CHAPTER 8

FLIGHT CONTROLS

CHAPTER 8

FLIGHT CONTROLS (Continued)

CHAPTER 8

FLIGHT CONTROLS

8.000 Description

Dual controls are standard equipment and all primary controls are actuated through push-pull tubes and bellcranks. Bearings used throughout the control system are either sealed ball bearings or have self-lubricated liners.

R22 Flight controls operate conventionally. The cyclic is center-mounted with the left and right control grips mounted to a cross tube which pivots on the center cyclic stick. On later aircraft, the pilot's cyclic grip angle can be adjusted fore and aft relative to the cross tube by a mechanic to achieve the most comfortable hand position.

The collective stick is also conventional with a twist grip throttle control. When the collective is raised, the throttle is opened by an interconnecting linkage. An electronic governor makes minor throttle adjustments required to maintain RPM. On later aircraft, a fixed (plastic) grip aft of the twist grip allows the pilot to rest their hand on the collective without inadvertently interfering with governor operation.

WARNING

Assembly of flight controls is critical and requires inspection by a qualified person. If a second person is not available, RHC recommends the installer take a 5-minute break prior to inspecting flight control connections the installer has assembled.

8.100 Cyclic Controls

8.110 Cyclic Assembly

A. Removal

1. Remove collective stick assembly per § 8.210.
2. If installed, remove C683 damper(s).
3. Remove screws securing mixture and carburetor heat control cable covers to cyclic box cover. If equipped with carb heat assist, unscrew carb heat knob from shaft.
4. Remove spring pin & knob from cyclic friction and right trim adjustment (if equipped); temporarily install spring pins to retain spacers. Unscrew & remove right trim actuation knob from shaft.
5. Remove screws securing cyclic box cover to cyclic box and vertical panels. Lift cyclic box cover and disconnect wiring at connectors. Temporarily secure cover up and clear of keel panels using ty-rap(s), as required.
6. Remove elastic cord per § 8.140.

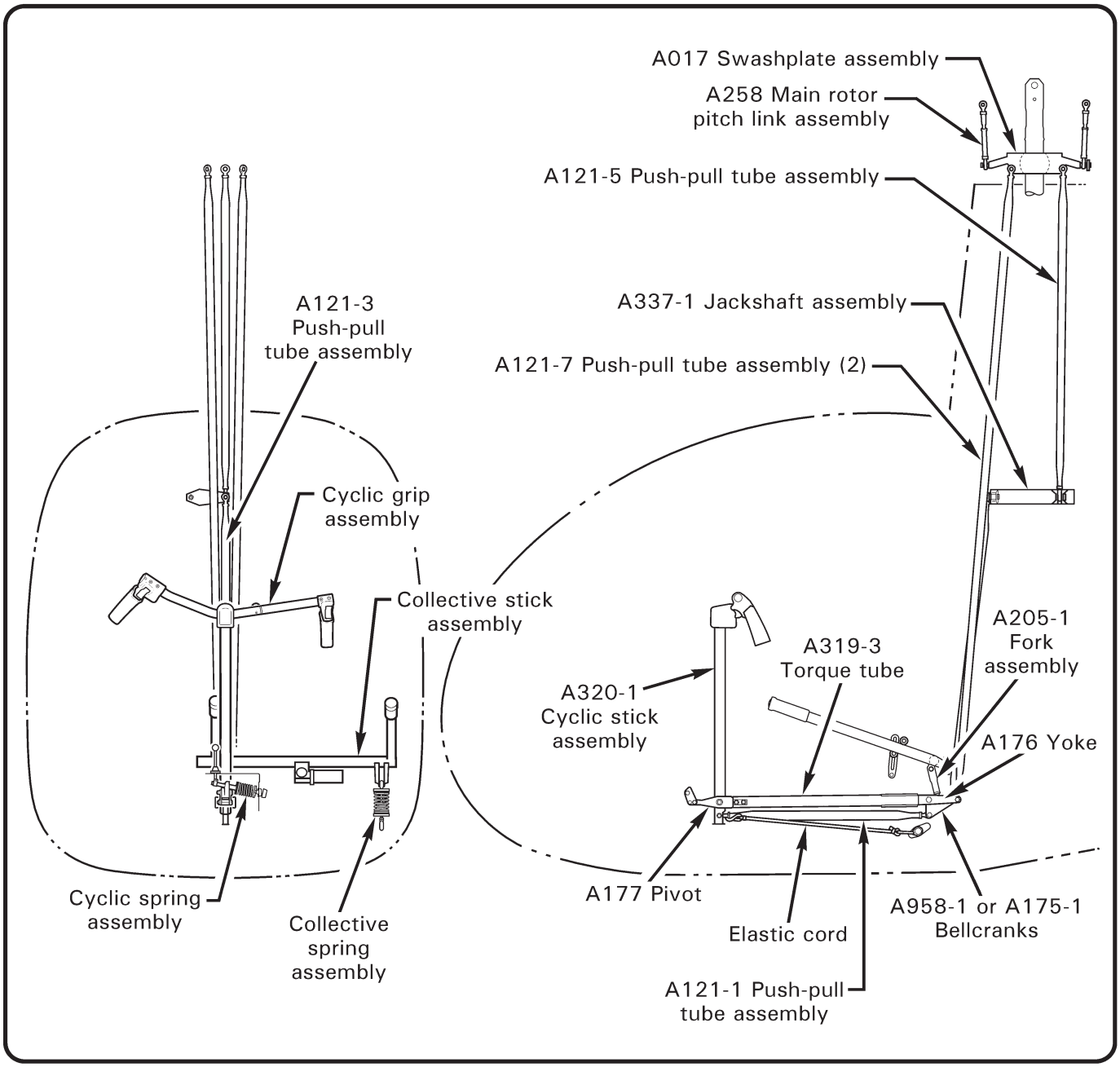

FIGURE 8-1 MAIN ROTOR FLIGHT CONTROLS

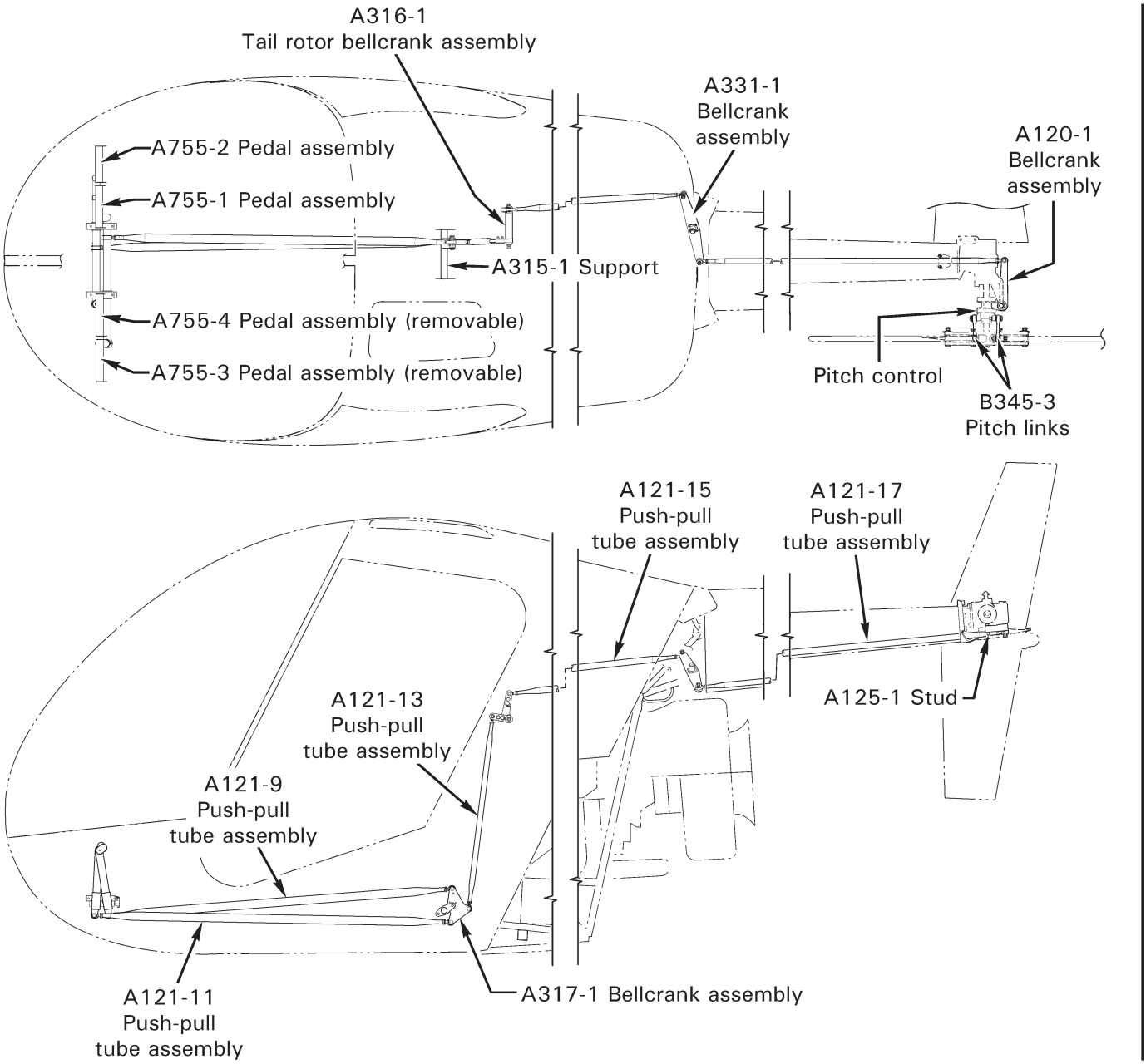

FIGURE 8-2 TAIL ROTOR FLIGHT CONTROLS

8.110 Cyclic Assembly (continued)

A. Removal (continued)

7. Position cyclic stick full forward. Remove bolt securing A121-3 push-pull tube to A958-1 (or A175-1) bellcranks.
8. Remove A231-9 plug assemblies from vertical firewall tunnel. Remove bolt securing left & right A121-7 push-pull tubes to cyclic pivot assembly.
9. Disconnect cyclic stick wiring at connectors.
10. Unscrew, but do not remove, bolts securing cyclic friction assembly to A500-1 plate (bolts will retain spacers between friction plates).
11. Remove screws securing cyclic box assembly to keel panels.
12. Move cyclic stick full right to relieve right trim spring compression and apply cyclic friction to hold friction assembly stackup in place. Pull cyclic box straight up from keel panels and remove cyclic assembly from helicopter.

B. Installation

CAUTION

Rigging must be checked if any of the following has occurred:

1. Replacement of cyclic assembly.
2. Replacement of A338-1 cyclic box or A320-1 cyclic stick.
3. Replacement or change of A205-1 fork assembly (connecting collective assembly to cyclic pivot assembly).
4. If A121-1, -3, -5, or -7 push-pull tube assembly rod end center-to-center dimension changes.
5. Jackshaft support length is changed.

NOTE

During cyclic installation, properly align cyclic friction stackup and apply friction to hold stackup in place.

1. Position cyclic assembly between keel panels. Ensure cyclic friction assembly and right-trim spring assembly are properly located.
2. Install screws securing cyclic box to keel panels except (4) screws that secure cyclic cover. Standard torque bolts securing cyclic friction assembly and torque stripe per Figure 2-1.
3. Assemble A121-7 push-pull tubes, A115-1 spacers, and A130-10 spacer to A176 yoke. Standard torque bolt & palnut per § 23-32 and torque stripe per Figure 2-1.
4. Position cyclic stick full forward. Assemble A121-3 push-pull tube and A115-1 spacers to A958-1 (or A175-1) bellcranks. Standard torque bolt per § 23-32 and torque stripe per Figure 2-1 (1 thread exposed minimum beyond nut is permissible).

8.110 Cyclic Assembly (continued)

B. Installation (continued)

5. Install elastic cord per § 8.140.
6. Attach cyclic stick electrical connector(s) to airframe harness. With cyclic friction off, move cyclic throughout full travel and verify wiring is clear of friction assembly.
7. Refer to Figure 8-3. If A205-1 fork was removed from A101-4 rod end, screw fork onto rod end between 3.50–3.60 inches from center of rod end hole to centerline of attach bolt hole. Standard torque jamnut per § 23-32 and torque stripe per Figure 2-1.

NOTE

Dimension of A205-1 fork should be 3.50–3.60 inches from center of rod end bearing to center of attaching bolt hole (no palnut required on this rod end). Verify autorotational RPM per § 10.250 if A205-1 fork dimension has changed.

8. Install collective stick per § 8.210 but do not install horizontal cover, vertical panel, or seat backs.
9. Cut and discard ty-rap(s) temporarily securing cyclic box cover. Connect post light wire & ELT connector as applicable and ty-rap clear of controls. Cinch ty-raps until snug without over-tightening and trim tips flush with heads.
10. Position cyclic box cover over keel panels, inserting right trim shaft, friction assembly shaft, fuel mixture control, and carb heat control through cover, as applicable. Install screws securing cover to keel panels.
11. Install knobs and control cover attach screws.
12. Move flight controls throughout complete travel. Verify 0.12 inch minimum clearance & no binding or interference with control movement, except the following:
    a. 0.030 inch minimum clearance permissible between A121-7 push-pull tubes and upper frame forward attach bolts & nearby surrounding cabin structure.
    b. Contact permissible between A121-3 & -7 push-pull tubes near lower ends when cyclic stick is positioned in aft corners of stop plate.
    c. Contact permissible between A121-1 push-pull tube and A327-1 overtravel spring when cyclic is positioned in forward right corner of stop plate.
    d. Contact permissible between A121-3 push-pull tube and B328-1 collective connecting rod when collective is positioned full up & cyclic is full aft.
13. Adjust friction assembly per § 8.150, as required.
14. Rig main rotor flight controls per §§ 10.110 & 10.120.
15. Install seat backs per § 15-22.
16. Install center horizontal cover & vertical panel.

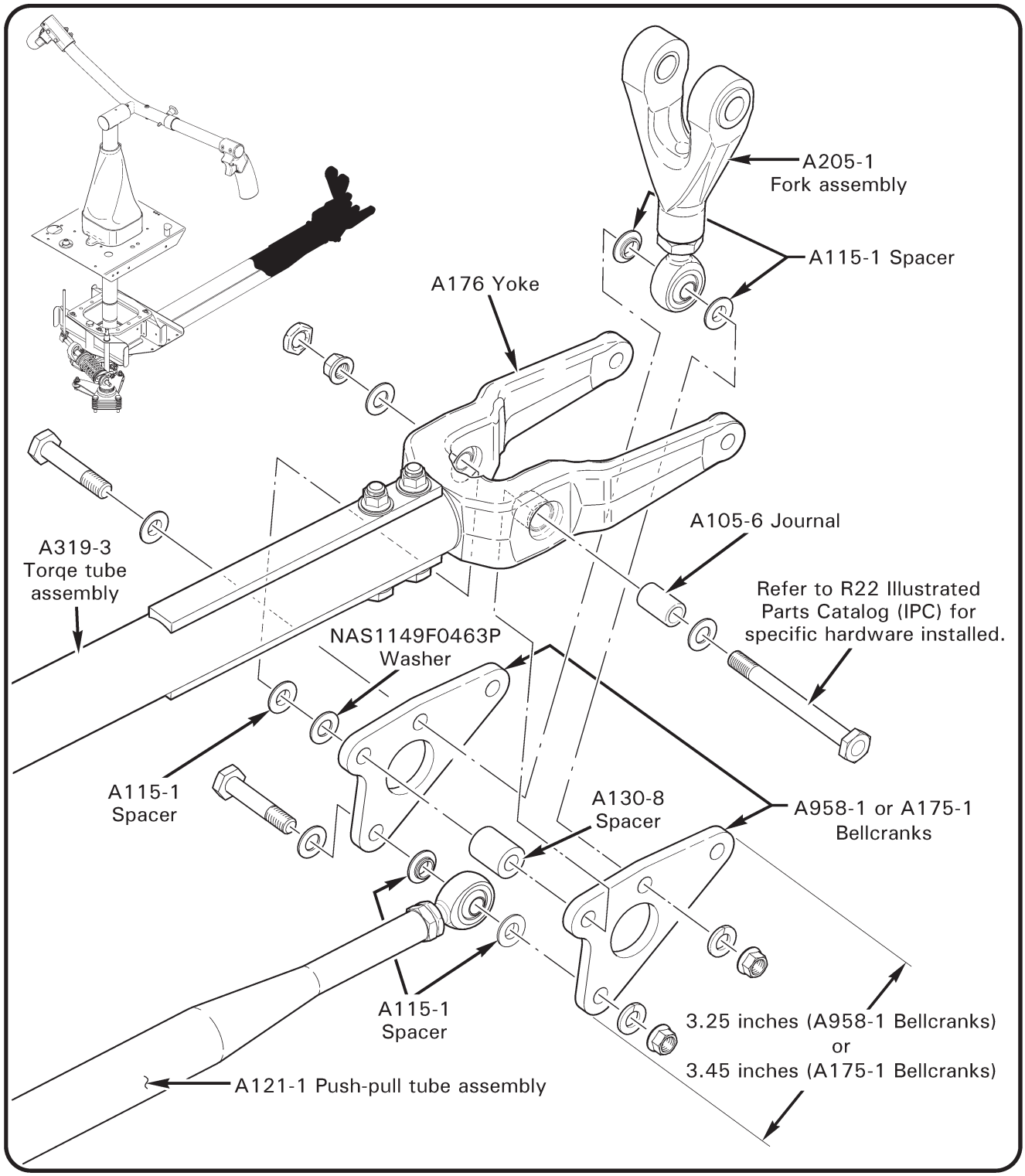

FIGURE 8-2A CYCLIC PIVOT ASSEMBLY AFT BELLCRANK

8.111 A958-1 or A175-1 Bellcranks

NOTE

A175-1 bellcranks are original equipment on helicopter S/N 0001 thru 0356 except S/N 0256, 0301, 0350, and 0351. A958-1 bellcranks are original equipment on helicopter S/N 0256, 0301, 0350, 0351, and 0357 and subsequent.

CAUTION

A958-1 bellcranks are required equipment if tailcone has B379-1 or -3 bracket installed.

A. Removal

1. Remove cyclic assembly per § 8.110.
2. Refer to Figure 8-2A. Remove hardware securing A121-1 push-pull tube to A958-1 (or A175-1) bellcranks.
3. Remove hardware securing bellcranks to A176 yoke and remove bellcranks.
4. Remove hardware securing A205-1 fork assembly's rod end to bellcranks.
5. As required for upgrade, earlier A175-1 bellcranks may be directly replaced with A958-1 bellcranks per Part B.

B. Installation

1. Refer to Figure 8-2A. Position A130-8 spacer between A958-1 (or A175-1) bellcranks and insert temporary bolt for alignment.
2. Install hardware securing A205-1 fork assembly's rod end and A121-1 push-pull tube to bellcranks. Standard torque bolts & palnuts per § 23-32 and torque stripe per Figure 2-1.
3. Remove temporary bolt and install hardware securing A958-1 (or A175-1) bellcranks and spacer in A176 yoke. Standard torque bolt & palnut per § 23-32 and torque stripe per Figure 2-1.
4. Install cyclic assembly per § 8.110, as required.
5. Perform main rotor rigging per § 10.120 and track and balance per § 10.230.

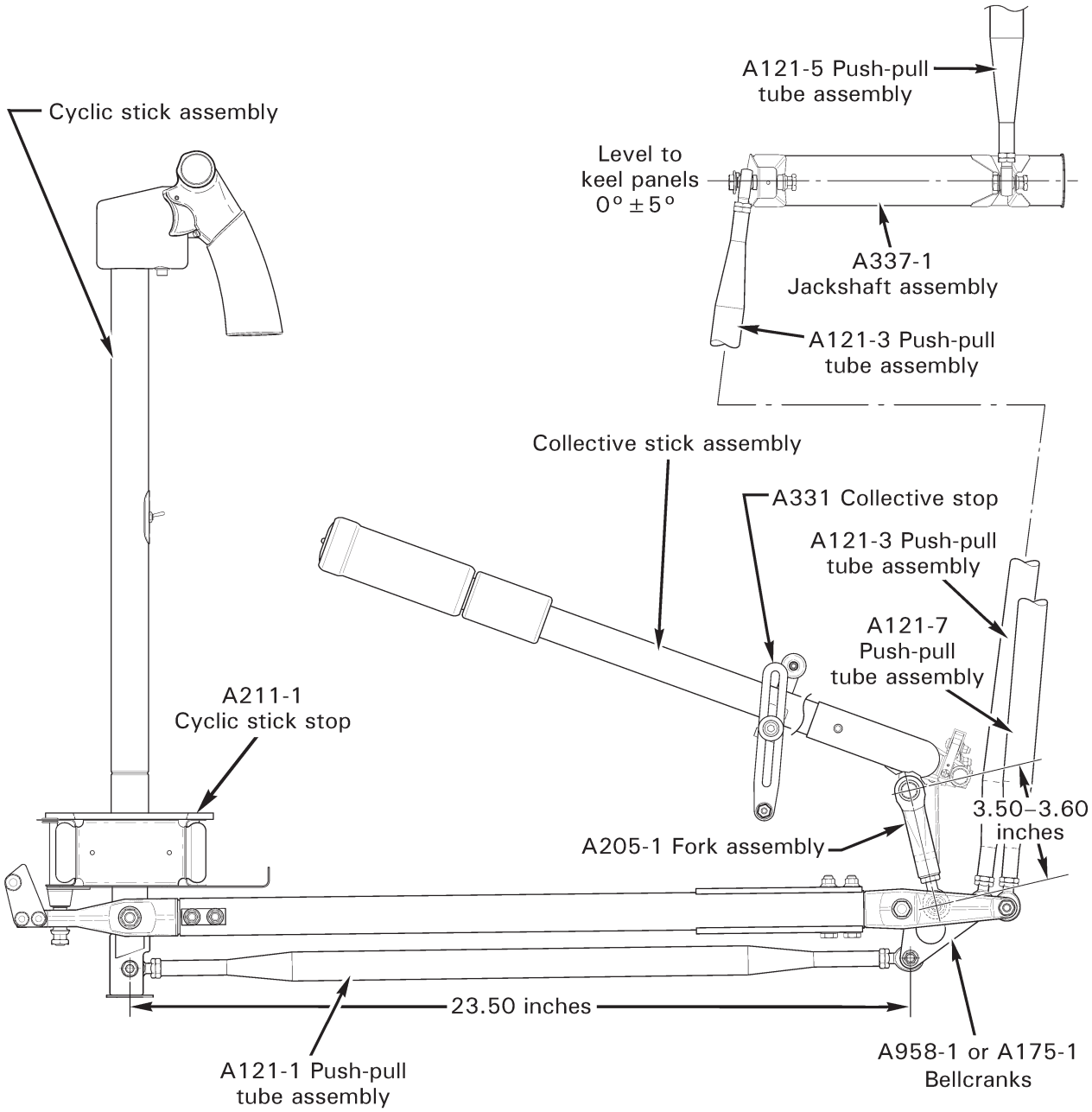

FIGURE 8-3 CYCLIC AND COLLECTIVE CONTROL

8.120 Cyclic Grip Assembly

A. Removal

NOTE

This may be accomplished without removal of complete cyclic assembly from helicopter.

1. Remove bottom center inspection panel.
2. Disconnect cyclic stick electrical connectors. Using pin extractor, remove pins from housing(s), retain housing(s). Wires -112, -138, and -355 may remain installed.
3. Remove heat shrink & sleeving from wires. Attach one piece of safety wire or lace tape to each group of wires near pins.
4. Remove grommet from upper aft side of stick assembly and pull each wire group out of stick leaving safety wires or lace tapes protruding from each end of stick.

NOTE

Wires are separated into two groups of wires at bottom-right forward & aft side of cyclic stick.

5. Remove C683-9 damper assembly (if installed), B209-4 plug, cotter pin, castellated nut and A141-14 washer from cyclic grip pivot.
6. With a soft-faced hammer, gently tap cyclic grip shaft and remove cyclic grip assembly from A320-1 stick. Ensure bearings remain inside stick.

NOTE

Do not damage bearings during removal.

B. Installation

1. Ensure B350-1 spring pin is installed in grip assembly. Ensure heat shrink, sleeving, and grommets (as applicable) are installed over grip assembly wiring.
2. Slide grip assembly thru bearings in stick assembly. Install A141-14 washer and castellated nut, tighten castellated nut until there is no axial movement of bearings and cyclic grip assembly. Install cotter pin.

CAUTION

Over-tightening nut will damage bearings.

3. Install B209-4 plug and C683-9 damper (as required).

8.120 Cyclic Grip Assembly (continued)

B. Installation (continued)

4. Separate wires into (2) groups. Attach lace tape or safety wire protruding from cyclic stick to each group of wires and pull wires thru cyclic stick. Install grommet in cyclic stick.

> NOTE
>
> One wire group will extend thru forward right side of cyclic stick; one wire group will extend thru aft right side of cyclic stick.

5. Install sleeving and heat shrink around all wires and slide heat shrink into cyclic stick as far as possible to prevent chafing of wires. Secure sleeving ends with lacing tape.
6. Refer to Figures 14-39A, 14-39B, and 14-39C for A024 electrical system schematic. Install wires in housing(s) per schematic.
7. Connect cyclic wiring at connectors and lock connectors using MS3367-4-9 ty-raps, as required. Cinch ty-raps until snug without over tightening and trim tips flush with heads. Move cyclic throughout complete travel and verify electrical wiring clearance & no binding.
8. Turn battery switch ON and verify correct function of all switches on cyclic grip and stick assemblies.
9. Install belly panel.

C. Adjustment (D379-1 Grip)

1. Loosen (2) 91251A194 (or NAS1352-08-8) cap screws securing pilot's grip to A756-18 weldment.
2. Rotate grip to desired position, special torque cap screws to 40 in.-lb.

> NOTE
>
> Verify full control travel prior to flight when changing grip angle.

8.130 Cyclic Spring (Right-Trim)

A. Description

The function of the cyclic spring is to balance the left-stick force in cruise conditions. It is actuated by pulling up on the black knob located forward of the cyclic stick. The trim spring (two forces available) may be changed or shimmed to create the force necessary to balance the cyclic control laterally. This usually is required after a main rotor blade change.

B. Removal

1. Remove screws securing mixture and carburetor heat control cable covers to cyclic box cover. If equipped with carb heat assist, unscrew carb heat knob from shaft.
2. Remove spring pin & knob from cyclic friction and right trim adjustment; temporarily install spring pins to retain spacers. Unscrew & remove right trim activation knob from shaft.
3. Remove screws securing cyclic box cover to cyclic box and keel panels. Lift cyclic box cover and disconnect wiring at connectors. Temporarily secure cover up and clear of keel panels using ty-rap(s), as required.
4. Remove right-trim assembly attach bolt. Firmly grasping spring assembly; tip cyclic stick right to relieve pressure from spring, pull spring up & right to remove assembly.

C. Spring Replacement & Shimming

B056 Assemblies (in-flight adjustable)

> NOTE
>
> Changing trim spring will create a large change in trim forces. Shimming A618-1 spring (primer colored) may be required to obtain desired trim force.

1. Remove right-trim assembly per Part B.
2. Remove A584-1 bearing support and A130-46 spacer from A585-2 shaft. Unscrew A583-2 cap from shaft and remove A618 spring.
3. Adjust shims as required between A583-1 cap and A588-1 spacer. A618-1 spring (primer colored) may be shimmed a maximum thickness of (3) NAS1149F0463P washers. A618-2 spring (black colored) must not be shimmed.

> **CAUTION**
>
> Do not shim beyond allowable thickness. Trim spring may bottom preventing full left cyclic travel.

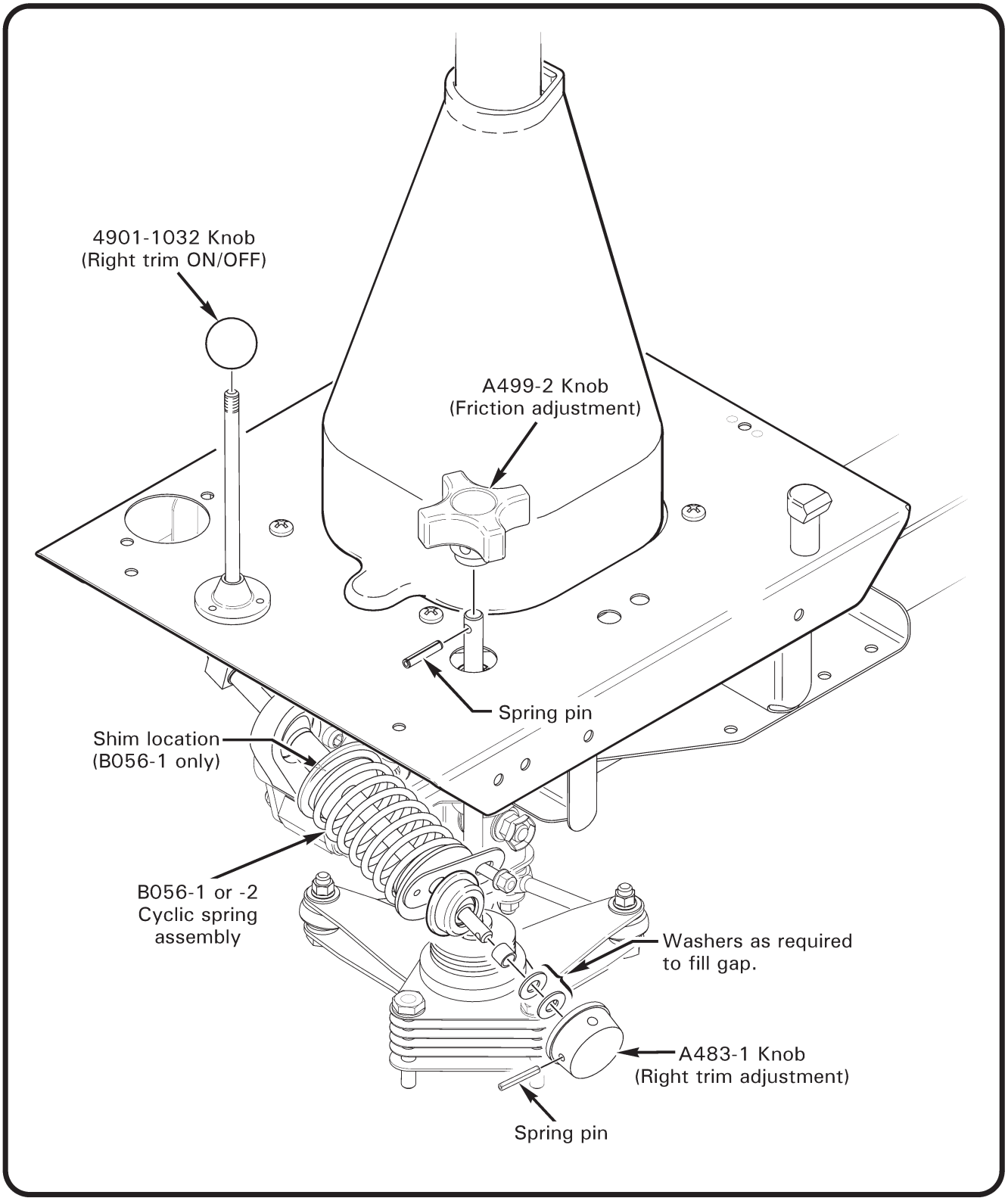

FIGURE 8-4 CYCLIC SPRING (RIGHT-TRIM)

8.130 Cyclic Spring (Right-Trim) (continued)

C. Spring Replacement & Shimming (continued)

B056 Assemblies (in-flight adjustable) (continued)

4. Install A618-1 (10.7 lb/in.) or A618-2 (14.5 lb/in.) spring to obtain desired trim force. Ensure light coat of A257-1 grease is applied to shaft at caps and A588-1 spacer. Thread A583-2 cap on shaft. Reinstall A130-46 spacer and A584-1 bearing support.
5. Install right-trim assembly per Part D.

A056 Assemblies (non-adjustable)

> NOTE
>
> If A056 cyclic spring assembly (originally installed on R22 helicopters S/N 0002 thru 0549) requires shimming, contact RHC Technical Support.

D. Installation

1. Move cyclic stick full right to minimize spring compression during installation. Insert bearing support flush into left vertical panel; ensure B160-1 pin is inserted through A594-1 tab, as required. Firmly grasp spring assembly and insert A581-1 arm in cyclic pivot assembly. Install hardware and standard torque per § 23-32.
2. For in-flight adjustable trim assemblies, install A483-1 knob and set to full trim. Verify spring does not limit full cyclic travel, or cause spring binding. Adjust shims as required per Part C.
3. Cut and discard ty-rap(s) temporarily securing cyclic box cover. Connect post light wire & ELT connector as applicable and ty-rap clear of controls. Cinch ty-raps until snug without over-tightening and trim tips flush with heads.
4. Position cyclic box cover over keel panels, inserting right trim shaft, friction assembly shaft, fuel mixture control, and carb heat control through cover, as applicable. Install screws securing cover to keel panels.
5. Install knobs and control cover attach screws.
6. Move flight controls throughout complete travel and verify no binding or interference with control movement. Adjust friction assembly per § 8.150, as required.

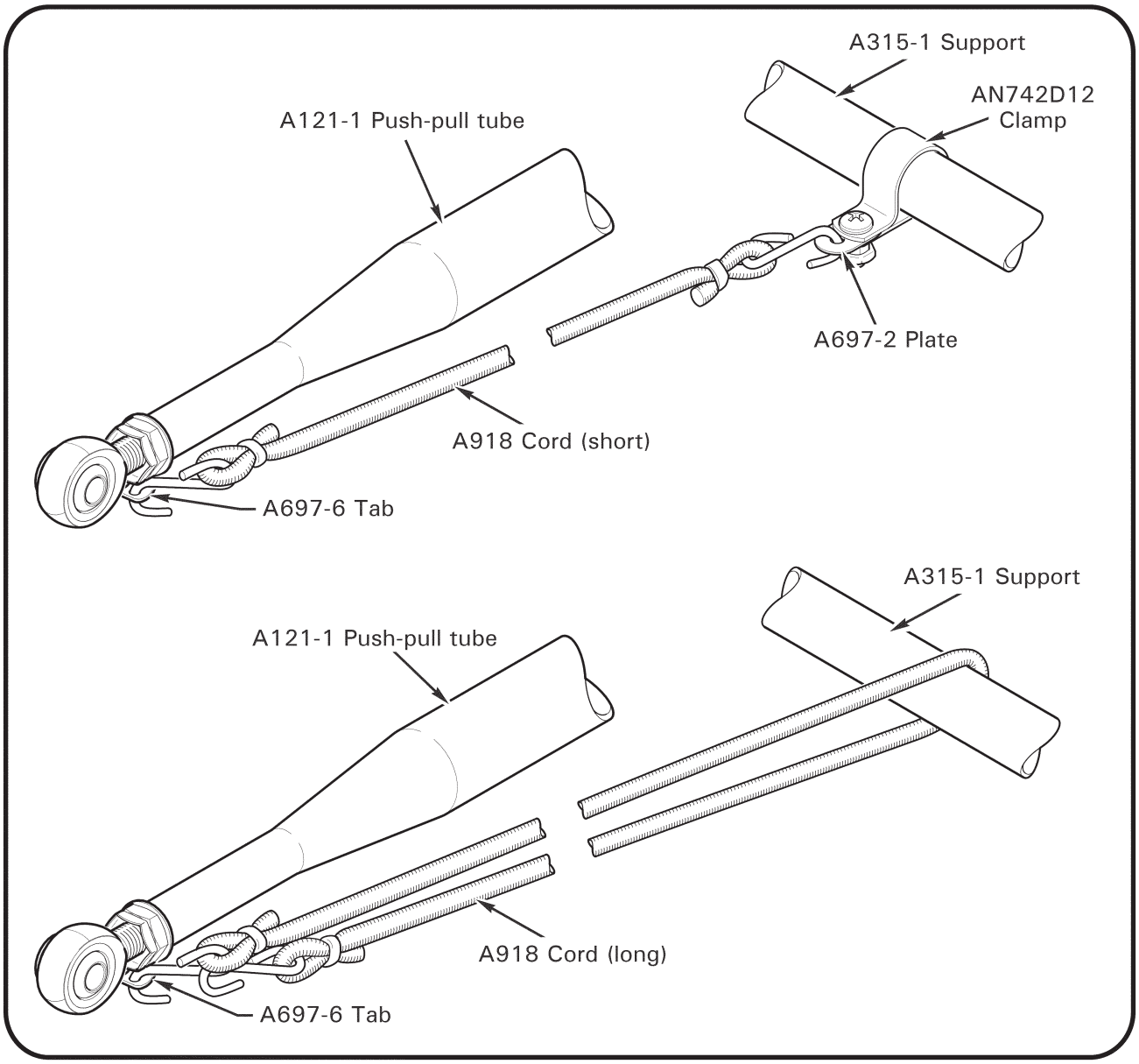

FIGURE 8-4A ELASTIC CORD (FORWARD-TRIM)

8.140 Elastic Cord (Forward-Trim)

A. Description

The elastic cord is used to balance most longitudinal (fore-aft) stick forces during cruise flight. If the cyclic grip moves forward in cruise flight, a weaker elastic cord is required. If the cyclic stick grip moves aft in cruise flight, a stronger elastic cord is required. Elastic cords can be identified by an I.D. tag, or by measuring the diameter and length of the cord. Refer to R22 Illustrated Parts Catalog (IPC) for available elastic cords. Test fly helicopter after elastic cord change to evaluate trim forces in level cruise flight, repeat until desired trim forces are obtained.

B. Removal

1. Remove A794-2 center belly panel. If transponder antenna installed in panel, pull XPDR (refer to electrical schematic) circuit breaker and disconnect antenna.
2. Position cyclic stick full forward.
3. a. Refer to Figure 8-4A. Unhook short elastic cord from forward end of A121-1 push-pull tube then unhook at A315-1 support and remove elastic cord, or

   b. Separate long elastic cord hooks from each other, then unhook from forward end of A121-1 push-pull tube and remove long elastic cord.
4. Inspect elastic cord. Stretch cord, while stretched look for voids which may indicate broken strands. Slide hooks back and verify security of locking rings.

C. Installation

NOTE
Select A918-1 thru -13 elastic cord as determined by flight test evaluation.

1. As required for short elastic cord installation, install hardware securing A697-2 plate and AN742D12 clamp to A315-1 support.
2. Position cyclic stick full forward.
3. a. Refer to Figure 8-4A. Attach short elastic cord to A697-2 plate then attach elastic cord to A697-6 tab at forward end of A121-1 push-pull tube, or

   b. Attach long elastic cord to A697-6 tab at forward end of A121-1 push-pull tube then route over A315-1 support and attach hooks together.
4. Move cyclic throughout full travel and verify clearance of elastic cord hooks to push-pull tube, wire bundle, and cyclic stick assembly wires.
5. Connect transponder antenna (as required) and install belly panel. Push in XPDR (refer to electrical schematic) circuit breaker.

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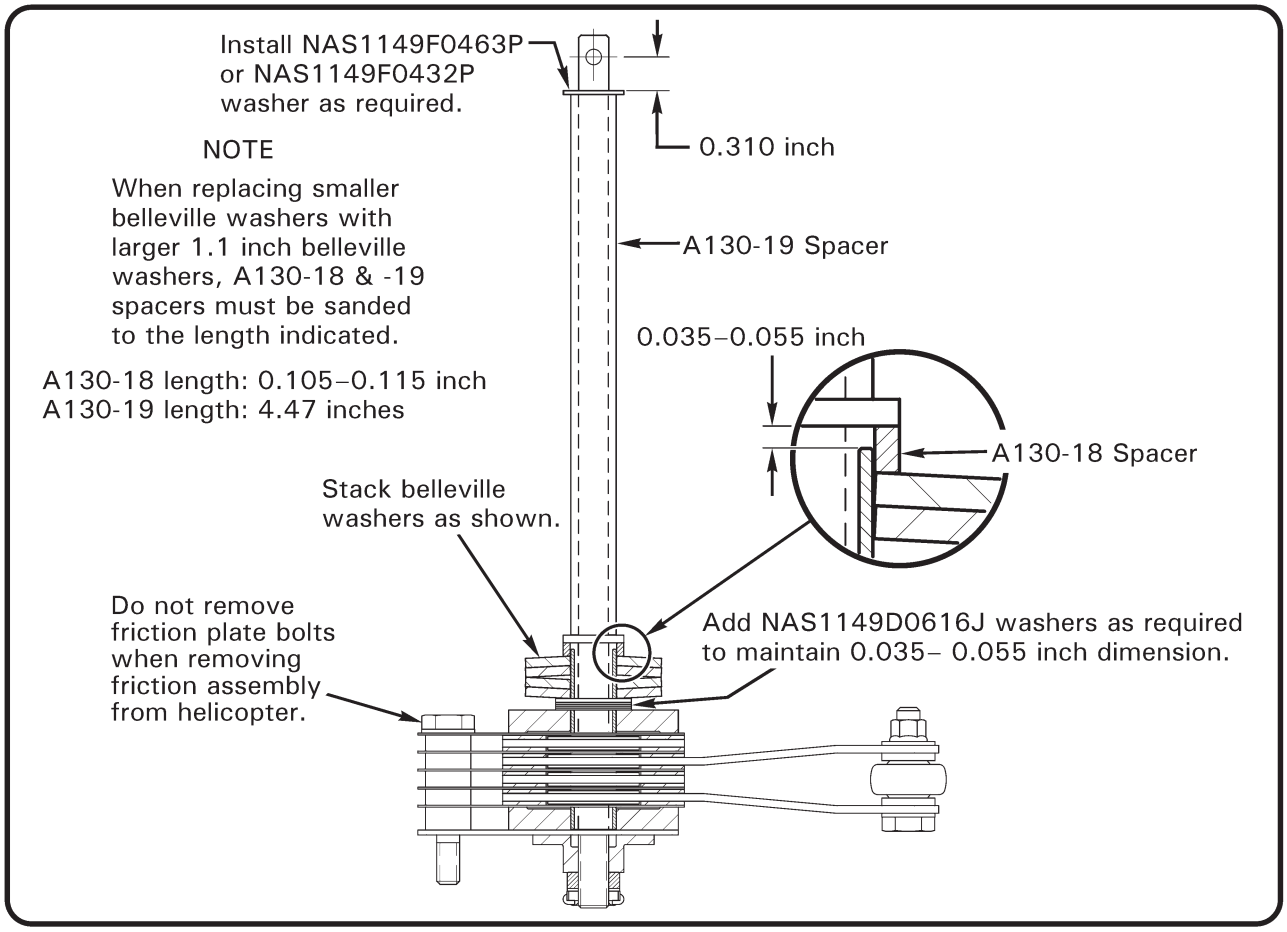

FIGURE 8-4B CYCLIC FRICTION ADJUSTMENT

8.150 Cyclic Friction Assembly

A. Description

Cyclic Friction knob is located at front left corner of cyclic box cover. Turning knob clockwise applies friction to both longitudinal and lateral cyclic. If friction cannot be applied by turning knob clockwise, adjustment of friction may be required.

B. Adjustment

1. Turn friction knob counter-clockwise until it stops. Verify knob rotates $^1/_8$ to 1 full turn before adding friction.
2. Remove elastic cord per § 8.140.
3. Rotate blades until pitch links are in right & left position to eliminate pitch link movement when measuring longitudinal cyclic friction.
4. Select right trim off. Using spring scale measure force required to move cyclic stick forward & aft. Average force required must not exceed 3 lb.
5. Rotate blades until pitch links are in forward & aft position to eliminate pitch link movement when measuring lateral cyclic friction.
6. Using spring scale measure force required to move cyclic stick left & right. Average force required must not exceed 2 lb.
7. Apply full cyclic friction and measure force required to move cyclic stick left & right. Force required must not exceed 10 lb.
8. Refer to Figure 8-4B. To adjust friction remove spring pin from friction knob and lift knob off shaft. Install NAS1149F0463P or NAS1149F0432P washer as required. Install friction knob & spring pin. Verify proper friction per preceding steps.

> NOTE
>
> If friction assembly will not tighten and does not have larger (1.1 inch) belleville washers installed (4 ea.), replace with A478-1 spring washer and change length of spacers per Figure 8-4A. Replace circular knob with A499-2, as required.

9. Move flight controls throughout complete travel. Verify operating clearance with no binding.
10. Install elastic cord per § 8.140.

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8.160 A121-7 Push Pull (P-P) Tube

8.161 A121-7 Push-Pull Tube Removal

a) Remove belly panel, vertical panel between seat backs and mast fairing, disconnecting pitot line at pitot fitting.

b) Remove vertical firewall maintenance hole plug to remove A121-7 P-P tubes.

NOTE

IF HOLES NOT PRESENT, INSTALL USING RHC KIT KI-21.

c) Remove NAS1304-44 bolt attaching -7 P-P tube rod ends to cyclic fork.

d) Disconnect bolts holding A121-7 P-P tubes at swashplate.

e) Tape sheet metal edges to prevent P-P tube removal damage.

f) Position swashplate and rotor to slide A121-7 P-P tube up and clear. Mark right and left tubes if they are to be reinstalled.

g) Inspect P-P tubes and sleeves for damage.

h) Inspect P-P tube guide for wear. The guide should be replaced if excessively worn or if fretting evident between guide material and riveted aluminum support.

NOTE

If P-P tube replaced, adjust rod ends to obtain same center-to-center length or M.R. Flight Controls will require rigging per R22 Maintenance Manual Section 10.

8.162 A121-7 Push-Pull Tube Inspection/Repair

1. Nicks, cuts or scratches in the tube which are longitudinal not more than 0.010 inches deep, or across the tube and not more than 0.005 inches deep may be polished out.

2. Dented or flattened tube of more than five percent of its diameter must be replaced.

3. Maximum tube wear at guide 0.015 inch per wall after smoothing wear ridges. Epoxy primer repair surfaces before sleeve installation. Any tube wear requires sleeve installation.

4. Replace tube worn in excess of 0.015 inch after polishing.

8.163 Sleeve Installation Onto A121-7 Push-Pull Tube

NOTE

Repair any wear damage on A121-7 P-P tube per Section 8.162 prior to the P-P tube sleeve installation.

a) Clean P-P tube by lightly using MEK or acetone.

b) Apply tape to restrict adhesive to 6.5 inch area located 31 inches from end of P-P tube (not end of rod end).

c) Test paint for paint bubbling; apply 1-inch band of adhesive to one end of 6.5 inch area. If paint bubbles, remove paint and apply epoxy primer to area before applying adhesive to whole 6.5 inch area.

WARNING

Adhesive to be applied to complete area under P-P tube sleeve.

d) Apply adhesive supplied in kit to whole 6.5 inch area. (It will set and become stringy very quickly. Brush thin coat of adhesive without large lumps as rapidly as possible).

NOTE

Sleeve must be installed within two minutes after adhesive applied.

e) Slide sleeve onto tube and center of adhesive.

f) Rotate tube and apply heat using up to 1200-watt heat gun to evenly shrink sleeve producing smooth surface.

CAUTION

DO NOT APPLY HEAT CONTINUOUSLY TO SAME AREA.

g) Allow to cool and apply adhesive to seal end of sleeve. Do not have adhesive at ends above surface of sleeve or sleeve will be damaged or will not enter guide during installation.

8.164 Push-Pull Tube Sleeve Inspection

a) Visually inspect sleeve for wrinkles, pin holes, bubbles, gouges, torn areas, etc. Replace sleeve if any damaged or suspect areas are found.

8.165 A121-7 Push-Pull Tube Installation

a) Inspect P-P tube guide for wear. The guide should be replaced if excessively worn or if fretting evident between guide material and moveable guide plate.

NOTE

Old-style guide bushings which are riveted to fuselage must be replaced with moveable guide kit (RHC Kit KI-19A) if A121-7 Push-Pull tubes are worn. Reference RHC Service Bulletin #36.

b) Loosely (snug) install moveable guide on underside of airframe support A439-1 per Figure 8-4E.

CAUTION

Extreme care must be taken when installing A121-7 P-P tube into guide to prevent damage to P-P tube sleeve.

c) Install A121-7 P-P tube, ensure spacers installed properly. Reference Figure 8.4E.Torque attach bolt 100 in.-lb. plus nut drag.

d) Attach A121-7 P-P tubes to swashplate. Torque attach bolts 100 in.-lb. plus nut drag.

e) Raise collective approximately seven (7) inches (measured from pilot throttle handle to center panel) with cyclic neutral.

f) Tighten guides three attach bolts to slight friction and verify A121-7 P-P tubes are centered in guide bore. Torque guide attach bolts 40 in.-lb. and torque stripe nuts.

g) Remove protective tape from sheet metal edges used to protect P-P tubes during installation.

h) Check full travel clearances of flight controls.

1) Upper frame forward two boltheads at horizontal firewall to A121-7 P-P tubes minimum clearance .010 inch.

2) Fuel tank top inboard flange to left A121-7 P-P tube minimum clearance .10 inch.

8.165 A121-7 Push-Pull Tube Installation (cont'd)

i) Verify fasteners disconnected are retorqued per R22 Maintenance Manual Section 1.300.

j) Reinstall panels, fairings and firewall plugs.

k) If rod ends were unscrewed from P-P tubes, main rotor rigging must be re-checked per Section 10.

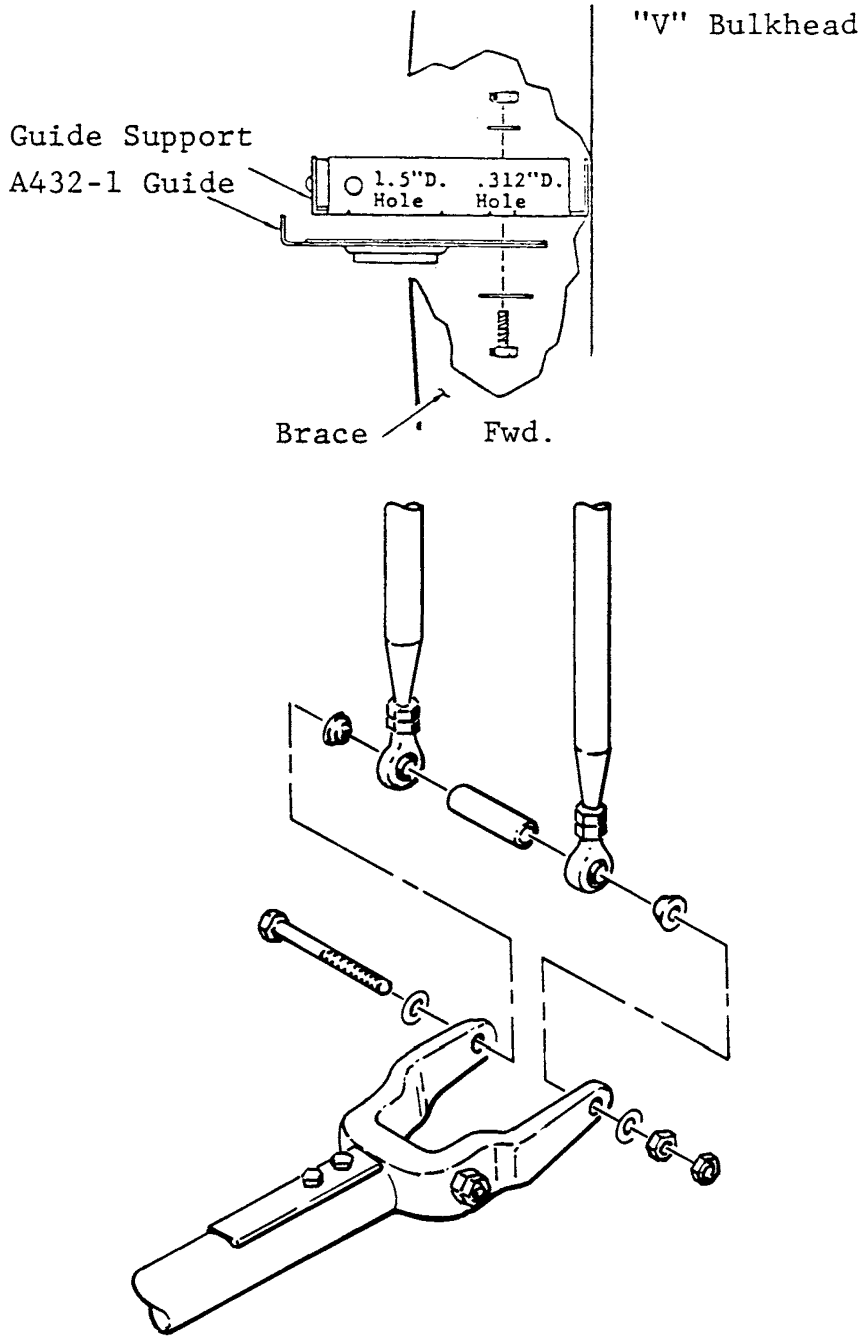

FIGURE 8-4E PUSH-PULL TUBES AND GUIDE

8.200 Collective Control

8.210 Collective Stick Assembly

A. Removal

1. Remove seat backs per § 15-22.
2. Remove center cover & vertical panel (cyclic control inspection panels).
3. Remove screws securing collective spring cover and remove cover. If spring cover aft mounting hole is slotted, screw may be loosened and left installed in vertical firewall stiffener.
4. Place collective in full down position. Install MT294-1 collective spring retainer or use 0.032 inch diameter safety wire to secure collective spring in compressed state. If safety wire is used, twist wire around rod end to rod end several times to ensure spring assembly can be removed safely.

> **WARNING**
>
> **Spring is under compression and failure to comply with above procedure can cause bodily harm and/or damage to helicopter.**

5. Remove spring lower attach bolt slowly while moving collective slightly to transfer spring compression onto restraining safety wire or MT294-1. When bolt is removed, position spring assembly forward for more clearance during removal.
6. Remove hardware securing A333-1 collective stop to A348-1 seat belt anchor, retain all hardware.

> NOTE
>
> To prevent damage, rotate collective stop slider in line with collective handle and tape in place.

7. Remove bolt and associated hardware securing A205-1 fork to collective stick.
8. Remove A486-4 (or -1) screw securing A327-1 overtravel spring to C341-3 (or C342-1) throttle arm.
9. If installed, disconnect aft end of carb heat assist push-pull tube from collective stick.
10. Cut and discard ty-raps securing electrical wiring and disconnect collective stick assembly wiring from main harness.
11. Remove (2) attach bolts and associated hardware securing collective stick and remove collective stick assembly from helicopter.

8.210 Collective Stick Assembly (continued)

B. Installation

1. If removed, assemble A332-2 (or-1) friction lever onto collective stick per § 8.230. Tape A333-1 collective stop in line with stick to prevent damage during installation.
2. Refer to Figure 8-3. If A205-1 fork was removed from A101-4 rod end, screw fork onto rod end between 3.50–3.60 inches from center of rod end hole to centerline of attach bolt hole. Standard torque jamnut per § 23-32 and torque stripe per Figure 2-1.

NOTE

Dimension of A205-1 fork should be 3.50–3.60 inches from center of rod end bearing to center of attaching bolt hole (no palnut required on this rod end). Verify autorotational RPM per § 10.250 if A205-1 fork dimension has changed.

NOTE

Replace A139-1 bearings in A205-1 fork per § 8.600 if bearings are damaged or worn.

3. Position collective stick in helicopter and install hardware, ensure smaller diameter of A115-1 spacer installed against A329-1 bearing block assembly. Standard torque per § 23-32 and torque stripe per Figure 2-1.
4. Install hardware securing A205-1 fork to collective stick, standard torque per § 23-32 and torque stripe per Figure 2-1. Verify smooth operation of fork pivot.
5. Assemble hardware securing lower end of A333-1 collective stop to A348-1 seat belt anchor using combination of NAS1149F0432P or NAS1149F0463P washers (as required) on A130-4 spacer to align stop and collective with 0.001 to 0.035 inch axial play. Standard torque hardware per § 23-32 and torque stripe per Figure 2-1. Verify correct axial play and no binding.
6. Raise or lower collective to align collective spring lower rod end in A476-1 support assembly and install hardware. Standard torque bolt per § 23-32 and torque stripe per Figure 2-1.
7. Lower collective stick to relieve spring tension from MT294-1 or safety wire, remove tool or cut and discard safety wire. Verify smooth operation and spring does not bind with collective full down.

WARNING

Failure to remove restraining safety wire after collective spring is installed can limit control travel creating a safety-of-flight hazard.

8.210 Collective Stick Assembly (continued)

B. Installation (continued)

8. Install collective spring guard.

9. Install hardware securing A327-1 overtravel spring upper rod end to throttle arm weldment. Ensure smaller diameter of A341-1 spacer is against rod end. Standard torque per § 23-32 and torque stripe per Figure 2-1.

NOTE

Use A486-1 screw for installation with C342-1 throttle arm. Use A486-4 screw for installation with C341-3 throttle arm. Screw head and smaller diameter of A341-1 spacer must be installed against rod end.

WARNING

Improper installation can cause binding, rod end damage or rod end separation with subsequent loss of engine throttle control

10. If installed, connect aft end of carb heat assist push-pull tube to flat side of collective arm. Standard torque per § 23-32 and torque stripe per Figure 2-1.

11. Attach collective stick assembly electrical connectors and ty-rap connectors to harness. Cinch ty-raps until snug without over-tightening and trim tips flush with heads.

12. Adjust throttle correlation rigging per § 10.150.

13. Install seat backs per § 15-22.

14. Install center cover & vertical panel (cyclic control inspection panels).

15. Verify autorotational RPM per § 10.250 if A205-1 fork assembly center-to-center dimension has changed.

16. Adjust collective spring per § 8.220 Part D, as determined by test flight.

8.220 Collective Spring Assembly

A. Description

The collective spring assembly is installed to balance in-flight main rotor collective control forces. A038-1 thru -7 spring assemblies may be adjusted and A429 springs may be changed to obtain desired collective control forces in Part D. Test fly helicopter after collective spring adjustment to evaluate collective control forces in level cruise flight, repeat until desired forces are obtained.

WARNING

Exercise extreme care when working with compressed collective springs. Always relieve spring compression slowly.

NOTE

A038-5 spring assembly replaces A038-2 assembly. A038-6 assembly replaces A038-1, -3, & -4 assemblies.

Assembly P/N	Spring P/N	Spring Color	Spring Constant
A038-1	A429-1 (old)	Silver	89 lb/in.
A038-2	A429-2 (old)	Primer	35 lb/in.
A038-3 or -5	A429-3	Grey	50 lb/in. (weak)
A038-4	A429-4 (old)	Black	70 lb/in.
A038-6	A429-5	Gold	50 lb/in. (standard)
A038-7	A429-8	White	71 lb/in. (strongest)

B. Removal

1. Remove left seat back per § 15-22.
2. Remove screws securing collective spring cover and remove cover. If spring cover aft mounting hole is slotted, screw may be loosened and left installed in vertical firewall stiffener.
3. Place collective in full down position. Install MT294-1 collective spring retainer or use 0.032 inch diameter safety wire to secure spring in compressed state. If safety wire is used, twist wire around rod end to rod end several times to ensure spring assembly can be removed safely.

WARNING

Spring is under compression and failure to comply with above procedure can cause bodily harm and/ or damage to helicopter.

4. Remove spring lower attach bolt slowly while moving collective slightly to transfer spring compression onto restraining safety wire or MT294-1 collective spring retainer.
5. Remove spring assembly upper attach bolt and remove spring assembly.

8.220 Collective Spring Assembly (continued)

C. Installation

NOTE

Spring assembly must be compressed for installation to between 4.30 and 4.00 inches from center-to-center of rod ends. Orient assembly with nut end of rod guides pointing up.

WARNING

When installing the A038-5, -6, or -7 spring assembly, both rod ends must be bottomed (B292-3 rod end has left-hand thread). Failure to bottom both rod ends can cause either one to run out of threads during adjustment and can cause bodily harm.

1. Position collective spring assembly upper rod end in collective arm and install hardware. Standard torque hardware per § 23-32.
2. Raise or lower collective to align collective spring lower rod end in A476-1 support assembly and install hardware. Standard torque hardware per § 23-32.
3. Lower collective stick to relieve spring compression from MT294-1 collective spring retainer or safety wire, remove tool or cut and discard safety wire.
4. Verify smooth operation & spring does not bind with collective full down.

WARNING

Failure to remove restraining safety wire after collective spring installation can limit collective control travel creating a safety-of-flight hazard.

5. Install collective spring guard.
6. Install left seat back per § 15-22.

8.220 Collective Spring Assembly (continued)

D. Adjustment

WARNING

Ensure that spring coils are not binding with collective stick full down after making adjustment. Binding spring coils can limit flight control travel.

A038-1 thru -4 Spring Assemblies

1. Remove left seat back per § 15-22, as required. Remove collective spring guard.
2. Place collective in full down position. Install MT294-1 collective spring retainer or use 0.032 inch diameter safety wire to secure collective spring in compressed state. If safety wire is used, twist wire around rod end to rod end several times to ensure spring assembly can be removed safely.
3. Remove spring lower attach bolt slowly while moving collective slightly to transfer spring compression onto restraining safety wire or MT294-1 collective spring retainer.
4. Loosen palnut and jamnut on lower rod end. Screw rod end into A426-4 cap to decrease collective-up force; extend rod end to increase collective-up force. Maximum extension for bottom rod end is 1.1 inches from cap to rod end center, provided spring does not bind.
5. Standard torque jamnut and palnut per § 23-32.
6. Raise or lower collective to align collective spring lower rod end in A476-1 support assembly and install hardware. Standard torque hardware per § 23-32.
7. Lower collective stick to relieve spring compression from MT294-1 collective spring retainer or safety wire, remove tool or cut and discard safety wire.
8. Verify smooth operation & spring does not bind with collective full down.
9. Install collective spring guard.
10. Install left seat back per § 15-22, as required
11. Evaluate collective trim forces per Part A. Adjust or replace spring as required.

A038-5, -6, or -7 Spring Assemblies

1. Remove collective spring guard.
2. Loosen palnut and jamnut on lower rod end.
3. With collective up, rotate spring by hand to screw rod ends in or out of caps (lower rod end is right-hand thread; upper rod end is left-hand thread). Screwing rod ends into caps decreases collective-up force; extending rod ends increases collective-up force.

8.220 Collective Spring Assembly (continued)

D. Adjustment (continued)

A038-5, -6, or -7 Spring Assemblies (continued)

4. Standard torque jamnut and palnut per § 23-32.
5. Install collective spring guard.
6. Evaluate collective trim forces per Part A. Adjust or replace spring as required.

E. A429 Spring Replacement

1. Remove collective spring per Part B.
2. Position spring assembly in a soft-jawed vise to compress spring, ensure rod ends will not slip during disassembly. Compress spring assembly slightly to relieve spring compression from MT294-1 collective spring retainer or safety wire, remove tool or cut safety wire and discard.
3. Carefully open vise to decompress spring and remove assembly from vice. Remove spring from assembly.
4. Inspect A428-1 guide rods for scratches or nicks; if damage found, replace rods. Apply light coat of A257-1 grease to guide rods, as required.

> NOTE
>
> If replacing B292-3 or A127-3 rod ends, apply light coat of A257-1 grease to threads.

5. Refer to table in Part A. Assemble collective spring using spring required to obtain desired collective control forces as determined by test flight.
6. Place collective spring assembly in a soft-jawed vise, ensure rod ends will not slip during spring compression. While guiding A428-1 rods into A426-4 or -6 cap, slowly compress spring assembly to between 4.30 and 4.00 inches from center-to-center of rod ends. Install MT294-1 collective spring retainer or secure spring assembly in a compressed state using 0.032 inch diameter safety wire. If safety wire is used, twist wire around rod end to rod end several times. Open vise slowly and remove spring assembly.
7. Reinstall collective spring assembly per Part C.

8.230 Collective Friction Assembly

A. Removal

1. Remove center horizontal cover (cyclic control inspection panel).
2. Remove hardware securing A333-1 stop to A348-1 anchor, retain hardware.
3. Loosen NAS1352-08LE8P (or -08-12P) screw in A332-2 (or -1) lever. Remove NAS1352-4-24P screw from lever and collective stick, retain washers.

B. Installation

1. Place (2) A478-2 (or B0500-022-S) washers on NAS1352-4-24P screw with concave side of washers facing each other.
2. Insert NAS1352-4-24P screw through (1) A141-20 washer, A333-1 stop (slotted hole), then second A141-20 washer, ensure gray Teflon®-coated surface of A141-20 washers are against A333-1 stop.
3. Thread NAS1352-4-24P screw into collective stick, as screw exits collective, thread screw into A332-2 (or -1) lever. Snug screw finger tight.
4. Assemble hardware securing lower end of A333-1 stop to A348-1 seat belt anchor using combination of NAS1149F0432P or NAS1149F0463P washers (as required) on A130-4 spacer to align stop and collective with 0.001 to 0.035 inch axial play. Standard torque hardware per § 23-32 and torque stripe per Figure 2-1. Verify correct axial play and no binding.
5. Set collective friction per Part C.
6. Install center horizontal cover (cyclic control inspection panel).

C. Adjustment

1. As required, loosen NAS1352-08LE8P (or -08-12P) screw in A332-2 (or -1) lever. Rotate friction lever aft to friction locked position.
2. Tighten NAS1352-4-24P screw to increase friction, or loosen screw to decrease friction as required to produce 12 to 20 pounds resistance measured at collective grip, using a spring scale pulling up from bottom of travel.
3. Tighten NAS1352-08LE8P (or -08-12P) screw. Verify 12 to 20 pounds of force required to raise collective measured at grip with friction locked; verify 6-10 pounds of force to raise collective with friction unlocked. Repeat steps 1 and 2 as required.

WARNING

Collective friction greater than 20 pounds may prevent aircraft from entering autorotation.

8.240 RPM Governor System

A. Description

The governor maintains engine RPM by sensing changes and applying corrective throttle inputs through a friction clutch which can be easily overridden by the pilot. The governor is active only above 80% engine RPM and can be switched on or off using the toggle switch on the end of the right seat collective.

The governor is designed to assist in controlling RPM under normal conditions. It may not prevent over- or under-speed conditions generated by aggressive flight maneuvers.

CAUTION

When operating at high density altitudes, governor response rate may be too slow to prevent overspeed during gusts, pull-ups, or when lowering collective.

B. Governor Controller Removal

Refer to § 33-137 for D270-1 Governor Controller and Engine Monitoring Unit (EMU) description. Refer to the EMU Technician's Guide and EMU User Guide online at https://robinsonheli.com for data access.

WARNING

No external adjustment of controller is available. If controller fails to operate correctly, remove and return it to RHC.

1. Turn battery switch off & pull GOV (2 amp) circuit breaker on circuit breaker panel.
2. Remove right seat back assembly to access D270-1 governor controller, or left seat back assembly to access B286-2 governor controller per § 15-22.
   a. D270-1 Governor controller: Loosen screws and disconnect airframe harness connector from governor controller; disconnect 1598-01C cable from governor controller. Cut and discard ty-raps as required and disconnect MAP line from governor controller.
   b. B286-2 Governor controller: Disconnect airframe harness connector from B286-2 governor controller.
3. Remove hardware securing governor controller to right side bulkhead (D270-1 governor controller) or left seat back assembly (B286-2 governor controller) and remove governor controller.

8.240 RPM Governor System (continued)

C. Governor Controller Installation

1. Turn battery switch off & pull GOV (2 amp) circuit breaker on circuit breaker panel.
2. Install hardware securing governor controller to right side bulkhead (D270-1 governor controller) or left seat back assembly (B286-2 governor controller). Verify security.
   a. D270-1 Governor controller: Connect airframe harness connector to governor controller and tighten screws; connect 1598-01C cable to governor controller. Connect MAP line to governor controller and install ty-raps. Cinch ty-raps until snug without over-tightening and trim tips flush with heads.
   b. B286-2 Governor controller: Connect airframe harness connector to B286-2 governor controller.
4. Push in GOV (2 amp) circuit breaker on circuit breaker panel.
5. Install seat back assembly per § 15-22.

D. Governor Assembly Removal

1. Remove collective stick per § 8.210.
2. Remove three screws securing governor assembly to collective stick.
3. Remove NAS6603-7 bolt securing governor assembly output arm to A498-1 rod end.

WARNING

Adjustment of the friction clutch is NOT permitted. Field replacement of the gearmotor is NOT permitted. If friction setting is incorrect, or gearmotor operates incorrectly, remove governor assembly from collective stick and return to RHC.

E. Governor Assembly Installation

1. Install hardware securing governor assembly output arm to A498-1 rod end, ensure bolt head is aligned to clear washers on arm. Standard torque bolt and palnut per § 23-32 and torque stripe per Figure 2-1.

NOTE

Link assembly length must be 2.47-2.53 inches from rod end center-to-center.

8.240 RPM Governor System (continued)

E. Governor Assembly Installation (continued)

2. Ensure governor assembly output arm points up toward B328-1 connecting rod. Install NAS1351-4-28P screw, (2) NAS1352N08-4 screws, and associated hardware securing governor assembly to collective stick. Standard torque screws per § 23-32.

   a. If installing (2) AN503-8-4 screws; torque to 27 in.-lb and safety wire with 0.020 inch diameter safety wire.

3. Rotate throttle grips, verify smooth operation and no interference.

4. Install collective stick per § 8.210.

F. Governor System Troubleshooting

The majority of governor problems are caused by the engine's right (helicopter left side) magneto tachometer contact assembly (points) being out of adjustment or faulty. Refer to TCM Master Service Manual for tachometer contact assembly installation and adjustment.

When operating in the 80% – 115% active range, the R22 governor will attempt to maintain engine rpm at 104% ± 1.5% (102.5% – 105.5%). The edges of this governed 3%-rpm wide window, called a "deadband", may be detected as follows:

1. With an appropriately rated person at controls, start engine and run-up helicopter per R22 Pilot's Operating Handbook (POH) Section 4. Collective must remain fully down during this and following steps.

2. Gently hold throttle and very slowly increase rpm (do not exceed 107%). Note and record engine rpm indication when governor input (subtle throttle resistance) is encountered.

3. Gently hold throttle and very slowly decrease rpm (do not go below 97%). Note and record engine rpm indication when governor input (subtle throttle resistance) is encountered.

4. After shutdown, subtract Step 3 indication from Step 2 indication. Result should be approximately 3%.

A result of 3% but centered beyond 104% ± 0.5% is indicative of a governor controller problem.

Results greater than 3% but still centered on 104% are usually indicative of excessive throttle linkage friction or insufficient governor friction.

8.240 RPM Governor System (continued)

F. Governor System Troubleshooting (continued)

Check throttle friction by disconnecting overtravel spring assembly upper rod end from C342 arm and attaching a spring scale to the rod end. With carburetor throttle arm in idle position, slowly pull up overtravel spring assembly with spring scale and note maximum 4 pounds moving friction prior to full-open throttle at carburetor. Excessive throttle linkage friction can be caused by binding rod ends, control interference, carburetor throttle shaft bushing elongation, or binding carburetor accelerator pump (typically binds in one direction only).

Check governor friction with collective down, collective friction on, overtravel spring assembly upper rod end disconnected from C342 arm, and C342 arm positioned horizontally. Attach a spring scale to hole in C342 arm and, with scale held tangential to arm, slowly pull on scale and note both the breakaway and the moving frictions. Breakaway friction is typically 0 – 0.5 pound greater than moving friction. Breakaway friction 1 pound or greater than moving friction may indicate damaged or contaminated governor friction clutch. Moving friction must be minimum 8 pounds until arm stops moving. Insufficient moving friction can be caused by wear, contamination, or loss of spring rate.

Proper governor operation requires a minimum 2:1 ratio of governor friction-to-throttle linkage friction.

Erratic operation is usually indicative of tachometer contact assembly problems or wiring damage. Wiring damage may be evidenced by crushing, pinching, or abrasion, all of which can result in grounding of one or both center wire conductor(s) to the shielding or to structure. Tachometer contact assembly problems may be caused by contamination, oxidation, or loose contact(s), in addition to installation or assembly errors.

Contamination can be caused by over-lubrication of cam follower felt, engine oil leaking past oil seal, or moisture intrusion thru vent plug. Oxidation can be caused by an obstructed vent plug or by engine oil leaking past the oil seal.

When flying in turbulence, or if the engine is lightly “loaded” (drive train almost freewheeling), a fluctuating MAP indication is expected.

Any loose connection in throttle linkage (including worn carburetor throttle shaft bushings) will result in both RPM & MAP oscillations.

8.300 JACKSHAFT AND SUPPORT STRUTS

8.310 Jackshaft (See Figure 8-9)

8.311 Jackshaft Removal

NOTE

Rigging check should not be necessary if jackshaft support strut rod ends or push-pull tube rod ends are not loosened or removed.

a) Disconnect the push-pull tubes from the jackshaft.

b) Disconnect the two (2) jackshaft support bolts at the upper support strut rod ends.

c) Remove jackshaft.

8.312 Jackshaft Installation

Install jackshaft to strut rod ends. Aft support rod end requires a safety washer A214-3 between the rod end and bolthead. Both upper strut attach boltheads point aft. Torque nut to 100 in.-lbs plus nut drag. Install palnut.

Connect the A121-3 and -5 push-pull tubes to jackshaft. Both push-pull tube attach boltheads point forward. The forward A121-3 push-pull tube rod end requires a safety washer A214-3 and A115 spacer between the rod end and bolthead. Torque nuts to 100 in.-lbs plus nut drag. Install palnut.

Verify no binding or interference with control movement throughout flight control travel.

8.320 Strut Assembly (Jackshaft Support)

8.321 Jackshaft Strut Removal

a) Remove jackshaft per Section 8.311

b) Remove the aft support strut. Disconnect horizontal strut assembly at the 'V' bulkhead. Disconnect the lower strut rod end at the aft main rotor gearbox fitting.

NUMBER	PART NUMBER	DESCRIPTION
1	NAS1304-23	Bolt
2	A214-3	Washer
3	A343-1	Strut
4	AN960-416L	Washer
5	NAS679A4	Nut
6	MS27151-13	Palnut
7	A121-5	Push-Pull Tube
8	NAS1304-7	Bolt
9	NAS1304-21	Bolt
10	A121-3	Push-Pull Tube
11	A115-1	Spacer
12	A337-1	Jackshaft
13	A347-1	Brace
14	NAS1304-2	Bolt
15	AN960-416	Washer
16	AN525-832R6	Screw
17	AN960-8L	Washer
18	A437-2	Tab
19	NAS679A08	Nut

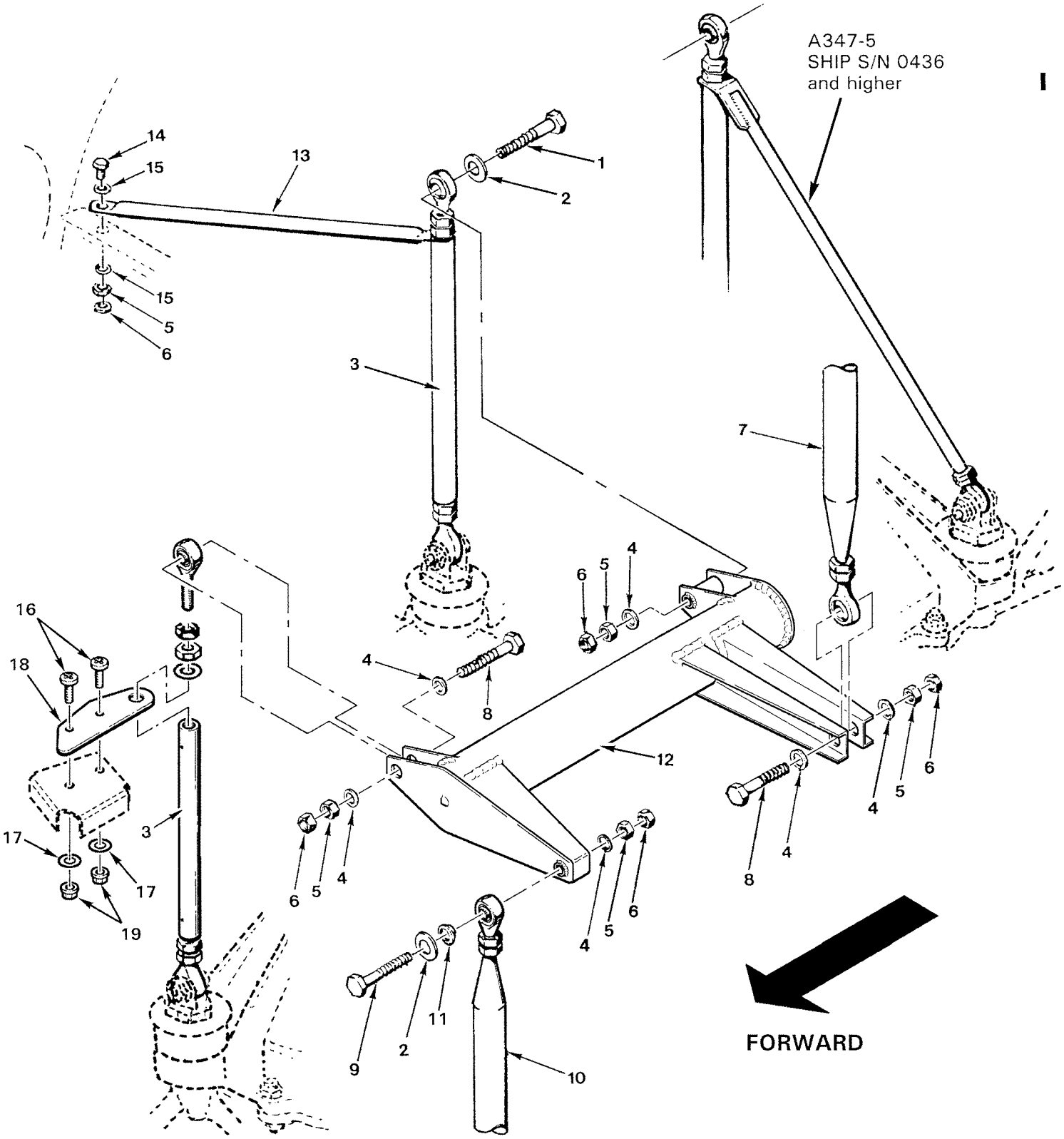

FIGURE 8-9 JACK SHAFT INSTALLATION

8.321 Jackshaft Strut Removal (cont'd)

> NOTE
>
> For ease of installation later, DO NOT disassemble the long horizontal strut from the vertical strut.

c. Forward support strut removal: To remove, it will be necessary to disconnect upper rod end installed through a fuselage tab, DO NOT remove lower rod end from support if possible.

> NOTE
>
> For ease of installation later, measure length of strut from center of rod ends and tag strut with length for later reference.

8.322 Jackshaft Strut Installation

> NOTE
>
> Two (2) AN960-516L washers are installed on forward supports; one between upper forward rod end jamnut and fuselage tab, other between upper aft jamnut and A347 horizontal strut.

1. Install forward support strut.

   a. Connect forward vertical support strut lower rod end to forward-right gearbox fitting. Verify minimum preload between bulkhead-mounted jackshaft brace tab and top of strut; adjust strut height as required. Verify proper rod end engagement via strut witness hole.

   b. Install strut upper rod end , with palnut and jam nut installed, thru brace tab into top of strut. Adjust rod end center-to-center dimension to previously recorded measurement, if applicable. Verify proper rod end engagement via strut witness hole.

2. Connect aft-vertical strut lower rod end to aft-right main rotor gearbox fitting. Connect vertical diagonal strut to aft-left gearbox fitting, or connect horizontal diagonal strut to Vee-bulkhead, as applicable.

3. Torque bolts per Section 1.320. Install palnuts, and torque per Section 1.320. Torque stripe per Figure 2-1.

4. Install jackshaft and push-pull tubes per Section 8.312.

5. If aft-vertical strut was disassembled or length changed, adjust aft strut and/ or forward strut to achieve jackshaft level to helicopter keel panel within ± 0.5°. Verify proper rod end engagement through witness hole in strut.

6. Verify proper rod end centering and all bolts, jamnuts, and palnuts are torqued per Section 1.320 and torque striped per Figure 2-1.

8.400 Swashplate and Main Rotor Pitch Links

8.410 Swashplate

8.411 Swashplate Removal

> NOTE
>
> Rigging check is not required if push-pull tube rod end bearing center-to-center dimension has not changed.

1. Remove main rotor hub and blade assembly per §§ 26-20 and 26-10.
2. Disconnect and remove A203 yoke halves.
3. Remove droop stops and elastic teeter stops.
4. Remove swashplate boot.
5. Disconnect three push-pull tubes and rod end of lower A205 fork assembly from lower, non-rotating swashplate.
6. Lift swashplate off slider tube.

8.412 Swashplate Installation

CAUTION

Swashplate plastic balls are obsolete and must be replaced.

1. Verify swashplate rotates freely.
2. On swashplate ear opposite interrupter, attach pitch link's lower rod end with five AN970-4 washers and two AN960-416L washers under bolt head, one A115-1 spacer on each side of rod end, with the small washers between spacer and large washers. Install additional AN960-416L washer on bolt inboard of inner A115-1 spacer and insert bolt into swashplate ear. Washer stack-up must be located on outside of ear. Install washers under nut as required to expose two to four threads after torquing. Standard torque nut per § 23-32. Install palnut, standard torque per § 23-32, and torque stripe per Figure 2-1.
3. On interrupter-side swashplate ear, attach pitch link with an A214-3 washer under bolthead, one A115-1 spacer on each side of pitch link rod end, and one AN960-416L washer between A115-1 spacer and swashplate ear.
4. On interrupter-side swashplate ear, install A115-1 spacer on protruding length of bolt, then A205 fork assembly rod end (rod end shank pointing up), another A115-1 spacer, one A214-3 washer, and the nut. Standard torque nut per § 23-32. Install palnut, standard torque per § 23-32, and torque stripe per Figure 2-1.
5. Attach A204 arm to A205 fork installed in previous step. If fork has plastic A139-1 bearings, line ream and spot face bearings for correct fit per § 8.600. If fork has C648-2 bearings (dark-brown colored face & bore), install a combination of A117-45, -46, and/or -47 shims between A105-17 journal and A141-43 washer on nut side to provide 0.010/0.001 inch axial play in joint. Refer to Figure 2-8. Verify 2.5 in.-lb maximum pivot friction.
6. Install swashplate and attached pitch links, fork, and arm onto slider tube assembly atop main rotor gearbox.
7. Slide boot over A251 main rotor shaft and set in place.
8. Install A203 yoke assembly onto A251 shaft using A210-1 key to position yoke on shaft. Radiused edge of A210-1 key goes into flange slot in A251 shaft. Standard torque nut per § 23-32. Install palnut, standard torque per § 23-32, and torque stripe per Figure 2-1.

CAUTION

Tighten and torque bolt through A210-1 key first.

8.412 Swashplate Installation (continued)

9. Install opposite clamping bolt in chord-arm side of yoke. As applicable, special torque NAS1305 or NAS6605 bolt per § 23-33, or standard torque NAS1304 or NAS6604 bolt per § 23-32. Install palnut, standard torque per § 23-32, and torque stripe per Figure 2-1.

> NOTE
>
> A small space between chord-arm side yoke halves adjacent to driveshaft is normal. Do not exceed bolt torque limits.

10. Connect A204-1 arm to A203 yoke assembly. If yoke has plastic A139-1 bearings, line ream and spot face bearings for correct fit per § 8.600. If yoke has C648-2 bearings (dark-brown colored face & bore), install a combination of A117-45, -46, and/or -47 shims between A105-17 journal and A141-43 washer on nut side to provide 0.010/0.001 inch axial play in joint. Refer to Figure 2-8. Verify 2.5 in.-lb maximum pivot friction.
11. Install A255 counterweights and AN970-4 washers on A203 yoke arm as required for balance.
12. Attach lower A205 fork's rod end to left side of middle of three lugs grouped together on lower swashplate. Connect forward push-pull tube rod ends to left side of remaining two forward lugs. Aft push-pull tube rod end attaches to right side of lower swashplate aft lug. A214-3 safety washer required between bolthead and A115-1 spacer. A115-1 spacers are required on each side of all rod end balls. Standard torque bolts per § 23-32. Install palnuts, standard torque per § 23-32, and torque stripe per Figure 2-1.
13. Position boot on upper swashplate and ty-rap in place. Ensure upper portion of boot clamps on shaft between upper flange and A203 yoke halves.
14. Temporarily install teeter hinge bolt and journals. Install droop stops and elastic teeter stops. Ensure teeter stop brackets are oriented per Figure 26-5. Standard torque bolts per § 23-32. Install palnut, standard torque per § 23-32, and torque stripe per Figure 2-1. Remove teeter hinge bolt and journals.
15. Verify no binding or interference with control movement throughout flight control travel.
16. Install main rotor hub and blades per §§ 26-20 and 26-10.
17. Track and balance main rotor per § 10.200.

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8.416 Shimming Upper (Unflanged) Spherical Sleeve with Aluminum Ball

Measure space between top of upper spherical sleeve to top surface of lower swashplate. Determine required A209 spacer thickness by installing a spacer that will completely fill the space. (A209 spacers are available in increments of 0.005 inch.)

a) Install shield plate. Torque screws to 17 in-lbs.

b) Use a spring scale (MT359-1 or equivalent) to pull down at bolt hole in upper swashplate arm as shown in Figure 8-12A. The force required to tilt the swashplate must be free-without-looseness to five pounds maximum, measured while moving; do not use breakaway reading.

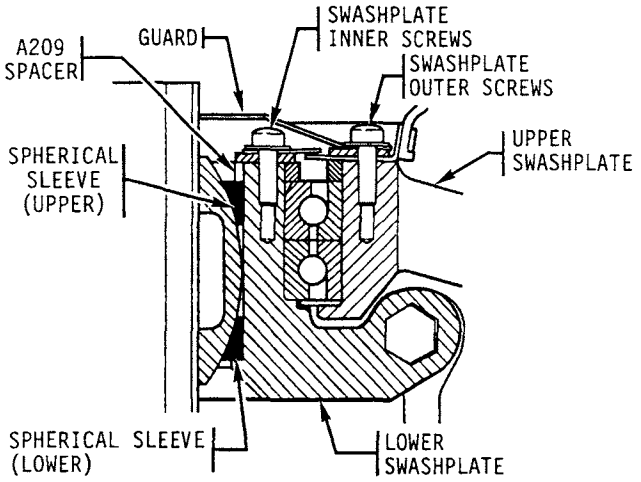
c) Use a thicker or thinner A209 spacer to adjust swashplate tilting force. Increase spacer thickness to increase force required to tilt swashplate.

8.500 TAIL ROTOR CONTROLS

8.510 Tail Rotor Pedals (Standard or Removable)

8.511 Tail Rotor Pedal Removal

a) Remove the landing light cover, belly cover and cabin cover between the seats (horizontal).



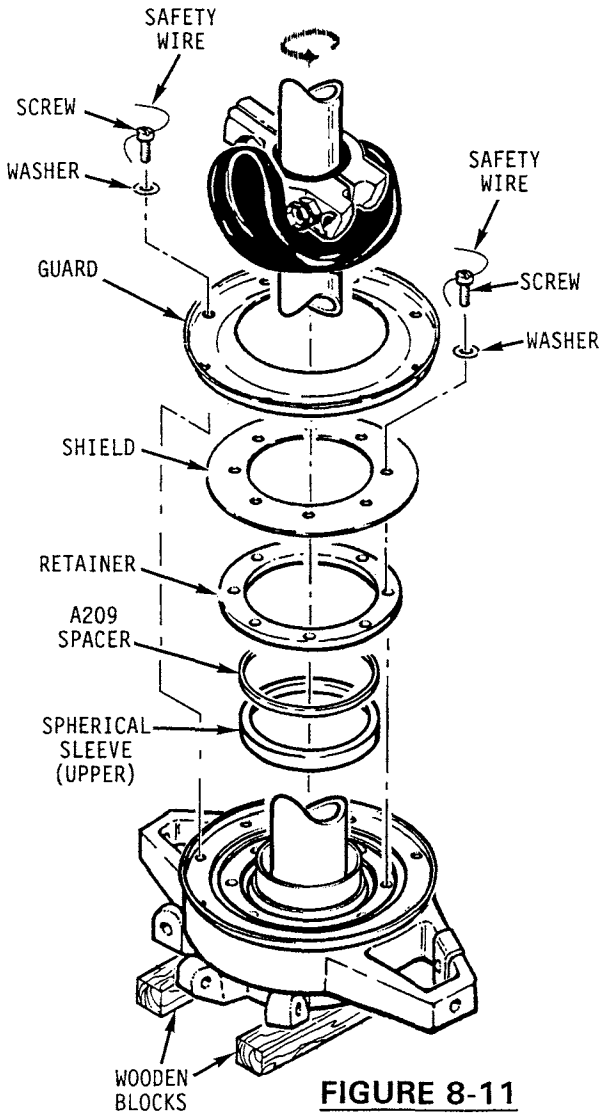
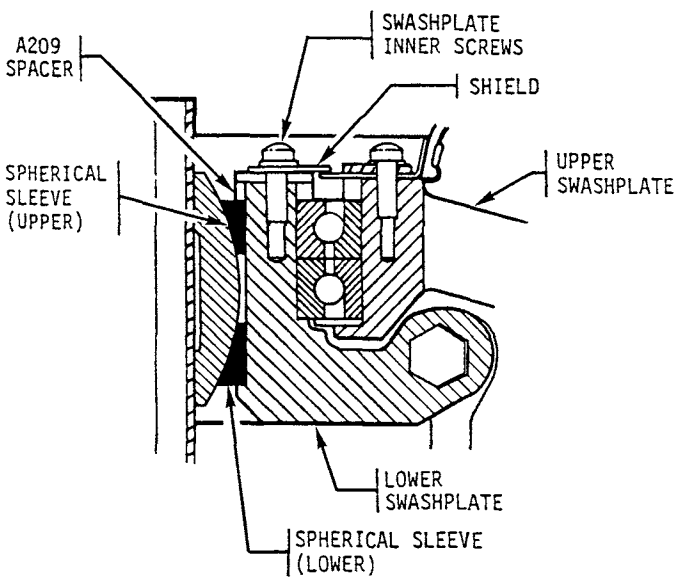


FIGURE 8-11



SWASHPLATE CUTAWAY
A209 SPACER (SHIM)
UNFLANGED SLEEVE

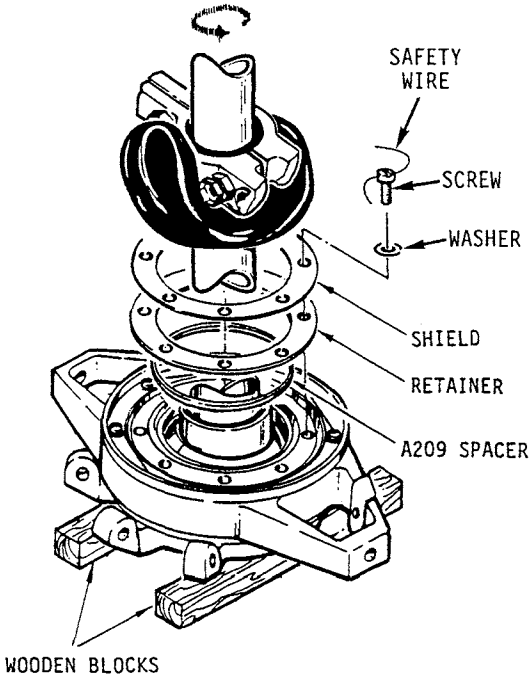


FIGURE 8-12

SWASHPLATE SHIMMING WITH A209 SPACER

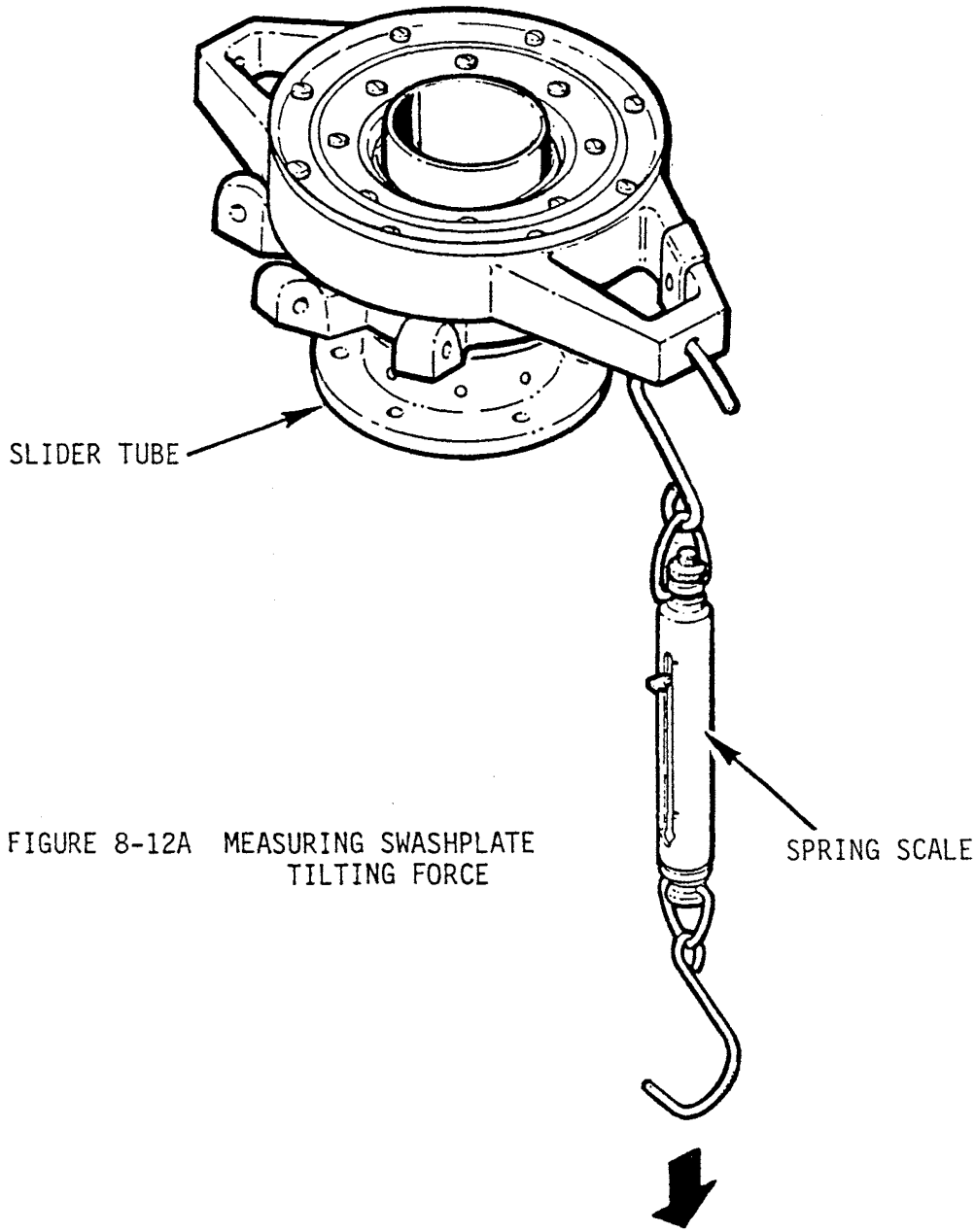


FIGURE 8-12A MEASURING SWASHPLATE TILTING FORCE

8.511 Tail Rotor Pedal Removal (cont'd)

b) Drill out the pop rivets holding the landing light bracket to the fiberglass chin with a #30 drill bit and remove.

c) Remove the two NAS1304-9 bolts holding the tail rotor push-pull tubes to the A317-1 tail rotor bellcrank (lower).

d) Pull the left tail rotor pedal aft, then working through the landing light access in the chin, disconnect the NAS1304-9 bolt that holds the A121-11 push-pull tube to the left pedal assembly.

e) Leaving the left pedal in the full aft position, pull the right pedal fully aft and disconnect the NAS1304-9 bolt that holds the A121-9 tube to the right pedal assembly.

f) Remove both push-pull tubes from the aircraft through the chin access.

g) Lift carpet carefully from the floor on both sides and remove from the cabin.

h) Remove the eight (8) screws that hold the access plates between the pedal assemblies and remove the plates.

i) The next step will require two (2) people. With someone holding the NAS1303-20 bolts from above that hold the A318-1 bearing block halves together, reach through the chin access and remove the NAS679-A3 nuts.

j) Remove the lower bearing block halves.

k) Remove the tail rotor pedals one at a time by lifting one end and allowing the other to drop into the chin. They can be removed from either the right or the left side.

NOTE

On reassembly the right pedal assembly is mounted forward in the bearing blocks and the left is mounted aft.

8.511 Tail Rotor Pedal Removal (cont'd)

NOTE

Pedal blocks (upper and lower) are machined matched set as indicated by matching letter or number on the upper and lower portion of blocks. DO NOT MIX THEM or alignment problems may develop on installation.

8.512 Tail Rotor Pedal Installation

a) Fill the grooves in the pedal bearing blocks with A257-1 grease.

b) Install the pedal assemblies into the bearing blocks and torque the bearing block attach bolts to 40 in.-lb plus nut drag.

NOTE

If a force greater than 5 lbs is required to move pedals, check the bearing blocks to ensure they are matched correctly.

c) Install the A121-9 and 11 push-pull tubes. The A121-9 will connect to the upper A317-1 bellcrank attach point and the left pedal assembly. The A121-11 will connect to the lower A317-1 bellcrank attach point and the right pedal assembly. Torque the attach bolts to 100 in.-lb plus nut drag. Install palnuts.

NOTE

The bolts attaching the push-pull tubes to the pedal assemblies must have their head toward each other for clearance.

d) Install the pedal cover plates and carpeting.

e) Pop rivet the landing light bracket to the chin and install the landing lights.

8.520 A317-1 Lower Bellcrank

8.521 A317-1 Lower Bellcrank Removal

a) Remove lower belly panel.

b) Disconnect the attaching hardware to the A121-9 and -11 push-pull tubes at the A317-1 bellcrank.

8.521 A317-1 Lower Bellcrank Removal (cont'd)

c) Disconnect the A315 support holding the A317 bellcrank by removing the 4 attach bolts and swing assembly forward.

d) Remove bolt attaching A317 bellcrank to the A315 support.

8.522 A317-1 Lower Bellcrank Installation

This procedure also covers rigging of the lower push-pull tubes and pedal assemblies. If re-checking of rigging is not required, disregard rigging portions and follow installation sequences.

a) Install A130-12 spacers and two A105-3 journals inside A316 bellcrank, A141-3 washers are installed against the A105-3 journals upon assembly to the A315 support outside of aircraft. Excess gap between A315 support attaching flanges and the A141-3 washers next to the assembled bellcrank may be filled with either A214-3 or A141-3 washers.

NOTE

When A317 bellcrank is installed, the 3/16"dia. rigging pin hole will be above the pivot point and the bellcrank itself will be aft of the bellcrank support.

Tighten pivot nut and check for smooth and free operation. Maximum spring scale drag of 2 lb is acceptable to move the bellcrank. Torque to 100 in-lb plus drag torque if acceptable.

If a force in excess of 2 lbs. is required to move the bellcrank, see Section 8.600 for A139-1 bearing reaming and spotface procedure.

b) Temporarily attach the A315-1 and A317-1 into aircraft to check for proper push-pull tube rigging length. Insert rigging pin thru the cabin assembly into the A317-1 bellcrank for rigging. Temporarily attach A121-9, 11 and 13 push-pull tubes to the A317.

Place the left and right pedals together at the mid (neutral) travel position. Place a 2.90 inch spacer between each inside pedal and stop. Adjust the rod ends on the A121-9 and A121-11 push-pull tubes as required to insert a bolt through the rod end and the A317-1 bellcrank. Check push-pull tube rod end and the A317-1 bellcrank. Check push-pull tube rod end witness holes for engagement.

8.522 A317-1 Lower Bellcrank Installation (cont'd)

c) After adjusting pedal travel, remove the rigging pin and apply full left pedal and adjust A121-13 push-pull tube to obtain .06" minimum clearance of the A013-3 bellcrank and the vertical firewall. Adjust push-pull tube as required.

NOTE

It is permissible for the bellcrank arm to touch and deflect acoustical foam, as long as it does not interfere with free movement and full travel of the controls.

d) With the A315 support and A317 bellcrank attachment, disconnected from the keel panels (A121-9 and -11 push-pull tubes disconnected) slide bellcrank forward.

NOTE

The A121-13 push-pull tube attach bolt must be installed with bolthead to the right side for clearance in vertical tunnel.

NOTE

On installation to the A317 bellcrank, an AN960-416 washer is installed to fill gap between rod end and the left plate of the A317 bellcrank (washer on left side of rod end).

e) Attach A315 bellcrank support to keel panels.

f) Attach the A121-9 and -11 push-pull tubes to the A317 bellcrank.

g) Torque all attaching NAS1304 bolts to 100 in.-lb plus nut drag. Install palnuts and torque stripe fasteners.

h) Check for smoothness and ease of operation. Move pedals full travel. Check for any interference between tubes, wires and structures.

8.522 C317-2 Lower Forward Bell Crank Installation (cont'd)

i) If required, check complete Tail Rotor rigging if changes to A121-9, -11, or -13 push-pull lengths have been made.

j) Verify all attach bolts and jamnuts torqued per Fastener Torques Section 1.300.

k) Install panels.

8.530 A013-3 Upper Bellcrank

8.531 Bellcrank Removal

1. Remove A121-15 push-pull tube.
2. Remove belly inspection panel.
3. Disconnect A121-9 and -11 at A317 bellcrank.
4. Disconnect A315 and A317 bellcrank with A317 bellcrank attached.
5. Slide A315 and A317 bellcranks with A121-13 push-pull tube attached up to disconnect -13 push-pull tube at upper bellcrank.

NOTE
Upper bellcrank needs to be rotated as far aft as possible to remove A121-13 push-pull tube attach bolt.

6. Remove upper bellcrank attach bolt. Catch all A214-2 and A141-3 washers installed as bolt is remove.
7. Remove upper bellcrank from structure.

8.532 Bellcrank Installation

1. Install A130-12 spacer and two A105-3 journals inside A013-3 bellcrank. Ream A139 bearing with 0.375/0.376 inch dead sharp reamer if required for journal's smooth installation.
2. Install bellcrank with A141-3 washers bellcrank with A141-3 washers next to blue Turcite A139-1 bearings. If gap exists between A141-3 washers and outboard support, fill either with A214-3 or A141-3 washers.
3. Torque attach bolt per Section 1.320. Install palnut.

8.532 A013-3 Upper Bellcrank Installation (cont'd)

4. Check for smoothness and ease of operation.

5. Attach A121-9, -11 and -13 push-pull tubes along with A315 and A317 bellcrank assemblies, following procedure in Section 8.522.

> **CAUTION**
>
> A121-13 push-pull tube to A013-3 upper bellcrank attach bolt head must point to right side of helicopter for clearance.

6. Install the A121-15 push-pull tube.

7. Check rigging if necessary.

8. Torque all attaching bolts and jamnuts per Section 1.300.

9. Check for smoothness and ease of operation. Move pedal full travel, check for any interference between tubes, wires and structures.

10. Install panels.

8.540 A331-1 Intermediate Bellcrank

8.541 A331-1 Intermediate Bellcrank Removal

1. Disconnect A121-15 and -17 push-pull tubes from A331-1 bellcrank.

2. Disconnect A331-1 attach bolt and remove bellcrank.

8.542 A331-1 Intermediate Bellcrank Installation

Install two A105-3 journals into bellcrank bearings. An A141-3 washer is required on each side of bellcrank to A139-1 bearings. (Ream A139-1 bearing with 0.375/0.376 inch dead sharp ream if required for journal's smooth installation).

> NOTE
>
> If required for A121-17 attach bolt clearance with the scroll two AN960-416 washers may be installed between the bell crank and the frame to raise the bellcrank. This will require use of NAS1304-40 bolt, to attach bellcrank to frame.

8.542 A331-1 Intermediate Bellcrank Installation (cont'd)

a) Torque to 100 in-lb plus nut drag. Install palnuts.

b) Check for smoothness and ease of operation.

c) Connect A121-15 and -17 push-pull tubes. A214-3 safety washers are required under the boltheads.

d) Re-rig if push-pull tube lengths were altered.

e) Move pedals full travel, check for any interference between tubes, wires, components or structures.

8.550 A120-1 Aft Bellcrank

8.551 A120-1 Aft Bellcrank Removal

a) Disconnect A121-17 push-pull tube from A120 aft bellcrank.

b) Disconnect bellcrank pivot from attach bolt connected to tail rotor gearbox.

c) Remove nut holding bellcrank to the pitch control. Remove bellcrank and reinstall nut and shims found between bellcrank and pitch control for bellcrank installation.

8.552 A120-1 Aft Bellcrank Installation

See A031 Pitch Control Installation (See Section 8.562).

8.560 A031 Pitch Control

8.561 Pitch Control Removal

a) Remove tail rotor hub and blade assembly. Mark corresponding tail rotor blade grips, tail rotor pitch change to each of the pitch control ears, for later reinstallation so re-rigging is not required.

b) Disconnect and remove aft bellcrank per Section 8.551.

c) Remove pitch control from tail rotor output shaft.

8.562 Pitch Control Installation

a) Slide A031-1 pitch control assembly onto output shaft.

b) Position A120-1 bellcrank assembly on the tail rotor gearbox and install NAS1304-25 bolt, one AN960-416 washer under bolt head, two MS20002-4 washers, one one each side of the bearing and NAS679-A4 nut.

8.562 Pitch Control Installation (cont'd)

b) Measure the gap existing between the A120-1 bellcrank ear and the flats on the A125-1 pitch control stud. Install sufficient A117-20, -21 and -22 washers between bellcrank and stud to completely fill the gap but not apply any axial preload on the spherical bearing after all the nuts are tightened. The clearance tolerance is plus or minus .003". Install one AN960-416L washer and NAS679-A4 nut on protruding end of stud. Torque nut to 70 in.-lbs plus nut drag while holding stud from rotating. Install palnut.

c) Torque nut on A120-1 bellcrank pivot to 100 in.-lbs plus nut drag. Install palnut.

d) Attach aft end of A121-17 push-pull tube to the A120 -1 bellcrank and A214-3 safety washer under nut next to rod end. Torque nut to 100 in.-lb. plus nut drag. Install palnut.

e) Install pitch control links per Section 8.572.

f) Install tail rotor hub and blade assembly (See Section 9.212).

g) Ensure all bolts, jamnut and palnuts torques per Fastener torques, Section 1.300.

8.570 Tail Rotor Pitch Links

8.571 Tail Rotor Pitch Link Removal

NOTE

To ensure proper rigging upon re-installation of pitch links, mark pitch links to corresponding blade grip and pitch control ear.

a) Disconnect the two attach bolts on either rod end of the pitch link.

b) Remove pitch link.

8.572 Tail Rotor Pitch Link Installation

WARNING

A214-3 safety washers are to be installed next to rod end.

8.572 Tail Rotor Pitch Link Installation (cont'd)

WARNING

Both pitch links must be same part number (same type and material). Mixing one-piece with adjustable-length pitch links is prohibited. Mixing steel one-piece with aluminum one-piece pitch links is prohibited.

Refer to Figure 9-11.

1. If installing one-piece pitch link(s); connect pitch link to pitch link control arm and blade pitch horn.

2. If installing new, adjustable-length pitch link(s) based on old pitch link length:

   a. Match pitch link to proper blade pitch horn and pitch control arm and connect pitch link. Torque attach bolts per Section 1.320. Install palnuts, torque per Section 1.320, and torque stripe per Figure 2-1. Repeat for opposite blade.

   b. Torque attach bolts per Section 1.320. Verify proper rod end centering and adjust as required. Install palnut, torque per Section 1.320, and torque stripe per Figure 2-1. Repeat for opposite blade.

   c. Check tail rotor control rigging per Section 10.140.

3. If installing new, adjustable-length pitch links (nominal length setting):

   a. Assemble male rod end, with jam nut and palnut installed, into female rod end. Adjust rod ends until a dimension of 2.360 inches, measured between rod end bearing centers.

   b. Attach pitch link female rod end to outboard side of pitch control arm. Torque bolt per Section 1.320. Install palnut, torque per Section 1.320, and torque stripe per Figure 2-1.

   c. Connect pitch link male rod end to blade pitch horn. AN960-416, AN960-416L, or A141-14 washers may be under nut for chordwise balance. Torque bolt per Section 1.320. Install palnut, torque per Section 1.320, and torque stripe per Figure 2-1.

   d. Torque pitch link jam nut and palnut per Section 1.320 and torque stripe per Figure 2-1. Repeat steps a. thru d. for opposite blade.

   e. Check tail rotor control rigging per Section 10.240.

8.572 Tail Rotor Pitch Link Installation (cont'd)

4. Operate the tail rotor controls thru their entire operating range an verify no binding or abnormality exists.

5. Dynamically balance tail rotor per Section 10.240.

8.600 A203 YOKE AND A205 FORK ASSEMBLY (Figure 8-10)

Three different bearing types have been used in A203 yoke and A205 fork assemblies: A139-1 blue-plastic Turcite journal bearings, B115-1 spherical bearings, and C648-2 Teflon-lined journal bearings. More than one type bearing may be used in an installation, but each pivot axis must have same type bearings.

8.610 Bearing Removal

Care must be taken not to damage yoke or fork assemblies during bearing removal.

A139-1 Turcite bearings may be removed from A203 yoke or A205 fork assemblies with a broken-screw extractor or by pressing or tapping them out with a small brass or aluminum drift.

B115-1 Spherical bearings and C648-2 journal bearings may be removed with a press. Press from inner side of bearings while supporting outboard side of yoke or fork. Use a socket or other suitable pressing tool to apply the force.

8.615 C648-2 Bearing Installation (0.5625/0.5630 inch diameter bearing bores)

1. Clean mating surfaces of A205 fork or A203 yoke where C648 bearing is installed. Deburr any sharp edges that may damage bearings during installation.

2. Coat yoke or fork bearing bores with zinc chromate or epoxy primer. While primer is still wet, press in C648 bearing while supporting backside of fork or yoke.

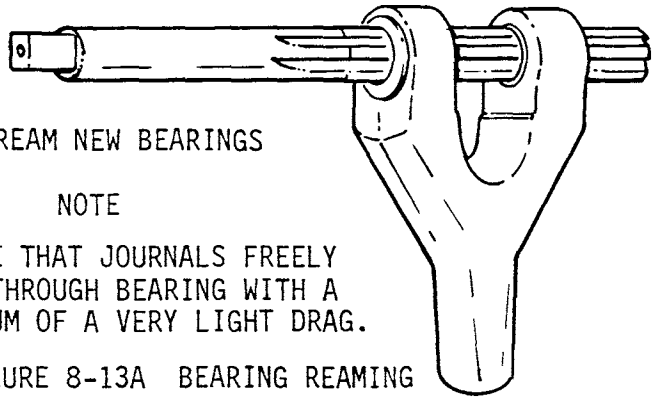
8.620 A139-1 Bearing Installation (0.499/0.501 inch diameter bearing bores)

a) Clean mating surfaces of A205 fork or A203 yoke where A139 bearing is installed. Deburr any sharp edges that may damage bearings during pressing operation.

b) Coat yoke or fork bearing bores with zinc chromate or epoxy primer. While primer is still wet, press in A139 bearing.

c) With both A139 bearings installed, ream inner bearing bores with a 0.375 inch dead sharp reamer. Using A105-11 journals as a gauge, continue to ream bores until a very light drag fit is achieved. It may be necessary to use a 0.376 or 0.377 inch reamer to obtain correct fit.

d) Place one A141-3 washer and one A105-11 journal on NAS6604 bolt. Insert bolt into A204-1 arm. Place second A105-11 journal and second A141-3 washer on bolt.

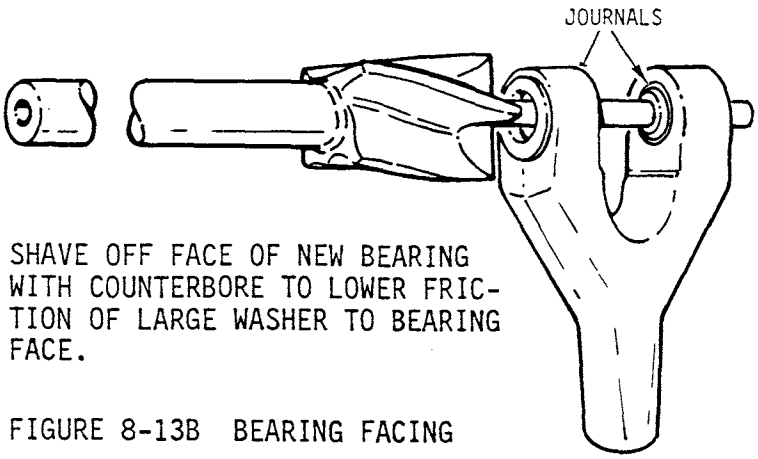


LINE REAM NEW BEARINGS

NOTE

ENSURE THAT JOURNALS FREELY MOVE THROUGH BEARING WITH A MAXIMUM OF A VERY LIGHT DRAG.

FIGURE 8-13A BEARING REAMING



SHAVE OFF FACE OF NEW BEARING WITH COUNTERBORE TO LOWER FRICTION OF LARGE WASHER TO BEARING FACE.

FIGURE 8-13B BEARING FACING

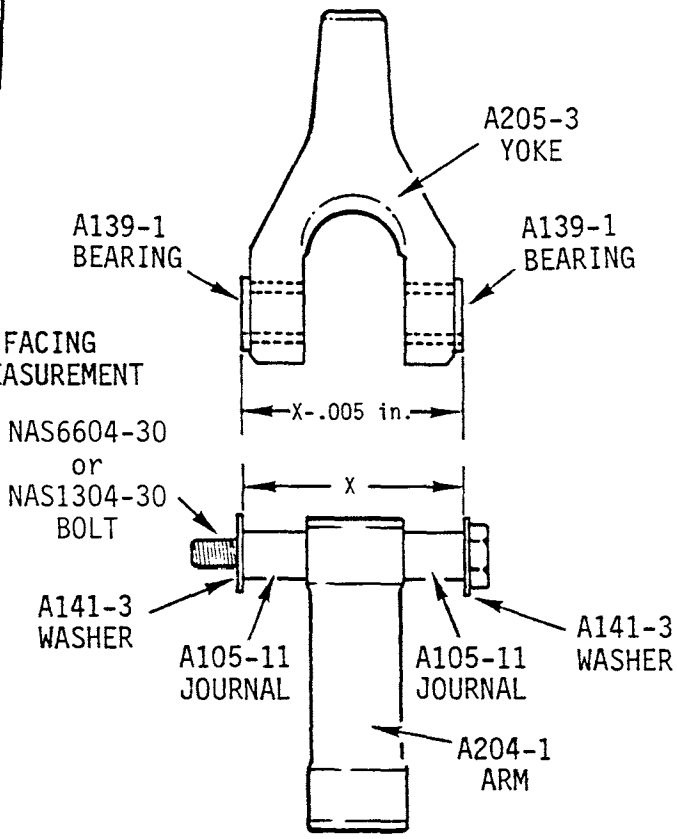


FIGURE 8-13C BEARING FACING WIDTH MEASUREMENT

FIGURE 8-13 BEARING REAMING, FACING, & WIDTH MEASUREMENT

8.620 A139-1 Bearing Installation (cont'd)

e) Measure the distance between the A141-3 washers with the washers held tightly against the journals. Using a one-inch spotface tool with a 0.25 inch pilot, lightly shave the face of each bearing until the measurement across the bearing faces is 0.005 inch less than the measurement between the A141-3 washers. When this dimension is achieved, do not shave any more material off the bearing faces (See Figure 8-13C).

f) Reassemble the yoke or fork assembly and torque the NAS6604 (or NAS1304) bolt to 100 in.-lb plus nut drag. Check for freedom of movement with no play or drag.

8.630 B115-1 Bearing Installation

The B115-1 Bearing may be either interference-fit or Loctite®-secured slip-fit in the A203 yoke or A205 fork, depending on the diameter of the bearing bores.

8.631 Interference-Fit Bearings (0.6239/0.6244 inch diameter bearing bores)

a) Clean the bearing bores of the yoke or fork assembly. Deburr any sharp edges and inspect and remove any metal shavings in the bearing bores.

b) Heat the yoke or fork assembly to approximately 180 degrees Fahrenheit.

c) Coat one bearing bore with zinc chromate primer. While the primer is still wet, press in the B115-1 bearing to the bottom of the bore.

d) Coat the other bearing bore with a graphite solution (Lubri-Kote Type A or equivalent). Press in the B115-1 bearing until it is 0.010 to 0.020 inch above the top of the bearing bore.

8.632 Loctite®-Secured Slip-Fit Bearings (0.6255/0.6260 inch diameter bearing bores)

a) Clean the yoke or fork assembly bearing bores of old Loctite®.

b) Measure the bearing bores; maximum allowable diameter is 0.6260 inch.

c) Lightly coat the B115-1 bearing outer races with Loctite® 271 compound and install the B115-1 bearings into the bearing bores. Wipe off excess Loctite®. Do not allow Loctite® to enter the B115-1 bearing.

8.630 B115-1 Bearing Installation (cont'd)

d) While the sealant is still wet, assemble yoke or fork assembly per Section 8.640. Wait until sealant has been allowed to cure per manufacturer's instructions prior to checking bearing pivot force.

8.640 Yoke and Fork Assembly Installation

1. Assemble fork or yoke assembly. Torque NAS6604 (or NAS1304) bolt per Section 1.320.

2. Place a torque wrench on bolt head at fork or yoke pivot point. The force required to pivot assembly must be 5 in-lbs or less.

3. To reduce pivot force for A139-1 bearings:

   a. Disassemble fork or yoke assembly.

   b. Ream inner bores of A139-1 bearings; a very slight oversized bore may be required.

   c. Reassemble yoke or fork assembly. Recheck pivot force.

4. To reduce pivot force for interference-fit B115-1 bearings:

> **CAUTION**
>
> Do not rotate bearing with a drill motor to reduce pre-load as this may damage Teflon® liner and cause premature failure.

   a. Place a 7/16 inch socket against outer race of the bearing installed with graphite solution. Tap bearing lightly to relieve axial preload caused by torquing bolt. The pivot force should drop with this slight movement of bearing race. If outer bearing race is moved too far inward, bearing will be preloaded in opposite direction and pivot assembly will have to be disassembled so that bearing can be pressed back into its original position. The pivot assembly will have to be reassembled and retorqued as described above.

   b. If pivot force is still too high, replace interference-fit bearing yoke or fork assembly with a adhesive-secured slip-fit bearing yoke or fork assembly.

   c. Reassemble yoke or fork assembly per Figure 8-10. Recheck pivot force.

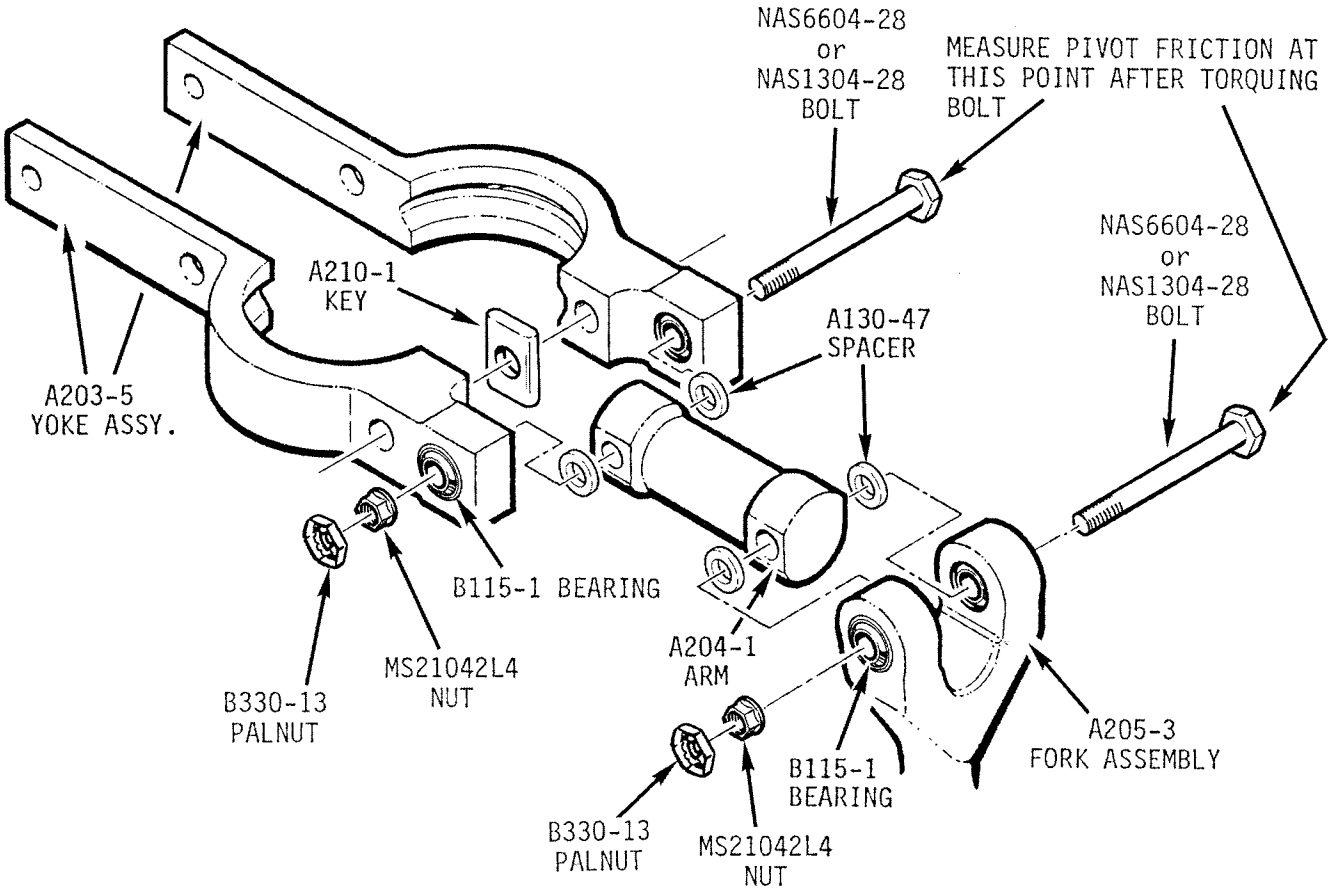


FIGURE 8-14 B115-1 BEARING INSTALLATION