SERVICE MANUAL

Model

UH-12E

Series Helicopters

HILLER AVIATION
PORTERVILLE, CALIFORNIA

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MODEL UH-12E SERVICE MANUAL

INTRODUCTION

GENERAL.

This manual contains instructions for the servicing and maintenance of both three-place and four-place Model UH-12E helicopters manufactured by Fairchild. These instructions include the description, troubleshooting, removal, minor repairs, parts replacement, cleaning, installation, adjusting and testing of individual components and complete systems.

The instructions and information in this manual are supplemented by Fairchild Service Bulletins, Service Information Letters and Interim Revisions as the need arises. These directives have a status equivalent to this manual and should be filed with the manual until such time as they are incorporated into formal Service Manual Revisions. Parts identification and replacement data are contained in the UH-12E Parts Catalog. Component Overhaul and Structural Repair instructions are issued as separate manuals and are not included as part of this Service Manual.

This manual pertains to all Model UH-12E helicopters and may, therefore, describe and provide maintenance information for optional equipment or accessory equipment not installed on every individual helicopter. When this situation is encountered, information that is not applicable should be disregarded.

ARRANGEMENT OF MANUAL.

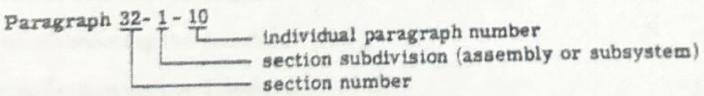
This manual is divided into major GROUPS, SECTIONS, and PARAGRAPHS as explained below. The purpose of this arrangement is to bring related subjects closely together in accordance with the engineering drawings upon which the information is based, to provide easy cross reference to related UH-12E Parts Catalog listings, and to present the information in a logical and easily understood manner.

Any desired subject in this manual may be located in several ways:

1. By turning to the GROUP INDEX located at the front of this manual, and then to the major group in which the desired information appears.
2. By referring to the detailed TABLE OF CONTENTS preceding this introductory information.
3. By referring to the alphabetical listing at the back of this manual.

Each major GROUP is subdivided into SECTIONS. Each SECTION is further subdivided into PARAGRAPHS, FIGURES, TABLES, etc. as indicated below.

1. GROUPS. This manual is divided into the consecutively numbered major GROUPS listed on the preceding group index page. To locate the first page of any GROUP, bend the manual until the black square on the first page of the desired group is exposed in line with the group title on the group index page.
2. SECTIONS. Most groups are divided into appropriate SECTIONS consecutively numbered within the major group. For example: Group number 30 (Flight Controls) is subdivided into Section 31 (Collective Pitch Controls), Section 32 (Rudder Controls), Section 33 (Cyclic Controls), etc. NOTE THAT EACH INDIVIDUAL SECTION IS IDENTIFIED WITH ITS OWN GROUP OF PAGE NUMBERS, EACH OF WHICH IS PREFIXED WITH THE SECTION NUMBER. For example: The first page of Section 31 is identified as page 31-1; the first page of Section 32 is identified as page 32-1.
3. PARAGRAPHS. Each SECTION is divided into appropriate PARAGRAPHS which are identified by a three-group numbering system. The first digit positions identify the SECTION, the second digit positions identify the section subdivision and the last digit positions identify individual paragraphs as indicated in the example below.



Numbers 101, 201, 301, etc. are used in the middle digit group to identify paragraphs which pertain to the various optional kit installations.

4. SUBPARAGRAPHS. For purposes of clarity, PARAGRAPHS are often broken down into SUBPARAGRAPHS. These are lettered in alphabetical order within the PARAGRAPH. Where necessary, the SUBPARAGRAPHS are divided into numbered procedural steps.
5. FIGURE and TABLE NUMBERS. Illustration FIGURES and TABLES (tabular matter) are numbered consecutively within each SECTION, following the same numbering system used to identify PARAGRAPHS. In the case of TABLES, Roman numerals are used in the final dash number position.

6. PAGE NUMBERS. The page numbering system is explained in connection with SECTIONS described above.
7. CROSS REFERENCES. References from one SECTION of the manual to another SECTION are normally made by SECTION number only. Complete references to individual PARAGRAPHS, FIGURES or TABLES are made only when such references are considered essential for clarity.

IMPORTANT - PLEASE READ CAREFULLY.

It may be noted that gaps or omissions are present in the SECTION and PARAGRAPH number sequences used in this manual. These are explained by the fact that certain section numbers have been reserved for new types or items of equipment if required in the future. Similarly, certain paragraph number blocks are assigned to a particular type of information (such as adjustment or repair) which may not be applicable to each individual system or item of equipment.

It will also be noted that there is a direct correlation or relationship between the section numbers used in this Service Manual and the figure numbering system used in the related UH-12E Parts Catalog. The purpose of this relationship is to facilitate cross-reference between the two publications.

GENERAL SERVICING INFORMATION

10-1-1. GENERAL DESCRIPTION. (See figure 10-1 and 10-2.)

10-1-2. The Model UH-12E Helicopter is a rotary wing aircraft with a single two-bladed main rotor and an anti-torque tail rotor. It accommodates three persons seated side by side in the standard configuration, or four persons in the four-place configuration.

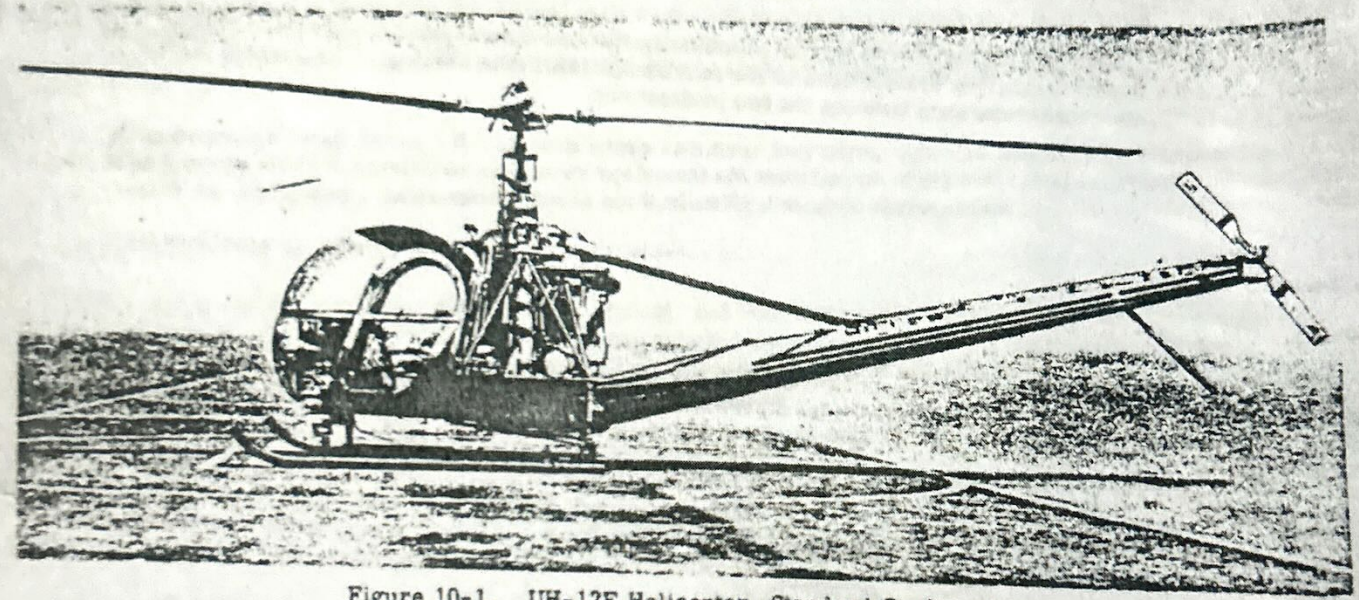


Figure 10-1. UH-12E Helicopter, Standard Configuration

Figure 10-2. UH-12E Helicopter, Four-Place Configuration

10-1-3. The basic body and tail boom sections are of all-metal stressed-skin construction. The helicopter is normally equipped with skid-type landing gear. A bubble-type reinforced clear plastic cabin enclosure is located forward of the power plant on the basic body structure. Suitable instrumentation, radio equipment and flight controls are located inside the cabin enclosure.

10-1-4. The main rotor assembly is located above the power plant. It is driven by a two-stage planetary transmission which is powered by a Lycoming aircooled engine. The tail rotor is driven by the same transmission through a mechanical drive system mounted externally on the tail boom section. The main rotor rotates in a horizontal plane. The tail rotor rotates in a vertical plane.

10-1-5. The helicopter flight controls include cyclic and collective pitch controls, cyclic trim, and directional and throttle control systems. Longitudinal and lateral maneuvers are accomplished by movement of the floor-mounted cyclic control stick. The rate of ascent or descent is changed by the collective pitch stick at the left of either of the operator positions. The helicopter heading is controlled by conventional rudder pedals mounted on the cabin floor. The electrically actuated cyclic trim system is controlled by a switch on the grip of the cyclic control stick.

10-1-6. The engine controls include a twist-action throttle control integral with the grip of the collective pitch stick. A synchronized throttle control is incorporated in the collective pitch control system. Additional engine controls, including an engine control quadrant, are located on the instrument tunnel in the center of the cabin.

10-1-7. The Table of Contents and figure 10-6 should be consulted for a listing of accessory kits that may be installed on the helicopter.

10-2-1. PRINCIPAL DIMENSIONS.

10-2-2. The dimensions in table 10-I and in figures 10-3 and 10-4 are given with the helicopter in a level flight attitude or in normal position on the ground unless otherwise noted. Reference station numbers for the basic body main and tail rotor assemblies are located as shown in figure 10-5.

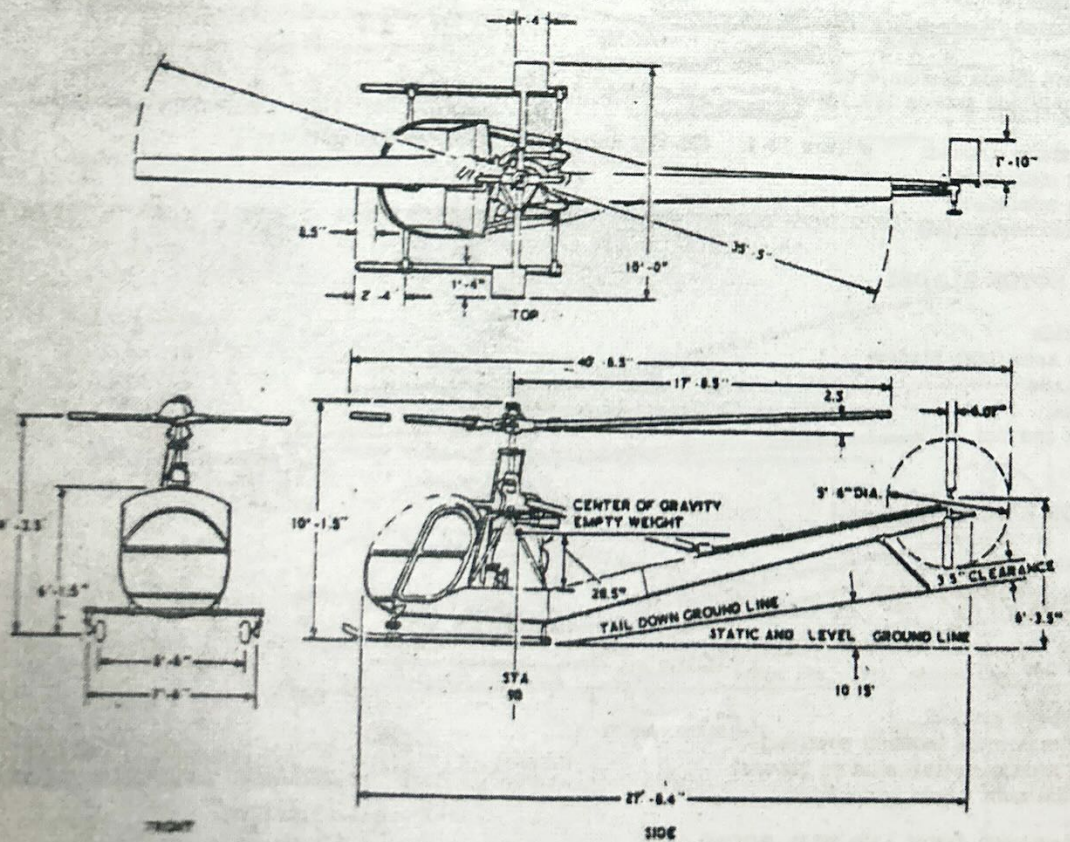


Figure 10-3. Principal Dimensions, Standard Configuration

Table 10-I. Principal Dimensions of UH-12E Helicopter

	DIMENSIONS
GENERAL	
Main rotor disc diameter (horizontal plane)	35 ft, 5 in.
Tail rotor disc diameter (vertical plane)	5 ft, 6 in.
Width (over-all):	
Maximum (main rotor extreme position)	35 ft, 5 in.
Minimum (main rotor minimum position)	10 ft
Minimum (main rotor assembly removed)	7 ft, 9.9 in.
Length (over-all):	
Maximum (both rotors extreme position)	40 ft, 8.5 in.
Minimum (both rotors minimum position)	28 ft, 6 in.
Minimum (main rotor minimum position - tail rotor extreme position)	30 ft, 6 in.
Minimum (main rotor extreme position - tail rotor minimum position)	38 ft, 10.5 in.
Minimum (both rotors removed)	28 ft, 6 in.
Height (over-all):	
Maximum (normal ground attitude)	10 ft, 1.5 in.
Maximum (hoisting sling attached)	11 ft, 7.3 in.
MAIN ROTOR BLADES (2 blades)	
Airfoil section (10 degree twist)	Special
Total blade area (both blades)	32.7 sq ft
Area per blade	16.35 sq ft
Area of rotation (rotor disc area)	990.0 sq ft
Blade radius	17 ft, 8.5 in.
Chord at root (blade station 4.63)	13.7 in.
Chord at tip (blade station 189.75)	10.4 in.
Clearance above ground:	
Rotating maximum	12 ft, 2 in.
Rotating minimum	6 ft, 4 in.
Static (hub horizontal)	9 ft, 10 in.
CONTROL ROTOR BLADES	
Airfoil section	NACA 0015
Total blade area (both blades)	512 sq in.
Area per blade	256 sq in.
Blade radius	5 ft
Chord (root and tip)	16 in.
Span	16 in.
TAIL ROTOR BLADES (2 blades)	
Airfoil section	NACA 0015
Total blade area (both blades)	2.66 sq ft
Area per blade	1.33 sq ft
Blade radius	33 in.
Chord (root and tip)	6.07 in.
Clearance above ground:	
Rotating maximum (normal position)	4 ft, 11 in.
Rotating minimum (tail skid on ground)	3.5 in.
Static maximum (blade horizontal)	5 ft, 9.7 in.
FUSELAGE (BASIC BODY AND TAIL BOOM)	
Width (over-all without landing gear)	4 ft, 11 in.
Length (over-all without landing gear)	27 ft, 8.4 in.
Height (over-all without landing gear)	5 ft, 7.4 in.
Height of door above ground	18 in.

Table 10-I. Principal Dimensions of UH-12E Helicopter (cont)

	DIMENSIONS
FUSELAGE (BASIC BODY AND TAIL BOOM) (cont)	
Door opening dimensions:	
Width	30 in.
Height	49 in.
STABILIZER (THREE-PLACE CONFIGURATION)	
Airfoil section	NACA 0015
Total stabilizer area	2.93 sq ft
Chord (root and tip)	1 ft, 4 in.
Span	1 ft, 10 in.
STABILIZER (FOUR-PLACE CONFIGURATION)	
Airfoil section	NACA 0015
Total stabilizer area	10.04 sq ft
Chord (root)	2 ft, 1.6 in.
Chord (tip)	1 ft, 7.1 in.
Span	6 ft, 2 in.

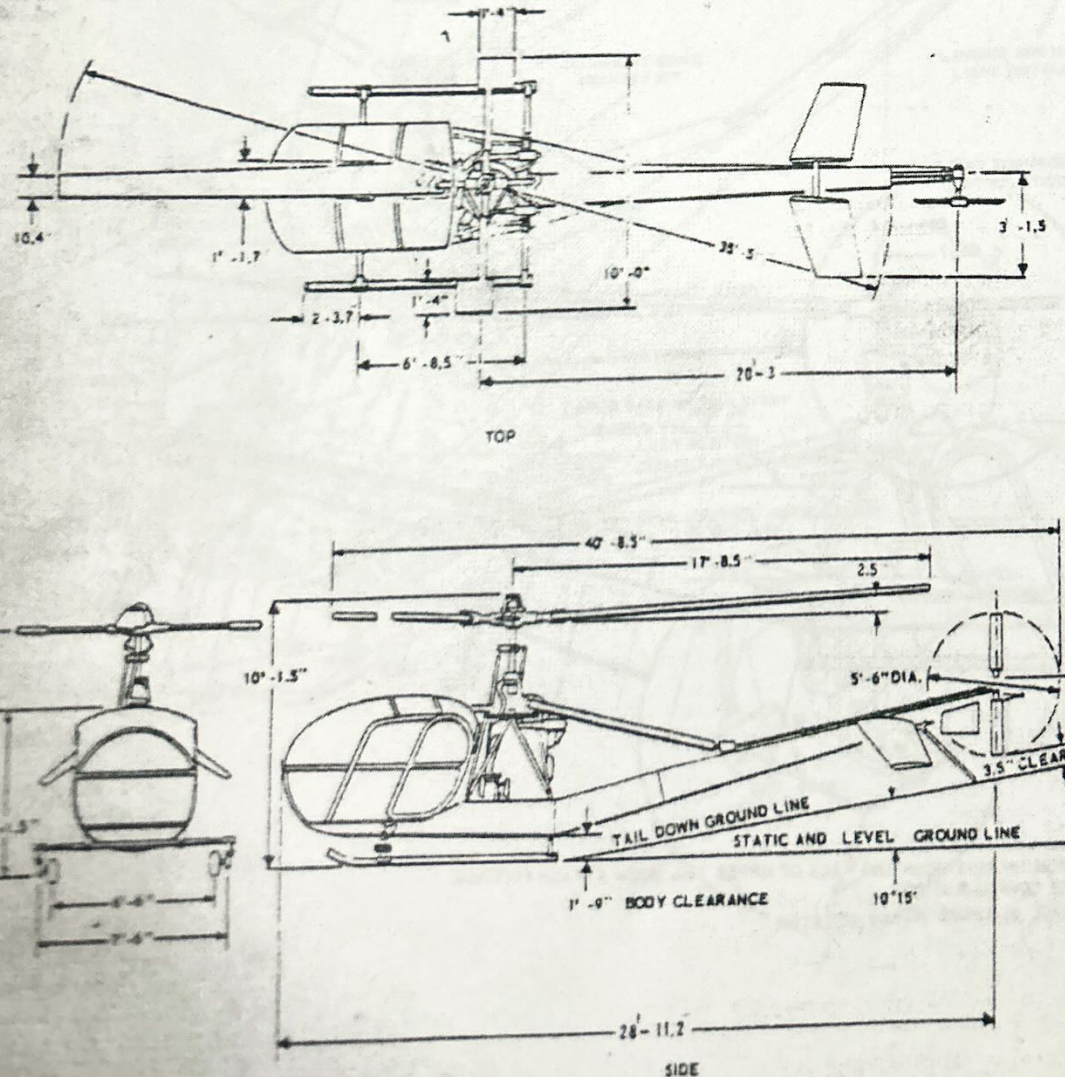
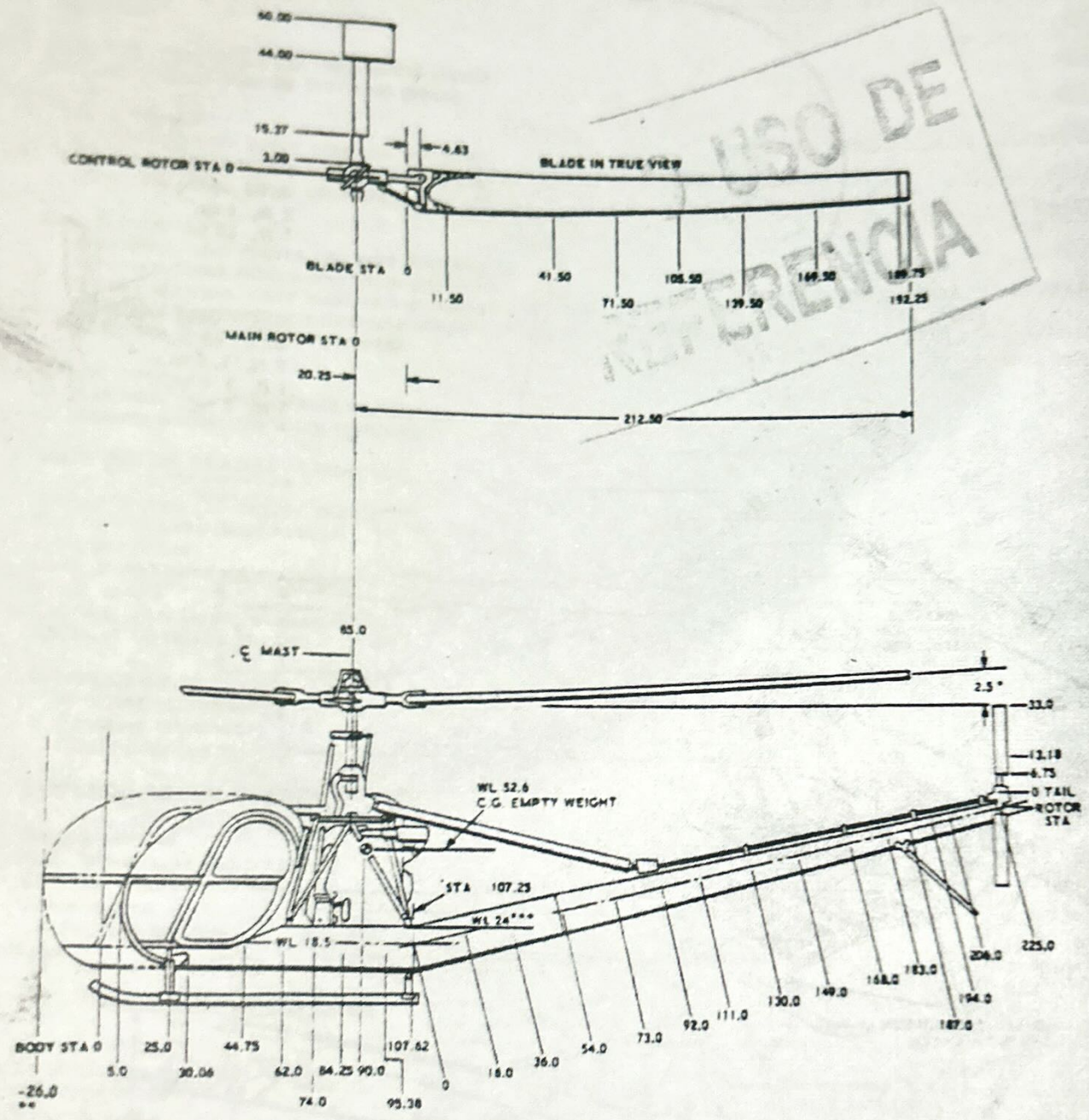


Figure 10-4. Principal Dimensions, Four-Place Configuration



* BODY STATION 107.25 IS MOUNTING FACE OF UPPER TAIL BOOM ATTACH FITTINGS
** FOUR PLACE CONFIGURATION
*** LOWER SURFACE OF ENGINE DECK

Figure 10-5. Stations Diagram, Three- and Four-Place Configurations

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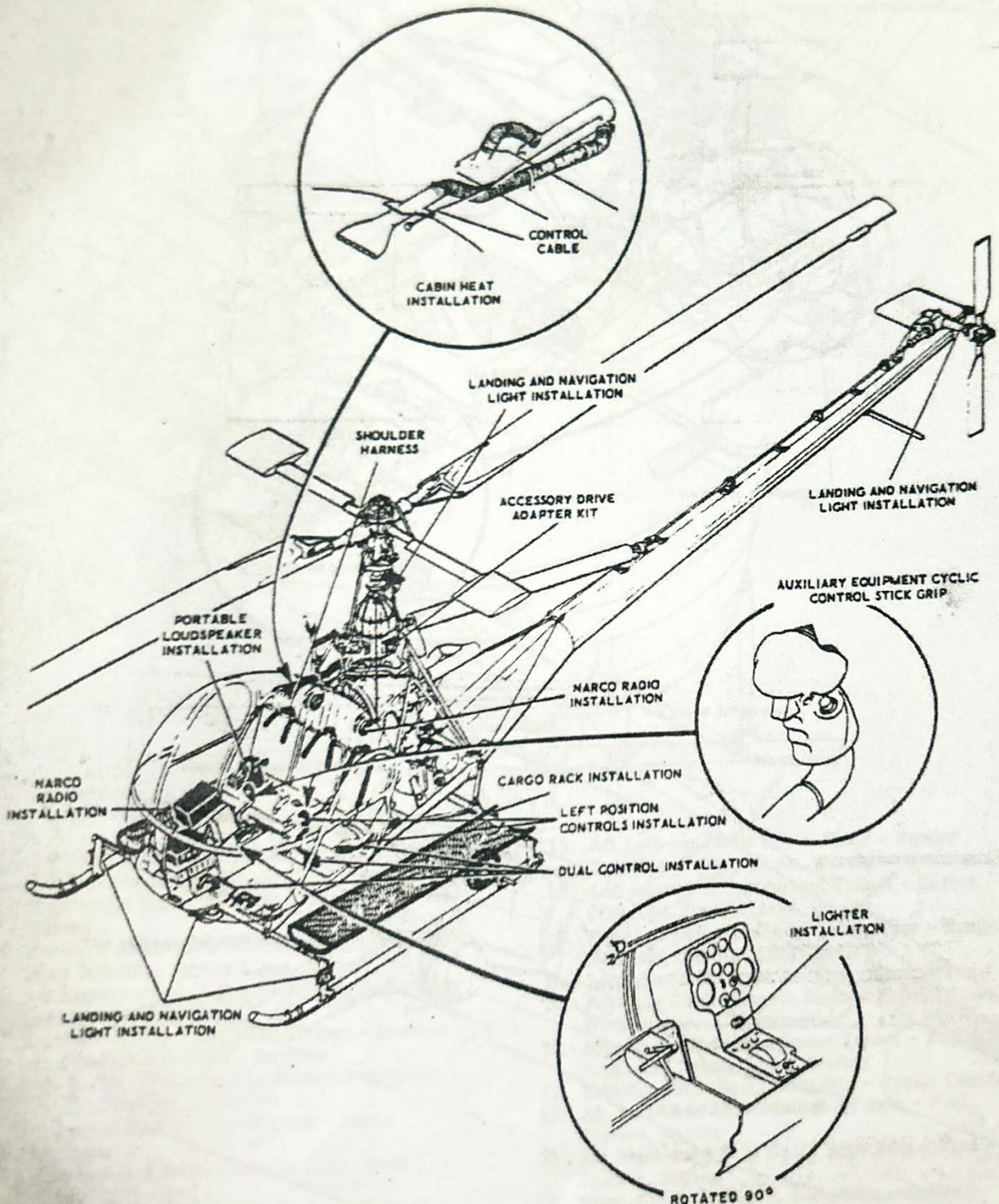

Figure 10-6. Accessory Equipment (Sheet 1 of 2)

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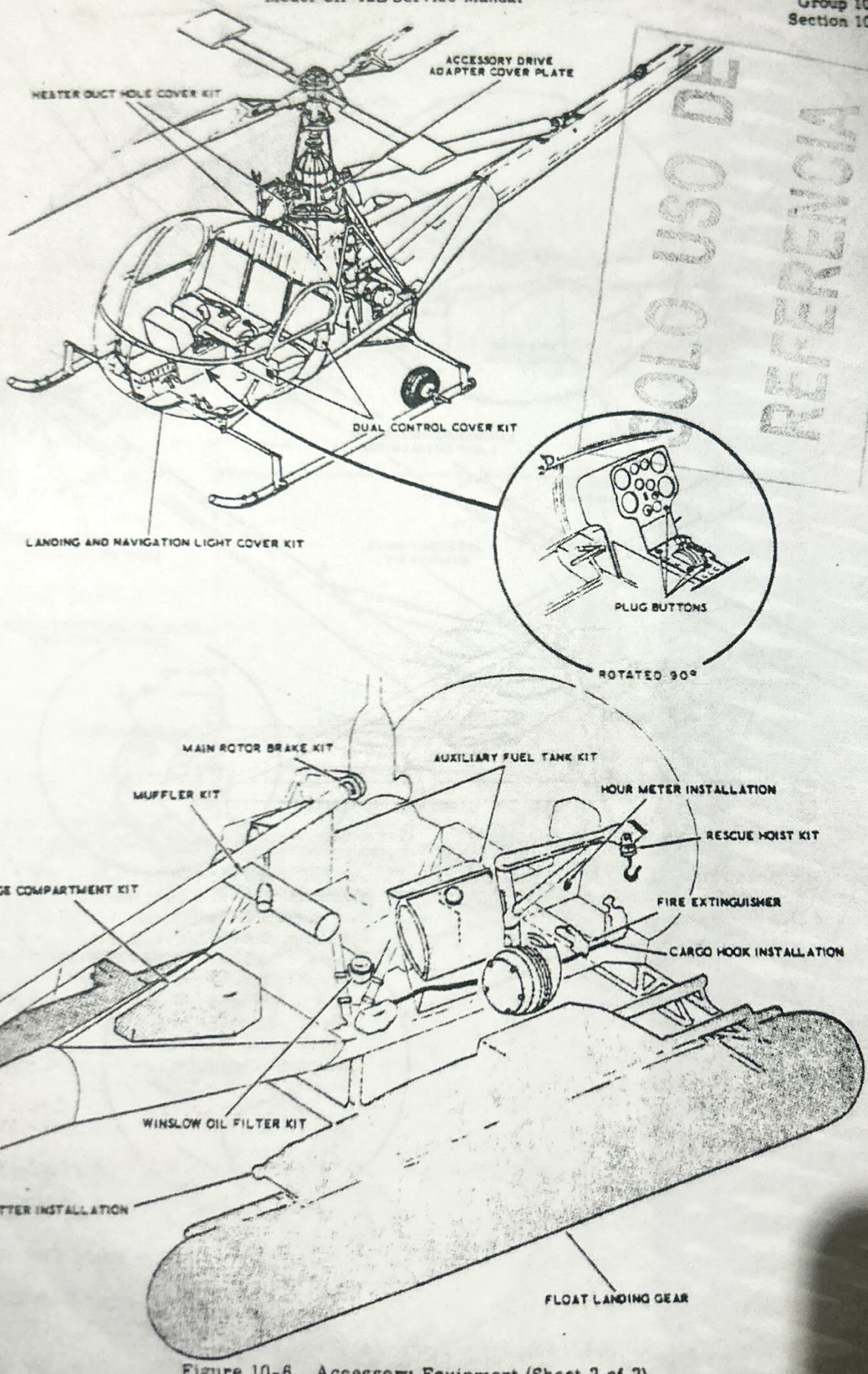
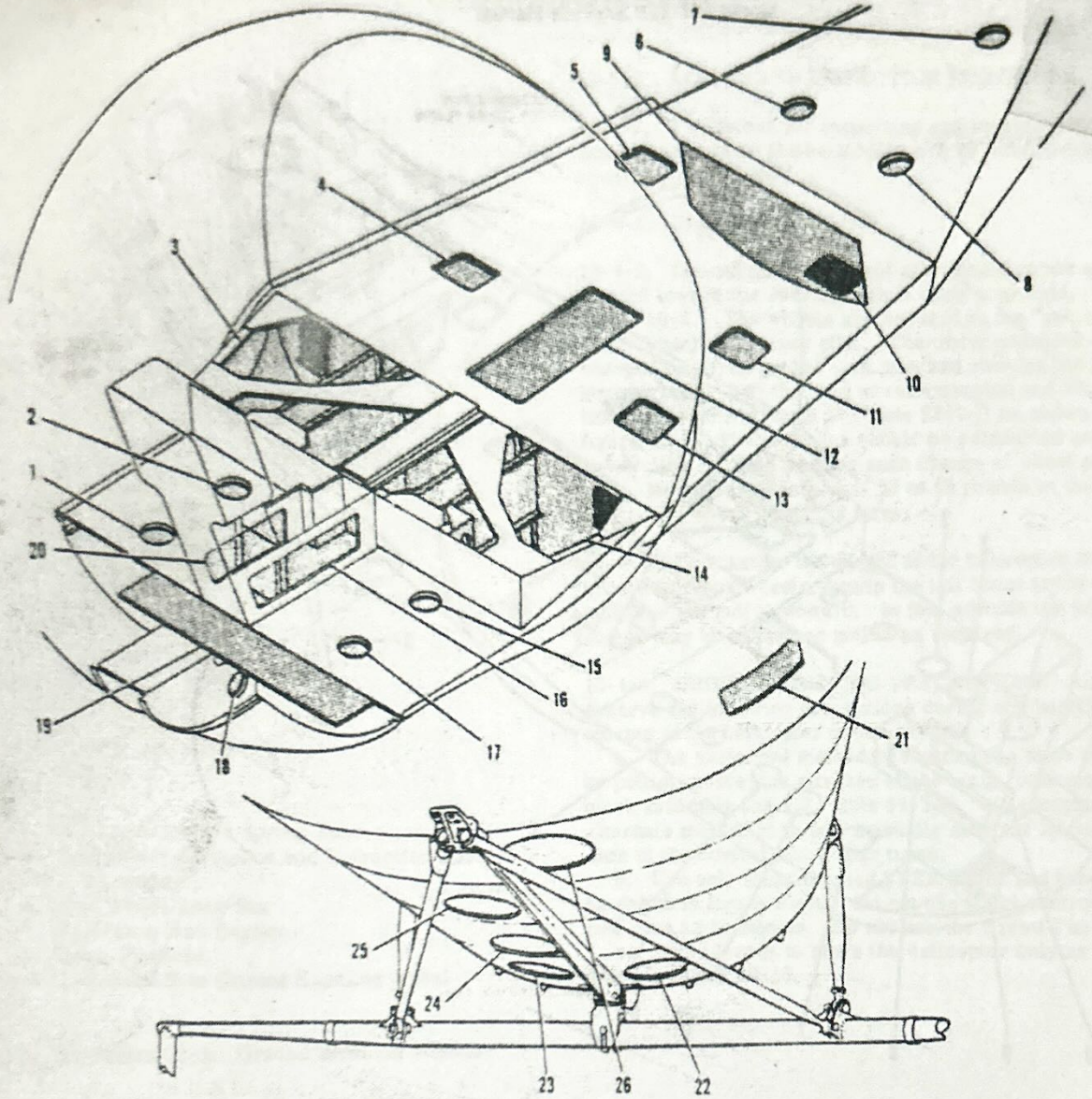
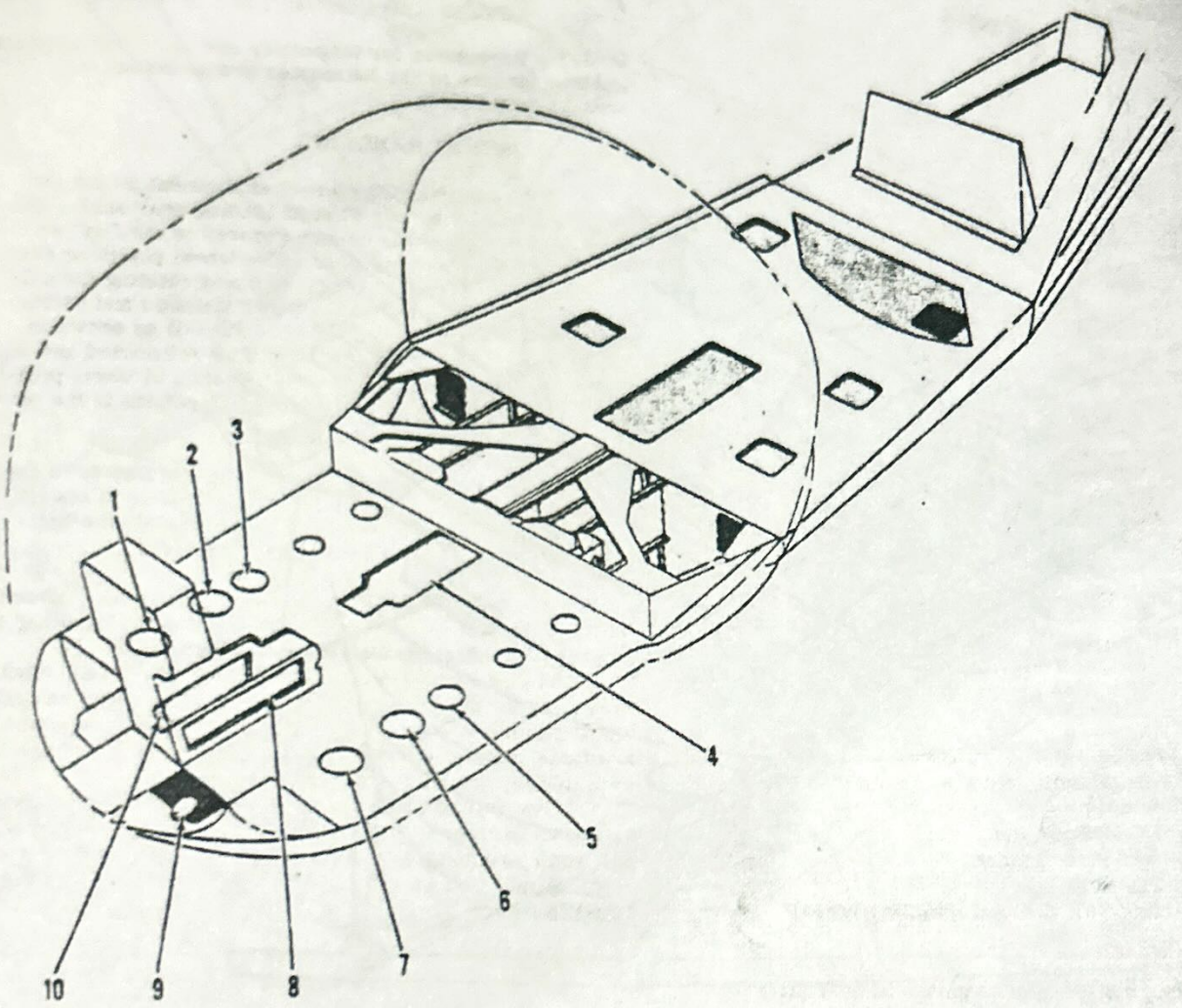


Figure 10-6. Accessory Equipment (Sheet 2 of 2)



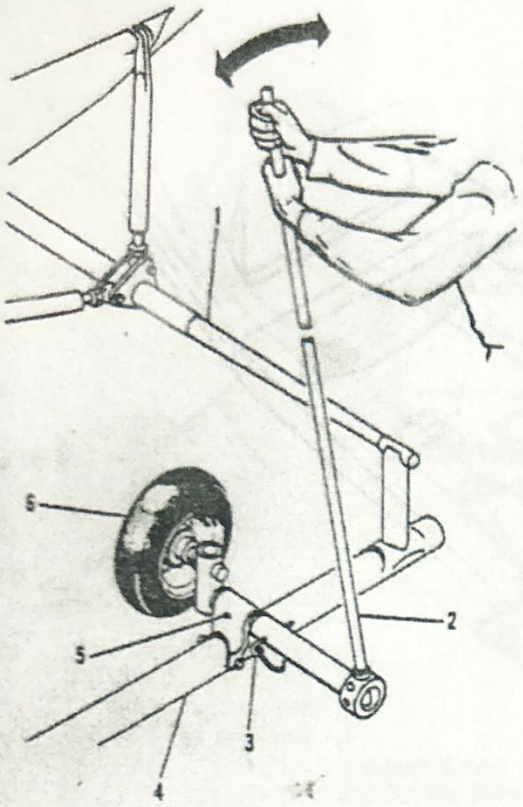
1. Forward Right-hand Side Cabin Floor - Wiring
2. Aft Right-hand Side Cabin Floor - Wiring
3. Right-hand Side Underseat - Cyclic Controls, Wiring
4. Forward Right-hand Side Engine Deck - Basic Body Interior, Tubing Lines, Wiring
5. Aft Right-hand Side Engine Deck - Basic Body Interior, Wiring
6. Right-hand Side Transition Section - Interior
7. Aft Transition Section - Interior
8. Left-hand Side Transition Section - Interior
9. Fuel Cell Access Cover
10. Aft Left-hand Side Engine Deck - Basic Body Interior
11. Left-hand Side Engine Deck - Basic Body Interior
12. Center Engine Deck - Fuel System, Tubing Lines, Wiring
13. Forward Left-hand Side Engine Deck - Basic Body Interior, Tubing Lines, Wiring
14. Left-hand Side Underseat - Cyclic Controls, Tubing Lines, Wiring
15. Aft Left-hand Side Cabin Floor - Rudder Controls, Tubing Lines, Wiring
16. Left-hand Side Instrument Tunnel - Engine Controls, Tubing Lines, Wiring
17. Forward Left-hand Side Cabin Floor - Rudder Controls, Tubing Lines, Wiring
18. Left-hand Side Light Well - Interior, Wiring
19. Forward Cabin Floor - Rudder Pedals, Light Well Interior, Wiring
20. Right-hand Side Instrument Tunnel - Engine Controls, Tubing Lines, Wiring
21. Left-hand Side Basic Body Skin - Cyclic Controls
22. Aft Left-hand Side Basic Body Skin - Fuel System, Wiring
23. Aft Right-hand Side Basic Body Skin - Fuel System, Wiring
24. Right-hand Side Basic Body Skin - Fuel System, Wiring
25. Forward Right-hand Side Basic Body Skin - Fuel System, Wiring
26. Forward Left-hand Side Basic Body Skin - Tubing Lines, Wiring

Figure 10-7. Access and Insnection Provisions



1. Forward Right-hand Side Cabin Floor - Wiring
2. Aft Right-hand Side Cabin Floor - Wiring
3. Right-hand Side Underseat - Cyclic Controls, Wiring
4. Instrument Tunnel - Engine Controls, Tubing Lines, Wiring, Collective Controls
5. Cabin Floor - Collective Controls, Rudder Controls, Tubing Lines, Wiring
6. Cabin Floor - Collective Controls, Rudder Controls, Tubing Lines, Wiring
7. Cabin Floor - Collective Controls, Rudder Controls, Tubing Lines, Wiring
8. Instrument Tunnel - Engine Controls, Tubing Lines, Wiring
9. Light Well - Interior, Wiring
10. Instrument Tunnel - Engine Controls, Tubing Lines, Wiring

Figure 10-8. Access and Inspection Provisions, Four-Place Configuration



1. Aft Landing Gear Spring Tube
2. Skid Wheel Extension and Retraction Bar Assembly
3. Skid Wheel Lock Pin
4. Left-hand Skid Runner
5. Lock Pin Hole
6. Left-hand Side Ground Handling Wheel

Figure 10-9. Ground Handling Wheels

10-3-1. ACCESS AND INSPECTION PROVISIONS.

10-3-2. Provisions for inspecting and servicing systems and components on the helicopter are as indicated in figures 10-7 and 10-8.

10-4-1. GROUND HANDLING.

10-4-2. Ground handling wheel attachment points are located toward the rear of each landing gear skid. (See figure 10-9.) The wheels are secured in the "up" or "down" position by lock pins. The wheel positions are changed by removing the lock pins and rotating the axle support tube. Use the skid wheel extension and retraction bar assembly (item 17, table 92-1-I) as shown in figure 10-9. The lock pins should be reinserted and the safety pins reinstalled after each change of wheel position. Maintain a pressure of 55 to 65 pounds in the pneumatic type wheel assembly tires.

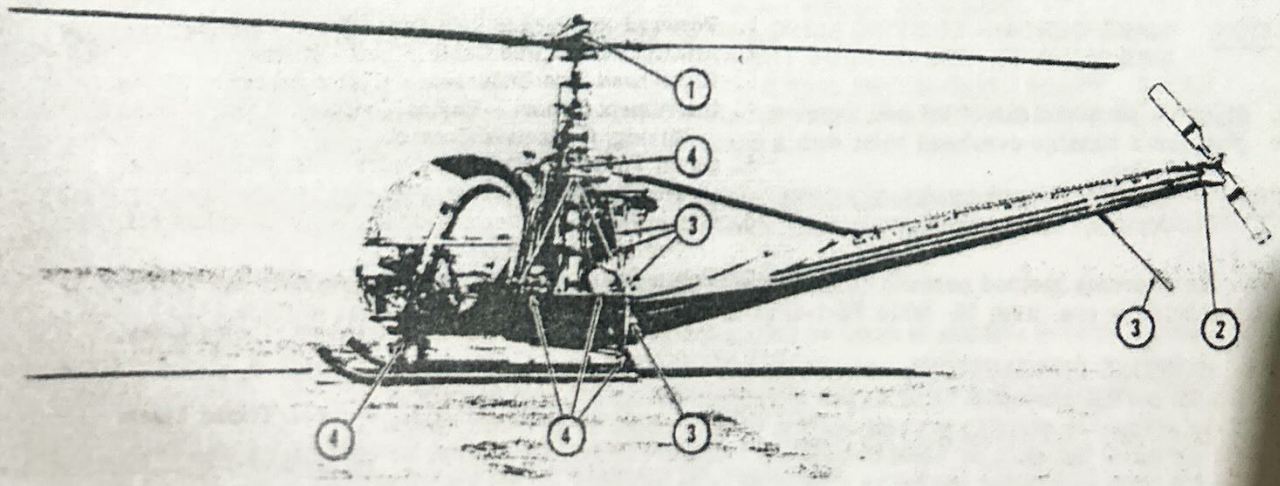
10-4-3. To transfer the weight of the helicopter to the ground handling wheels, grasp the tail boom at the aft bulkhead and pull downward. In this attitude the helicopter may be pushed or pulled as required.

10-4-4. GROUND HANDLING PRECAUTIONS. Always observe the following precautions during any handling or moving of the helicopter on the ground:

a. The preferred method of rotating the main rotor is by pulling on the line attached to the main rotor mooring block assembly (item 3, table 92-1-I). An acceptable alternate method is to pull manually near the inboard ends of the control rotor spar tubes.

b. Use only steps marked STEP HERE and handholds as shown in figure 10-10. Do not use flight control push-pull rods as handholds. Do not use the firewall as a step.

c. Apply forces to move the helicopter only as indicated in figure 10-10.



1. Rotating the Rotors
2. Lowering the Tail Boom
3. Pushing and Pulling the Helicopter
4. Step Here

Figure 10-10. Handholds and Steps

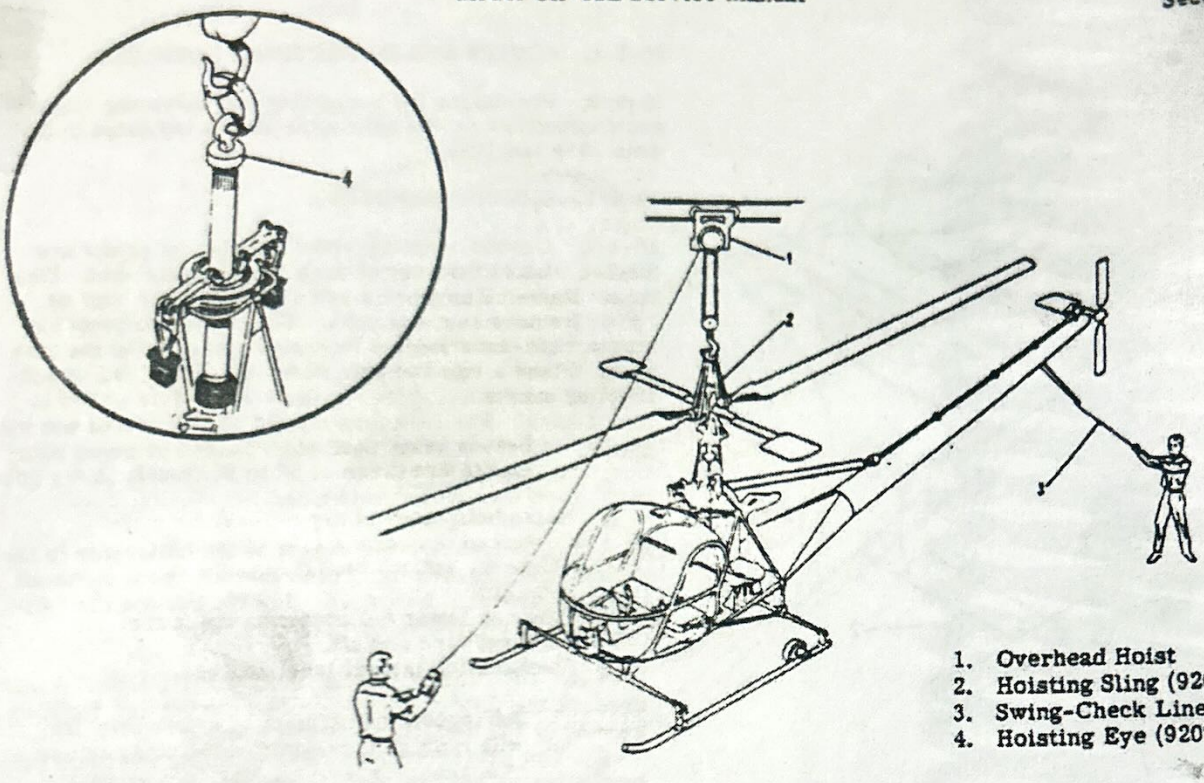


Figure 10-11. Hoisting the Helicopter

CAUTION: DO NOT PUSH OR PULL THE STABILIZER, STABILIZER SPAR TUBE, TAIL ROTOR OR TAIL ROTOR GEAR BOX. DO NOT PUSH ON ANY CONTROL SURFACES, LINKAGES, DRIVE ASSEMBLIES OR TRANSPARENT CABIN ENCLOSURE SURFACES.

10-5-1. HOISTING THE HELICOPTER. (See figure 10-11.)

10-5-2. The helicopter may be hoisted without removing the main rotor assembly.

a. Before attaching the hoisting slings or other special tools, protect the main rotor hub with suitable padding.
b. Secure a line to the tail skid to check swinging of the helicopter while it is hoisted.
c. Attach the hoisting sling (item 1, table 92-1-I) as shown in figure 10-11.

CAUTION: MAKE CERTAIN HOISTING SLING PASSES UNDER THE MAIN ROTOR HUB. DO NOT PERMIT THE SLING TO RIDE OUTSIDE THE HUB.

d. Station a person clear of the helicopter to handle the line attached to the tail skid.
e. Position a suitable overhead hoist with a minimum rated capacity of 4000 pounds.

WARNING: REQUIRE PERSONNEL TO KEEP WELL CLEAR OF THE HELICOPTER DURING HOISTING OPERATION. ALWAYS HOIST SLOWLY AND SMOOTHLY.

10-5-3. An alternate method permits hoisting the helicopter after the main rotor assembly has been removed. Attach the hoisting eye (item 19, table 92-1-I) as shown in figure 10-11. Proceed as in steps d and e, above.

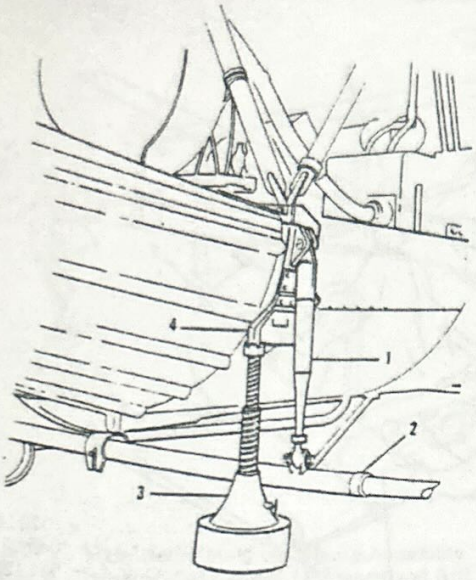
10-5-4. HOISTING PRECAUTIONS. Always observe the following precautions when hoisting the helicopter:

a. Do not permit personnel in or on the helicopter during hoisting operations.
b. Take necessary steps to prevent chafing or scratching of main rotor hubs.
c. Do not allow the sling or hoist to bend the incidence arms, flyweights, or collective pitch ballast system.
d. Do not hoist helicopter except as described in paragraphs 10-5-2 and -3, above.

10-6-1. JACKING THE HELICOPTER. (See figure 10-12.)

10-6-2. Three jack pad fittings are installed on the basic body. One jack pad is located on the bottom of the helicopter at station 44.75. The other two jack pads are located on each side at station 109.00, adjacent to the landing gear support brace attachment pints. Observe the following sequence in jacking the helicopter.

a. Position an offset or standard type jack at each rear jack pad. The jacks must have a minimum rated



1. Landing Gear Support Brace
2. Aft Landing Gear Spring Tube
3. Jack
4. Right-hand Side Jack Pad

Figure 10-12. Jacking the Helicopter

capacity of 1000 pounds each.

b. Position another jack at the forward center jack pad. The jack must have a minimum rated capacity of 750 pounds.

c. Jack the helicopter carefully. Maintain the helicopter at a nearly level attitude.

10-7-1. LEVELING THE HELICOPTER.

a. Raise helicopter as outlined in paragraph 10-6-1.

b. Remove seat cushions, safety belts and seat deck on the right-hand side.

c. Place a suitable spirit level across the lateral leveling marks.

NOTE: Before using spirit level make certain leveling marks are clean.

d. Raise helicopter at the left-hand or right-hand side as required to obtain a lateral level attitude.

e. Place the spirit level across the longitudinal leveling marks.

f. Raise or lower helicopter at the forward jack pad until it is level fore and aft.

g. Recheck the lateral level attitude.

NOTE: Subsequent adjustment of either level attitude will require a recheck of the other to verify that accurate leveling has been attained.

10-8-1. ANCHORING AND MOORING INSTRUCTIONS. (See figure 10-13.) Local regulations and procedures supplement the instructions given in this manual.

10-8-2. MOORING IN NORMAL WEATHER. The following procedures are suitable for securing the helicopter under normal weather conditions and wind velocities up to 15 knots.

a. Close cabin doors.
b. Disconnect battery.
c. Locate helicopter well clear of other aircraft, equipment or buildings.
d. Head helicopter into the prevailing wind or the local forecasted wind direction.
e. Set ground handling wheels in the "up" position.
f. Aline main rotor blades fore and aft observing the precaution described in paragraph 10-4-4.
g. Attach main rotor mooring clamp assembly (item 3, table 92-1-I) at the end of the aft main rotor blade.
h. Tilt main rotor head backward until main rotor hub is in contact with the drive shaft.
i. Secure mooring clamp line as shown in figure 10-13.

CAUTION: ALL MOORING LINES MUST BE KEPT CLEAR OF THE TAIL ROTOR DRIVE SHAFT. AVOID EXCESSIVE TENSION ON BLADE TIE-DOWN LINE. THE BLADE MUST NOT BEND OR WARP UNDER THE TENSION OF THE BLADE TIE-DOWN LINE.

j. Electrically ground the helicopter by connecting one of the power plant grounding straps to a suitable low-resistance ground such as an iron pipe driven into the ground. Use a large soft copper wire or other suitable connector.

k. Cover pitot tube with the pitot tube cover (item 41, table 92-1-I) or with tape.

10-8-3. MOORING IN ADVERSE WEATHER. The following steps shall be taken in addition to those outlined in paragraph 10-8-2, whenever the forecasted wind velocities exceed 25 knots.

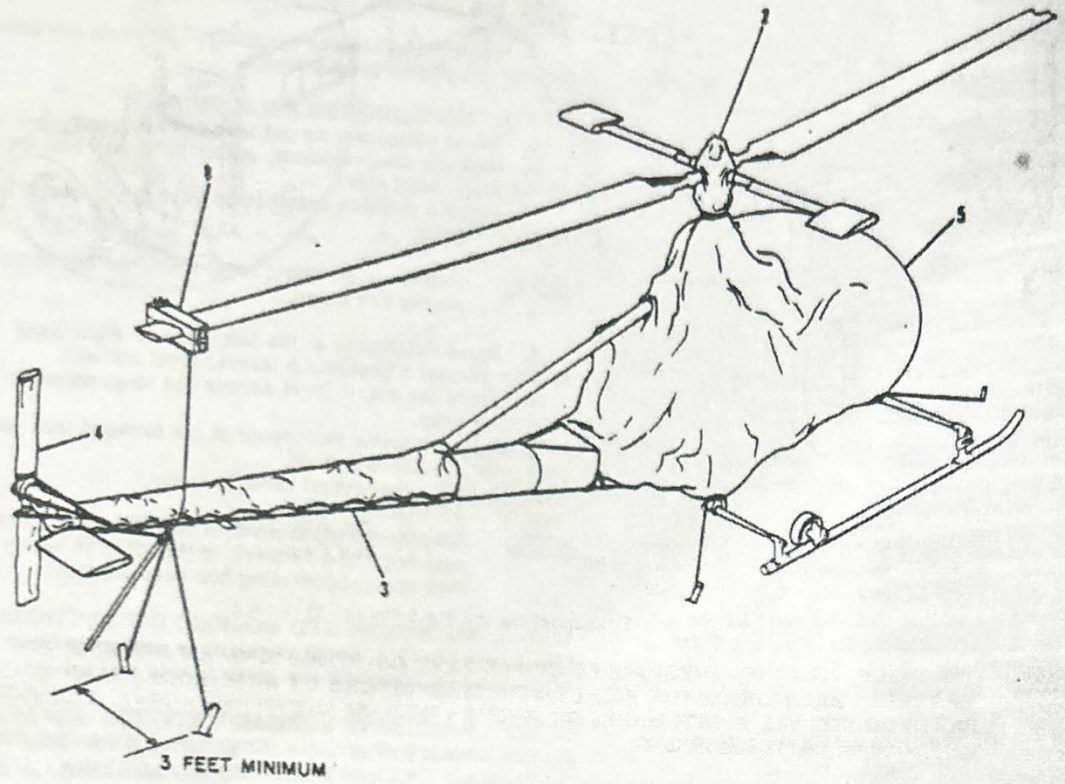
a. Attach and secure protective covers on the cabin, main rotor head, tail boom and tail rotor as shown in figure 10-13.

b. Install suitable dust plugs in the induction system intake screen and in the exhaust outlets. Use pressure-sensitive tape to cover these openings if covers or plugs are not available.

c. Fill the fuel tank.

NOTE: Use 1/4-inch aircraft cable and three-hole cable clamps, or 3000-pound test chain and bolts to secure the helicopter as shown in figure 10-13.

10-8-4. Manila ropes with a minimum test of 3000-pounds may be substituted for chains or cables where neces-



1. Mooring Clamp Assy (92225) or Mooring Block Assy (92016-2)
2. Main Rotor Head Cover Assy (92028)
3. Tail Boom Cover Assy (92029)
4. Tail Rotor Cover Assy (92030)
5. Basic Body Cover Assy (92193)

Figure 10-13. Mooring the Helicopter

sary. Allow sufficient slack in all rope mooring lines to prevent damage caused by rope shrinkage because of rain or high humidity conditions.

10-8-5. MOORING IN EXTREME WEATHER. In storm conditions such as hurricanes, typhoons, and tornadoes, or when wind velocities above 40 knots are forecast, the helicopter should be evacuated to a safe area.

10-9-1. PARKING THE HELICOPTER. For short periods, such as between closely scheduled flights, secure the helicopter as follows:

a. Attach main rotor mooring clamp assembly (item 3, table 92-1-I) at the end of one main rotor blade.
b. Aline blade fore and aft observing the precautions outlined in paragraph 10-4-4.
c. Tilt main rotor head backward until the main rotor is in contact with the rotor assembly drive shaft.
d. Secure mooring clamp tie-down line as shown in figure 10-13.

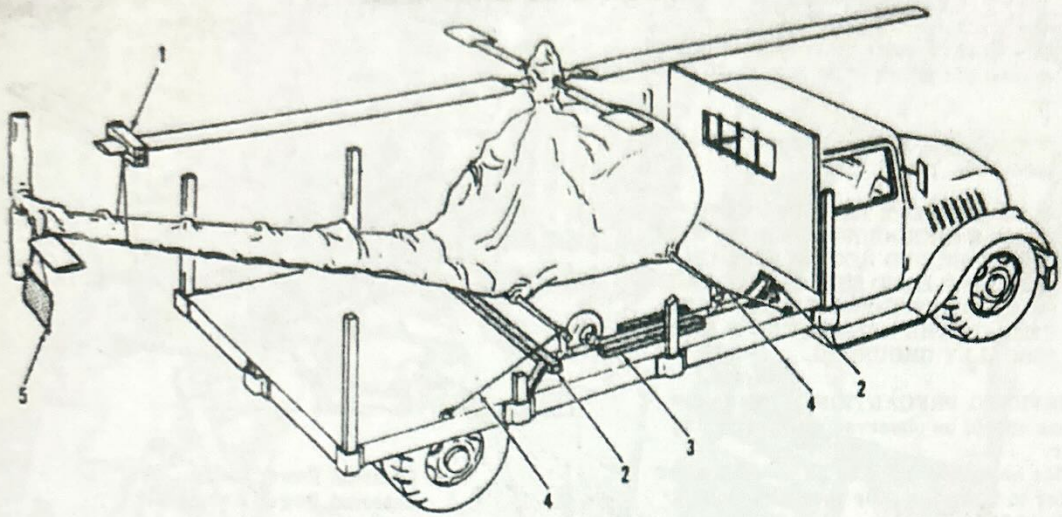
CAUTION: ALL MOORING LINES MUST BE KEPT CLEAR OF THE TAIL ROTOR DRIVE SHAFT. DO NOT APPLY A DOWNWARD BENDING LOAD TO THE MAIN ROTOR BLADE WITH THE TIE DOWN.

e. Cover the pitot tube.

NOTE: Observe the mooring procedures outlined in paragraphs 10-8-2 and -3 whenever the helicopter is to be left unattended for an extended period.

10-10-1. TRANSPORTING THE HELICOPTER. Disassemble, pack and protect the helicopter prior to transporting as follows:

a. Match-mark all mating surfaces at the point of disassembly to facilitate reassembly and rigging.



1. Main Rotor Mooring Clamp Assembly
2. Landing Gear Block (Forward and Aft)
3. Landing Gear Block (Side to Side)
4. Cable or Rope Tie-downs
5. Red Caution Flag for Overhang

Figure 10-14. Transporting the Helicopter by Truck

CAUTION: USE PAINT, CRAYON, PRESSURE SENSITIVE TAPE OR OTHER SIMILAR METHODS OF MARKING. BECAUSE OF THE HIGHLY-STRESSED NATURE OF NUMEROUS HELICOPTER PARTS DO NOT USE PUNCH MARKS OR SCRIBE LINES OR ANY OTHER SURFACE DEFACING METHODS OF MATCHMARKING.

b. Remove main rotor assembly as described in Section 50. Detach main rotor blades as described in Section 53.

c. Remove tail rotor assembly as described in Section 55 and the forward tail rotor drive shaft as described in Section 24. Attach tail rotor cover assembly (item 7, table 92-1-1) as shown in figure 10-13.

d. Disconnect radio antennas from the tail skid. Coil the wires in a loose roll and secure them to the tail boom transition section with tape.

e. Disconnect and remove battery from helicopter. The battery should be boxed separately with special care to prevent damaging the disconnect adapter.

f. Apply preservative to portions of the helicopter as required to cover the anticipated shipping and storage period. Use cloth and tape to protect mating surfaces exposed by disassembly. Provide adequate padding to prevent damage to helicopter at all lashing or tie-down points.

g. Box or crate all parts removed from helicopter.

CAUTION: PARTICULAR CARE MUST BE TAKEN TO AVOID DENTING OR SCRATCHING THE MAIN ROTOR BLADES.

10-10-2. TRANSPORTING THE HELICOPTER BY TRUCK. (See figure 10-14.)

a. Remove the forward drive shaft and secure the helicopter on the truck as shown in figure 10-14.

b. If the overall height of the helicopter after it is loaded on the truck is higher than the road clearance along the projected route, remove the rotor blades, rotor head assembly and main transmission. Provide suitable support covers and tie-downs for the parts removed.

c. After arrival, reinstall all removed parts.

d. Prior to the next flight, clean, inspect and lubricate the helicopter.

10-11-1. APPLICATION OF EXTERNAL POWER. (See figure 10-15.)

10-11-2. Externally supplied 28-volt dc power is connected to the helicopter power supply system through the external power receptacle on the right-hand aft side of the firewall. The spring-loaded cover is lifted to permit insertion of a standard external power supply plug.

NOTE: The positive (+) and negative (-) terminals are clearly indicated on the base of the receptacle to prevent reversing polarity where a standard plug is not available.

10-12-1. SERVICING THE HELICOPTER.

10-12-2. Servicing requirements and specifications are listed in table 10-II. Service requirements for accessory equipment are shown in figures 10-20 and 10-20A.

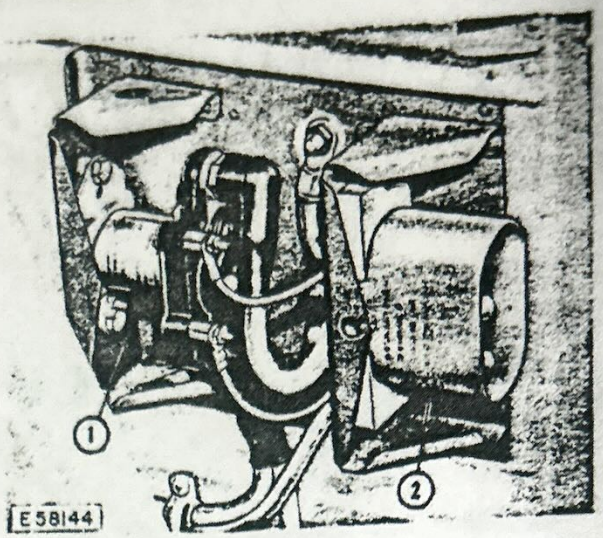
10-12-3. SERVICING THE FUEL SYSTEM. (See figures 10-16 and 10-16A.)

WARNING: ALWAYS INSERT THE FUEL HOSE NOZZLE GROUNDING CHAIN OR WIRE IN THE GROUND RECEPTACLE ON THE LEFT-HAND SIDE OF THE TAIL BOOM TRANSITION SECTION. MAKE CERTAIN THE HELICOPTER IS ELECTRICALLY GROUNDED.

10-12-4. SERVICING PRECAUTIONS. The following precautions should be observed when servicing the helicopter.

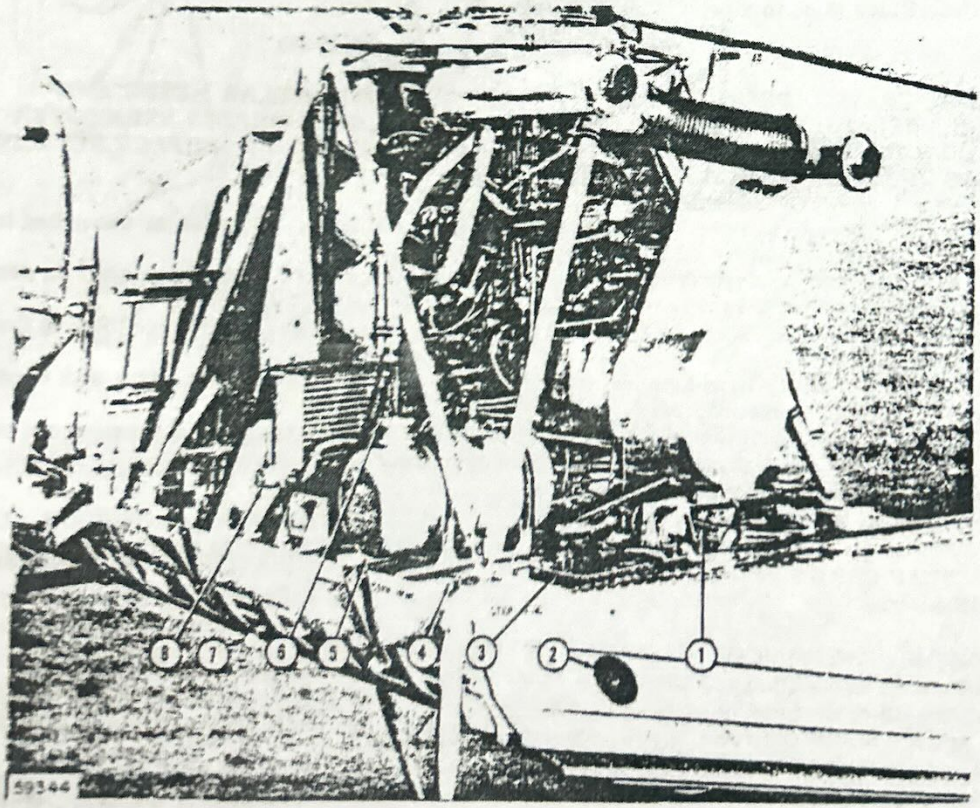
a. Service helicopter as soon as possible after landing. Refer to table 10-II for correct specification and grade of fuel.

b. Always insert fueling nozzle grounding chain or fuel truck grounding wire into the GROUND HERE receptacle (2, figure 10-16).



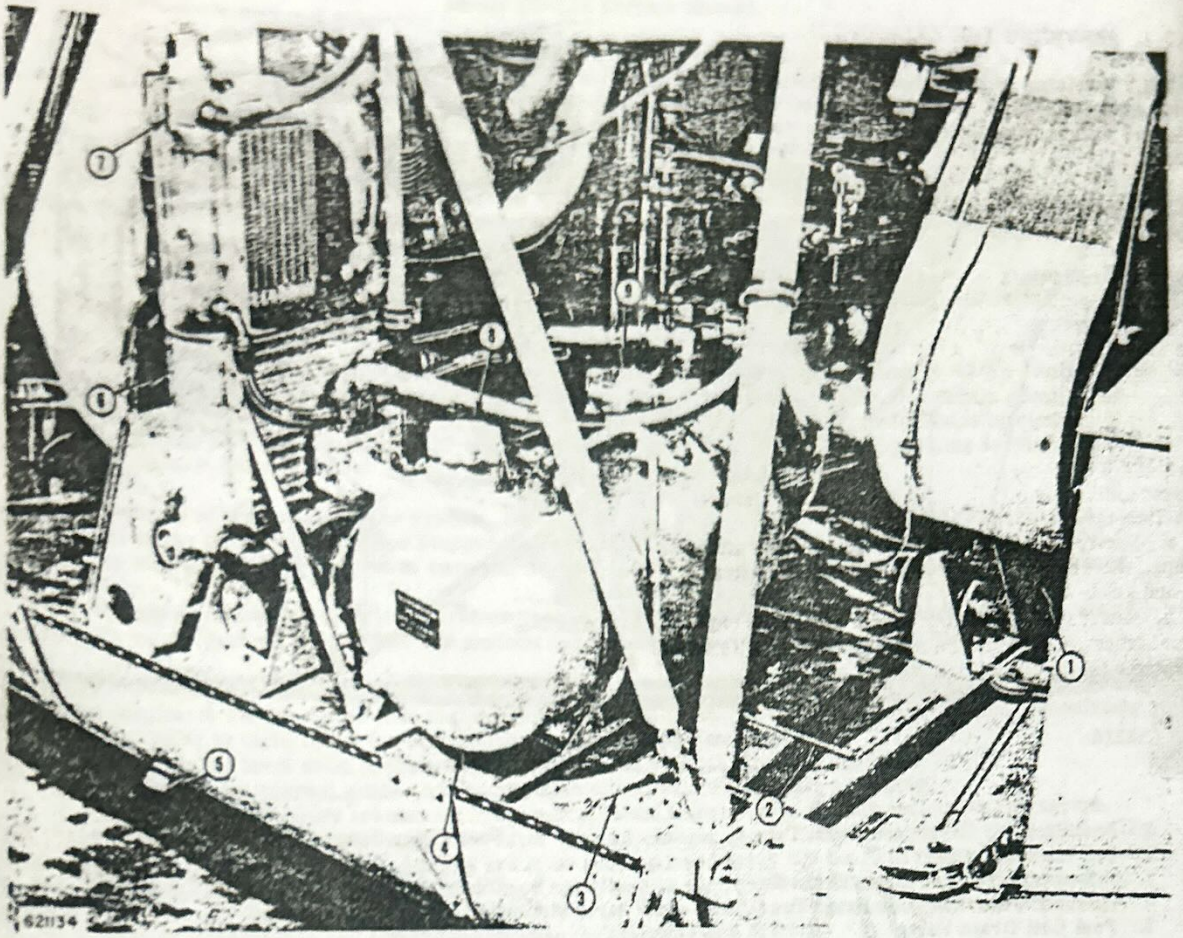
1. External Power Relay
2. External Power Receptacle

Figure 10-15. External Power Receptacle



1. Engine Driven Fuel Pump and Induction System Overboard Drain Lines
2. Electrical Ground Receptacle (fueling)
3. Fuel Tank Filler Cover Plate
4. Engine Mount Electrical Ground Strap
5. Oil Tank
6. Oil Tank Filler Cap
7. Oil Overboard Drain Tube
8. Oil Cooler

Figure 10-16. Servicing Fuel and Oil Systems, Early Configuration



1. Carburetor and Engine Fuel Pump Drain Tube
2. Fuel Tank Filler Cover Plate
3. Engine Mount Electrical Ground Strap
4. Engine and Transmission Oil Tank Assy
5. Oil Overboard Drain Tube
6. Engine Oil Cooler
7. Transmission Oil Cooler
8. Transmission Oil Tank Filler Cap
9. Engine Oil Tank Filler Cap

Figure 10-16A. Servicing Fuel and Oil Systems, Late Configuration

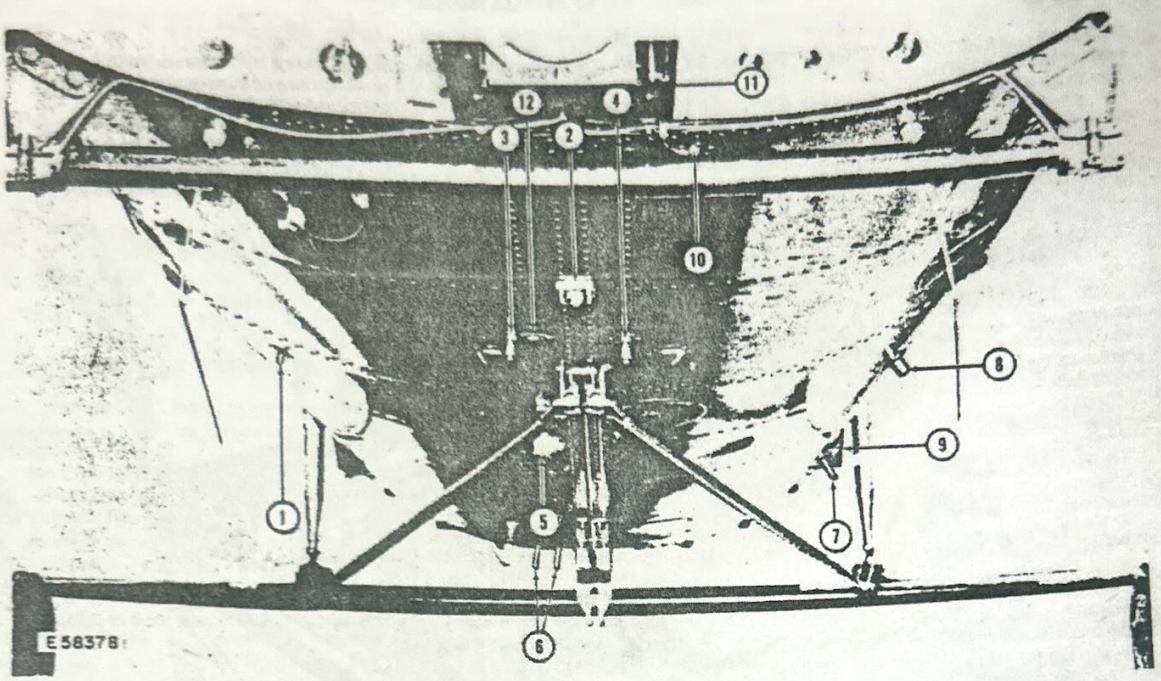
c. Drain the fuel cell, fuel strainer and carburetor filter, as described in paragraph 10-12-5.
d. Keep fuel hose nozzles free of snow, water and dirt.
e. Replace fuel filler cap immediately after each fuel tank servicing. Secure the filler cap well cover plate.
f. A serviced helicopter should be left outside subject to ambient temperatures, whenever possible, to minimize fuel cell condensation.

10-12-5. DRAINING THE FUEL SYSTEM. (See figure 10-17.)
a. Place helicopter on a level surface with the ground handling wheels in the "down" position.
b. Electrically ground the helicopter as described in step j, paragraph 10-8-2.
c. Open the fuel cell drain valve on the bottom side of the basic body at station 70.00.
d. Open the fuel strainer drain valve on the lower outboard side of the fuel strainer.
e. Open the carburetor drain valve located in the tubing on the right-hand aft side of the carburetor.

NOTE: The fuel strainer drains overboard through tubing passing through the basic body at station 68.00. The carburetor drains overboard through the tubing system between the basic body and the tail boom transition section. (See figure 10-17.)

f. Close all drain valves before servicing the fuel system.

10-12-6. REMOVAL OF CONDENSATION MOISTURE. Water present in the fuel system from condensation or other causes shall be drained from the fuel cell and fuel strainer in accordance with the following schedule.



1. Fuel Strainer Overboard Drain Tube
2. Forward Jack Pad
3. Pitot-Static System-Static Drain Tee
4. Manifold Pressure Line Drain Tee
5. Fuel Cell Drain Valve
6. Engine Driven Fuel Pump and Induction Overboard Drain Lines
7. Fuel Filler Scupper Overboard Drain Tube
8. Oil System Overboard Drain Tube
9. Left-Hand Side Jack Pad
10. Pitot Drain
11. Pitot Pressure Tube
12. Pitot-Static Source

Figure 10-17. Draining Provisions

a. Immediately after each flight.
b. 15 minutes after each fuel system servicing.
c. 30 minutes after each removal of helicopter from heated shelter.

NOTE: Condensed moisture is removed by opening the drain valves as described in paragraph 10-12-5.

10-12-7. SERVICING THE LUBRICATION SYSTEM. (See figures 10-16 and 10-16A.)

a. Perform periodic engine and transmission oil changes as required. Refer to paragraphs 10-12-7A, and 10-12-7B for correct specifications and grades of engine and transmission lubricants.

b. After each oil change, verify oil level in oil tank(s) following first engine runup.

NOTE: When auxiliary fuel tanks are installed, engine oil level requirements are changed as listed in table 10-II.

c. Be sure that oil tank filler cap(s) are tightened in place immediately after each servicing.

NOTE: Since the bayonet-type oil filler caps and dip sticks can be inadvertently interchanged between the transmission oil tank and engine oil tank, make sure the correct bayonet-type gage is used when taking oil quantity readings.

d. If an engine and/or transmission is to be stored, observe the preservation requirements of paragraph 10-12-7C.

10-12-7A. SERVICING THE ENGINE OIL SYSTEM. On helicopters with the separated oil system installed, the engine lubrication oil is contained in the right-hand (inboard) section of the dual transmission-engine oil tank. The following instruction outlines the method and frequency of engine oil system servicing.

a. Check oil tank oil level with the bayonet-type oil filler cap gage and replenish as required with the correct specification and grade lubricant recommended in the Operators Manual, Lycoming VO-540 Series Helicopter Engines, Lycoming Service Instruction No. 1014 and other applicable Lycoming directives, to maintain a 7 quart oil supply in those helicopters without separated oil systems and an 8 quart oil supply in helicopters with the separated oil system.

NOTE: During engine break-in period use only aircraft quality straight mineral oil or MIL-C-6529C preservative oil for the first 50 hours of operation.

b. After the first 25 hours of engine operation, drain engine oil system [paragraph 10-12-8]. Refill engine oil tank with 9.3 quarts of oil. Operate the engine for 5 minutes, then refill oil tank to maintain specified oil level. Subsequent oil changes are every 50 hours of engine operation when using mineral base lubricants. Refer to Lycoming Service Instruction No. 1014 prior to using compounded oils, or Lycoming Service Letter No. L147A before using Anderol 456H.

NOTE: Because of trapped oil in the system, the oil tank gage indicates approximately 1 1/2 quarts less oil in the tank with the engine stopped than with the engine operating. For this reason, oil should be added to the tank only when required to bring the oil level to the quantity required in step a above.

c. Whenever subzero ambient temperature operation is anticipated, refer to paragraph 10-12-7B, step f, substep (1) for oil preheating schedule and ambient temperature restrictions for mineral base oils.

10-12-7B. SERVICING THE TRANSMISSION OIL SYSTEM. The transmission lubricating oil is contained in the left-hand (outboard) section of the dual engine-transmission oil tank. For transmission lubricant replenishing information, refer to table 10-IA for lubricating oil, specification and grade.

a. Check the oil level daily in the transmission oil tank with oil filler cap dip stick.

b. Replenish with correct grade and specification to maintain a 4.5-quart oil supply.

c. After the first 25 hours transmission operation, drain transmission oil tank and cooler [paragraph 10-12-8]. Refill tank with 4.5 quarts of oil. After each oil change, verify the oil level in the oil tank after the first engine run-up. Subsequent oil changes are to be accomplished every 500 hours of transmission operation.

d. When changing from straight mineral base lubricants to compounded lubricants, or from compounded lubricants to straight mineral lubricants, completely drain the lubrication system [paragraph 10-12-8]. Do not mix straight mineral oils and compounded oils in the transmission system.

e. Whenever converting from any mineral base oils to synthetic oils (Anderol 456H), the following flushing procedure shall be accomplished.

(1) Drain the transmission oil system.

(2) Add 2.25 quarts of Synthetic Anderol Flushing Oil [table 10-VII] to the transmission oil tank. Operate the engine for a minimum of 10 minutes and a maximum of 15 minutes at 2000 rpm input shaft speed.

(3) Drain flushing oil while hot and clean transmission oil filter element.

(4) Refill transmission oil tank with Anderol 456H. [Refer to step c.]

f. When ever subzero ambient temperature operation is anticipated, engine and transmission oil shall be preheated as follows.

(1) At temperatures of minus (-) 21°C [-6°F] and below: preheat straight mineral, compounded or multiviscosity oils SAE Grade 20 to minus (-) 10°C [+14°F] or above. Do not use SAE Grade 20 lubricants below minus (-) 40°C [-40°F].

(2) At temperatures of minus (-) 27°C [-17°F] and below: preheat Anderol 456H to minus (-) 15°C [+5°F] or above. Do not use Anderol 456H when operating in ambient temperatures below minus (-) 32°C [-25°F].

10-12-7C. STORAGE PRESERVATION REQUIREMENTS FOR LUBRICATION SYSTEM. Whenever an engine and/or transmission, in operating condition, are to be placed in storage, accomplish the preservation procedures contained in the Lycoming Operators Manual for Model VO-540 engines. The following information applies to the UH-12E Series helicopters.

a. Drain engine lubrication system (paragraph 10-12-8) and fill with preservation lubricating oil (table 10-VI, item 2A). Refer to table 10-II for lubrication system oil capacity.

b. If the separated transmission oil system is installed, the transmission oil system shall be prepared for storage by draining and refilling the transmission oil tank with preservation lubricating oil (table 10-VI, item 2) prior to engine preservation ground run.

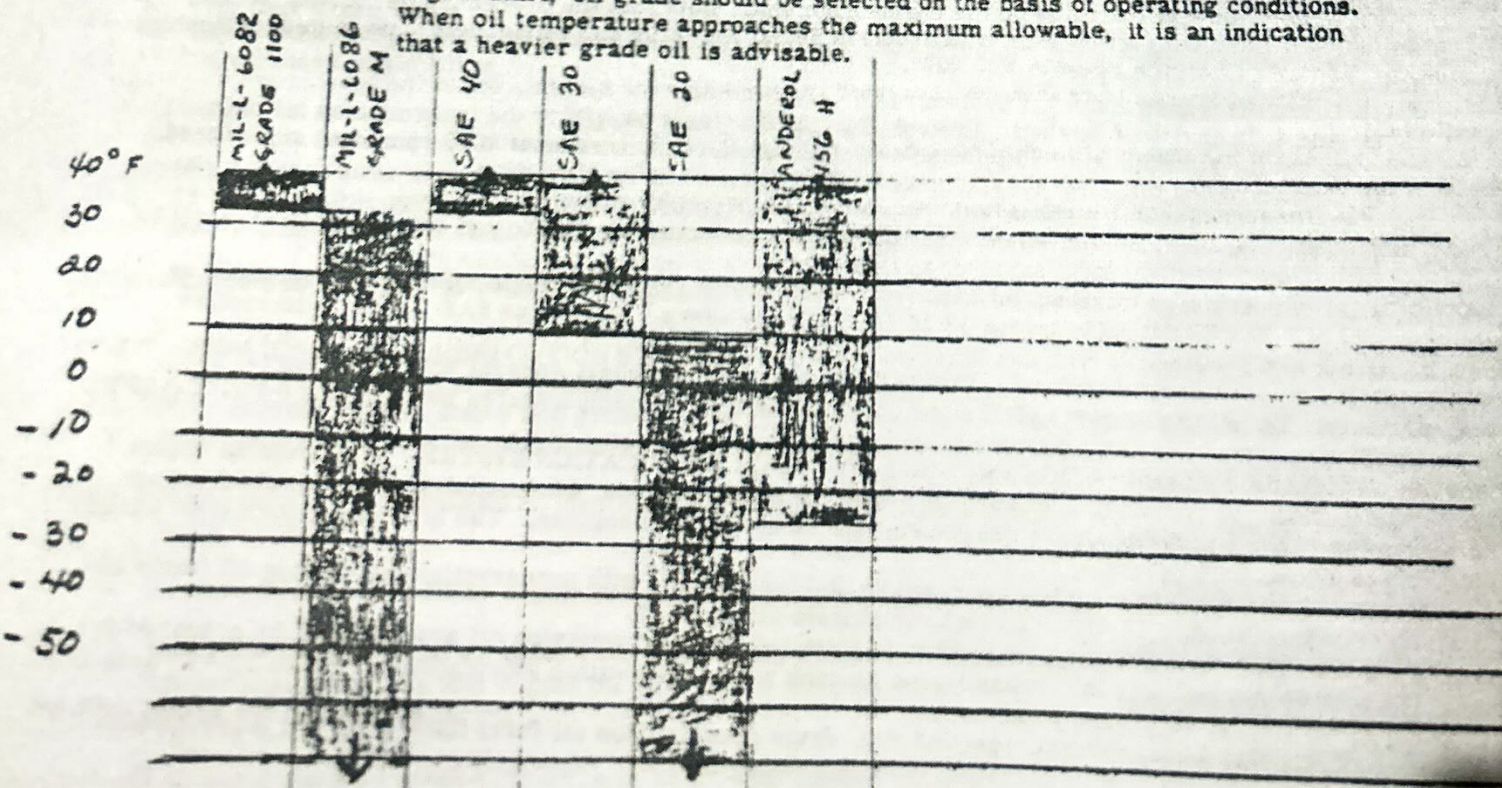
c. Upon completion of preservation ground run, drain preservation oil from the engine and transmission lubrication system(s) and refill with operating lubricant (table 10-II).

Table 10-1A. Transmission Lubrication Requirements (Capacity 4.5 quarts)

Average Ambient Air Temp for Engine Starting [Note 2]	Recommended Lubrication Oil [Note 1]
0°C (+32°F) and above	MIL-L-6082, Grade 1100
0°C (+32°F) and below	MIL-L-6086, Grade M
0° (+32°F) to +32°C (+90°F)	SAE Grade 40
-12°C (+10°F) to +21°C (+70°F)	SAE Grade 30
-12°C (+10°F) and below	SAE Grade 20
-35°C (-25°F) and above	Anderol 456H

NOTE 1: Use straight mineral oils or compounded oils or equivalent multiviscosity oils of aircraft quality.

NOTE 2: Ambient air temperatures are intended only as a general guide. If helicopter is operated in an area much colder or warmer than ambient air temperature at engine start, oil grade should be selected on the basis of operating conditions. When oil temperature approaches the maximum allowable, it is an indication that a heavier grade oil is advisable.



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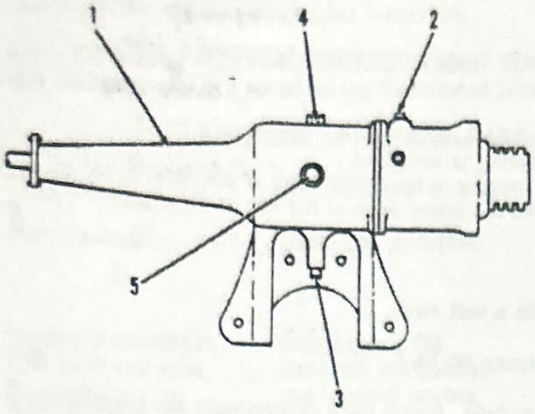

VIEW LOOKING FORWARD

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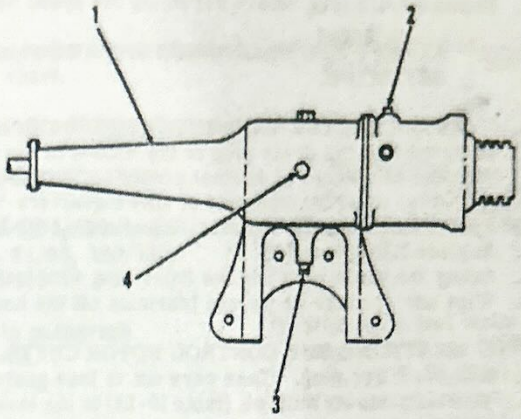


VIEW LOOKING FORWARD

1. Speed Decreaser Housing
2. Vent
3. Drain Plug
4. Filler Plug
5. Oil-Level Sight Gage

Figure 10-18. Servicing the Tail Rotor Speed Decreaser Gear Assembly

10-12-8. DRAINING THE LUBRICATION SYSTEM. (See figures 10-17, 71-1-3, 71-1-3A and 73-1-5.) The lubrication system should be drained at normal operating temperature; it is advisable to operate the engine until operating temperature is indicated on the engine gage unit. Note that the procedure pertaining to the separated transmission oil system applies only to helicopters Serial No. 2199 and subsequent, and to helicopters modified in accordance with Service Bulletin No. 2027.

a. On helicopters equipped with the separated transmission oil system, drain the lubrication system as follows:

(1) Open the transmission oil tank drain valve in the hose line located forward and below the outboard end of the dual oil tank.

(2) Disconnect the transmission oil cooler inlet hose line at the transmission oil pump. Remove the hose line supporting clamps, and swivel the hose so that it drains overboard into a container.

(3) Close drain valve, install hose clamps, and reconnect oil cooler inlet line at the pump before servicing transmission lubrication system.

(4) The engine lubrication system is drained as outlined in paragraph b.

b. Drain the engine lubrication system (all models) as follows:

(1) Open the engine oil sump drain valve in the hose line located at the lower left-hand aft side of the engine.

(2) Open the engine oil tank drain valve in the hose line assembly located forward of the tank assembly, between the oil drain manifold and the engine oil tank.

(3) Disconnect the oil cooler outlet hose line assembly at the oil tank. Loosen the hose attach nut at the oil cooler fitting, and swivel the hose assembly so that it drains overboard into a container.

(4) Close both drain valves and reconnect oil cooler outlet hose at the tank assembly before servicing the system.

10-12-9. DRAINING THE TAIL ROTOR SPEED DECREASER GEAR ASSEMBLY. (See figure 10-18.)

NOTE: The lubricants prescribed for the tail rotor speed decreaser may be satisfactorily drained at ambient temperatures above 0°C (32°F).

a. Use a funnel or splash shield to prevent lubricant from draining into tail boom cavity.
b. Insert splash shield under drain plug.
c. Remove lockwire securing the drain plug and filler plug on the main housing.

d. The helicopter may be tilted back onto the tail skid to facilitate drainage.
e. Replace drain plug before servicing the speed decreaser.

CAUTION: SAFETY THE DRAIN PLUG AND THE FILLER PLUG TOGETHER WITH LOCKWIRE AFTER SERVICING.

10-12-10. SERVICING THE TAIL ROTOR SPEED DECREASER GEAR ASSEMBLY. (See figure 10-18.)
a. Make certain the drain plug in the bottom of the main housing is installed.
b. With the helicopter in normal ground attitude, fill gear housing to the lower edge of the filler hole, or where applicable, to within one-half or three-quarters-inch above the lower edge of the visual sight gage. Use specified petroleum base gear lubricating oil (table 10-IA).
c. Replace filler plug.
d. Safety the drain plug and the filler plug with lockwire.
e. Wipe any spillage or excess lubricant off the housing with a soft cloth.

10-12-11. SERVICING THE CONTROL ROTOR CUFFS. (See figure 10-19.)
a. Remove filler plug. Take care not to lose gasket.
b. Fill cuffs slowly with oil (table 10-IA) to the level of filler hole, taking care to eliminate any trapped air. Allow sufficient time for the oil to flow through the cuff and into the hollow trunnion.
c. Install gasket and filler plug. Safety filler plug with lockwire.

NOTE: Recheck oil level of the cuffs after the first run-up. If necessary, add oil as directed in step b above.

10-12-12. SERVICING THE TAIL ROTOR HUB AND YOKE ASSEMBLY. (See figure 10-19.)
a. Remove filler plug. Rotate tail rotor until it is horizontal.
b. Fill yoke with oil (table 10-IA). Rotate tail rotor to vertical position with filler hole at top to allow any excess oil to drain from yoke. Install filler plug and secure with lockwire.
c. Repeat steps a and b on opposite yoke.
d. For grease lubricated hubs: fill cavity through grease fittings until new grease appears at seals.

10-13-1. SERVICING THE BATTERY. Refer to Section 83.

10-14-1. SPECIAL SERVICE NOTES. Refer to table 10-IA and to figures 10-19 through 10-20A.

10-14-1A. SPECIAL SERVICING REQUIREMENTS. Refer to table 10-IA and to figures 10-19 through 10-20A for special servicing requirements and specifications.

10-15-1. LUBRICATION REQUIREMENTS.

10-15-1A. Lubrication requirements are listed in table 10-IA and illustrated in figures 10-19 through 10-20A. Commercial equivalents for specified lubricants identified in the figures are listed in table 10-VII.

10-15-2. No single factor in maintenance is more important to the satisfactory performance of the helicopter than correct lubrication. The illustrated lubrication charts (figures 10-19 through 10-20A) specify the points of application, frequency of service, and specified lubricants. Except as noted on the charts, there is no authorized deviation from required specifications and grades of lubricants; acceptable commercial equivalents are listed in table 10-VII. General requirements applicable to all UH-12E models are illustrated in figure 10-19; installations peculiar to the four-place configuration are presented in figure 10-20; and optional kit installations that may be installed on either configuration are shown in figure 10-20A.

CAUTION: FREQUENCY OF APPLICATION IS INTENDED AS A MINIMUM SERVICE REQUIREMENT WHEN OPERATING THE HELICOPTER UNDER NORMAL CONDITIONS. WHEN ADVERSE OPERATING CONDITIONS PREVAIL OR ARE ENCOUNTERED (SUCH AS EXCESSIVE DUST, ETC.), THE FREQUENCY RATE SHOULD BE REVISED DOWNWARD, AS REQUIRED, TO MAINTAIN SATISFACTORY LUBRICATION.

10-15-3. HAND PACKING, BRUSHING AND OIL CAN APPLICATION. Thoroughly clean the parts to be lubricated with dry-cleaning solvent. Do not use excessive amounts of lubricant. After applying lubricant, wipe excess or spillage from adjacent parts.

10-15-4. ZERK AND ALEMITE FITTINGS APPLICATION. Wipe the fittings and the adjacent areas free of dirt or grease accumulations before applying fresh lubricant. Keep the grease gun nozzle free of dirt and water or other contaminants. Do not use excessive amounts of lubricant. Wipe off excess grease forced through bearings.

10-15-5. GREASE AND OIL SEALS. Inspect all grease and oil seals at each lubrication period for evidence of leakage or defects. Tighten securing clamps or replace seals as necessary. Wipe dirt and dust accumulations from seals following each lubrication to facilitate inspection at next subsequent lubrication.

0-15-6. OSCILLATING BEARING OPERATION. Bearings which operate only in an oscillating motion are subject to fretting corrosion. Bearing life may be extended by disconnecting linkage and rotating the bearings pproximately 180 degrees at regular intervals.

0-15-7. EXTREME WEATHER LUBRICATION. Special lubrication requirements imposed by severe dust, eat and extreme cold are noted on the illustrated lubrication chart.

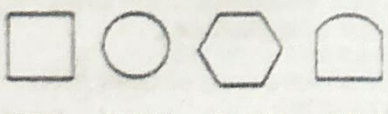
Table 10-1A. Servicing Requirements and Specifications

SYSTEM OR ITEM	AGENT	SPECIFICATION	CAPACITY
Fuel Tank(s)	Gasoline, Aviation	MIL-G-5572, Grades 80/87, 91/96, 100/130, or 115/145	46 US gal (38.3 Imp. gal, 174.1 liters)
Engine-Helicopters S/N 2199 and subq, or after Service Bulletin 2027	Lubricating Oil, Aircraft reciprocating (piston) engine	Refer to paragraph 10-12-7A.	(1) With main fuel tanks only: 8.0 US qts (6.67 Imp. qt, 7.57 liter) (2) With main plus auxiliary fuel tanks: 11.0 US qt (9.18 Imp. qt, 10.41 liters)
Engine-Helicopters prior to S/N 2199 or Service Bulletin 2027	Lubricating Oil, Aircraft reciprocating (piston) engine	As above	(1) With main fuel tanks only: 9.3 US qts (7.76 Imp. qt, 8.79 liters) (2) With main plus auxiliary fuel tanks: 12.3 US qt (10.2 Imp. qt, 11.61 liters)
Transmission - Helicopters S/N 2199 and subq, or after Service Bulletin 2027	Lubricating Oil, Aircraft reciprocating (piston) engine	Aero-Shell W, Grade 80 (SAE 40); Esso E-80 (SAE 40); MIL-L-6082, Grade 1065 (SAE 30); Aero-Shell W, Grade 65 (SAE 20W/30); Mobiloil Aero Gold Band (SAE 20-20W); Anderol 456 H.	4.5 US quarts (3.75 Imp. qt, 4.26 liters)
Oil Pressure Gage (instrument pressure line)	Lubricating Oil, internal combustion engine	MIL-L-2104, Grade 10 (SAE 10)	1/2 pint (approximately)
	Kerosene (for cold weather operation)	VV-K-211	1/2 pint (approximately)
Tail Rotor Speed Decreaser Gear Assy	Lubricating oil, gear, petroleum base	MIL-L-6086, Grade M or L	To edge of filler hole, or 1/2 to 3/4 inch above bottom of sight gage, as applicable
Control Rotor Cuff and Trunnion Assy	Lubricating oil, gear petroleum base	MIL-L-6086, Grade L	To level of filler hole
	Hydraulic Fluid, petroleum base, aircraft and ordnance	MIL-H-5606	To level of filler hole
Tail Rotor Hub and Yoke Assy	Lubricant, gear, universal	MIL-L-2105, Grade 90 or 75	To edge of filler hole
	Grease, Helicopter Oscillating Bearing)	MIL-G-25537	Fill cavity until new new grease appears at seals

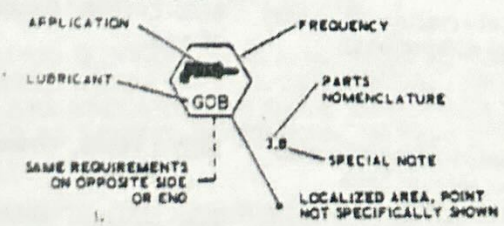
TABLE 10-II. LUBRICANTS AND SYMBOLS

Identification Letter	Specification	Lubricant
FG	MIL-G-6711	Graphite, Lubricating
GB	MIL-L-7711	Lubricating Grease, (General Purpose Aircraft)
GH	MIL-G-3545C	Grease, Aircraft, High Temperature
GLT	MIL-G-23827	Grease, Aircraft and Instrument (Low and High Temperature)
GO	MIL-L-2105	Lubricant, Gear, Universal
GOB	MIL-G-25537	Grease, Helicopter, Oscillating Bearing
GRG	MIL-G-6032	Lubricating Grease, Gas and Oil Resistant
GSG	MIL-G-23827	Grease, Aircraft Gear and Actuator Screw (Low and High Temperatures)
GWT	Braycote 660 AMS-5 MIL-G-81322 (Alt)	Grease, Aircraft; Ball and Roller, Wide Temperature Range
OEA	MIL-L-6082 Aero Shell W, or ESSO E-80 (SAE 40)	Lubricating Oil, Aircraft Reciprocating (Piston) Engine (Grade as specified in General Service
OGP	MIL-L-7870	Lubricating Oil, General Purpose (Low Temperature)
OGR	MIL-L-6086	Lubricating Oil, Gear, Petroleum Base, Grades L and M
OHA	MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance
SPL-1	630AA	Lubriplate
SPL-2	SAE-20/20W	Oil Aircraft Engine (Noncompounded)
SPL-4	Anderol 456H	Synthetic Multi-Purpose Oil

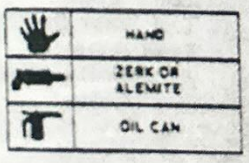
FREQUENCY SYMBOLS



EXAMPLE



APPLICATION SYMBOLS



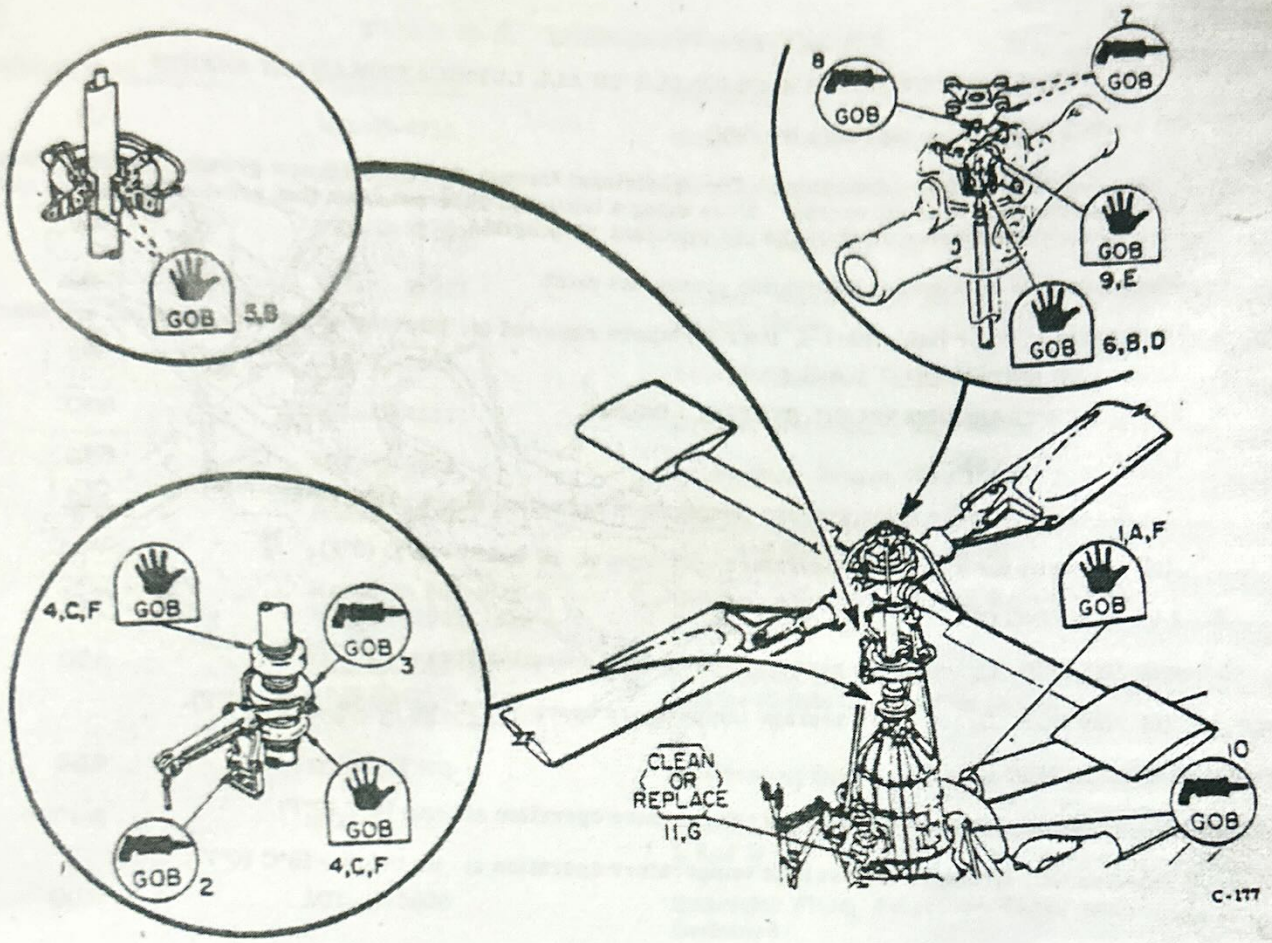
GENERAL SERVICE NOTES APPLICABLE TO ALL LUBRICATION CHART SHEETS

1. GB or GSG is alternate lubricant for GOB.
2. Clean all fittings before lubricating. Force lubricant through fittings until new grease appears at part being lubricated. Wipe off excess. When using a lubricant different from that previously applied, purge thoroughly to remove as much of the old lubricant as possible.
3. Applicable only if pressure lubrication provisions exist.
4. Use grease injector (table 92-1-I, item 29) where required for lubricating bellcrank and rod end bearings.
5. AIRCRAFT ENGINE OIL. Deleted.
6. SEPARATE TRANSMISSION OIL SYSTEM. Deleted.
7. LUBRICATING OIL
   (a) Use OGR, Grade L for average temperature operation above -18°C (0°F).
   (b) Use OHA for average temperature operation at, or below -18°C (0°F).
8. LUBRICATING OIL
   (a) Use OGR, Grade M for average temperature operation above -18°C (0°F).
   (b) Use OGR, Grade L for average temperature operation at, or below -18°C (0°F).
9. LUBRICATING OIL
   (a) Use GO, Grade 90 for average temperature operation above -18°C (0°F).
   (b) Use GO, Grade 75 for average temperature operation at, or below -18°C (0°F).

SYSTEMS LOCATIONS - LUBRICATION CHARTS

System	Figure 10-19 Sheet No.	Figure 10-20 Sheet No.	Figure 10-20A Sheet No.
Basic Body	3		
Cargo Hook			2
Flight Controls	2 and 6	1 and 2	1
Power Plant	3 and 5	1	
Rescue Hoist			3
Rotor Brake			2
Tail Rotor Drives	4 and 6	1	
Transmission	2, 3 and 5		
Winslow Oil Filter			3

Figure 10-19. Lubrication Chart (sheet 1 of 6)



SPECIAL SERVICE NOTES

A. Remove boot clamp from large end of boot, slide boot off housing, and hand pack slip joint with grease. Do not fill boot with grease. Reinstall boot and clamp after greasing.

B. Clean and repack bearings as required.

C. Remove boot clamps and apply a thin film of grease to sliding surface between mast and ring at top and bottom.

D. Clean and repack rod end bearing whenever main rotor head is removed. (See General Service Note No. 3).

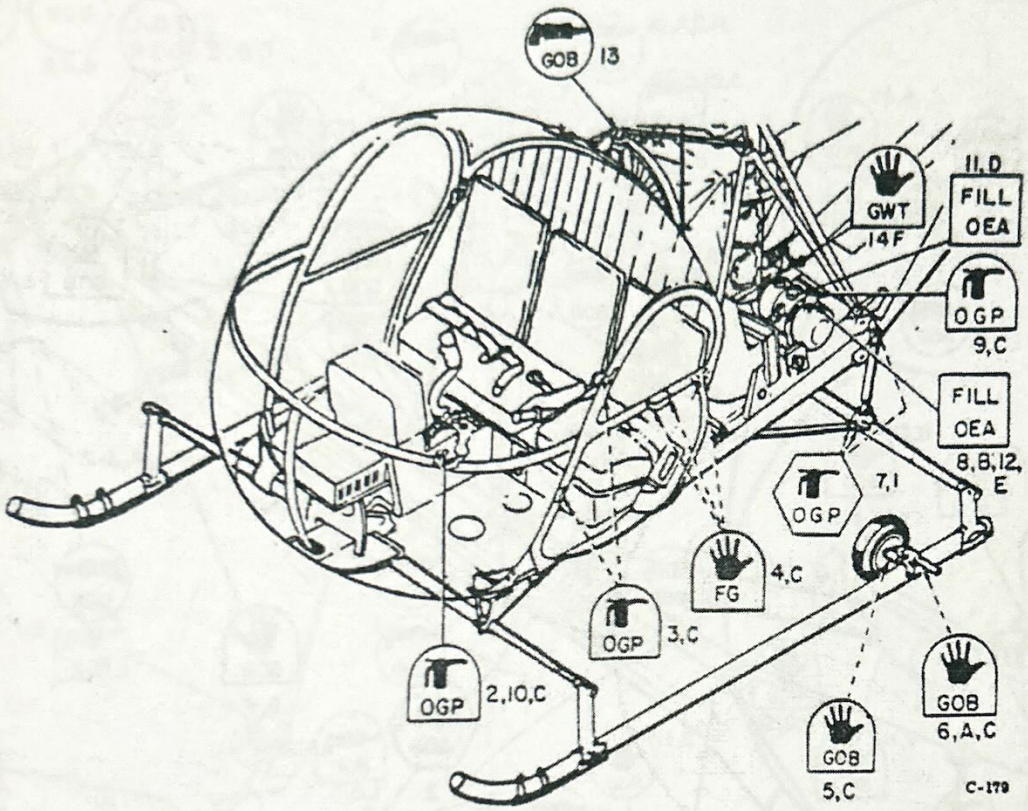
E. Apply grease to splines and fitting prior to installation to prevent seizing of mating parts.

F. Lubricate every second 100 hours.

G. Remove and clean reusable element in mineral base solvent with soft bristle brush. Replace disposable element.

1. Slip Joint Assembly
2. Collective Pitch Yoke Support Bushing
3. Collective Pitch Ring Assembly Bearing
4. Collective Pitch Bearing Sleeve
5. Wobble Plate Gimbal Ring Bearings
6. Rod End Bearings
7. Ballast Arm
8. Ballast Rod Bushings
9. Splined Fitting
10. Engine Mount Support Bearing
11. Transmission Oil Filter

Figure 10-19. Lubrication Chart (sheet 2 of 6)



SPECIAL SERVICE NOTES

A. Remove pin and wipe shank with grease. Reinstall pin.

B. Refer to paragraph 10-12-7A.

C. Lubricate as required.

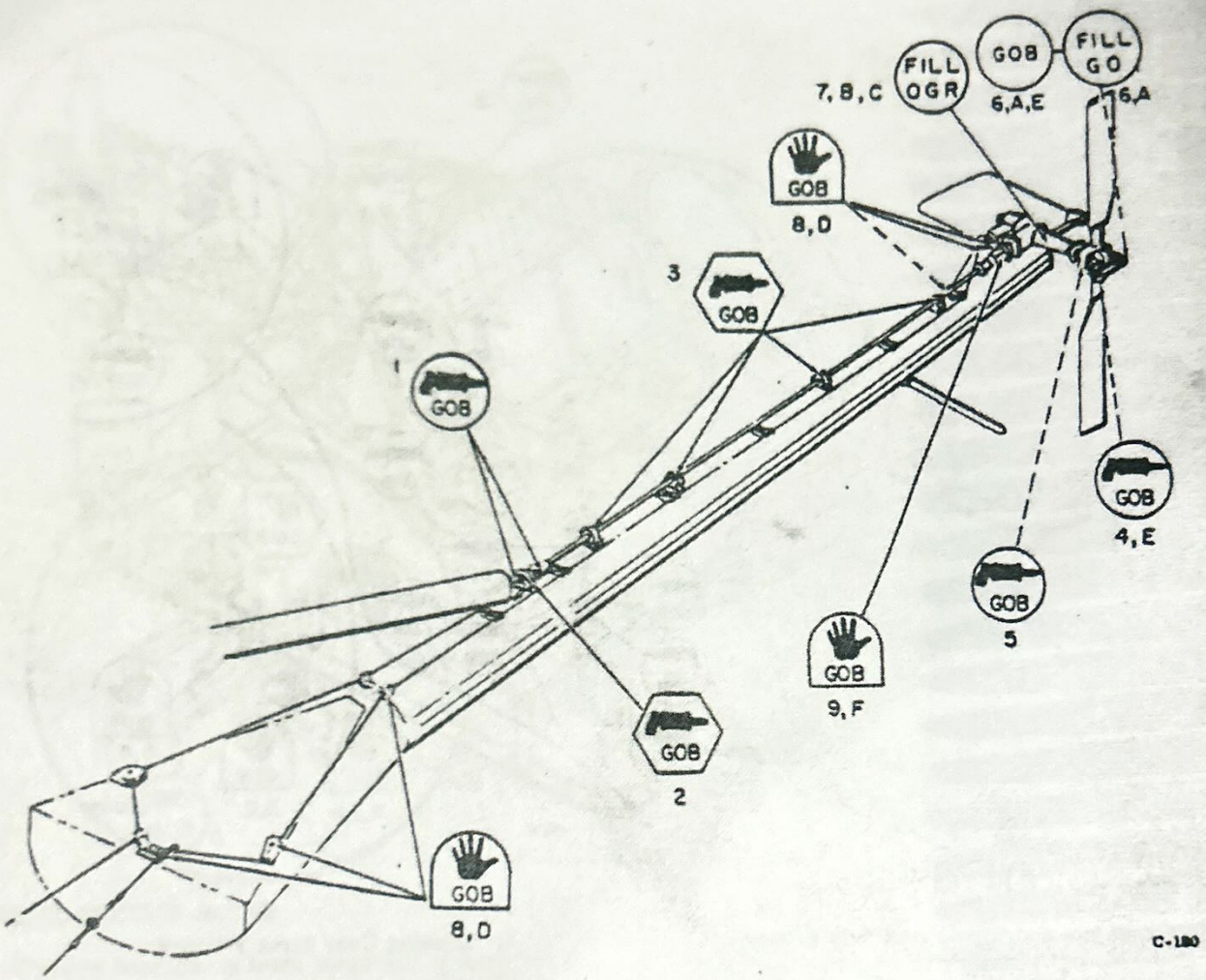
D. Special Service Note B applies to helicopters equipped with transmission separate oil system except: maintain engine stopped oil level at 8 qt.

E. Refer to paragraph 10-12-7B.

F. Fill seal cavity with grease at initial installation and each pump replacement.

1. Landing Gear Strut Fittings
2. Engine Control Quadrant
3. Door Hinges
4. Door Latches
5. Wheel Bearings
6. Wheel Support Shank
7. Landing Gear Rod End Bearings
8. Engine Oil Tank
9. Fuel Filler Access Door Hinge
10. Control Cable Clevis Fittings
11. Engine Oil Tank, Separated Oil System
12. Transmission Oil Tank, Separated Oil System
13. Engine Mount Support Bearing
14. Transmission Oil Pump Seal Cavity

Figure 10-19. Lubrication Chart (sheet 3 of 6)



SPECIAL SERVICE NOTES

A. Fill with blades in horizontal position; then place blades in vertical position to check oil level. Tighten plug finger tight. For grease lubricated hub: fill cavity through grease fitting at each end of hub until new grease appears at seals.

B. With helicopter in normal ground attitude, fill speed decreaser gear assy to edge of filler plug hole, or (if applicable) to 1/2 to 3/4 inch above bottom of sight gage level.

C. Drain, check for metal particles, and refill every 100-hour inspection.

D. Clean and repack bearings as required.

E. Do not force grease seals out of position by using excessive grease pressure.

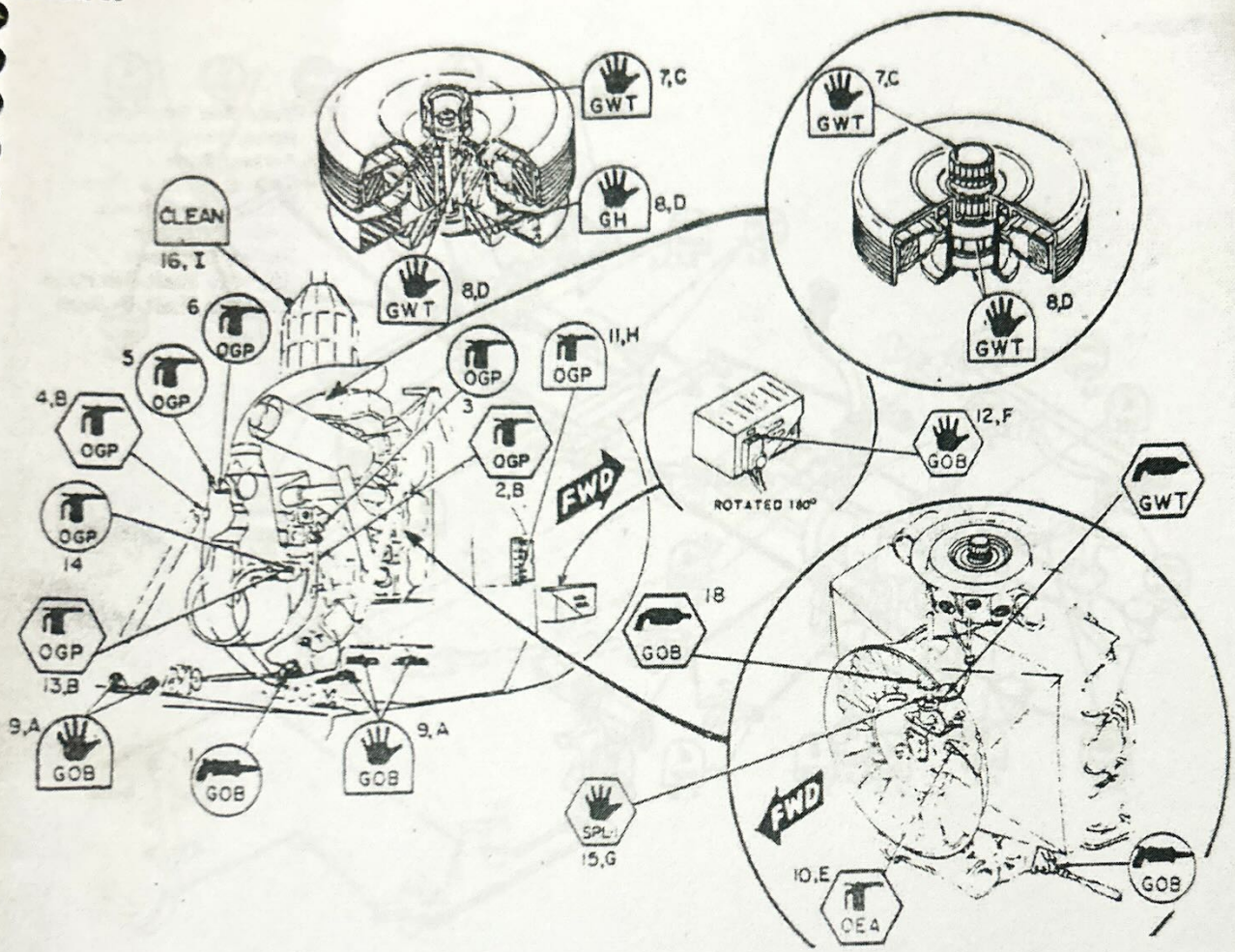
F. Remove boot clamp from large end of boot. Slide boot off housing and hand pack slip joint with grease. Do not fill boot with grease. Reinstall boot and clamp after greasing. Lubricate every second 100-hour inspection.

1. Universal Joint
2. Cardan Joint
3. Aft Drive Shaft Support Bearings
4. Blade and Yoke Bearings
5. Pitch Change Rod End Bearings (See General Service Note No. 3.)
6. Hub and Yoke Assy Bearings (See General Service Note No. 9.)
7. Speed Decreaser Gear Assy (See General Service Note No. 8.)
8. Pulley Bearings
9. Aft Slip Joint Assy

Figure 10-19. Lubrication Chart (sheet 4 of 6)

Figure 10-19. Lubrication Chart (sheet 5 of 6 continued)

1. Bellcrank Bearings
2. Rod End Bearings
3. Pillow Block Bearings
4. Torque Tube Bearings
5. Cyclic Stick Yoke Bearings
6. Wobble Plate Bearings
7. Pylon Yoke Bearings
8. Scissors Bearings
9. Control Rotor Bearings (See General Service Note No. 7)
10. Gimbal Ring Bearings
11. Trim Spring Rod
12. Trim Spring Support Bolt
13. Trim Spring Housing
14. Trim Spring Rod Clevis Fitting
15. Throttle Control Assembly Cam
16. Collective Pitch Shaft Support Bearings
17. Friction Block Bearing
18. Yoke Pivot Bushings
19. Yoke End Bushings
20. Rotor Fork Bearings
21. Ballast Link
22. Throttle Cable Fittings
23. Cable Connections
24. Pedal Bearings
25. Pulley Bearings
26. Throttle Shaft Bearings
27. Throttle Shaft U-Joint



SPECIAL SERVICE NOTES:

A. Clean and repack bearings as required.

B. Wipe exposed portions of engine control cable wires with oil.

C. Coat splines on shaft and/or housing with the specified grease at each clutch, transmission or engine change.

D. Repack bearing with specified grease at each clutch or engine change.

E. Drain trapped oil and inspect for metal particles every 100-hour inspection. Refill with specified engine oil to level of outlet port prior to operating.

F. Wipe thin film of grease onto battery disconnect plug locking cam.

G. Clean old lubricant from input seal oil cavity with a soft cloth or paper wipes. Repack to fill cavity with Lubriplate 630-AA.

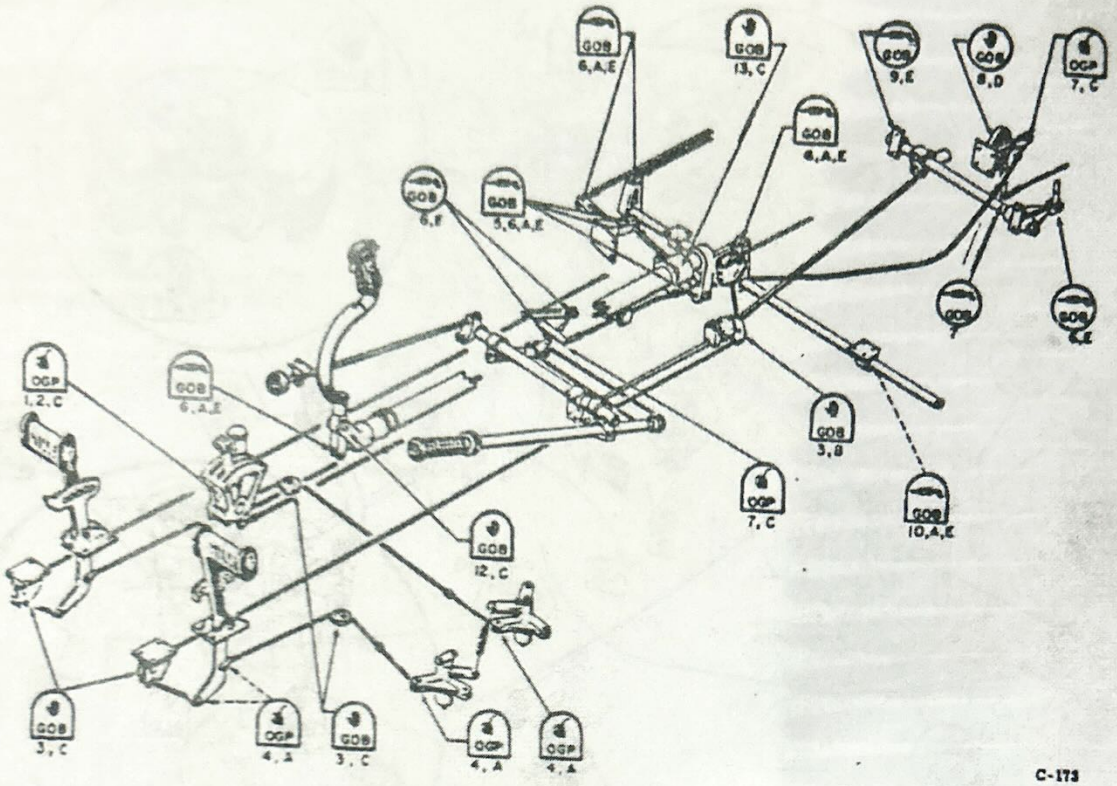
H. Lubricate as required.

I. Clean vent valve every 500 hours.

J. Lubricate both grease fittings until old lubricant is forced from ends of fitting.

1. Snubber Rod End Bearings
2. Throttle Control Cable
3. Throttle Cable Fitting
4. Carburetor Heat Control Cable
5. Carburetor Heat Control Cable Fitting
6. Carburetor Heat Control Valve Hinge
7. Intermediate Shaft and/or Clutch Housing
8. Main Drive Clutch Bearing
9. Pulley Bearings
10. Cooling Fan Gear Box
11. External Power Receptacle Cover Hinge
12. Battery Disconnect Plug
13. Mixture Control Cable
14. Mixture Control Cable Fitting
15. Cooling Fan Gear Box Oil Seal Input Shaft
16. Transmission One-Way Vent Valve
17. Lower Cooling Fan Drive Fitting
18. Cooling Fan Drive Flexible Coupling Shaft

Figure 10-19. Lubrication Chart (sheet 6 of 6)



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SPECIAL SERVICE NOTES

A. Lubricate every second 100-hour inspection.

B. Clean and repack as required.

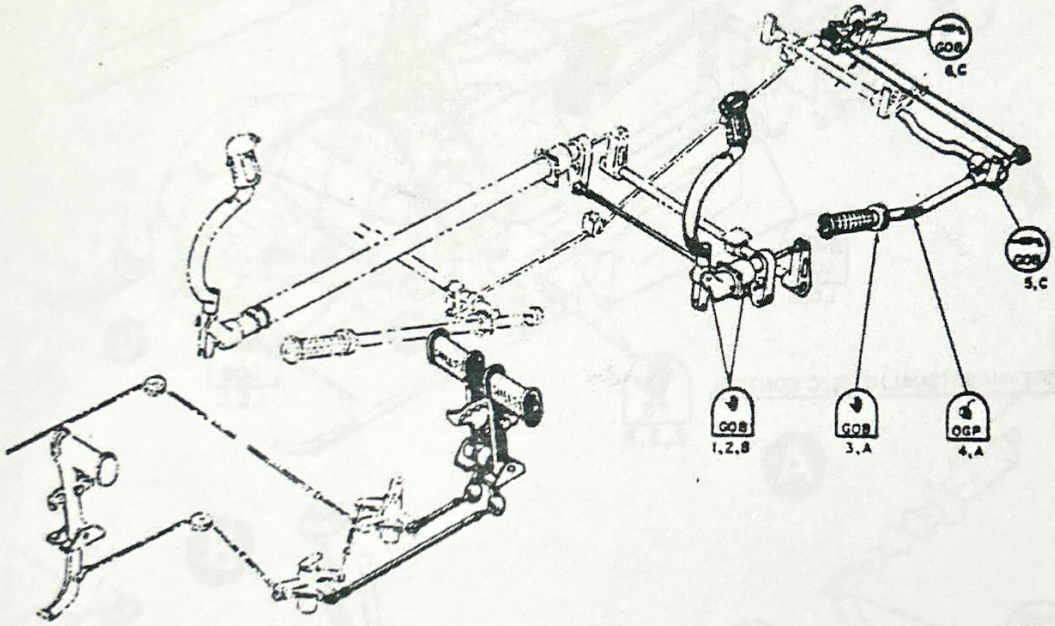
C. Lubricate as required.

D. Remove snap cover and pack cavity with grease. Reinstall cover.

E. Refer to General Service Note No. 3, figure 10-19, sheet 1.

1. Engine Control Quadrant
2. Control Cable Clevis Fittings
3. Pulley Bearings
4. Tail Rotor Cable Connections
5. Bellcrank Bearings
6. Rod End Bearings
7. Throttle Cable Fittings
8. Throttle Control Assy Cam
9. Collective Pitch Shaft Support Bearings
10. Pillow Block Bearings
11. Deleted
12. Cyclic Stick Yoke Bearings
13. Torque Tube Bearings

Figure 10-20. Lubrication Chart, Cyclic and Collective Controls, Four-Place Configuration (Sheet 1 of 2)



SPECIAL SERVICE NOTES:

A. Lubricate as required.

B. Clean and replace as required.

C. See General Service Note No. 3, figure 10-19.

1. Torque Tube Bearings
2. Cyclic Stick Yoke Bearings
3. Collective Stick Throttle Shaft Bearings
4. Collective Stick Throttle Shaft
5. Collective Pitch Shaft Support Bearings
6. Rod End Bearings

Figure 10-20. Lubrication Chart, Cyclic and Collective Controls, Four-Place Configuration
(Sheet 2 of 2)
February 1963

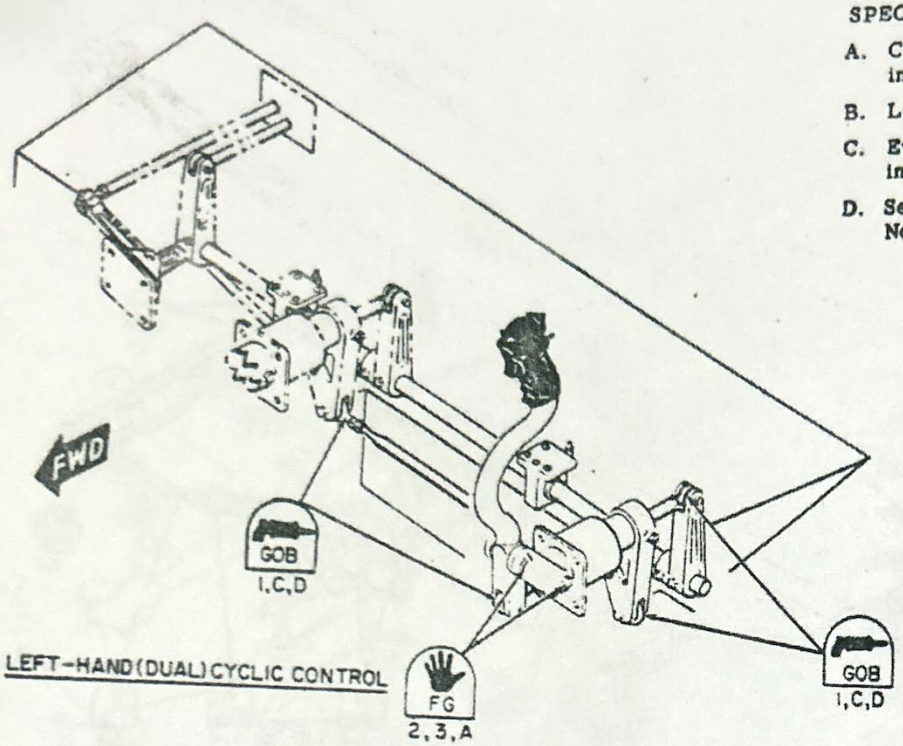
SPECIAL SERVICE NOTES:

A. Clean and repack bearings as required.

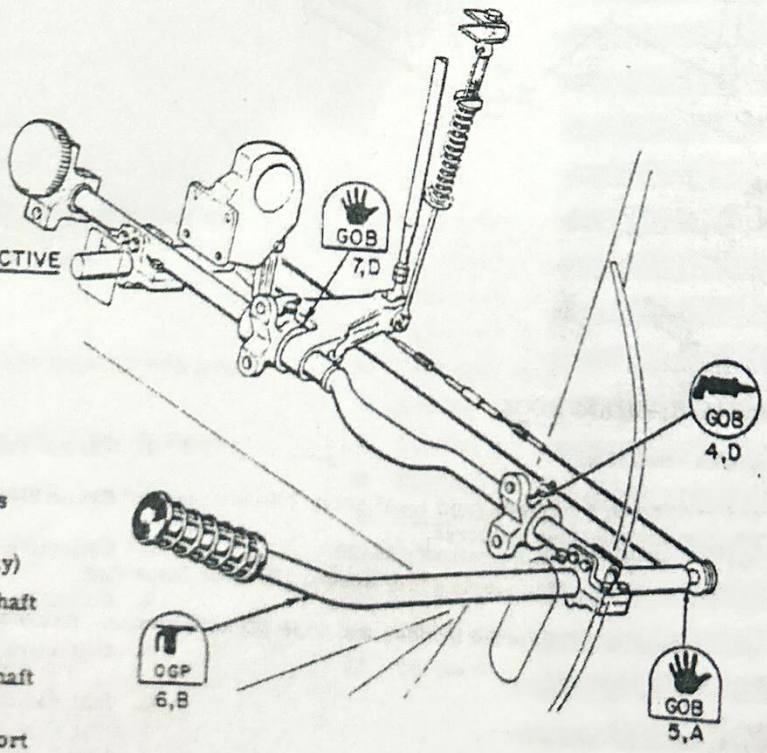
B. Lubricate as required.

C. Every second 100-hour inspection.

D. See General Service Note No. 3, figure 10-19.



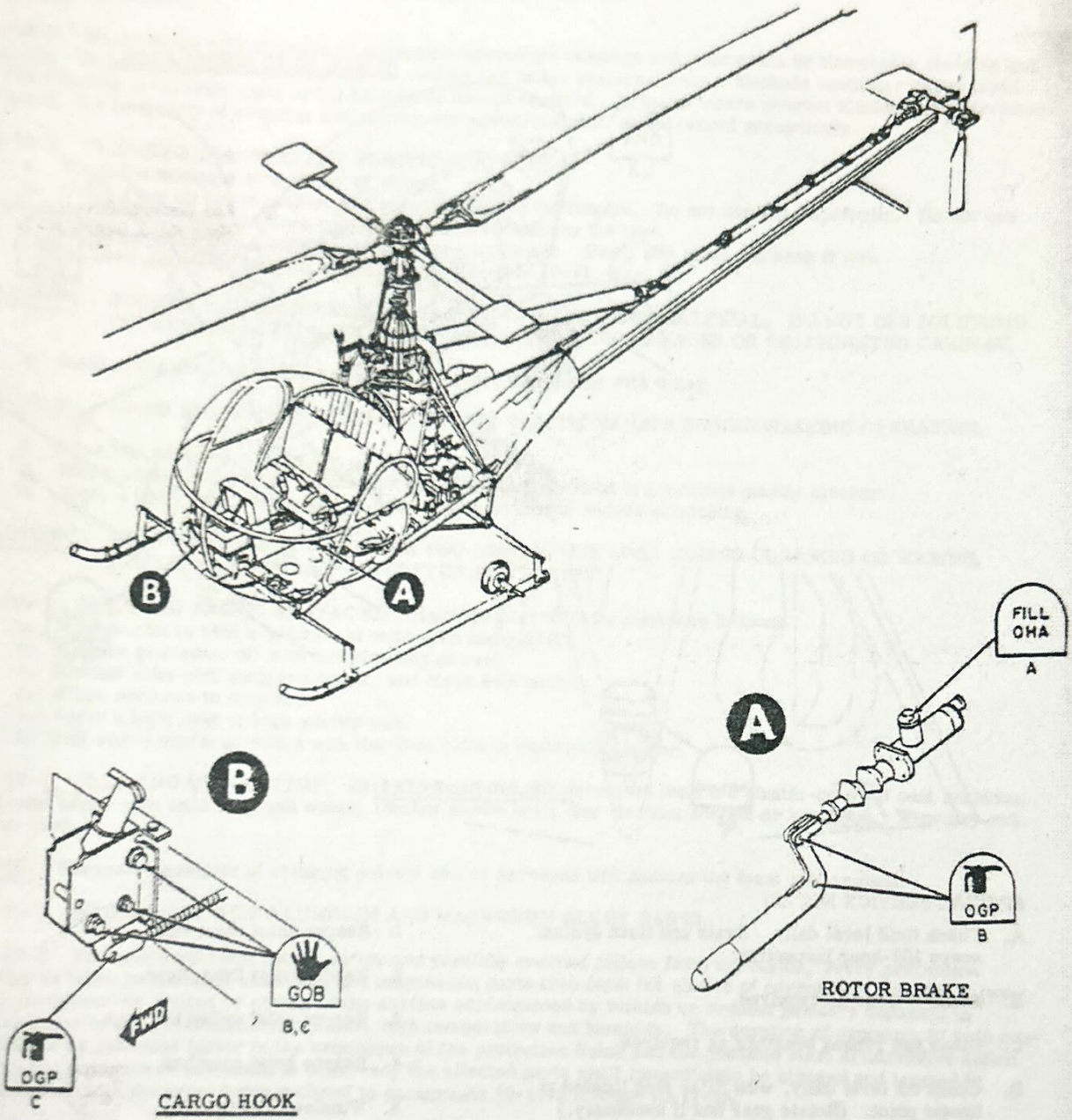
LEFT-HAND (DUAL) CYCLIC CONTROL



OUTBOARD (DUAL) COLLECTIVE CONTROL

1. Rod End Bearings
2. Torque Tube Bearings
3. Cyclic Stick Yoke Bearings
4. Stub Shaft Bearing (Left position Controls Only)
5. Collective Stick Throttle Shaft Bearing
6. Collective Stick Throttle Shaft U-Joint
7. Collective Pitch Shaft Support Bearing

Figure 10-20A. Lubrication Chart, Optional Kit Equipment (sheet 1 of 3)



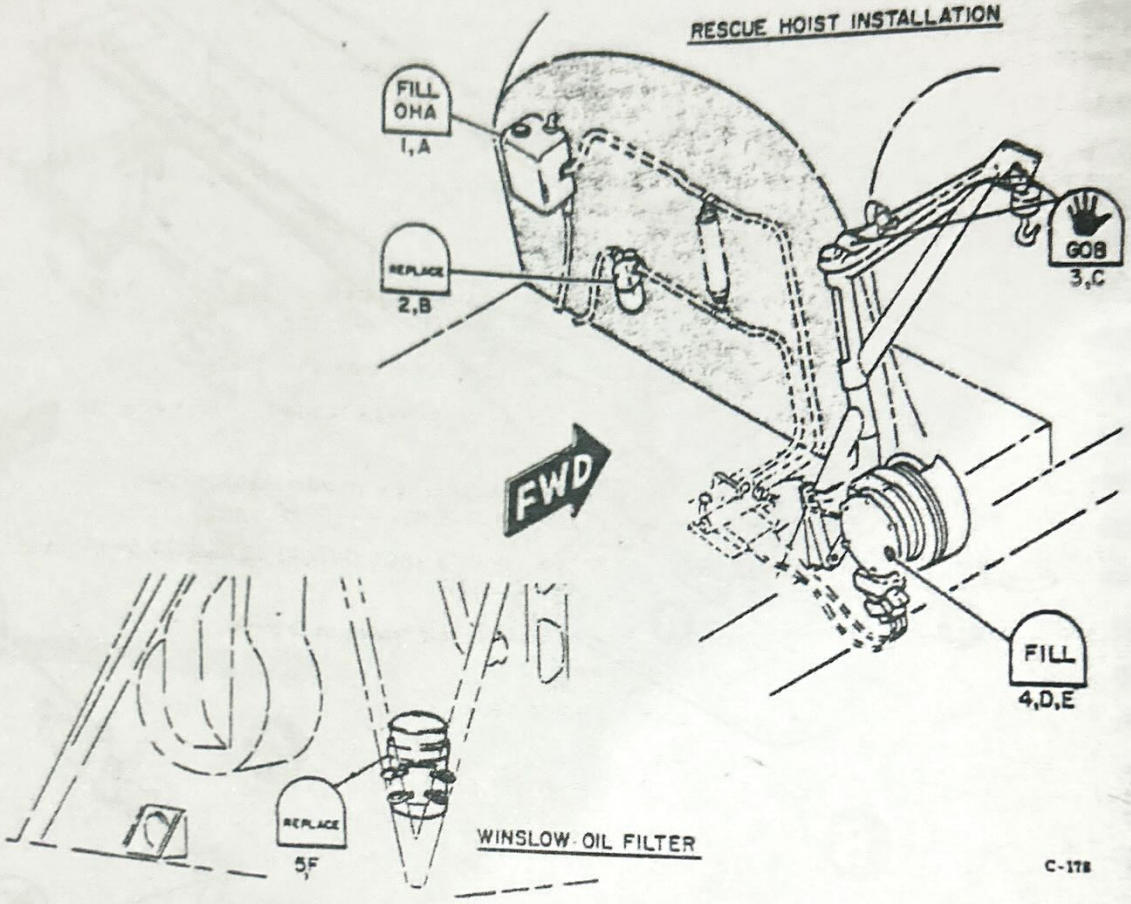
SPECIAL SERVICE NOTES

A. Check fluid level every 100-hour inspection. Drain, flush and refill as required.

B. Lubricate every second 100-hour inspection.

C. Remove bushing and wipe OD with grease. Reinstall bushing.

Figure 10-20A. Lubrication Chart, Optional Kit Equipment (sheet 2 of 3)



SPECIAL SERVICE NOTES:

A. Check fluid level daily. Drain and flush system every 100-hour inspection.

B. Replace filter as required.

C. Clean and repack bearings as required.

D. Check oil level daily, with filler plug located at lowest point. (Rotate gear box if necessary.)

E. For average temperature operation above 0°C (32°F); use 250 cc Socony Mobiloil Compound DD mixed with 20 cc Alpha Molykote.
For average temperature operation at or below 0°C (32°F): use Socony Mobiloil 10W-30.

F. Replace with Winslow Aero Filter (P/N 1A0286):
(1) After 50 hours operation under normal operating conditions.
(2) When oil condition is poor due to engine condition; minor part failure and/or repair; or as required by severe operational conditions.

1. Rescue hoist reservoir.
2. Rescue hoist fluid filter.
3. Rescue hoist pulley bearings.
4. Rescue hoist gear box.
5. Winslow Oil Filter.

Figure 10-20A. Lubrication Chart, Optional Kit Equipment (sheet 3 of 3)
Changed September, 1965

10-16-1. CLEANING.

10-16-2. Maintain the effectiveness of corrosion-preventive coatings and treatments by thoroughly cleaning and rinsing. To prevent deterioration, keep all rubber and fabric surfaces clean. Methods customarily employed in the cleaning of aircraft apply to the helicopter except as noted. In areas where unusual atmospheric corrosion is noted, the frequency of cleaning and preserving operations shall be increased accordingly.

10-16-3. CLEANING TRANSPARENT PLASTIC SURFACES.

a. Flush the surfaces with plenty of water.
b. Gently free all caked mud or dirt with the pads of the fingers. Do not use the fingernails. Do not use sponges or cloths. Rinse the area continuously while removing the mud.
c. Wash surfaces with a solution of mild soap and water. Use a soft cloth and keep it wet.
d. Remove grease or oil with aliphatic naphtha (table 10-VI, item 4).

CAUTION: DO NOT USE COMPOUNDS CONTAINING ANY ABRASIVE MATERIAL. DO NOT USE SOLUTIONS CONTAINING ESTERS, KETONES, AROMATIC HYDROCARBONS OR CHLORINATED CARBONS.

e. Rewash the area with soap and water and rinse thoroughly with water.

CAUTION: AVOID EXCESSIVE SCRUBBING OF THE PLASTIC PANELS DURING WASHING OPERATION.

f. Allow the surfaces to drip dry.
g. Minor scratches may be reduced or removed by application of a suitable plastic cleaner.
h. Apply a light coat of high quality wax to the surfaces to reduce scratching.

CAUTION: AVOID RUBBING TOO HARD OR TOO LONG IN ONE AREA DURING CLEANING OR WAXING. FRICTION HEAT TENDS TO SOFTEN THE PLASTIC.

10-16-4. CLEANING FABRIC SURFACES. Clean the control rotor blades as follows:

a. Wash surfaces with a solution of mild soap and water.
b. Remove grease or oil with dry cleaning solvent.
c. Rewash area with soap and water, and rinse with water.
d. Allow surfaces to drip dry.
e. Apply a light coat of high quality wax.
f. Buff waxed surfaces with a soft lint-free cloth to restore the luster.

10-16-5. CLEANING UPHOLSTERY. Dirt and grease may be removed from the plastic-covered seat cushions and seat backs with mild soap and water, leather saddle soap, dry cleaning solvent or kerosene. Wipe dry with clean cloth.

NOTE: Excessive amounts of cleaning solvent and/or kerosene will damage the foam rubber pads.

10-17-1. MAINTENANCE OF ALUMINUM AND MAGNESIUM ALLOY PARTS.

10-17-2. To avoid structural deterioration and possible eventual failure from corrosion, every precaution should be taken to maintain aluminum and magnesium parts free from the effects of corrosion. Corrosion (usually recognized by dulling or pitting of the surface accompanied by whitish or reddish powdery deposits) is accelerated by the presence of salt water, high temperature and humidity. The duration of exposure to such conditions is an essential factor in the breakdown of the protective finish and the possible start of corrosive action. Whenever evidence of corrosion is observed, the affected parts shall immediately be cleaned and treated in accordance with the procedures outlined in paragraphs 10-17-3 through 10-17-4A.

CAUTION: PROTECTIVE CHEMICAL COATINGS (ANODIZING, ALODIZING, ETC.) THAT HAVE BEEN REMOVED FROM ANY ALUMINUM ALLOY PART DURING SERVICE BY WEAR OR OTHER CAUSES MUST BE RESTORED IF CONTINUED SERVICEABILITY OF THE AFFECTED PARTS IS TO BE EXPECTED. RESTORE PROTECTIVE COATING IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED IN PARAGRAPHS 10-17-4 AND 10-17-4A.

10-17-3. CLEANING OF ALUMINUM ALLOY AND MAGNESIUM ALLOY PARTS. Whenever corrosion is detected or suspected, the affected part or parts shall be cleaned immediately by removing the products of corrosion (scale, loose metal flakes, powder or salt crystals) to determine the extent of the damage to the base metal. Since the methods and the solutions used in cleaning and treating aluminum and magnesium vary, the procedure outlined below is intended as a simplified process, using a minimum number of solutions, for the removal of corrosion products prior to retreatment of affected areas.

NOTE: Any other suitable method known to be acceptable may be used in lieu of the processes outlined below.

a. Remove old paint coatings by sanding, or by using a recommended Government Specification paint stripper (MIL-R-8633 or MIL-R-25134) or paint solvent. Remove any wax film residue remaining on the surface by washing with a wax-free solvent. Remove all grease and oil from the area to be treated with benzene or other organic solvent which will not attack metal. Provide a final rinse with clean unused solvent.

b. Chemically remove corrosion products from aluminum alloy in the following manner.

(1) Mask off nonclad aluminum, steel, and magnesium as well as cracks and faying surfaces with masking tape.

(2) Apply thickened metal conditioner, Phosphoric Acid Etchant (table 10-IIA) to the corroded area, using a brush or cloth.

(3) With a short stiff bristle brush, aluminum brush or aluminum wool, agitate areas of deep pitting until all corrosion products are removed. Pay particular attention to areas around rivet heads and at butt joints of skins.

CAUTION: DO NOT USE STEEL WOOL OR STEEL WIRE BRUSHES FOR REMOVAL OF CORROSION ON ALUMINUM OR MAGNESIUM.

(4) Sponge off the metal conditioner with a damp cloth rinsed frequently in fresh water. Do not leave conditioner in contact with the metal surface any longer than twenty minutes.

(5) Repeat the above steps as many times as necessary, until all corrosion is removed from the damaged area.

(6) Thoroughly rinse the cleaned area with water after all corrosion is removed.

(7) Apply protective treatment (paragraph 10-17-4) after removal of corrosion.

Table 10-IIA. Phosphoric Acid Etchant for Cleaning Aluminum Alloys .

Material and Specification	Quantity	Container	Temperature
Phosphoric Acid Etchant (MIL-C-25378)	1 volume	Polyethylene or Earthenware	21° to 32°C (70° to 90°F)
Water	1 volume		

c. Chemically remove corrosion products from magnesium alloy in the following manner.

(1) Remove all paint, grease, oil and wax from the affected surfaces (step a.)

(2) Mask off steel parts as well as mechanical linkages, cracks and faying surfaces with masking tape.

(3) Apply a solution of chromic acid (table 10-IIB) to corroded area, being careful to prevent acid from entering cracks, faying surfaces and coming in contact with any organic material.

NOTE: The solution is most effective when used hot. If this is not practical; the solution will also work at normal room temperature.

(4) Allow solution to remain in contact with the metal surface from 1 to 15 minutes, depending on extent of corrosion.

(5) Wash treated area thoroughly with tap water or hot water, scrubbing affected area lightly with a bristle brush.

(6) Repeat operation as many times as necessary to remove all corrosion products.

(7) Apply protective treatment (paragraph 10-17-4A) after removal of corrosion products.

Table 10-IIB. Chromic Acid Solution for Cleaning Magnesium

Material and Specification	Quantity	Container	Temperature
Chromic Acid (O-C-303) (CrO_3)	1.5 lb.	Mild Steel or Earthenware	88° to 100°C (190° to 212°F)
Water	1.0 gal.		

d. Remove corrosion by mechanical means using emery paper, aluminum wire brush (on aluminum) or stainless steel wire brush (on magnesium) or other suitable abrasive to remove corrosion from structural parts. Complete the cleaning process by applying a chemical solution as applicable (steps b and c.)

CAUTION: PARTS THAT ARE HIGHLY STRESSED OR THAT HAVE OTHER RESTRICTIVE REPAIR LIMITATIONS SHALL BE REPAIRED ONLY WITHIN THE LIMITATIONS SPECIFIED FOR THAT PART. PARTS SUBJECT TO STRESS LOADING MUST BE FINISHED WITH CROCUS CLOTH TO A FINISH EQUIVALENT TO THAT OF THE SURROUNDING AREA.

10-17-4. PROTECTIVE TREATMENT OF ALUMINUM ALLOY PARTS. After cleaning aluminum alloy parts apply Alodine 1200 (or equivalent), prepared in accordance with table 10-IIC, and apply as follows:

a. Apply Alodine solution to the affected surface by brushing, spraying or swabbing. If spraying method is selected, stainless steel or plastic cups and nozzle should be used.
b. Allow the solution to remain on the surface from three to five minutes.
c. Wash excess solution from surface by rinsing with cold water and wiping with a water-dampened cloth.
d. Dry with a mild blast of filtered compressed air, or a clean, dry cloth.

Table 10-IIC. Alodine Protective Treatment for Aluminum Alloy Parts

Material and Specification	Quantity	Container	Temperature
Alodine 1200 (MIL-C-5541)	3.0 oz.	Earthenware Aluminum or Stainless Steel	21° to 32°C (70° to 90°F)
Nitric Acid (O-N-350A)	0.5 oz. (fluid)		
Water	1.0 gal.		

CAUTION: WHEN PREPARING OR APPLYING ANY SOLUTION CONTAINING NITRIC ACID, BE CERTAIN TO FOLLOW THE HANDLING PROCEDURES OUTLINED IN PARAGRAPH 10-17-5.

10-17-4A. PROTECTIVE TREATMENT OF MAGNESIUM ALLOY PARTS. After cleaning magnesium alloy parts apply one of the following chromic acid solutions to affected areas. When using chromic acid solution for touch-up of abraded or reworked areas it is preferable that Dow 19 (table 10-IID) be used. This solution is less concentrated, less hazardous and less expensive than chrome-pickle(table 10-IIE). Also control of application is less critical.

a. Apply chromic acid brush-on solution (table 10-IID) as follows.

(1) After cleaning, brush surfaces liberally with the solution keeping the abraded area wet for one to three minutes.

(2) Rinse with cold water and dry.

NOTE: A hot air blast or oven may be used to facilitate drying but in no case shall the parts be rinsed in hot water.

(3) Properly treated surfaces will have a brassy iridescent to dark brown appearance.

Table 10-IID. Chromic Acid Brush-on Treatment for Magnesium

Material and Specification	Quantity	Container	Temperature
Chromic Acid (O-C-303) (CrO_3)	1-1/3 oz.	Mild Steel	21° to 32°C (70° to 90°F)
Calcium Sulfate ($CaSo_4$)	1.0 oz.		
Water	1.0 gal.		

b. Application of chrome-pickle (table 10-IIE) may be used as surface treatment for magnesium parts if the following conditions are adhered to. Since chrome-pickle solutions may remove as much as 0.0006 inch of metal per surface during treatment do not apply to machined surfaces unless tolerances will permit.

CAUTION: WHEN TREATING RIVETED OR BOLTED ASSEMBLIES, CARE MUST BE TAKEN TO AVOID TRAPPING CHROME-PICKLE SOLUTION IN THE JOINTS.

(1) After cleaning brush freshly made chrome-pickle solution generously on the surface to be treated. Brush thoroughly until surface appears iridescent, with either a red or yellow shade predominating.

NOTE: An excessive bright yellow color indicates an excess of nitric acid in the solution. Correct excess by adding small amounts of sodium dichromate.

(2) Rinse treated area thoroughly with cold running water, followed by a hot water rinse to facilitate drying.

(3) Apply a coat of zinc chromate primer (Specification MIL-P-8585) immediately after drying.

Table 10-IIE. Chrome-Pickle Solution for Treating Magnesium Surfaces

Material and Specification	Quantity	Container	Temperature
Sodium Dichromate (O-S-595) ($Na_2Cr_2O_7 \cdot 2H_2O$)	1.5 lb.	Earthenware, Aluminum or Stainless Steel	21° to 32°C (70° to 90°F)
Nitric Acid (O-N-350A)	1.5 pt.		
Water	1.0 gal.		

10-17-5. HANDLING PRECAUTIONS. Observe the following precautions when handling solutions used in the cleaning and treating of aluminum and magnesium parts.

a. Work in a well ventilated area and avoid inhalation of chemical vapors. If respiratory distress is experienced from inhalation of vapors, consult a doctor immediately.

b. Avoid direct skin contact with chemicals. Wear goggles, rubber gloves and protective clothing when mixing chemical solutions. If chemicals contact the skin, wash the area immediately with profuse amounts of water. If skin becomes irritated from contamination, consult a doctor.

c. Make certain that immediate treatment is received for all injuries.

WARNING: ALWAYS POUR ACID INTO WATER, NEVER WATER INTO ACID. NITRIC ACID IS INTENSELY POISONOUS AND CAN CAUSE SERIOUS BURNS IF IT CONTACTS THE SKIN. INHALATION OF NITRIC ACID FUMES CAN CAUSE EDEMA OF THE LUNGS AND SUBSEQUENT DEATH. ANTIDOTE - EXTERNAL: WIPE OFF THE ACID GENTLY AND FLOOD THE AREA WITH WATER, WASHING FREELY WITH SOAP. COVER THE AFFECTED AREA WITH MAGNESIA OR BAKING SODA. ANTIDOTE - INTERNAL: DRINK A TEASPOONFUL OF MAGNESIA, CHALK, WHITING, WALL PLASTER OR A SMALL PIECE OF SOAP (SOFTENED IN WATER) IN MILK, MUCILAGE OR RAW EGG WHITE.

10-18-1. BOLT, STUD AND RIVET IDENTIFICATION.

10-18-2. The bolts used in aircraft are made of special alloys having superior strength characteristics required to transmit large loads in critical locations. All aircraft bolts are identified by code marks stamped on the bolt head, and some are further marked with the manufacturer's symbols or initials. The special-purpose bolts include the high-strength types, close-up tolerance types, and those that have been reworked into special shapes or sizes.

NOTE: In disassembling helicopter parts, note carefully the type and specific location of all special bolts, so that the special type required will be used in the correct location.

10-18-3. IDENTIFICATION CODES FOR BOLTS. Refer to figure 10-21 for identification codes of typical bolts.

a. AN standard steel bolts are marked with a cross or asterisk.

b. Corrosion resistant standard steel bolts are indicated by a single raised dash.

c. AN aluminum alloy bolts are marked with two raised dashes.

d. AN close tolerance bolts are identified by either a raised or recessed triangle. (Do not substitute a standard AN hex head bolt in this application.)

e. Specially reworked bolts are marked with a circle.

f. Bolts that have had individual (or 100 percent) magnetic inspection are marked with the symbol "M" or with green dye on the bolt heads.

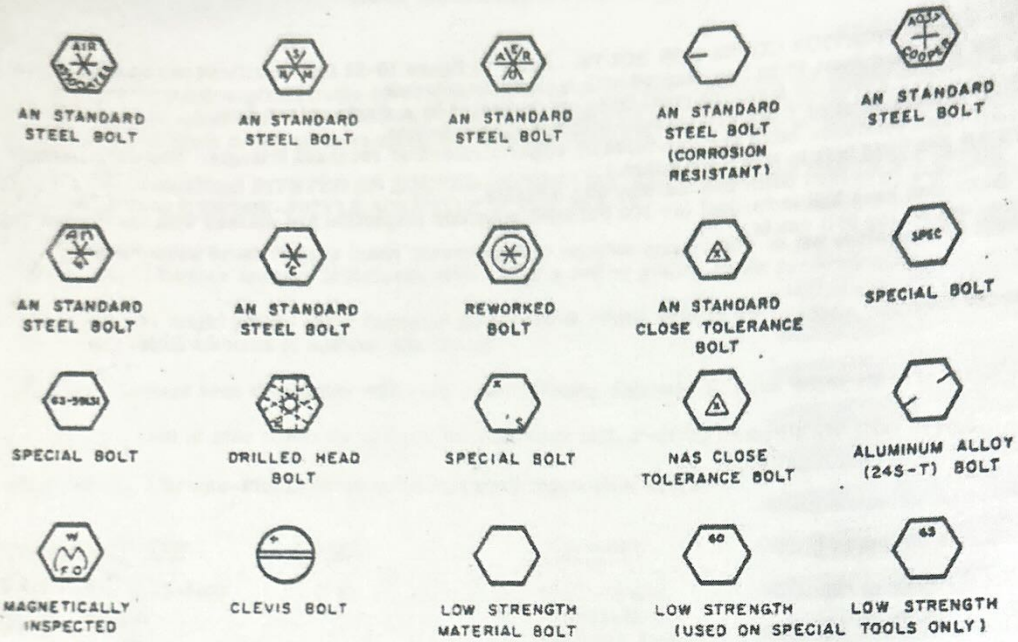


Figure 10-21. Bolt Code

10-18-4. STUD CODES. In certain locations on the helicopter, studs must be installed within a specified set of torque values. For these applications, special oversize studs are available in a limited range of pitch diameters for each nominal shank diameter size, and provide the required selective thread fit. Prior to installation, the studs must be coated with general purpose, white lead base, antiseize compound. For ease of identification, the studs are color coded as follows:

Color	Incremental Pitch Diameter
Red	+0.002-inch oversize
Blue	+0.004-inch oversize
Purple	+0.006-inch oversize

10-19-1. BOLTS AND THREADED SHAFTS TORQUE APPLICATION. (See figure 10-22 and tables 10-III, 10-IV and 10-V.)

10-19-2. There is a definite point of tightness for all bolts and threaded shafts. This point is known as the proper torque. If the proper torque is exceeded, the part may fail through breakage, thread strippage or elongation. If the proper torque is not reached, the part may break in service due to stresses or fluctuations which result in fatigue failure. Low bolt torque may reduce the service lift to less than half. To obtain the proper torque, use a torque wrench, which measures the torque applied to the nut, but not the tension in the bolt or shaft.

NOTE: Keep all threaded surfaces clean. Presence of any dirt or lubrication can change the relationship between the torque value and bolt tension to a degree that will make the torquing operation valueless.

10-19-3. Whenever possible, a spanner wrench that is driven by a torque wrench should be placed at 90 degrees to the torque wrench. When used in this way, the torque wrench will read the actual torque exerted on the nut or bolt. (See detail A, figure 10-22.)

10-19-4. A spanner wrench that is placed in line with the torque wrench will actually create a torque that is greater than that read on the torque wrench (see Detail B, figure 10-22.). If it is necessary to use a spanner wrench in this position, the torque wrench reading should be less than the desired actual torque at the nut. The correct reading is found as follows:

$$\text{Reading} = \frac{L_1}{L_1 + L_2} \times T$$

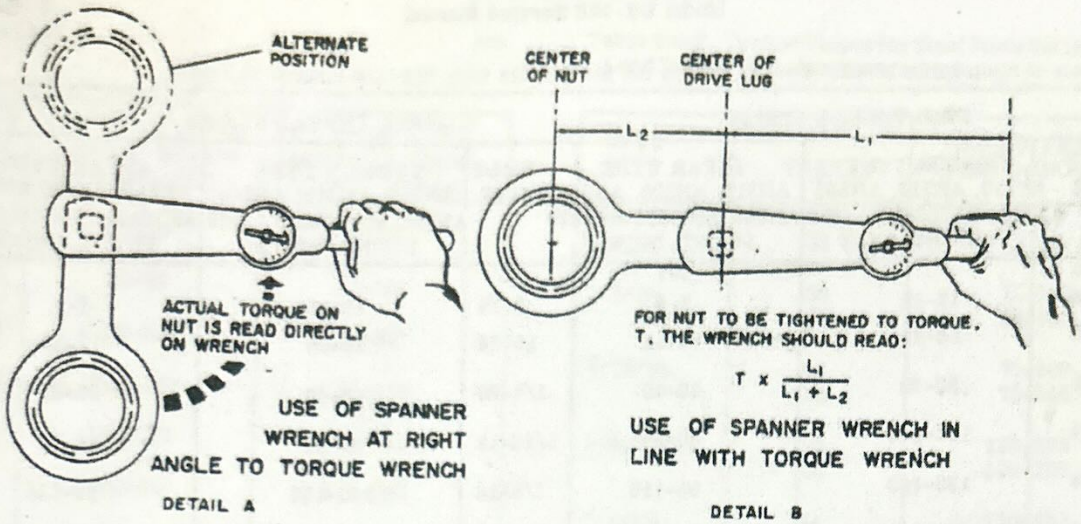


Figure 10-22. Torque Wrench and Spanner Application

T = Desired actual torque at the nut

L_1 = Length of the torque wrench, measured from the center of the drive lug to the center of the grip.

L_2 = Length of the spanner wrench measured from the center of the drive lug to the center of the nut that is being torqued.

10-19-5. For example, suppose it is necessary to tighten a spanner nut to a torque value of 100 pound-inches and the torque wrench can only be applied in line with the spanner wrench. If the length of the torque wrench, from the center of the drive lug to the center of the grip is 15 inches, and if the length of the spanner wrench, from the center of the drive lug hole to the center of the nut, is 5 inches, then the torque wrench reading should be:

$$\text{Reading} = \frac{15 \text{ in.}}{15 \text{ in.} + 5 \text{ in.}} \times 100 \text{ lb-in.} = 75 \text{ lb-in.}$$

10-19-6. APPLYING TORQUE. The following precautions shall be observed when applying torque:

a. Keep all the threaded surfaces (except aluminum alloy threads) dry and free of dirt and lubricants during torquing.

b. Lubricate all aluminum alloy threads with antiseize paste of the following (or equivalent) composition: 50 percent dry zinc-dust pigment and 50 percent technical petrolatum (table 10-VI, item 26).

c. Apply the torque wrench to the nut, not to the bolt.

d. Keep the plane of the wrench as nearly as possible at a right angle to the bolt when applying torque.

e. Apply torque with a steady, even pressure.

f. Tighten the castellated nuts slowly, checking alinement of the cotter pin hole in the bolt with the castellation of the nut. This procedure prevents exceeding the given torque range for insertion of the safetying element. If it is not possible to aline the safety hole without exceeding the proper torque, replace the nut and tighten to specified torque.

g. Do not retighten already installed bolts or studs. Remove the nut, and check the nut, bolt or stud threads and mating surfaces for cleanliness.

10-20-1. FLUID LINE THREADED FITTINGS.

10-20-2. INSTALLATION OF FLUID LINE THREADED FITTINGS. Lubricate and install fluid line threaded fittings as follows:

a. Unless a special lubricant or sealant material is specified in the assembly instructions, lubricate all pipe thread fluid fittings with a coat of white lead base antiseize compound (table 10-VI, item 1) prior to installation. Apply the compound sparingly to the male threads and wipe away any excess compound after final tightening.

b. Lubricate all straight thread hose and tube fittings with either Threadlube No. 6 PB (table 10-VI, item 18) or hydraulic oil prior to installation.

c. Install and position straight thread tube or hose connectors utilizing O-ring packing according to instructions contained in paragraphs 10-20-3 and -4 below, taking care not to damage the packing during installation.

Table 10-III. Torque Values for Steel Bolts with Non-Lubricated Threads

FINE THREAD SERIES			COARSE THREAD SERIES		
BOLT SIZE	TENSION TYPE AN310, AN315, AN365 AN366, MS20365,NAS679 POUND-INCHES	SHEAR TYPE AN316, AN320, AN350 AN364, MS20364,NAS679 POUND-INCHES	BOLT SIZE	TENSION TYPE AN310, AN315, AN365 AN366, MS20365,NAS679 POUND-INCHES	SHEAR TYPE AN316, AN320,AN350 AN364,MS20364,NAS679 POUND-INCHES
6-40		5-7			
8-36	12-15	7-9	8-32	12-15	7-9
10-32	20-25	12-15	10-24	20-25	12-15
1/4-28	50-70	30-40	1/4-20	40-50	25-30
5/16-24	100-140	60-85	5/16-18	80-90	48-55
3/8-24	160-190	95-110	3/8-16	160-185	95-110
7/16-20	450-500	270-300	7/16-14	235-255	140-155
1/2-20	480-690	290-410	1/2-13	400-480	240-290
9/16-18	800-1000	480-600	9/16-12	500-700	300-420
5/8-18	1100-1300	600-780	5/8-11	700-900	420-540
3/4-16	2300-2500	1300-1500	3/4-10	1150-1600	700-950
7/8-14	2500-3000	1500-1800	7/8-9	2200-3000	1300-1800
1-14	3700-5500	2200-3300	1-8	3700-5000	2200-3000

Note: AN nuts are being replaced by NAS679 nuts.

10-20-3. Install a nut type fitting (see figure 10-23) as follows:

a. Assemble nut on fitting end and run back to clear packing groove.

b. Lubricate packing with system fluid.

c. Place packing in packing groove.

d. Run nut down until it contacts packing, and maintain contact during positioning to prevent cutting packing on fitting thread.

e. Screw fitting into boss until packing contacts boss.

f. Screw fitting in an additional 180 degrees. Any further positioning of fitting must be accomplished by turning fitting in up to three-quarters turn or by backing out up to one-quarter turn.

g. Tighten nut lightly.

h. Connect hose or tube to fitting and retighten nut against boss.

CAUTION: WHEN INSTALLING NUT TYPE FITTINGS, TAKE CARE NOT TO BOTTOM THE FITTING IN THE THREADED BOSS.

10-20-4. Install a plain tube fitting (without nut)(see figure 10-23) as follows:

a. Lubricate packing with system fluid.

b. Install packing on fitting as shown in Detail A, figure 10-23.

c. Screw the fitting assembly into boss until it bottoms tightly on the boss as shown in Detail B, figure 10-23.

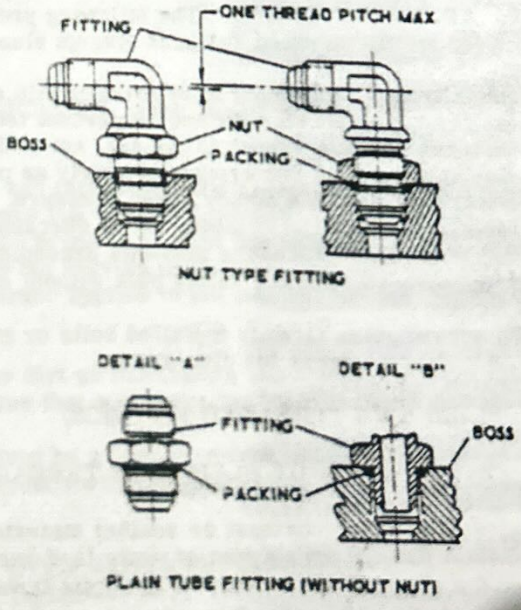


Figure 10-23. Straight Thread Tube Connectors with O-ring Packing

Table 10-IV. Torque Values for 2024-T4 Aluminum Alloy Bolts with Antiseize Thread Lubricant

BOLT SIZE	NUT TYPE AN365, MS20365, NAS679 POUND-INCHES	NUT TYPE AN364, MS20364, NAS679 POUND-INCHES
1/4-28	20-35	20-34
5/16-24	50-75	40-55
3/8-24	80-110	65-85
7/16-20	100-140	85-110
1/2-20	170-220	125-155
5/8-18	400-460	235-300
3/4-16	---	490-630

Table 10-V. Torque Values for Steel Studs Set in White Lead (installed in aluminum, magnesium or steel)

STUD SIZE	THREAD	TORQUE RANGE POUND-INCHES
No. 10	24	15-40
	32	15-40
1/4-in.	20	25-100
	28	25-120
5/16-in.	18	70-200
	24	70-225
3/8-in.	16	120-325
	24	120-325
7/16-in.	14	170-450
	20	170-450

10-21-1. CONSUMABLE MATERIALS.

10-21-2. Materials normally required for maintenance of the helicopter are listed in table 10-VI, and are referenced by item number throughout the text of this manual. Alternate or substitute materials are noted where applicable in this table, as well as in table 10-VII, which lists commercial equivalents for lubricants identified by military specifications.

Table 10-VI. List of Consumable Materials

ITEM NO.	NOMENCLATURE	SPEC. OR PART NO.	MANUFACTURER
1	Antiseize compound, white lead base, general purpose (for threaded fittings)	TT-W-261	
2	Lubricating oil, internal combustion engine, preservative	MIL-L-21260 Grade 3	
2A	Lubricating oil, internal combustion engine, preservative	MIL-C-6529	
3	Primer, zinc chromate for aircraft use	MIL-P-8585	
4	Naphtha, aliphatic	TT-N-95	
5	Grease, plug valve, gasoline and oil resistant	MIL-G-6032	
6	Wire, steel, corrosion resistant	MS20995C (Diameter as specified)	
7	Swabbing solution	No. 1249C	Goodyear Tire and Rubber Co., Los Angeles, Calif.
8	Deleted		
9	Sealing Compound, Synthetic rubber accelerated	MIL-S-8516	
10	Wax, Rotor Blade	Grade FR	The Winged Wax Company Dayton, Ohio

ITEM NO.	NOMENCLATURE	SPEC. OR PART NO.	MANUFACTURER
11	Cement, synthetic (for hard cellular buoyancy-material	MIL-C-2749	
12	Abrasive Tape, Scotchcal brand film	3655-3	Minnesota Mining and Mfg. St. Paul, Minnesota
13	Adhesive, heat resistant, air-frame structural metal to metal	(A) MIL-A-5090 (B) MIL-A-8431	
14	Sealer, edge	FE 75 A	Minnesota Mining and Mfg. St. Paul, Minnesota
15	Sealant, Cement	MIL-A-5092, Type III	American Latex Corp. San Francisco, Calif.
16	Lubriplate	630-AA or 105 (as specified)	Fisk Bros Refining Co. Newark, New Jersey
17	Gasoline, Aviation	MIL-G-5572C	
18	Threadlube	No. 6PB	Parker-Hannifin Cleveland, Ohio
19	Kerosene	VV-K-211	
20	Compound, Sealing, Silicon	DC 4	Dow Corning Corp. Midland, Michigan
21	Twine and Tape, Lacing and tying (waxed cord)	MIL-T-713, Type P, Class 2, MIL-T-2520 (No. 6)	
22	Alcohol, Ethel, Special Denatured	MIL-A-6091	
23	Sealant, Permatex	Permatex No. 3	Permatex Co. Inc. Oakland, California
24	Sealant, Loctite	Grade as specified	American Sealants Hartford, Conn.
25	Solvent, Mineral	P-D-680	Standard Oil Co., San Francisco, California
26	Petrolatum, Technical	VV-P-236	
27	Alodine	No. 1200 MIL-C-5541	Amchem Products Inc. Ambler, Pennsylvania
28	Thread, Silk	Size A, V-T-301	
29	Tape, Polyken	No. 105	The Kendall Co., Polyken Division, Chicago, Illinois
30	Molykote		The Alpha Molykote Corp. Stamford, Conn.
31	Socony Mobile Oil	SAE 10W-30	Socony Mobile Oil Co., Inc. New York, New York
32	Trichlorethyline, Stabilized Degreasing	MIL-T-7003	Wolverine Solvent and Chemical Company, Grand Rapids, Michigan

ITEM NO.	NOMENCLATURE	SPEC. OR PART NO.	MANUFACTURER
33	Lacquer, Lusterless Black	TT-L-20, Type I Federal Standard Color No. 37038	
34	Adhesive, Aerobond P-E		Adhesive Engineering, San Carlos, California
35	Sealant	No. 4	P.O.B. Mfg Co. Inc., Cincinnati, Ohio
36	Crocus Cloth	P-C-458	
37	Metlhesive	2006	Adhesive Engineering, San Carlos, California
38	Everlube	620	Everlube Corp., North Hollywood, California

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Table 10-VII. Military Specification - Commercial Equivalent Lubricants List

This list of equivalent lubricants is not intended as a complete list of acceptable commercial lubricating materials and processors. Any lubricant meeting the listed specifications may be substituted. Engine and transmission lubricating oil must meet the requirements of Lycoming Lubricating Oil Specification No. 301E.
Addresses of listed manufacturers (indicated by the numbers in parentheses) are provided in the Appendix at the end of the table.

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-L-21260	Brayco 2604, Brayco 445, Grade 3	Bray Oil Company (5)
	Gulf No-Rust Engine Oil, Grade 3	Gulf Oil Corporation (25)
	Shell Ensis Oil 412, 413, Grade 3	Shell Oil Company (49)
	Infilrex 101 SAE 50	Socony Oil Company (53A)
	SUPERMIL Preservation Engine Oil No. 06212, Grade 3	American Oil Company (2A)
	Preservative Oil 50	The Texas Company (58)
MIL-G-6711	GP39	National Carbon Co. (37)
MIL-H-5606	AeroShell Fluid 4	Shell Oil Co. (49)
	Univis J-43 (Code WS 2997)	Esso Standard Oil Co. (22)
	RL 102 A	Socony-Mobil Oil Co., Inc. (52)
	RPM Aviation Hydraulic	Standard Oil of California (54)
	Aircraft Hydraulic Oil AA	The Texas Co. (58)
	Brayco 756 (Code P-190)	Bray Oil Co. (5)
	Hydraulic Oil (Code 566)	Golden Bear Oil Co. (48)
	Royco 756	Royal Lubricants Co. (48)
	Caltex Aircraft Hydraulic Oil AA	California-Texas Oil Co., Ltd. (7)
	Caltex RPM Aviation Oil No. 2	California-Texas Oil Co., Ltd. (7)
MIL-G-7711 (alternate for AeroShell Grease 14 or MIL-G-25537)	AeroShell Grease 6	Shell Oil Co. (49)
MIL-G-23827 (Alternate for MIL-L-7711)	AeroShell Grease 7	Shell Oil Co. (49)
	1944 Regal Starfak Special	California-Texas Oil Co., Ltd. (7)
	Esso Aviation General Purpose Grease 1	Esso Standard Oil Co. (22)
	Penola Aviation General Purpose Grease 1	Penola Oil Co. (40)
	Durolube 11	Sinclair Refining Co. (50)
	Mobilgrease Aero General Purpose	Socony-Mobil Oil Co., Inc. (52)
	RPM Aviation Grease No. 1	Standard Oil of California (54)
	Regal Starfak Special	The Texas Co. (58)
MIL-G-81322	Braycote 660 AMS-5	Bray Oil Company (5)
	Deleted	
	Mobilgrease 26	Socony Mobil Oil Co. Inc. (52A)
	Sohimil 06752	American Oil Company (2A)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-G-6032	L237	Lehigh Chemical Company (33)
	Rockwell 950	Rockwell Mfg. Co. (46A)
	Royco 32	Royal Engineering Co. (47)
MIL-L-6082 (Grade 1065) SAE 30	Winsor Lube 1065	F. E. Anderson Oil Co., Inc. (3)
	Caltex 1065	California-Texas Oil Co., Ltd. (7)
	Carter Aviation Oil 65	The Carter Oil Co. (9)
	Castrolaero 113 (Grade 1065)	Castrol Oils, Inc. (10)
	Grade 1065	Champlin Refining Co. (11)
	Cisco Aero 1065-A	Cities Service Oil Co. (13)
	Commavio 1065	Commerce Oil Corporation (15)
	Grade 1065	Consumers Cooperative Ass'n. (17)
	Conoco Aero Oil 1065	Continental Oil Co. (18)
	D-X Aviation Oil 1065	D-X Sunray Oil Co. (20)
	Esso Aviation Oil 65	Exxon Company, U.S.A. (29) Esso Standard Oil Co. (22)
	Gulf A-1065	Gulf Oil Corporation (25)
	Imperial 1065	Imperial Oil Co., Inc. (30)
	Aviation Oil 1065 (RM-27-C)	Magnolia Petroleum Co. (34)
	Mobil Aero White Band (RM-31-C)	Socony-Mobil Oil Co., Inc. (53)
	Phillips 66 Aviation Engine Oil, Grade 1065	Phillips Petroleum Co. (42)
	Pureflight Aviation Oil 1065	The Pure Oil Co. (53)
	AeroShell Oil 65	Shell Oil Co. (49)
	Sinclair 1065	Sinclair Refining Co. (50)
	Grade 1065	Sta-Vis Oil Co. (56)
	Formula No. 77675-7L	Sun Oil Co. (57)
	Formula No. 77675-8L	Sun Oil Co. (57)
	Texaco Aircraft Engine Oil 1065	The Texas Co. (58)
	Valvoline 1065	Valvoline Oil Co. (59)
	Grade 1065	Wolf's Head Oil Refining Co. (60)
MIL-L-6082 Grade 1100	Grade 1100	American Oil Company (2)
	BP Aviation Oil 1100	BP Trading Ltd. (6)
	Brayco 48OR	Bray Oil Company (5)
	Cisco Aero Oil 1100A	Cities Service Oil Co. (13)
	Conoco L. C. Aero 1100	Continental Oil Company (18)
	Conoco L. C. No. 3 Aero Oil 1100	Continental Oil Company (18)
	Gulf A-1100	Gulf Oil Corporation (25)
	Esso Aviation Oil 100	Exxon Company, U.S.A. (29)
	Enco Aviation Oil 100	Exxon Company, U.S.A. (29)
	Exxon Aviation Oil 100	Exxon Company, U.S.A. (29)
	2320 Aviation Oil	Exxon Company, U.S.A. (29)
	Ser M-1100	Kendal Refining Company (32)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-L-6082 (cont) Grade 1100	Phillips 66 Aviation Engine Oil Grade 1100	Phillips Petroleum Co. (42)
	Aeroshell Oil 100 (Code 60 005)	Shell Oil Company (49)
	E-1100	Sinclair Refining Co. (50)
	Mobil Aero Red Band (RM-31-E)	Socony Mobile Oil Co. Inc. (53)
	RPM Aviation Oil 900	Standard Oil Co. of Calif. (54)
	Texaco Aircraft Engine Oil 1100	The Texas Company (58)
SAE 20-20W	Mobiloil Aero Gold Band	Socony Mobile Oil Co., Inc. (53)
SAE 20 (No military specification)	RPM Aviation Oil, Non-Compounded	Standard of California (54)
	Sinclair Aircraft Engine Oil 55	Sinclair Refining Co. (50)
	Texaco Aircraft Engine Oil 55	The Texas Co. (58)
MIL-L-6086 Grade L	Trojan Gear Oil 6086L	Cities Service Oil Co. (13)
Grade M	Trojan Gear Oil 6086M	Cities Service Oil Co. (13)
Grade L	70344-B	R. M. Hollingshead Corp. (27)
Grade M	70344-C	R. M. Hollingshead Corp. (27)
Grade L	AeroShell Fluid 5 L	Shell Oil Co. (49)
Grade M	AeroShell Fluid 5 M	Shell Oil Co. (49)
Grade L	NY3717	Sinclair Refining Co. (50)
Grade M	NY3426	Sinclair Refining Co. (50)
Grade L	Calresearch 113	Standard Oil of California (54)
Grade M	Calresearch 107M	Standard Oil of California (54)
Grade L	Aircraft Gear Oil EP Light	The Texas Co. (58)
Grade M	Aircraft Gear Oil EP Medium	The Texas Co. (58)
MIL-L-7870	"PQ" Rust Preventive No. 107	American Oil and Supply Co. (2)
	Winsor Lube L-1018	F. E. Anderson Oil Co., Inc. (3)
	Brayco 363	Bray Oil Co. (5)
	Esso Aviation Instrument Oil	Esso Standard Oil Co. (22)
	Gulflite Oil 6	Gulf Oil Corporation (25)
	Cosmolubric No. 263	E. F. Houghton & Co. (28)
	L-407	Lehigh Chemical Products Co. (33)
	Nox Rust 529	Nox Rust Division, Daubert Chemical Co. (38)
	Petrotect 7870A	Pennsylvania Refining Co. (39)
	Low Temperature Oil (TL-2665)	The Texas Co. (58)
	TL-2851	The Texas Co. (58)
	Royco 363	Royal Lubricants Co. (48)
	Caltex Low Temperature Oil	California-Texas Oil Co. Ltd. (7)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-G-25537	AeroShell Grease 14	Shell Oil Co. (49)
MIL-L-2104 (Grade 10)	Rotella Oil 10W	Shell Oil Co. (49)
	Talona Oil 10W	Shell Oil Co. (49)
	Alliance Heavy Duty 1901SAE-10	Alliance Oil Corp. (1)
	Anglo Heavy Duty Motor Oil	Anglo-Canadian Oil Co. (4)
	Brayco 2604	Bray Oil Co. (5)
	Atlantic Ultramo 10	British Petroleum Trading Co., Ltd. (6)
	B. P. 2104	British Petroleum Trading Co., Ltd. (6)
	B. P. Energol Diesel D	British Petroleum Trading Co., Ltd. (6)
	Caltex 112	Caltex (Australia) Pty, Ltd. (8)
	Caltex RPM Delo Heavy Lubricating Oil SAE-10W	California-Texas Oil Co., Ltd. (7)
	Caltex 112	California-Texas Oil Co., Ltd. (7)
	CSR-L-304	Cities Service Oil Co. (13)
	CSR-L-315	Cities Service Oil Co. (13)
	Commerce 810 MIL 10	Commerce Oil Corp. (15)
	Commerce 400 MIL 10	Commerce Oil Corp. (15)
	OR-2237 TOTAL HD SAE 10	Compagnie Francaise de Raffinage (16)
	Conoco HD	Continental Oil Co. (18)
	Conoco Super Motor Oil	Continental Oil Co. (18)
	Deagen HD SAE 10	Deutsche Erdol Aktiengesellschaft (19)
	Essolube HD 10W	Esso Standard Oil Co. (22)
	Oliofiat	Fiat (23)
	Gulf HD Oil A SAE 10W	Gulf Oil Corporation (25)
	Hancock Premium Heavy Duty	Hancock Oil Co. (26)
	Essolube HD	Exxon Company, U.S.A (29)
	Kendall F & L (K)	Kendall Refining Co. (32)
	Ward's Vitalized Heavy Duty Motor Oil	Montgomery Ward Co. (36)
	Phillips 66 Heavy Duty Motor Oil	Phillips Petroleum Co. (42)
	Pemex Dol	Petroleos Mexicanos (41)
	Pemex Sol S-1	Petroleos Mexicanos (41)
	Sonap TTE HD	Societe Nacional de Petroleos (51)
MIL-S-8516	3C-1300 with 3C-1300 A Accelerator	Churchill Chemical Corp. (12)
	Pro-seal 727 with Pro-seal Accelerator 727A	Coast Pro-seal and Mfg. Co. (14)
	3M-EC-1120-PC	Minnisota Mining & Mfg. Co. (35)
	PR-1201-Q with PR-1201-Q-A Accelerator	Products Research Co. (44)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-L-2105 (Grade 90)	Whiz Lubricant SAE 90	Hollingshead, R. M. Co. of Canada Ltd. (27)
	Houghton M. P. Gear Lubricant	Houghton, E. F. & Co. (28)
	Imperial EP	Imperial Oil Co., Inc. (30)
	Imperial A. P. Gear Oil	Imperial Oil Co., Inc. (30)
	Imperial Extreme Pressure	Imperial Oil Co., Inc. (30)
	Imperial E. P. Gear Oil	Imperial Oil Co., Inc. (30)
	Marvelube T-T Gear Oil	Imperial Oil Limited (31)
	A. P. HYPOID Lubricant	Imperial Oil Limited (31)
	Esso X. P. Compound	Imperial Oil Limited (31)
	A. P. Gear Oil 90	Imperial Oil Limited (31)
	Truck Type Gear Lubricant 90	Imperial Oil Limited (31)
	Kendall Three Star Gear Lube	Kendall Refining Co. (32)
	Kendall Hypoid Multi-Purpose Gear Lubricant	Kendall Refining Co. (32)
	Kendall 80-90-140 All Weather All Purpose Gear Lubricant	Kendall Refining Co. (32)
	Engraves Universal M. P.	Petroleos Mexicanos (41)
	Philube All Purpose Gear Oil	Phillips Petroleum Co. (42)
	1095-C	Phillips Petroleum Co. (42)
	Super Amovis Gear Oil	American Oil & Supply Co. (2)
	Anglo All Gear	Anglo-Canadian Oils Ltd. (4)
	BP energol Transmission	Anglo Iranian Oil Co., Ltd. (6)
	Oil KP	Anglo Iranian Oil Co., Ltd. (6)
	Braycolube UG	Bray, U. B., Company (5)
	Brayco Gear Lubricant	Bray, U. B., Company (5)
	All Purpose SAE 90	Champlin Refining Co. (11)
	All Purpose EP	Champlin Refining Co. (11)
	Trojan LB Gear Oil	Cities Service Oil Company (13)
	CSR-M-208-210	Cities Service Oil Company (13)
	CSR-L-309-311	Cities Service Oil Company (13)
	Commerce 1838, 3172	Commerce Oil Corporation (15)
	Commerce 3345, 3171	Commerce Oil Corporation (15)
	COMMERCE	Commerce Oil Corporation (15)
	CO-OP Universal Gear Lubricant	Consumers Cooperative Association (17)
	CO-OP Universal Hypoid Gear Lubricant	Consumers Cooperative Association (17)
	Conoco Universal Gear Lubricant	Continental Oil Company (18)
	Conoco UGLC	Continental Oil Company (18)
	Conoco UGLC No. 2 SAE 90	Continental Oil Company (18)
	Gulf Hypoid Gear Lubricant All Purpose Type	Gulf Oil Corporation (25)
	Gulf Multi-Purpose Gear Lubricant	Gulf Oil Corporation (25)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-L-2105 (cont) (Grade 90)	Allgear Universal	Prairie States Oil & Grease Co. (43)
	Allgear	Prairie States Oil & Grease Co. (43)
	Universal Gear Lubricant	Prairie States Oil & Grease Co. (43)
	Poco Purelube EE	The Pure Oil Co. (45)
	Purelube Multi-Purpose Gear Oil SAE 80/90	The Pure Oil Co. (45)
	Quaker State Super Quadrolube	Quaker State Oil Refining Corporation (46)
	Shell Spirax EP	Shell Oil Co. (49)
	RPM Multi-Service Gear Lubricant	Standard Oil Co. of California (54)
	RPM Hypoid Lubricant	Standard Oil Co. of California (54)
	Universal Gear Lubricant	Standard Oil Co. of California (54)
	Texaco Universal Gear Lubricant EP	The Texas Co. (58)
	Texaco Gear Lube HD	The Texas Co. (58)
	Wolf's Head All Purpose Lube	Wolf's Head Oil Refining Co., Inc. (60)
MIL-L-2105 (Grade 75)	Winsor	Anderson, F. E. Oil Co. (3)
	GL-175, GL-190	Anderson, F. E. Oil Co. (3)
	Anglo All Gear	Anglo-Canadian Oils, Ltd. (4)
	Braycolube UG	Bray, U. B., Company (5)
	Braycolube UGS	Bray, U. B., Company (5)
	Brayco Gear Lubricant	Bray, U. B., Company (5)
	Trojan AP Gear Oil	Cities Service Oil Co. (13)
	Trojan MP Gear Oil	Cities Service Oil Co. (13)
	CSR-M-225M-50073	Cities Service Oil Co. (13)
	Trojan LB Gear Oil	Cities Service Oil Co. (13)
	CSR-M-208-210	Cities Service Oil Co. (13)
	CSR-L-309-311	Cities Service Oil Co. (13)
	CO-OP Universal Gear Lubricant	Consumers Cooperative Association (17)
	CO-OP Universal Hypoid Gear Lubricant	Consumers Cooperative Association (17)
	Conoco UGLC	Continental Oil Co. (18)
	WS-1813, WS-1774 E. P. Lubricant	Esso Standard Oil Company (22)
	ESSO EXPEE	Esso Standard Oil Company (22)
	NATOR 2105	Esso Standard Oil Company (22)
	Houghton M. P. Gear Lubricant	Houghton, E. F. & Co. (28)
	Imperial EP	Imperial Oil Col, Inc. (30)
	Imperial A. P. Gear Oil	Imperial Oil Co., Inc. (30)
	Imperial Extreme Pressure	Imperial Oil Co., Inc. (30)
	Imperial E. P. Gear Oil	Imperial Oil Co., Inc. (30)
	Marvelube T-T Gear Oil Artic	Imperial Oil Limited (31)
	A. P. Gear Oil 75 & 90	Imperial Oil Limited (31)

Table 10-VII. Military Specification - Commercial Equivalent Lubricants List (continued)

MILITARY SPECIFICATION	COMMERCIAL EQUIVALENT	MANUFACTURER
MIL-L-2105 (cont) (Grade 75)	Esso XP Compound Arctic	Imperial Oil Limited (31)
	Quaker State Supper Quadrolube	Quaker State Oil Refining
	Shell 3-1110 Oil	Shell Oil Co. (49)
	RPM Multi-Service Gear Lubricant	Standard Oil Co. of California (54)
	Standard Heavy Duty Gear Lubricant	Standard Oil Co. of Indiana (55)
	Standard Multi-Purpose Gear Lubricant	Standard Oil Co. of Indiana (55)
	LF-0601, LF-0500 Oil No. 90	Standard Oil Co. of Indiana (55)
	Sta-Vis H.D. Gear Lubricant	Sta-Vis Oil Co. (56)
	Sta-Vis Gear Lube	Sta-Vis Oil Co. (56)
	STA-VIS Gear Lubricant	Sta-Vis Oil Co. (56)
	STA-MIL 2105	Sta-Vis Oil Co. (56)
	Sunoco Multi-Purpose Gear Lubricant "B"	Sun Oil Co. (57)
	Sunoco Hypoid Gear Lubricant "C"	Sun Oil Co. (57)
MIL-C-6529C	Rust Ban 628	Esso Standard Oil Company (22)
	Avrex 901	Socony-Mobile Oil Co., Inc. (52)
No MIL Specification	Anderol 456H	Lehigh Chemical Co. (33)
No MIL Specification	Anderol Flushingoil	Lehigh Chemical Co. (33)

Appendix to Table 10-VII - Manufacturers Addresses

(1) Alliance Oil Corp., 277 Park Avenue, New York, New York 10017

(2) American Oil and Supply Co., 239 Wilson Avenue, Newark, New Jersey 07105

(2A) American Oil Company, 910 South Michigan Avenue, Chicago, Illinois 60680 - Products distributed by Standard Oil Co. of Ohio, Cleveland, Ohio 44113

(3) Anderson Oil and Chemical Co., Inc., Portland, Connecticut 06480

(4) Anglo-Canadian Oil Co., Ltd., Brandon, Manitoba, Canada

(5) Bray Oil Co., 3344 Medford St., Los Angeles, California 90063

(6) British Petroleum Trading Co., Ltd., Anglo Iranian Oil Co., Ltd., Britannic House, Finsbury Circus, London E. C. 2, England

(7) California - Texas Oil Co., Ltd., 380 Madison Avenue., New York, New York 10017

(8) Caltex (Australia) Pty., Ltd., George and Margaret Streets, Sydney, Australia

(9) The Carter Oil Co., P.O. Box 2514, Billings, Montana

(10) Castrol Oils, Inc., 75 West Street, New York, New York 10006

(11) Champlin Refining Co., Enid, Oklahoma 73701

(12) Churchill Chemical Corp., 3137 E. 26th St., Los Angeles, California 90023

(13) Cities Service Oil Co., 60 Wall St., New York, New York 10005

(14) Coast Pro-seal and Manufacturing Co., 19451 Susana Rd., Comtpon, California 90221

(15) Commerce Oil Corporation, Warren, Pennsylvania 16365

(16) Compagnie Francaise de Raffinage, 11 rue de Dr. Lancereaux, Paris (VIII), France

(17) Consumers Cooperative Association, P. O. Box 2359, Kansas City, Missouri 64142

(18) Continental Oil Co., Drawer 1267 Ponca City, Oklahoma 74601

(19) Deutsche Erdol Aktiengesellschaft, Shell Haus, Alsterufer 4-5, Hamburg, Germany

(20) D-X Sunray Oil Co., Box 2039 Tulsa, Oklahoma 74102

(21) Elk Refining Co., P. O. Box 1033, Charleston, W. Virginia 25324

(22) Esso Standard Oil Co., 15 W. 51st St., New York, New York 10019

(23) Fiat, Via Paddo Boule 26, Turin, Italy

(24) Golden Bear Oil Co., 325 W. 8th St., Los Angeles, California 90014

(25) Gulf Oil Corporation, Gulf Bldg., P.O. Box 1166, Pittsburgh, Pennsylvania 15230

(26) Hancock Oil Co., P. O. Box 810, 2828 Junipero Ave., Long Beach, California 90806

(27) R. M. Hollingshead Corp. of Canada Ltd., 840 Cooper St., Camden, New Jersey 08102

(28) E. F. Houghton & Co., 303 West Lehigh Ave., Philadelphia, Pennsylvania 19133

(29) Exxon Company, U.S.A., Box 2180, Houston, Texas 77001

(30) Imperial Oil Co., Inc., 7009 River Road, Edgewater, New Jersey 07020

(31) Imperial Oil Limited, Imperial Oil Bldg., Toronto 1, Ontario, Canada

(32) Kendall Refining Co., 77 North Kendall Ave., Bradford, Pennsylvania 16701

(33) Lehigh Chemical Products Co., Trainer Chester, Pennsylvania

(34) Magnolia Petroleum Co., Beaumont, Texas

(35) Minnesota Mining and Manufacturing Co., St. Paul, Minnesota 55101

(36) Montgomery Ward Co., 618 W. Chicago Ave., Chicago, Illinois 60607

(37) National Carbon Co., 30 East 42nd St., New York, New York 10017

(38) Nox Rust Division, Daubert Chemical Co., 2000 Spring St., Hinsdale, Illinois 60523

(39) Pennsylvania Refining Co., Butler, Pennsylvania 16001

(40) Penola Oil Co., 15 W. 51st St., New York, New York 10019

(41) Petroleos Mexicanos, Av. Juarez 94, Mexico D. F.

(42) Phillips Petroleum Co., Bartlesville, Oklahoma 74003

(43) Prairie States Oil and Grease Co., Tilton Road, Danville, Illinois

(44) Products Research and Chemical Corp., 2919 Empire Ave., Burbank, California 91504

(45) The Pure Oil Co., Division of Union Oil Co., 200 E. Golf Rd., Palatine, Illinois 60067

(46) Quaker State Oil Refining Corp., Oil City, Pennsylvania 16302

(46A) Rockwell Mfg. Co., 411 North Lexington Ave., Pittsburgh, Pennsylvania 15208

(47) Royal Engineering Co., East Hanover, New Jersey 07981

(48) Royal Lubricants Co., River Road, Hanover, New Jersey 07936

(49) Shell Oil Co., R. C. A. Bldg., 50 W. 50th St., New York 10020, or San Francisco, California

(50) Sinclair Refining Co., 600 5th Ave., New York, New York 10020

(51) Societe Nacional de Petroleos, Rua D Pedro V. 80, Lisbon, Portugal

(52) Socony-Mobil Oil Co. Inc., 26 Broadway, New York, New York 10004

(52A) Socony-Mobil Oil Co. Inc., Shoreham Building, Washington, D. C. 20005

(53) Socony-Mobil Oil Co. Inc., 150 E. 42nd St., New York, New York 10017

(53A) Socony-Mobil Oil Co., Inc., Research & Development Laboratory, Paulsboro, New Jersey 08066

(54) Standard Oil of California, Standard Oil Bldg., 225 Bush St., San Francisco, California 94120

(55) Standard Oil Co., (Indiana), 910 South Michigan Ave., Chicago, Illinois 60680

(56) Sta-Vis Oil Co., 2314 Wycliff St., St. Paul, Minnesota 55114

(57) Sun Oil Co., Marcus Hook, Pennsylvania 19061

(58) The Texas Co., 135 E. 42nd St., New York, New York 10017

(59) Valvoline Oil Co., Freedom, Pennsylvania 15042

(60) Wolf's Head Oil Refining Co., Executive Offices, Oil City, Pennsylvania 16302

MAIN DRIVE CLUTCH

21-1-1. MAIN DRIVE CLUTCH ASSEMBLY.

21-1-2. DESCRIPTION. (See figure 21-1-1.) The main drive clutch assembly is mounted on an adapter bolted to the engine crankshaft drive flange, between the engine and base of the mechanical transmission. The clutch assembly, comprising a certrifugal friction clutch rotor and clutch housing, functions primarily to reduce loads imposed on the engine during starting. The housing, similar in appearance to an automobile brake drum, encloses the rotor which is driven by the engine crankshaft. When the engine is started, centrifugal force, acting upon the mercury contained in the rotor, causes the rotor friction shoes to engage the clutch housing which is directly connected to the transmission input shaft. During engine start, the clutch engages automatically at approximately 700 rpm, and is positively engaged at approximately 1600 to 1800 rpm as the engine is gradually accelerated.

NOTE: UH-12E Helicopters, Serial No. 2199 and subsequent, and helicopters modified in accordance with Service Bulletin No. 2027 are equipped with the engine drive flexible coupling. (Refer to paragraph 21-2-1.)

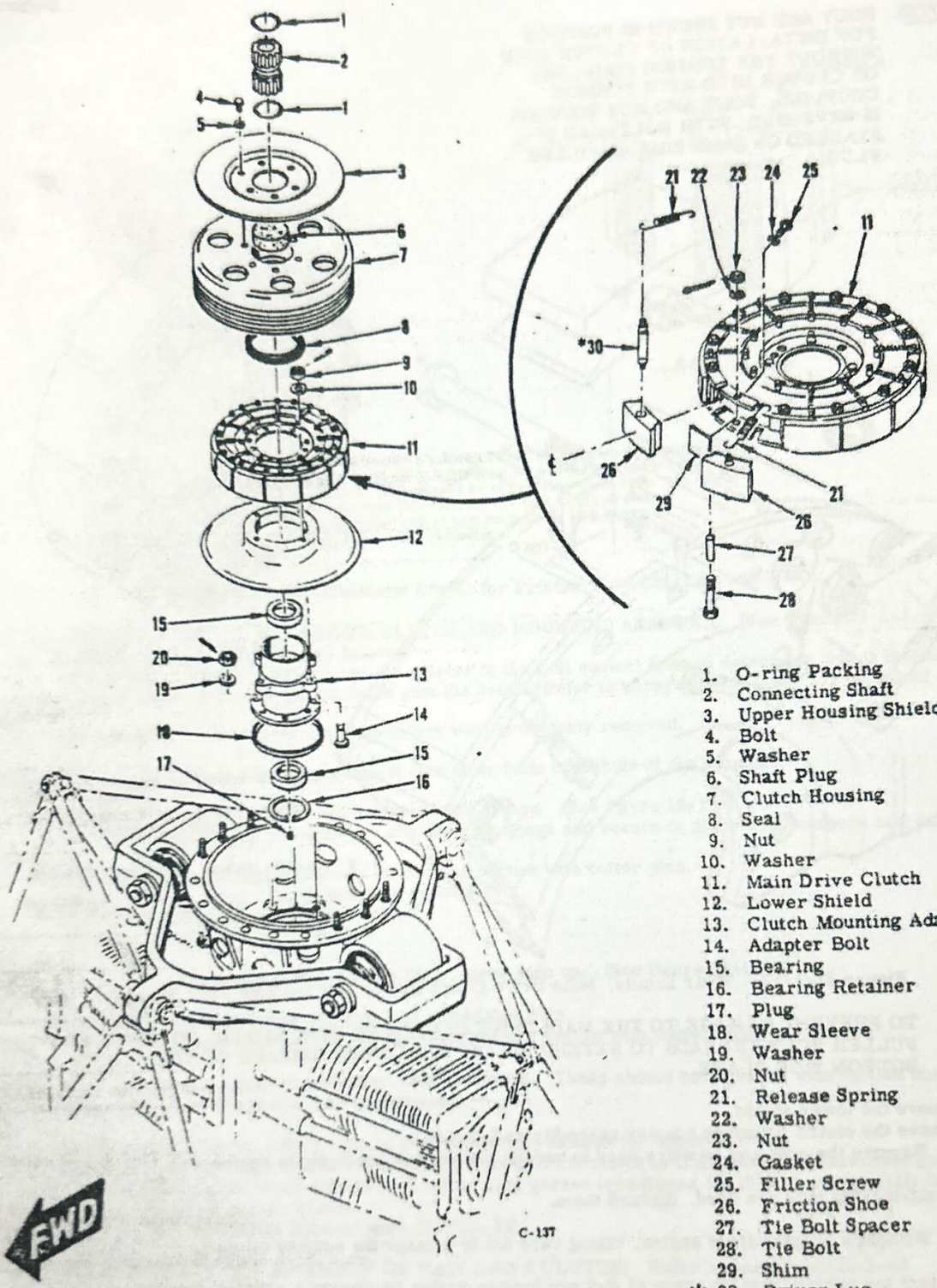
21-1-3. TROUBLESHOOTING THE MAIN DRIVE CLUTCH. Refer to Table 21-1-I for main drive clutch troubleshooting information.

Table 21-1-I. Troubleshooting the Main Drive Clutch and Engine Drive Flexible Coupling Assemblies

TROUBLE	PROBABLE CAUSE	REMEDY
Clutch grabbing or engaging at too low speed	Mercury content of clutch in excess of specified amount	Check mercury content (paragraph 21-1-40).
	Oil on shoes	Clean with dry cleaning solvent.
Clutch slipping	Clutch housing deeply scored or rusted on internal surface	Replace clutch housing with serviceable unit.
	Worn shoes	Replace with new set of shoes and springs.
	Oil on shoes	Clean with dry cleaning solvent.
	Clutch housing wear and/or normalizing due to overheating	Replace clutch and housing assembly
	Low mercury content	Check content. Fill as required.
	Mercury leakage	Replace clutch assembly. Remove mercury deposits.
	Leaking inner gimbal seal	Replace seal.
	Leaking clutch adaptor seal or input gearshaft oil seal	Replace seal(s).
	Broken clutch springs	Replace springs and shoe set as required.
	Glazed shoes	Blast clean shoe friction surfaces

21-1-10. REMOVAL OF MAIN DRIVE CLUTCH AND ADAPTER ASSEMBLY. (See figure 21-1-1.) Remove the main drive clutch from the engine as follows:

a. Remove the mechanical transmission. (Refer to Section 23.)
b. Remove clutch-to-transmission interconnecting shaft. Remove the two packing seals if required.
c. Lift off the clutch housing assembly.
d. Remove the four castellated nuts and washers securing the main drive clutch to the clutch mounting adapter bolts.
e. Using the puller holes (5/16 x 18 thread) provided in the clutch side plates, install a slotted yoke-type puller with appropriate length bolts and remove the clutch from the adapter.



1. O-ring Packing
2. Connecting Shaft
3. Upper Housing Shield
4. Bolt
5. Washer
6. Shaft Plug
7. Clutch Housing
8. Seal
9. Nut
10. Washer
11. Main Drive Clutch
12. Lower Shield
13. Clutch Mounting Adapter
14. Adapter Bolt
15. Bearing
16. Bearing Retainer
17. Plug
18. Wear Sleeve
19. Washer
20. Nut
21. Release Spring
22. Washer
23. Nut
24. Gasket
25. Filler Screw
26. Friction Shoe
27. Tie Bolt Spacer
28. Tie Bolt
29. Shim
* 30. Driver Lug

* LUG (30) BONDED IN SHOE IN LATER CONFIGURATION

Figure 21-1-1. Main Drive Clutch Assembly

NOTE: BOLT AND NUT SHOWN IN POSITION FOR INSTALLATION OF CLUTCH USED WITHOUT THE TORSION COUPLING. ON CLUTCH USED WITH TORSION COUPLING, BOLT AND NUT POSITION IS REVERSED, WITH BOLTHEAD INSTALLED ON SAME SIDE AS FILLER PLUG.

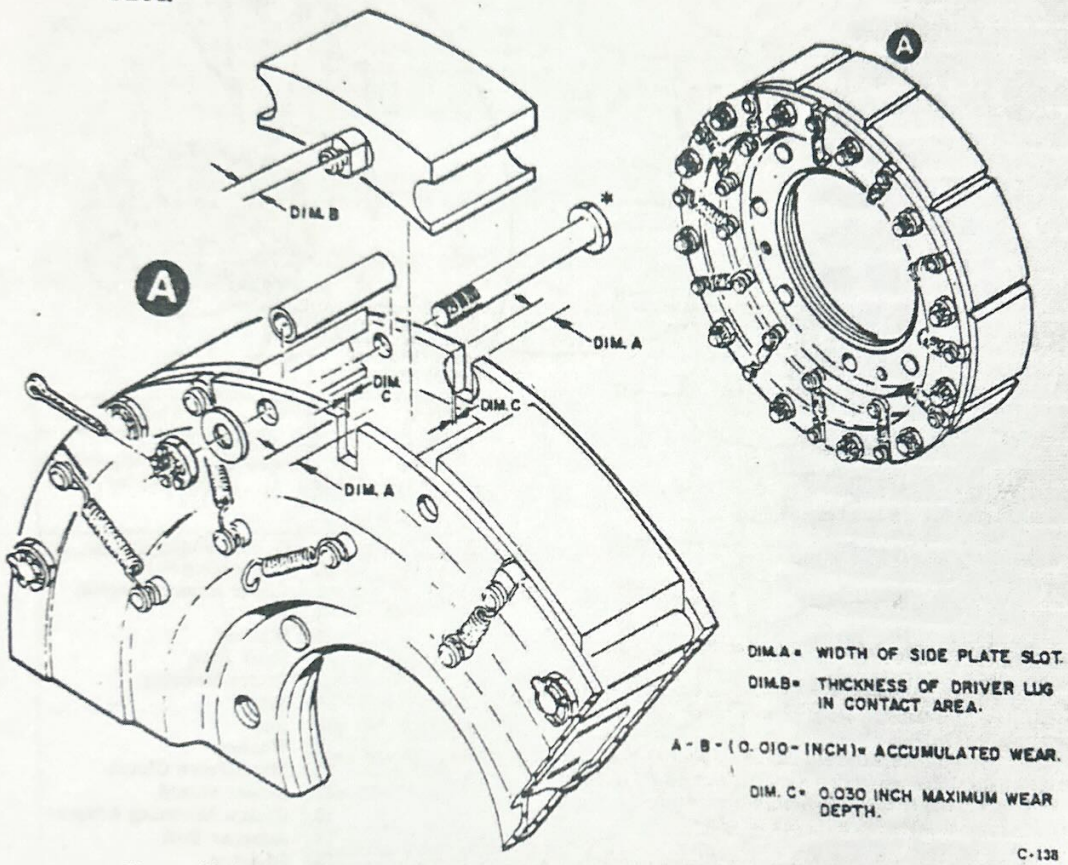


Figure 21-1-1A. Wear Limits, Main Drive Clutch Driver Lug and Side Plate Slots

CAUTION: TO PREVENT DAMAGE TO THE MAIN DRIVE CLUTCH HOUSING SHIELD, DO NOT ALLOW THE PULLER BOLT THREADS TO EXTEND BELOW THE LOWER SURFACE OF THE CLUTCH BOTTOM SIDE PLATE.

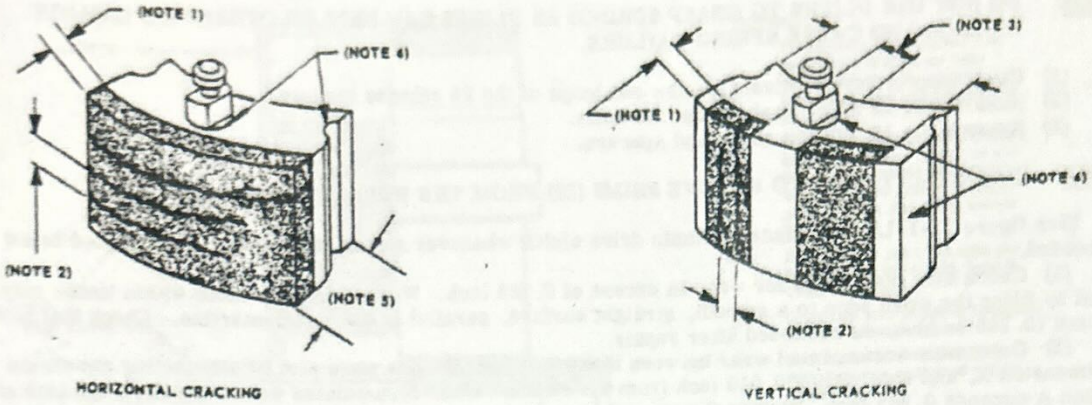
f. Remove the lower shield.
g. Remove the clutch mounting adapter assembly as follows:
(1) Remove the nuts and washers used to secure the adapter assembly to engine.

NOTE: If self-locking nuts are used, discard them.

(2) Withdraw adapter from engine, taking care not to damage the adapter oil seal.

NOTE: Protect the engine from entrance of dirt and foreign matter by placing a suitable cover over engine opening.

(3) If required, press out the two bearings located inside the adapter assembly.
(4) If required, remove and replace adapter oil seal (Section 63.)



NOTES:

(1) DEPTH OF CRACK PROGRESSION IS LIMITED TO 25% OF EXISTING SHOE THICKNESS
(2) PARALLEL CRACKS MAY NOT BE CLOSER THAN 1/4 INCH ALONG THEIR LENGTH
(3) DETERMINE SHADED AREA WIDTH LIMITS BY PROJECTING LINES FROM THE EDGES OF THE LUG HOLE WALL AND THE RADII OF THE SIDE FACES AS SHOWN
(4) NO VERTICAL CRACKS PERMITTED AT LUG HOLE OR ON SIDE FACES
(5) 0.794 MINIMUM PERMISSIBLE SHOE THICKNESS

Figure 21-1-2. Maximum Limits for Friction Shoe Cracking and Wear

21-1-11. INSTALLATION OF MAIN DRIVE CLUTCH AND MOUNTING ADAPTER. (See figure 21-1-1.)

a. Install the adapter assembly as follows:

(1) Inspect the outer perimeter of the adapter in the seal contact area to determine that it is smooth and free of nicks which would permit oil leaks past the seal. (Refer to paragraph 21-1-41, for repair of clutch adapter.)

(2) Install the two adapter bearings if they were previously removed.

NOTE: The sealed sides of the bearings must face away from the inside of the adapter.

(3) Pack the cavity between the bearings with grease. (See figure 10-19.)

(4) Install the adapter assembly on engine drive flange and secure in place with washers and castellated nuts.

(5) Tighten nuts to 160/240 pound-inches and secure with cotter pins.

b. Install the main drive clutch assembly as follows:

(1) Install the clutch shield on adapter.

(2) Install clutch on the adapter.

NOTE: The clutch must be installed with the filler screw side up. (See figure 21-1-1.)

(3) Secure the clutch with washers and castellated nuts.

(4) Tighten attach nuts to 300/340 pound-inches and secure with cotter pins.

NOTE: Early production adapters contained undrilled bolts. These should be replaced with drilled bolts so that castellated attach nuts can be installed.

c. Install clutch housing, taking care to seat it properly against the upper bearing.

d. Install the two packing seals in the annular grooves of the clutch to transmission interconnecting shaft.

e. Coat the interconnect shaft splines with lubricating grease (see figure 10-19) and insert shaft into clutch housing splines. Wipe off excess grease.

f. Reinstall the mechanical transmission (Section 23).

21-1-20. DISASSEMBLY AND ASSEMBLY OF MAIN DRIVE CLUTCH. Refer to paragraph 21-1-40.

21-1-40. MINOR REPAIR AND PARTS REPLACEMENT OF MAIN DRIVE CLUTCH. Clutch repairs are limited to those that can be accomplished without disassembly of the riveted side plates.

a. (See figure 21-1-1.) Disassemble main drive clutch as follows.

CAUTION: DO NOT USE PLIERS TO GRASP SPRINGS AS PLIERS CAN NICK OR OTHERWISE DAMAGE SPRINGS AND CAUSE SPRING FAILURE.

(1) Use a loop of wire to disengage the end loops of the 24 release springs.
(2) Remove the 12 nuts, washers and tie bolts.
(3) Remove the 12 friction shoes and spacers.

CAUTION: DO NOT ATTEMPT TO REMOVE SHIMS (29) FROM THE RUBBER BLADDER.

b. (See figure 21-1-1A.) Replace the main drive clutch whenever maximum wear limits specified below are exceeded.

(1) Check side plate slots for wear in excess of 0.285 inch. Worn side plate slots within limits may be repaired by filing the worn edge to a smooth, straight surface, parallel to the slot centerline. Check that slot width limit (0.285 inch) is not exceeded after repair.

(2) Determine accumulated wear between the driver lug and side plate slot by subtracting dimension B from dimension A, and subtracting 0.010 inch from the result. If the accumulated wear exceeds 0.050 inch and dimension A exceeds 0.285 inch, replace the main drive clutch assembly. If the accumulated wear exceeds 0.050 inch but dimension A does not exceed 0.285 inch after repair, new friction shoe assemblies may be installed.

(3) Check the side plate areas under the release springs for wear. The groove depth in the worn area must not exceed 0.030 inch.

(4) Check side plate for wear in driver lug contact area (dimension C). Wear in the contact area must not reduce side plate thickness more than 0.030-inch maximum.

c. Replace the main drive clutch if there is heavy rust on the side plates or burned or charred friction shoes.

d. Replace rusted, nicked, or otherwise damaged release springs.

e. Replace unserviceable friction shoes or springs by installing a complete kit of replacement parts. (Refer to UH-12E Parts Catalog.) Serviceability is determined as follows.

(1) Check friction shoe wear by measuring the depth of the groove in the outer surface of the shoe. If groove depth is 0.025 inch or less, measure overall thickness of the shoe. The minimum allowable overall shoe thickness is 0.794 inch. (Figure 21-1-2).

(2) Check friction shoes for excessive cracking. Some vertical and horizontal cracking is permissible but must not exceed limits shown in figure 21-1-2.

f. Serviceable shoes may be cleaned according to the following procedure:

(1) Remove any oil or grease from the shoes using dry cleaning solvent.
(2) Mask off the clutch shoe driver lugs with masking tape.
(3) Blast clean shoe friction surfaces using silica sand, aluminum oxide, glass beads or other suitable abrasive media.

NOTE: Subject the clutch to the blast only long enough to remove any glaze or dirt.

(4) Remove all abrasive residue and dust from the clutch shoes.

g. Cement any loose shims to the bladder after thoroughly cleaning each shim and exposed surface of the rubber gland with thinner or acetone.

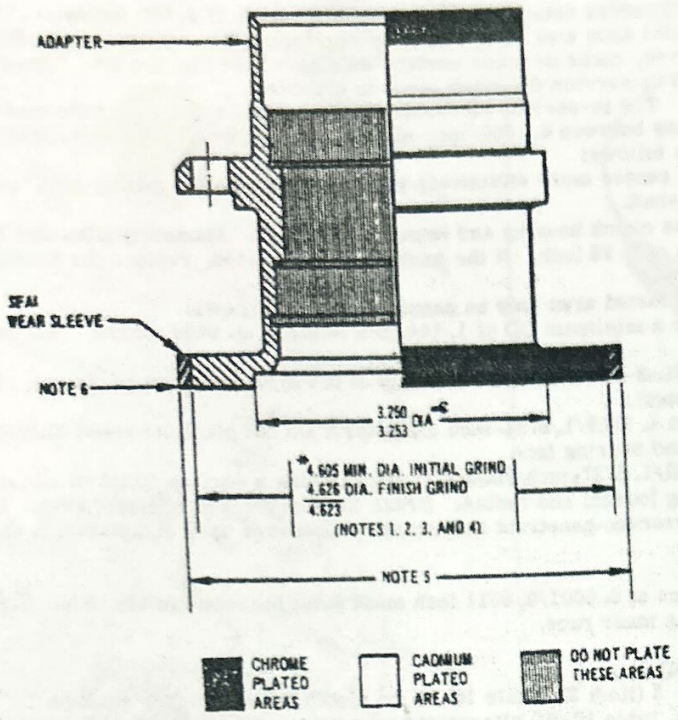
(1) Position each shim so that shim centerline lines up with the respective tie bolt centerline.
(2) Bond shims to rubber gland with cement (item 15, table 10-VI). Secure shims to gland in proper position with elastic bands or suitable cord.
(3) Allow cement to dry for 24 hours. Remove elastic bands or cord.

h. Assemble main drive clutch as follows:

(1) Check that no shims are loose (step f above).
(2) Install one friction shoe assembly and its release springs, using a loop of wire to stretch the spring in place.
(3) Prior to installing the next friction shoe assembly, insert a tie bolt spacer into position between the shoes. Slip a tie bolt through the tie bolt holes and spacer, and retain finger tight with a castellated nut.

NOTE: On a main drive clutch used without the torsion coupling (figure 21-1-1), install the tie bolt, washer and nut with the nut on the same side as the filler plug (figure 21-1-1A). On a main drive clutch used with the torsion coupling (figure 21-1-3), the tie bolt head is installed on the same side as the filler plug.

(4) Install the remainder of the friction shoe assemblies, release springs, spacers, tie bolts, washers and castellated nuts.
(5) Tighten the castellated nuts to 80/105 pound-inches after the main drive clutch has been assembled and secure with cotter pins.



NOTES:

*To maintain diameter and concentricity required for wear sleeve installation, adapter lower seal area may be repaired as noted.

*1. Remove chrome plating from this area by grinding. Shot peen per MIL-S-13165, with an intensity of 0.010A/0.014A before chrome plating. Shot size not to exceed No. 280.

*2. Hard chrome plate this area per Specification QQ-C-320, Type II, Class 2 standards.

*3. Grind this area to obtain 32-micro-inch surface finish or better.

*4. This diameter to be concentric with diameter marked ℄ within 0.003-inch TIR.

5. Wear Sleeve (J-1155) installed diameter to be concentric with diameter marked ℄ within 0.007-inch TIR.

6. Wear Sleeve lower edge to be flush with lower surface of adapter flange.

7. All dimensions in inches.

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Figure 21-1-2A. Clutch Adapter Seal Wear Sleeve Installation

1. Check clutch mercury content as follows:

(1) The net weight and mercury content are indicated in grams, stamped on the steel side plate. The minimum mercury content is 975 grams (34.39 ounces), and the maximum is 1025 grams (36.16 ounces). The clutch net weight is the complete assembly weight less the mercury weight. No parts need be removed to determine the mercury content.

CAUTION: USE EXTREME CARE WHEN HANDLING MERCURY. AVOID SPILLING IT ON ALUMINUM OR MAGNESIUM PARTS, AS DAMAGE MAY RESULT. (REFER TO PARAGRAPH 21-1-43.)

(2) Add or remove mercury through the filler plug hole as required to obtain the correct weight. Conversion factors are: 1 gram equals 0.03527 ounces; 1 ounce equals 28.3495 grams.

(3) Check that the mercury filler plug and gasket are securely in place. Secure plug with 0.032-inch-diameter wire (item 6, table 10-VI), to the nearest release spring post.

21-1-41. MINOR REPAIR OF CLUTCH ADAPTER. Clutch adapters that are unserviceable due to damaged inner gimbal seal to adapter sealing surface may be repaired by installation of a wear sleeve on the adpater sealing surface.

NOTE: Whenever a seal wear sleeve is installed on an adapter, make sure the proper seal is installed in the engine inner gimbal. (Refer to UH-12E Parts Catalog for correct seal part number.)

a. Stone any ridges, raised metal or sharp groove radii from adapter lower seal bearing surface. Maintain a seal bearing surface diameter of 4.623/4.626 inches concentric with adapter bore (3.250/3.253-inch diameter) with 0.003-inch TIR.

b. If necessary to maintain required dimensions and cencentricity, the adapter lower seal surface may be reworked as shown in figure 21-1-2A.

c. Press seal wear sleeve over adapter flange bearing surface with the lower edge of sleeve flush with lower surface of adapter flange. After installation, the seal wear sleeve shall be concentric with adapter bore (3.250/3.253-inch diameter) within 0.007-inch TIR.

d. Replace damaged or worn wear sleeve in service whenever necessary.

21-1-42. MINOR REPAIR OF CLUTCH HOUSING. Check clutch housing for serviceability, and repair or replace components as follows.

a. Replace clutch housing if the inside diameter exceeds the serviceability limit of 9.540 inches.

b. The clutch housing friction shoe contact area may be repaired by regrinding to a maximum diameter of 9.534 inches in order to remove taper, grooves, nicks or other surface defects. Note that the maximum diameter for regrinding is less than the maximum in-service diameter given in a above.

c. Check internal spline area for wear. The in-service allowable between-pin dimension for the mercury clutch housing spline is limited to 1.636 inches between 0.1800-inch-diameter pins. Determine serviceability in terms of backlash between mating parts as follows:

(1) Since the interconnect shaft will center more effectively when meshed with the mating part, install both the O-ring packing and the interconnect shaft.

(2) Measure the backlash between the clutch housing and interconnect shaft. Maximum allowable backlash is 0.026 inch measured on a pitch radius of 0.95 inch. If the tolerance is exceeded, replace the housing or interconnect shaft, as applicable.

d. Repair of any clutch housing bearing journal area may be accomplished as follows:

(1) Grind the bearing journal area to a minimum OD of 1.544 inch to clean up wear marks. Magnetic-particle inspect affected area after grinding.

(2) Shot peen the ground area per MIL-S-13165 with an intensity of 0.010/0.014A before plating. Use cast shot no larger than No. 280 (0.028 diameter).

(3) Hard chrome plate ground area to 1.5775/1.5781-inch diameter. Do not plate the relief diameter between journals, nor between inner journal and bearing face.

(4) Finish grind plated area to 1.5742/1.5737-inch diameter, maintaining a surface finish of 125 micro-inches. Maintain existing chamfer and bearing journal end radius. Break all sharp edges in plated area. Magnetic-particle inspect the base metal and fluorescent-penetrant inspect the plated area upon completion of the final machining operation.

NOTE: To obtain proper bearing fit, clearance of 0.0001/0.0011 inch must exist between the clutch housing bearing journal and the mating bearing inner race.

e. Replace the clutch housing shield as follows:

(1) Apply a thin coat of Permatex No. 3 (item 23, table 10-VI) on clutch housing upper surface.

(2) Wrap silk thread, Size A (item 28, table 10-VI) alternately on outside and inside of shield mounting holes.

(3) Install shield on housing with specified bolts, tighten to 25/35 pound-inches. Secure bolts with 0.032-inch-diameter wire (item 6, table 10-VI).

21-1-43. CLEANING OF PARTS AFTER EXPOSURE TO MERCURY. Mercury is a cumulative poison which must be promptly and thoroughly removed from the helicopter in the event of mercury clutch leakage or spillage. Use the following procedure to remove the mercury and treat any contaminated areas.

WARNING: TO AVOID POSSIBLE TOXIC EFFECTS WHICH COULD RESULT FROM MERCURY REMOVAL OPERATIONS, MOVE THE HELICOPTER OR THE AFFECTED PARTS TO A WELL VENTILATED LOCATION IMMEDIATELY: THEN PROCEED WITH THE CLEANING STEPS OUTLINED BELOW.

a. Use a soft brush or cloth to collect or sweep all visible mercury into a container for disposal. Avoid dispersing the mercury over surrounding surfaces during the removal process and avoid dropping it onto hard surfaces where it will tend to spread.

b. Scrub the spillage area and surrounding surfaces thoroughly with hot water, paying particular attention to porous surfaces and small crevices.

c. Inspect the cleaned area carefully for evidence of mercury damage.

d. Cadmium plated surfaces, magnesium surfaces or aluminum surfaces which have been attacked by mercury will become darkened by amalgam. In stubborn cases it will be necessary to use mechanical scraping to clean the area.

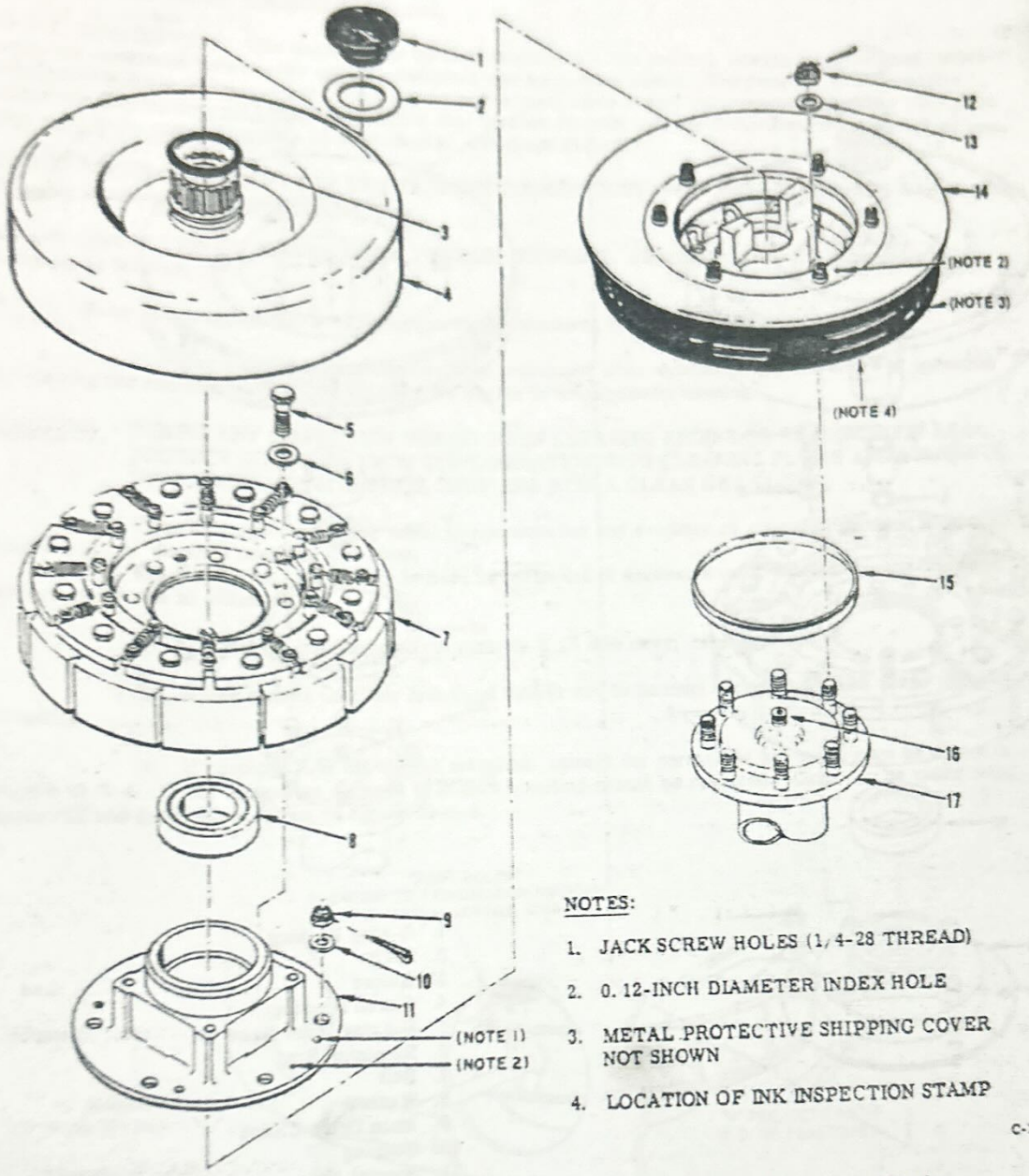
e. Allow a minimum of 4 hours to elapse after cleaning, then reinspect the affected areas. If amalgam darkening is again noted, repeat the hot water and scraping treatment until no further reaction is detected.

NOTE: Any copper, brass or other copper based alloys that have been in contact with mercury must be replaced. Cleaning operations are ineffective on these materials.

f. If the surface damage is not extensive after cleaning, use the appropriate method outlined below to restore the protective finish to the reworked area. If the damaged area is extensive, replace the affected parts.

(1) Renew the protective coating on aluminum alloy or magnesium alloy parts in accordance with instructions provided in Section 10.

(2) Protect the damaged surface of cadmium plated steel parts by brushing two coats of primer (item 3, table 10-VI) over the bare areas.



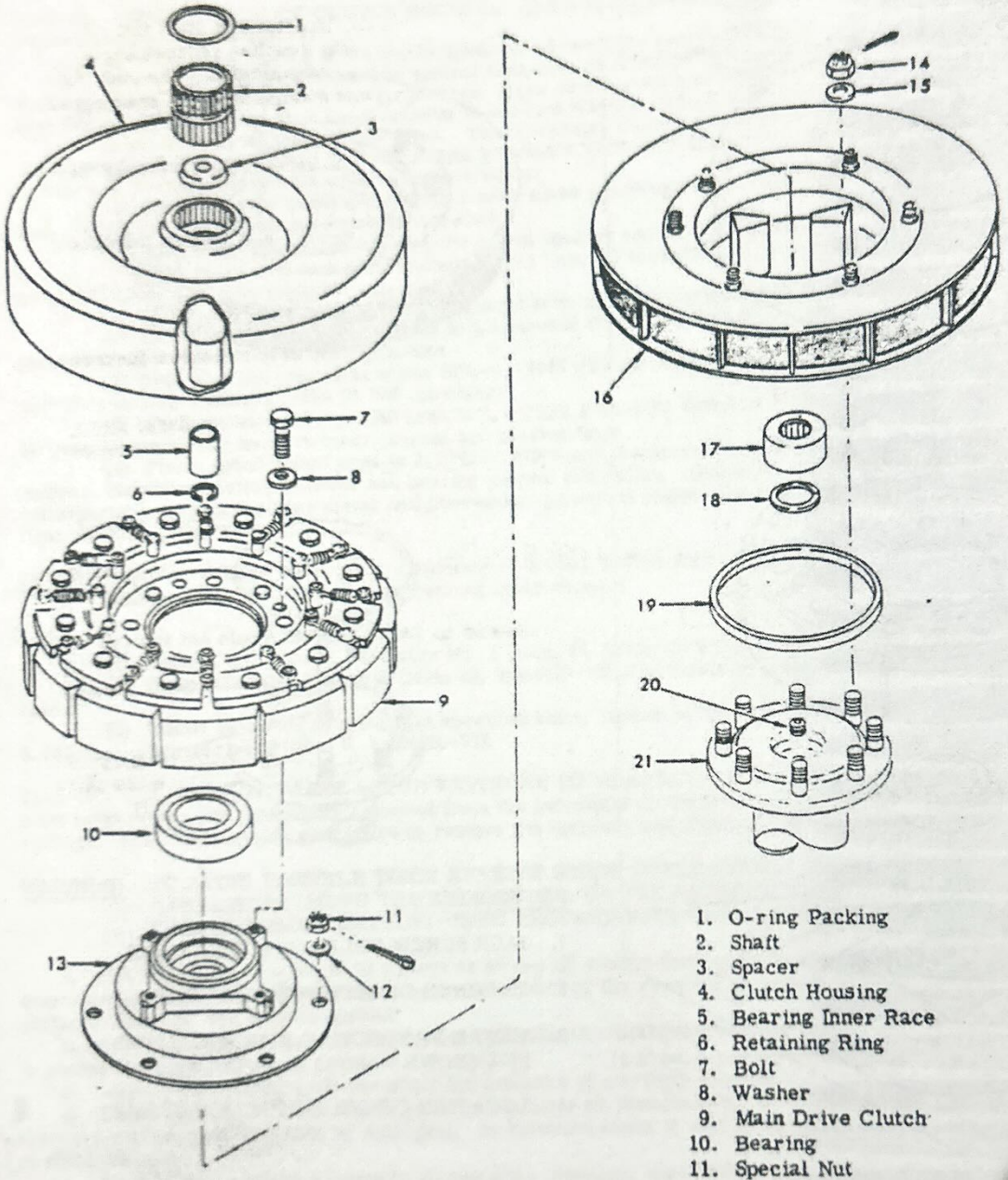
NOTES:

1. JACK SCREW HOLES (1/4-28 THREAD)
2. 0.12-INCH DIAMETER INDEX HOLE
3. METAL PROTECTIVE SHIPPING COVER NOT SHOWN
4. LOCATION OF INK INSPECTION STAMP

C-129

1. Bumper
2. Shim Washer
3. O-ring Packing
4. Clutch Housing
5. Bolt
6. Washer
7. Main Drive Clutch
8. Bearing
9. Special Nut
10. Special Washer
11. Upper Torsion coupling Section
12. Nut
13. Washer
14. Lower Torsion Coupling Section
15. Wear Sleeve
16. Crank Shaft Oil Front Plug (ref)
17. Engine Crankshaft Mounting Flange (ref)

Figure 21-1-3. Engine Flexible Drive Coupling



1. O-ring Packing
2. Shaft
3. Spacer
4. Clutch Housing
5. Bearing Inner Race
6. Retaining Ring
7. Bolt
8. Washer
9. Main Drive Clutch
10. Bearing
11. Special Nut
12. Special Washer
13. Torsion Coupling Upper Section
14. Nut
15. Washer
16. Torsion Coupling Lower Section
17. Bearing Outer Race
18. Retaining Ring
19. Wear Sleeve
20. Crankshaft Oil Front Plug
21. Engine Crankshaft Mounting Flange

Figure 21-1-3A. Main Drive Clutch Assembly (P/N 21070-11) and Torsion Coupling (P/N 21047-11)

21-2-1. ENGINE DRIVE TORSION COUPLING.

21-2-2. DESCRIPTION. The engine drive torsion coupling is a two section, interlocking steel and rubber assembly positioned between the engine crankshaft and main drive clutch. The coupling reduces engine torsional vibration loads imposed by the engine on the main drive clutch and transmission. The main drive clutch housing incorporates a splined section that meshes directly with the transmission input shaft splines. The main drive clutch functions as described in paragraph 21-1-2.

21-2-3. TROUBLESHOOTING THE ENGINE DRIVE TORSION COUPLING. Refer to table 21-1-I for torsion coupling troubleshooting information.

21-2-4. INSPECTION OF ENGINE DRIVE TORSION COUPLING. (See figure 21-1-4.) Inspect installed coupling as follows:

NOTE: Refer to paragraph 21-2-42 for inspection procedures of disassembled coupling.

a. The following visual inspections should be performed after approximately 100 hours of operation by viewing the coupling through the holes in the engine to transmission housing.

CAUTION: DURING ANY INSPECTION PERIOD WHEN CLEANING ENGINE OR TRANSMISSION AREA, PROTECT COUPLING FROM CONTAMINATION WITH CLEANING FLUIDS AND SOLVENTS. WIPE CONTAMINANTS FROM COUPLING WITH A CLEAN DRY CLOTH.

(1) Visually inspect coupling metal components for any evidence of cracks or damage which imply failure. Replace coupling if evident.

(2) Visually inspect elastomer section for evidence of excessive cuts, cracks, bond separation or permanent set as follows:

(a) If metal-to-bond separation exceeds 0.15 inch deep, replace coupling.

(b) If flex cracks (surface failure of rubber due to flexing) exceed 0.15 inch deep, replace coupling.

(c) If coupling P/N 21046-5 is installed, inspect for permanent set using gage as shown in figure 21-1-4. If "S" dimension exceeds 0.25 inch coupling should be replaced. Gage can be made using material and dimensions shown on figure 21-1-6.

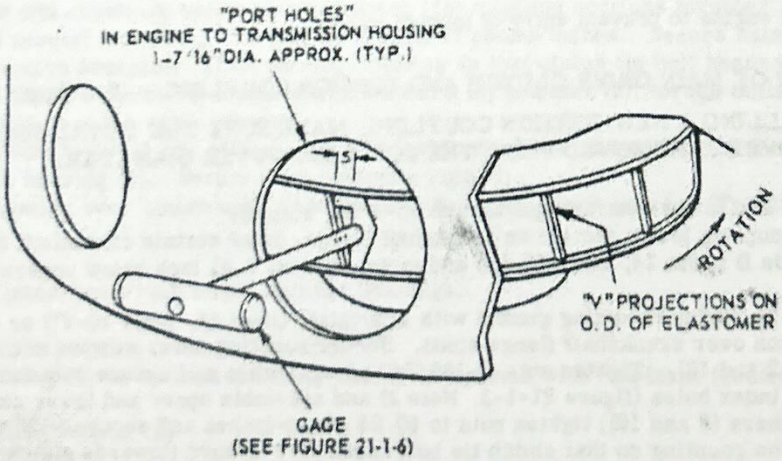


Figure 21-1-4. Measuring for Permanent Set with Gage

21-2-10. REMOVAL OF MAIN DRIVE CLUTCH AND TORSION COUPLING. (See figure 21-1-3.)

a. Remove the transmission (Section 23).

b. Remove clutch housing (4). Retain bumper (1), O-ring packing (3) and shim washers (2) for reinstallation. Replace bumper and O-ring packing if damaged.

CAUTION: TO AVOID DAMAGING TORSION COUPLING, DO NOT ALLOW PULLER BOLT THREADS TO EXTEND BELOW THE LOWER SURFACE OF THE CLUTCH SIDE PLATE.

c. Detach main drive clutch (7) from torsion coupling by removing four attaching bolts and washers (5 and 6), and attaching a slotted-yoke type puller to the clutch side plates with bolts (5/16 x 18 thread) of appropriate length.

d. Remove six nuts and washers (9 and 10) that attach coupling upper section (11) to lower section (14). Install four bolts (AN4-10A) in the jackscrew holes provided in coupling upper section flange and tighten the bolts equally to separate the upper and lower sections. Remove the jackscrews.

e. Remove eight special nuts and washers (12 and 13) that attach coupling lower section to engine crankshaft flange; remove coupling lower section, taking care not to damage oil seal in the engine mounting gimbal. Retain the special nuts and washers for reinstallation.

CAUTION: THE UPPER AND LOWER SECTIONS (11 AND 14) OF THE COUPLING MUST BE MAINTAINED AS A SERIALIZED MATCHED SET.

f. Place a covering over the engine to prevent entry of foreign matter.

21-2-10A. REMOVAL OF MAIN DRIVE CLUTCH (P/N 21070-11) AND TORSION COUPLING (P/N 21047-11). (See figure 21-1-3A.)

a. Remove main transmission (Section 23).

b. Remove splined connecting shaft (2) and O-ring packing (1).

c. Remove spacer (3) from clutch housing (4) and remove housing from clutch assembly.

d. Detach main drive clutch (9) from torsion coupling by removing four attaching bolts (7) and washers (8) and attach a slotted-yoke type puller to the clutch side plates with bolts (5/16 x 18 thread) of appropriate length, threaded into holes provided in clutch side plates.

CAUTION: TO AVOID DAMAGING TORSION COUPLING, DO NOT ALLOW PULLER BOLT THREADS TO EXTEND BELOW THE LOWER SURFACE OF THE CLUTCH SIDE PLATE.

COUPLING UPPER AND LOWER SECTION (13 AND 16) MUST BE MAINTAINED AS A SERIALIZED MATCH SET.

e. Remove cotter pins and six special nuts (11) and special washers (12) securing coupling upper section (13) to lower section (16); separate the sections by installing AN4-10A bolts into jackscrew holes. Tighten bolts equally to separate the sections. Remove the jackscrews.

f. Remove bearing (10) from coupling upper section.

g. Remove the eight nuts and washers (14 and 15) that attach coupling lower section to engine crankshaft flange; remove coupling lower section taking care not to damage oil seal in the engine mounting gimbal. Retain nuts and washers for reinstallation.

h. Cover open end of engine to prevent entry of foreign matter.

21-2-11. INSTALLATION OF MAIN DRIVE CLUTCH AND TORSION COUPLING. (See figure 21-1-3.)

CAUTION: WHEN INSTALLING A NEW TORSION COUPLING, MAKE SURE THE METAL PROTECTIVE SHIPPING COVER IS REMOVED FROM THE COUPLING OUTER DIAMETER.

a. Separate the upper and lower sections (paragraph 21-2-10, step d).

b. Before installing coupling lower section on crankshaft flange, make certain crankshaft oil plug (16) is installed with Loctite, grade B (item 24, table 10-VI) and is set at least 0.41 inch below uppermost surface of crankshaft flange.

c. Coat lip of oil seal in engine mounting gimbal with Lubriplate (item 16, table 10-VI) or equivalent, and install coupling lower section over crankshaft flange studs. Secure coupling lower section to crankshaft with special nuts and washers (12 and 13). Tighten nuts to 180/240 pound-inches and secure with cotter pins.

d. Align dowel pin or index holes (figure 21-1-3, Note 2) and assemble upper and lower coupling assemblies. Install nuts and washers (9 and 10); tighten nuts to 60/85 pound-inches and secure with cotter pins.

e. Position clutch (7) on coupling so that clutch tie bolt heads face upward (towards clutch housing). Install bolts and washers (5 and 6) to secure clutch to coupling, and tighten bolts to 300/400 pound-inches. Secure boltheads in pairs with 0.041-inch-diameter lockwire (item 6, table 10-VI).

f. Apply a coat of Lubriplate (item 16, table 10-VI) or equivalent, to bearing mounting journal of clutch housing (4). Position clutch housing over clutch. Push clutch housing downward until housing shaft bearing journal seats against bearing inner race.

g. Check that O-ring packing (3) is installed on clutch housing splines; and coat splines with specified lubricant (Section 10).

h. Install bumper (1) and shim washers (2).

NOTE: The procedures for determining the required thickness of the washers for installation between the bumper and the top of the housing splines are given in Section 23, paragraph 23-1-30.

i. Install transmission (Section 23).

21-2-11A. INSTALLATION OF MAIN DRIVE CLUTCH (P/N 21070-11) AND TORSION COUPLING (P/N 21047-11). (See figure 21-1-3A.)

CAUTION: BEFORE INSTALLING A NEW TORSION COUPLING, MAKE SURE METAL PROTECTION COVER IS REMOVED FROM LOWER SECTION OUTER DIAMETER.

a. If installing a new torsion coupling, separate upper section (13) from lower section (16) by removing cotter pins and six special nuts (11) and special washers (12).

NOTE: Wear sleeve (19) must be installed in accordance with paragraph 21-2-42.

b. Before installing coupling lower section on crankshaft flange, make certain crankshaft oil plug (20) is installed and is set at least 0.41 inch below uppermost surface of crankshaft flange. Install oil plug (20) with Loctite, Grade B (American Sealants).

c. Install bearing (17) outer race in coupling lower section and secure with retaining ring (18). Pack bearing with grease MIL-G-3545C until level with seal.

NOTE: Bearing (5) inner race is installed on clutch housing (4); see step h following.

d. Coat lip of oil seal in engine mounting gimbal with Lubriplate 630AA (Fisk Bros. Refining Co.) or equivalent, and install coupling lower section over crankshaft flange studs. Secure coupling lower section to crankshaft with nuts and washers (14 and 15). Tighten nuts to 180/240 pound-inches and secure with cotter pins.

CAUTION: COUPLING UPPER AND LOWER SECTIONS (13 AND 16) ARE A SERIALIZED MATCHED SET. CLUTCH END AND ENGINE END SHALL NOT BE INTERCHANGED WITH OTHER COUPLING PARTS.

e. Coat bearing (10) outer surface with Lubriplate and install in coupling upper section (13).

CAUTION: SUPPORT COUPLING UPPER SECTION (13) WHILE PRESSING BEARING (10) TO AVOID LOADING LUGS.

f. Align index holes and assemble upper (13) and lower (16) coupling sections together. Secure with special washers (12) and special nuts (11). Torque nuts to 60/85 pound-inches. Secure nuts with cotter pins.

g. Install mercury clutch assembly (9) on torsion coupling so that clutch tie bolt heads face upward (toward clutch housing). Secure clutch to coupling with washers (8) and bolt (7); torque bolts to 300/340 pound-inches. Secure bolts in pairs with lockwire.

h. Apply Loctite, grade A (10-1) per MIL-S-22473 to inside diameter of bearing (5) and install on bearing mounting journal of clutch housing (4). Secure with retaining ring (6).

i. Position clutch housing over clutch and press housing downward until bearing (5) inner and outer races are seated.

NOTE: Avoid excessive pressure which might damage bearings.

j. Place spacer (3) into position in clutch housing.

k. Install O-ring packing (1) on splined coupling (2). Coat splines with lubricant (Section 10) and install in clutch housing.

l. Install transmission (Section 23).

21-2-40. MINOR REPAIR AND PARTS REPLACEMENT OF MAIN DRIVE CLUTCH. Refer to paragraph 21-1-40 for repair and parts replacement of main drive clutch.

21-2-41. REPAIR AND REPLACEMENT OF MAIN DRIVE CLUTCH HOUSING.

a. Refer to paragraph 21-1-42 for minor repairs of main drive clutch housing.

b. Check the clutch housing splines for wear. The allowable minimum over-pin dimension for the clutch housing splines is 2.1532 inches over 0.1920-inch-diameter pins.

c. Repair worn clutch housing as follows (figure 21-1-4A):

(1) Worn clutch housing may be repaired if area "A" dimension is 0.101-inch minimum after machining to remove scoring.

(2) Bond wear washer (P/N 21073-3), chamfered side toward housing surface, to clutch housing using Metlhesive 2006 (item 37, table 10-VI).

(3) Apply Everlube 620 (item 38, table 10-VI), Solid Film Lubricant, to area "B" of the clutch housing.

(4) Reidentify housing as P/N 21070-31.

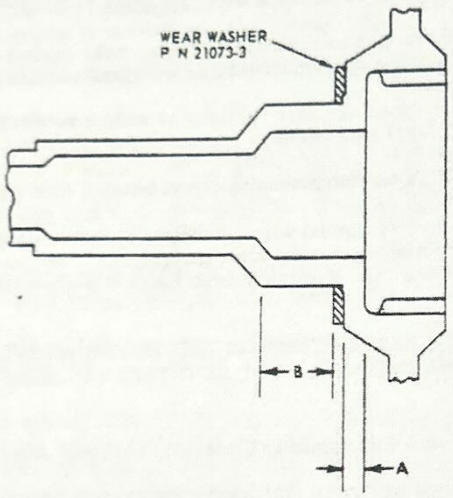


Figure 21-1-4A. Repair of Worn Clutch Housing, P/N 21070-11

21-2-42. REPAIR AND REPLACEMENT OF TORSION COUPLING PARTS. (See figure 21-1-3.) Replace unserviceable coupling parts in accordance with removal and installation procedures (paragraph 21-2-10 and 21-2-11) and as follows.

a. Replace bearing (8) in the following manner.

(1) After removing coupling, insert four rods of equal length in the four puller holes, spaced equidistant around the coupling upper section inner perimeter, and press out bearing.

(2) Coat new bearing outer race with Lubriplate (item 16, table 10-VI) or equivalent, and press into place in the upper section.

b. Install or replace seal wear sleeve (15) on the torsion coupling lower seal bearing surface as follows.

NOTE: Whenever the initial installation of the wear sleeve is accomplished be sure the correct seal is installed in the engine inner gimbal assembly. (Refer to the UH-12E Parts Catalog.)

(1) Stone any ridges, raised metal or sharp grooved radii from coupling lower seal bearing surface. Maintain a seal bearing surface diameter of 4.623/4.626 inch concentric with coupling bore (3.250/3.253-inch diameter) within 0.001-inch TIR.

(2) Press seal wear sleeve (15) over coupling lower housing seal bearing surface, with the lower edge of the wear sleeve flush with the lower surface of coupling mounting flange. After installation, the seal wear sleeve must be concentric with coupling bore (3.250/3.253-inch diameter) within 0.005-inch TIR.

(3) Replace a worn or damaged wear sleeve in service as required.

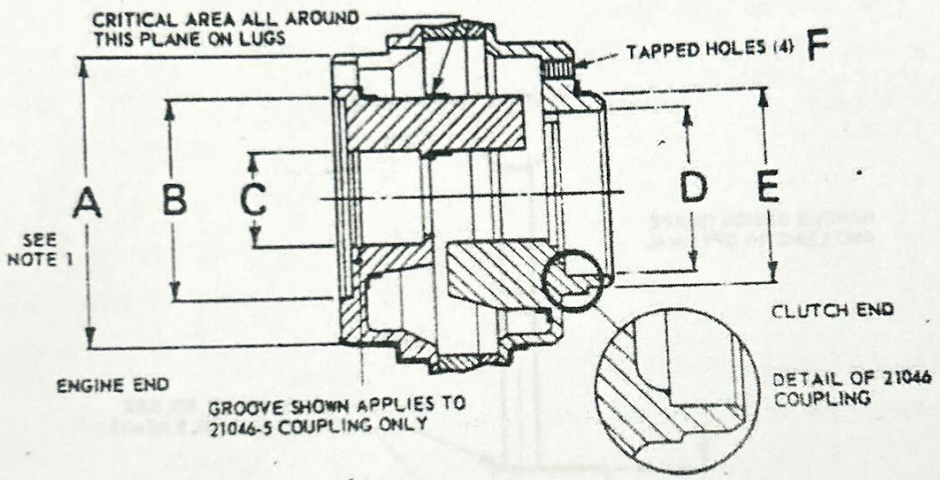
c. With coupling disassembled follow same inspection procedures as outlined in paragraph 21-2-4, together with the following additional procedures.

(1) The clutch end and the crankshaft end of the coupling should be checked for excessive wear of the critcal dimensions indicated in figure 21-1-5. If dimensions are not within allowable tolerances, replace the coupling.

(2) Inspect for cracks using dye penetrant only and exercise care not to allow penetrant to spill on elastomer portion of coupling. Special attention should be given when inspecting for cracks at bottom of safety lugs. (See bold lines on figure 21-1-5 for critical areas). No cracks or bent lugs are permitted.

(3) Inspect for nicks or gouges and if they exceed 0.03 inch depth, replace coupling. Nicks or gouges less than 0.03 inch deep may be polished out except in critical areas of safety lugs and then painted with zinc chromate primer to prevent corrosion.

NOTE: To maintain a record of the number of times coupling has been inspected at engine overhaul, mark the date of overhaul and the number of service hours on the coupling since last inspection. Use an ink stamp to mark the data on the face of the engine end as shown in figure 21-1-3.



FAIRCHILD PART NUMBER	ENGINE END DIMENSIONS *			CLUTCH END DIMENSIONS **		
	A	B	C	D	E	F
21046	4.623 4.626	3.250 3.253	1.6875 1.6880	2.6772 2.6779	3.0615 3.0620	3/8-24 UNF-3B Thread
21046-5	4.623 4.626	3.250 3.253	1.4989 1.4996	2.6759 2.6775	3.0615 3.0620	3/8-24 UNF-3B Thr ad

1. Dimension "A" applies if wear sleeve (15), figure 21-1-3, has been removed for replacement. Otherwise may be disregarded.

* Dimensions shown in columns A and B shall be concentric with dimensions shown in column C within 0.001 inch TIR.

** Dimensions shown in column D shall be concentric with dimensions shown in column E within 0.002 inch TIR.

Figure 21-1-5. Critical Inspection Dimensions

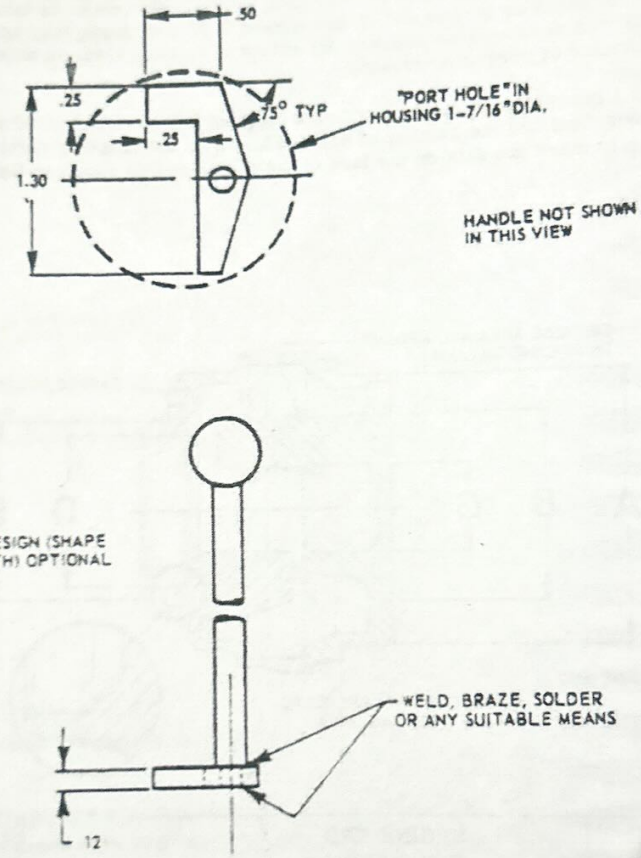


Figure 21-1-6. Dimensions for Making Permanent Set Gage

ROTOR BRAKE INSTALLATION

22-101-1. MAIN ROTOR BRAKE KIT INSTALLATION. (See figures 22-101-1 and -2.)

22-101-2. DESCRIPTION. The main rotor brake kit installation provides a manually operated, hydraulically actuated means for fast, cabin-controlled stopping of the main rotor and secondary drive systems. The rotor brake installation consists of a brake and drum assembly and a master cylinder mounted to the seat deck structure at the left-hand side of the pedestal tunnel in the cabin. Direct hydraulic coupling is provided through associated tube and hose assemblies secured to the engine mount and inside the structure in the left-hand side of the helicopter.

a. The rotor brake is comprised of an expander tube brake assembly containing a segmented lining (six shoes), a brake drum, a tail rotor oil seal and rotor brake retainer, and a brake drum adapter. The brake linings are held in position by clip-type springs which also serve to return the linings to the disengaged condition after fluid pressure is released. The tail rotor oil seal and rotor brake retainer is a replacement for the standard tail rotor drive oil seal retainer and attaches the expander tube brake assembly to the tail rotor drive housing. The brake drum adapter attaches the drum housing to the tail rotor drive coupling--this provides for unit attachment of the forward slip joint, the drive coupling, and the drum adapter with a single set of bolts.

22-101-10. REMOVAL OF THE ROTOR BRAKE KIT INSTALLATION. (See figures 22-101-1 and -2.)

NOTE: The following removal and installation instructions apply to the rotor brake kits installed on both the three-place and four-place configurations.

a. Remove the brake and drum assembly from the tail rotor drive system in the following manner:

(1) Cut the lockwire securing the special bolts attaching the forward slip joint to the drive coupling. Remove the bolts and washers.

(2) Remove the bolts and washers attaching the forward tail rotor drive shaft to the forward universal joint and lift the drive shaft clear of the helicopter.

(3) Check that the master cylinder control rod is in the down (no pressure) position and then disconnect the hydraulic fluid hose assembly from the union at the rotor brake tube. Plug the hose fitting and cap the union.

(4) Remove the cotter pin, left-hand threaded nut and two thrust washers from the tail rotor drive coupling. Remove the drive coupling, brake drum adapter and brake drum.

(5) Place some rags under the tail rotor drive housing to absorb oil drainage and then slide the oil seal and rotor brake retainer from the drive housing.

(6) Check the rotor brake retainer O-ring packing and the tail rotor drive coupling oil seal for evidence of deterioration or damage caused by removal of the rotor brake. Replace defective seals.

NOTE: The O-ring and oil seal are the same seals used in the standard tail rotor drive oil seal retainer (Part No. 23582).

b. Remove the master cylinder from the cabin structure in the following manner:

(1) Remove the seat cushions, the safety belts as necessary, the seat deck from the left-hand side of the seat deck structure and pilots seat, if installed.

(2) Remove the nuts, bolts, bushing and washers attaching the control rod to the bulkhead brackets and the piston rod clevis. (Observe that two AN960-10L washers are used to shim the control rod in the piston rod clevis.)

(3) Remove the control rod from the front of the seat deck bulkhead.

(4) Place some rags underneath the master cylinder; then disconnect the tube assembly from the master cylinder. Cap the master cylinder fitting and plug the tube fitting.

(5) Remove the nuts, bolts and washers securing the master cylinder to the bulkhead support and withdraw the master cylinder assembly.

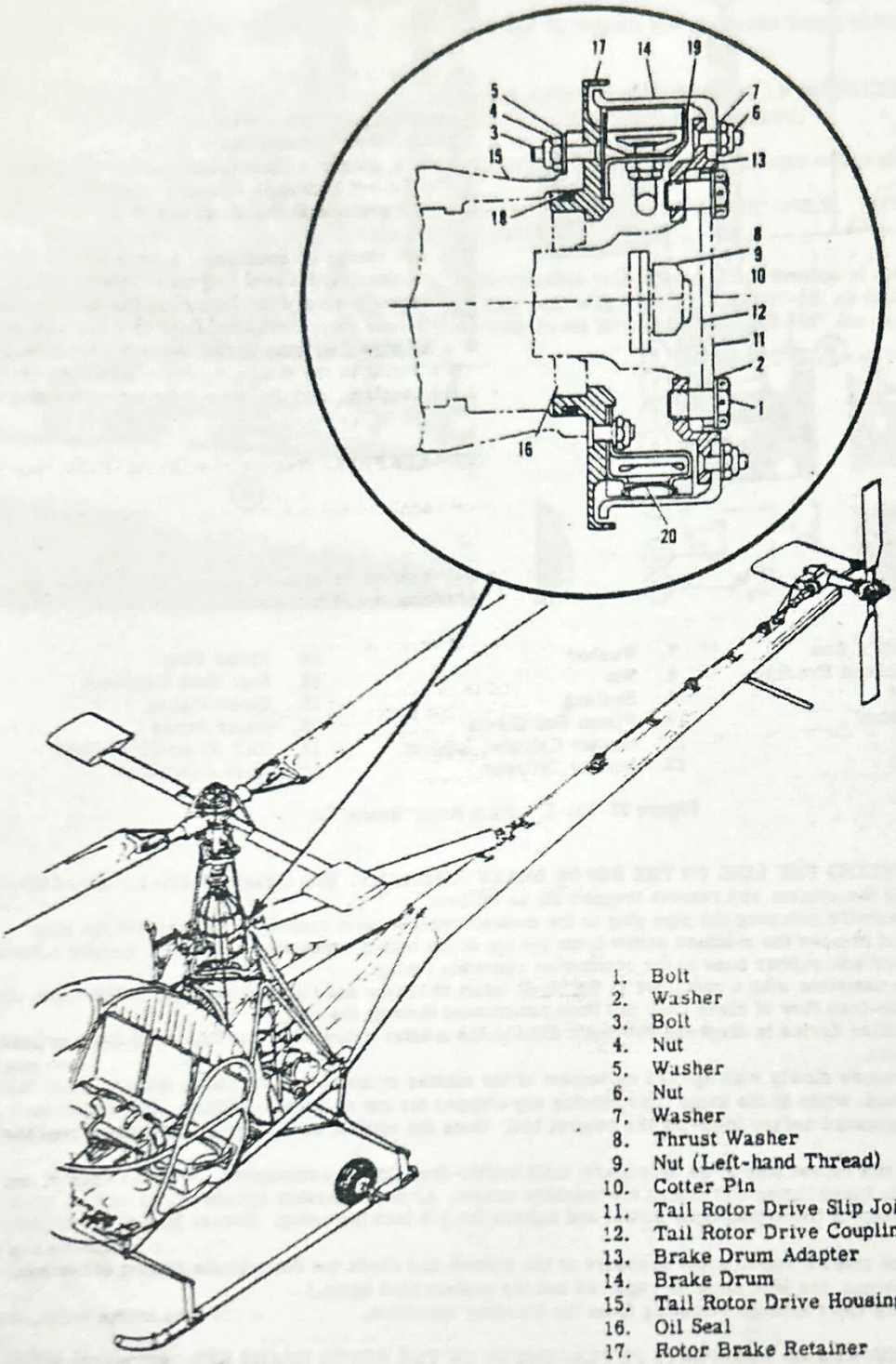
22-101-11. INSTALLATION OF THE ROTOR BRAKE KIT. Installation of rotor brake kit components is essentially the reverse of removal. Accomplish the following as applicable, during installation of the rotor brake in the tail rotor drive system:

a. Tighten the tail rotor drive coupling left-hand threaded nut to 315/455 pound-inch torque value, and safety with a cotter pin.

b. Safety the bolts attaching the forward tail rotor drive shaft to the forward universal joint with lockwire. Lockwire the bolt heads in pairs, but do not safety across the open throat of the joint.

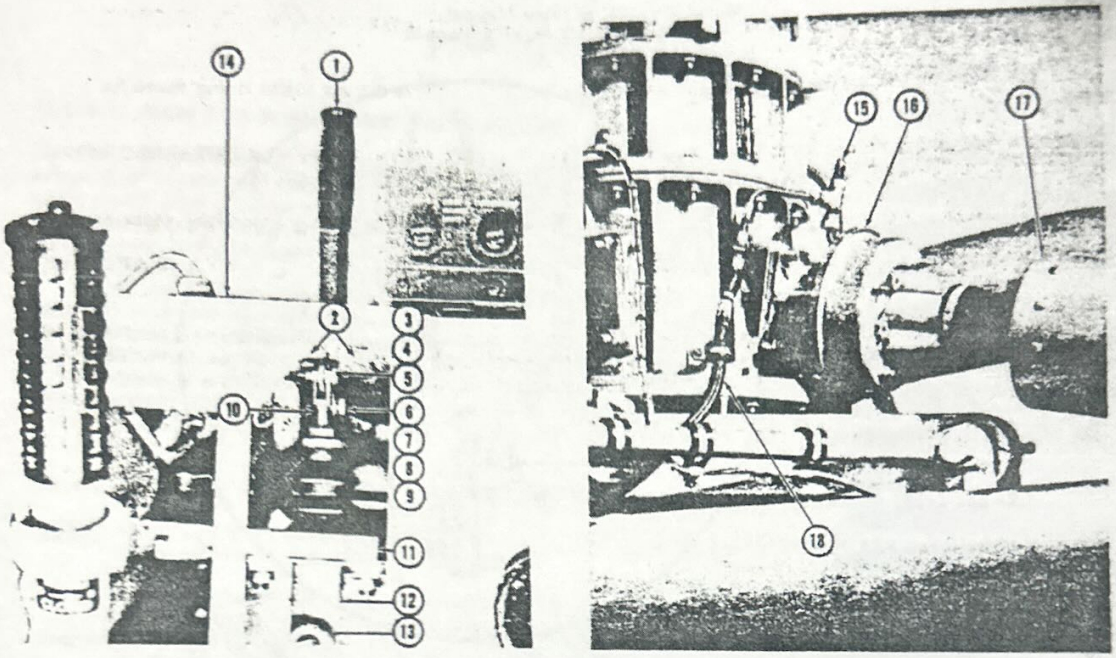
c. Tighten the special slip joint-to-drive coupling bolts to 160/190 pound-inch torque. Add washers under the bolt heads as required to position end of bolts flush with forward face of rotor brake retainer within 0.020 inch. Secure bolt heads in pairs with lockwire.

d. Bleed the rotor brake installation in accordance with paragraph 22-101-30.



1. Bolt
2. Washer
3. Bolt
4. Nut
5. Washer
6. Nut
7. Washer
8. Thrust Washer
9. Nut (Left-hand Thread)
10. Cotter Pin
11. Tail Rotor Drive Slip Joint Body
12. Tail Rotor Drive Coupling
13. Brake Drum Adapter
14. Brake Drum
15. Tail Rotor Drive Housing
16. Oil Seal
17. Rotor Brake Retainer
18. O-Ring
19. Expander Tube Brake
20. Spring Clip

Figure 22-101-1. Rotor Brake Installation, Transmission



1. Control Rod	7. Washer	13. Filler Plug
2. Bulkhead Bracket	8. Nut	14. Seat Deck Bulkhead
3. Bolt	9. Bushing	15. Bleed Fitting
4. Washer	10. Piston Rod Clevis	16. Rotor Brake
5. Nut	11. Master Cylinder Support	17. Tail Rotor Drive Shaft
6. Bolt	12. Master Cylinder	18. Hose Assembly

Figure 22-101-2. Main Rotor Brake Kit

22-101-30. BLEEDING THE LINE TO THE ROTOR BRAKE ASSEMBLY. (See figure 22-101-1.) Bleed the hydraulic line to fill the system and remove trapped air as follows:

a. Cut the lockwire securing the pipe plug to the master cylinder inlet connector and remove the plug.

b. Loosen and remove the machine screw from the top of the tubing connection assembly. Secure a piece of plastic tubing or soft rubber hose to the connection assembly fitting.

c. Station an assistant with a container at the bleed outlet to loosen and tighten the bleed fitting and to observe when bubble-free flow of clean fluid has been established through the line.

d. Obtain a filler device to dispense hydraulic fluid to the master cylinder inlet. Fill the master cylinder with hydraulic fluid.

e. Apply pressure slowly with upward movement of the master cylinder control rod to displace fluid in the line with clean fluid, while at the same time forcing any trapped air out of the bleed fitting. Check that the bleed fitting is tightened before lowering the control rod. Once the control rod is lowered, reloosen the bleed fitting.

f. Add fluid and repeat step e, as necessary, until bubble-free flow is established.

g. Tighten the bleed fitting and install the machine screw. After the master cylinder fluid level is raised to the bottom thread of filler plug boss install and tighten the 1/4 inch pipe plug. Secure plug to the cylinder with lockwire.

h. Actuate the control rod to apply pressure to the system and check the rotor brake system for leaks. (If leakage is detected, the leak must be repaired and the system bled again.)

i. Wipe up any fluid spillage resulting from the bleeding operation.

22-101-40. MINOR REPAIR AND PARTS REPLACEMENT OF THE ROTOR BRAKE KIT. (See figure 22-101-1.) Replace the parts listed below if they become defective or otherwise damaged.

a. Remove the rotor brake retainer oil seal and O-ring packing. (Refer to paragraph 22-101-10.)

b. When either the brake lining or the expander type brake assembly requires replacement, accomplish the following:

(1) Remove the spring clips retaining the brake lining to remove the six brake lining shoes for replacement.

CAUTION: MAKE CERTAIN THAT THE EXPANDER TUBE SHIELDS ARE PROPERLY INSTALLED BEHIND THE BRAKE LININGS WHEN REINSTALLING OR REPLACING THE LINING.

(2) Remove the nuts, special washers and special bolts which attach the expander tube assembly.

CAUTION: THE EXPANDER TUBE ASSEMBLY SHOULD BE REPLACED AS A UNIT ONLY. NO ATTEMPT SHOULD BE MADE TO DISASSEMBLE THE UNIT.

c. Remove and replace the master cylinder with a serviceable unit if fluid leaks develop at the piston stop ring in the front of the cylinder. (Replace the piston O-ring seal with Part No. AN6227-15, or equivalent.)

d. Refer to B. F. Goodrich "Overhaul Instructions with Parts Breakdown Manual 362" for rotor brake overhaul information.

MECHANICAL TRANSMISSION

23-1-1. MECHANICAL TRANSMISSION AND ACCESSORY DRIVES.

23-1-2. DESCRIPTION. (See figure 23-1-1.) The mechanical transmission is mounted on the engine mounting gimbal assembly above the main drive clutch on top of the engine. The two-stage planetary type transmission comprises the main rotor drive shaft, the upper, center, and lower housings, two planetary gear carriers, accessory drive assemblies and a one-way clutch unit. The accessory drive assemblies, mounted on the lower housing, include the single-stage tail rotor drive, and the two-stage tachometer generator and cooling fan drive (figure 23-1-2). An optional location for the electric generator is provided by installation of an accessory drive adapter kit (figure 23-101-1). All accessory drive assemblies are directly geared to the first stage planetary gear train, rotating in direct proportion to the rotor drive shaft. Removal of these externally mounted drive assemblies does not require major disassembly of the transmission. Lubrication of the transmission is accomplished as described in Section 73. All parting surfaces are sealed against oil leakage by O-ring packings, and conventional oil seals are used at input and output shaft locations.

23-1-3. TROUBLESHOOTING THE MECHANICAL TRANSMISSION. Refer to table 23-1-I for mechanical transmission troubleshooting information.

Table 23-1-I. Troubleshooting the Mechanical Transmission

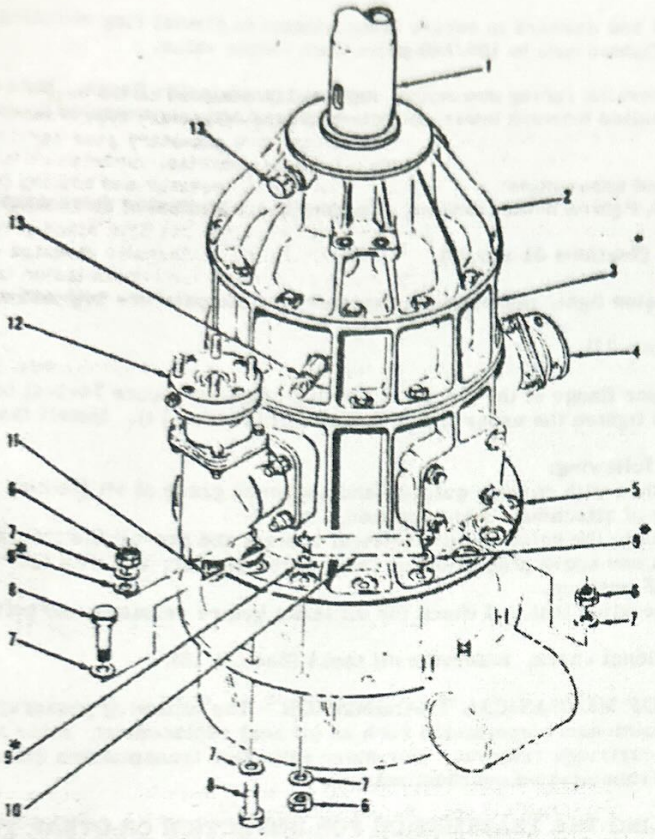
TROUBLE	PROBABLE CAUSE	REMEDY
Tachometer needles will not split with decrease in engine rpm	One-way clutch malfunction	Replace with serviceable one-way clutch or replace transmission.
Engine tachometer needle indicates slippage in drive system	Slipping mercury clutch (more evident in low rpm range)	Refer to Section 21.
Excessive oil leakage at input gearshaft, tail rotor drive, fan drive assemblies	Faulty oil seal or O-ring packing	Replace seal or O-ring packing.
Oil leakage at gimbal vent holes or at transmission or gimbal mounting flanges	Leaking clutch adapter seal or input gearshaft oil seal; defective engine-to-transmission connector shaft or input gearshaft O-ring packings	Replace O-ring packing or oil seals. Replace clutch adapter if necessary.
Indication of abnormally high oil temperature or low oil pressure	Lubrication system defect	Refer to Section 73.

23-1-10. REMOVAL OF MECHANICAL TRANSMISSION. (See figure 23-1-1.) To prevent inadvertent engine cranking or possible short-circuiting of electrical wiring connections, make sure the Master Switch is in the OFF position before commencing transmission removal operations. Install plugs in oil orifices, and cap lubrication lines as necessary to prevent entry of contaminants.

a. Remove or disconnect the following parts or assemblies as applicable, in any convenient sequence. Refer to Sections referenced for detailed instructions.

(1) Main rotor assembly (Section 50).
(2) Wobble plate pylon and cyclic scissors assemblies (Section 34).
(3) Collective control yoke assembly (Section 31).
(4) Cyclic and collective control push rod assemblies from their respective brackets on the transmission (Sections 33 and 31).
(5) Disconnect and cap oil system lines and fittings.
(6) Disconnect electrical connections to the anticollision light, tachometer generator, transmission oil temperature bulb and oil pressure warning light system.
(7) Separate the forward slip joint assembly from the tail rotor drive coupling.

CAUTION: ON THOSE TRANSMISSIONS HAVING THE UPPER FLANGE (FIGURE 74-1-4) OF THE FAN DRIVE FLEXIBLE COUPLING BOLTED TO THE TRANSMISSION FAN DRIVE SHAFT (11, FIGURE 23-1-1), MAKE CERTAIN TO REMOVE THE BOLT SECURING THE UPPER COUPLING FLANGE TO THE TRANSMISSION FAN DRIVE SHAFT BEFORE ATTEMPTING TO LIFT THE TRANSMISSION FROM THE ENGINE MOUNT INNER GIMBAL RING. REFER TO SECTION 74 FOR FAN DRIVE COUPLING DISASSEMBLY INSTRUCTIONS.



* INSTALL COUNTERSUNK WASHER (9) SO THAT CHAMFERED SIDE FACES DOWNWARD AGAINST TRANSMISSION LOWER HOUSING FLANGE.

1. Main Rotor Drive Shaft
2. Upper Housing
3. Center Housing
4. Tail Rotor Drive Coupling
5. Lower Housing
6. Nut
7. Plain Washer
8. Bolt
*9. Countersunk Washer
10. Collective Hanger Assy (Ref)
11. Cooling Fan Drive Shaft
12. Rotor Tachometer Generator Drive Pad
13. Oil Orifice Fitting

Figure 23-1-1. Mechanical Transmission Installation

(8) Remove induction system upper air duct intake from the right side of transmission housing.

NOTE: To reduce the possibility of bending and cracking the support, the support should be removed at the transmission lower housing when the duct is removed. Care should be exercised during handling to prevent bending.

b. Place an overhead hoist having sufficient capacity to lift the transmission (weight approximately 150 pounds) from the helicopter as follows:

(1) Attach hoisting eye (item 19, table 92-1-I) to main drive shaft as shown in figure 10-11.
(2) Remove hardware securing transmission mounting flange to the engine mount inner gimbal.
(3) Lift transmission clear of the helicopter and place it on a suitable bench or work platform.

23-1-11. INSTALLATION OF THE MECHANICAL TRANSMISSION. When installing the transmission on a helicopter equipped with main drive clutch torsion coupling, refer to paragraph 23-1-30 for procedure to establish proper preload on main drive clutch housing rubber bumper. For greater convenience install the following items on the transmission prior to its installation on the helicopter:

Collective yoke, collective control brackets and push rods (Section 31); Wobble Plate (Section 34); Cyclic control rods and brackets (Section 33); Anticollision light and bracket (Section 83); Transmission oiling system lines and fittings (Section 73).

a. Attach hoisting eye (item 19, table 92-1-I) to transmission rotor drive shaft.
b. Establish proper preload on torsion coupling clutch housing bumper, if applicable.
c. Lubricate main drive interconnect splines (Section 10); install O-ring packing on connecting shaft or clutch housing (Section 21).

CAUTION: SERIOUS DAMAGE CAN OCCUR TO THE MAIN DRIVE CLUTCH HOUSING IF FULL WEIGHT OF TRANSMISSION IS ALLOWED TO BEAR ON THE INTERCONNECT SHAFT.

d. Liberally coat gimbal ring mounting flange with primer (item 3, table 10-VI). While primer is still wet, carefully lower transmission onto inner gimbal mounting flange, taking care to engage clutch interconnect shaft splines.

e. (See figure 23-1-1.) Install bolts, nuts and washers to secure transmission to gimbal ring mounting flange, setting bolts and washers in primer. Tighten nuts to 100/140 pount-inch torque value.

NOTE: Install countersunk washers with countersink facing downward, against transmission flange. Note that countersunk washers must also be installed between lower collective hanger and transmission housing flange.

f. Install or connect the following parts and assemblies:

(1) Forward tail rotor drive slip joint, tighten bolts attaching slip joint to transmission drive coupling to 160/190 pound-inch torque value.

(2) Collective and cyclic control rods (Sections 31 and 33).

(3) Main rotor assembly (Section 50).

(4) Electrical connections to anticollision light, tachometer generator, oil temperature bulb and oil pressure warning light.

(5) Oil system lines and fittings (Section 73).

(6) Intake air upper duct (Section 76).

(7) On those transmissions having upper flange of the fan drive flexible coupling (figure 74-1-4) bolted to the transmission fan drive shaft: install and tighten the upper flange attach bolt (Section 74). Install fan drive shaft.

g. Prior to engine runup, accomplish the following:

(1) Check that oil tank(s) are replenished with correct quantity and approved grade of oil (Section 10).

(2) Check all components for security of attachment and operation.

(3) Connect an electrical power source to the helicopters electrical system and pre-oil the transmission by cranking the engine for 30 seconds with one spark plug removed from each cylinder, and with the ignition switch and fuel shutoff valve in the OFF position.

h. Accomplish a normal engine ground operation test and check for oil leaks before releasing the helicopter for flight.

i. After engine shutdown following operational check, reservice oil tanks (Section 10).

23-1-20. DISASSEMBLY AND REASSEMBLY OF MECHANICAL TRANSMISSION. The following paragraphs provide instructions for minor transmission maintenance operations such as oil seal replacement, rotor shaft nick and scratch removal, and one-way clutch cartridge removal. For more extensive transmission disassembly information consult the applicable mechanical transmission overhaul manual.

CAUTION: WHEN PARTIALLY DISASSEMBLING THE TRANSMISSION FOR INSPECTION OR OTHER PURPOSES, DO NOT ATTEMPT TO SEPARATE THE CENTER HOUSING FROM THE LOWER HOUSING WITHOUT FIRST REMOVING THE FOLLOWING LISTED SUBASSEMBLIES OR PARTS: UPPER HOUSING AND DRIVE SHAFT; SECOND STAGE SUN GEAR; UPPER RING GEAR; CENTER HOUSING OIL ORIFICE NOZZLE; RING GEAR SPACER BAFFLE; AND LOWER RING GEAR. FAILURE TO OBSERVE THIS SEQUENCE WILL ALMOST CERTAINLY RESULT IN DAMAGE TO GEARS AND OTHER PARTS OF THE TRANSMISSION. REFER TO THE APPLICABLE TRANSMISSION OVERHAUL MANUAL FOR DETAILED DISASSEMBLY INSTRUCTIONS.

23-1-30. ADJUSTING PRELOAD ON TORSION COUPLING MAIN DRIVE CLUTCH HOUSING BUMPER. If installing a replacement transmission, or if the transmission input gear shaft or any of the main drive clutch and torsion coupling components have been replaced, adjust the clutch housing bumper preload as follows.

NOTE: A straight flat bar and a machinist scale may be used to obtain the measurements described in steps a and b following.

a. (See figure 23-1-1A.) Measure the distance from the lower surface of the transmission mounting flange to the bottom of the input shaft retaining ring, and record measurement as A.

b. Install bumper without preload washers and measure the distance from the upper surface of the gimbal mounting flange to the top surface of the bumper, and record measurement as dimension B.

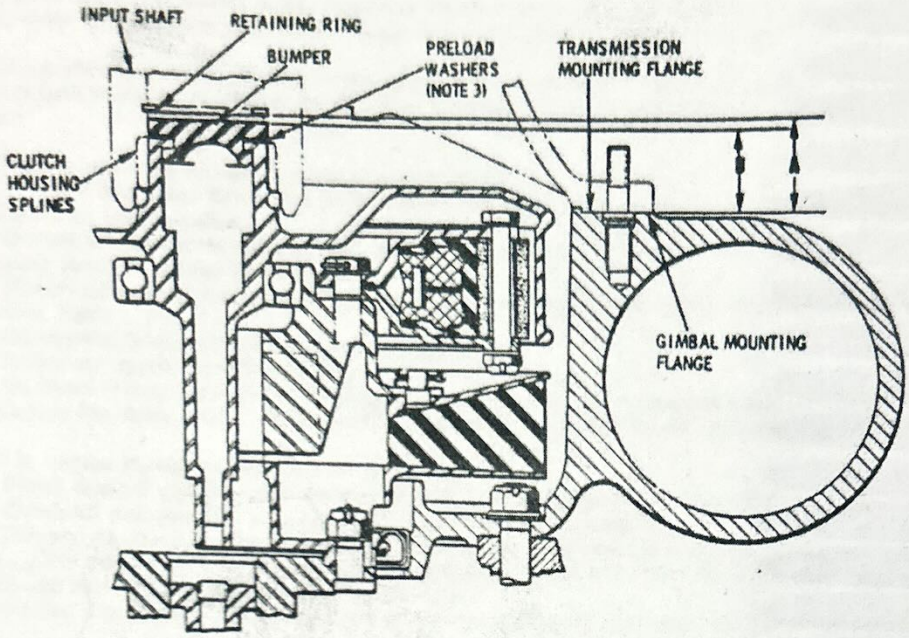
c. Use the formula provided in figure 23-1-1A to determine the total thickness of washers required to establish the proper preload on the clutch housing bumper.

d. Install washers of the total thickness determined in step c, between the top surface of the clutch housing splines and the bumper.

23-1-40. REPLACEMENT OF EXTERNAL OIL SEALS. (See figure 23-1-1B.) Replacement procedures for mechanical transmission oil seals are outlined below.

a. Observe the following general procedures in any case of oil seal replacement:

(1) After removing oil seal, mask off area between shaft and housing to prevent contamination by



DIMENSION A - MEASURED DISTANCE FROM LOWER SURFACE OF TRANSMISSION MOUNTING FLANGE TO BOTTOM SURFACE OF RETAINING RING INSIDE INPUT SHAFT.

DIMENSION B - MEASURED DISTANCE FROM UPPER SURFACE OF GIMBAL MOUNTING FLANGE TO TOP SURFACE OF BUMPER.

A - B - GAP DIMENSION BETWEEN TOP OF BUMPER AND RETAINING RING.

NOTES:

1. SELECT WASHERS OF TOTAL THICKNESS EQUAL TO GAP DIMENSION PLUS 0.013/0.045-INCH (REQUIRED BUMPER PRELOAD).
2. IF DIMENSION B IS 0.010-INCH OR MORE GREATER THAN DIMENSION A, NO WASHERS ARE REQUIRED.
3. DIMENSION B TO BE OBTAINED WITHOUT WASHERS INSTALLED UNDER BUMPER.

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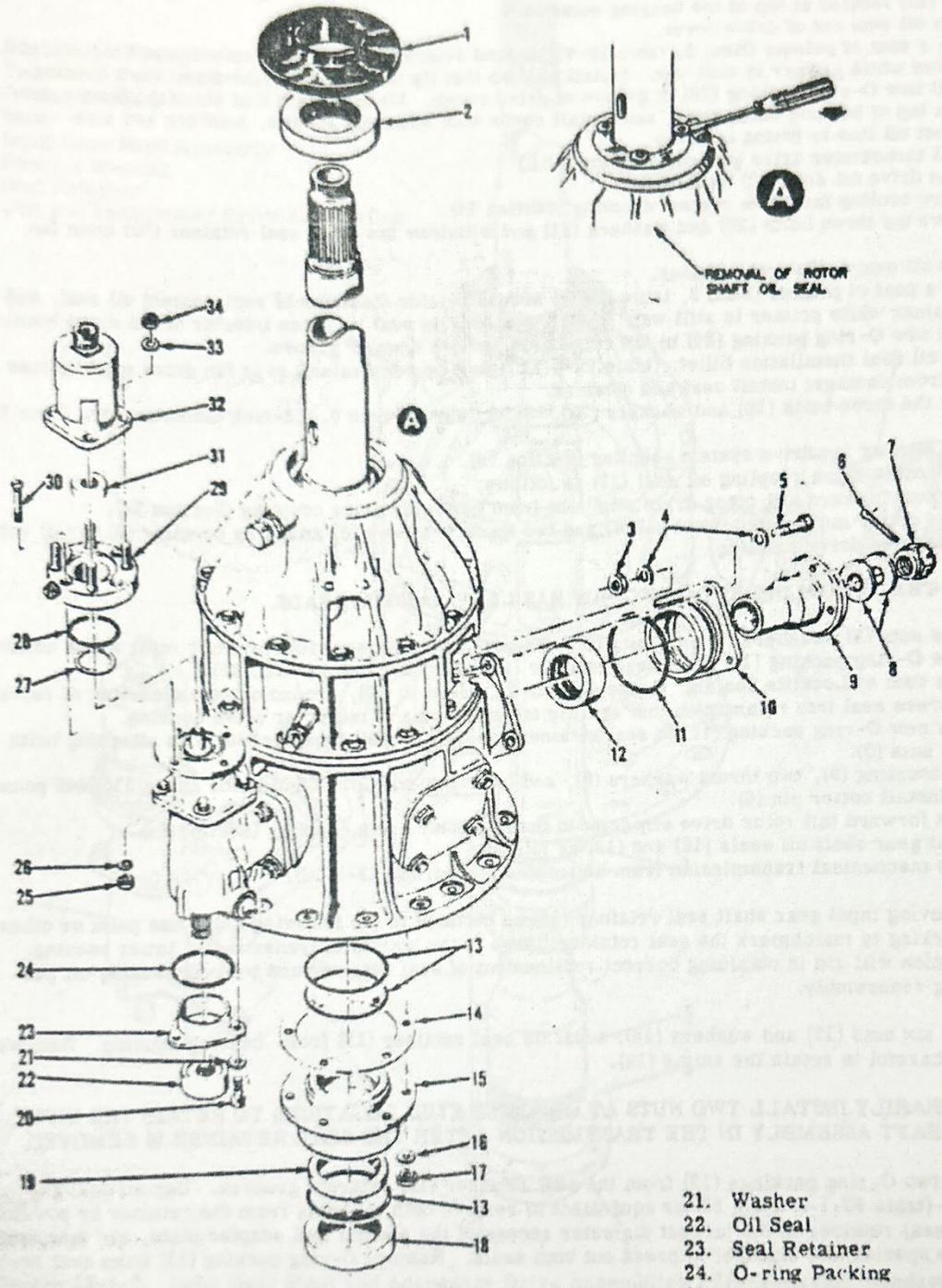
Figure 23-1-1A. Method of Establishing Preload on Main Drive Clutch Housing Bumper

abrasive dust or other foreign material. Lightly polish shaft seal area with crocus cloth (Specification P-C-458) dipped in a light coat of lubricating oil. After completing polishing operation, use an oil soaked cloth to wipe shaft seal area to remove any abrasive dust or foreign particles.

(2) Coat lip of any replacement oil seal or O-ring packing with Lubriplate 630AA (item 16, table 10-VI) prior to installation.

NOTE: Allowable oil leaks from a new oil seal shall not exceed 15 countable drops per hour. This limit applies to the first 25 hours of operation. After 25 hours of operation, seal leakage shall not exceed 10 countable drops per hour.

b. Replace tachometer drive oil seal (31) as follows:
(1) Remove rotor tachometer generator (Section 81).
(2) Disconnect and cap oil line to tachometer drive cover (29).



1. Shield
2. Oil Seal
3. Nut
4. Washer
5. Bolt
6. Cotter Pin
7. Nut (Left-hand thread)
8. Thrust Washer
9. Tail Rotor Drive Coupling
10. Oil Seal Retainer
11. O-ring Packing
12. Oil Seal
13. O-ring Packing
14. Shim
15. Seal Retainer
16. Washer
17. Nut
18. Oil Seal
19. Oil Seal
20. Bolt
21. Washer
22. Oil Seal
23. Seal Retainer
24. O-ring Packing
25. Nut
26. Washer
27. Shim
28. O-ring Packing
29. Tachometer Drive Cover
30. Screw
31. Oil Seal
32. Tachometer Generator
33. Washer
34. Nut

Figure 23-1-1B. Replacement of Oil Seals, Mechanical Transmission

(3) Remove attaching hardware and lift cover from tachometer drive housing, taking particular care not to disturb shim(s) (27) located at top of the bearing outer race.

(4) Press oil seal out of drive cover.

(5) Apply a coat of primer (Item 3, table 10-VI) around outside diameter of replacement oil seal, and press seal into cover while primer is still wet. Install seal so that lip faces tachometer drive shaft bearing.

(6) Install new O-ring packing (28) in groove of drive cover. Make certain that shim(s) (27) are properly positioned on top of bearing outer race, and install cover with attaching screws, washers and nuts.

(7) Connect oil line to fitting in cover.

(8) Install tachometer drive generator (Section 81.)

c. Replace fan drive oil seal (22) as follows:

(1) Remove cooling fan drive system coupling (Section 74).

(2) Remove the three bolts (20) and washers (21) and withdraw fan drive seal retainer (23) from fan drive shaft.

(3) Press oil seal from seal retainer.

(4) Apply a coat of primer (Item 3, table 10-VI) around outside diameter of replacement oil seal, and press seal into retainer while primer is still wet. Install seal so that seal lip faces interior of fan drive housing.

(5) Install new O-ring packing (24) in fan drive housing bore annular groove.

(6) Place oil seal installation billet, (table 92-1-I, Item 52 or equivalent) over fan drive shaft splines to protect seal lip from damage; install seal and retainer.

(7) Install the three bolts (20) and washers (21). Safety screws with 0.032-inch diameter wire (Item 6, table 10-VI).

(8) Install cooling fan drive system coupling (Section 74).

d. Replace tail rotor drive coupling oil seal (12) as follows:

(1) Disconnect forward tail rotor drive slip joint from tail rotor drive coupling (Section 24).

(2) Remove cotter pin (6), left-hand nut (7) and two thrust washers (8) attaching coupling (9) to tail rotor drive gear shaft. Remove drive coupling.

CAUTION: NOTE THAT COUPLING RETAINING NUT HAS LEFT-HAND THREADS.

(3) Remove nuts (3), washers (4) and bolts (5). Remove seal retainer (10) from tail rotor drive housing.

(4) Remove O-ring packing (11) from seal retainer (10) and press out oil seal (12).

(5) Apply a coat of Locktite Sealant, Grade C (Item 24, table 10-VI), around outside diameter of replacement oil seal, and press seal into retainer so that seal lip faces interior of tail rotor drive housing.

(6) Place a new O-ring packing (11) in seal retainer groove. Install retainer (10) with attaching bolts (5), washers (4) and nuts (3).

(7) Install coupling (9), two thrust washers (8), and left-hand nut (7). Tighten the nut to 315/445 pound-inch torque value. Install cotter pin (6).

(8) Connect forward tail rotor drive slip joint to the tail rotor drive coupling (Section 24).

e. Replace input gear shaft oil seals (18) and (19) as follows:

(1) Remove mechanical transmission from helicopter (paragraph 23-1-10).

NOTE: Before removing input gear shaft seal retainer (15) as outlined in the following step, use paint or other suitable marking to matchmark the seal retainer flange to the bottom of transmission lower housing. This precaution will aid in obtaining correct realinement of seal retainer and bearing housing oil passages during reassembly.

(2) Remove six nuts (12) and washers (16); separate seal retainer (15) from bearing housing. Remove seal retainer, being careful to retain the shims (14).

CAUTION: TEMPORARILY INSTALL TWO NUTS AT OPPOSITE STUD LOCATIONS TO RETAIN THE INPUT GEAR SHAFT ASSEMBLY IN THE TRANSMISSION AFTER THE SEAL RETAINER IS REMOVED.

(3) Remove two O-ring packings (13) from the seal retainer (15) external grooves. Use oil seal extractor-installer set, (table 92-1-I, Item 53) or equivalent to remove both oil seals from the retainer by positioning the bottom of the seal retainer in the largest diameter recess of the special tool adapter plate, and then using the smaller end of the special tool mandrel to press out both seals. Remove O-ring packing (13) from seal retainer internal groove.

(4) Apply a coat of Lubriplate (Item 16, table 10-VI) around outside diameter of replacement upper oil seal (19). Position seal retainer in the smaller diameter recess of the special tool adapter plate, and use the mandrel and guide ring to press seal into retainer so that seal lip faces the retainer bottom.

(5) Install new O-ring packing (13) in retainer internal groove. Press replacement oil seal (18) in retainer so that seal lip faces retainer top.

(6) Install two new O-ring packings (13) in the external grooves above the seal retainer flange.

(7) Position shim (14) on seal retainer flange; then aline the matchmarks and install retainer. Install the six nuts (17) and washers (16).

1. Oil Orifice Fitting
2. Tail Rotor Drive Assembly
3. O-ring Packing
4. Shim
5. Input Gear Shaft Assembly
6. Bearing Housing
7. Seal Retainer
8. Fan and Tachometer Drive Assemblies

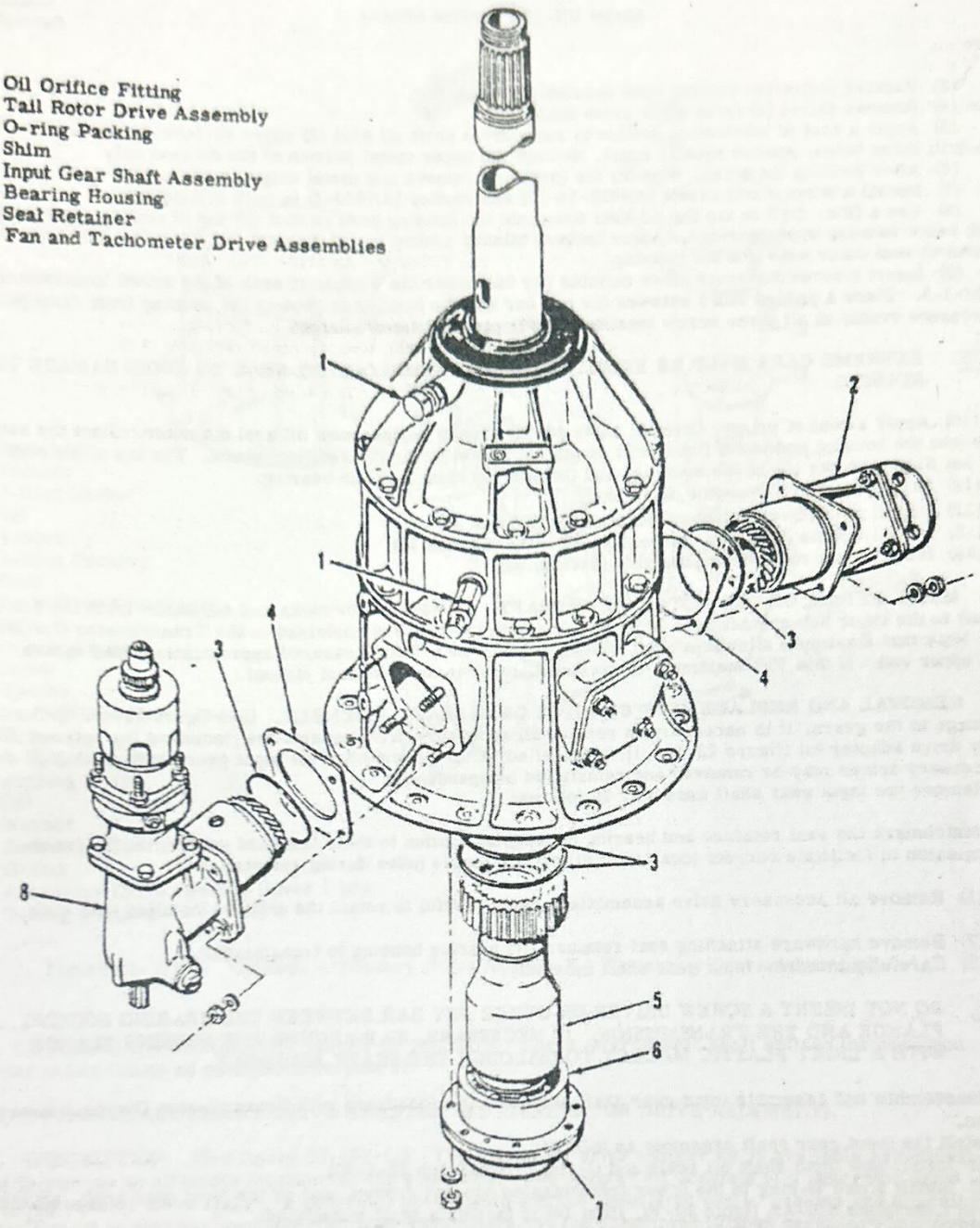


Figure 23-1-2. Input Gear Shaft and Accessory Drive Assemblies, Transmission Standard Configuration

CAUTION: WHEN INSTALLING THE SEAL RETAINER, MAKE CERTAIN TO ALINE SEAL RETAINER OIL PASSAGE WITH THE BEARING HOUSING OIL PASSAGE. FAILURE TO OBTAIN CORRECT ALINEMENT OF THE OIL PASSAGES MAY RESULT IN SERIOUS DAMAGE TO THE TRANSMISSION.

(8) Install transmission on the helicopter (paragraph 23-1-11).

f. Replace rotor drive shaft oil seal (2) as follows:
   (1) Remove main rotor head assembly (Section 50).
   (2) Remove wobble plate and scissors assemblies (Section 34).

(3) Remove collective control yoke assembly (Section 31).
(4) Remove shield (1) from rotor drive shaft.
(5) Apply a coat of lubricating grease to rotor drive shaft oil seal (2) upper surface; then use a No. 7 drill to drill three holes, spaced equally apart, through the upper metal portion of the oil seal only.
(6) After drilling the holes, wipe off the grease to remove any metal chips or shavings.
(7) Install a sheet metal screw (AN530-14-10) and washer (AN960-4) in each drilled hole.
(8) Use a fiber drift to tap the oil seal down into the housing bore so that the top of seal is approximately 1/8-inch below housing upper surface. Apply lacquer thinner around top of the seal and allow the thinner to penetrate between seal outer edge and the housing.
(9) Insert a screwdriver or other suitable pry bar under the washer at each of the screw locations;see figure 23-1-3. Place a padded block between the pry bar and the housing to protect the housing from damage, and apply pressure evenly at all three screw locations to remove seal from housing.

CAUTION: EXTREME CARE MUST BE EXERCISED WHEN PRYING OUT OIL SEAL TO AVOID DAMAGE TO HOUSING.

(10) Apply a coat of primer (Item 3, table 10-VI) around replacement oil seal diameter. Start the seal squarely into the housing and use a fiber drift or plastic mallet to tap the seal into place. The top of the seal must be set flush with the top of the housing, and the seal lip must face the bearing.
(11) Install shield (1) on rotor drive shaft.
(12) Install collective control yoke assembly (Section 31).
(13) Install wobble plate and scissors assemblies (Section 34).
(14) Install main rotor head assembly (Section 50).

23-1-41. MINOR REPAIR OF THE ROTOR DRIVE SHAFT. Remove minor nicks and scratches from the rotor drive shaft in the rotor hub contact area in accordance with instructions contained in the Transmission Overhaul Manual. Note that maximum allowable shaft runout is 0.013-inch TIR, measured approximately four inches from the upper end. If this TIR maximum is exceeded, refer to the Overhaul Manual.

23-1-42. REMOVAL AND REPLACEMENT OF INPUT GEAR SHAFT ASSEMBLY. (See figure 23-1-2.) To avoid damage to the gears, it is necessary to remove all accessory drive assemblies [including the optional accessory drive adapter kit (figure 23-101-1), if installed] prior to removing the input gear shaft assembly. Any of the accessory drives may be removed and reinstalled independently.
a. Remove the input gear shaft assembly as follows:

NOTE: Matchmark the seal retainer and bearing housing in relation to their installed position on the transmission to facilitate correct location of oil orifice nozzle holes during reinstallation.

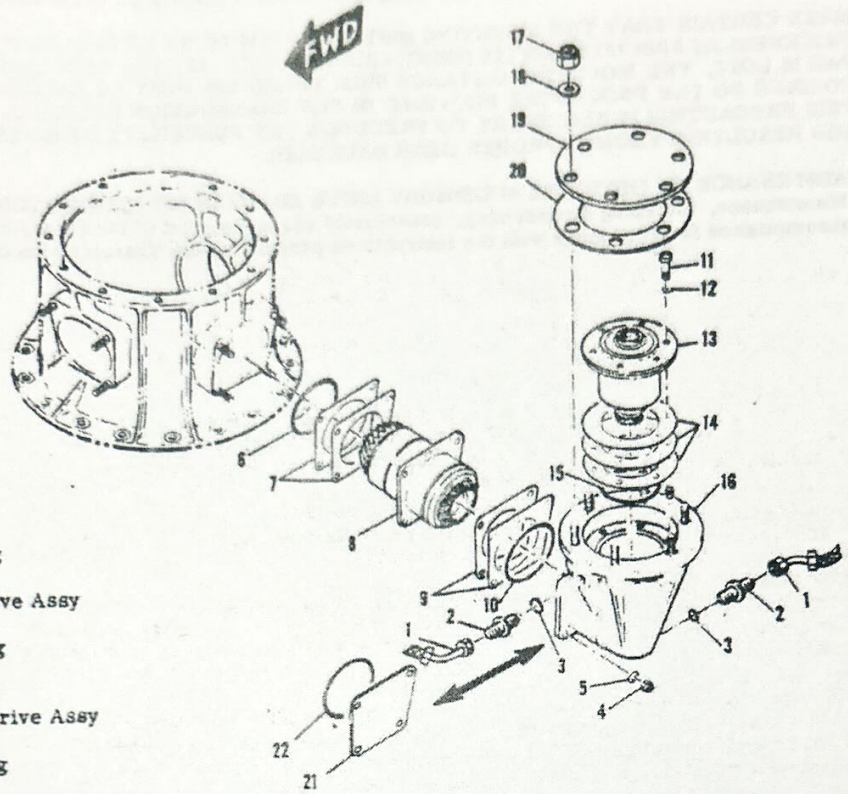
(1) Remove all accessory drive assemblies, being careful to retain the shim(s) installed with each assembly.
(2) Remove hardware attaching seal retainer and bearing housing to transmission.
(3) Carefully withdraw input gear shaft assembly.

CAUTION: DO NOT INSERT A SCREW DRIVER OR OTHER PRY BAR BETWEEN THE BEARING HOUSING FLANGE AND THE TRANSMISSION. IF NECESSARY, TAP AROUND THE HOUSING FLANGE WITH A LIGHT PLASTIC MALLET TO DISLODGE THE SHAFT ASSEMBLY.

b. Disassemble and assemble input gear shaft assembly in accordance with Transmission Overhaul Manual instructions.
c. Install the input gear shaft assembly as follows:
(1) Install new input shaft oil seals and O-rings (paragraph 23-1-40).
(2) Install a new O-ring in the lower transmission housing groove, and on the input gear shaft, applying a thin film of Lubriplate 630-AA (table 10-VI, Item 16) to facilitate shaft installation.
(3) Start the shaft carefully into the transmission, rotating the shaft as necessary to mesh the sun gear with the planetary gears. When gears are correctly meshed, push shaft into place.

CAUTION: MAKE CERTAIN THAT THE OIL ORIFICE NOZZLE HOLES IN THE SEAL RETAINER AND BEARING HOUSING ARE IN ALINEMENT WITH EACH OTHER, AND WITH THE OIL PASSAGE IN THE TRANSMISSION HOUSING INTERIOR.

(4) Secure bearing housing and seal retainer to transmission with the washers and nuts.
(5) Reinstall the accessory drive assemblies, making certain that all shims are reinstalled in their correct location.



1. Hose Assy
2. Reducer
3. O-Ring Gasket
4. Nut
5. Washer
6. O-Ring Packing
7. Shim
8. First Stage Drive Assy
9. Shim
10. O-Ring Packing
11. Screw
12. Washer
13. Second Stage Drive Assy
14. Shim
15. O-Ring Packing
16. Housing Assy
17. Nut
18. Washer
19. Generator Cover Plate
20. Gasket
21. Accessory Drive Opening Cover Plate
22. O-Ring Packing

Figure 23-101-1. Optional Accessory Drive Adapter Kit (Generator Drive Assembly)

23-1-43. CHECKING INTERCONNECT SHAFT CONDITION. Check interconnect shaft splines for condition and for wear within limits as outlined in Section 21.

23-101-1. OPTIONAL ACCESSORY DRIVE ADAPTER KIT (GENERATOR DRIVE ASSEMBLY).

23-101-2. DESCRIPTION. (See figure 23-101-1.) The accessory drive adapter kit is available as optional equipment to provide an alternate location for the generator. The adapter kit consists of a generator drive housing, two generator drive stages, a generator cover plate and the associated seals, gaskets and attaching hardware. The kit is also equipped with two hose assemblies and the associated fittings necessary to connect the drive housing into the transmission oil supply and return system.

NOTE: A cover plate is installed over the accessory drive opening on all standard configuration transmissions. When removed, this cover plate should be retained for future use.

23-101-10. REMOVAL OF OPTIONAL ACCESSORY DRIVE ADAPTER KIT (GENERATOR DRIVE ASSEMBLY). (See figure 23-101-1.)

a. Remove the oil hose assemblies.
b. Remove the nuts and washers attaching the accessory drive assembly to the transmission lower housing.
c. Remove the generator drive assembly (two-stage unit), the O-ring packing and mounting distance shims.

NOTE: Tag identify the mounting distance shims for location and thickness.

23-101-11. INSTALLATION OF OPTIONAL ACCESSORY DRIVE ADAPTER KIT (GENERATOR DRIVE ASSEMBLY). (See figure 23-101-1.) Installation of the accessory drive adapter kit is the reverse of removal.

CAUTION: MAKE CERTAIN THAT THE MOUNTING DISTANCE SHIM TO BE INSTALLED IS THE SAME THICKNESS AS SPECIFIED ON ITS IDENTIFICATION TAG. IF, THE SHIM IDENTIFICATION TAG IS LOST, THE MOUNTING DISTANCE SHIM THICKNESS MUST BE CALCULATED ACCORDING TO THE PROCEDURE PROVIDED IN THE TRANSMISSION OVERHAUL MANUAL. THIS PRECAUTION IS NECESSARY TO PRECLUDE THE POSSIBILITY OF INTERNAL DAMAGE RESULTING FROM IMPROPER GEAR BACKLASH.

23-101-40. MAINTENANCE OF OPTIONAL ACCESSORY DRIVE ADAPTER KIT (GENERATOR DRIVE ASSEMBLY). Maintenance, including disassembly, reassembly and adjustment of the generator drive assembly unit, shall be accomplished in accordance with the instructions provided in the Transmission Overhaul Manual.

TAIL ROTOR DRIVE SYSTEM

24-1-1. TAIL ROTOR DRIVE SYSTEM.

24-1-2. DESCRIPTION. (See figures 24-1-1 through 24-1-4.) The tail rotor drive system includes the forward slip joint and drive shaft; cardan and universal joint assemblies; aft drive shaft and support bearing block assemblies, and the aft slip joint. The forward slip joint is coupled to the tail rotor drive assembly of the transmission. Rotary motion is transmitted from the forward to the aft drive shaft at the cardan joint. The aft drive shaft connects to the aft slip joint which drives the input gear mechanism of the speed decreaser gear assembly.

24-1-3. TROUBLESHOOTING THE TAIL ROTOR DRIVE SYSTEM. The following procedure is recommended for troubleshooting vibrations in the tail rotor drive system.

a. Check the system for out-of-tolerance conditions as follows:

(1) Check aft drive shaft runout (paragraph 24-50-40) and forward drive shaft runout (paragraph 24-1-40).

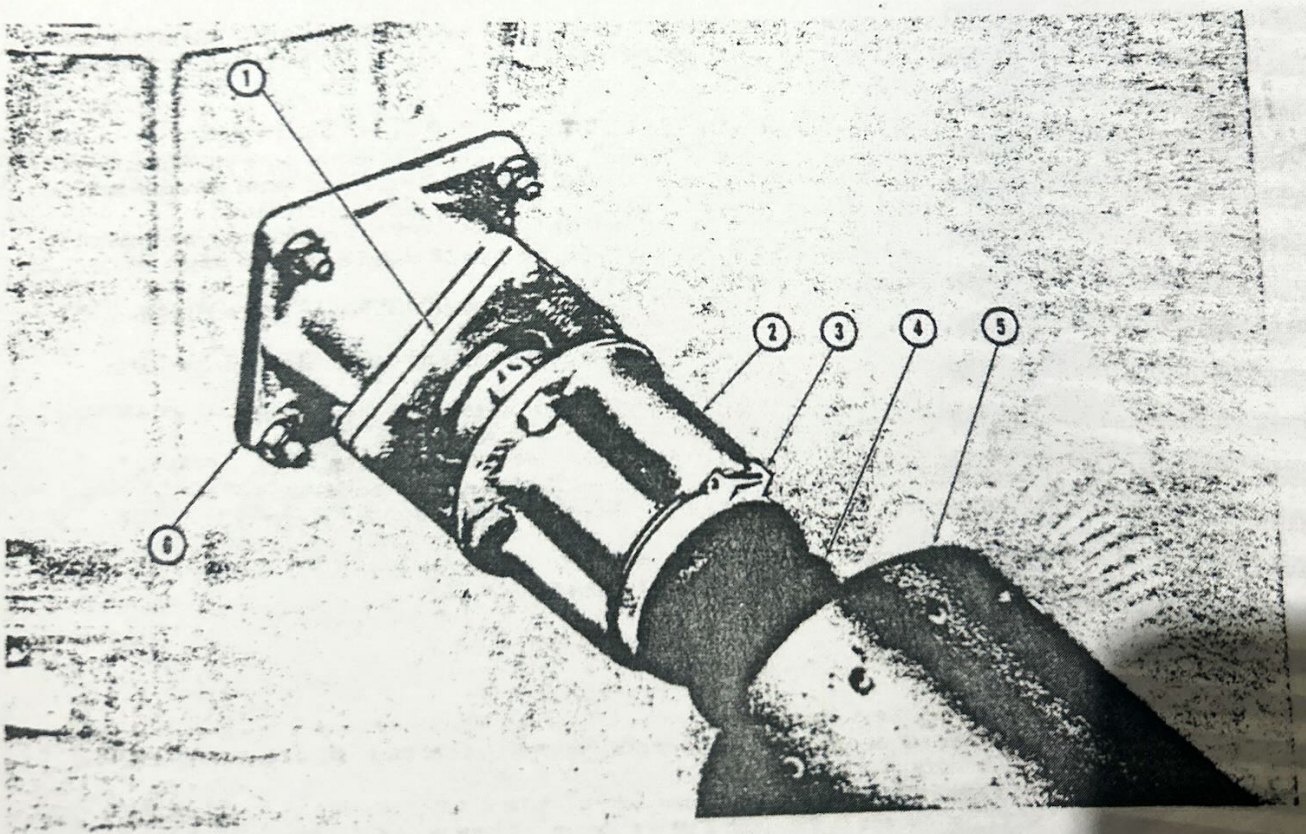
(2) Check alinement of aft drive shaft (paragraph 24-50-30).

b. If drive shaft runout and alinement are within tolerance, remove the cardan joint and check the cardan joint components for excessive wear and for binding yoke bearings (paragraph 24-40-40).

(1) Repair or replace cardan joint units as necessary.

(2) Repair or replace universal joints as required (paragraph 24-30-40).

c. If drive system vibration is still excessive after steps a and b have been accomplished, it is often possible to alter the magnitude of vibration by repositioning the drive shafts. Make the following adjustments in the sequence given, and evaluate each change separately before proceeding with the next.



1. Oil Seal Retainer
2. Forward Slip Joint Assembly
3. Attachment Clamp
4. Dust Boot and Moisture Seal
5. Forward Tail Rotor Drive Shaft Assembly
6. Transmission Tail Rotor Drive

Figure 24-1-1. Forward Slip Joint and Drive Shaft Installation

NOTE: Prior to disconnecting or removing any units of the tail rotor drive system, make sure to matchmark mating components with paint or other suitable marking material to ensure their reassembly in the same relative positions.

(1) Disconnect and rotate aft drive shaft 180 degrees with respect to the aft slip joint.
(2) Disconnect and rotate forward drive shaft 180 degrees with respect to the cardan joint.
(3) Disconnect and rotate forward drive shaft 180 degrees with respect to the forward slip joint.
(4) Disconnect and rotate aft drive shaft approximately 90 degrees at cardan joint. Realign aft drive shaft as required (paragraph 24-50-30), and readjust cardan joint if necessary to obtain correct forward slip joint setting (paragraph 24-40-30).
(5) Check forward drive shaft balance (paragraph 24-20-30).

24-1-10. REMOVAL OF TAIL ROTOR DRIVE SYSTEM. Remove tail rotor drive system components in any convenient sequence, as outlined in the paragraphs referenced.

NOTE: When necessary to remove or disconnect any drive system component, it is recommended that each rotating component and its mating assembly be matchmarked to facilitate correct reassembly.

a. Forward slip joint assembly (24-10-10).
b. Forward drive shaft (24-20-10).
c. Universal joints (24-30-10).
d. Cardan Joint (24-40-10).
e. Aft drive shaft (24-50-10).
f. Aft slip joint (24-60-10).

24-1-11. INSTALLATION OF TAIL ROTOR DRIVE SYSTEM. Tail rotor drive system components may be installed in the reverse order of removal, or in any convenient sequence. Check matchmarking on removed parts for correct relationship.

24-1-40. MINOR REPAIR AND PARTS REPLACEMENT OF THE TAIL ROTOR DRIVE SYSTEM.

a. Lubricate the universal joints, slip joints and drive shaft bearings according to the requirements given in the lubrication chart, figure 10-19. Check for excessive radial play of the universal joint yokes attached to the cardan joint assembly. Check for excessive axial (end) play in the universal joint crosses.

b. Check the tail boom skin in the vicinity of the cardan joint and bearing support housings for cracks, loose or missing rivets, dents in the skin, and for elongated or otherwise damaged bolt holes which would affect the critical alignment of the tail rotor drive system.

c. Whenever any tail rotor drive system parts are removed or replaced that would affect alignment, check the alignment of the tail rotor drive shaft. (Refer to paragraph 24-50-30.)

d. Check for excessive play (lash) between tail rotor drive system mating units. Refer to paragraph 24-40-40 for cardan joint serviceability limits.

(1) Mount a dial indicator on the aft drive shaft, as close as possible to the cardan joint aft end yoke. Position the indicator contact point against the OD of the end yoke near its aft end.

(2) Use hand pressure to move the aft end yoke radially, and observe the dial indicator readings. Check the radial play at several points around the yoke perimeter. Permissible radial play between the yoke and shaft splines is 0.005-inch for shafts with three support bearings, and 0.010-inch for shafts with four support bearings.

(3) If the radial play limits specified above are exceeded, remove the aft drive shaft and check the end yoke and aft drive shaft splines for excessive wear (paragraph 24-40-40, d).

(4) Replace all excessively worn parts.

CAUTION: SPLINE REPAIRS ARE NOT PERMISSIBLE.

e. At regular intervals inspect the rubber mounts between the aft drive shaft bearings and drive shaft. If there is evidence that the mounts turn on the shaft, or if there is lengthwise creepage, or dead or otherwise damaged rubber, replace the mounts.

f. Forward drive shaft serviceability limits and permissible repairs are as follows:

(1) Shaft runout shall not exceed 0.090-inch TIR along its entire length. (Remove shaft, and use an adapter set, Special Tool 92241, and V-blocks to check shaft runout.)
(2) Smooth contour dents in shaft not exceeding 3 square inches in area are permissible.
(3) No more than four dents are allowed in any 24-inch length of the tube.
(4) Circumferential scratches, regardless of number or location are permissible if the following limits are not exceeded:
(a) 0.010-inch in depth around 1/4 of the tube circumference.
(b) 0.005-inch in depth for the entire tube circumference.
(c) A combination of (a) and (b) provided the depths and lengths given are not exceeded.
(5) Lengthwise scratches in the tube must not exceed 0.010-inch in depth and no more than four such scratches are permissible in any 24-inch length of the tube.

g. Scratches that do not require drive tube replacement must be carefully blended out. Treat the repaired areas with Alodine and repaint. (Refer to Section 10.)

24-10-1. TAIL ROTOR DRIVE FORWARD SLIP JOINT ASSEMBLY. (See figure 24-1-1.)

24-10-2. DESCRIPTION. The forward slip joint assembly is located on the aft side of the lower transmission housing. The forward slip joint assembly transmits rotary motion from the transmission to the forward tail rotor drive shaft. Connection is made by flanged fittings on both ends of the slip joint assembly.

24-10-10. REMOVAL OF FORWARD SLIP JOINT ASSEMBLY.

a. Remove lockwire from the bolts connecting the slip joint to the forward drive shaft.
b. Remove the bolts and washers securing the slip joint flange to the forward drive shaft.
c. Remove the attaching bolts and nuts from the flange of the slip joint assembly and the pinion flange.
d. Remove the slip joint assembly.

24-10-11. INSTALLATION OF TAIL ROTOR DRIVE FORWARD SLIP JOINT ASSEMBLY.

a. Pack the inside of the housing with lubricating grease (see figure 10-19). Place the gasket in place against the forward body of the slip joint.
b. Assemble the slip joint to the transmission coupling with four bolts, nuts and washers. Tighten nuts to 160/190 pound-inches torque value.
c. Secure the slip joint aft flange to the forward drive shaft with four bolts and washers. Tighten bolts to 80/100 pound-inches torque value. Secure boltheads in pairs with 0.032-inch diameter (item 6, table 10-VI) lockwire.
d. Check that the forward slip joint assembly length setting is within the established tolerance. (See figure 24-1-4.)
e. Adjust the cardan joint assembly if requires to establish the correct position of the slip joint.

24-10-40. MINOR REPAIR AND PARTS REPLACEMENT OF THE FORWARD SLIP JOINT ASSEMBLY. Repair of the tail rotor drive forward slip joint assembly shall be limited to disassembly and installation of a replacement tail rotor drive slip joint kit. Check that backlash (rotational play) between the bell-shaped body housing and the internal ballhead does not exceed 0.023-inch, as measured at the outer edge of the ballhead mounting flange (the flange nearest the small end of the protective boot). If the replacement slip joint kit is not available, the slip joint assembly shall be replaced with serviceable assembly.

CAUTION: MAKE CERTAIN THAT THE REPLACEMENT PIN IS CENTERED IN THE BALLHEAD WITHIN 0.005-INCH WHENEVER A REPLACEMENT SLIP JOINT KIT IS INSTALLED. USE A PIN CENTERING SLEEVE GAGE (ITEM 45, TABLE 92-1-I) TO FACILITATE CENTERING THE PIN WITHIN THIS TOLERANCE.

24-20-1. FORWARD TAIL ROTOR DRIVE SHAFT. (See figures 24-1-1 and -2.)

24-20-2. DESCRIPTION. The forward tail rotor drive shaft transmits rotary motion between the main transmission and the cardan joint mounted on the tail boom. It is of built-up tubular construction, statically prebalanced.

24-20-10. REMOVAL OF FORWARD TAIL ROTOR DRIVE SHAFT.

a. Disconnect the slip joint from the forward end of the drive shaft. (Refer to paragraph 24-10-10.)
b. Remove the four bolts and washers attaching the forward tail rotor drive shaft to the forward universal joint.
c. Lift the forward tail rotor drive shaft clear of the helicopter.

24-20-11. INSTALLATION OF FORWARD TAIL ROTOR DRIVE SHAFT.

a. Position the aft end of the forward drive shaft against the cardan joint drive flange, and secure with four bolts and washers. Tighten bolts to 80/100 pound-inches torque value. Secure boltheads in pairs with 0.032-inch diameter lockwire. Do not secure across open throat of drive flange.
b. Connect drive shaft to forward slip joint (paragraph 24-10-11).

24-20-30. MINOR BALANCE CORRECTION, FORWARD DRIVE SHAFT. Because of surplus paint buildup, shaft repair work or other maintenance operations which may have affected the balance of the forward tail rotor drive shaft, it is sometimes necessary to verify that the shaft is still within its balance tolerance or to correct an out of balance condition. However, due to the improbability of the shaft becoming appreciably unbalanced, all other sources of tail rotor drive system vibration should be investigated and eliminated before proceeding with a shaft balance check. If drive system vibration persists, proceed as follows to check and correct the forward drive shaft balance.

a. (See figure 24-1-1A.) Attach a shaft balancing adapter set (item 51, table 92-1-I) to the shaft with the four special bolts included in the set. Do not use substitute bolts; the bolts contained in the adapter set are

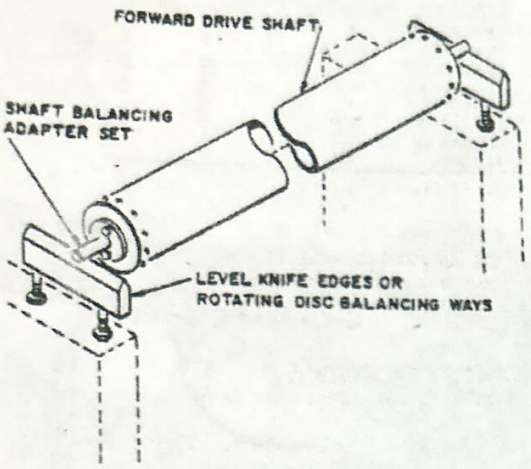


Figure 24-1-1A. Checking Static Balance of Forward Drive Shaft

specially selected so that the maximum difference in weight between the heaviest and lightest bolt does not exceed one gram.

b. Support the shaft on previously leveled knife edges (or rotating disc balancing ways) and allow it to rotate until it comes to rest. Mark the uppermost(light) side of the shaft, rotate approximately one-half turn, and again allow it to come to rest in order to verify that the marked side is consistently the lighter side.

c. Use a small strip of pressure sensitive tape to attach four AN960-10 balance check washers to the light side of the shaft and repeat step b. If the added weight neutralizes or reverses the out of balance condition the shaft is within its balance tolerance and the washers should be removed before returning the shaft to service.

d. If the washers do not offset the out of balance condition it is sometimes possible to accomplish minor balance corrections by applying one or more coats of finish paint to the light side of the shaft. The probability of correcting the condition by painting can be judged by adding additional balance check washers to determine how much additional weight is required, and whether a reasonable amount of paint will suffice.

e. If the addition of paint fails to balance the shaft within the tolerance given in step c above, completely rebalance the shaft in accordance with instructions provided in paragraph 24-20-50 or replace the shaft.

24-20-40. REPAIR OF THE FORWARD TAIL ROTOR DRIVE SHAFT. No welding or brazing repair of the forward tail rotor drive shaft is permissible. Shaft repairs are limited to the following.

a. Removal of minor nicks and scratches from the shaft may be accomplished by polishing out the defect within the limits defined in paragraph 24-1-40.

b. Replace any loosened shaft end cap or balance weight attaching rivets. Use MS20600AD5W4 rivets for attaching end caps. If rivet holes have become enlarged, use next larger size rivets.

c. After any shaft repair, check shaft balance (paragraph 24-20-50).

24-20-50. REBALANCING FORWARD DRIVE SHAFT. Complete rebalancing of the forward tail rotor drive shaft should not be undertaken until attempts have been made to remedy the unbalance condition by minor balancing corrections (paragraph 24-20-30). When it has been determined that minor balance corrections are inadequate, use the following procedure to completely rebalance the shaft.

NOTE: The following procedure employs the static balancing method. However, dynamic balancing methods are equally acceptable provided that the balance weight locations, limitations and distribution pattern described hereunder are observed. The shaft balancing adapter set depicted in figure 24-1-1A is designed for use with either static or dynamic balancing equipment.

a. Strip all of the paint from the exterior surfaces of the shaft. Take care not to disturb the paint on the interior shaft surfaces.

b. Carefully remove the rivets attaching the original shaft balance weight(s) to the interior of the shaft and remove the balance weights. See figure 24-1-1B for balance weight locations.

c. Plug all open rivet holes with suitable length blind rivets of the type specified in figure 24-1-1B.

d. Repaint the shaft as evenly as possible with zinc chromate primer and finish paint of the appropriate type and color. Allow ample drying time before proceeding with the next steps.

e. Perform the preliminary operations described in paragraph 24-20-30 steps a and b in order to locate and mark the light side of the shaft.

f. (See figure 24-1-1B.) Drill a single 0.128/0.132-inch diameter rivet hole 25 inches from each end of the shaft as shown in the illustration. Take care to locate the holes directly in line with the mark identifying the light side of the shaft.

g. Determine the approximate amount of weight required to balance the shaft by attaching one or more trial weights to the exterior wall of the shaft with a narrow strip of pressure sensitive tape at one of the two rivet holes. Keep adding weight in 1/4-ounce increments until the light side of the shaft becomes the heavy side. When the balance shift occurs, deduct 1/4-ounce of weight from the total; this will compensate for an equal amount of solder needed in the following step.

h. Remove the balancing adapter fittings from the ends of the shaft and transfer the weight calculated in the preceding step to the interior of the shaft. Secure the weight in place at one of the rivet holes with exactly 4-1/8 inches (1/4 oz.) of 1/8-inch diameter wire solder as shown in the illustration. If more than one weight is required, divide the total weight as equally as possible at both ends of the shaft and use one half of the wire solder to attach each weight. Take care to clinch the wire solder down as securely as possible in order to hold the weights in tight contact with the shaft wall.