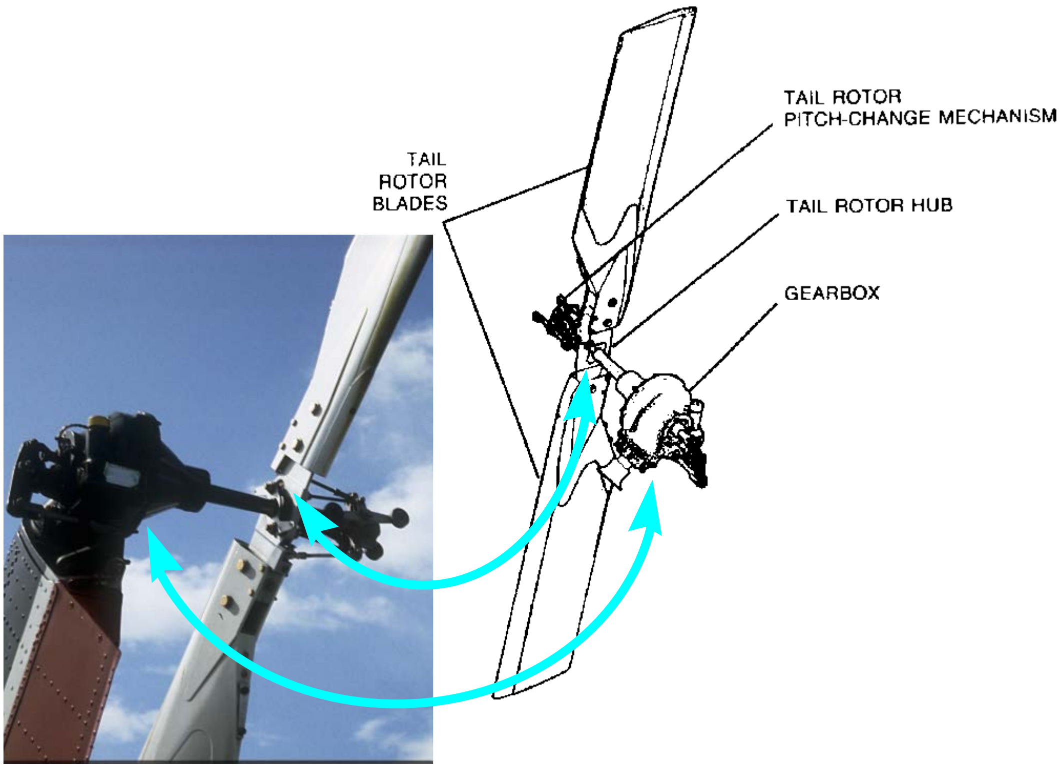


Figure 10-1 Tail Rotor System

The tail rotor hub assembly is mounted to the hollow tail rotor mast (output shaft) of the 90° tail rotor gearbox. The rotor hub is secured by means of the trunnion, which is splined to and rotates with the tail rotor mast.

Trunion

The steel trunnion set serves to attach the hub assembly to the 90° gearbox output shaft and to provide a flapping axis for the assembly. The delta hinge action is achieved by installing the trunnion set to the yoke with the trunnion offset 45° the pitch change axis. The trunnion set consists of two matched halves, both of which are master splined to assure correct control linkage relationship. The trunnion half located on inboard (flat) side of yoke serves as a flapping stop and has a chamfer for seating to cone set on output shaft. This flapping hinge decreases the amount of flapping, provides increased tail rotor stability and reduces loads on the tail rotor components. Trunnion set is secured by two bolts to the bearing located near center of yoke. Special chamfered washer is used under head and nut. Bolts are installed from outboard side of yoke.

Yoke Assembly

The yoke is a steel flex-beam type and is preconed 1° to reduce bending loads. There is a total of six Teflon lined, self-aligning uniball type bearings that are installed (roll staked) into the yoke. Two bearings near the yoke center adapt the trunnion set to the yoke, providing a flapping axis for rotor assembly. Two bearings adapt each blade assembly to the yoke, permitting the blades to change pitch.

Bearing Housing

The steel bearing housing assembly attaches to the yoke with four bolts. It fits over the inner race that is mounted to the yoke spindle. The housing has grease fitting to lubricate the baring. Each housing contains a roller bearing that allows tail rotor flapping. A grease seal is pressed into the inboard side of the housing. Shims are used to position the bearing housing to the yoke for trunnion centering and preloading.

BLADES

Two blades are bonded metal construction and are tapered in thickness from root to tip. Two bolts attach each blade to the yoke bearings. A special chamfered washer is used next to blade in each side. Balance washers are added to bolt as required for spanwise balance of the rotor hub and blade assembly. Each blade is constructed of the following major parts:

STRUCTURE

The components of the tail rotor blades are as follows: Stainless-steel leading edge spar Aluminum alloy skin, Aluminum-alloy honeycomb, Aluminum trailing-edge strip, Doublers, Grip plate, Balance weights, End cap, Balance screws, Pitch horn.

Tail rotor blade structure is shown in (Figure 10-3). The upper and lower aluminum-alloy skin panels are bonded to the trailing-edge strip and aluminum-alloy honeycomb core. A stainless steel leading-edge spar that provides abrasion resistance is bonded to the skin panels. Doublers and grip plates are bonded to the blade roots to add structural integrity at the point where the blades are attached to the pitch-change bearings in the yokes.

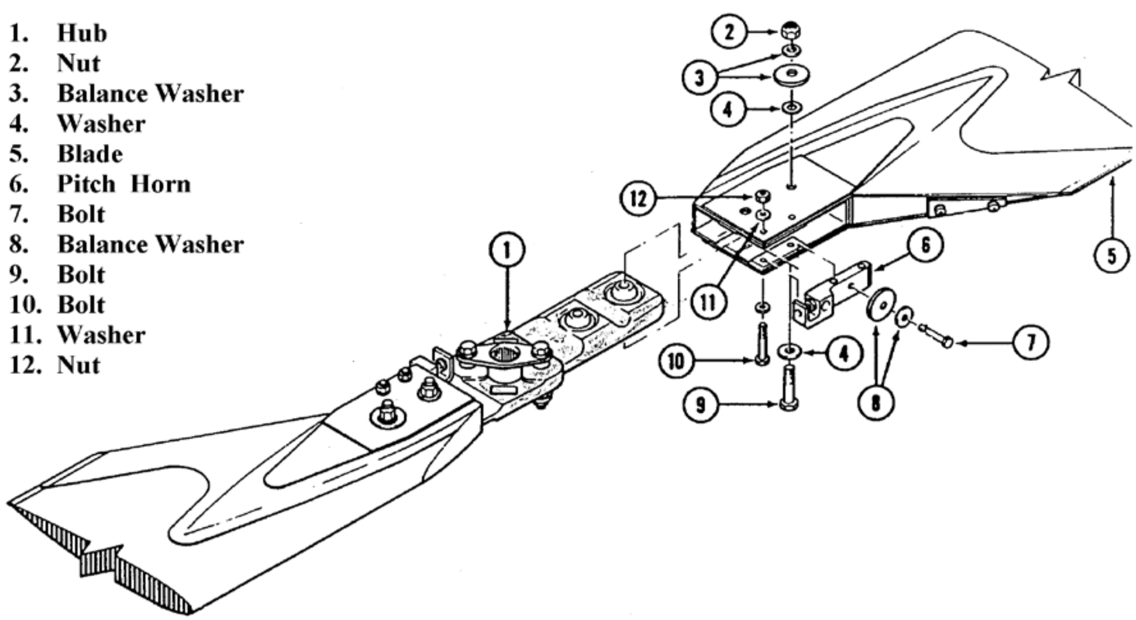
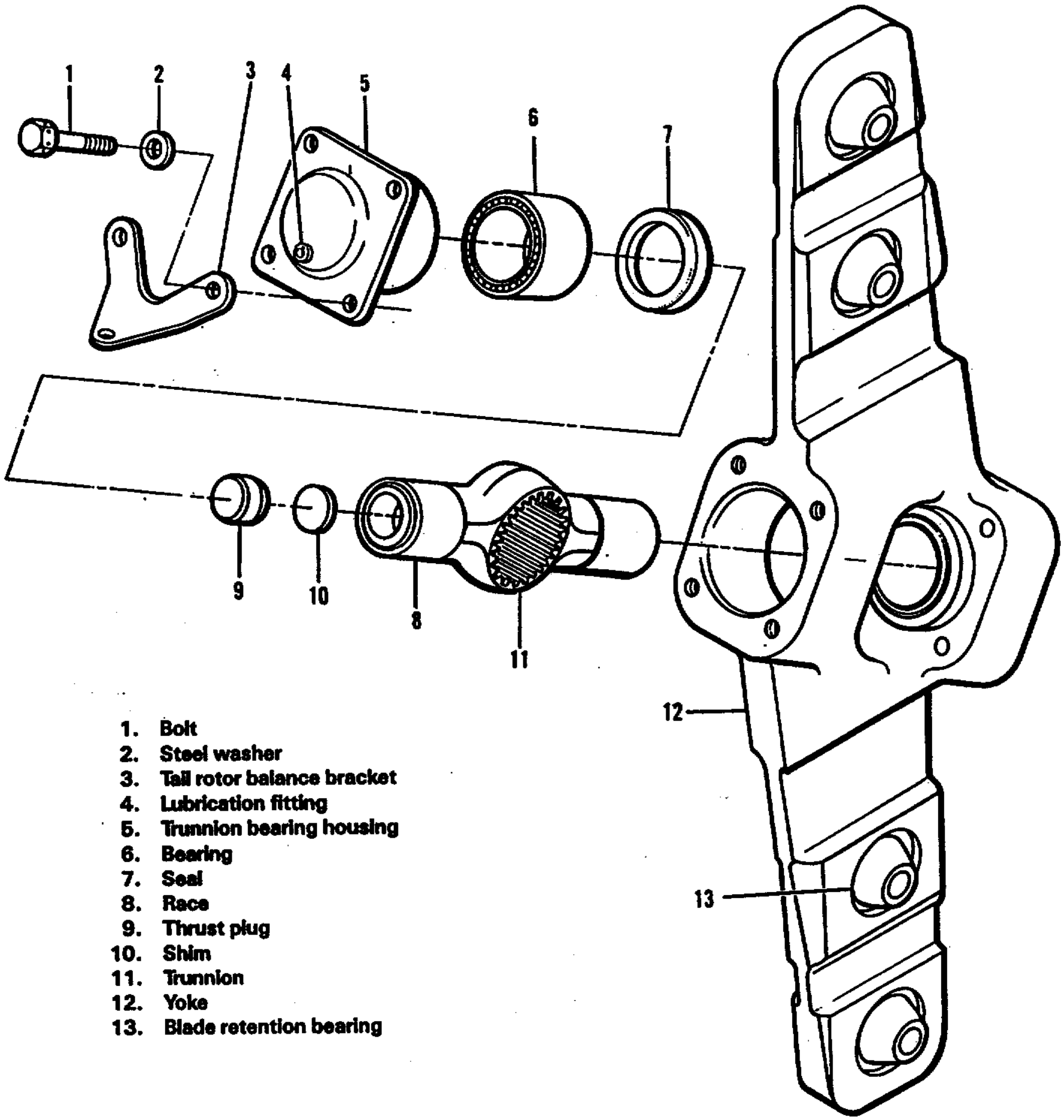


Figure 10-2a Tail Rotor Hub Assembly Old Style



1. Bolt
2. Steel washer
3. Tail rotor balance bracket
4. Lubrication fitting
5. Trunnion bearing housing
6. Bearing
7. Seal
8. Race
9. Thrust plug
10. Shim
11. Trunnion
12. Yoke
13. Blade retention bearing

Figure 10-2b Tail Rotor Hub Assembly New Style

Balance weights are added to each blade and provide chordwise balancing. The end plate and balance screws provide spanwise balancing.

The trailing-edge pitch horn provides the correct location and lever action for attachment to the tail rotor pitch-change mechanism.

For optimum performance, tail rotor blades incorporate symmetrical high-lift airfoils at the root that taper down to thinner asymmetrical high-speed airfoils at the tip. The airfoils include provisions for electronic "tracking."

Blade Major Parts

Spar Extends from butt to tip, forming the leading edge of blade and made from .040 inch stainless steel. Trailing portions are chemically milled to receive skins.

Skin: Upper and lower skin extending from butt to tip is made of .016 inch aluminum alloy.

Trailing Edge Strip: Made from .016 inch aluminum alloy and is bonded between trailing edges of skin for full span of 11.5 inch chord.

Core: Bonded between upper and lower skins from butt to tip and is made of aluminum honeycomb.

Tip Block: Secured to spar at forward end of upper skin by four countersunk screws. Made of aluminum alloy, the block has four tapped holes to receive balance screws.

Closure: Aluminum alloy channel encloses blade tip aft of tip block and is bonded to inner surface of upper and lower skin.

Butt Block: Made of metal and bonded to blade at root end. Tapped holes receive screws attaching balance washers and/or weights.

Doublers: One .020 inch thick aluminum alloy doubler on both upper and lower surface at root end of blade.

Grip Plates: Two inner and outer aluminum alloy plates at root end of blade.

Bushings: Four steel bushings thermal fitted and bonded in holes through inner grip plate, spar, skin, doubler and outer grip plate.

Drain Hole Doubler: Made of .040 inch thick stainless steel and forms root end of blade leading edge.

PITCH-CHANGE MECHANISM

The tail rotor pitch-change mechanism converts pilot movements of the tail rotor flight control pedals into a collective pitch change of the tail rotor blades. This collective pitch change increases or decreases tail rotor thrust as required for flight control. The tail rotor thrust, acting at the end of the tail boom "arm," effectively counteracts the torque of the main rotor.

The components of the tail rotor pitch-change mechanism are as follows:

- Tail rotor flight control push/pull tube
- Crosshead and bearing assembly
- Pitch links (2)

(Figure 10-4) shows the tail rotor pitch-change mechanism.

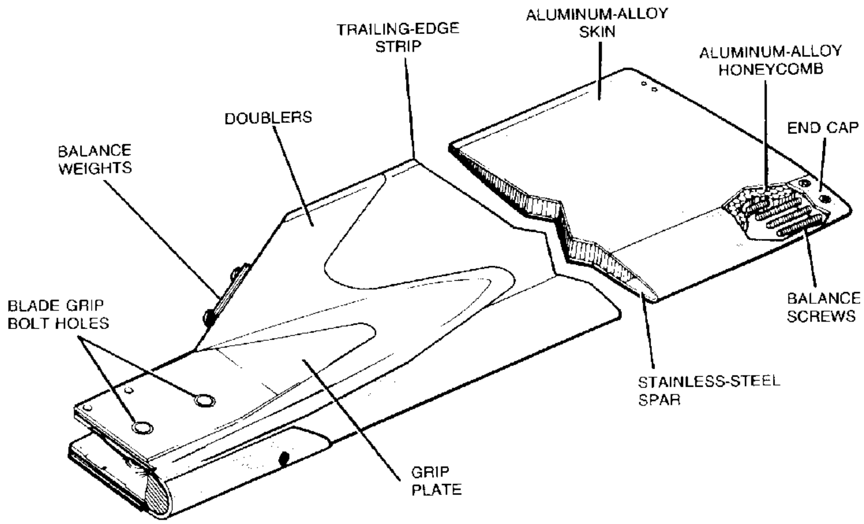


Figure 10-3 Tail Rotor Blade Structure

The tail rotor flight control push/pull tube, connected to the tail rotor flight controls, moves in and out within the rotating tail rotor mast. The crosshead assembly is attached to the outboard end of the push/pull tube by means of a bearing/retainer that allows the crosshead to rotate with the tail rotor. Pitch links attach between the crosshead and the pitch horns on each tail rotor blade to convert the in-and-out movement of the crosshead into a collective pitch change of the tail rotor blades.

Pitch Horns

One aluminum alloy pitch horn located between grip plates of each blade on trail side. Horn secured by two bolts (heads inboard), steel washers and two nuts. Horn has two steel bushings, one floating, at pitch link connection and has a threaded insert to receive bolt securing chordwise balance washers.

PROTECTIVE DEVICES

Two tail rotor protective devices are included as part of the tail rotor system. These are the static stops and the counterweight assemblies (Figure 10-5).

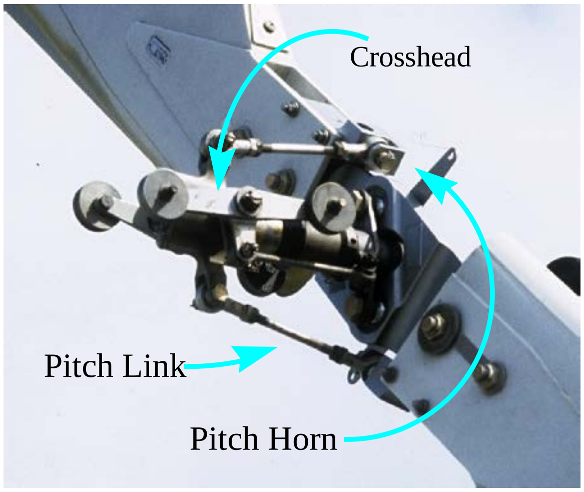


Figure 10-4 Tail Rotor Pitch Change Mechanism

STATIC STOP

The static stop is splined to the tail rotor mast just above the trunnion and prevents excessive flapping of the tail rotor while static (not rotating).

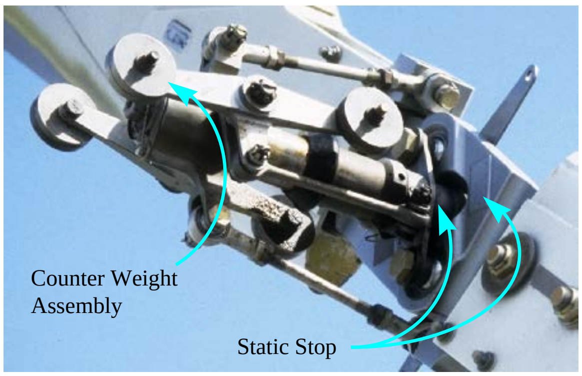


Figure 10-5 Tail Rotor Protective Devices

COUNTERWEIGHT ASSEMBLIES

The counterweight assemblies are provided to relieve strain on the crosshead/bearing assembly during periods of high tail rotor thrust loads, such as hovering. The counterweight assemblies also prevent "wandering" of the pitch-change mechanism in the event the pilot experiences a loss of tail rotor flight control movement.

The counterweight assemblies include the following:

- Counterweight bellcranks (2)
- Counterweight support
- Counterweight links (2)

Two counterweight bellcranks are located one on each side of the crosshead. Each bellcrank clevis is connected to the counterweight support by means of a counterweight link.

As the crosshead moves in response to tail rotor flight control movement, there are corresponding changes in blade pitch, tail rotor thrust, and dynamic forces exerted upon the blades. The angular relationship between the counterweight bellcrank and the crosshead changes as the crosshead moves. The angle change results in a change in the amount of centrifugal force generated by the weights on the ears of the bellcranks. The counterweight system is designed so that the amount of dynamic force exerted on the blades is offset by an approximately equal amount of centrifugal force from the counterweights.

MALFUNCTIONS

While extremely rare, tail rotor system malfunctions have occurred. It is important that the pilot have a thorough understanding of these possible malfunctions so that proper and rapid corrective action can be taken. Section 3 of the Flight Manual provides extensive discussion of three tail rotor system malfunctions:

- Complete loss of tail rotor thrust
- Tail rotor fixed-pitch malfunction
- Loss of tail rotor components

Loss of tail rotor effectiveness (LTE) has also become an area of increased concern, particularly in high-density altitude operations. In some cases it may become a limiting factor in hovering or other maneuvers. The pilot should become familiar with the Critical Relative Wind Azimuth chart and the tail rotor malfunction section of chapter 22 of this manual.

Operational Check

The tail rotor hub and blade assembly must be balanced chordwise and spanwise to eliminate vibrations. The tail rotor hub and blades must be balanced as an assembly. Balancing should be accomplished in a draft-free room. Blade tracking must be accomplished to eliminate vibrations. Blades must be tracked after each installation of the tail rotor hub, blades or pitch change mechanism.

Pedal Force Check

Set-up Operate engine and rotor at 100% and position tail rotor pedals to neutral position.

Check the HYDR SYS No. 1 switch is OFF so that the tail rotor servo actuator is not powered. With foot pressure removed, the pedals should remain in neutral. Should the pedal creep from neutral, adjustment of the crosshead counterweights may be required.

Adjustment Left pedal creep - less weight required. Right pedal creep - more weight required. Basic counterweight configuration (maximum allowable weight) at each location includes two 212-010-710 weights and one standard steel washer. To balance pedal forces, one 212-010-710 weight may be removed at each location. Replace removed weight with AN960-416 and/or AN970-4 washers. Minimum resulting stack will consist of one 212-010-710 weight and five washers.

CAUTION: All four locations must have same weight and washer configuration. Repeat operational check after changing weight configuration.

Recheck for security and safety of all parts.

Balancing

Chordwise Static

A maximum of 10 washers is used to obtain chordwise static balance. A bolt torqued to 50 inch pounds secures the weight washers to a pitch horn.

Chordwise Dynamic

A balance bracket is mounted on the bearing housing by two of the four mounting bolts. A hole is provided in the bracket for adding balance weights. A combination of AN970-4 (Max. 2) and AN960-416 (Max. 10) washers may be used on the balance bracket to obtain dynamic chordwise balance. The washers are to be installed equally under the bolt head and nut with the heaviest washers next to the bracket.

Spanwise Static

Correct static or dynamic spanwise balance using a combination of 4 types of approved washers. Bolts may be of two types as required to accommodate the balance washers and obtain balance. The Blade bolt may be installed with the heads either inboard or outboard, but all four bolts are to be installed in the same direction. The nuts are to be torqued to 500 to 550 inch pounds.