

2002 STEERING

Steering - RAV4

STEERING SYSTEM

PRECAUTION

- Care must be taken to replace parts properly because they could affect the performance of the steering system and result in a driving hazard.
- The RAV4 is equipped with SRS (Supplemental Restraint System) such as the driver airbag and passenger airbag. Failure to carry out service operation in the correct sequence could cause the SRS to unexpectedly deploy during servicing, possibly leading to a serious accident. Before servicing (including removal or installation of parts, inspection or replacement), be sure to read the precautionary notices in the **AIR BAG SAFETY PRECAUTIONS**.

TROUBLESHOOTING

PROBLEM SYMPTOMS

Use the table below to help you find the cause of the problem. The numbers indicate the priority of the likely cause of the problem. Check each part in the order shown. If necessary, repair or replace these parts.

Symptom	Suspect Area	See page
Hard steering	1. Tires (Improperly inflated)	SA-3
	2. Power steering fluid level (Low)	SR-5
	3. Drive belt (Loose)	SR-3
	4. Front wheel alignment (Incorrect)	SA-4
	5. Steering system joints (Worn)	-
	6. Suspension arm ball joints (Worn)	-
	7. Steering column (Binding)	-
	8. Power steering vane pump	SR-25
	9. Power steering gear	SR-36
Poor return	1. Tires (Improperly inflated)	SA-3
	2. Front wheel alignment (Incorrect)	SA-4
	3. Steering column (Binding)	-
	4. Power steering gear	SR-36
Excessive play	1. Steering system joints (Worn)	-
	2. Suspension arm ball joints (Worn)	-
	3. Intermediate shaft, Sliding yoke (Worn)	-
	4. Front wheel bearing (Worn)	SA-11
	5. Power steering gear	SR-36
Abnormal noise	1. Power steering fluid level (Low)	SR-5
	2. Steering system joints (Worn)	-
	3. Power steering vane pump	SR-25
	4. Power steering gear	SR-36

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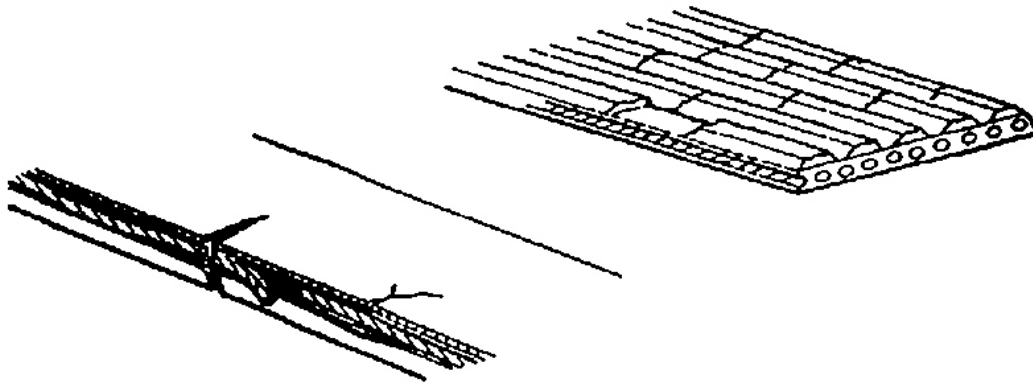
Fig. 1: Displaying Steering Problems & Possible Suspect Areas
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

DRIVE BELT

INSPECTION

Inspect Drive Belt

Visually check the drive belt for excessive wear, frayed cords, etc.



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Fig. 2: Checking Drive Belt Condition

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

If any defect has been found, replace the drive belt.

NOTE:

- Cracks on the rib side of a belt are considered acceptable. If the missing chunks from the ribs are found on the drive belt, it should be replaced.
- After installing a drive belt, check that it fits properly in the ribbed grooves.

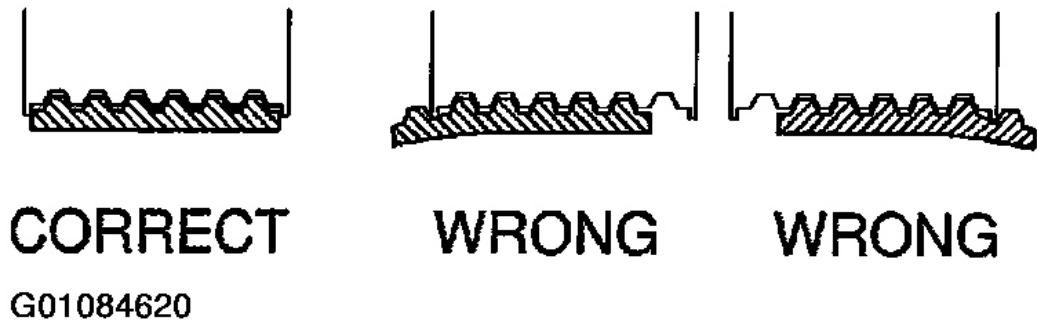


Fig. 3: Checking For Proper Installation
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- Check with your hand to confirm that the drive belt has not slipped out of the groove on the bottom of the pulley.

POWER STEERING FLUID

BLEEDING

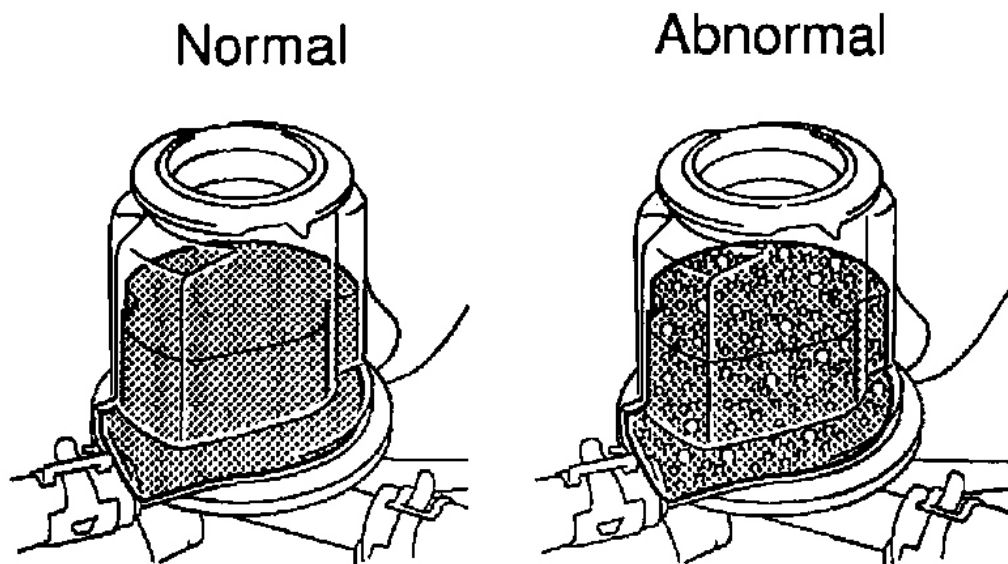
1. **Check fluid level (See INSPECTION) .**
2. **Jack up front of vehicle and support it with stands .**
3. **Turn steering wheel .**

With the engine stopped, turn the steering wheel slowly from lock to lock several times.

4. **Lower vehicle .**
5. **Start engine .**

Run the engine at idle for a few minutes.

6. **Turn steering wheel .**
 - a. With the engine idling, turn the steering wheel to left or right full lock position and keep it there for 2 - 3 seconds, then turn the steering wheel to the opposite full lock position and keep it there for 2 - 3 seconds.
 - b. Repeat step a several times.
7. **Stop engine .**
8. **Check for foaming or emulsification .**



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Fig. 4: Displaying Normal & Abnormal System
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

If the system has to be bled twice specifically because of foaming or emulsification, check for fluid leaks in the system.

9. Check fluid level (See INSPECTION) .

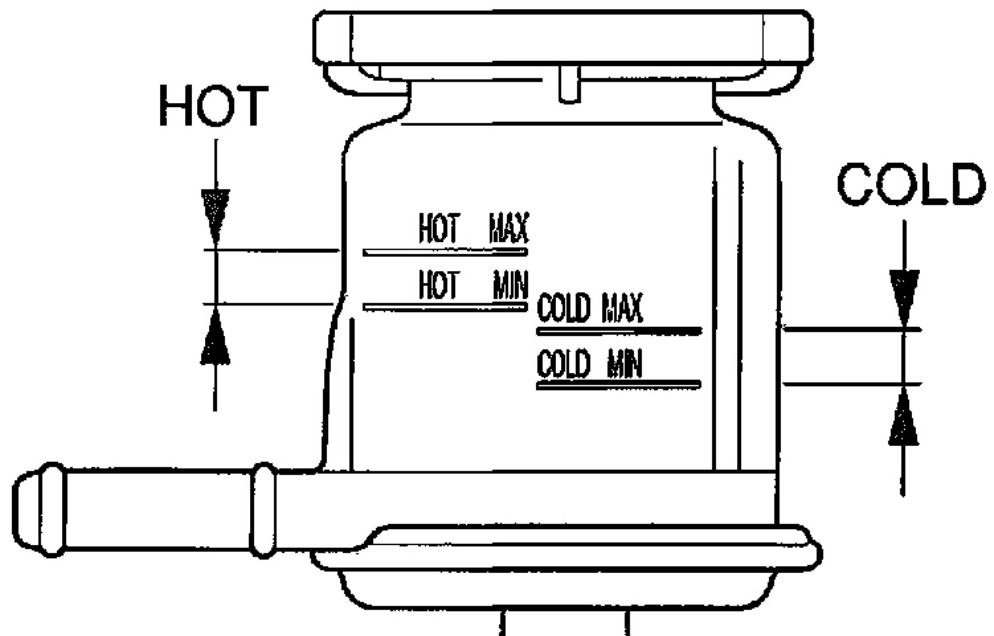
INSPECTION

1. Check fluid level .

- a. Keep the vehicle level.
- b. With the engine stopped, check the fluid level in the oil reservoir.

If necessary, add fluid.

Fluid: ATF DEXRON(R) II or III



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Fig. 5: Checking Fluid Level

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: If the fluid is hot, check that the fluid level is within the **HOT LEVEL** range on the reservoir. If the fluid is cold, check that it is within the **COLD LEVEL** range.

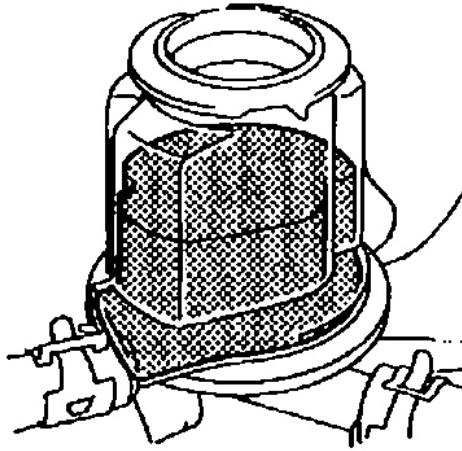
- c. Start the engine and run it at idle.
- d. Turn the steering wheel from lock to lock several times to boost fluid temperature.

Fluid temperature: 80°C (176°F)

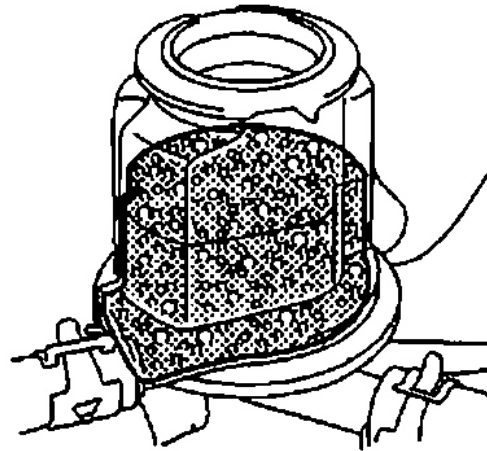
- e. Check for foaming or emulsification.

If there is foaming or emulsification, bleed power steering system (See **BLEEDING**).

Normal



Abnormal

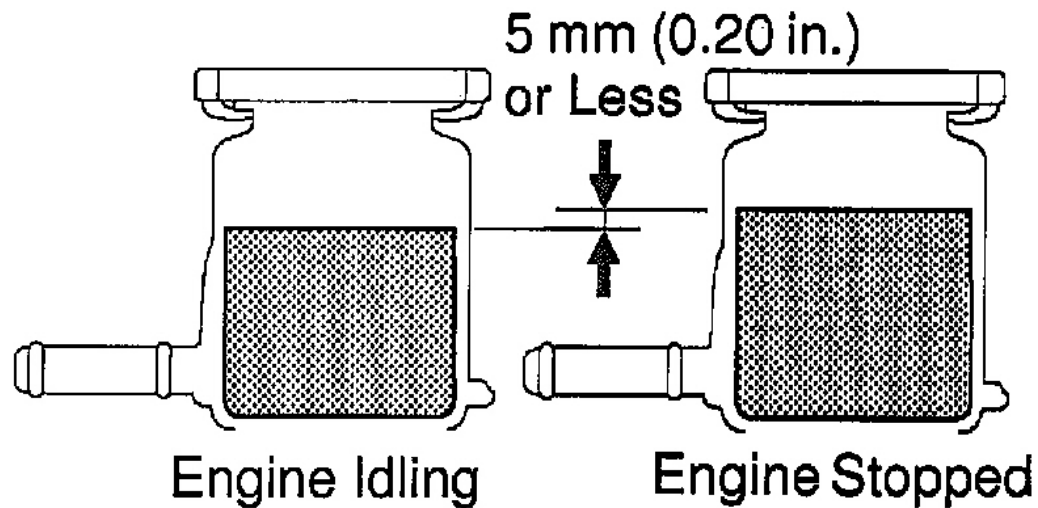


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Fig. 6: Displaying Normal & Abnormal System
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- f. With the engine idling, measure the fluid level in the oil reservoir.



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Fig. 7: Measuring Oil Level

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- g. Stop the engine.
- h. Wait a few minutes and remeasure the fluid level in the oil reservoir.
Maximum fluid level rise: 5 mm (0.20 in.)

If a problem is found, bleed power steering system (See **BLEEDING**).

- i. Check the fluid level.
2. **Check steering fluid pressure .**
- a. Disconnect the pressure feed tube from the PS vane pump (See **REMOVAL**).
 - b. Connect SST, as shown in the illustration below.
SST 09640-10010 (09641-01010, 09641-01030, 09641-01060)

NOTE: **Check that the valve of the SST is in the open position.**

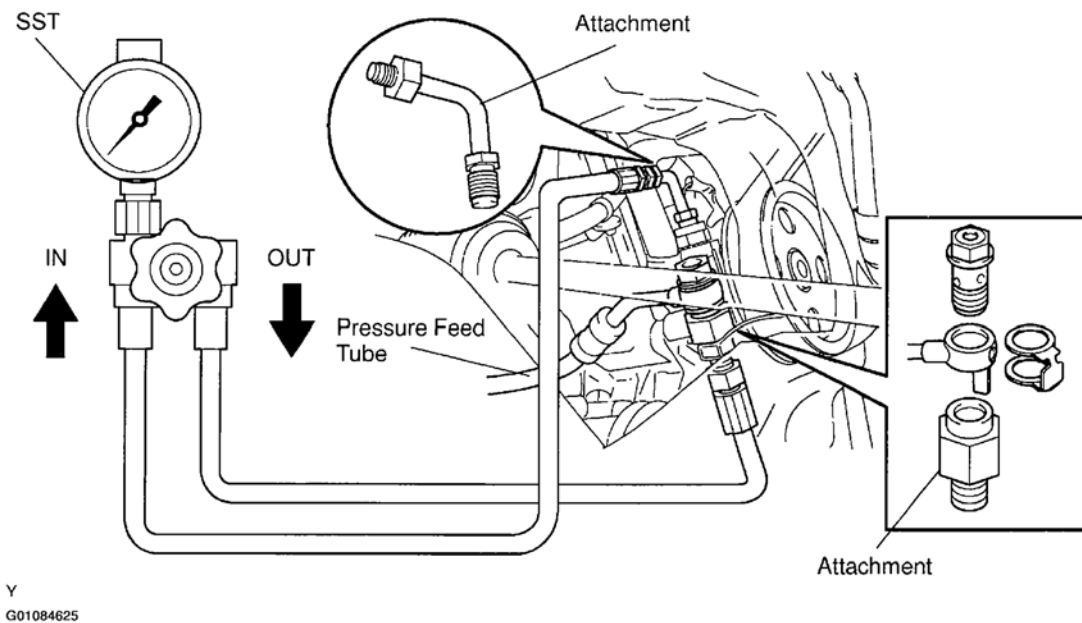
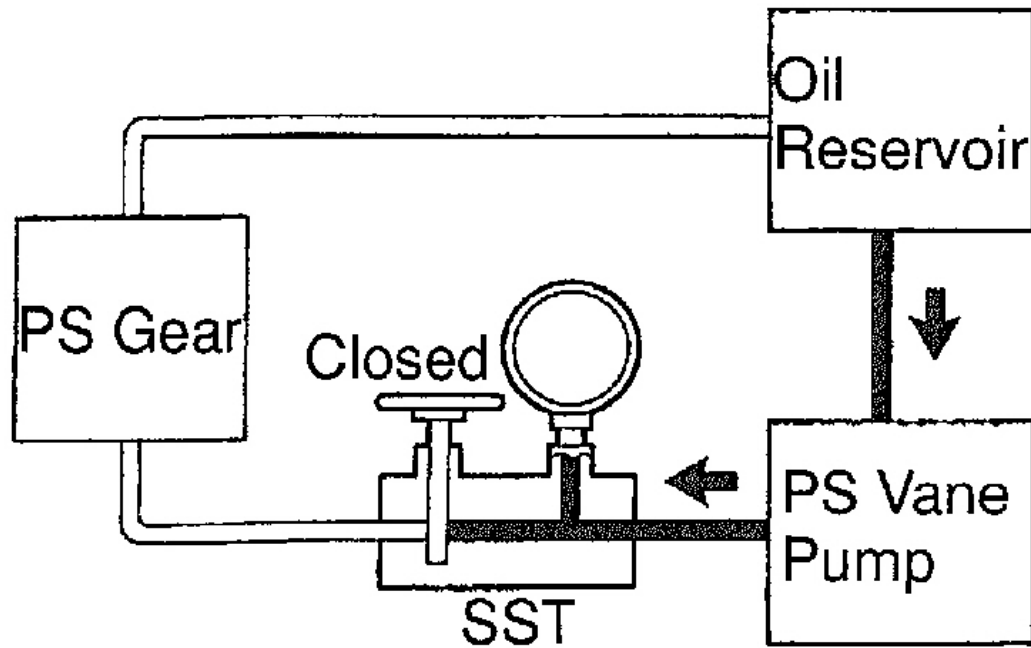


Fig. 8: Checking Steering Fluid Pressure
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- c. Bleed the power steering system (See **BLEEDING**).
- d. Start the engine and run it at idle.
- e. Turn the steering wheel from lock to lock several times to boost fluid temperature.
Fluid temperature: 80°C (176°F)
- f. With the engine idling, close the valve of the SST and observe the reading on the SST.
Minimum fluid pressure: 7,400 kPa (75 kgf/cm² , 1,067 psi)



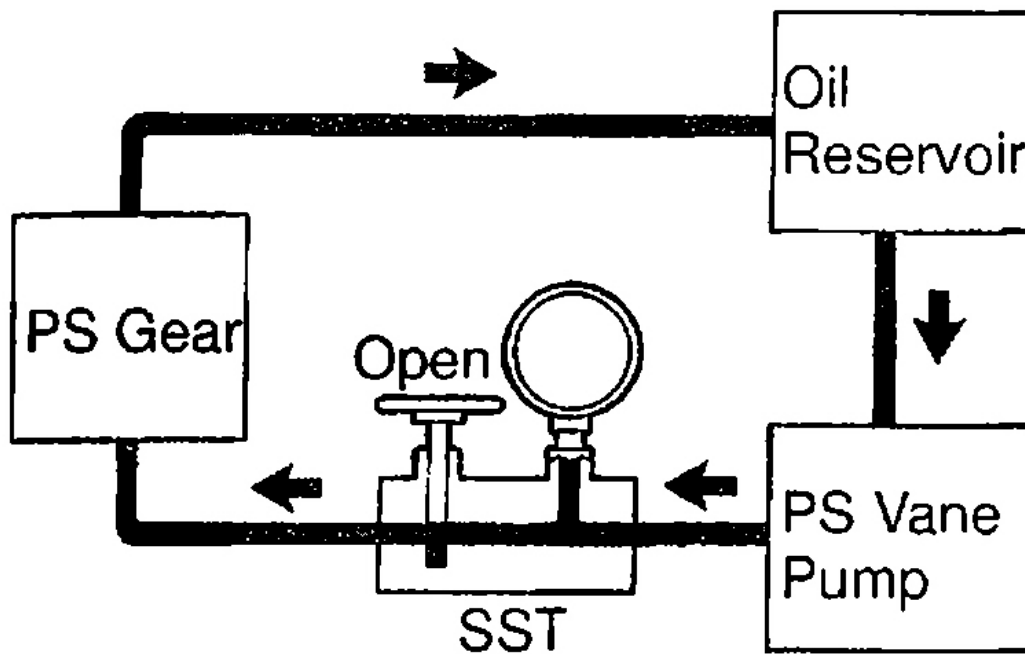
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Fig. 9: Displaying Closed SST Valve
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE:

- Do not keep the valve closed for more than 10 seconds.
- Do not let the fluid temperature become too high.

g. With the engine idling, open the valve fully.



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Fig. 10: Displaying Open SST Valve

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

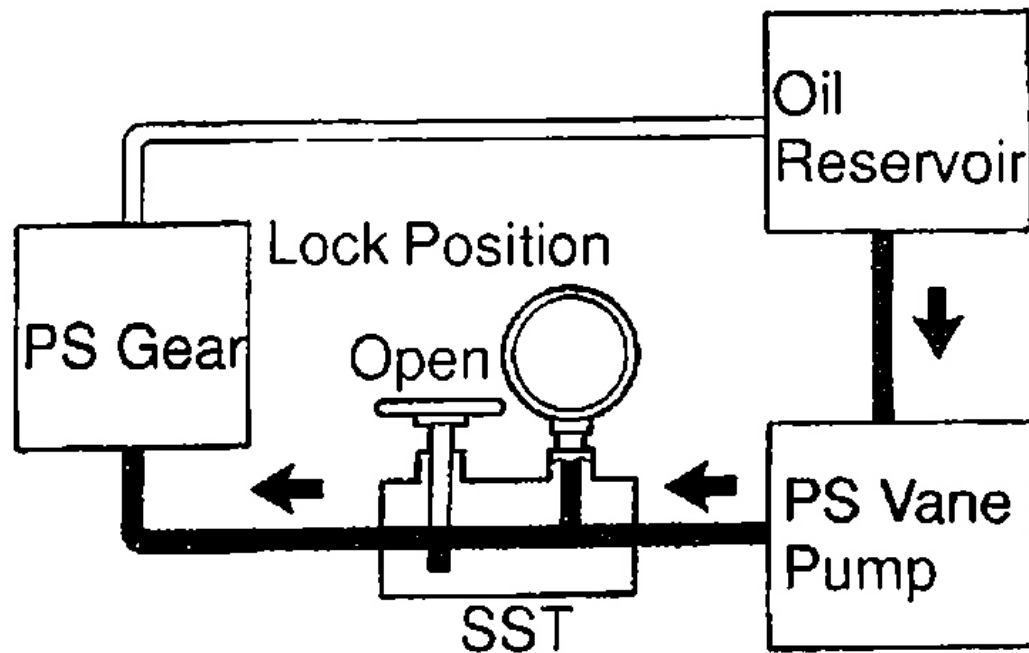
- h. Measure the fluid pressure at engine speeds of 1,000 RPM and 3,000 RPM.

Difference in fluid pressure: 490 kPa (5 kgf/cm² , 71 psi) or less

NOTE: Do not turn the steering wheel.

- i. With the engine idling and valve fully opened, turn the steering wheel to full lock.

Minimum fluid pressure: 7,400 kPa (75 kgf/cm² , 1,067 psi)



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Fig. 11: Displaying Opened Valve & Steering Wheel At Full Lock
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE:

- Do not maintain lock position for more than 10 seconds.
- Do not let the fluid temperature become too high.

j. Disconnect the SST.

SST 09640-10010 (09641-01010, 09641-01030, 09641-01060)

k. Connect the pressure feed tube to the PS vane pump (See **INSTALLATION**).

l. Bleed the power steering system (See **BLEEDING**).

STEERING WHEEL

INSPECTION

1. Check steering wheel free play .

- a. Stop the vehicle and face the tires straight ahead.
- b. Rock the steering wheel gently up and down with a finger lightly, checking the steering wheel free play.

Maximum free play: 30 mm (1.18 in.)

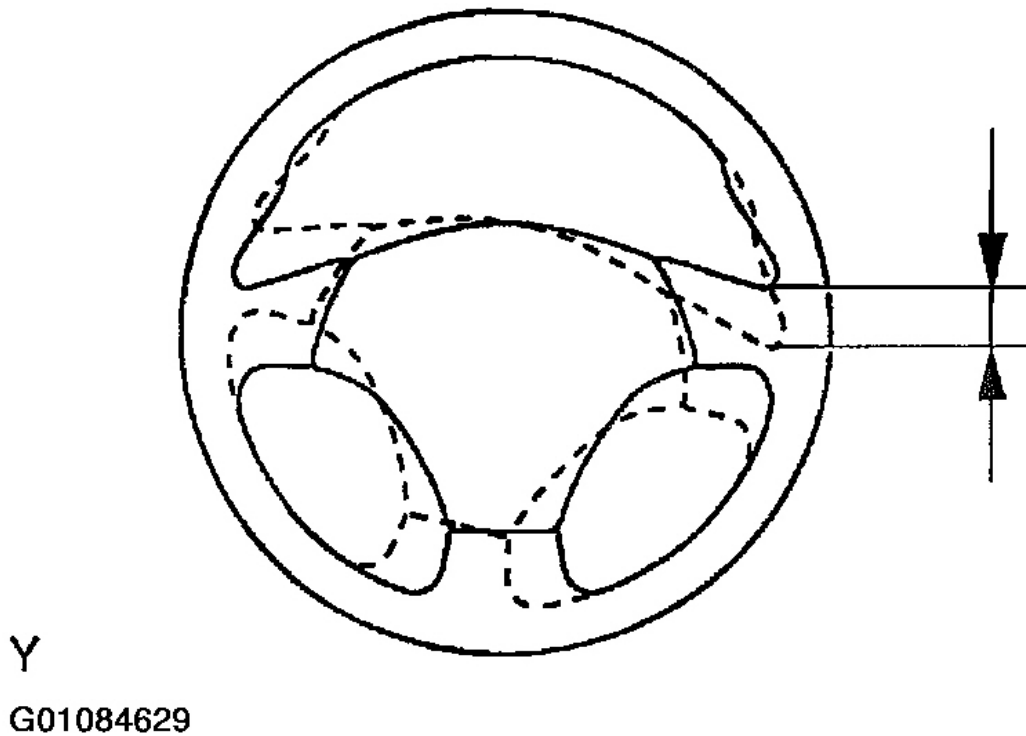


Fig. 12: Checking Steering Wheel Free Play
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

2. Check steering effort .

- a. Center the steering wheel.
- b. Remove the steering wheel pad (See **REMOVAL**).
- c. Start the engine and run it at idle.
- d. Measure the steering effort in both directions.

Steering effort (Reference): 5.9 N.m (60 kgf. cm, 52 in. lbf)

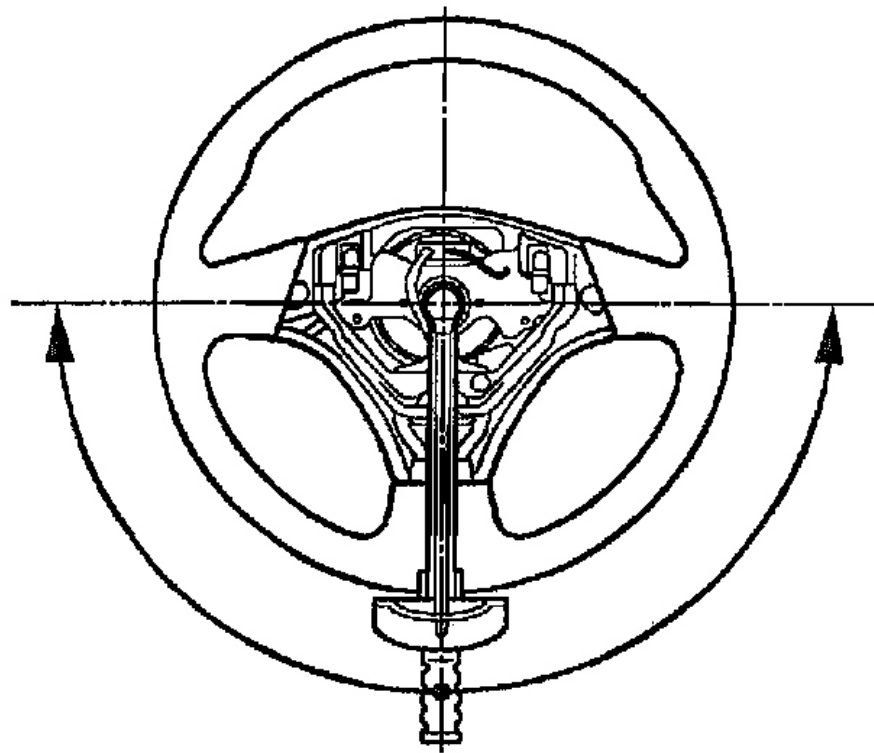


Fig. 13: Checking Steering Effort
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

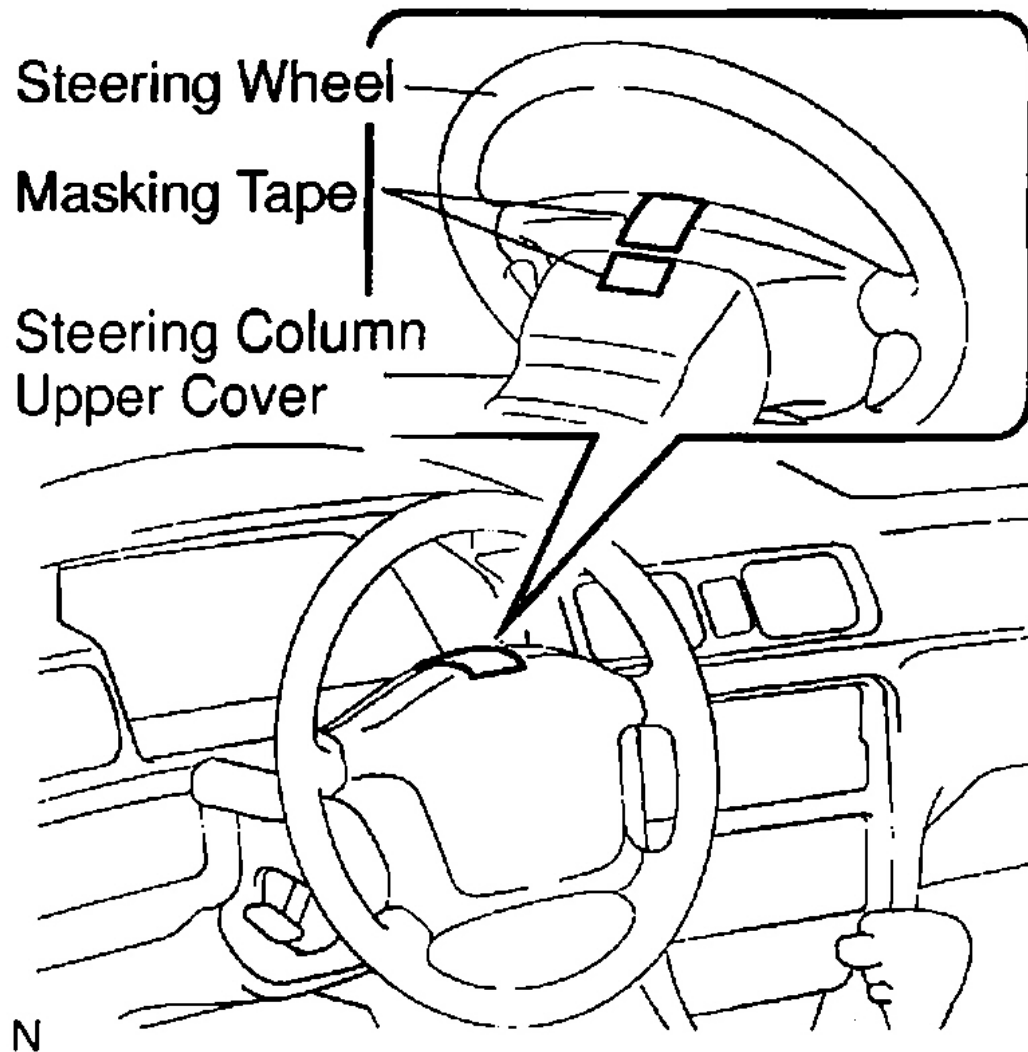
NOTE: Take the tire type, pressure and contact surface into consideration before making your diagnosis.

- e. Install the steering wheel set nut.
Torque: 50 N.m (500 kgf. cm, 35 ft. lbf)
- f. Install the steering wheel pad (See INSTALLATION).

REPAIR PROCEDURES

NOTE: This is the repair procedure for correcting steering off center.

1. **Inspect steering wheel off center .**
 - a. Apply masking tape on the top center of the steering wheel and steering column upper cover.

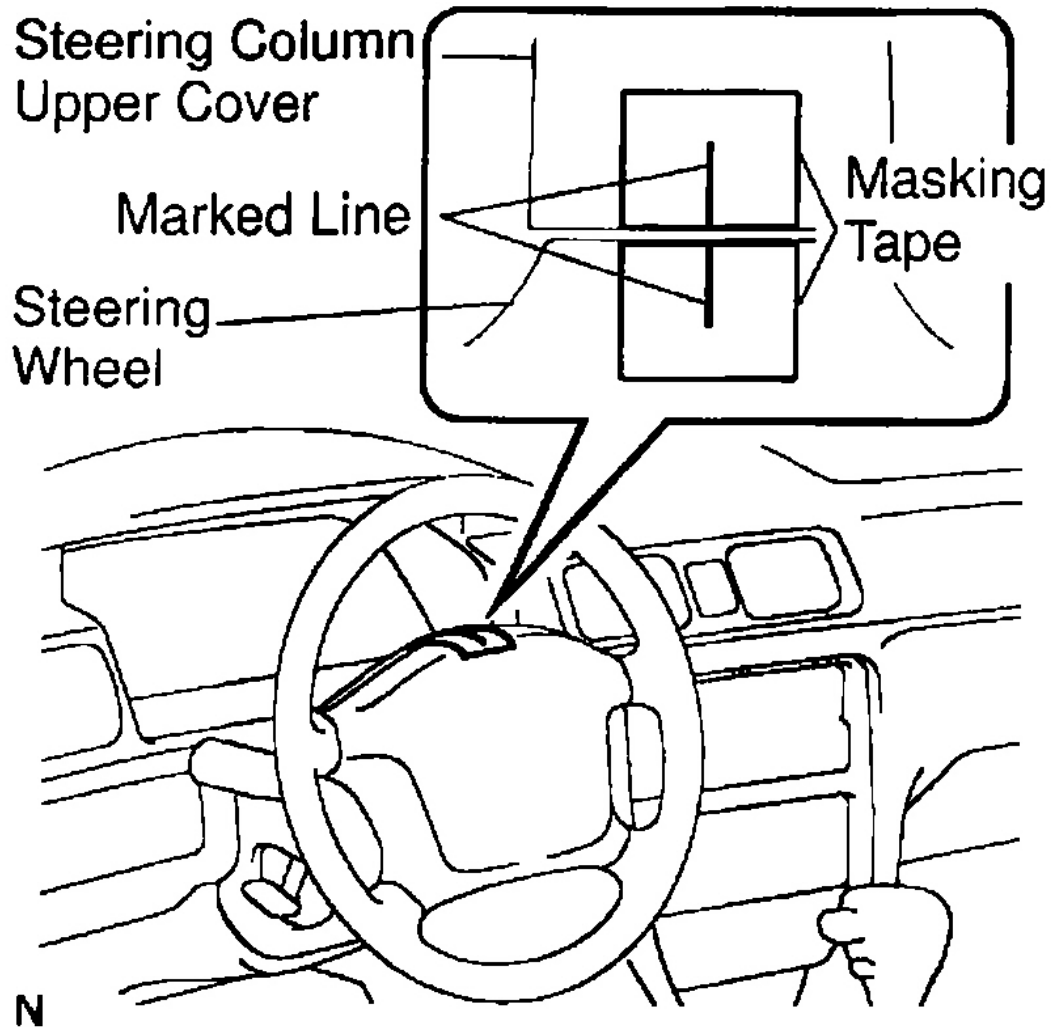


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Fig. 14: Applying Masking Tape

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Drive the vehicle in a straight line for 100 meters at a constant speed of 35 mph (56 km/h), and hold the steering wheel to maintain the course.



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Fig. 15: Drawing A Line On Masking Tape
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- c. Draw a line on the masking tape as shown.
- d. Turn the steering wheel to its straight position.

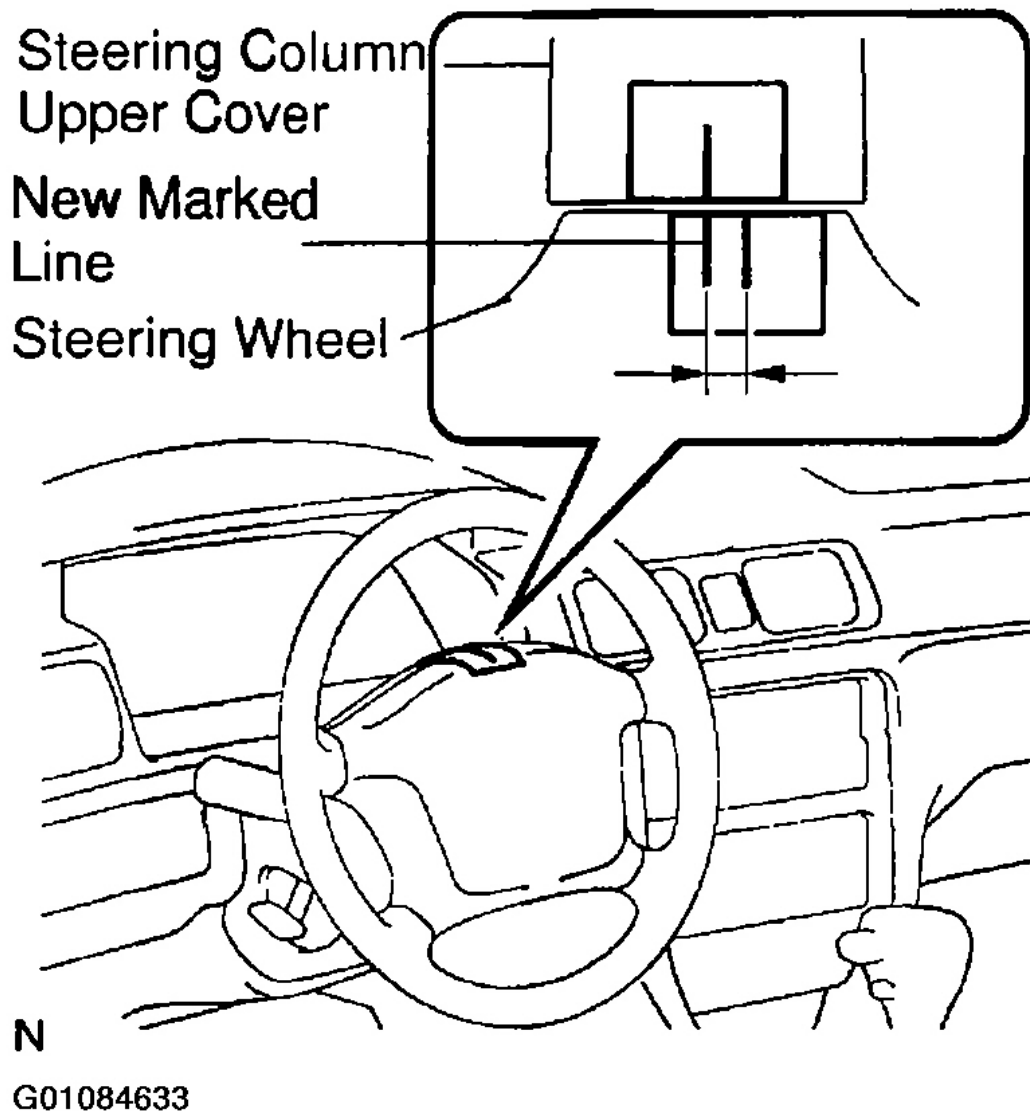


Fig. 16: Drawing Line In Masking Tape
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Refer to the upper surface of the steering wheel, steering spoke and SRS airbag line for the straight position.

- e. Draw a new line on the masking tape of the steering wheel as shown.
- f. Measure the distance between the 2 lines on the masking tape of the steering wheel.
- g. Convert the measured distance to steering angle.

Measured distance 1 mm (0.04 in.) = Steering angle approximately 1 deg.

NOTE: Make a note of the steering angle.

2. **Adjust steering angle .**

- a. Lift up the vehicle.

NOTE: The adjustment method for steering angle is different depending on the models. Check whether it is type A or B.

- b. Draw a line on the RH and LH tie rod and rack ends where it can easily be seen.
c. Using a paper gauge, measure the distance from RH and LH tie rod ends to the rack end screws.

NOTE:

- Measure the RH side and LH side.
- Make a note of the measured values.

- d. Remove the RH and LH boot clips from the rack boots.

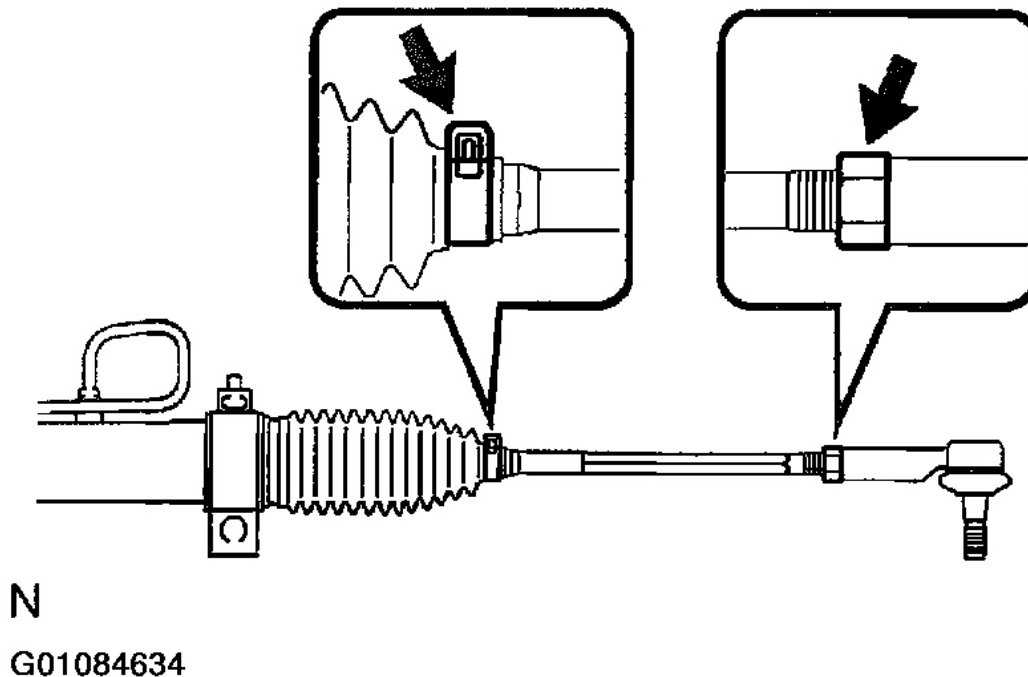


Fig. 17: Identifying RH & LH Boot Clips
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- e. Loosen the RH and LH lock nuts.
- f. Turn the RH and LH rack end by the same amount (but in different directions) according to the steering angle.
1 turn 360 deg. of rack end (1.5 mm (0.059 in.) horizontal movement) = 12 deg. of steering angle
- g. Tighten the RH and LH lock nuts by the specified torque.

NOTE: **Make sure that the difference in length between RH and LH tie rod ends and rack end screws are within 1.5 mm (0.059 in.).**

- h. Install the RH and LH boot clips.

POWER STEERING VANE PUMP

COMPONENTS

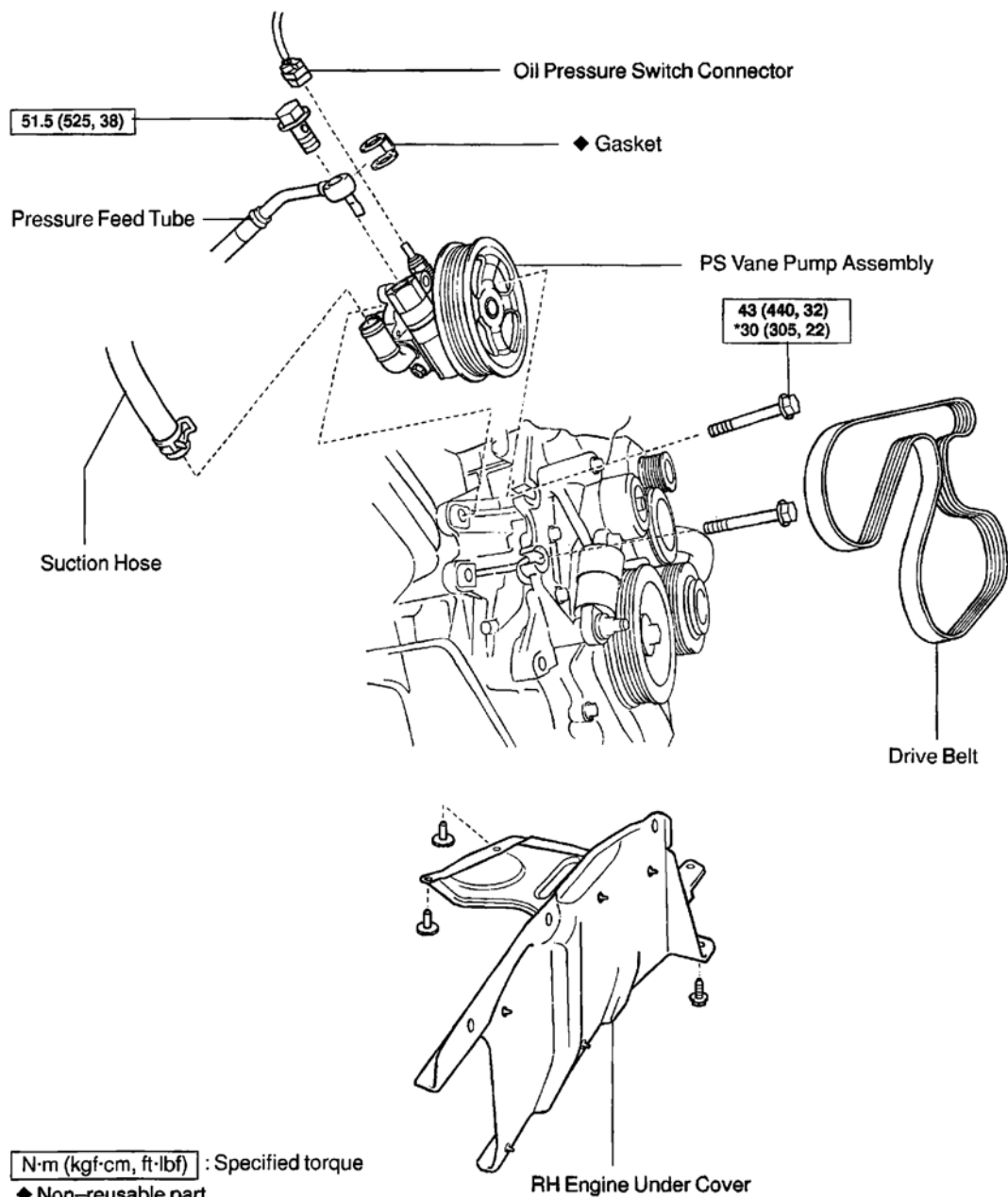
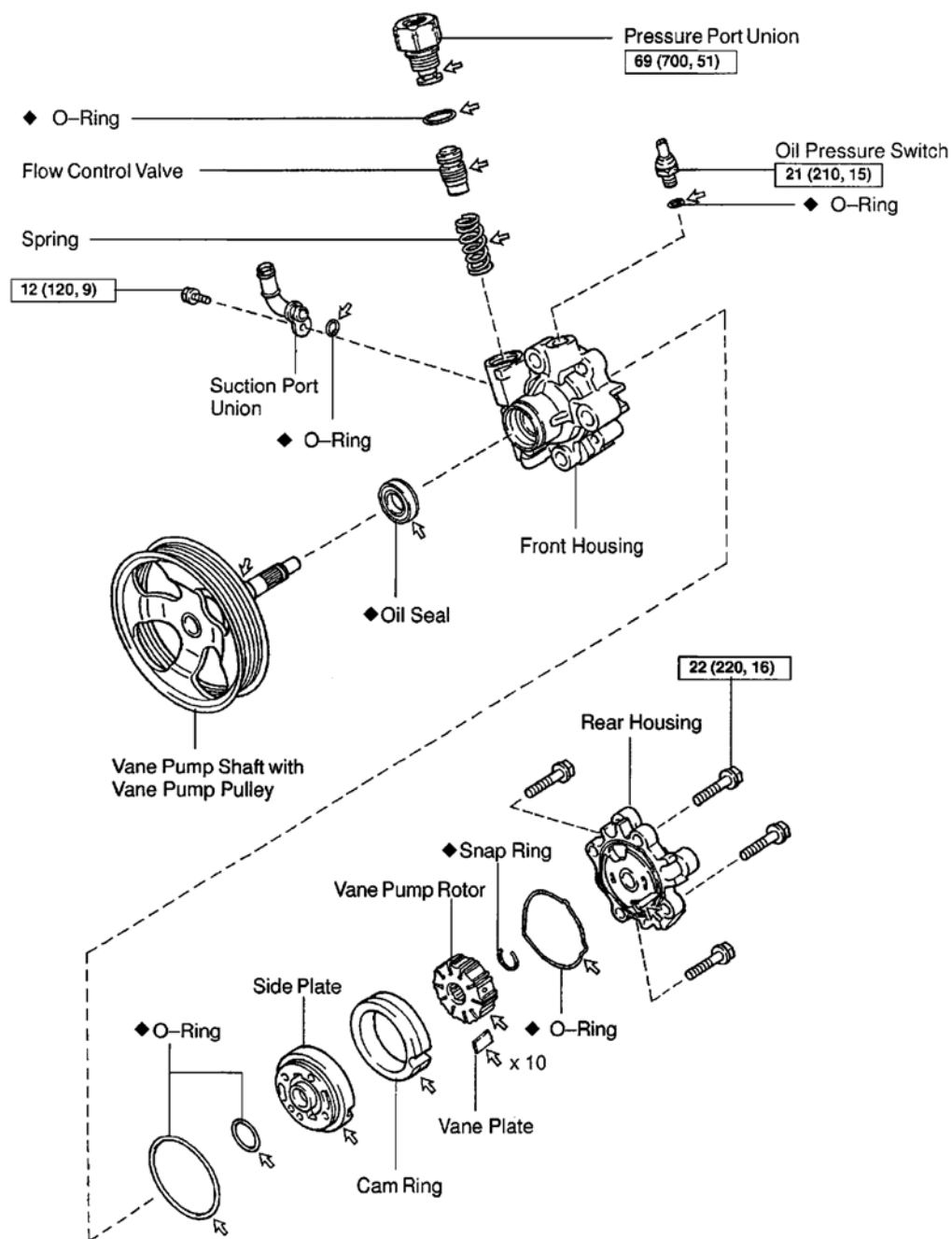


Fig. 18: Identifying Components For Power Steering Pump Removal
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

N ⇄ Power steering fluid

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Fig. 19: Exploded View Of Power Steering Vane Pump
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

REMOVAL

1. **Remove RH engine under cover .**
2. **Remove drive belt .**

Hook SST on the hexagonal portion of the drive belt tensioner bracket, compress the drive belt tension by turning the drive belt tensioner bracket clockwise, and remove the drive belt.

SST 09249-63010

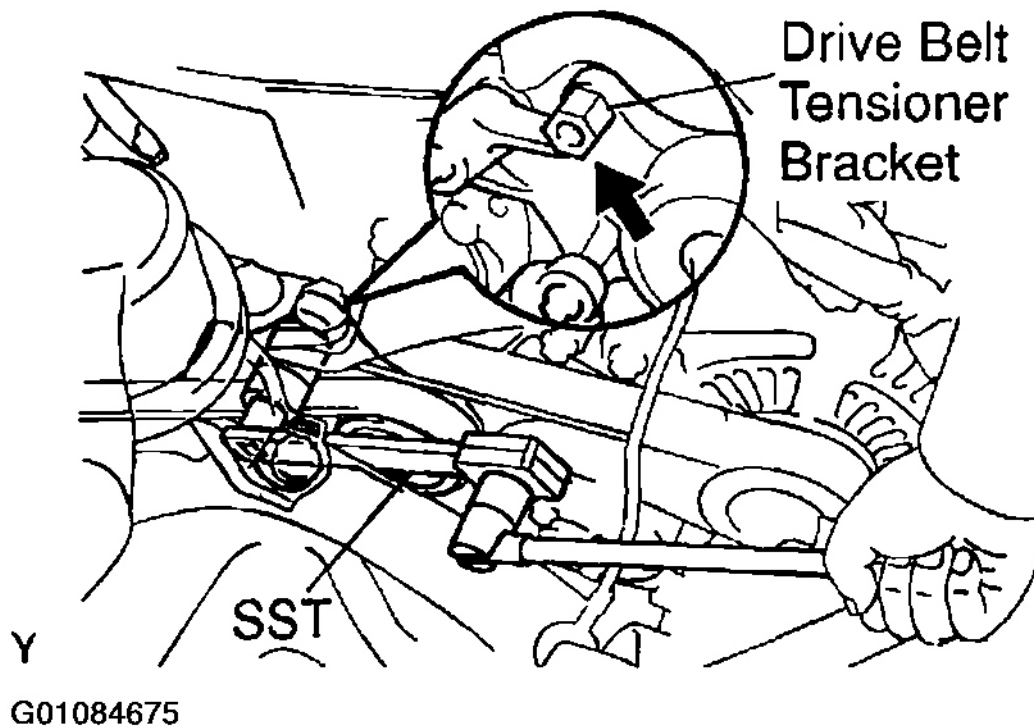


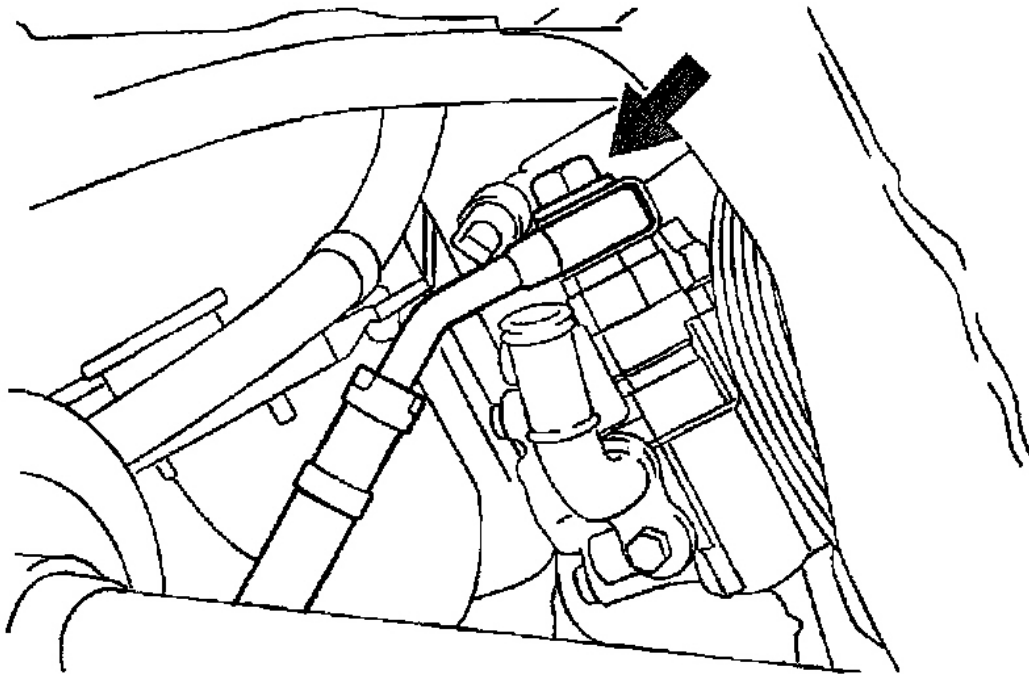
Fig. 20: Compressing Drive Belt Tensioner
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

3. **Disconnect suction hose .**

Loosen the clip and disconnect the suction hose.

NOTE: Take care not to spill fluid on the drive belt.

4. **Disconnect pressure feed tube .**



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Fig. 21: Disconnecting Pressure Feed Tube
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Remove the union bolt and gasket, and disconnect the pressure feed tube.

5. **Disconnect oil pressure switch connector .**
6. **Remove PS vane pump assembly .**
 - a. Using SST, loosen the bolt A sufficiently so that pump assembly can be removed.
SST 09249-63010

NOTE: Bolt A cannot be removed.

- b. Remove the bolt B and PS vane pump assembly.

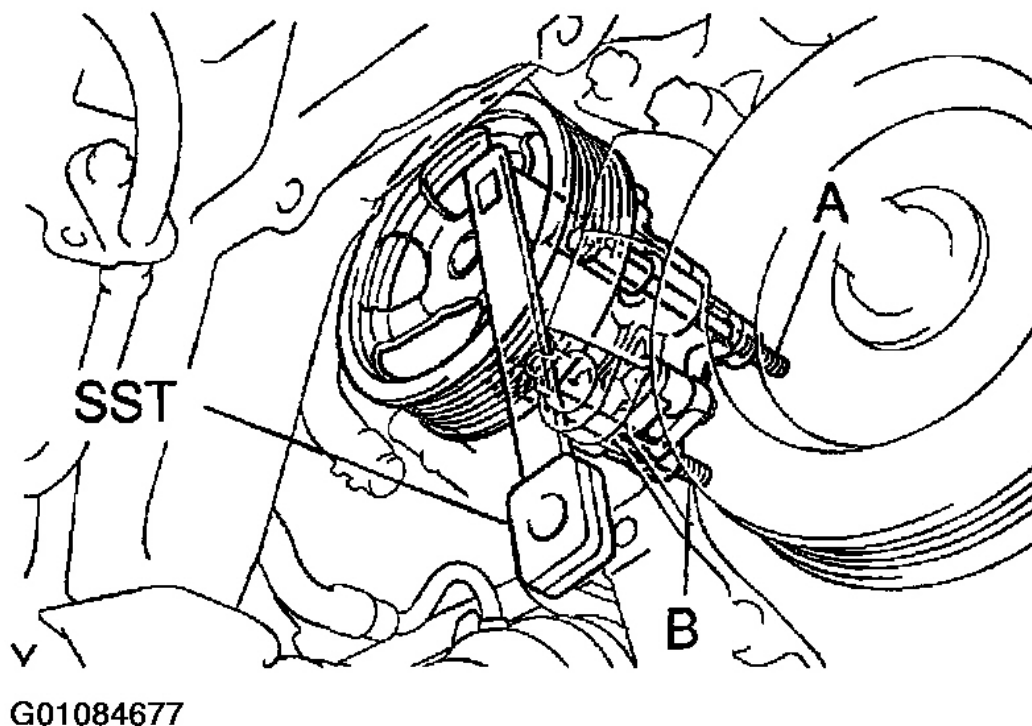


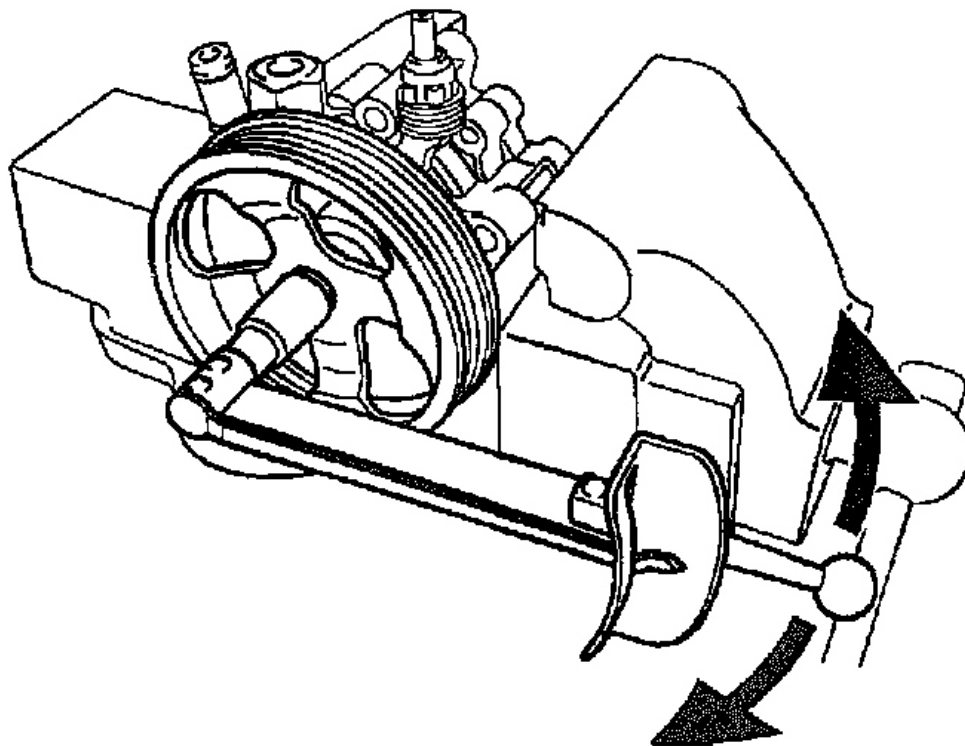
Fig. 22: Locating Bolt A & B
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

DISASSEMBLY

NOTE: When using a vise, do not overtighten it.

1. **Measure PS vane pump rotating torque .**
 - a. Check that the pump rotates smoothly without abnormal noise.
 - b. Using a torque wrench, check the pump rotating torque.

Rotating torque: 0.27 N.m (2.8 kgf. cm, 2.4 in. lbf) or less



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Fig. 23: Checking Pump Rotating Torque
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

2. **Remove suction port union .**
 - a. Remove the bolt and suction port union.
 - b. Remove the O-ring from the suction port union.
3. **Remove pressure port union, flow control valve and spring .**
 - a. Remove the pressure port union, flow control valve and spring.
 - b. Remove the O-ring from the pressure port union.
4. **Remove oil pressure switch .**

NOTE: **Be careful not to drop the oil pressure switch.**

If the oil pressure switch is dropped or strongly damaged, replace it with a new one.

5. **Remove rear housing .**

- a. Remove the 4 bolts and rear housing.
- b. Remove the O-ring from the rear housing.
6. **Remove cam ring, 10 vane plates, vane pump rotor and side plate .**
 - a. Remove the cam ring and 10 vane plates.

NOTE: Take care not to drop the vane plate.

- b. Using a screwdriver, remove the snap ring, vane pump rotor and side plate.
- c. Remove the 2 O-rings from the side plate.
7. **Remove vane pump shaft with vane pump pulley .**

INSPECTION

1. **Measure oil clearance between vane pump shaft and bushing .**

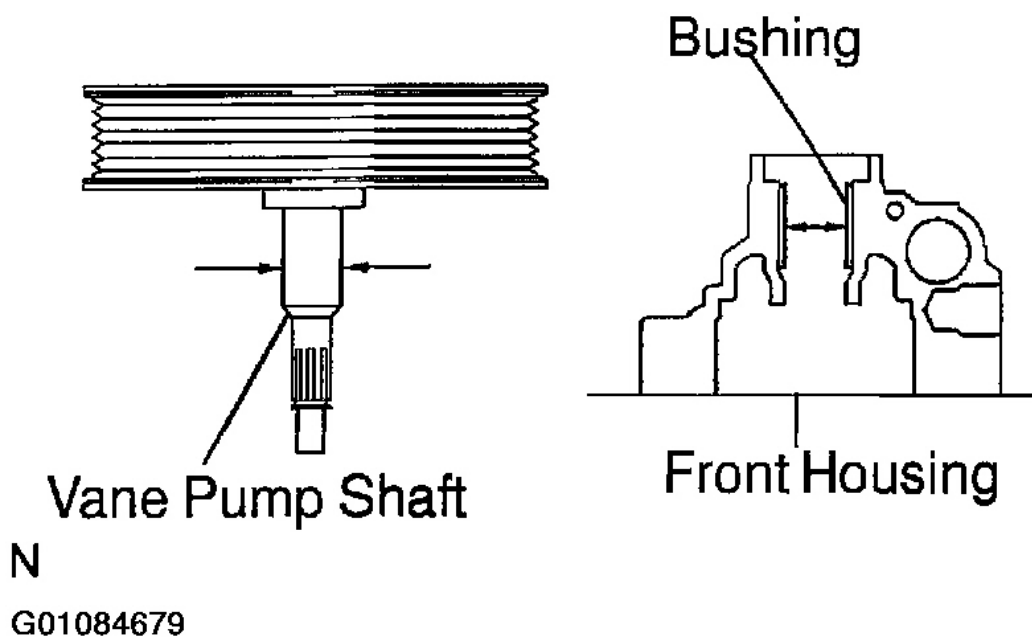


Fig. 24: Identifying Vane Pump Shaft & Bushing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Using a micrometer and a caliper gauge, measure the oil clearance.

Standard clearance: 0.021 - 0.043 mm (0.0008 - 0.0017 in.)

Maximum clearance: 0.07 mm (0.0028 in.)

If it is more than the maximum, replace the front housing and vane pump shaft.

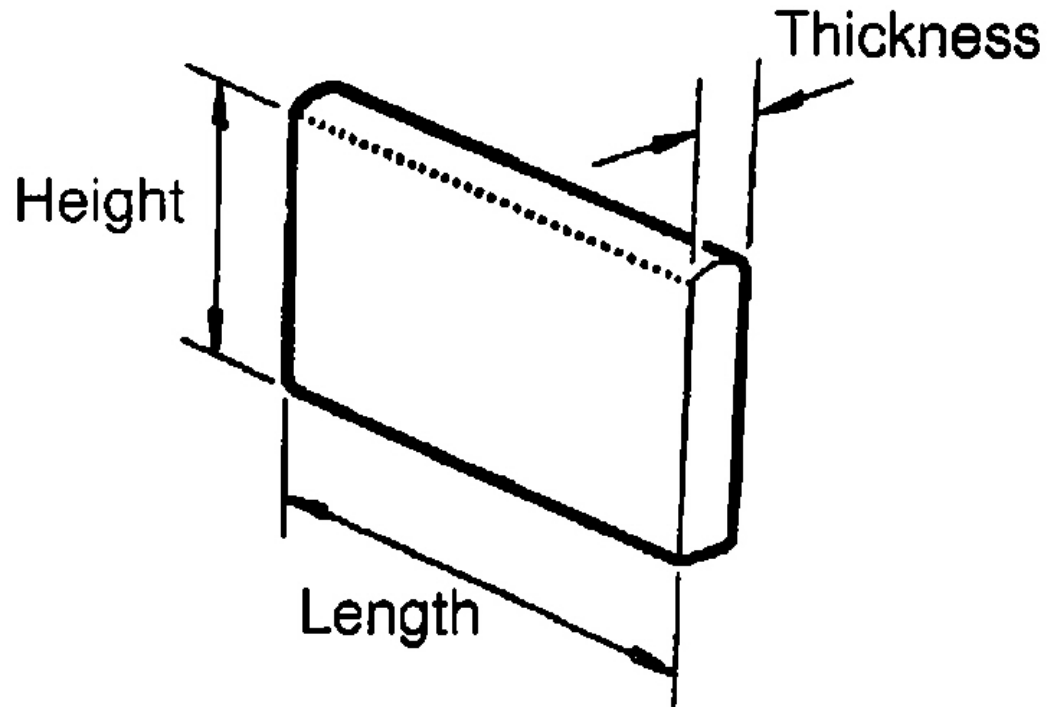
2. **Inspect vane pump rotor and vane plates .**

- a. Using a micrometer, measure the height, thickness and length of the 10 vane plates.

Minimum height: 7.6 mm (0.299 in.)

Minimum thickness: 1.405 mm (0.0553 in.)

Minimum length: 11.993 mm (0.4722 in.)



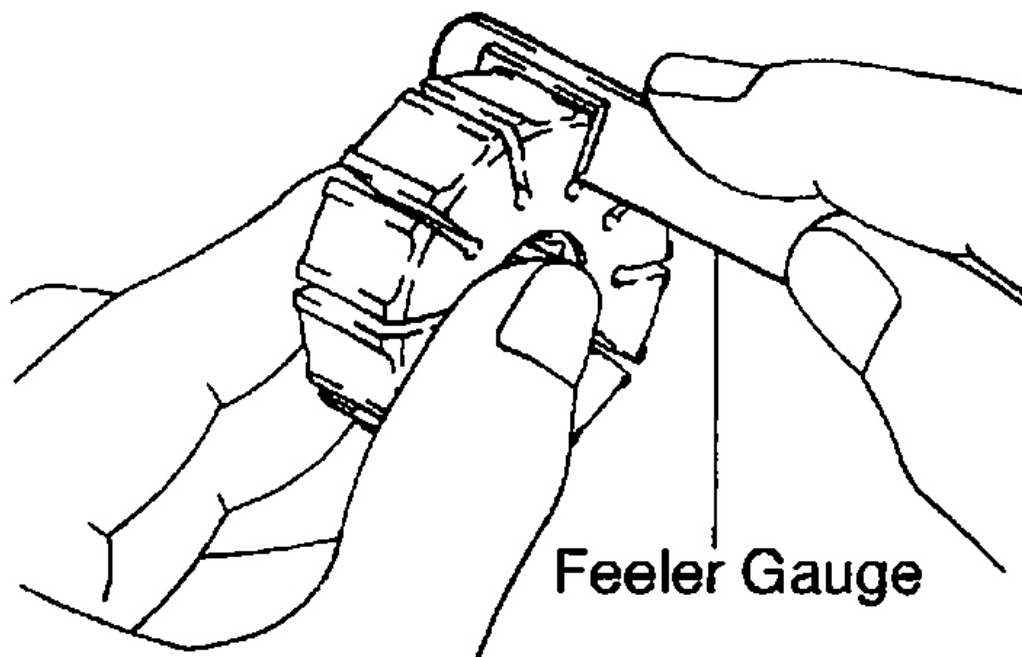
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Fig. 25: Measuring Vane Plates

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Using a feeler gauge, measure the clearance between the vane pump rotor groove and vane plate.

Maximum clearance: 0.025 mm (0.0010 in.)



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Fig. 26: Measuring Vane Pump Rotor Groove Clearance
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

If it is more than the maximum, replace the vane plate and/or vane pump rotor with the one having the same mark stamped on the cam ring.

Inscribed mark: 0, 1, 2, 3, or 4

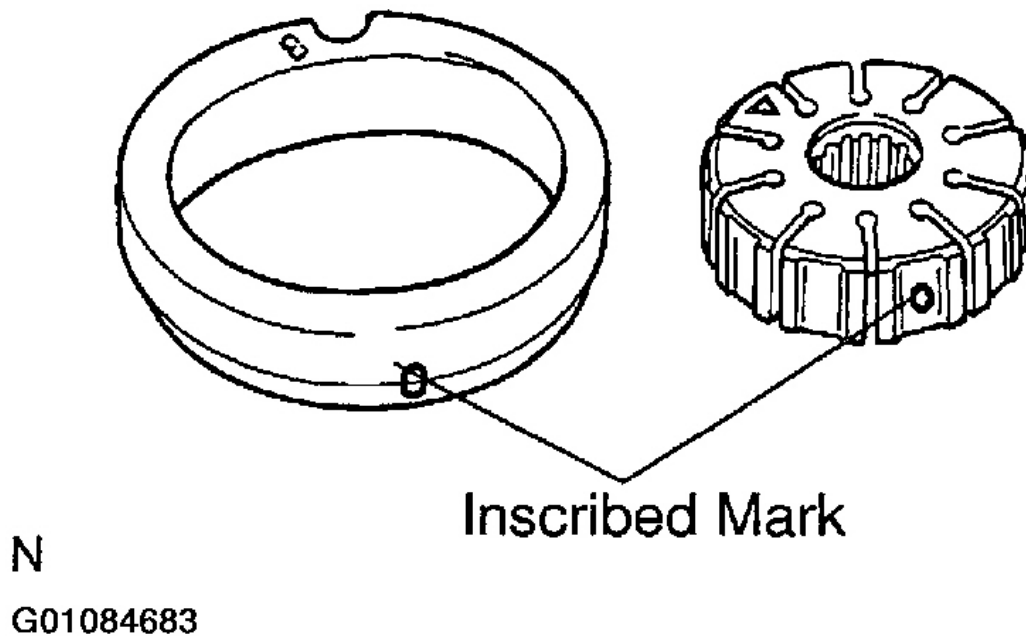


Fig. 27: Identifying Inscribed Marks

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: There are 5 vane plate lengths corresponding to the following vane pump rotor and cam ring marks:

Vane pump rotor and cam ring mark	Vane plate part number	Vane plate length mm (in.)
0	44345 – 32100	12.001 – 12.003 (0.47248 – 0.47256)
1	44345 – 32110	11.999 – 12.001 (0.47240 – 0.47248)
2	44345 – 32120	11.997 – 11.999 (0.47232 – 0.47240)
3	44345 – 32130	11.995 – 11.997 (0.47224 – 0.47232)
4	44345 – 32140	11.993 – 11.995 (0.47216 – 0.47224)

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Fig. 28: Displaying Plate Length Corresponding Specification
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

3. Inspect flow control valve .

- a. Coat the flow control valve with power steering fluid and check that it falls smoothly into the valve hole of the front housing by its own weight.

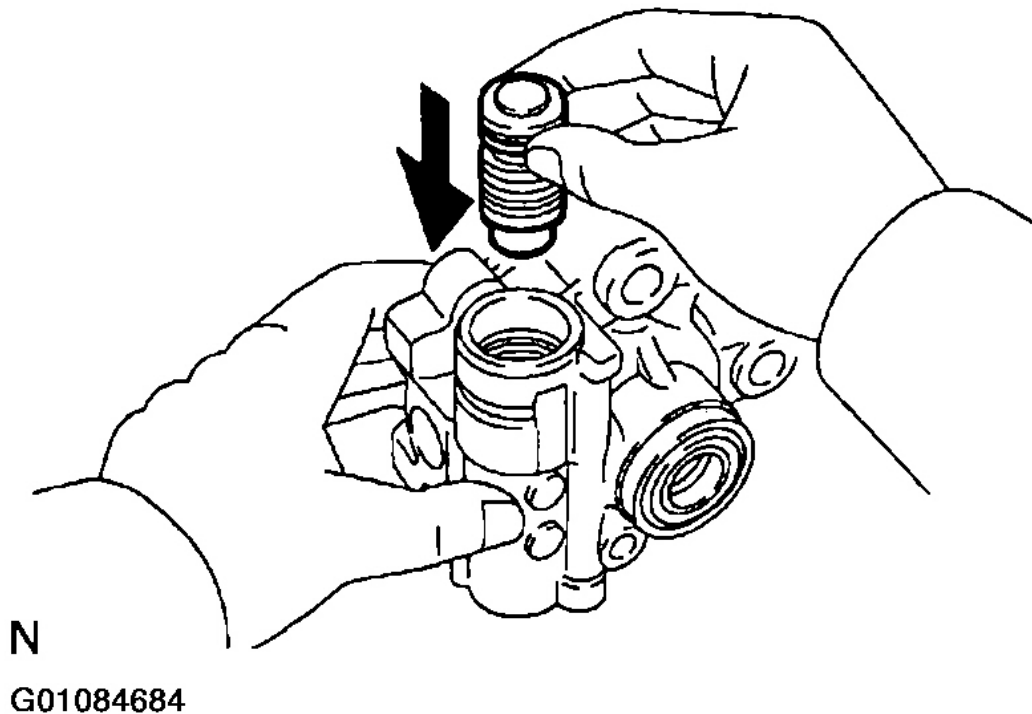
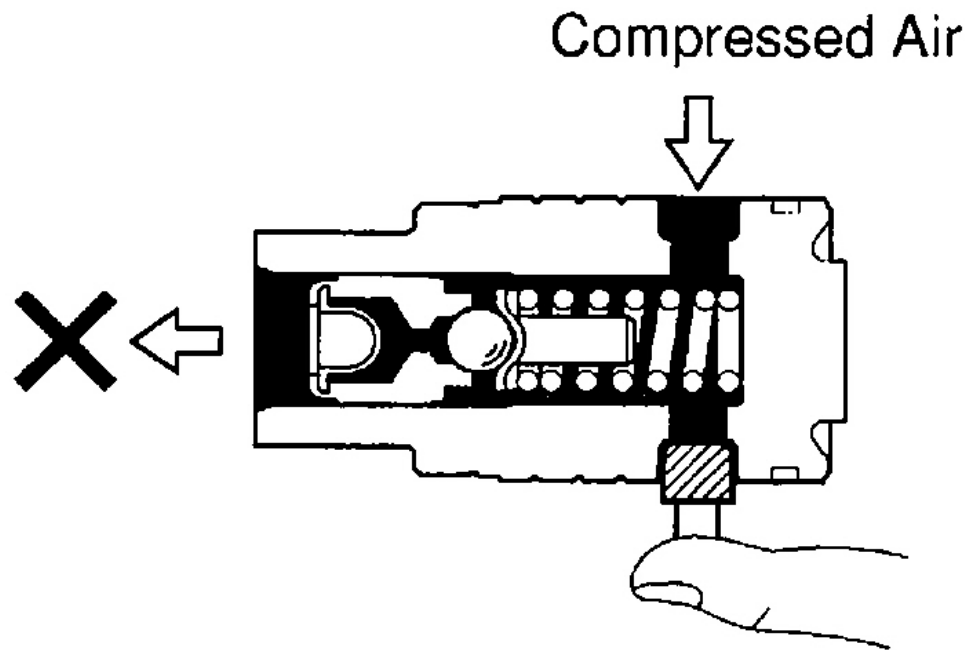


Fig. 29: Installing Flow Control Valve Into Pump Housing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Check the flow control valve for leakage. Close one of the holes and apply compressed air of 392 - 490 kPa (4 - 5 kgf/cm² , 57 - 71 psi) into the opposite side hole, and confirm that air does not come out from the end hole.



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Fig. 30: Checking Flow Control Valve For Leakage
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

If necessary, replace the flow control valve with the one having the same letter as inscribed on the front housing.

Inscribed mark: A, B, C, D, E or F

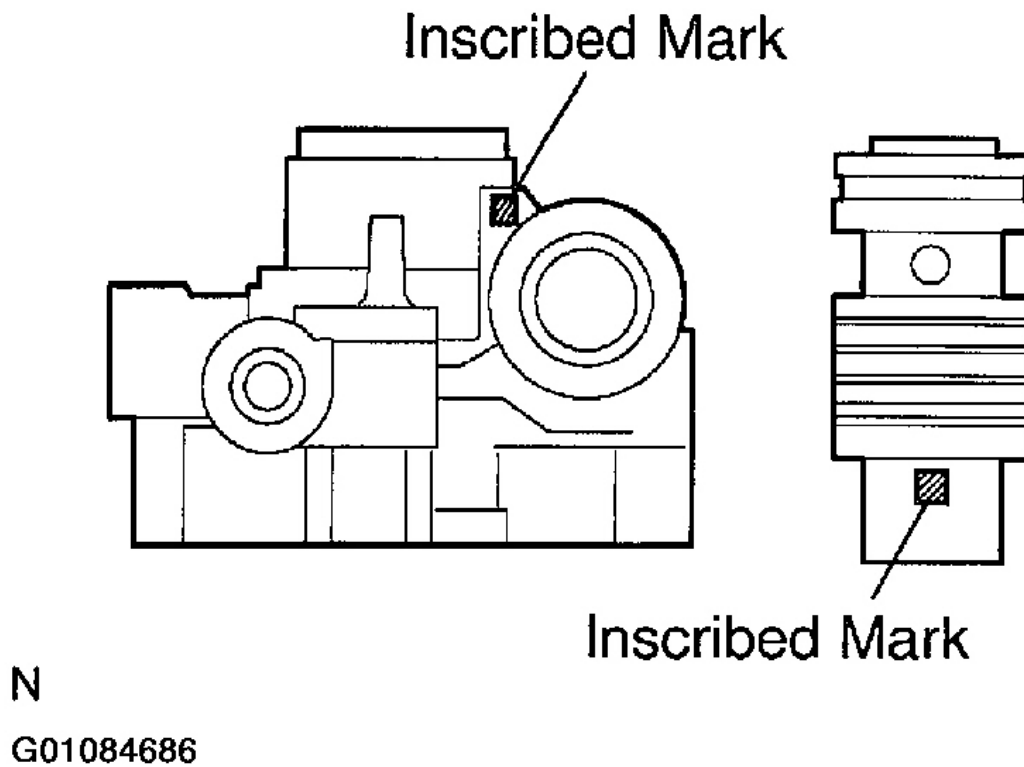


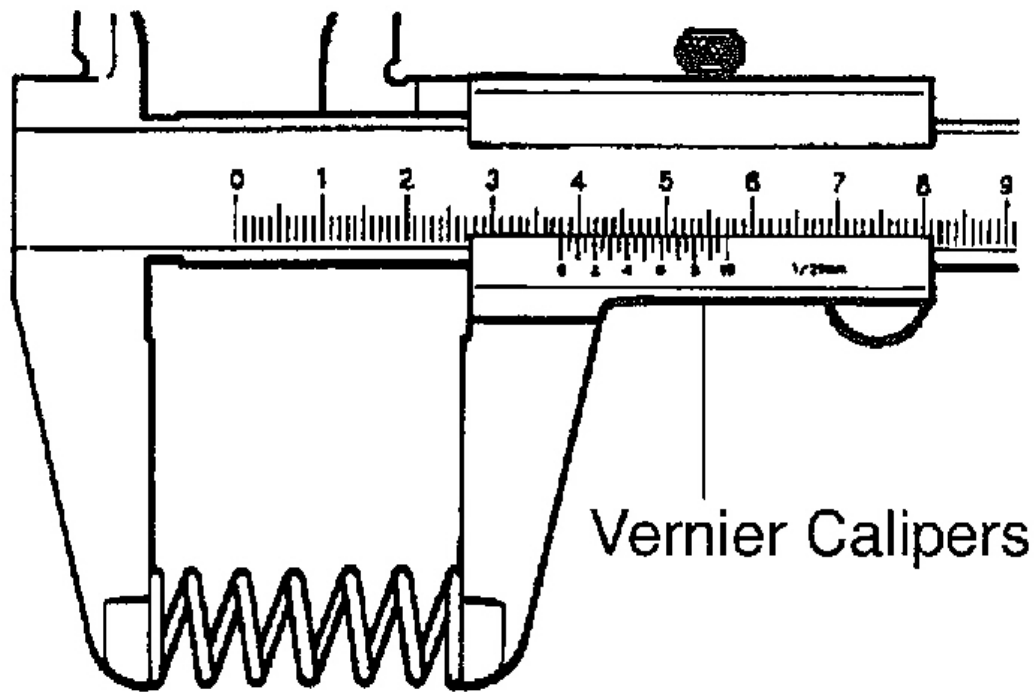
Fig. 31: Identifying Front Control Valve Letter
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

4. Inspect spring .

Using vernier calipers, measure the free length of the spring.

Minimum free length: 36.9 mm (1.453 in.)

If it is not within the specification, replace the spring.



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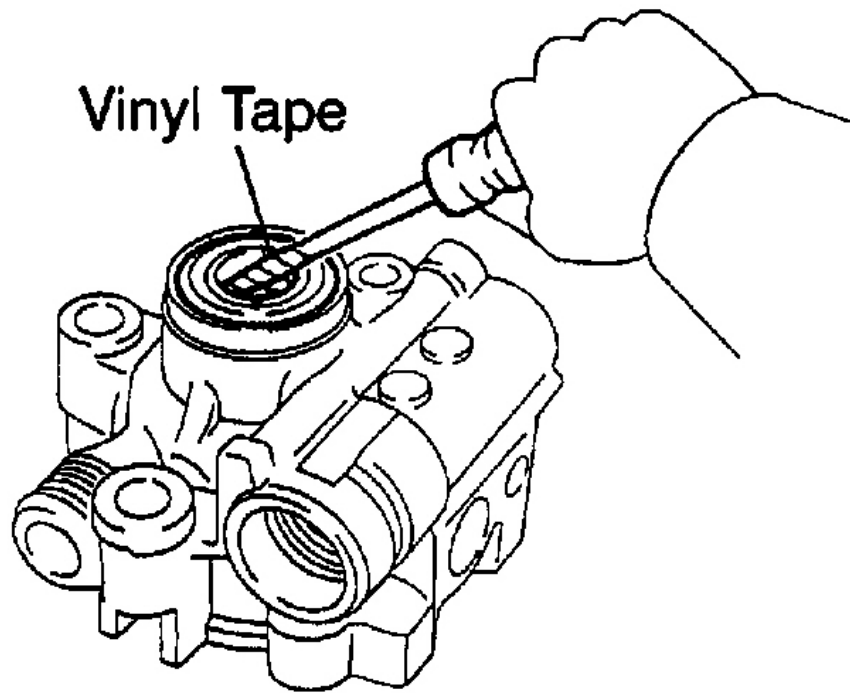
Fig. 32: Measuring Spring Free Length
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

REPLACEMENT

NOTE: When using a vise, do not overtighten it.

Replace Front Housing Oil Seal

- a. Using a screwdriver with vinyl tape wound around its tip, remove the oil seal.



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Fig. 33: Removing Oil Seal

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Be careful not to damage the bushing of the front housing.

- b. Coat a new oil seal lip with power steering fluid.
- c. Using SST, press in the oil seal.

SST 09950-60010 (09951-00280), 09950-70010 (09951-07100)

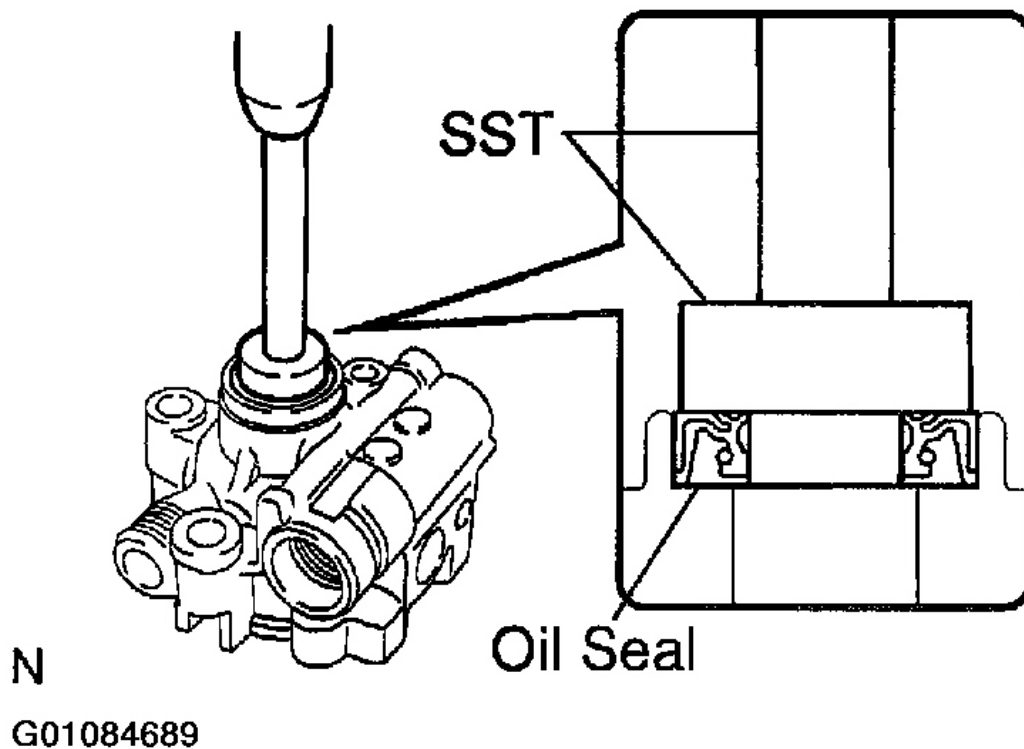


Fig. 34: Pressing In Oil Seal

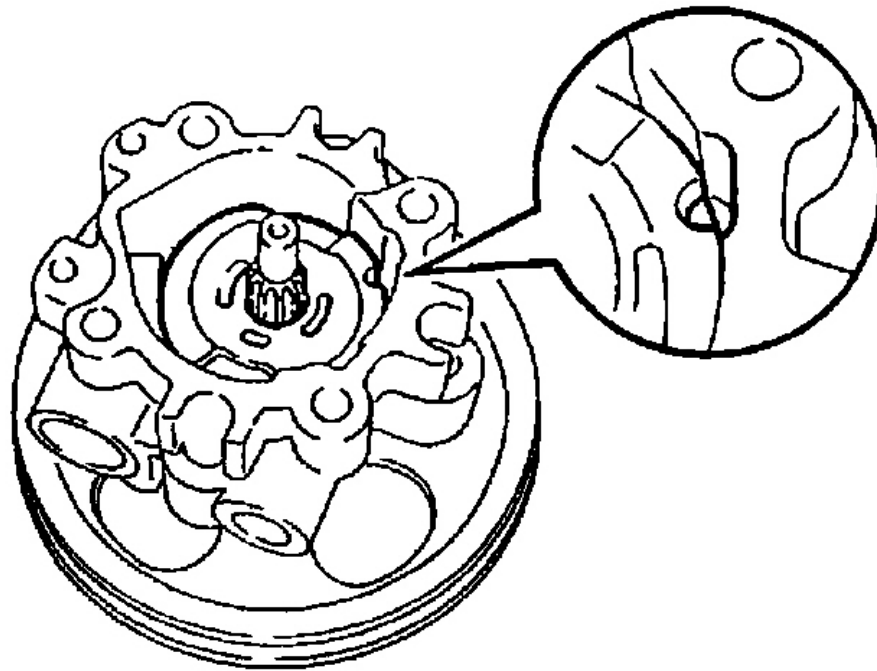
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Make sure that the oil seal is installed facing in the correct direction.

REASSEMBLY

NOTE: When using a vise, do not overtighten it.

1. Coat parts indicated by arrows with power steering fluid (See COMPONENTS) .
2. Install vane pump shaft with vane pump pulley .
3. Install side plate .
 - a. Coat 2 new O-rings with power steering fluid, and install them to the side plate.
 - b. Align the dent of the side plate with the dent of the front housing, and install the side plate.



N

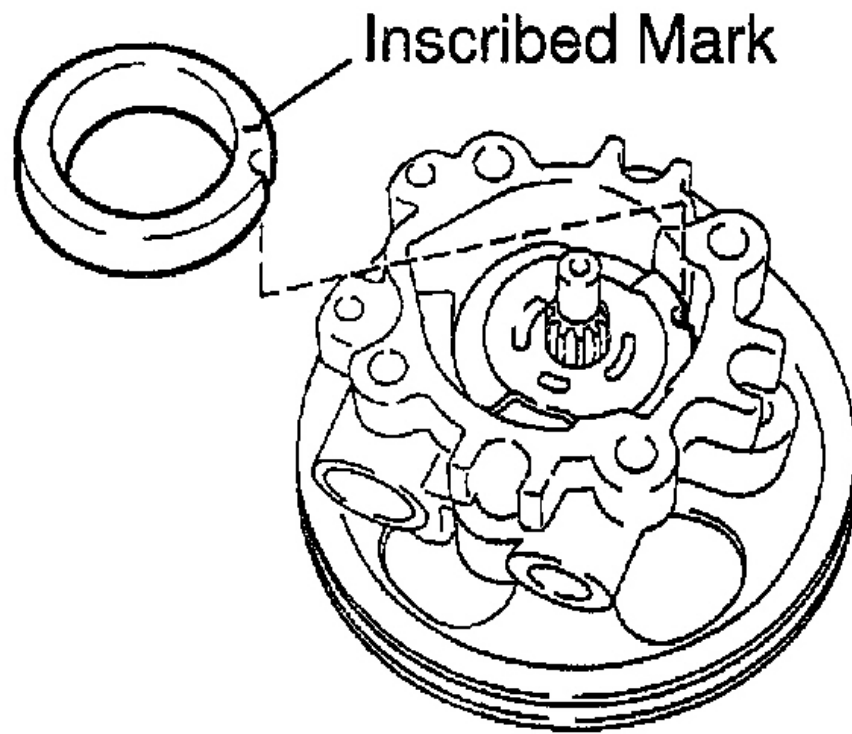
G01084690

Fig. 35: Aligning Side Plate With Front Housing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Make sure that the side plate is installed facing in the correct direction.

4. Install cam ring .

Align the dent of the cam ring with the dent of the side plate, and install the cam ring with the inscribed mark facing outward.



N

G01084691

Fig. 36: Locating Inscribed Mark For Installation
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

5. **Install vane pump rotor .**
 - a. Install the vane pump rotor with the inscribed mark facing outward.
 - b. Install a new snap ring to the vane pump shaft.
6. **Install vane plates .**

Install the 10 vane plates with the round end facing outward.

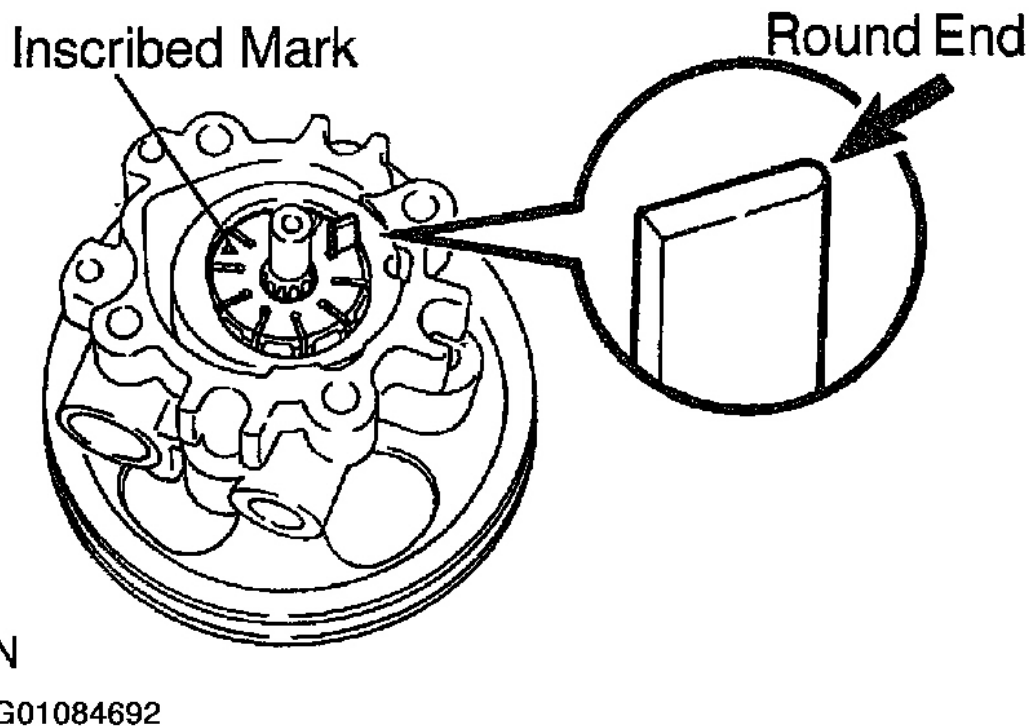


Fig. 37: Installing Vane Plate Correctly
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

7. Install rear housing .

- a. Coat a new O-ring with power steering fluid, and install it to the rear housing.
- b. Align the straight pin of the rear housing with the dents of the cam ring, side plate and front housing, and install the rear housing with the 4 bolts.

Torque: 22 N.m (220 kgf. cm, 16 ft. lbf)

8. Install oil pressure switch .

Torque: 21 N.m (210 kgf. cm, 15 ft. lbf)

9. Install spring, flow control valve and pressure port union .

- a. Install the spring.
- b. Install the flow control valve facing in the correct direction (See **COMPONENTS**).
- c. Coat a new O-ring with power steering fluid, and install it to the pressure port union.
- d. Install the pressure port union.

Torque: 69 N.m (700 kgf. cm, 51 ft. lbf)

10. Install suction port union .

- a. Coat a new O-ring with power steering fluid, and install it to the suction port union.

b. Install the suction port union with the bolt.

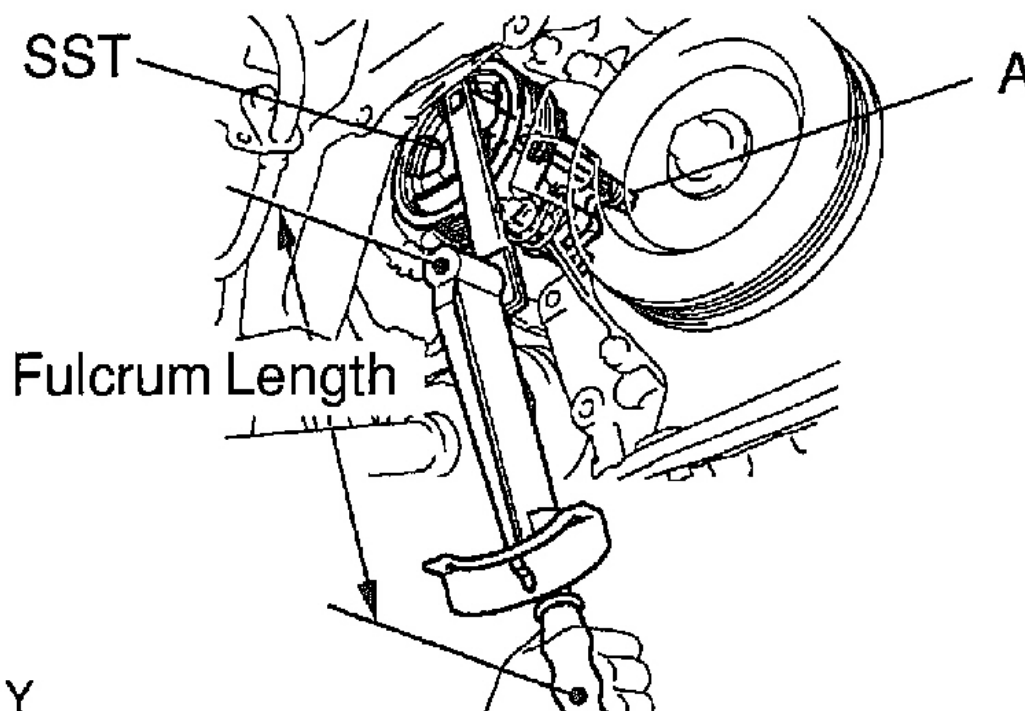
Torque: 12 N.m (120 kgf. cm, 9 ft. lbf)

11. **Measure PS vane pump rotating torque (See DISASSEMBLY) .**

INSTALLATION

1. **Install PS vane pump assembly .**

a. Insert the mounting bolt A to the PS vane pump assembly.



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Fig. 38: Installing PS Vane Pump Assembly

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

b. Set the PS vane pump assembly in installation position.

c. Using SST, install and torque the PS vane pump assembly mounting bolts.

SST 09248-63010

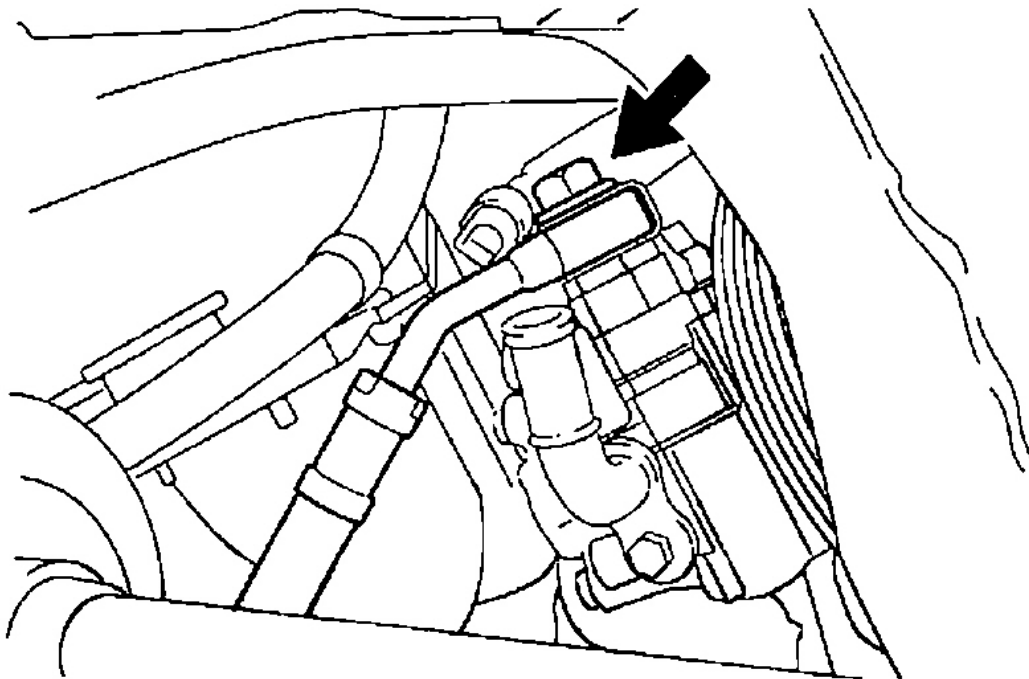
NOTE: Use a torque wrench with a fulcrum length of 345 mm (13.58 in.).

Torque: 30 N.m (305 kgf. cm, 22 ft. lbf)

2. **Connect oil pressure switch connector .**

NOTE: Be careful to prevent oil from being attached to the connector.

3. **Connect pressure feed tube .**



G01084694

Fig. 39: Locating Pressure Feed Tube Bolt
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Connect the pressure feed tube with the union bolt and new gasket.

Torque: 51.5 N.m (525 kgf. cm, 38 ft. lbf)

4. **Connect suction hose .**

Connect the suction hose with the clip.

5. **Install drive belt .**

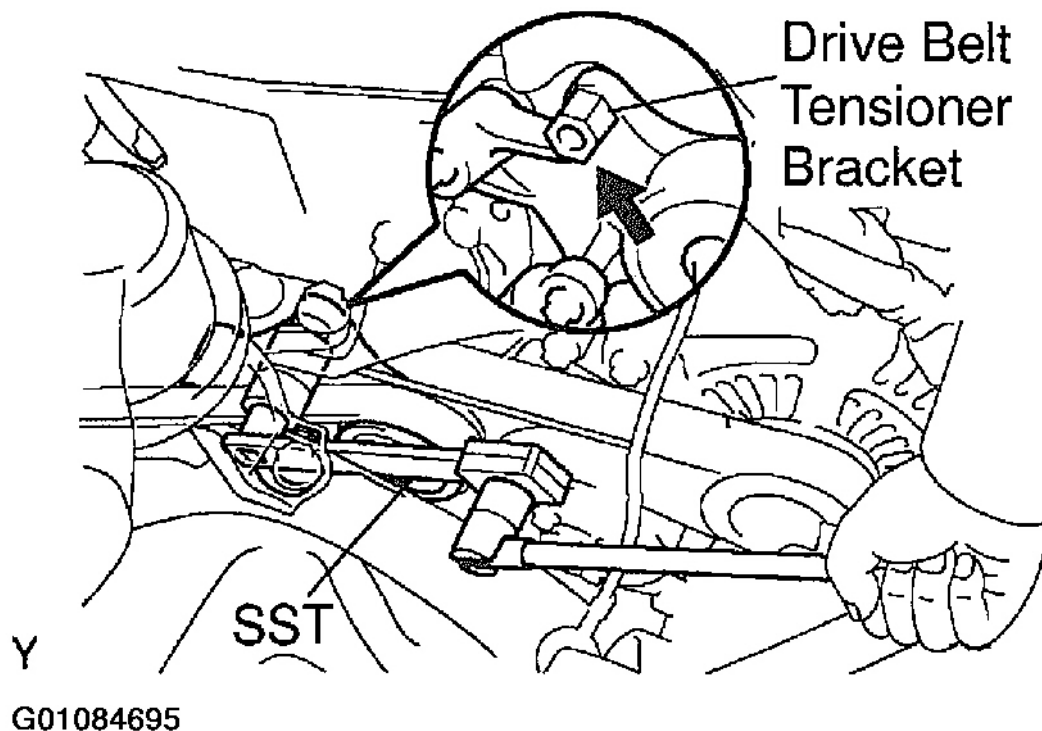


Fig. 40: Locating Drive Tensioner Bracket
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Hook SST on the hexagonal portion of the drive belt tensioner bracket and slowly compress the drive belt tension by turning the drive belt tensioner bracket clockwise, and install the drive belt.

SST 09249-63010

NOTE: Compress the drive belt tensioner by taking 3 seconds or more and installing the drive belt.

6. Install RH engine under cover .
7. Bleed power steering system (See BLEEDING) .

POWER STEERING GEAR

COMPONENTS

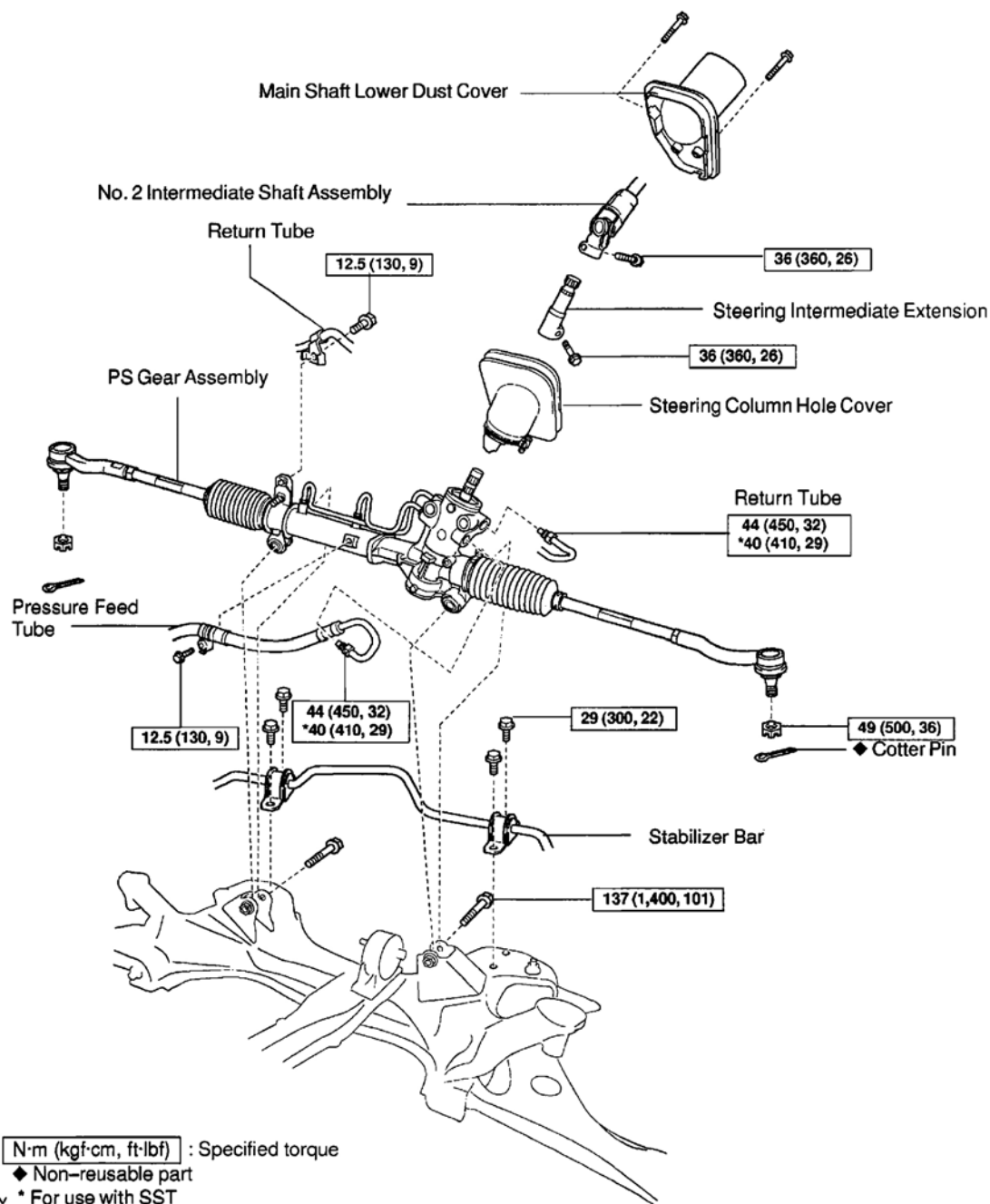
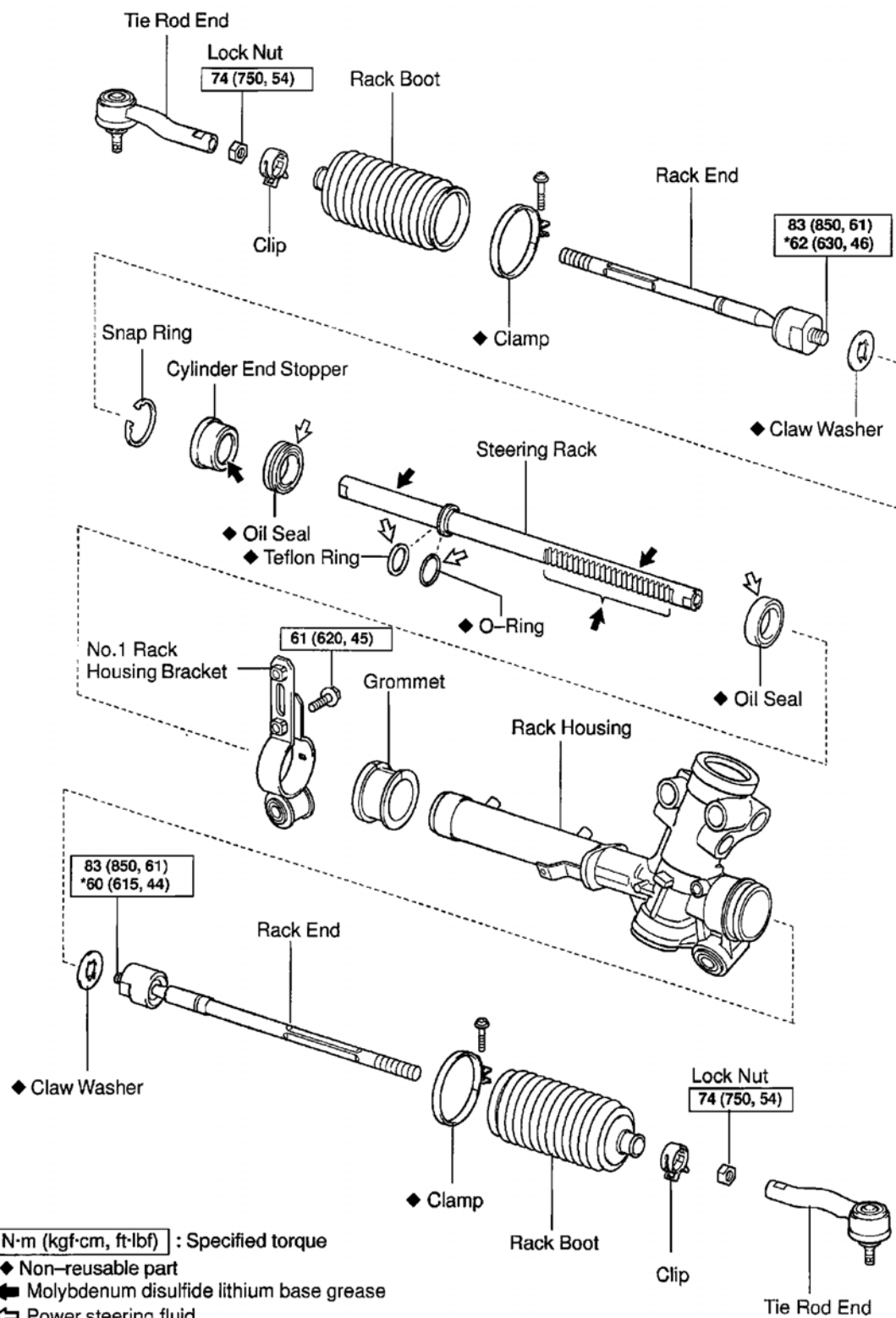


Fig. 41: Identifying Components For Power Steering Gear Removal
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



N·m (kgf·cm, ft·lbf) : Specified torque

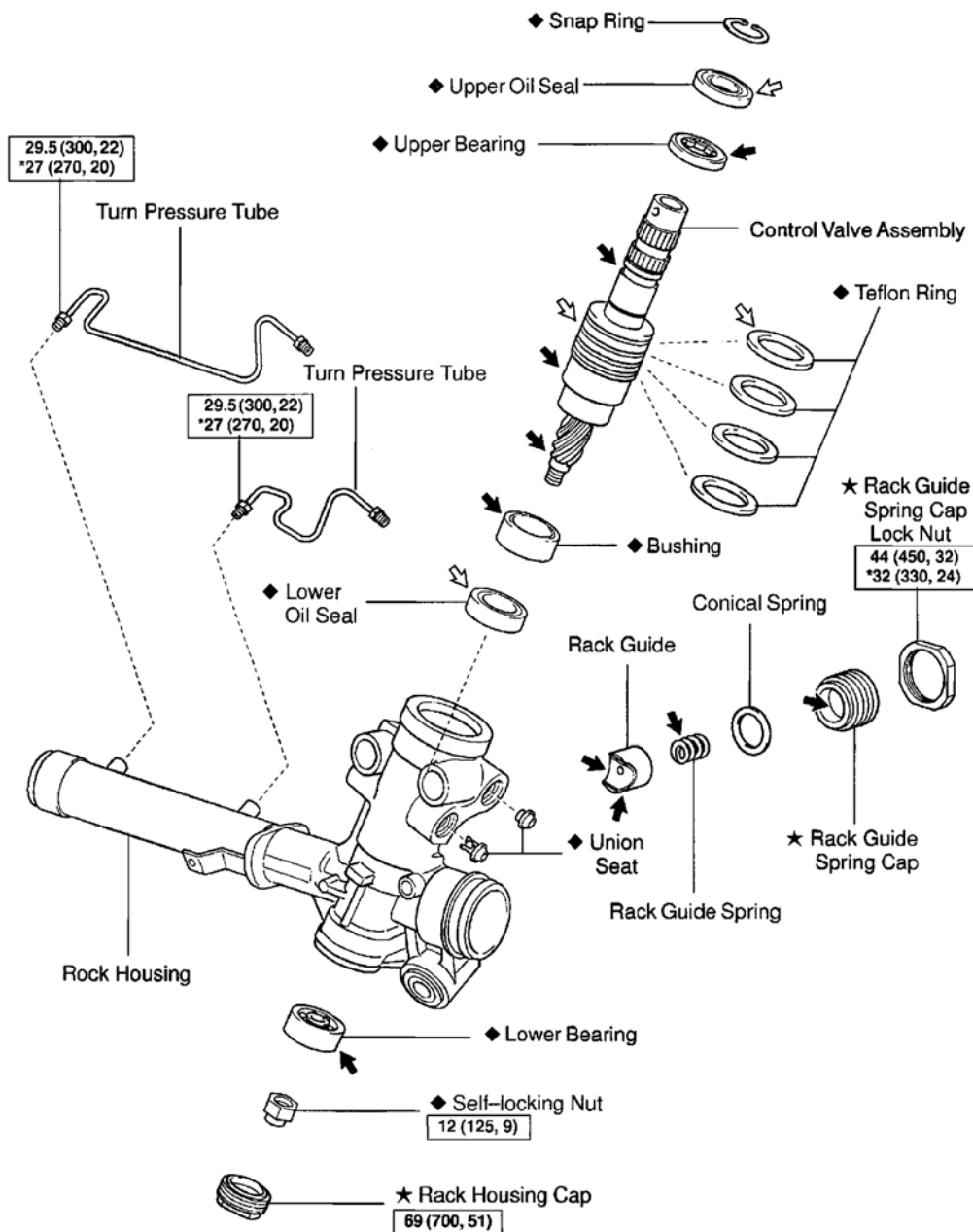
◆ Non-reusable part

➡ Molybdenum disulfide lithium base grease

➡ Power steering fluid

* For use with SST

Fig. 42: Exploded View Of Power Steering Gear (1 Of 2)
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.



N·m (kgf·cm, ft·lbf) : Specified torque
 ◆ Non-reusable part
 ★ Precoated part
 ◀ Molybdenum disulfide lithium base grease
 ⇨ Power steering fluid
 γ * For use with SST

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Fig. 43: Exploded View Of Power Steering Gear (2 Of 2)

REMOVAL

NOTE: Remove the steering wheel assembly before the steering gear removal, because there is possibility of breaking of the spiral cable.

1. Place front wheels facing straight ahead .
2. Remove steering wheel pad (See REMOVAL) .
3. Remove steering wheel (See REMOVAL) .
4. Disconnect No. 2 intermediate shaft assembly (See REMOVAL) .
5. Disconnect steering column hole cover .
 - a. Loosen the clamp of the steering column hole cover.
 - b. Disconnect the steering column hole cover from the dash panel.
6. Disconnect RH and LH tie rod ends (See FRONT AXLE HUB & WHEEL BEARING) .
7. Disconnect stabilizer bar .

Remove the 4 bolts and disconnect the stabilizer bar.

NOTE: Do not remove the stabilizer bar.

8. Disconnect pressure feed and return tubes .
 - a. Using SST, disconnect the pressure feed and return tubes from the PS gear.
SST 09023-12700

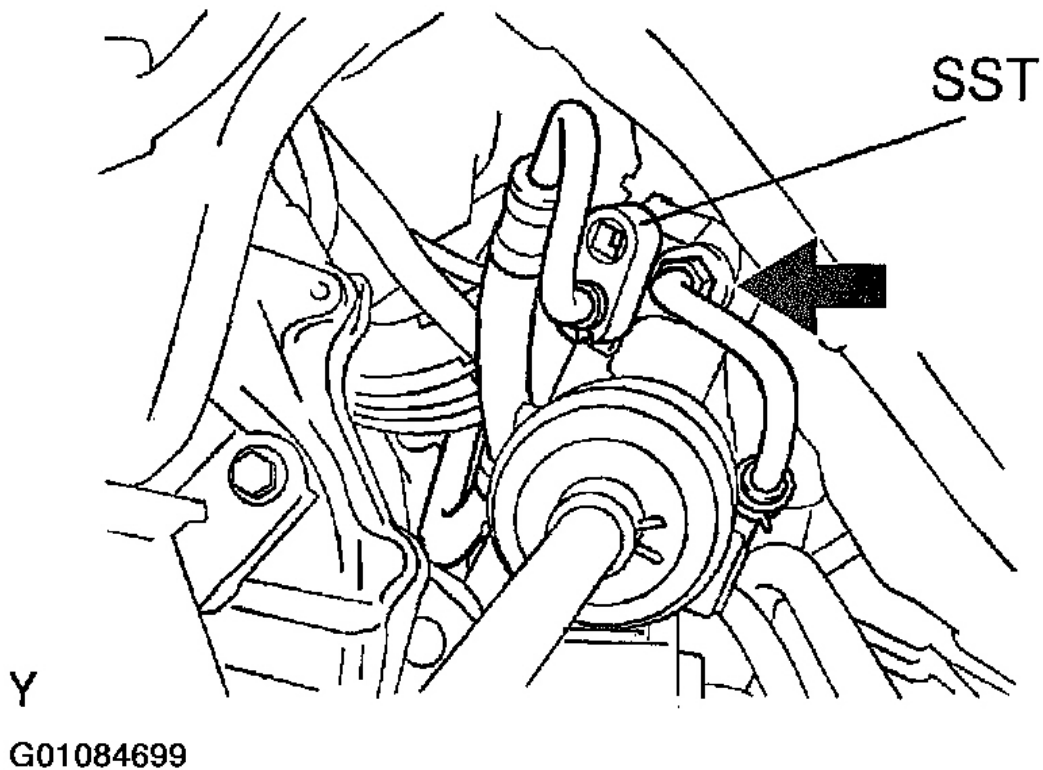


Fig. 44: Disconnecting Pressure Feed & Return Tubes
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Remove the 2 bolts and disconnect the pressure feed and return tube from the PS gear.
9. **Remove PS gear assembly .**
- a. Remove the 2 PS gear assembly mounting bolts.
 - b. Remove the steering column hole cover and clamp.
 - c. Place matchmarks on the steering intermediate extension and control valve shaft.

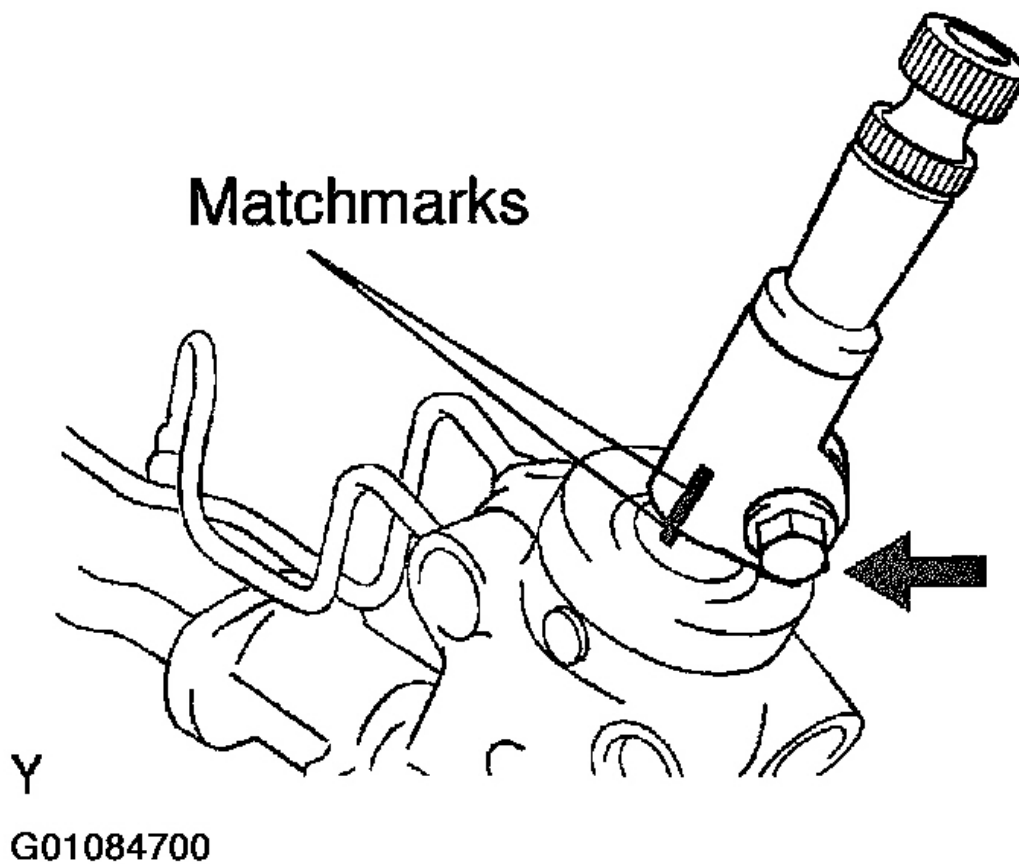


Fig. 45: Placing Match Marks

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- d. Remove bolt and steering intermediate extension.
- e. Remove the PS gear assembly.

NOTE: **Do not damage the turn pressure tubes.**

DISASSEMBLY

NOTE: **When using a vise, do not overtighten it.**

1. **Remove turn pressure tubes .**

Using SST, remove the 2 turn pressure tubes.

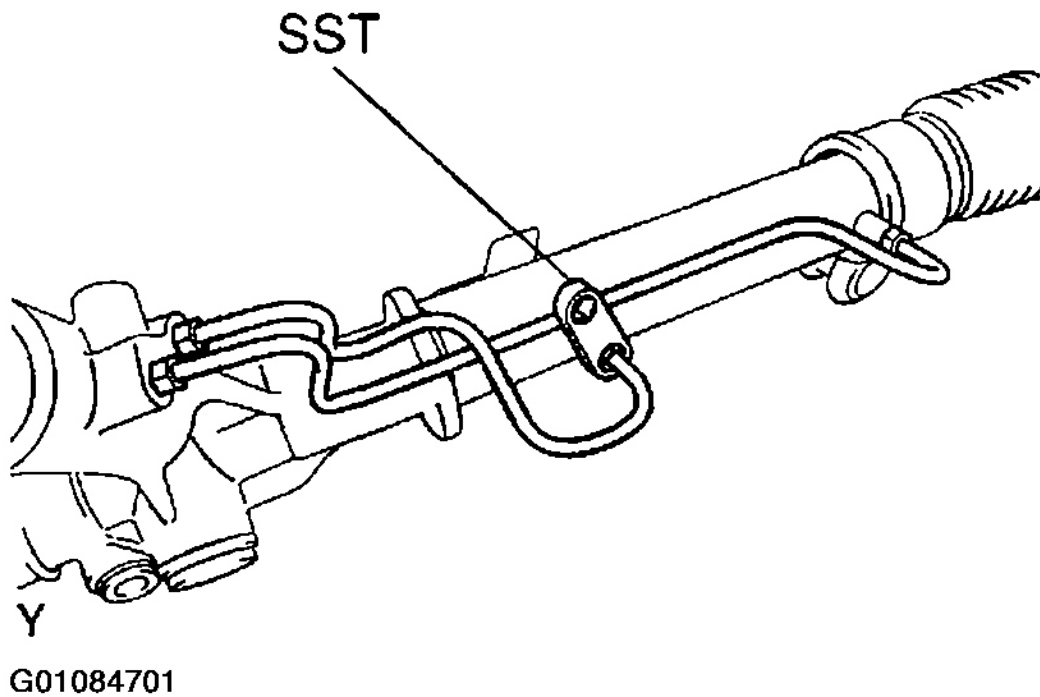
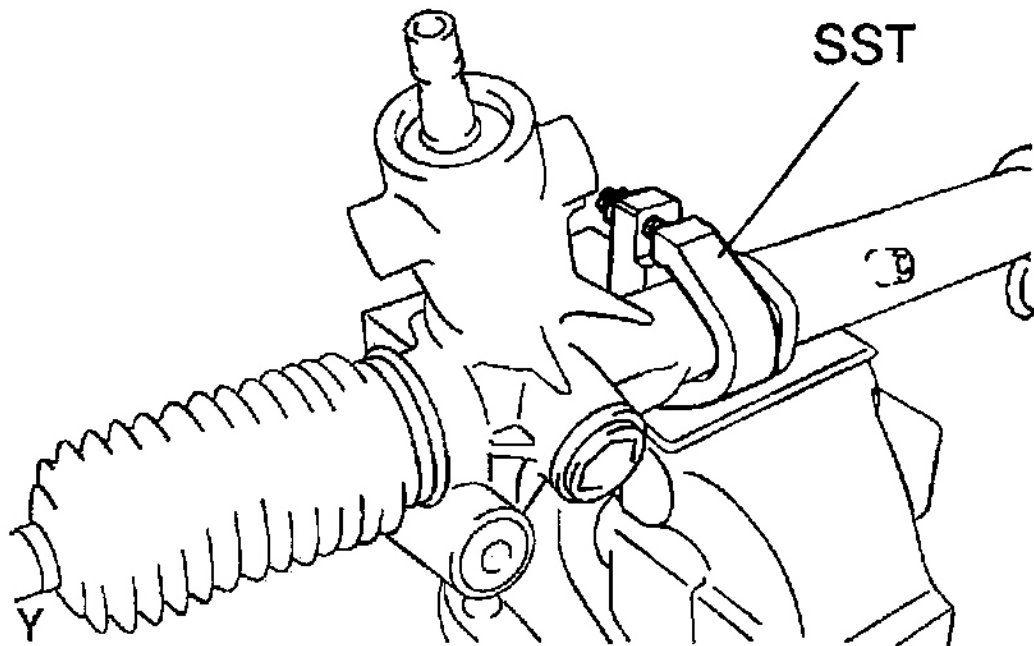


Fig. 46: Removing Turn Pressure Tubes
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

2. Secure PS gear assembly in vise

Using SST, secure the PS gear assembly in a vise.

SST 09612-00012



G01084702

Fig. 47: Securing PS Gear Assembly

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- 3. Remove RH and LH tie rod ends and lock nuts .**
 - a. Place matchmarks on the tie rod end and rack end.
 - b. Loosen the lock nut, and remove the tie rod end and lock nut.
 - c. Employ the same manner described above to the other side.

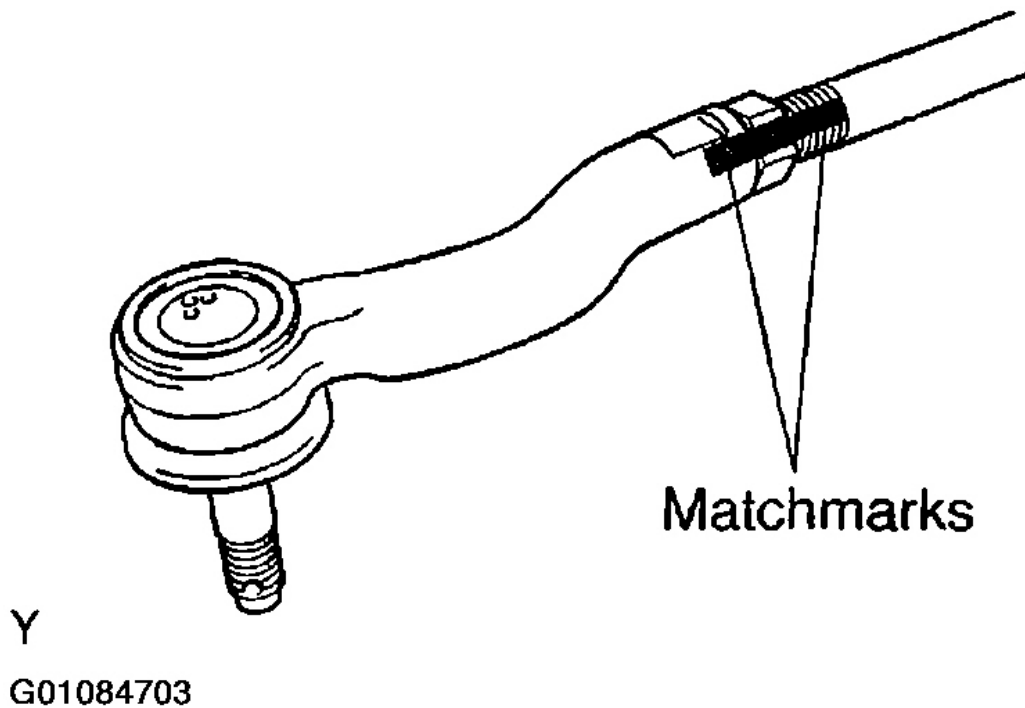


Fig. 48: Placing Matchmarks On Tie Rod Ends & Rack End
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Mark the RH and LH tie rod ends and lock nuts.

4. Remove RH and LH clips, clamps and rack boots .

- a. Loosen the clamp screw.
- b. Remove the clip, clamp and rack boot.

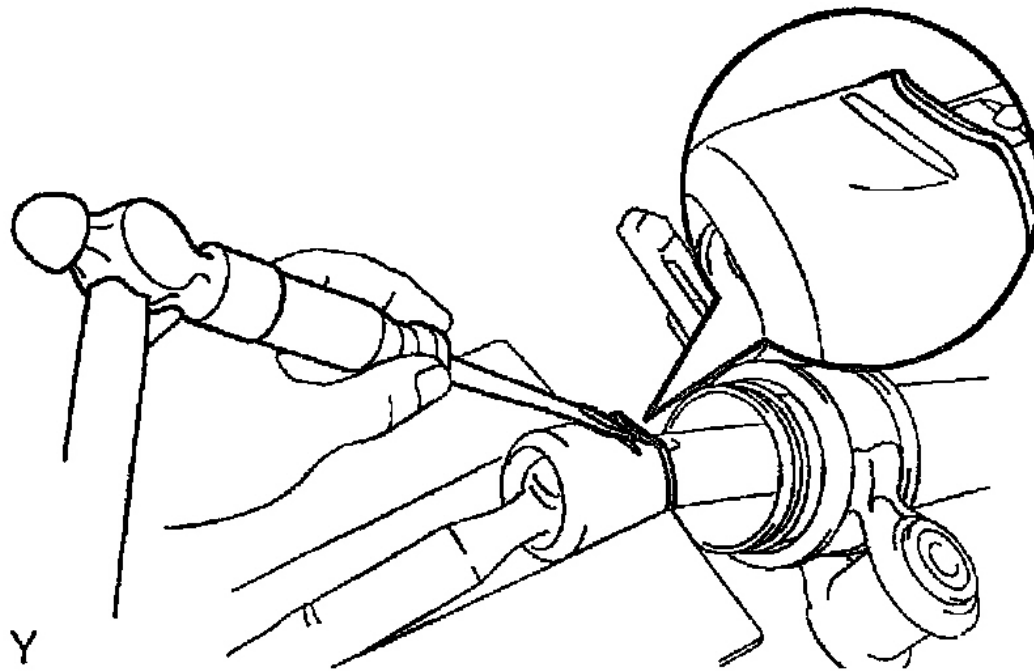
NOTE: Be careful not to damage the boot.

- c. Employ the same manner described above to the other side.

NOTE: Mark the RH and LH rack boots.

5. Remove RH and LH rack ends and claw washers .

- a. Using a screwdriver and a hammer, unstake the claw washer.



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Fig. 49: Unstaking Claw Washer

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: **Avoid any impact on the steering rack.**

- b. Using a spanner (22 mm), hold the steering rack steadily and using SST, remove the rack end.
SST 09922-10010

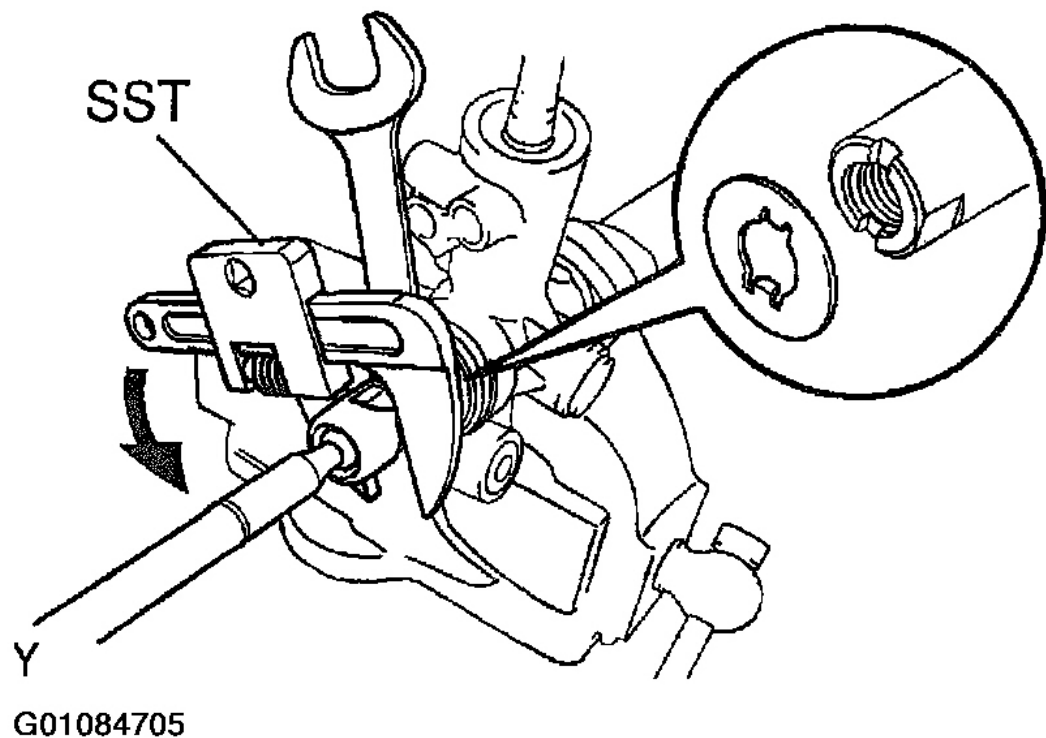


Fig. 50: Removing Rack End
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Use SST 09922-10010 in the direction shown.

- c. Remove the claw washer.
- d. Employ the same manner described above to the other side.

NOTE: Mark the RH and LH rack ends.

6. Remove No. 1 rack housing bracket and grommet .

- a. Place matchmarks on the No. 1 rack housing bracket and rack housing.
- b. Remove the bolt and bracket.
- c. Remove the grommet from the bracket.

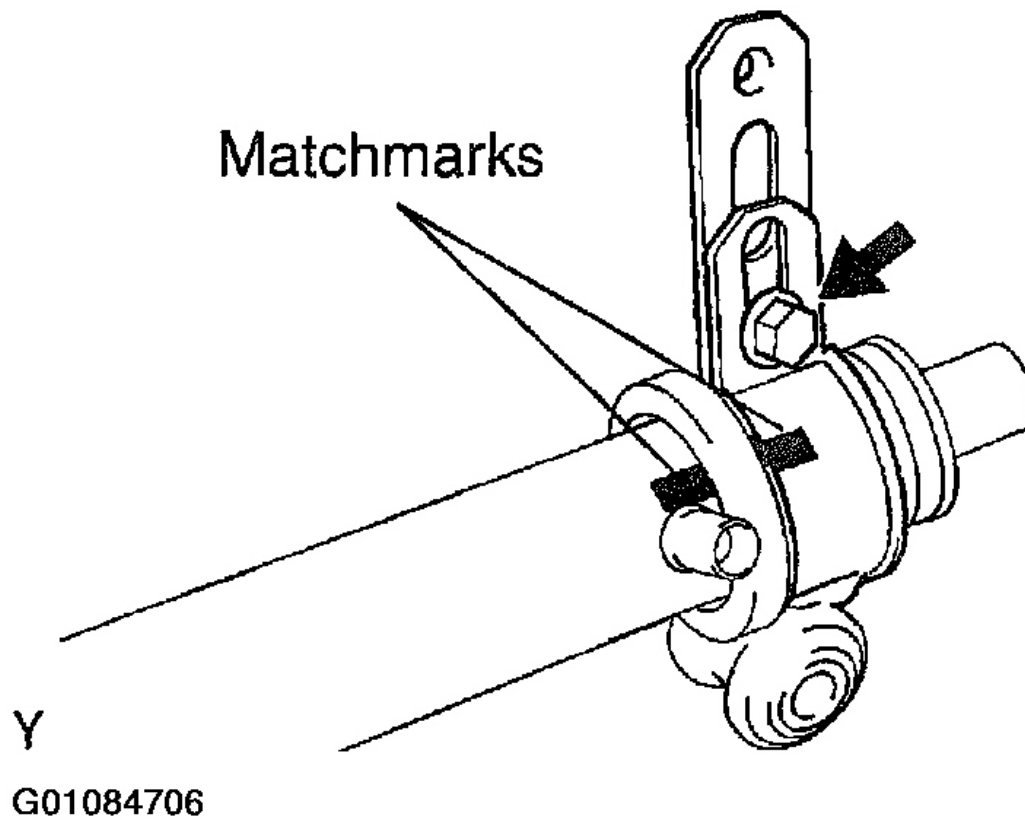


Fig. 51: Placing Matchmarks On No. 1 Housing Bracket & Rack Housing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

7. Remove rack guide spring cap lock nut .

Using SST, remove the rack guide spring cap lock nut.
SST 09922-10010

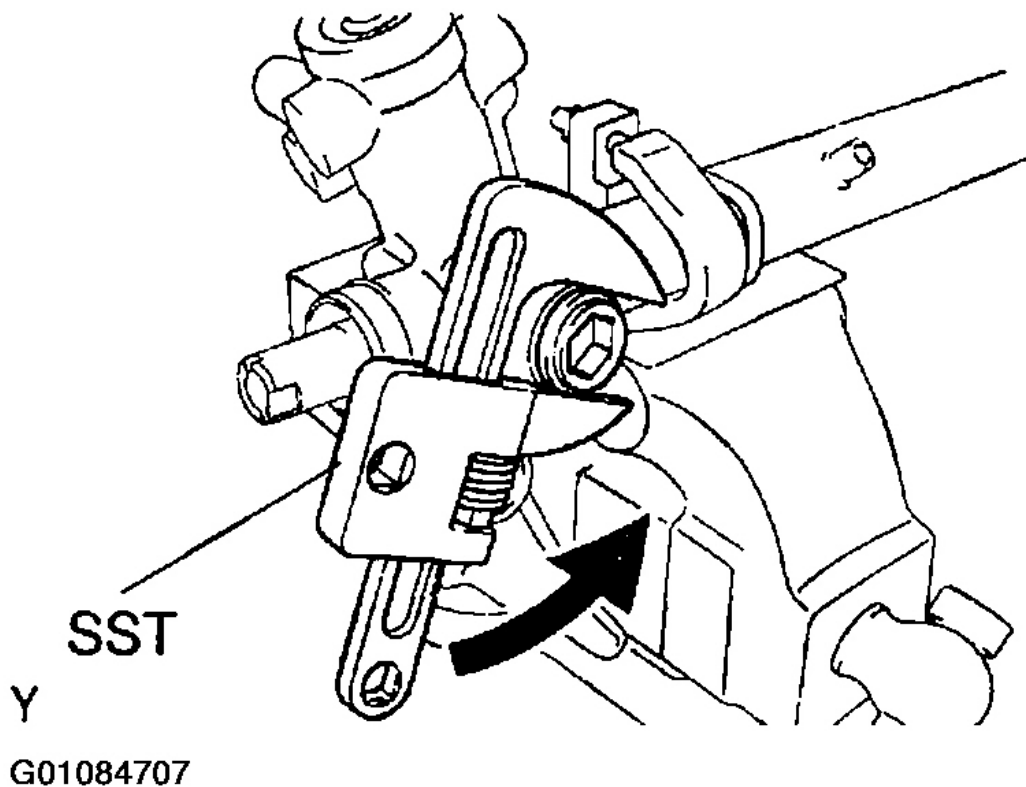


Fig. 52: Removing Rack Guide Spring Cap Lock Nut
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Use SST 09922-10010 in the direction shown.

8. **Remove rack guide spring cap, rack guide spring, conical spring and rack guide .**
 - a. Using a hexagon wrench (21 mm), remove the rack guide spring cap.
 - b. Remove the rack guide spring, conical spring and rack guide.
9. **Remove rack housing cap .**
10. **Remove self-locking nut .**

Using SST, stop the control valve shaft rotating and remove the self-locking nut.

SST 09616-00011

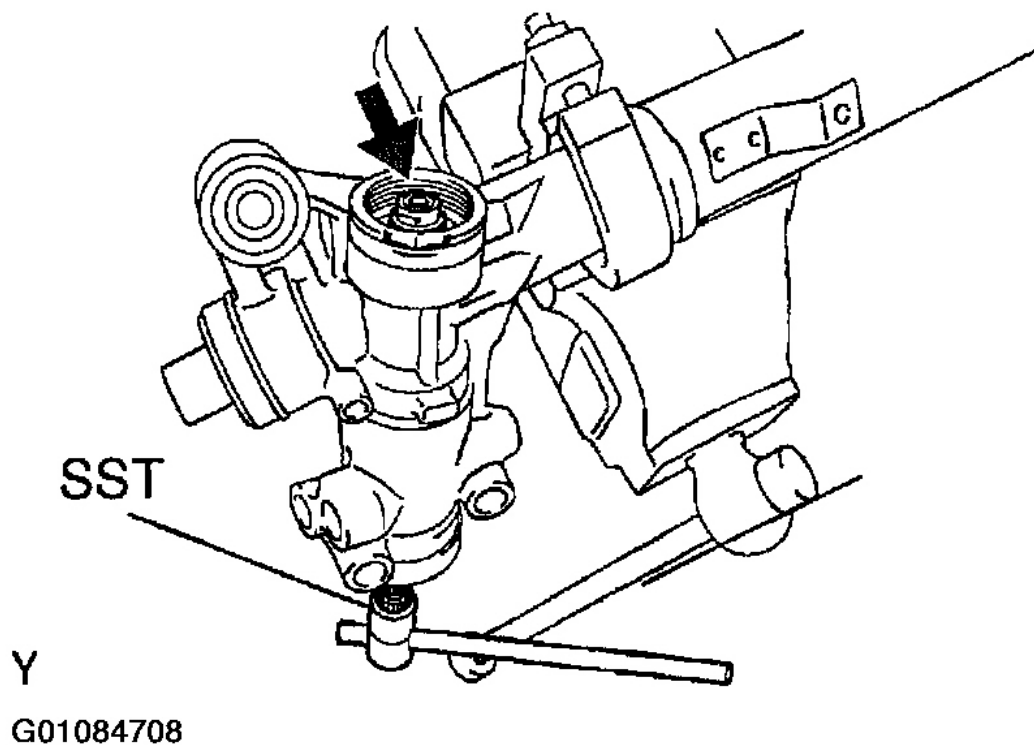


Fig. 53: Removing Self-Locking Nut
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

11. **Remove control valve assembly, upper oil seal and upper bearing .**
 - a. Using snap ring pliers, remove the snap ring from the rack housing.

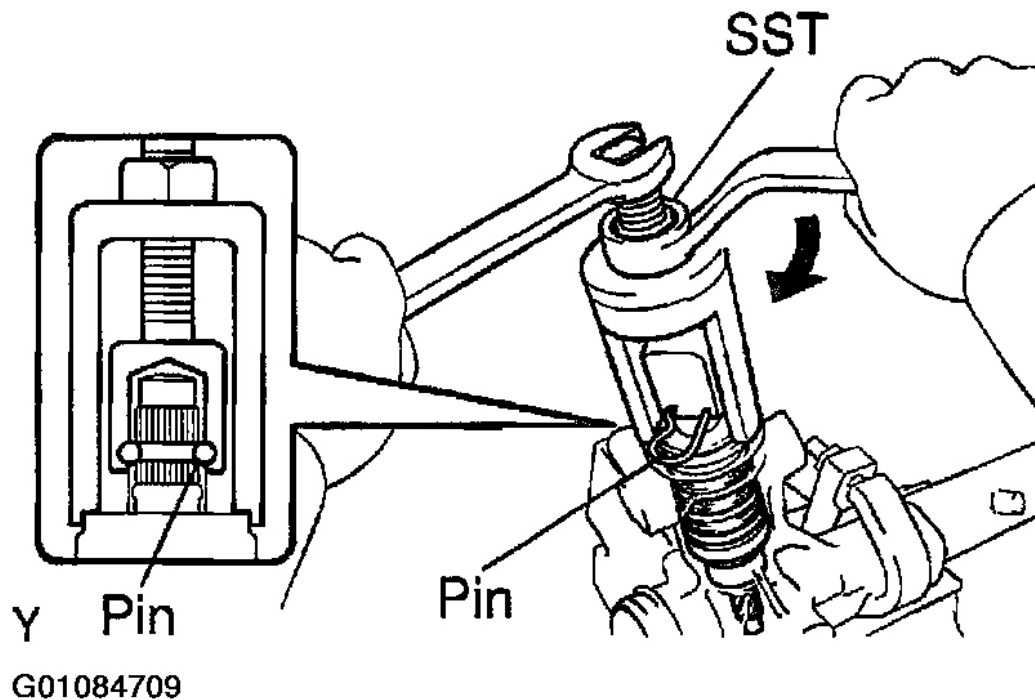


Fig. 54: Removing Snap Ring

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Using SST, remove the control valve assembly with the oil seal and upper bearing.
SST 09613-12010

NOTE: **Never attempt to tap out the control valve as this would damage it.**

- c. Remove the oil seal and bearing from the control valve assembly.
12. **Remove cylinder end stopper .**
 - a. Using snap ring pliers, remove the snap ring from the rack housing.
 - b. Remove the cylinder end stopper.
13. **Remove steering rack and oil seal .**
 - a. Using a brass bar, press out the steering rack with the oil seal.
 - b. Remove the oil seal from the steering rack.

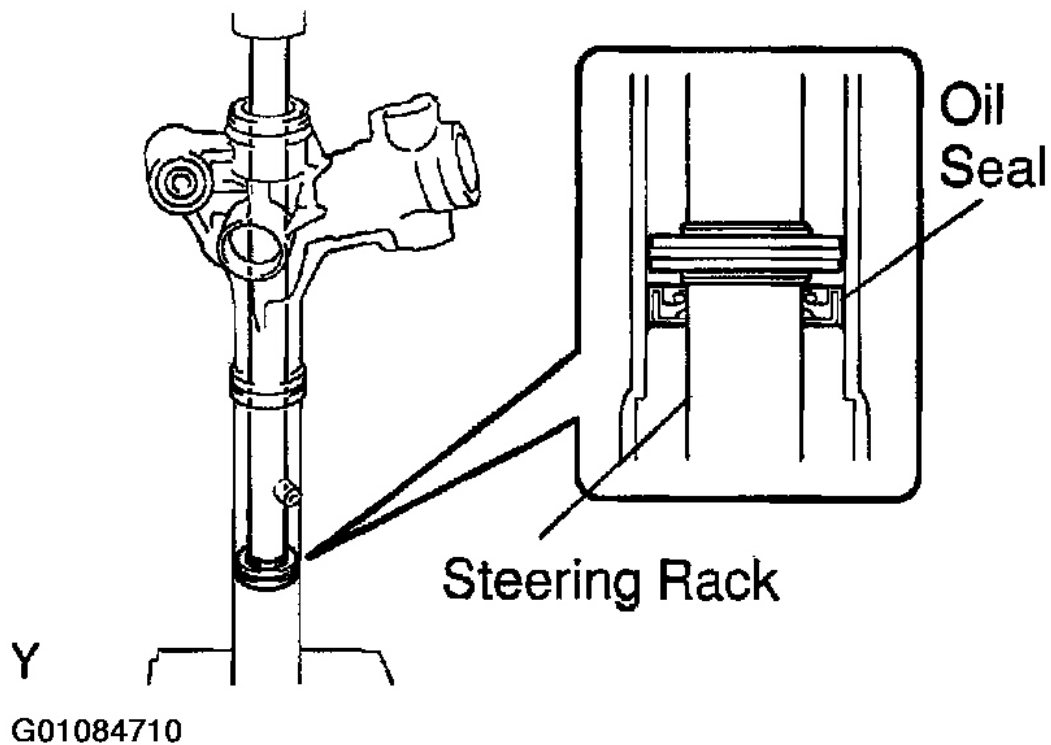


Fig. 55: Locating Steering Rack & Oil Seal
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

INSPECTION

NOTE: When using a vise, do not overtighten it.

1. **Inspect steering rack .**
 - a. Using a dial indicator, check the rack for runout, teeth wear and damage.

Maximum runout: 0.30 mm (0.0118 in.)

- b. Check the back surface for wear and damage.

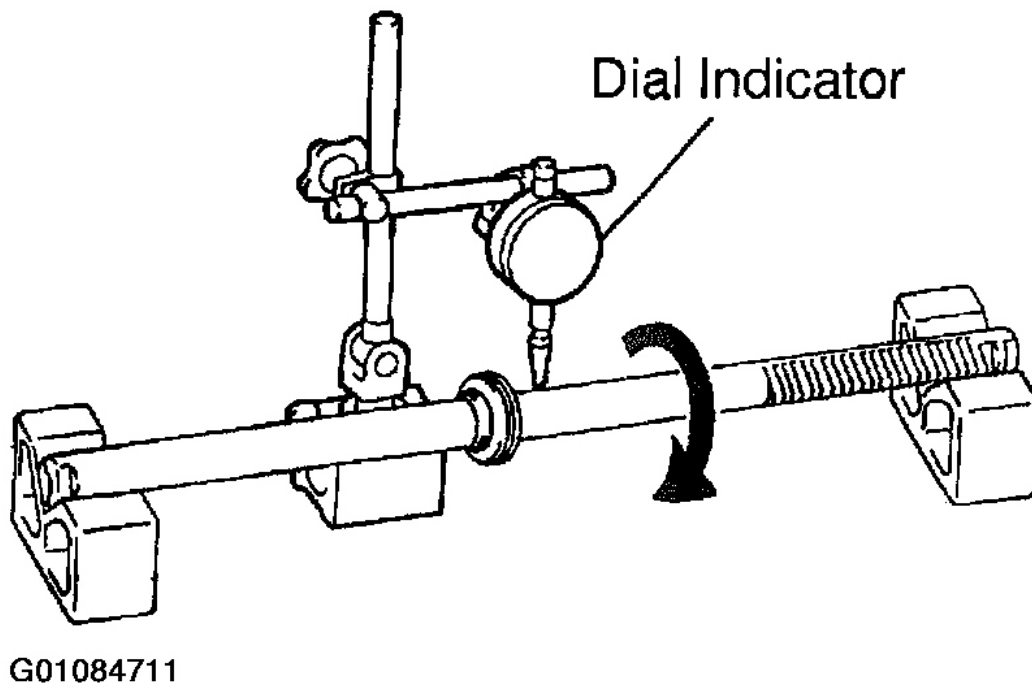


Fig. 56: Identifying Dial Indicator
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

If necessary, replace the steering rack.

2. **Check control valve assembly and bushing .**

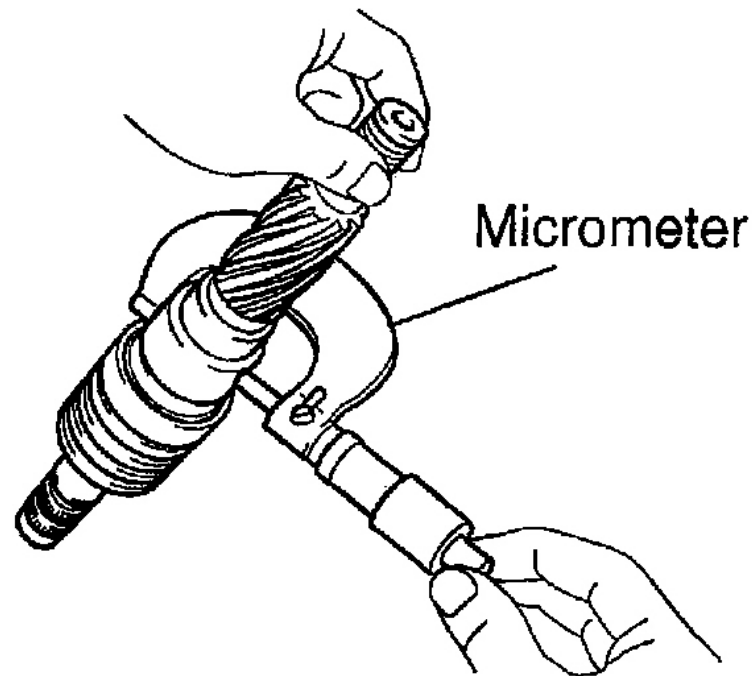
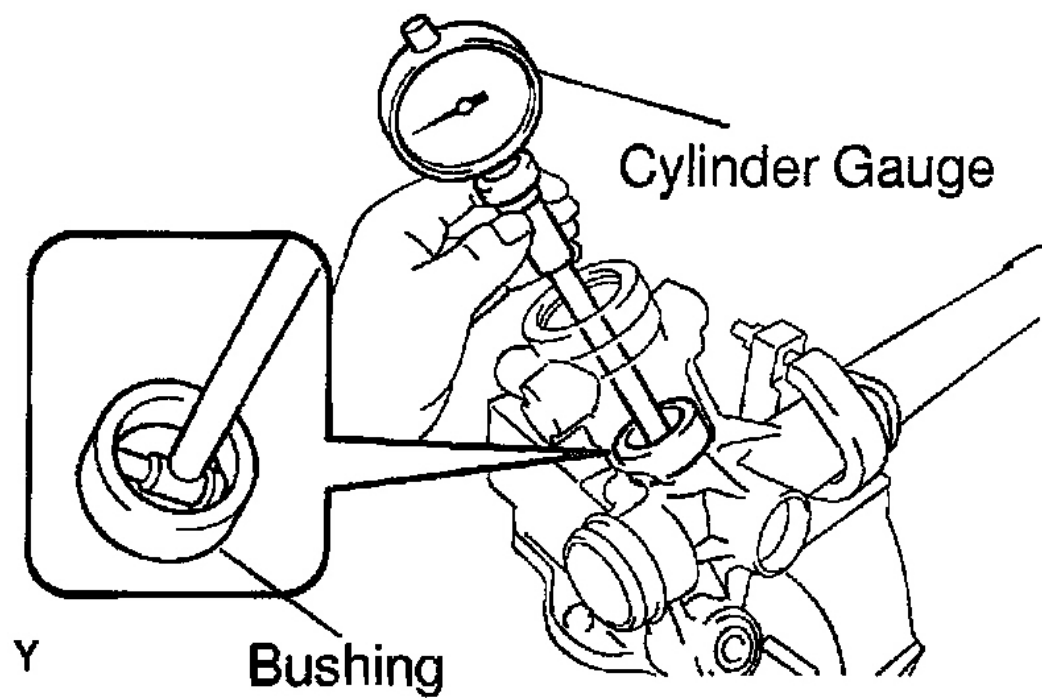


Fig. 57: Identifying Cylinder Gauge & Micrometer
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Using a cylinder gauge and a micrometer, measure the inside diameter of the bushing and outside diameter of the control valve assembly.

Maximum inside diameter: 28.20 mm (1.1102 in.)

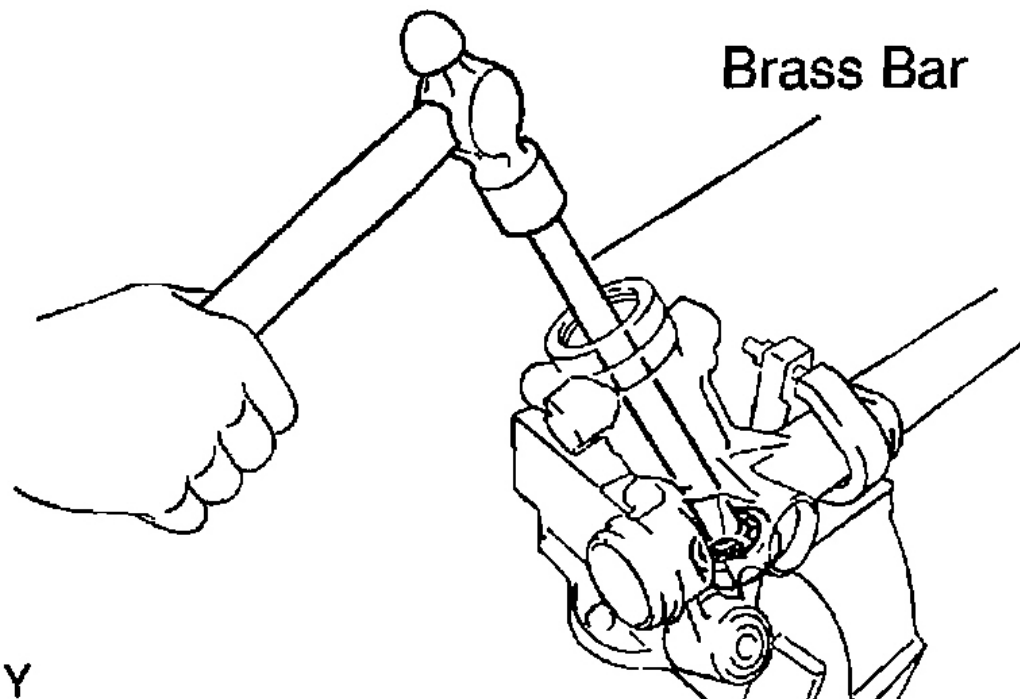
Minimum outside diameter: 27.75 mm (1.0925 in.)

If necessary, replace the control valve assembly or bushing.

REPLACEMENT

NOTE: When using a vise, do not overtighten it.

1. **Replace lower bearing of control valve shaft .**
 - a. Using a brass bar and a hammer, tap out the lower bearing from the rack housing.
 - b. Coat a new bearing with molybdenum disulfide lithium base grease.
 - c. Install the bearing into the rack housing.



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Fig. 58: Tapping Out Lower Bearing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

2. **Replace oil seal of rack housing for control valve shaft assembly side .**
 - a. Using SST, press out the oil seal.
SST 09950-60010 (09951-00260), 09950-70010 (09951-07360)

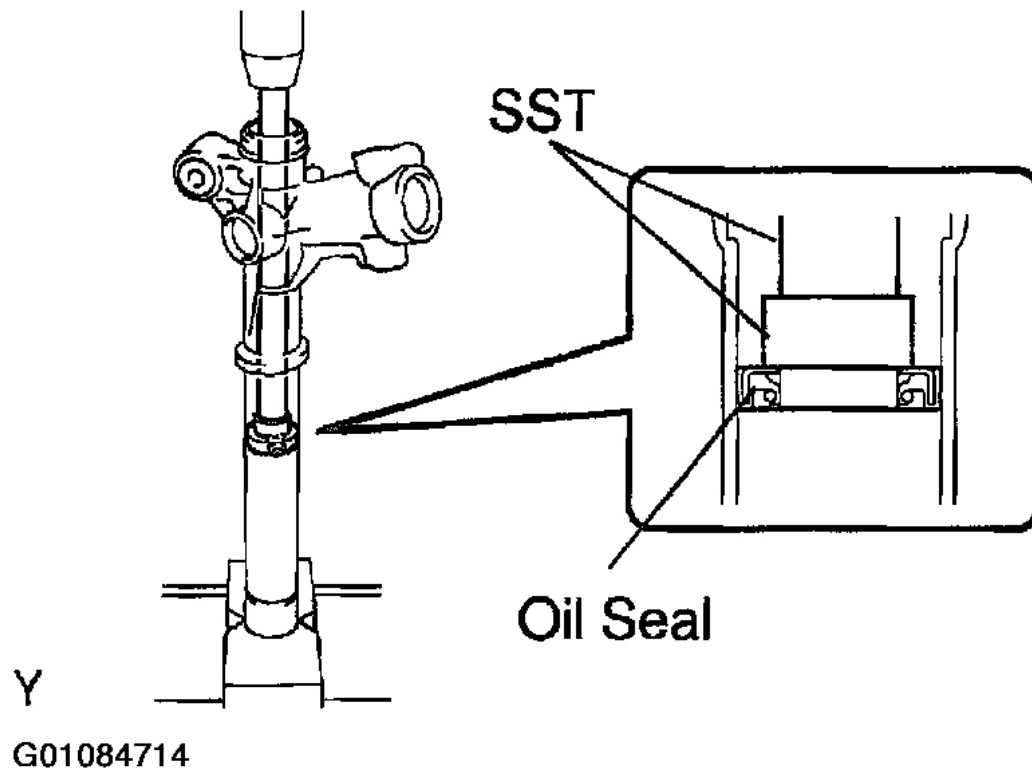


Fig. 59: Pressing Out Oil Seal
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Be careful not to damage the rack housing.

- b. Coat a new oil seal lip with power steering fluid.
- c. Using SST, press in the oil seal.
SST 09950-60010 (09951-00230, 09951-00400, 09952-06010), 09950-70010 (09951-07360)

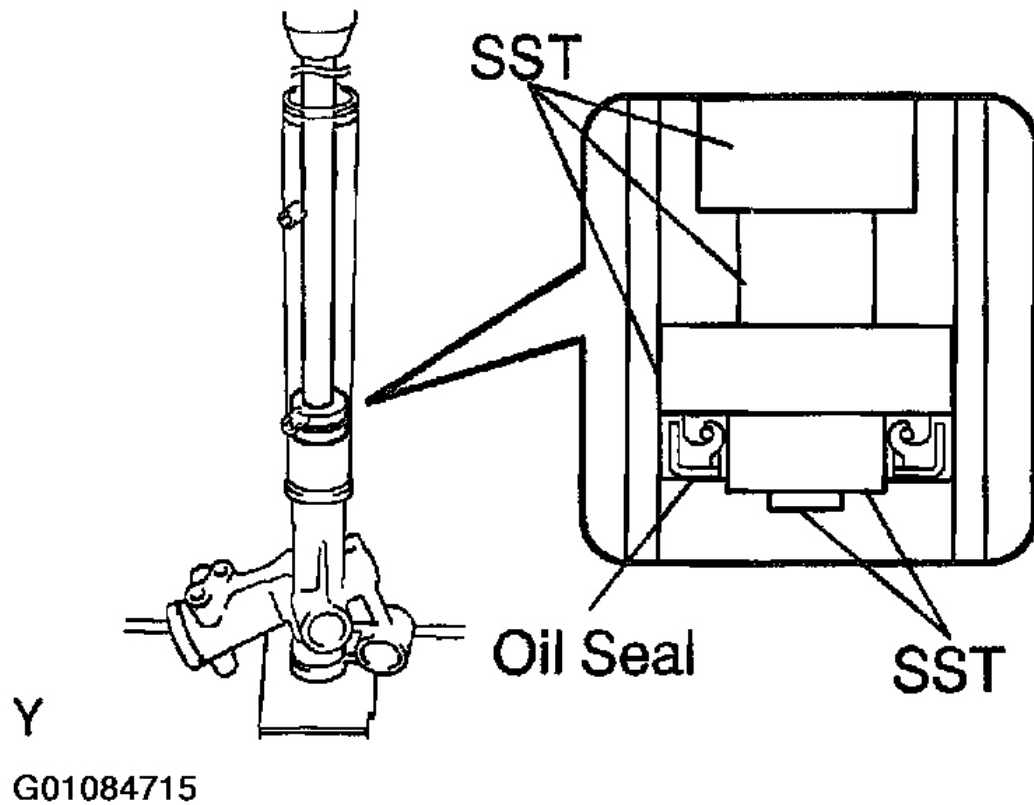


Fig. 60: Pressing In Oil Seal

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

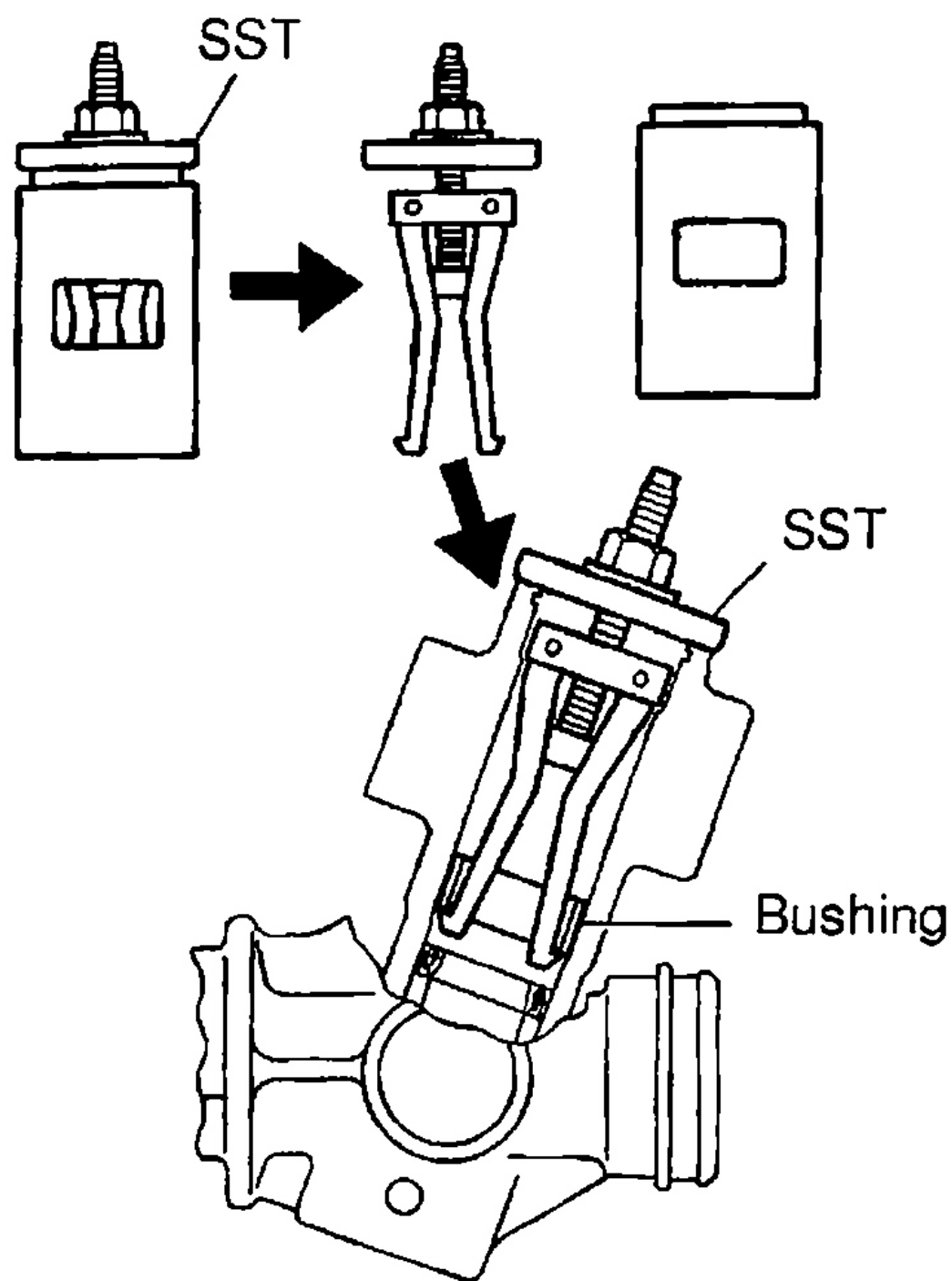
NOTE:

- Make sure to install the oil seal facing in the correct direction.
- Take care that the oil seal does not get reversed as you install it.

3. Replace bushing and lower oil seal of control valve assembly .

- a. Using SST, remove the bushing from the rack housing.

SST 09612-24014 (09613-22011)



G01084716

Fig. 61: Removing Bushing From Rack Housing
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

CAUTION: Be careful not to damage the rack housing.

NOTE:

- Separate the SST as shown in Fig. 61 to use it.
- As shown in Fig. 61 , from the opposite side of SST confirm that it's claw is firmly caught on the bushing.

- b. Using a screwdriver and a hammer, tap out the oil seal from the rack housing.

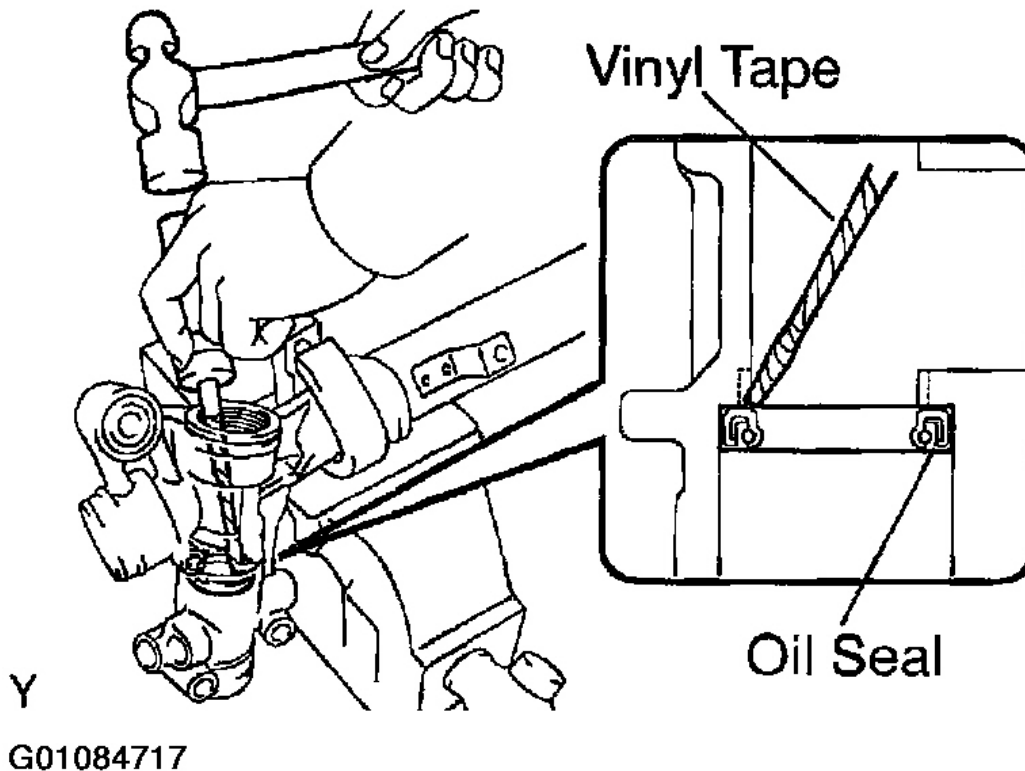


Fig. 62: Tapping Out Oil Seal
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: To prevent rack housing damage, wind vinyl tape on the screwdriver.

- c. Coat a new oil seal lip with power steering fluid.

- d. Using SST, press in the oil seal.

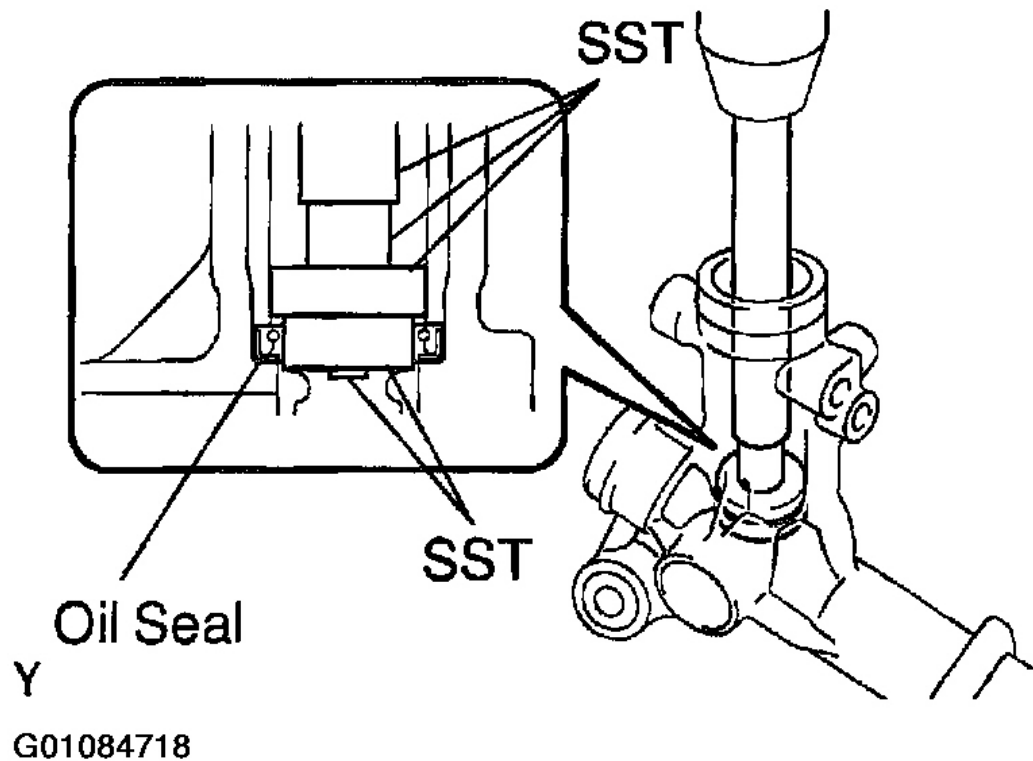


Fig. 63: Pressing In Oil Seal

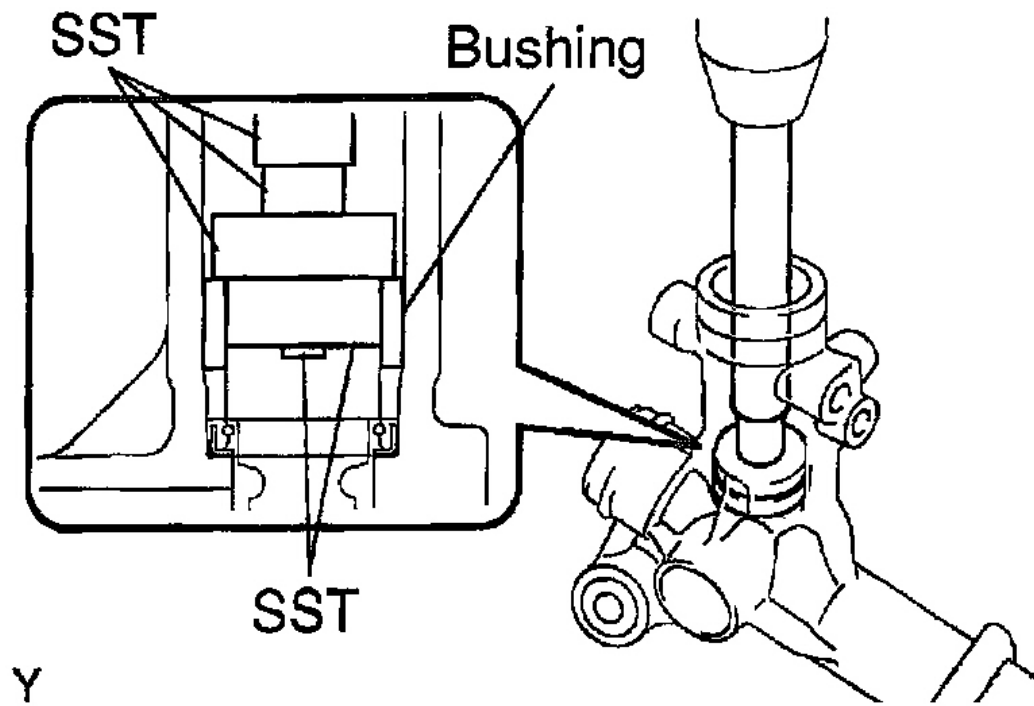
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: SST 09950-60010 (09951-00230, 09951-00340, 09952-06010), 09950-70010 (09951- 07150)

NOTE: Make sure to install the oil seal facing in the correct direction.

- e. Coat a new bushing with molybdenum disulfide lithium base grease.
f. Using SST, press in the bushing.

SST 09950-60010 (09951-00280, 09951-00350, 09952-06010), 09950-70010 (09951-07150)



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G01084719

Fig. 64: Pressing In Bushing

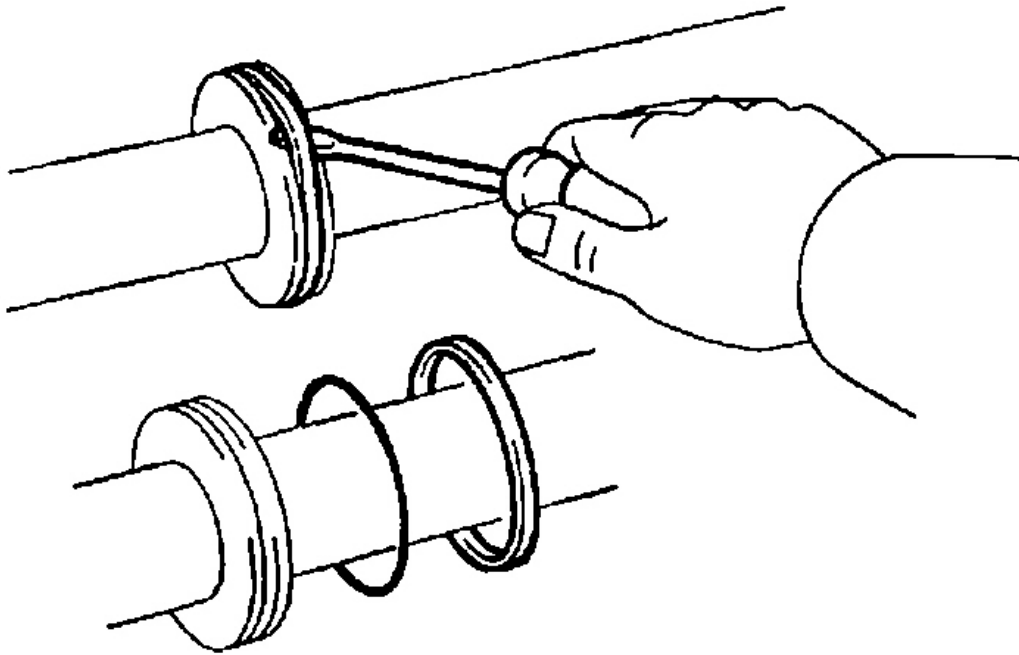
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

4. Replace teflon ring and O-ring of steering rack .

- a. Using a screwdriver, remove the teflon ring and O-ring from the steering rack.

NOTE: **Be careful not to damage the groove for the teflon ring.**

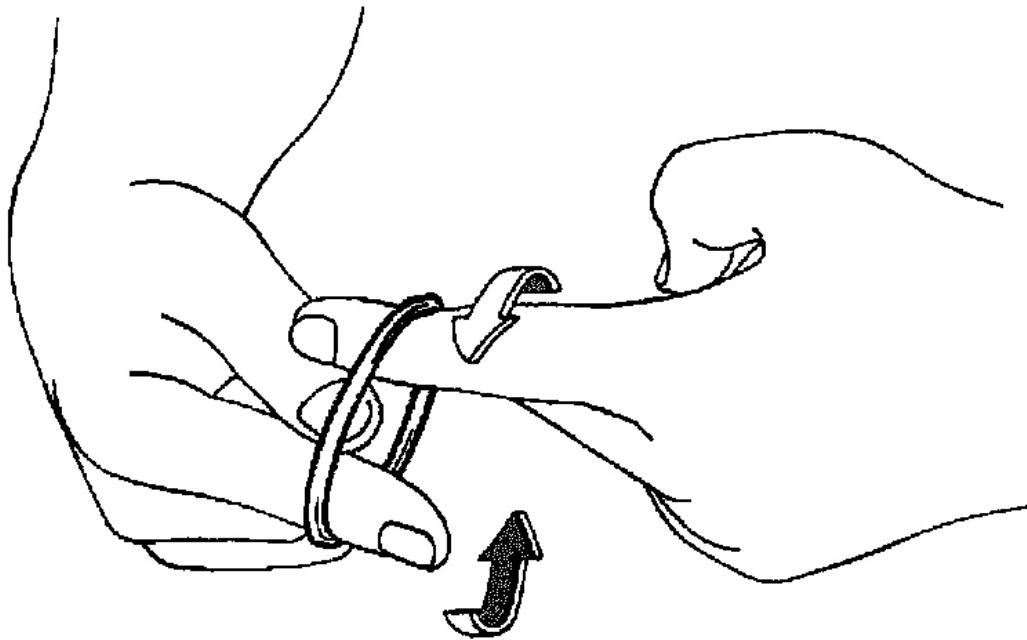
- b. Coat a new O-ring with power steering fluid and install it to the steering rack.



G01084720

Fig. 65: Removing Teflon Ring & O-Ring
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- c. Expand a new teflon ring with your fingers.

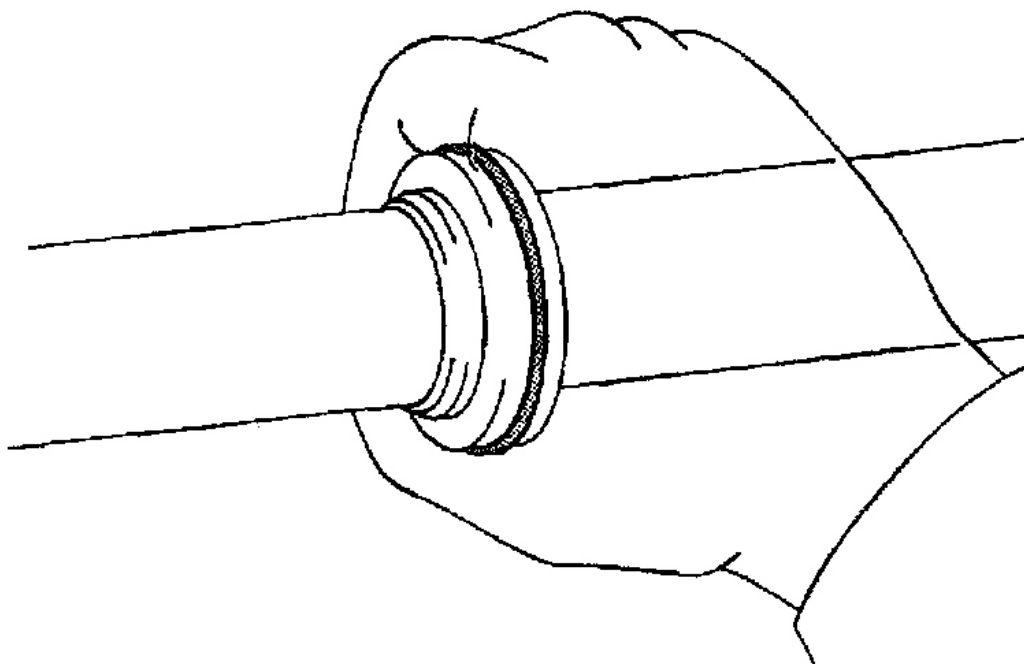


G01084721

Fig. 66: Showing Teflon Ring Proper Expansion
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Be careful not to overexpand the teflon ring.

- d. Coat the teflon ring with power steering fluid.
- e. Install the teflon ring to the steering rack and settle it down with your fingers.



G01084722

Fig. 67: Installing Teflon Ring

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- f. Carefully slide the tapered end of SST over the ring to seat it.
SST 09630-24014 (09631-24031)

NOTE: Be careful not to damage the ring.

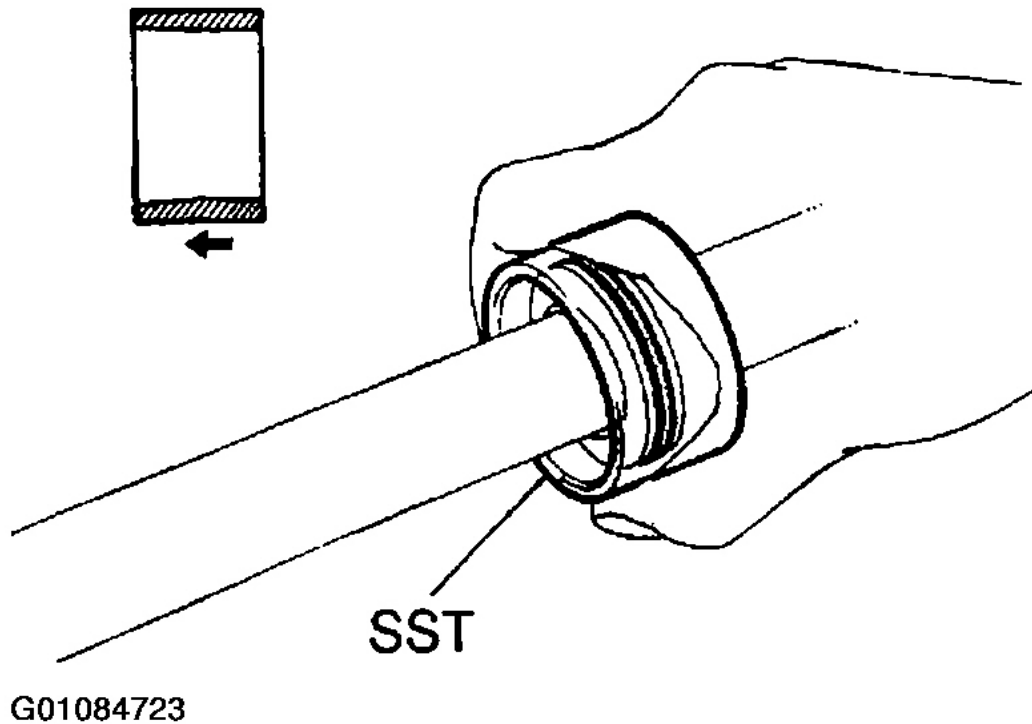


Fig. 68: Displaying Proper Ring Seating
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

5. **Replace teflon rings of control valve assembly .**

- a. Using a screwdriver, remove the 4 teflon rings from the control valve assembly.

NOTE: **Be careful not to damage the grooves for the teflon rings.**

- b. Expand 4 new teflon rings with your fingers.

NOTE: **Be careful not to overexpand the teflon ring.**

- c. Coat the teflon rings with power steering fluid.

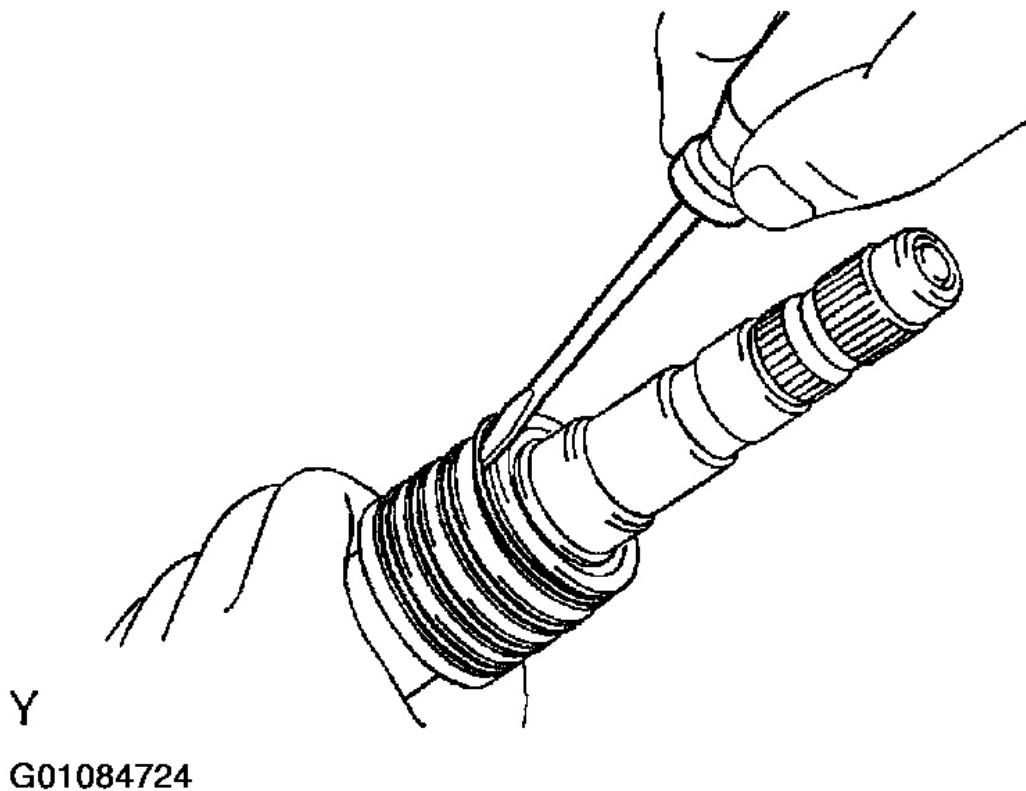


Fig. 69: Removing Teflon Rings

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- d. Install the teflon rings to the control valve assembly and settle them down with your fingers.
- e. Carefully slide the tapered end of SST over the teflon rings until they fit to the control valve assembly.

SST 09631-20081

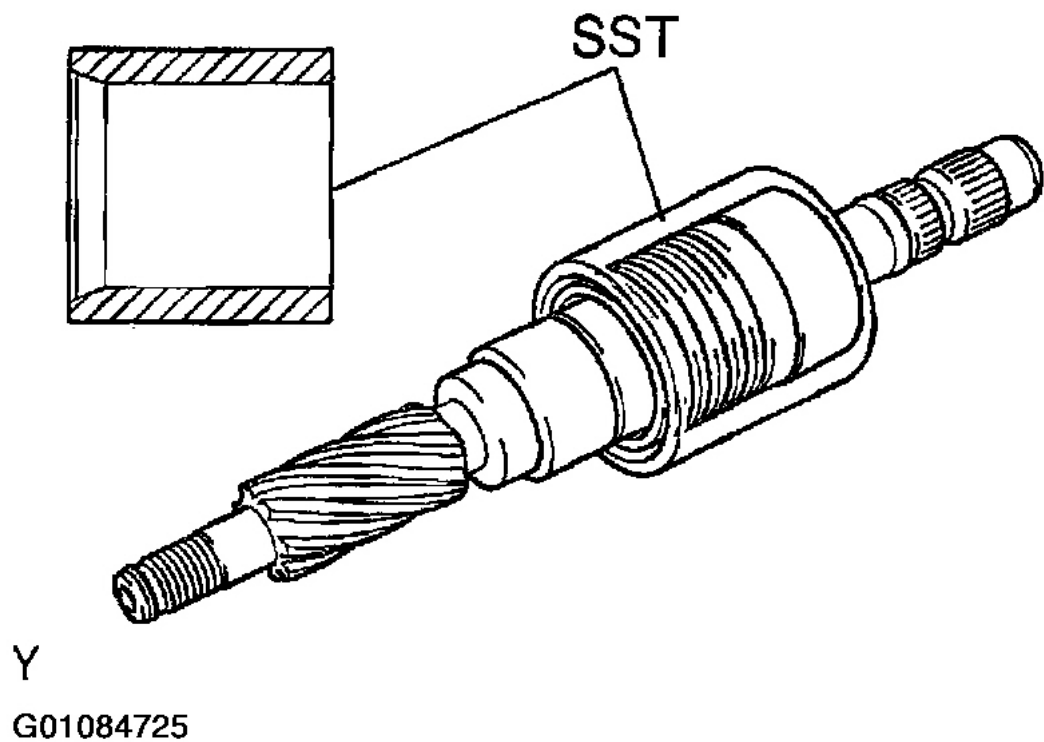
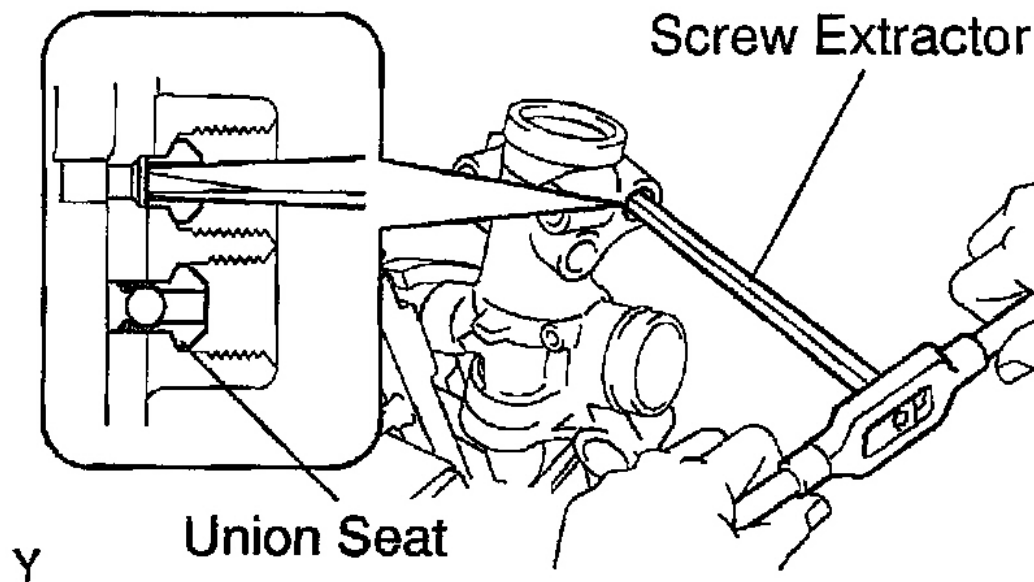


Fig. 70: Installing SST Over Teflon Rings
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Be careful not to damage the teflon rings.

6. **Replace union seats .**
 - a. Using a screw extractor, remove the 2 union seats.



G01084726

Fig. 71: Using Screw Extractor To Remove Union Seats
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Using an extension bar and a hammer, tap in 2 new union seats.

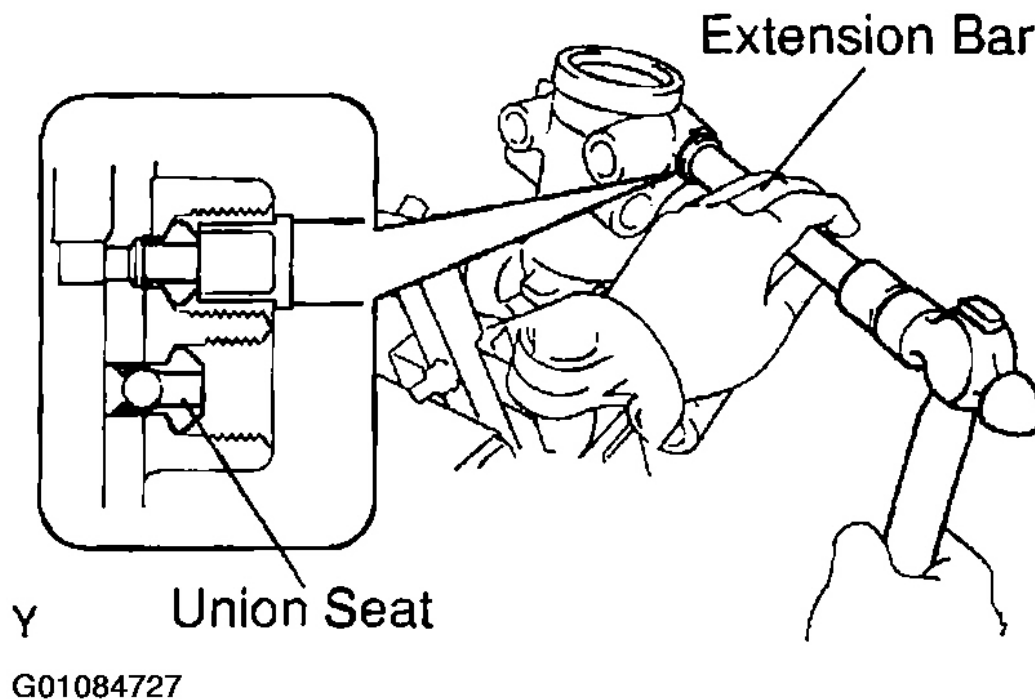


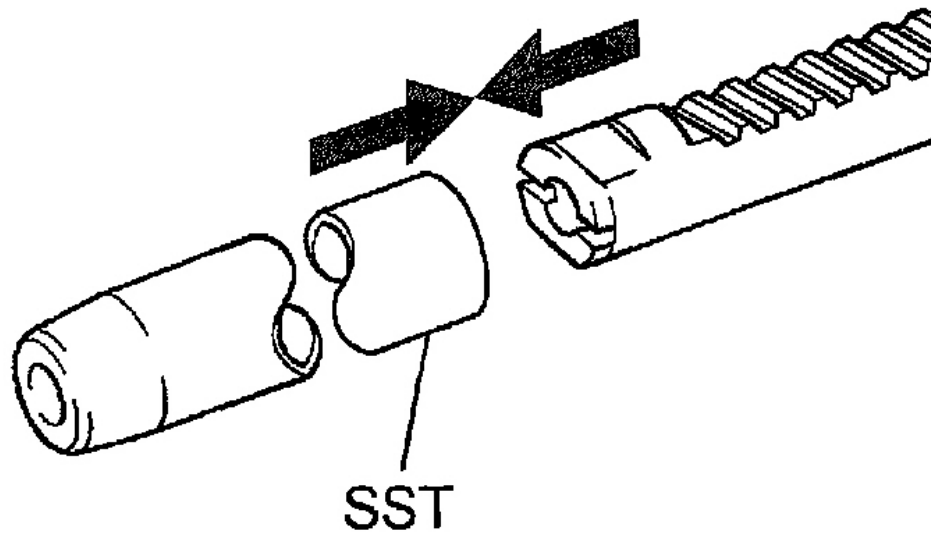
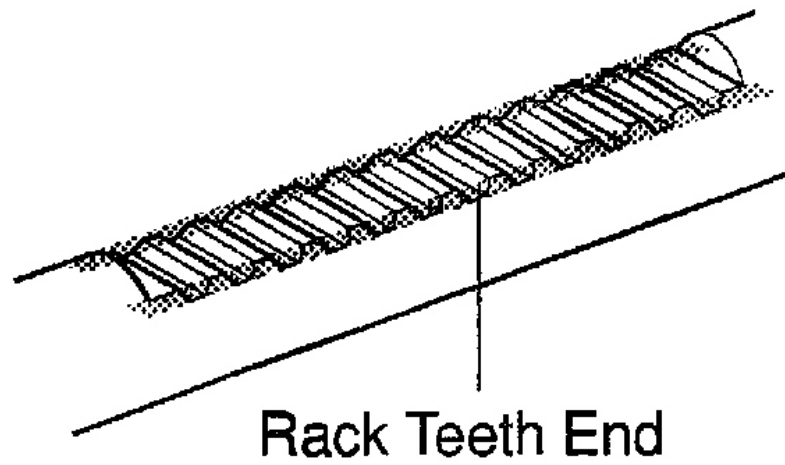
Fig. 72: Installing New Union Seats
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Before installing the union seat, remove dust sticking to the rack housing.

REASSEMBLY

NOTE: When using a vise, do not overtighten it.

1. Coat parts indicated by arrows with power steering fluid or molybdenum disulfide lithium base grease (See COMPONENTS) .
2. Install steering rack .
 - a. Install SST to the rack.
SST 09631-16020



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Fig. 73: Using SST To Protect Rack Teeth

NOTE: If necessary, scrape the burrs off the rack teeth end and burnish.

- b. Coat SST with power steering fluid.
- c. Install the steering rack into the rack housing.
- d. Remove the SST.

SST 09631-16020

3. Install oil seal .

- a. To prevent oil seal lip damage, wind vinyl tape on the steering rack end, and apply power steering fluid.
- b. Coat a new oil seal lip with power steering fluid.
- c. Install the oil seal by pushing it into the rack housing without tilting.

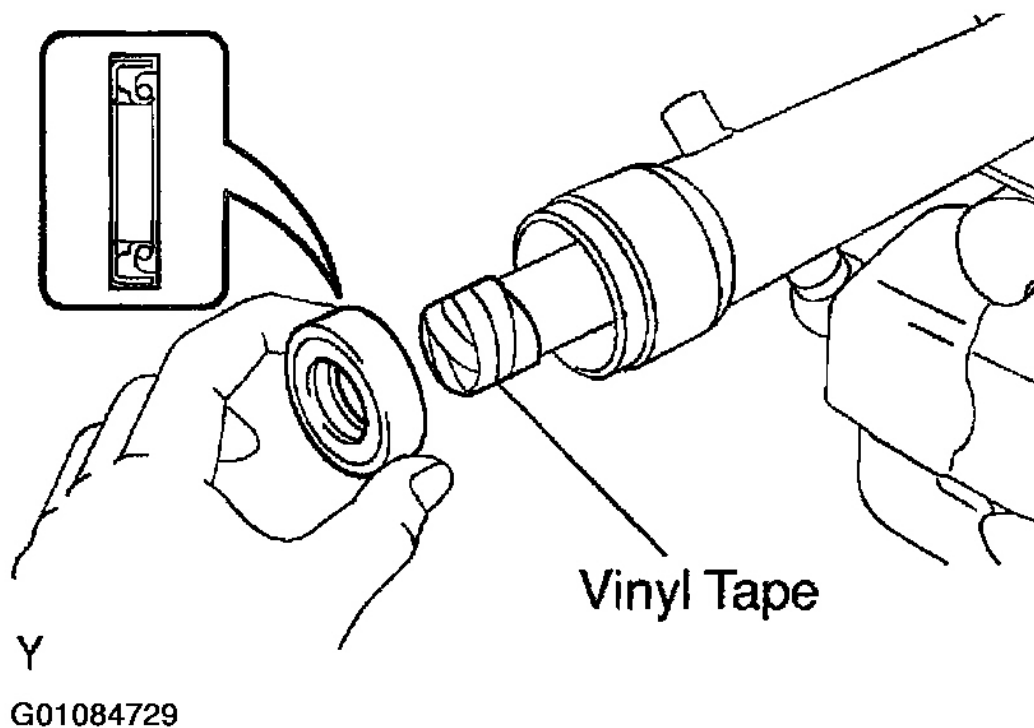


Fig. 74: Installing Oil Seal

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Make sure to install the oil seal facing in the correct direction.

4. **Install cylinder end stopper .**

- a. Using SST and a hammer, drive in the cylinder end stopper.

SST 09612-22011

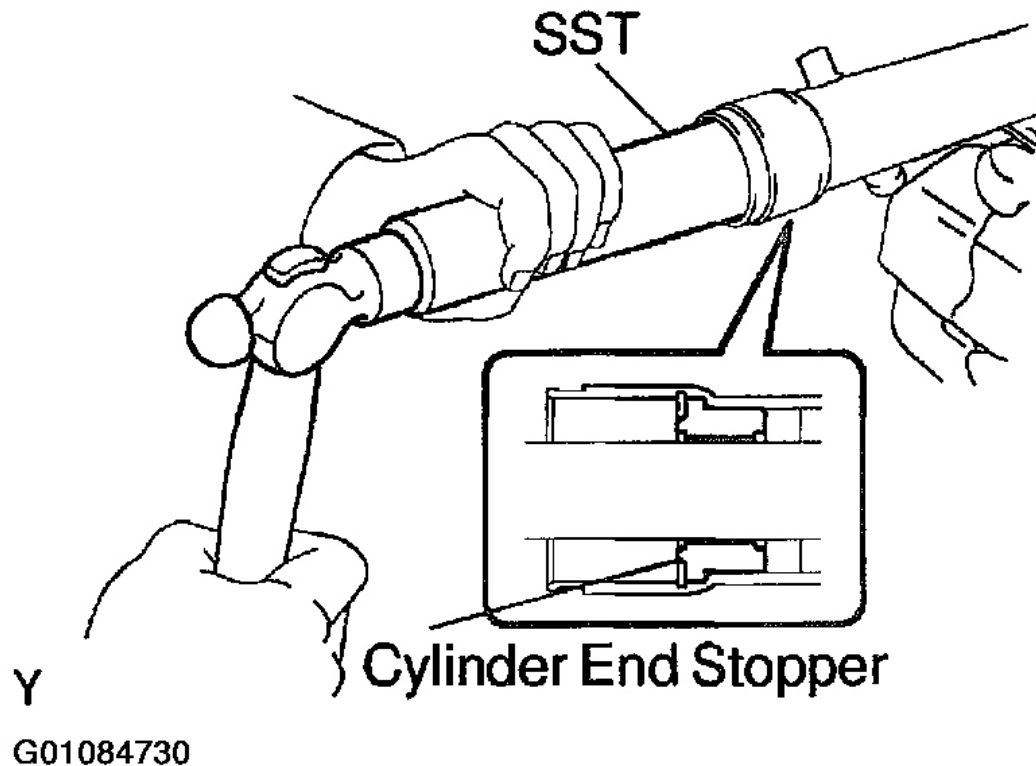


Fig. 75: Installing Cylinder Head End Stopper
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Using snap ring pliers, install a new snap ring to the rack housing.

5. **Air tightness test .**

- a. Install SST to the rack housing.

SST 09631-12071

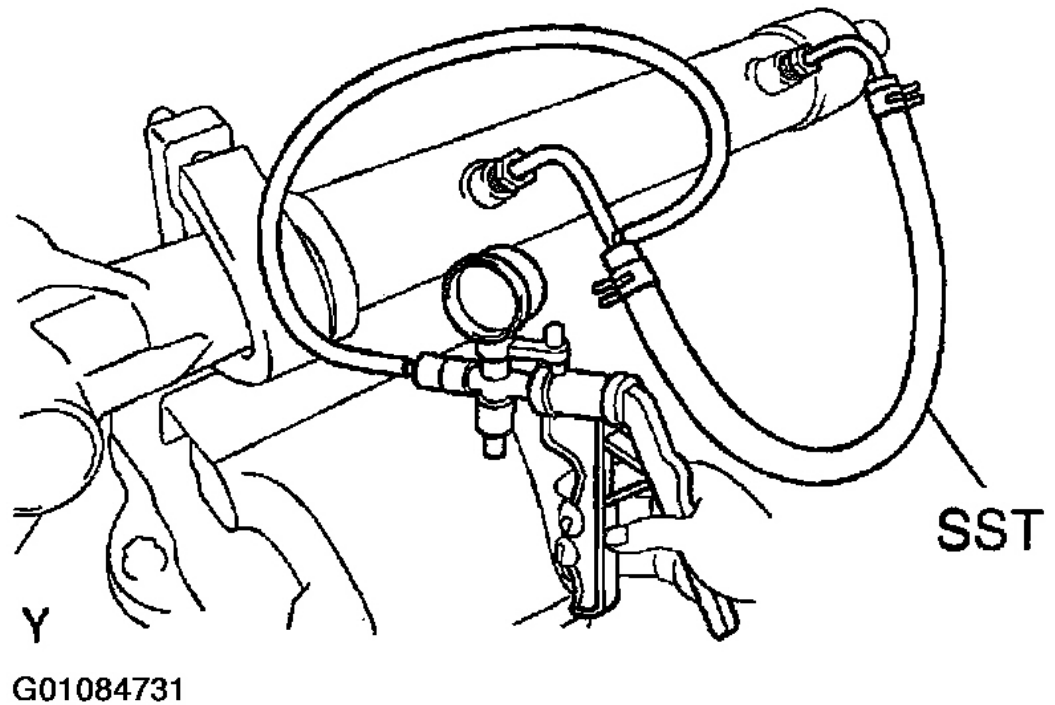


Fig. 76: Displaying Air Tightness Test
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Apply 53 kPa (400 mm Hg, 15.75 in. Hg) of vacuum for about 30 seconds.
- c. Check that there is no change in the vacuum.

If there is a change in the vacuum, check the installation of the oil seals.

6. Install control valve assembly .

Install the control valve assembly into the rack housing.

7. Install upper bearing of control valve assembly .

- a. Coat a new bearing with molybdenum disulfide lithium base grease.
- b. Using SST, press in the bearing to the rack housing.

SST 09612-22011

8. Install upper oil seal of control valve assembly .

- a. Coat a new oil seal lip with power steering fluid.

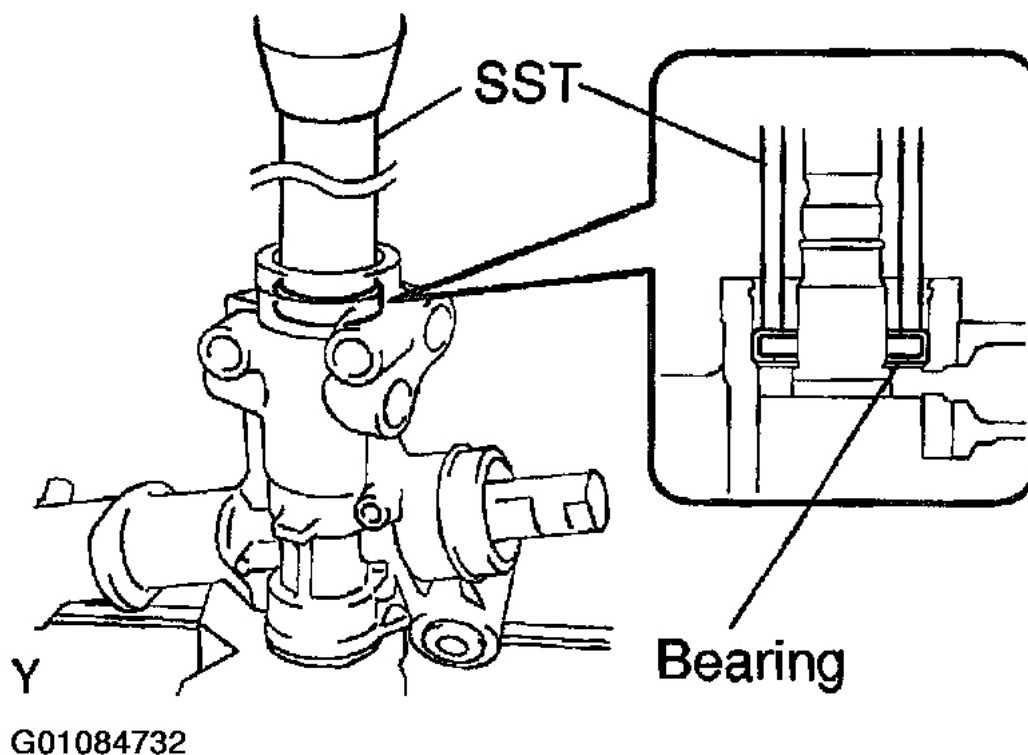


Fig. 77: Identifying Bearing & SST
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Using SST, press in the oil seal.
SST 09612-22011

NOTE: Make sure to install the oil seal facing in the correct direction.

- c. Using snap ring pliers, install a new snap ring to the rack housing.

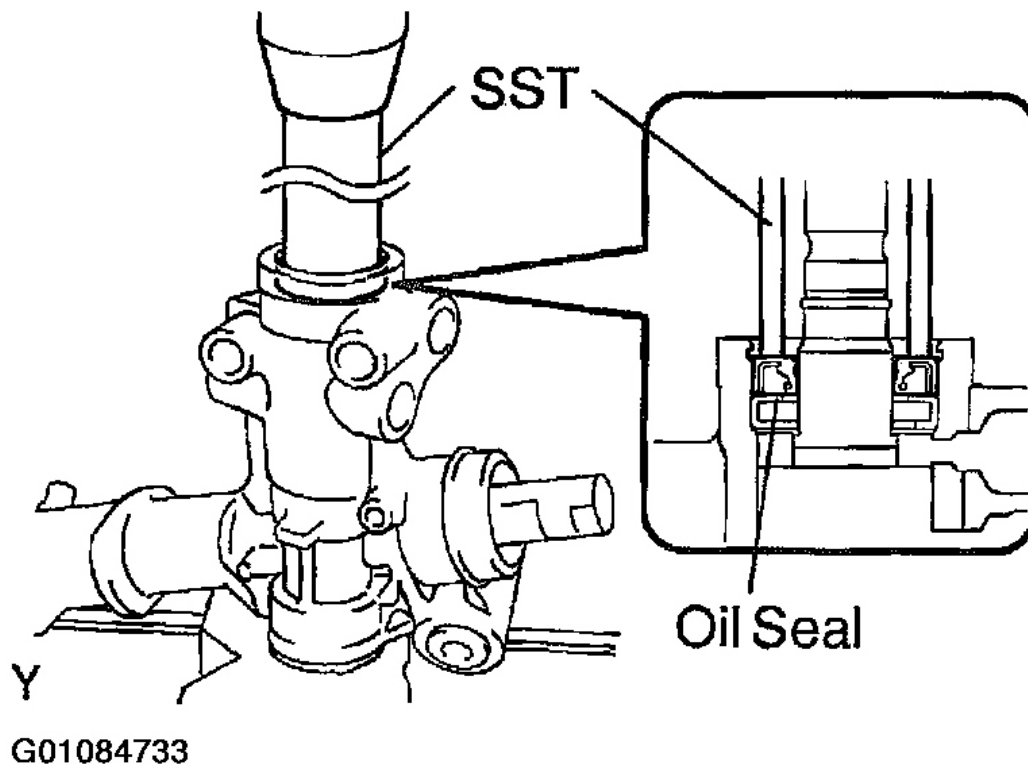
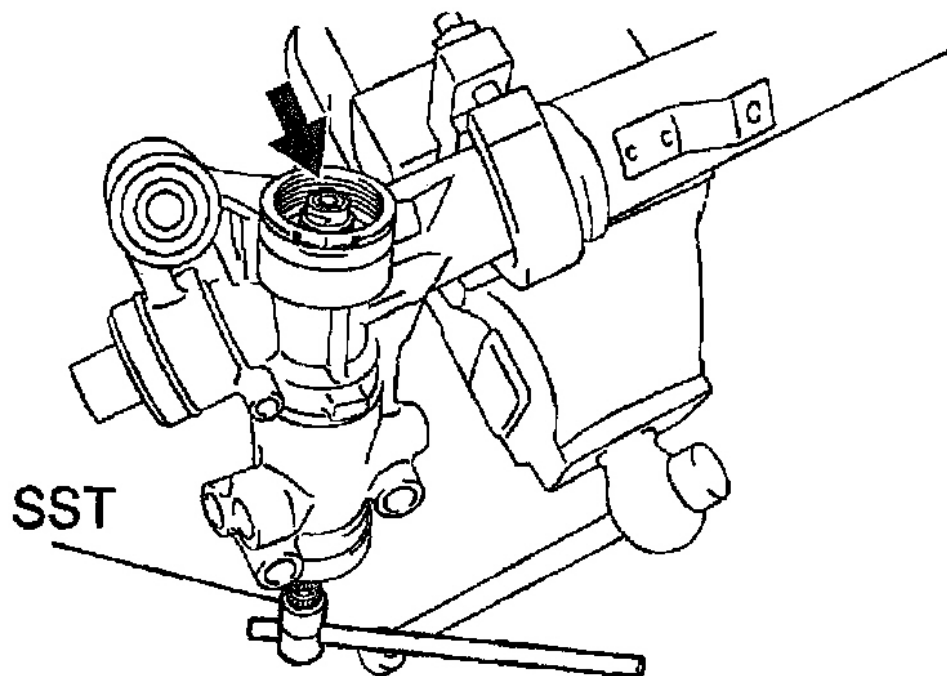


Fig. 78: Identifying Oil Seal & SST
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

9. Install self-locking nut .

- a. Using SST, stop the control valve shaft rotating and install a new self- locking nut.
SST 09616-00011
Torque: 12 N.m (125 kgf. cm, 9 ft. lbf)



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Fig. 79: Installing Self-Locking Nut
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Turn "C" of SST to measure the dimension "A," then set SST as shown in **Fig. 80** .
SST 09613-12020

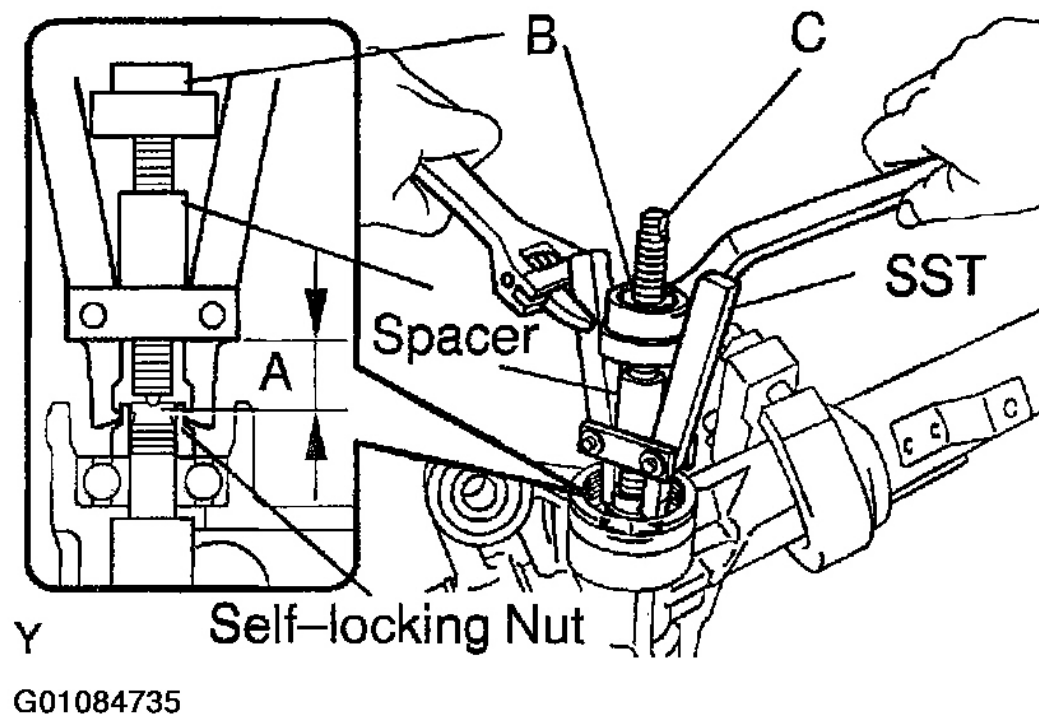


Fig. 80: Locating A, B & C
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Dimension A: 16.5 - 17.0 mm (0.65 - 0.67 in.)

- c. Stake the self-locking nut by turning "B" of the SST until it touches the spacer of the SST.

10. Install rack housing cap .

- a. Apply sealant to 2 or 3 threads of the rack housing cap.

Sealant: Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent

- b. Install the rack housing cap.

Torque: 69 N.m (700 kgf. cm, 51 ft. lbf)

11. Install rack guide, conical spring, rack guide spring and rack guide spring cap .

- a. Install the rack guide, conical spring and rack guide spring.

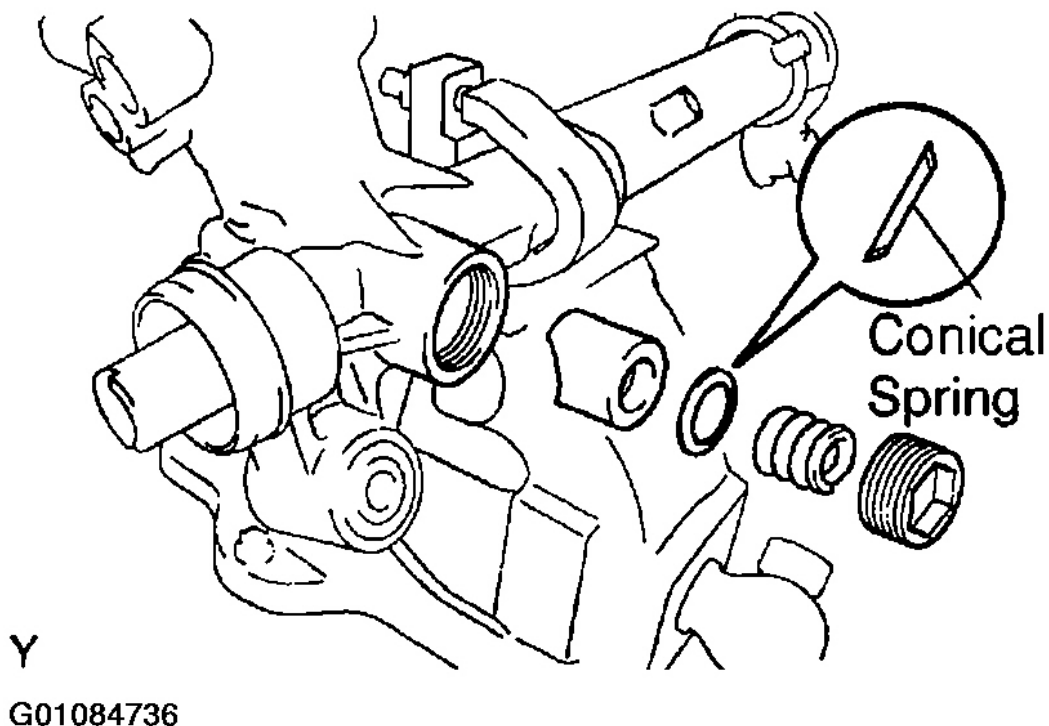


Fig. 81: Identifying Conical Spring

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Make sure to install the conical spring facing in the correct direction.

- b. Apply sealant to 2 or 3 threads of the rack guide spring cap.

Sealant: Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent

- c. Temporarily install the rack guide spring cap.

12. Adjust total preload .

- a. To prevent the steering rack teeth from damaging the oil seal lip, temporarily install the RH and LH rack ends.

- b. Using a hexagon wrench (21 mm), torque the rack guide spring cap.

Torque: 25 N.m (250 kgf. cm, 18 ft. lbf)

- c. Using a hexagon wrench (21 mm), return the rack guide spring cap 12°.

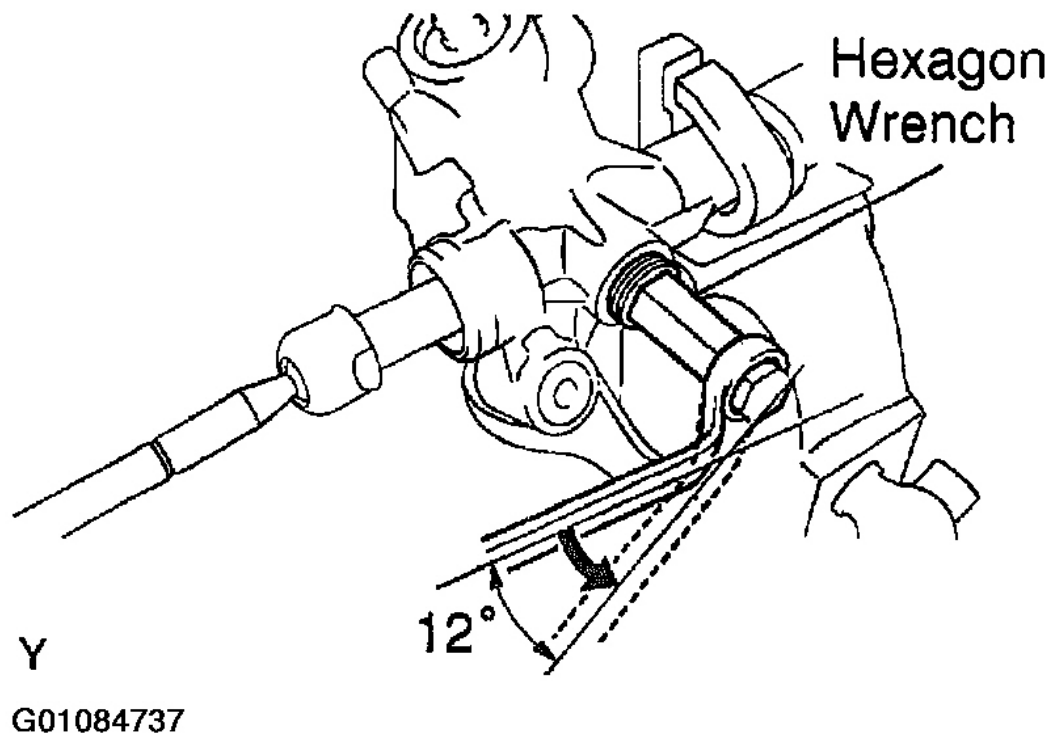


Fig. 82: Returning Rack Guide Spring
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- d. Using SST, turn the control valve shaft right and left 1 or 2 times.
SST 09616-00011

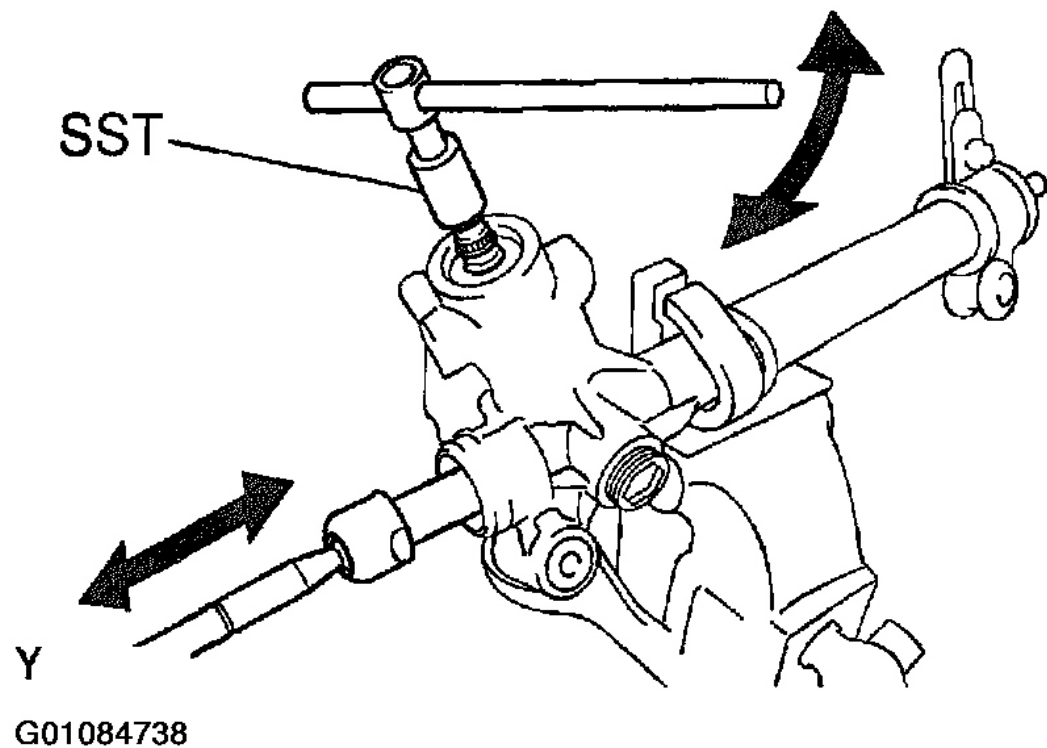


Fig. 83: Turning Control Valve Shaft Right & Left
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- e. Using a hexagon wrench (21 mm), loosen the rack guide spring cap until the rack guide spring is not functioning.
- f. Using SST, a torque wrench and a hexagon wrench (21 mm), tighten the rack guide spring cap until the preload is within the specification.

SST 09616-00011

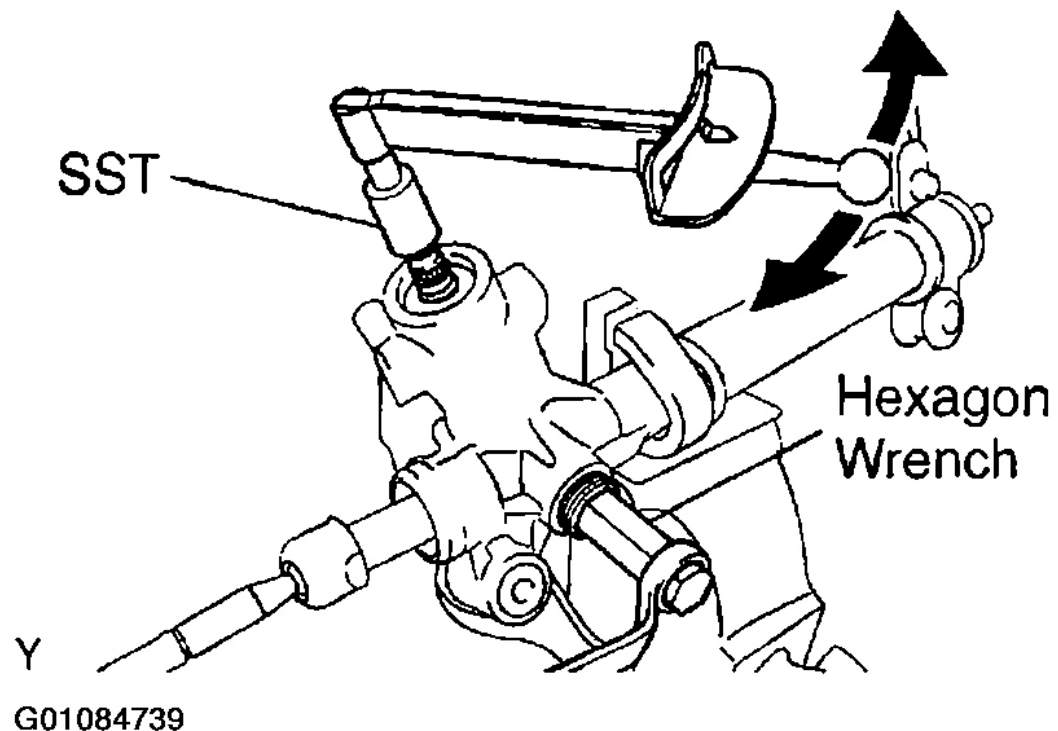


Fig. 84: Tightening Rack Guide Spring Cap
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Preload (turning): 1.1 -1.6 N.m (11 - 16 kgf. cm, 9.7 - 14.2 in. lbf)

13. Install rack guide spring cap lock nut .

- a. Apply sealant to 2 or 3 threads of the rack guide spring cap lock nut.
 1. **Sealant: Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent**
- b. Temporarily install the rack guide spring cap lock nut.
- c. Using a hexagon wrench (21 mm), hold the rack guide spring cap and using SST, torque the rack guide spring cap lock nut.

SST 09922-10011

Torque: 32 N.m (330 kgf. cm, 24 ft. lbf)

NOTE: Use SST 09922-10010 in the direction shown in Fig. 85 .

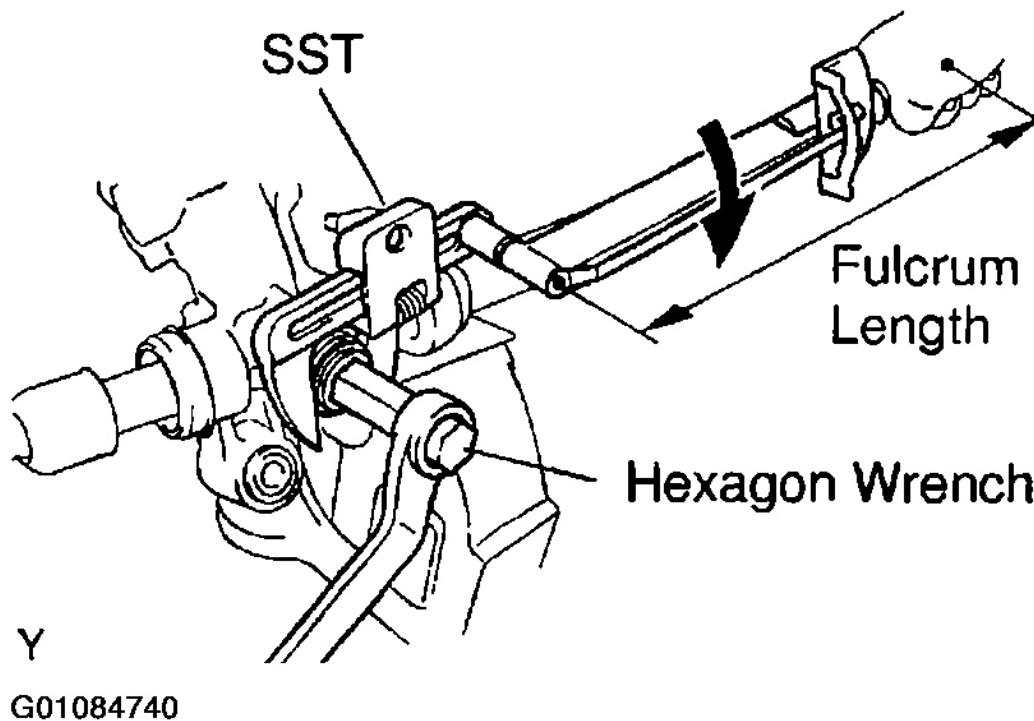


Fig. 85: Displaying Hexagon Wrench & Fulcrum Length
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Use a torque wrench with a fulcrum length of 345 mm (13.58 in.).

- d. Recheck the total preload.

Preload (turning): 1.1 - 1.6 N.m (11 - 16 kgf. cm, 9.7 - 14.2 in. lbf)

- e. Remove the RH and LH rack ends.

14. Install RH and LH claw washers and rack ends .

- a. Install a new claw washer, and temporarily install the rack end.

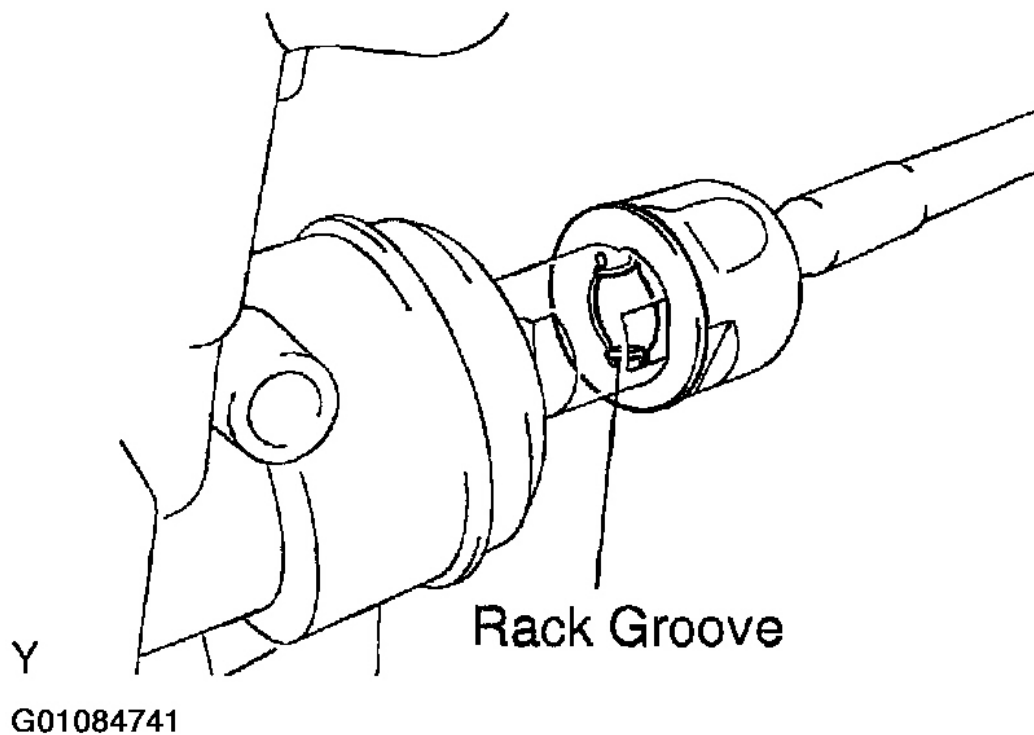
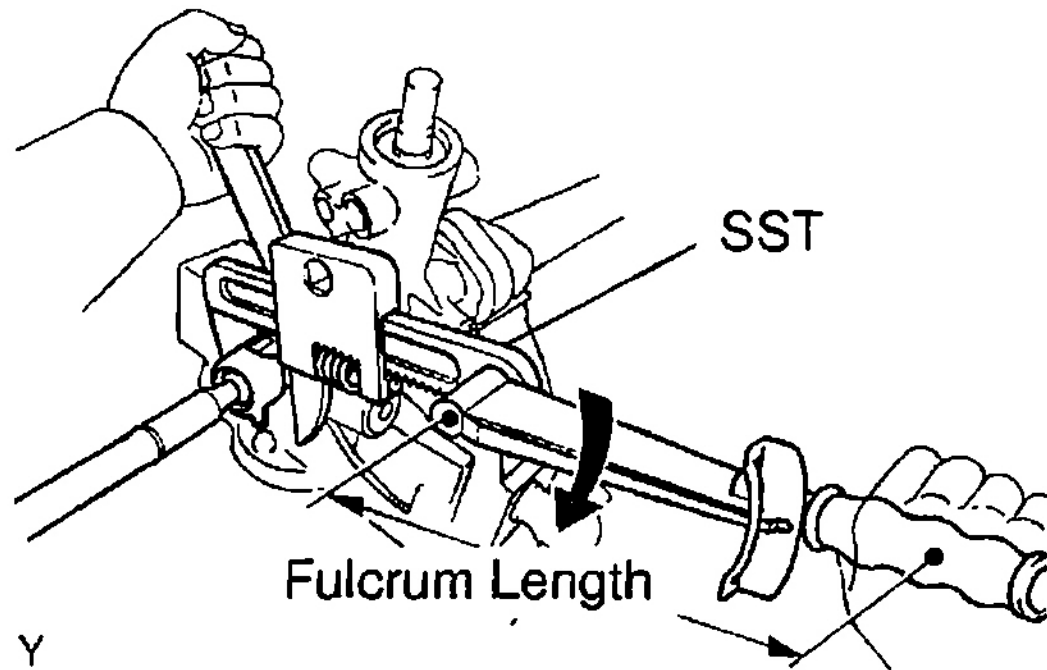


Fig. 86: Identifying Rack End

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: **Align the claws of the claw washer with the steering rack grooves.**

- b. Using a spanner (22 mm), hold the steering rack steadily and using SST, torque the rack end.
SST 09922-10010



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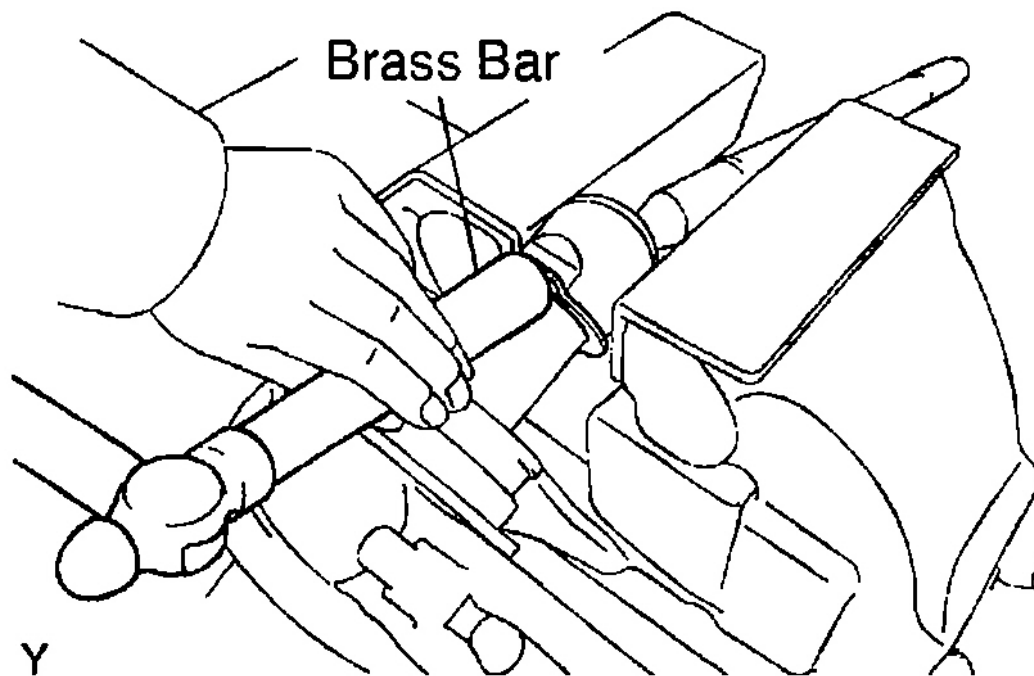
Fig. 87: Using Spanner & SST To Torque Rack End
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Torque: 60 N.m (615 kgf. cm, 44 ft. lbf)

NOTE: Use SST 09922-10010 in the direction shown in Fig. 87 .

NOTE: Use a torque wrench with a fulcrum length of 345 mm (13.58 in.).

- c. Using a brass bar and a hammer, stake the washer.



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Fig. 88: Using Brass Bar To Stake Washer
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: **Avoid any impact on the steering rack.**

- d. Employ the same manner described above to the other side.
- 15. **Install No. 1 rack housing bracket .**
 - a. Install the grommet to the No. 1 rack housing bracket.
 - b. Align the matchmarks on the bracket and housing.
 - c. Install and torque the bolt.

Torque: 61 N.m (620 kgf. cm, 45 ft. lbf)

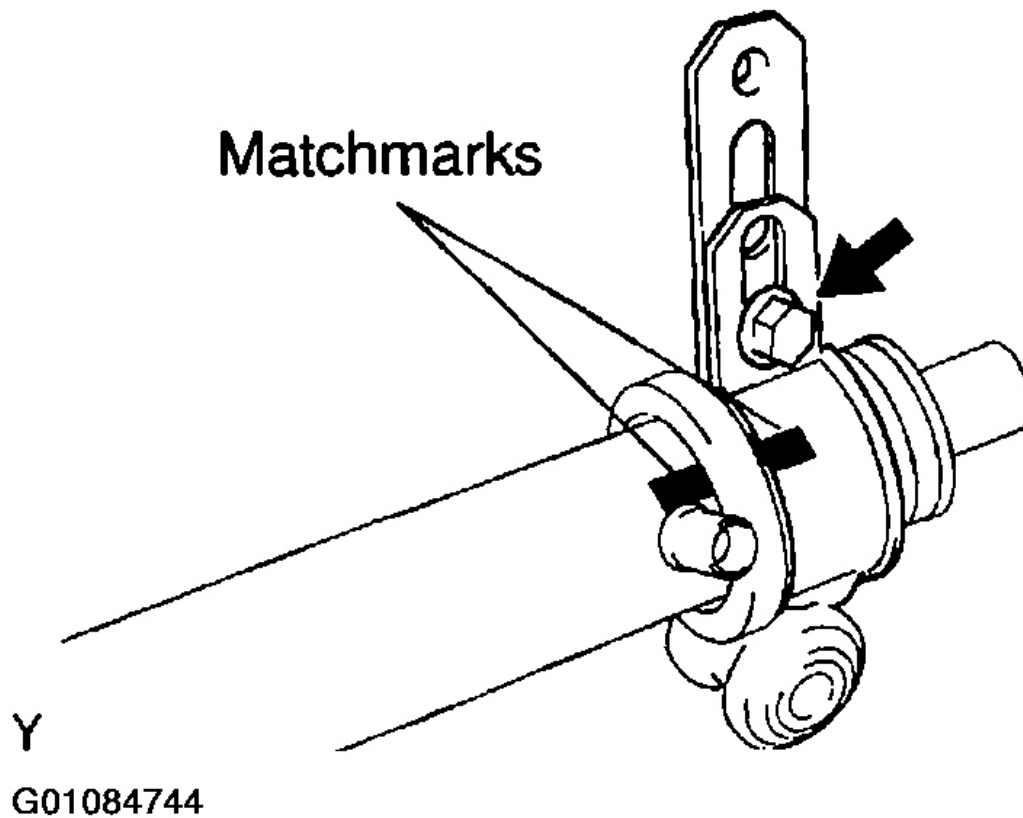


Fig. 89: Aligning Bracket & Housing Matchmarks
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

16. Install RH and LH rack boots, clamps and clips .

- a. Ensure that the steering rack hole is not clogged with grease.

NOTE: If the hole is clogged, the pressure inside the boot will change after it is assembled and the steering wheel is turned.

- b. Install the boot, clip and a new clamp.

NOTE: Be careful not to damage or twist the boot.

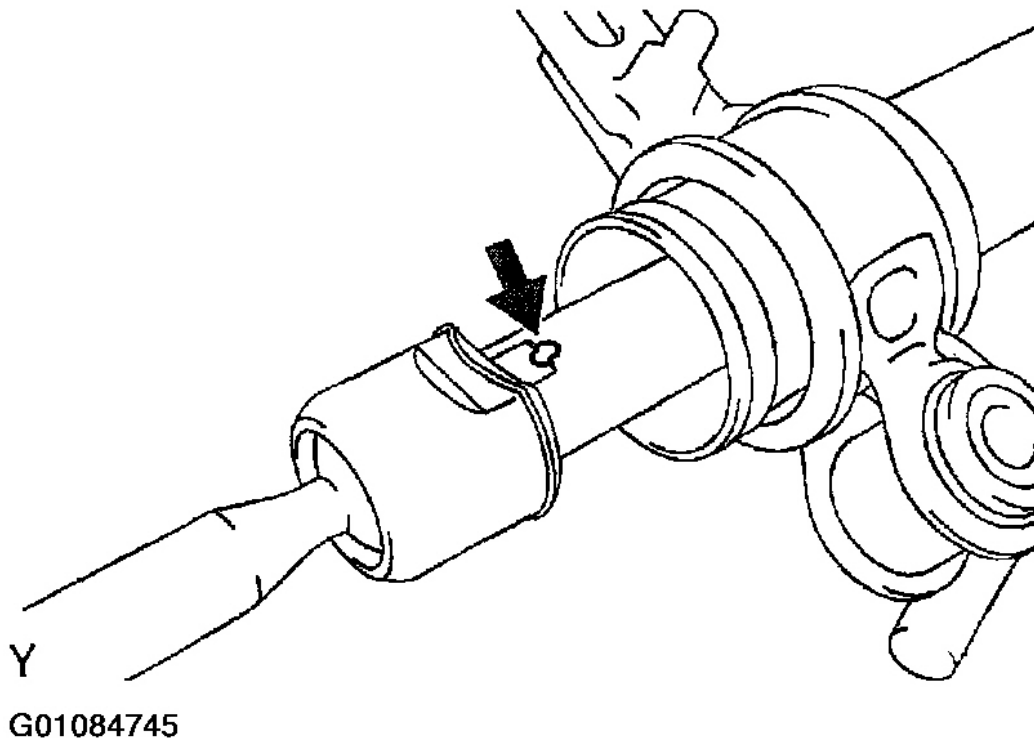


Fig. 90: Installing Boot, Clip & new Clamp
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- c. Tighten the clamp as shown in **Fig. 91** .

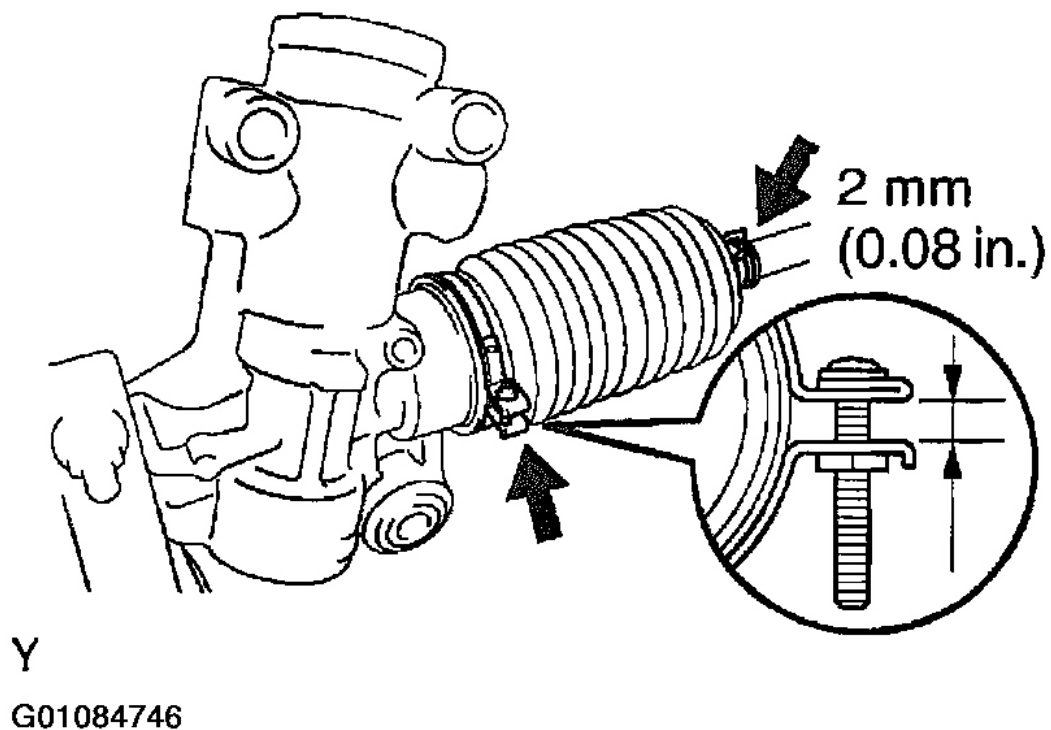


Fig. 91: Tightening Clamps

Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- d. Employ the same manner described above to the other side.
- 17. **Install RH and LH tie rod ends and lock nuts .**
 - a. Screw the lock nut and tie rod end onto the rack end until the matchmarks are aligned.

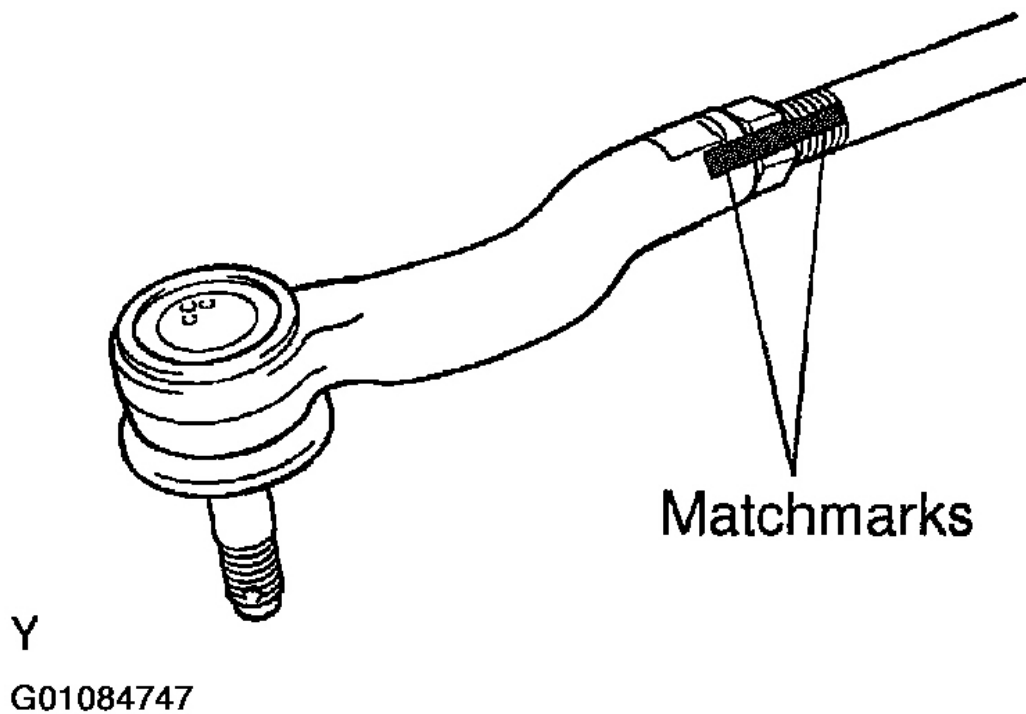


Fig. 92: Locating & Aligning Matchmarks
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- b. Employ the same manner described above to the other side.
- c. After adjusting toe-in, torque the nut (See **BLEEDING**).

Torque: 74 N.m (750 kgf. cm, 54 ft. lbf)

- 18. **Install turn pressure tubes .**

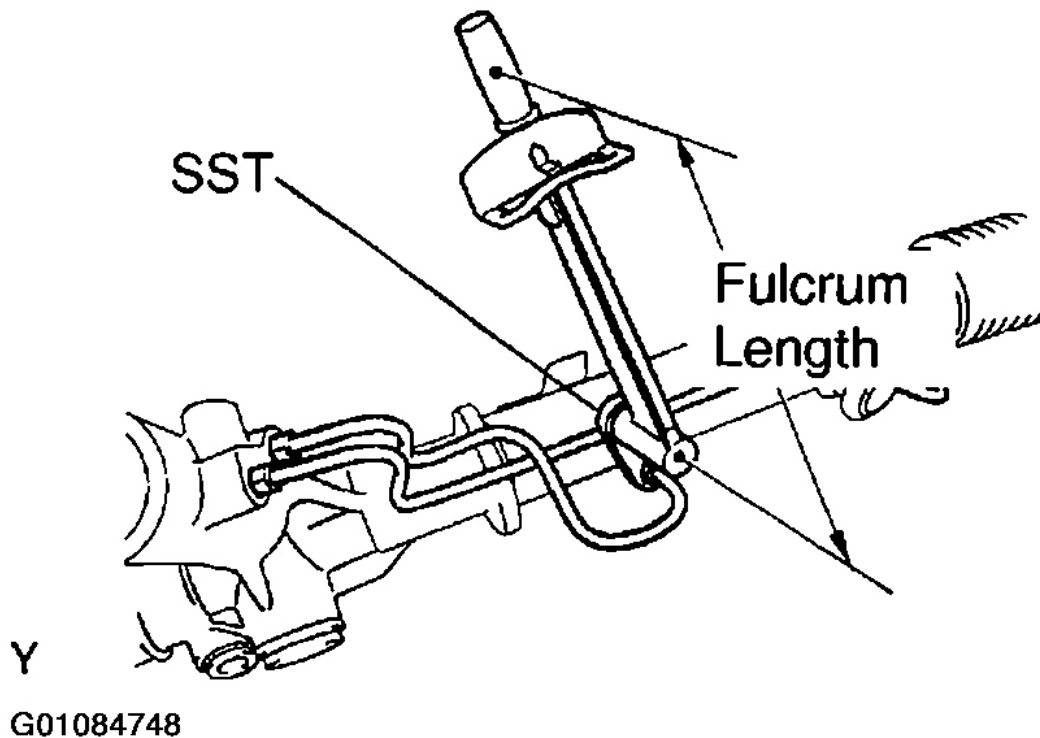


Fig. 93: Installing Turn Pressure Tubes
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Using SST, install the 2 turn pressure tubes.

SST 09023-38200

Torque: 27 N.m (270 kgf. cm, 20 ft. lbf)

NOTE: Use a torque wrench with a fulcrum length of 250 mm (9.84 in.).

INSTALLATION

1. **Install PS gear assembly .**
 - a. Place the PS gear assembly in installation position.

NOTE: Do not damage the turn pressure tubes.

- b. Align the matchmarks on the steering intermediate extension and control valve shaft.

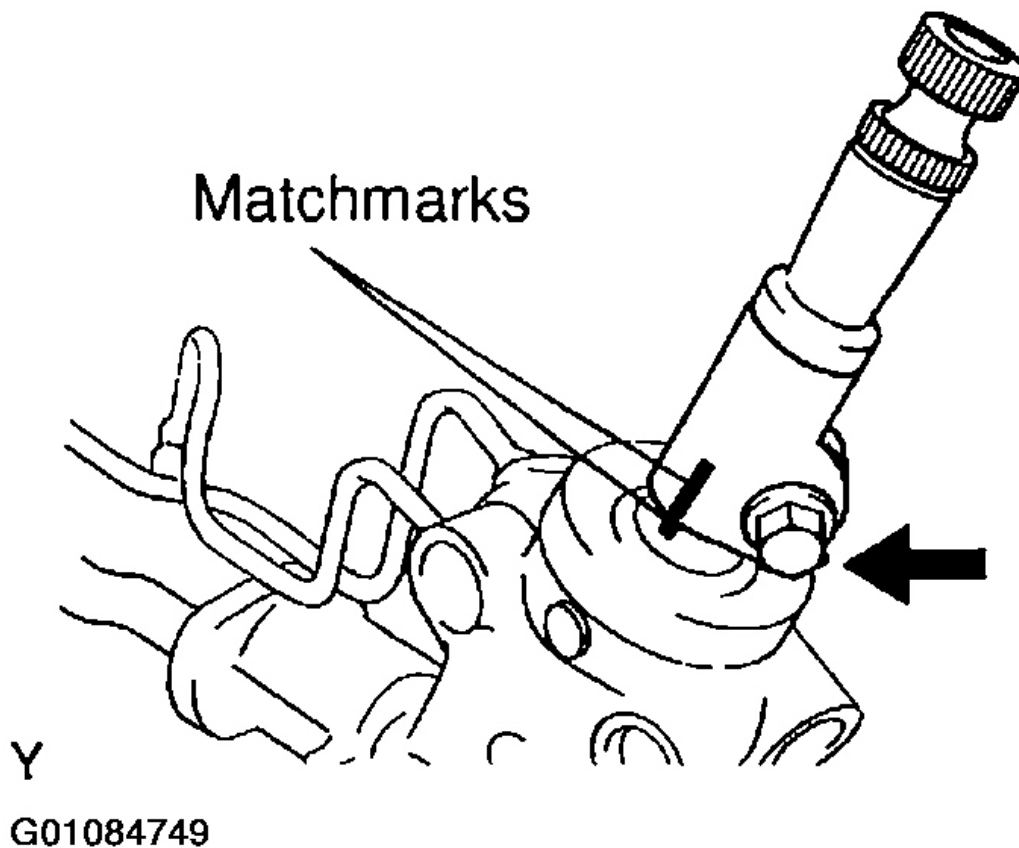


Fig. 94: Locating & Aligning Matchmarks
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

- c. Install the bolt.

Torque: 35 N.m (380 kgf. cm, 26 ft. lbf)

- d. Place the steering column hole cover clamp and cover on the control valve shaft.
- e. Install the PS gear assembly with the 2 bolts.

Torque: 137 N.m (1,400 kgf. cm, 101 ft. lbf)

2. Connect pressure feed and return tubes .

- a. Connect the pressure feed and return tubes to the PS gear with the 2 bolts.

Torque: 12.5 N.m (130 kgf. cm, 9 ft. lbf)

- b. Using SST, connect the pressure feed and return tubes.

SST 09023-12700

Torque: 40 N.m (410 kgf. cm, 29 ft. lbf)

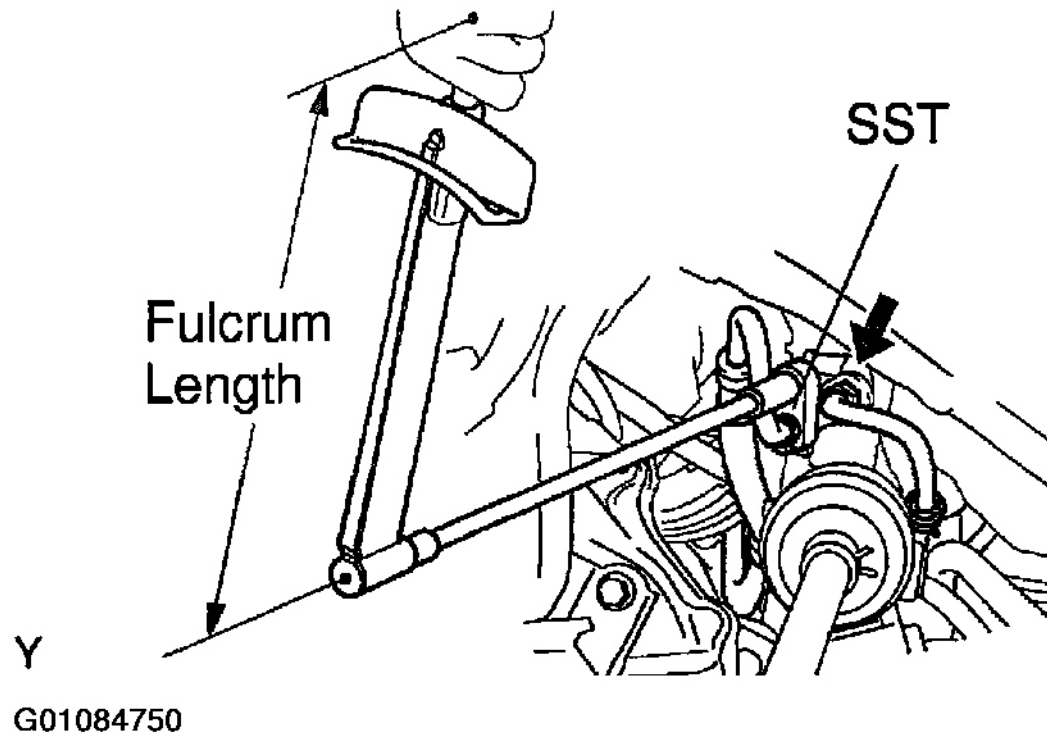


Fig. 95: Connecting Pressure Feed & Return Tubes
 Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

NOTE: Use a torque wrench with a fulcrum length of 345 mm (13.58 in.).

3. Connect stabilizer bar .

Connect the stabilizer bar with the 4 bolts.

Torque: 29 N.m (380 kgf. cm, 22 ft. lbf)

4. Connect RH and LH tie rod ends (See FRONT AXLE HUB & WHEEL BEARING) .

5. Connect steering column hole cover .

- a. Connect the steering column hole cover to the dash panel.
- b. Tighten the clamp of the steering column hole cover.

6. Connect No. 2 intermediate shaft assembly (See INSTALLATION) .

7. Place front wheels facing straight ahead .

NOTE: Do it with the front of the vehicle jacked up.

8. **Center spiral cable (See INSTALLATION) .**
9. **Install steering wheel .**
 - a. Align the matchmarks on the steering wheel and steering column main shaft.
 - b. Temporarily tighten the steering wheel set nut.
10. **Bleed power steering system (See BLEEDING) .**
11. **Check steering wheel center point .**
12. **Torque steering wheel set nut .**

Torque: 34 N.m (350 kgf. cm, 25 ft. lbf)
13. **Install steering wheel pad (See INSTALLATION) .**
14. **Check front wheel alignment (See RAV4) .**