

**SECTION 9**

**RUDDER AND RUDDER TRIM CONTROL SYSTEMS**

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**9-1. RUDDER CONTROL SYSTEM.**

**9-2. DESCRIPTION.** The rudder control system consists of the rudder pedal installation, cables, pulleys, push-pull rods and rudder bellcranks. The

rudder bars are connected to the forward rudder bellcrank by a push-pull rod and rudder trim actuator. Nose gear steering is controlled by the rudder pedals through a bungee, bellcrank and push-pull rod.

9-3. TROUBLE SHOOTING.

NOTE

Due to remedy procedures in the following trouble shooting chart it may be necessary to re-rig system, refer to paragraph 9-16.

TROUBLE	PROBABLE CAUSE	REMEDY
RUDDERS DO NOT RESPOND TO PEDAL MOVEMENT.	Broken or disconnected cables or push-pull rods.	Check visually. Connect cables and push-pull rods. Replace if broken.
BINDING OR JUMPY MOVEMENT OF RUDDER PEDALS.	Incorrect cable tension.	Check and adjust cable tension.
	Cables not routed properly on pulleys.	Check cable routing. Route cables properly.
	Defective pulleys or cable guards.	Check visually. Replace defective parts and install guards properly.
	Rudder bars binding.	Visually inspect rudder bars. Install bearing blocks properly and lubricate bearing surfaces. Replace defective parts.
	Defective rudder hinge bearing or bellcrank bearings.	Replace defective bearings.
	Clevis bolts too tight.	Readjust to eliminate binding.
	Incorrect rigging.	Rig in accordance with paragraph 9-16.
	Defective rudder trim bungee.	Disconnect bungee and check operation of rudder system. Replace defective bungee.
RUDDER TRAVEL INCORRECT.	Incorrect rigging.	Rig in accordance with paragraph 9-16.
	Bent push-pull rods.	Check visually. Replace push-pull rods.
RUDDER PEDALS DO NOT RETURN TO NEUTRAL.	Weak or binding bungee. Improperly rigged bungee. Friction in rudder system.	Repair or replace bungee. Re-rig bungee in accordance with paragraph 9-16. Check cable tension. Check for correct installation and routing of cables.
	Rudder trim system.	Check rigging of trim system in accordance with paragraph 9-16.

#### 9-4. RUDDER PEDAL ASSEMBLY.

#### 9-5. REMOVAL AND INSTALLATION.

- a. Remove lower section of control quadrant cover.
- b. (Refer to figure 9-5.) Remove safety wire, relieve chain tension at either turnbuckle (6) and disconnect rod end (23) at rudder bar arm (21). **DO NOT TURN ROD END.**
- c. (Refer to figure 9-2.) Disconnect push-pull rod (18) at rudder bar arm.
- d. Disconnect steering bungee (6) at rudder bar arm.
- e. Disconnect master cylinders (7) at rudder bar arms (1).
- f. Remove bolts securing bearing blocks (4).
- g. Carefully work rudder bars down and aft to remove.

#### NOTE

If additional clearance is desired, depending on the equipment installed, complete step "h."

- h. Disconnect pedal supports (17) and brake links (16) at rudder bars.
- i. Reverse the preceding steps for reinstallation. If the trim actuator rod end was not turned, re-rigging should not be necessary, although it is advisable to check for proper rudder travel and tension.
- j. Rig rudder trim system, if necessary, in accordance with paragraph 9-16, safety turnbuckle and re-install all items removed for access.

9-6. REPAIR. Repair of rudder bar assemblies consists of attaching parts replacement as necessary. Lubricate as outlined in Section 2.

#### 9-7. RUDDERS.

9-8. REMOVAL AND INSTALLATION. (Refer to figure 9-3.)

- a. Remove access plate from top of stabilizer adjacent to vertical fin to expose rudder bellcrank (index 12, figure 9-1).
- b. Disconnect push-pull rod at bellcrank (index 12, figure 9-1).
- c. Remove hinge bolts (5) and carefully work the lower end of rudder inboard as the upper end of rudder is worked outboard until rudder clears the vertical fin structure, then work rudder inboard and aft until push-pull rod and arm assembly (7) clears vertical fin.

#### NOTE

If additional clearance is required, rudder tip (2) and weight assembly (1) and its bracket may be removed.

- d. Reverse the preceding steps for reinstallation. If adjustment of push-pull rod was not disturbed, re-rigging of system should not be necessary. Rig system, if necessary, in accordance with paragraph 9-16 and re-install all items removed for access.

9-9. REPAIR. Repair may be accomplished as outlined in Section 16.

#### 9-10. BELLCRANKS.

9-11. REMOVAL AND INSTALLATION.

- a. FORWARD. (Refer to figure 9-5.)
  1. Remove wing strut fairings as necessary to expose turnbuckle (index 8 or 9, figure 9-1).
  2. Remove safety wire and relieve cable tension at turnbuckle.
  3. Disconnect cable (3) at each end of bellcrank (4).
  4. Remove safety wire and relieve chain tension at either turnbuckle (6). **DO NOT ALLOW ROD END (23) TO TURN.**
  5. Remove bolt (5) securing rod end (23) to bellcrank (4).
  6. Remove bolt securing push-pull rod (index 18, figure 9-2) to bellcrank (4).
  7. Remove bellcrank pivot bolt and remove bellcrank from under instrument panel. Use care not to drop parts.
  8. Reverse the preceding steps for reinstallation. Rig rudder and trim systems in accordance with paragraph 9-16, safety turnbuckles and re-install all items removed for access.
- b. AFT. (Refer to figure 9-1.)
  1. Remove access plate from top of stabilizer adjacent to vertical fin to expose rudder bellcrank (12).
  2. Remove access plate from top of stabilizer to expose turnbuckle (7).
  3. Remove safety wire and relieve cable tension at turnbuckle (7).
  4. Disconnect cables (10 and 14) at bellcrank (12).
  5. Disconnect push-pull rod at bellcrank.
  6. Remove pivot bolt and remove bellcrank through access opening.
  7. Reverse the preceding steps for reinstallation. Rig rudder system in accordance with paragraph 9-16, safety turnbuckle and re-install all items removed for access.

9-12. RUDDER BUNGEE. (Refer to figure 9-6.)

9-13. REMOVAL AND INSTALLATION.

- a. Remove lower console cover.
- b. Remove bolt (10) securing rod end (8) to bellcrank (9).
- c. Remove bolt (4) securing bungee (5) to rudder bar arm (2) and remove bungee.
- d. Reverse the preceding steps for reinstallation. Adjust bungee to dimension shown on installation, rig system in accordance with paragraph 9-16 and re-install all items removed for access.

#### NOTE

Before installation of a new bungee, a complete rudder and rudder trim system operational check should be accomplished. Refer to paragraph 9-16.

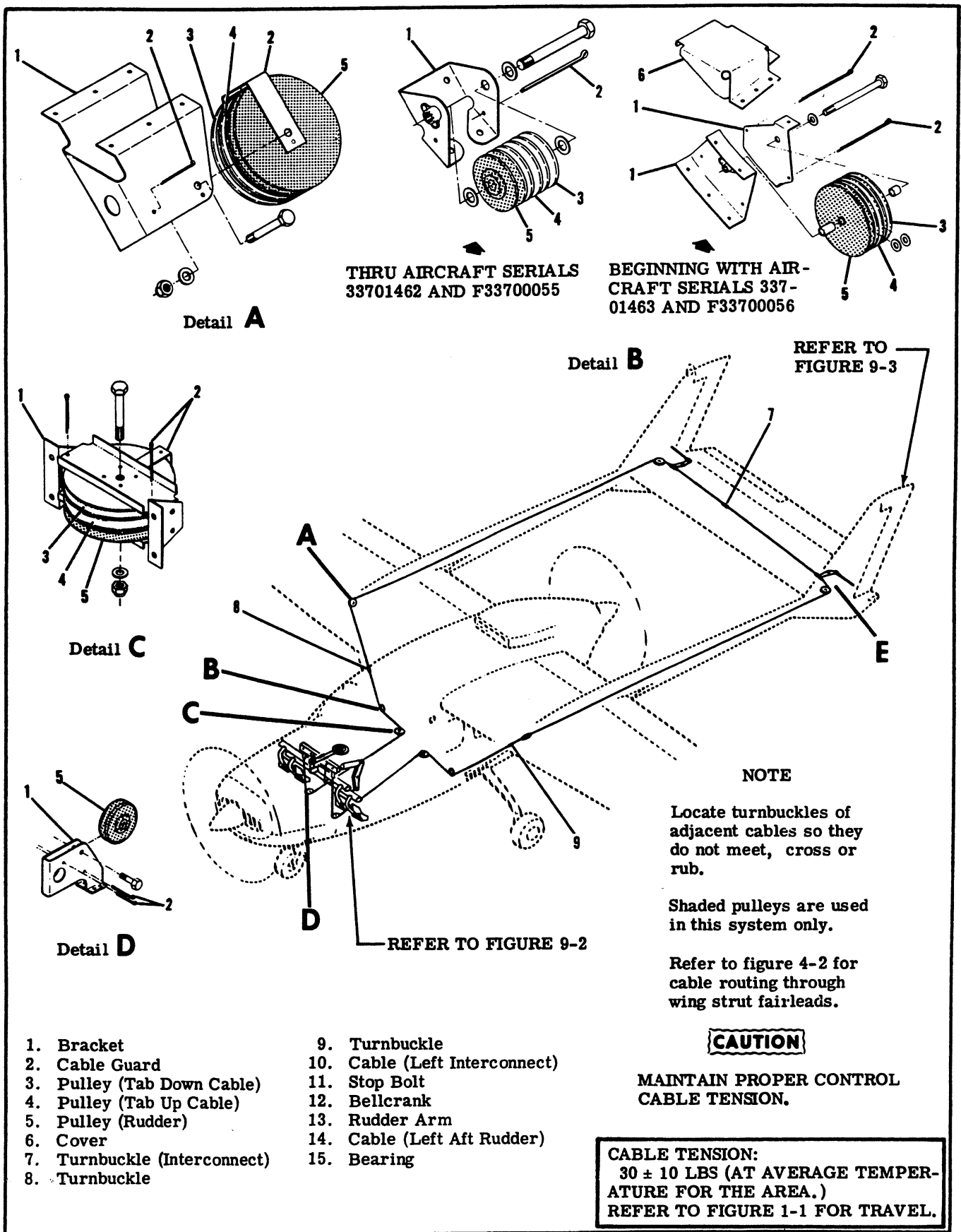


Figure 9-1. Rudder Control System (Sheet 1 of 2)

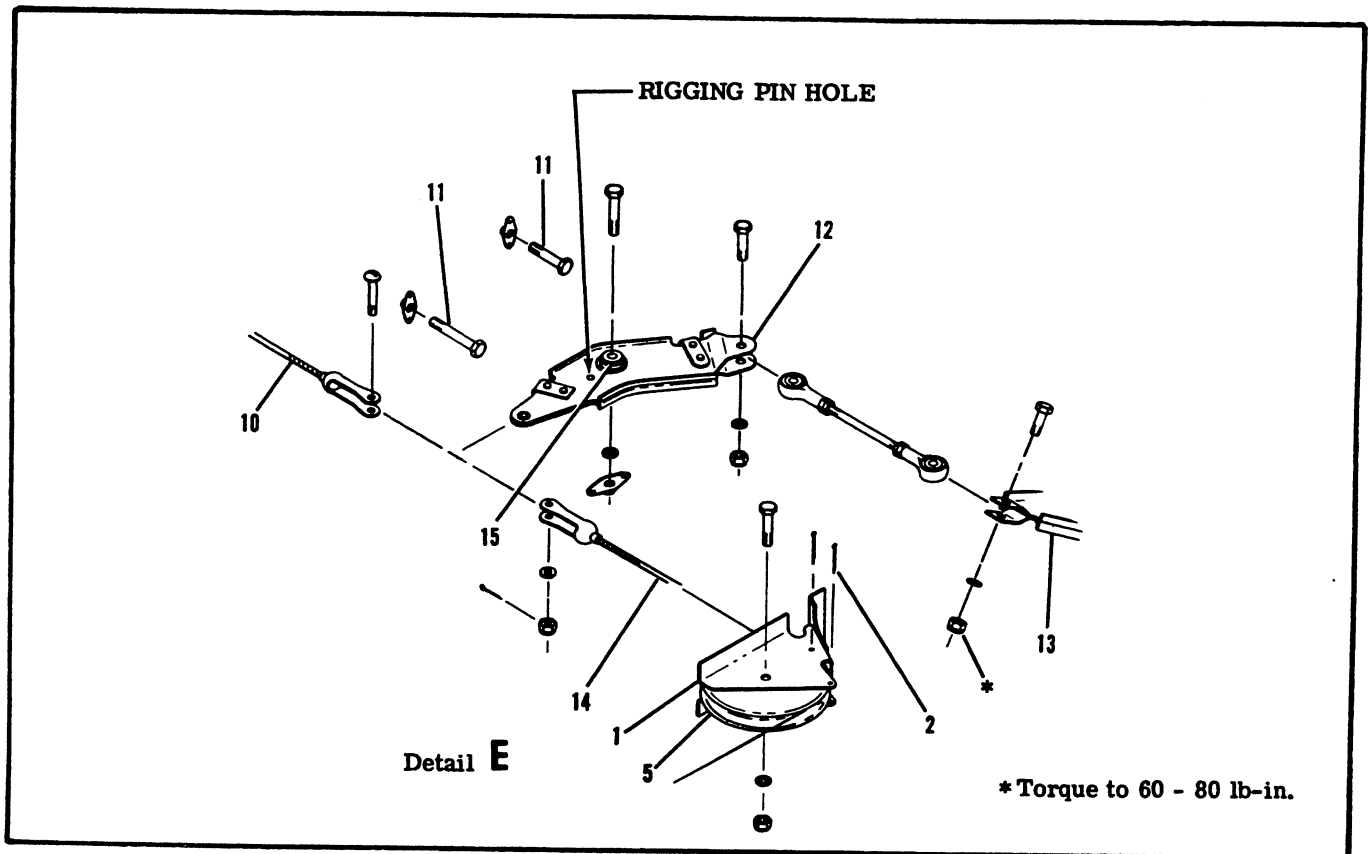


Figure 9-1. Rudder Control System (Sheet 2 of 2)

9-14. CABLES AND PULLEYS.

9-15. REMOVAL AND INSTALLATION.

a. FORWARD CABLES. (Refer to figure 9-1.)

NOTE

The following procedure is written for removal of BOTH forward cables. If ONE is to be removed, use only the steps necessary for that particular cable.

1. Remove seats, carpeting and access plates as necessary to expose Details B, C, and D.
2. Remove wing strut fairings as necessary to expose turnbuckles (8 and 9).
3. Remove safety wire, relieve cable tension and disconnect turnbuckles (8 and 9).
4. Remove safety wire and relieve elevator control system cable tension at turnbuckles (index 8, figure 8-1).
5. Remove access plates from inboard aft side of right tail boom as necessary to expose turnbuckles (index 8 and 9, figure 8-6). Remove safety wire and relieve cable tension.
6. Disconnect cables (index 3, figure 9-5) from bellcrank (index 4, figure 9-5).
7. Mark or tag cables and pulleys in Details B and C and remove bolts securing pulleys to brackets (1).
8. Remove cable guards (2) from bracket (1) in Detail D.

9. Work cables free of aircraft by routing cables from under floorboards and out of wing struts.

NOTE

To ease routing of cables, a length of wire may be attached to the end of the cable being withdrawn from the aircraft. Leave wire in place, routed through structure; then attach the cable being installed and pull the cable into position.

10. Reverse the preceding steps for reinstallation and install pulleys and cable guards. Ensure cables are positioned in pulley grooves before installing guards.

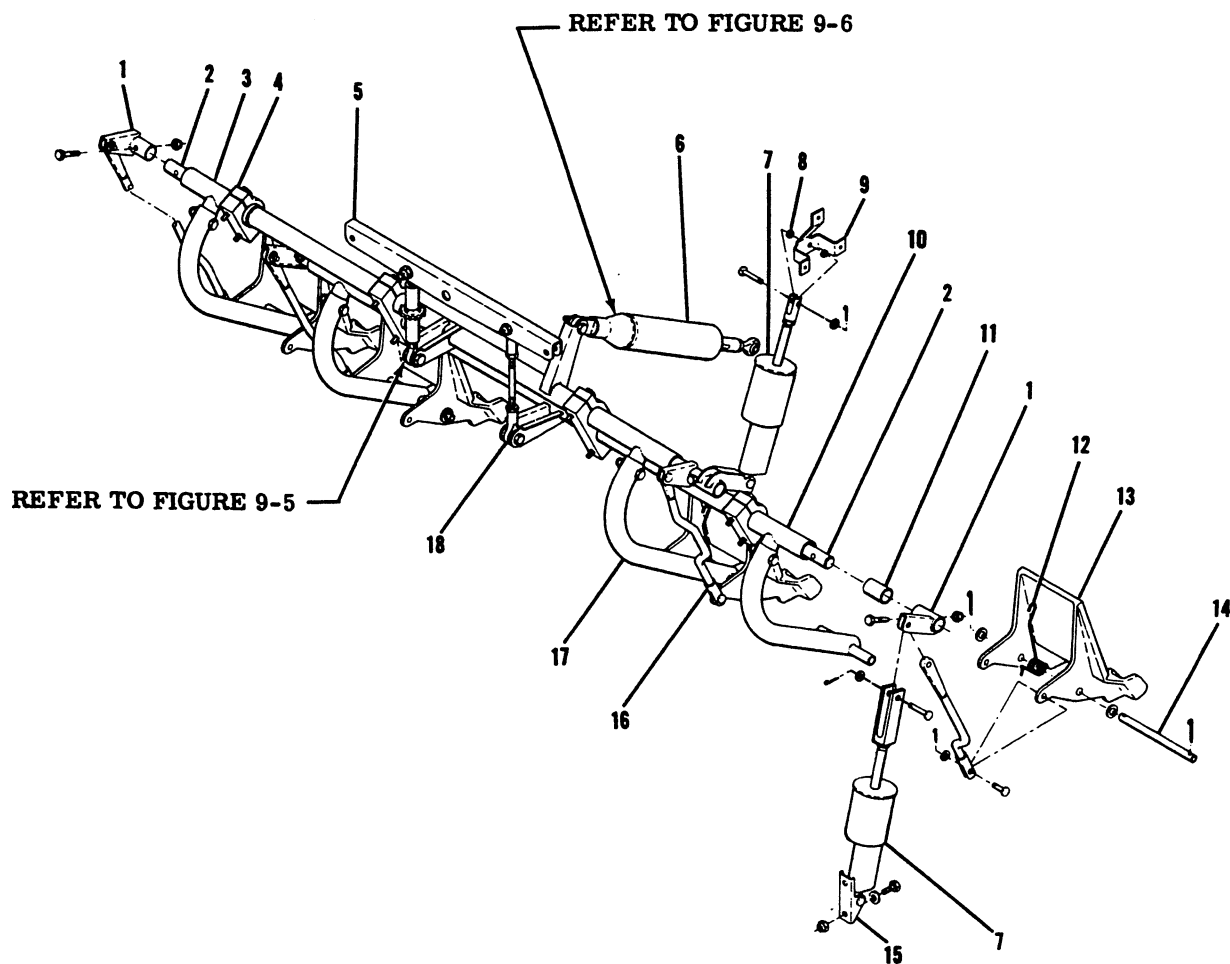
11. Re-rig system in accordance with paragraph 9-16 and safety turnbuckles.

12. Re-rig elevator and elevator trim systems in accordance with paragraphs 8-12 and 8-26 respectively, safety turnbuckles and reinstall all items removed for access.

b. CENTER CABLES. (Refer to figure 9-1.)

NOTE

The following procedure is written for removal of BOTH center cables. If ONE is to be removed, use only the steps necessary for that particular cable.



1. Brake Actuating Arm
2. Brake Actuating Torque Tube
3. Right Rudder Bar
4. Bearing Block
5. Bellcrank
6. Steering Bungee
7. Master Cylinder
8. Spacer
9. Bracket
10. Left Rudder Bar
11. Bearing
12. Anti-Rattle Spring
13. Pedal
14. Pivot Shaft
15. Support
16. Brake Link
17. Support
18. Push-Pull Rod

**NEUTRAL PEDALS  
AT STATION 73.42**

Figure 9-2. Rudder Pedals Installation

1. Remove wing strut fairings as necessary to expose Detail A and turnbuckles (8 and 9).
2. Remove access plates as necessary to expose Detail E.
3. Remove safety wire, relieve cable tension and disconnect turnbuckles (8 and 9).
4. Complete steps 4 and 5 of subparagraph "a."
5. Disconnect cable (14) from forward side of bellcrank (12).
6. Mark or tag cables and pulleys in Detail A and remove bolt securing pulleys to bracket (1).
7. Remove cable guards (2) from bracket (1) in Detail E.
8. Complete "NOTE" in step 9 of subparagraph "a."
9. Work cables free of aircraft by routing cables through tail booms and out of wing struts.
10. Reverse the preceding steps for reinstallation and install pulleys and cable guards. Ensure cables are positioned in pulley grooves before installing guards.
11. Re-rig system in accordance with paragraph 9-16 and safety turnbuckles.
12. Complete step 12 of subparagraph "a."
- c. INTERCONNECT CABLE. (Refer to figure 9-1.)
  1. Remove access plates from stabilizer and vertical fins as necessary to expose Detail E and turnbuckle (7).
  2. Remove safety wire and relieve cable tension at turnbuckle (7).
  3. Disconnect cable (10) at forward end of bellcranks (12).
  4. Complete "NOTE" in step 9 of subparagraph "a."
  5. Work cable free of aircraft by routing cable out through bellcrank access opening.
  6. Reverse the preceding steps for reinstallation. Rig system in accordance with paragraph 9-16, safety turnbuckle (7) and reinstall all items removed for access.

#### 9-16. RIGGING-RUDDER, RUDDER TRIM AND NOSE WHEEL STEERING SYSTEMS.

##### NOTE

Since rudder, rudder trim and nose wheel steering systems are interconnected, adjustments to one system may affect the others. The following procedure outlines rigging, in proper sequence, for all three systems.

- a. (Refer to figure 9-1.) Remove quadrant covers, wing strut fairings and stabilizer access plates as necessary to expose turnbuckles (7, 8 and 9), rudder trim system and steering bungee.
- b. (Refer to figure 9-5.) Disconnect steering bungee (18) from right rudder bar (20).
- c. Clamp rudder pedals in neutral position.
- d. Remove safety wire, relieve chain tension at turnbuckles (6) and disengage chain (8) from actuator sprocket (24). Adjust trim control wheel (16) so position indicator (14) is neutral and an equal number of chain links are between turnbuckles (6) and trim

wheel sprocket (9). Re-engage chain on sprocket if necessary.

##### NOTE

The actuator MUST be installed with the left hand threaded rod end at top and approximately .18" exposed threads at each end. If necessary, disconnect actuator at bellcrank (4) and rotate sprocket (24) to extend actuator to 4.23" between rod ends and reconnect actuator to bellcrank (4). (Refer to VIEW A-A.)

- e. While maintaining the actuator dimensions required in step "d" and bellcrank (4) in the horizontal position, re-engage chain on sprocket (24). Make sure the chain (8) has an equal number of links as outlined in step "d."
- f. Connect turnbuckles (6) and adjust chain tension.

##### NOTE

Remove clamps from rudder pedals. Holding full right rudder and maintaining neutral position of trim wheel and actuator, tighten chain turnbuckles (6) evenly to remove slack from chains without binding. Safety turnbuckles, then reclamp the rudder pedals in neutral position.

g. (Refer to figure 9-1.) Remove safety wire and loosen turnbuckles (7, 8 and 9).

h. Install 3/16 inch diameter rigging pins at least five inches long in rudder bellcranks (12), adjust rudder push-pull rods to place rudders in neutral (streamlined) position and remove rigging pins.

i. Adjust turnbuckles (7, 8 and 9) to obtain proper cable tension while keeping the rudders in the neutral position. Results of adjusting the turnbuckles are as follows:

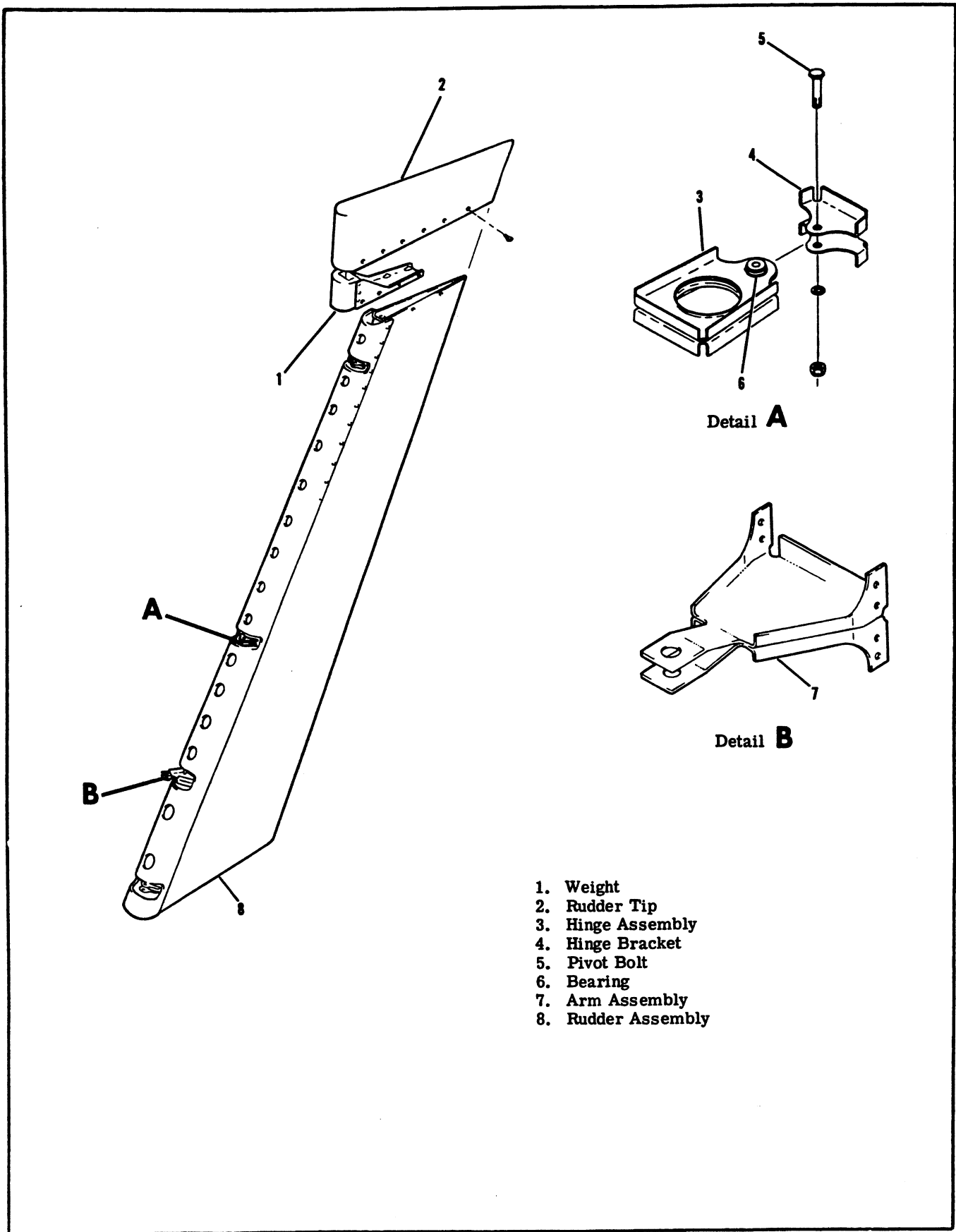
1. Loosening turnbuckles (8 and 9) and tightening turnbuckle (7) will move both rudder trailing edges inboard.
2. Loosening turnbuckle (7) and tightening turnbuckles (8 and 9) will move both rudder trailing edges outboard.
3. Loosening turnbuckle (7) and tightening turnbuckle (8 or 9) will move the rudder trailing edge for that particular side outboard.
4. Loosening turnbuckle (8 and 9) and tightening turnbuckle (7) will move the rudder trailing edge for that particular side inboard.

j. Safety turnbuckles (7, 8 and 9).

k. Remove clamps from rudder pedals. Adjust stop bolts (11) at both bellcranks (12) to degree of travel specified in figure 1-1. Adjust inboard travel first, then outboard travel to ensure no interference between rudders and elevator. Refer to figure 9-4 when adjusting travel.

l. Jack the nose gear free of ground and make sure the centering lug on the upper torque link seats firmly against flap spot on strut, locking nose gear in neutral.

m. (Refer to figure 9-6.) Adjust push-pull rod (12) to 11.09 ± .03 inches between centers of rod end holes, tighten jam nuts and reinstall.



Detail A

Detail B

- 1. Weight
- 2. Rudder Tip
- 3. Hinge Assembly
- 4. Hinge Bracket
- 5. Pivot Bolt
- 6. Bearing
- 7. Arm Assembly
- 8. Rudder Assembly

Figure 9-3. Rudder Installation



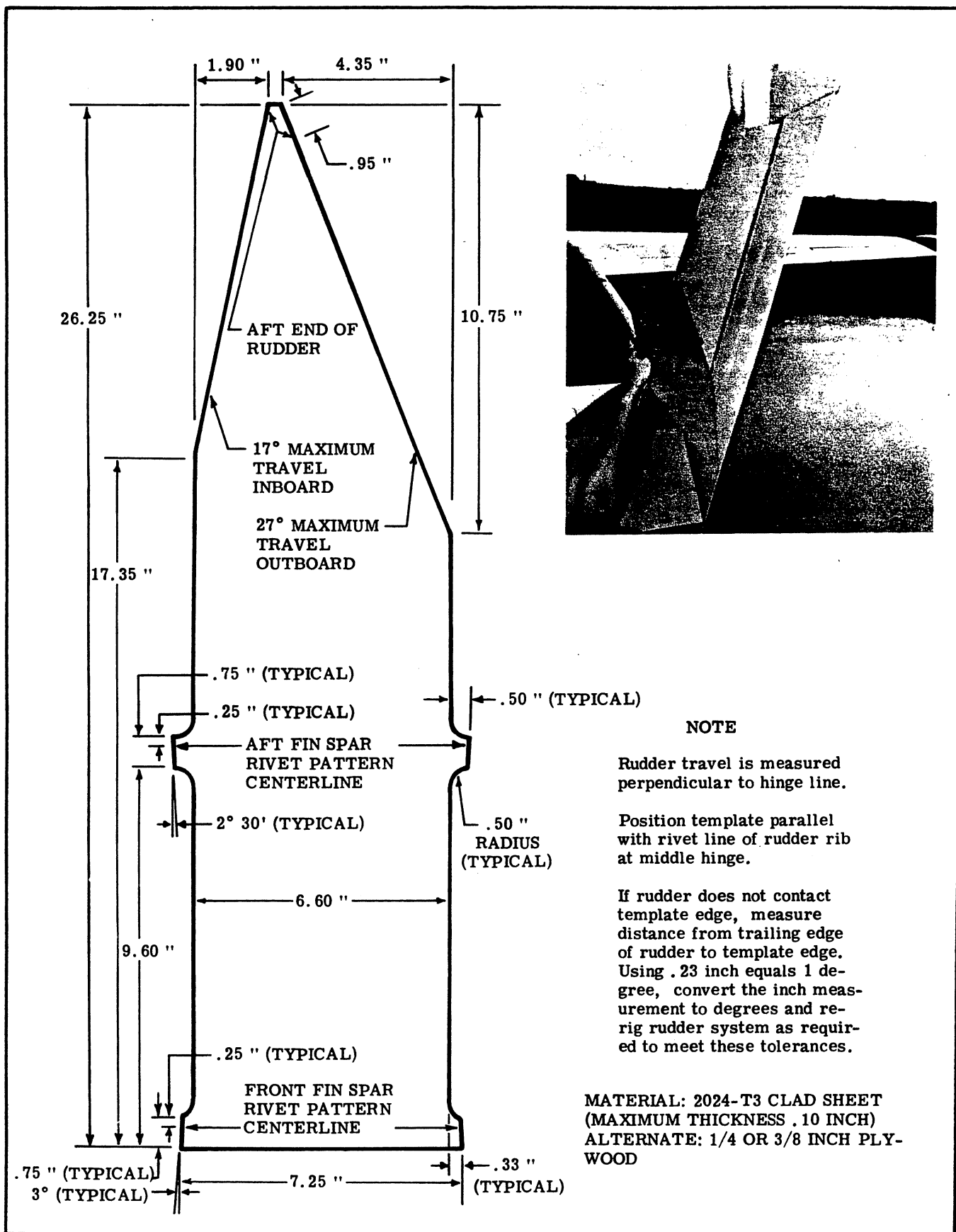


Figure 9-4. Measuring Rudder Travel

n. Position rudder pedals in neutral position (streamlined), adjust bungee (5) to dimension shown by adjusting rod end (8) to align with rudder bar arm (2) and reinstall hardware. DO NOT uncover safety inspection hole on shaft (7).

o. Inspect rudder, rudder trim and nose wheel steering systems for neutral positions. If all systems are not neutral, repeat rigging procedures.

p. Lower the nose gear to ground, check all components are secure and safetied as required and re-install all items removed for access.

**WARNING**

Be sure rudders move in the correct direction when operated by the pedals and that

operation of trim wheel applies correct rudder trim.

9-17. RUDDER TRIM CONTROL SYSTEM.

9-18. DESCRIPTION. The rudder trim control system is operated by a control wheel, mounted in the control console and is connected by chains to a trim actuator located between the right rudder bar and the forward rudder control bellcrank. As the trim wheel is rotated, the actuator is lengthened or shortened, causing the bellcrank to pivot against the force of the bungee, effecting rudder offset. The bungee serves as a rudder trim bungee when airborne and a steering bungee when on the ground.

9-19. TROUBLE SHOOTING.

NOTE

Due to remedy procedures in the following trouble shooting chart it may be necessary to re-rig system, refer to paragraph 9-16.

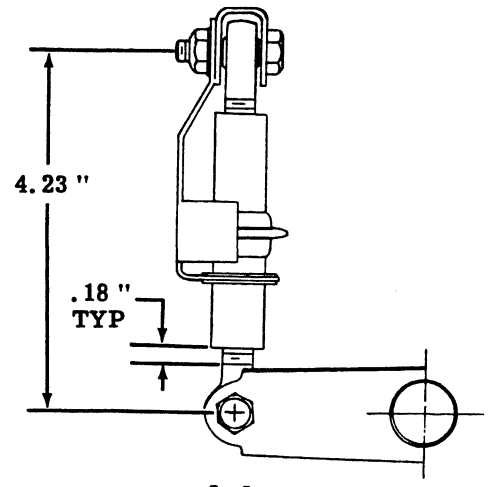
TROUBLE	PROBABLE CAUSE	REMEDY
NO RESPONSE TO TRIM WHEEL MOVEMENT.	Broken or disconnected chain.	Check visually. Connect if disconnected. Replace defective parts.
	Defective actuator.	Disconnect actuator and check manually. Replace defective actuator.
BINDING OR JUMPY MOVEMENT OF TRIM WHEEL.	Incorrect chain adjustment.	Check and adjust tension.
	Defective actuator.	Disconnect actuator and check manually. Replace actuator.
	Defective trim wheel bearings.	Check and replace defective bearings.
REVERSE TRIM APPLIED WHEN SYSTEM IS OPERATED.	Inverted actuator.	Disconnect actuator and check manually. Replace actuator with left hand threads UP.
INSUFFICIENT RUDDER TRIM IMMEDIATELY AFTER TAKE-OFF. (Refer to figure 9-6.)	Idler bellcrank (9) attach bolt loose.	Jack aircraft and partially retract gear. Check visually. Tighten bolt. Add washers as necessary.
	Steering cam lock (15) bolt loose.	Jack aircraft and partially retract gear. Check visually. Torque bolt until cam lock is free of lateral movement, but still free to move up or down.
	Improper cable tension.	Check and adjust cable tension.
	Rudders improperly aligned.	Rig rudders in accordance with paragraph 9-16.

1. Spacer
2. Chain Guard
3. Cable (Right Fwd)
4. Bellcrank
5. Bolt
6. Turnbuckle
7. Chain Stop
8. Chain
9. Sprocket
10. Upper Support Assembly
11. Bearing
12. Chain Guard
13. Roll Pin
14. Position Indicator (Typical)
15. Pin
16. Trim Control Wheel
17. Lower Support Assembly
18. Steering Bungee
19. Bolt
20. Right Rudder Bar
21. Arm
22. Bolt
23. Rod End
24. Sprocket

★ Screws and clinch nuts beginning with aircraft serials 33701195 and F33700001

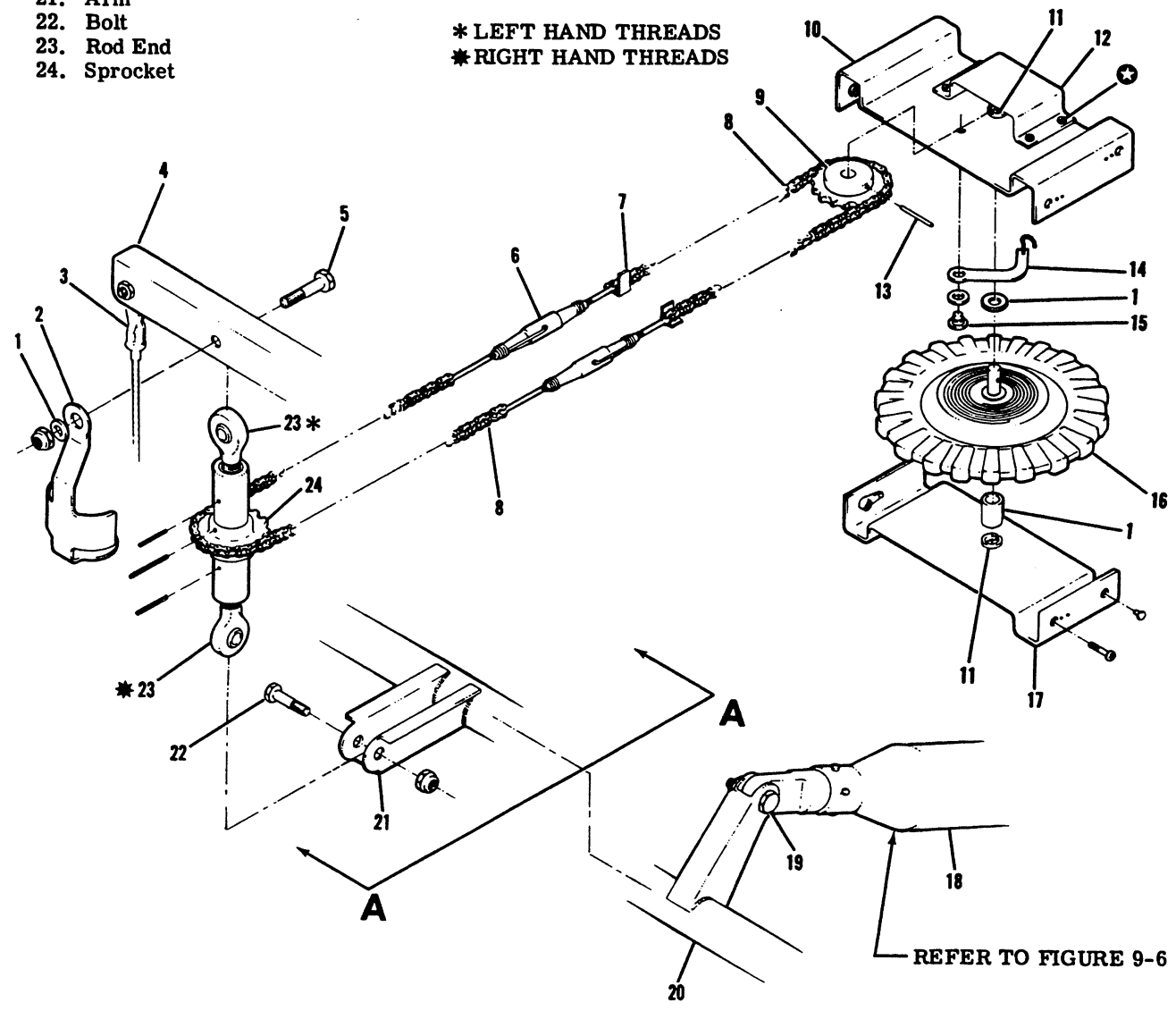
**NOTE**

Dimensions shown are for no rudder, no trim and no nose steering condition.



**VIEW A-A**

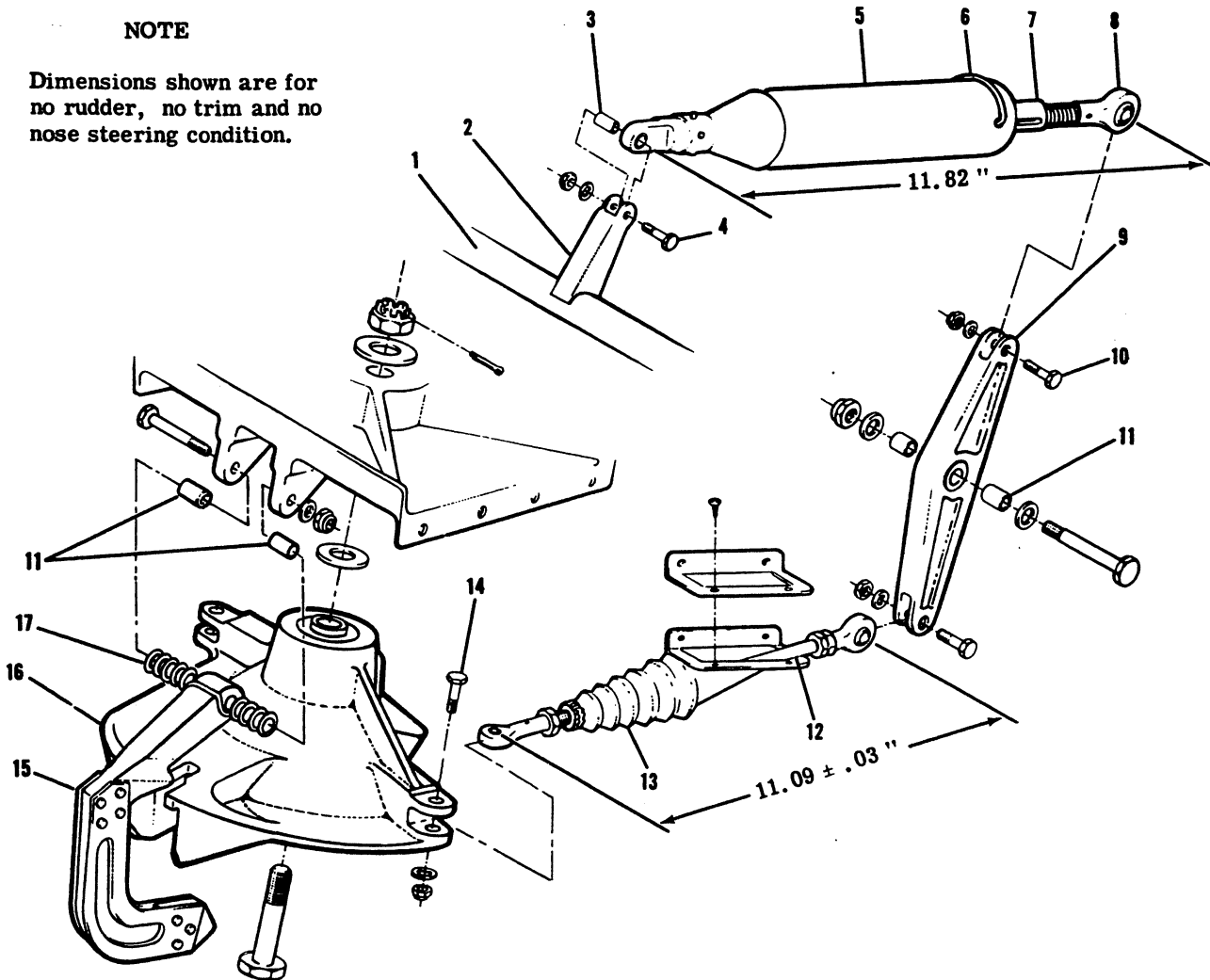
\* LEFT HAND THREADS  
\* RIGHT HAND THREADS



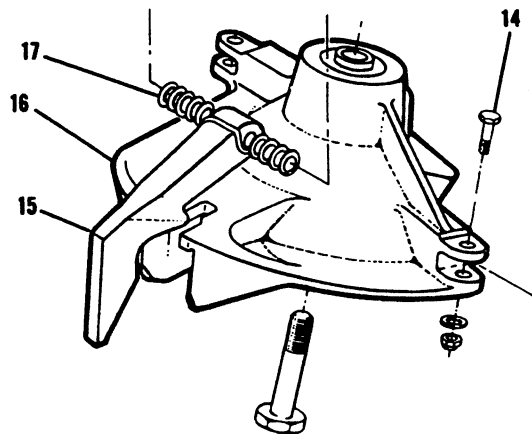
**Figure 9-5. Rudder Trim Control System**

**NOTE**

Dimensions shown are for no rudder, no trim and no nose steering condition.



THRU AIRCRAFT SERIAL 337-0500 WHEN NOT MODIFIED IN ACCORDANCE WITH SK337-4



BEGINNING WITH AIRCRAFT SERIALS 337-0501, F33700001 AND ALL AIRCRAFT MODIFIED IN ACCORDANCE WITH SK337-4

1. Right Rudder Bar
2. Arm
3. Bushing
4. Bolt
5. Steering Bungee
6. Safety Wire
7. Shaft
8. Rod End
9. Bellcrank
10. Bolt
11. Spacer
12. Rod Assembly
13. Boot
14. Bolt
15. Steering Cam Lock
16. Steering Cam
17. Spring

Figure 9-6. Nose Wheel Steering and Rudder Trim System Check Points

9-20. TRIM CONTROL WHEEL. (Refer to figure 9-5.)

9-21. REMOVAL AND INSTALLATION.

a. Remove console covers as necessary in accordance with paragraph 9-24.

b. Remove chain guard (12) from upper support assembly (10).

c. Remove safety wire, relieve chain tension and disengage chain from sprocket (9).

d. Remove screws securing upper support assembly (10) to console structure. Lift upper support, trim indicator and control wheel assembly out of structure. Use care not to lose spacer (1).

e. Sprocket (9) and control wheel (16) may be removed from upper support (10) by driving out roll pin (13).

f. Trim indicator may be removed by drilling out pin (15).

g. Reverse the preceding steps for reinstallation. Rig trim control system in accordance with paragraph 9-16, safety turnbuckles and reinstall all items removed for access.

9-22. RIGGING. The rudder, rudder trim and nose wheel steering systems are interconnected and adjustments to one system may affect the others. A complete rigging procedure, in proper sequence, for all three systems is outlined in paragraph 9-16.

9-23. CONSOLE AND QUADRANT COVERS.

9-24. REMOVAL AND INSTALLATION. (Refer to figure 10-4, sheet 2.)

**SHOP NOTES:**

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