

Section 6

**FRONT END  
AND  
STEERING GEAR**

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# GROUP 60

## GENERAL TOOLS

Special tools are marked 999 or SVO (e.g. 9991801 or SVO 1801).

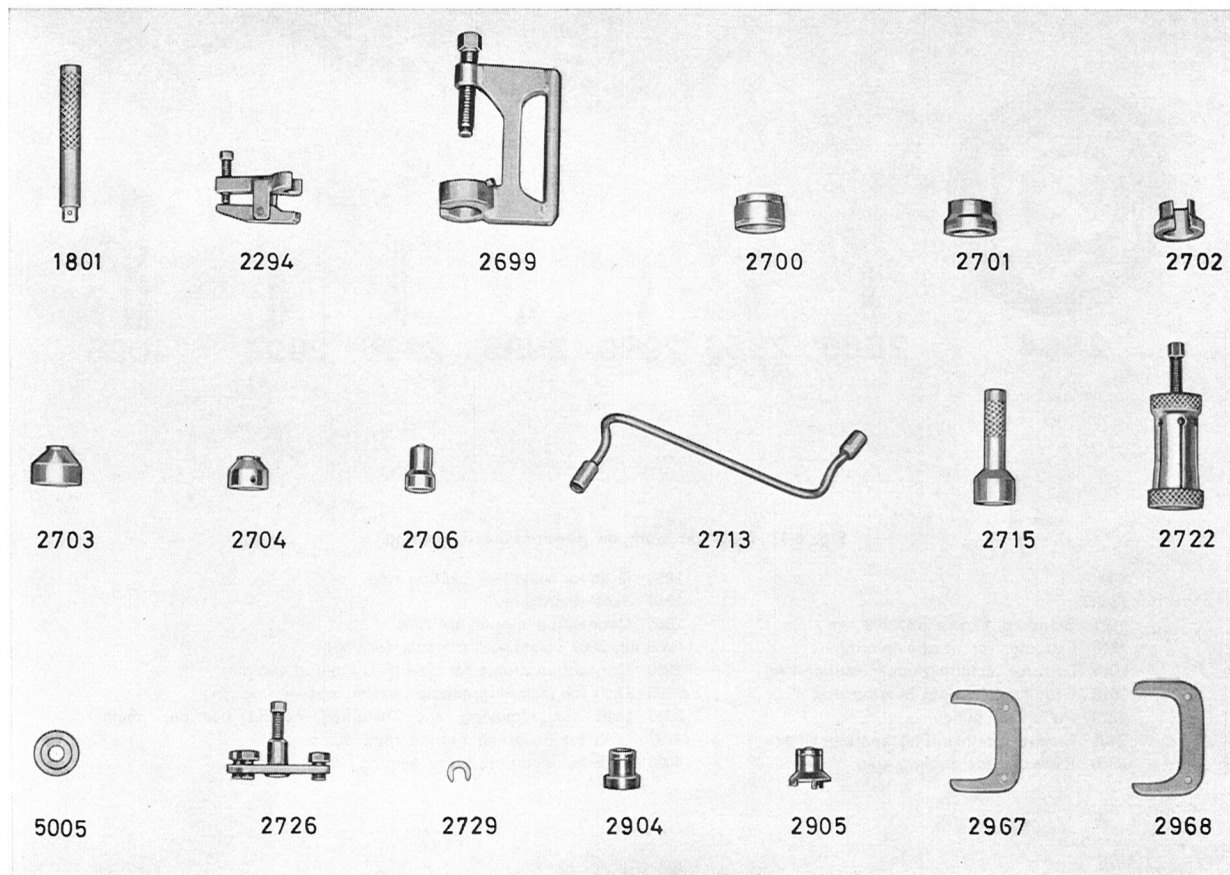


Fig. 6-1. Tools for wheel adjustment and work on front axle

- 999  
(SVO)
- 1801 Standard handle 18×200
  - 2294 Press tool, for removing ball joints, tie-rod end
  - 2699 Press tool, for removing and installing ball joints and rubber bushings, control arms
  - 2700 Sleeve, removing lower ball joint
  - 2701 Sleeve, removing and installing upper ball joint and bushings in lower control arm, also installing lower ball joint
  - 2702 Sleeve, removing and installing bushings upper control arm
  - 2703 Drift, installing lower ball joint
  - 2704 Drift, installing upper ball joint
  - 2706 Drift, removing and installing bushings, upper control arm
  - 2713 Spanner ( $\frac{5}{8}$ " ) for upper control arm shaft bolt
  - 2715 Drift, installing and removing grease cap on hub
  - 2722 Puller, inner ring, inner front wheel bearing
  - 2726 Puller, front wheel hub
  - 2729 Spacer, removing shaft, upper control arm
  - 2904 Drift, removing and installing bushings for diagonal tires, lower control arm
  - 2905 Drift, for removing and installing bushings for radial tires
  - 2967 Gauge for lower ball joint, type 1
  - 2968 Gauge for lower ball joint, type 2
  - 5005 Drift, for installing outer ring, inner front wheel bearing and spacer hub

For removal and installation of front end complete, engine lift tool 5006 is also used, see Fig. 6-16.

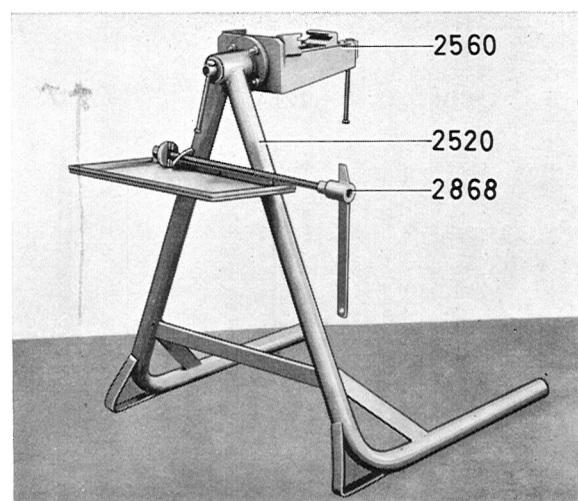
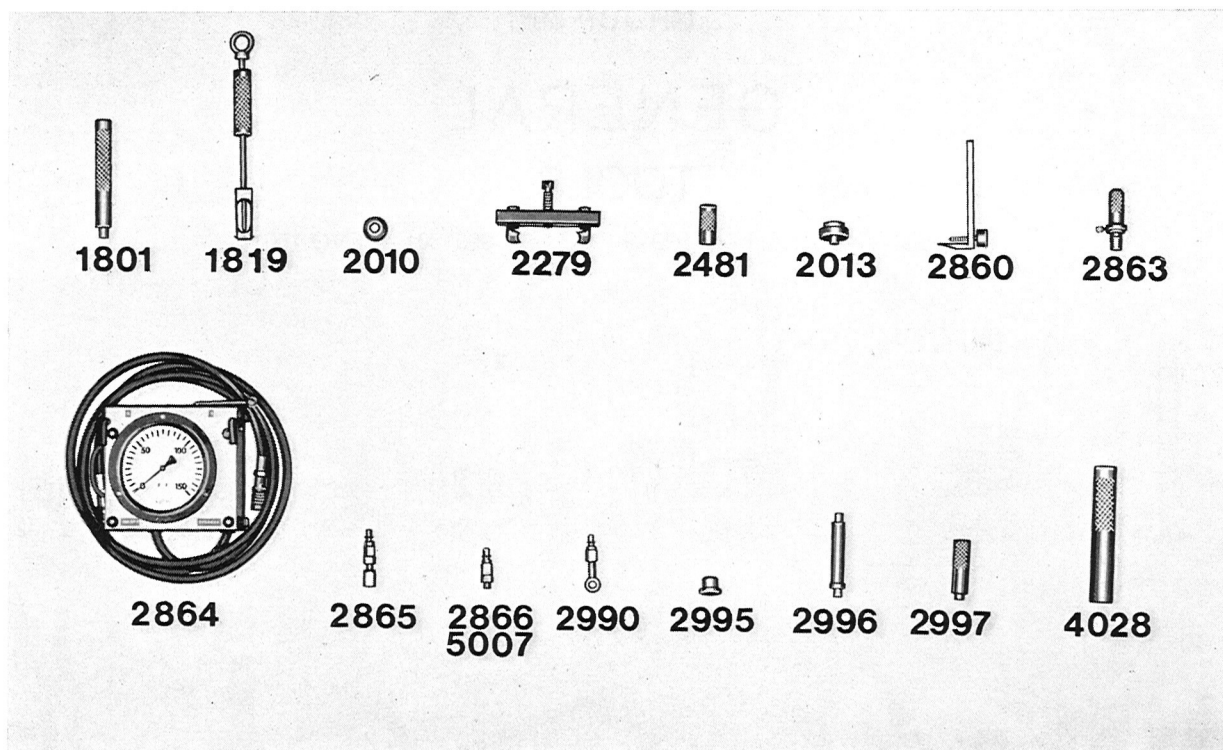


Fig. 6-2. Tools for work with removed front axle

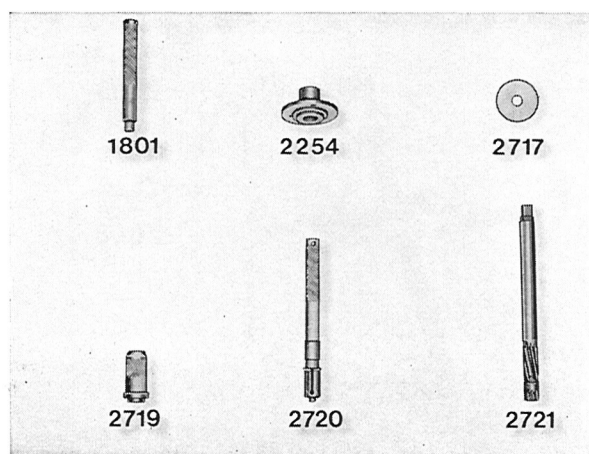
- 999  
(SVO)
- 2520 Stand for fixture
  - 2560 Fixture
  - 2868 Press tool for spring



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Fig. 6-3. Tools for work on power-assisted steering

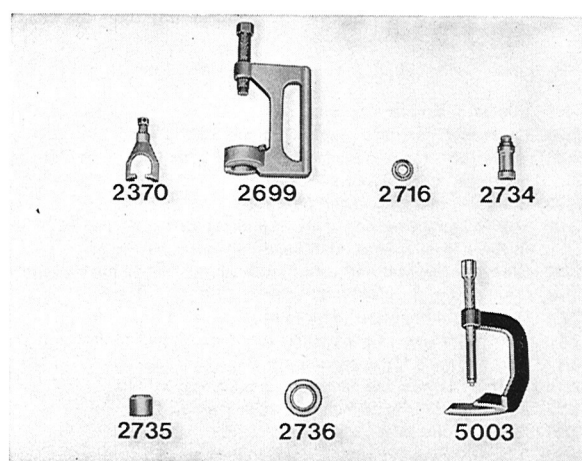
- |                                         |                                                        |
|-----------------------------------------|--------------------------------------------------------|
| 999                                     | 2863                                                   |
| (SVO)                                   | Drift for installing sealing ring                      |
| 1801                                    | 2864                                                   |
| Standard handle 18×200                  | Test instrument                                        |
| 1819                                    | 2865                                                   |
| Extractor for needle bearings           | Connection nipple for 2864                             |
| 2010                                    | 2866 alt. 5007                                         |
| Drift for installing upper sealing ring | Connection nipple for 2864                             |
| 2013                                    | 2866 alt. 5007 Connection nipple for 2864              |
| Drift for installing bearing ring       | Connection nipple for 2864 (R-H steered vehicle)       |
| 2279                                    | 2990                                                   |
| Puller for pulley                       | Connection nipple for 2864 (R-H steered vehicle)       |
| 2481                                    | 2995                                                   |
| Sleeve for installing bearing sleeve    | Drift for installing needle bearing and sealing ring   |
| 2860                                    | 2996                                                   |
| Extractor for sealing ring              | Drift for removing and installing needle bearing, pump |
|                                         | 2997                                                   |
|                                         | Drift for installing sealing ring, pump                |
|                                         | 4028                                                   |
|                                         | Drift for installing lower sealing ring                |



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107165

Fig. 6-4. Tools for work on removed mechanical steering

- |                                                         |
|---------------------------------------------------------|
| 999                                                     |
| (SVO)                                                   |
| 1801                                                    |
| Standard handle 18×200                                  |
| 2254                                                    |
| Guide for reamer SVO 2721                               |
| 2717                                                    |
| Drift, for installing upper bearing race, steering worm |
| 2719                                                    |
| Sleeve, for installing ring, pitman arm shaft           |
| 2720                                                    |
| Tool for removing bushing, pitman arm shaft             |
| 2721                                                    |
| Reamer for bushing, pitman arm shaft                    |



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Fig. 6-5. Tools for work on other steering components

- |                                                               |
|---------------------------------------------------------------|
| 999                                                           |
| (SVO)                                                         |
| 2370                                                          |
| Puller, pitman arm                                            |
| 2699                                                          |
| Press tool, for removing and installing bushings on relay arm |
| 2716                                                          |
| Drift, for installing bushing, pitman arm shaft               |
| 2734                                                          |
| Drift, for removing bushing, relay arm                        |
| 2735                                                          |
| Drift, for installing bushing, relay arm                      |
| 2726                                                          |
| Counterhold, for removing and installing bushing, relay arm   |
| 5003                                                          |
| Puller for steering wheel                                     |

# STEERING GEOMETRY

## WHEEL ANGLES

The front wheels must have certain pre-determined settings, normally known as the "front end alignment" or the "wheel angles", in order to give the vehicle good steering properties and a minimum of tire wear.

The "wheel angles" refer to: caster, camber, king pin inclination, toe-out and toe-in.

## CASTER

Caster generally refers to the longitudinal inclination (forwards or backwards) of the king pin. As this vehicle does not have a king pin, the caster consists of the angle between a vertical line and a line through the center of the ball joints (Fig. 6-6). Positive caster imparts a trailing action to the front wheels and helps to keep the front wheels in the straight-ahead position.

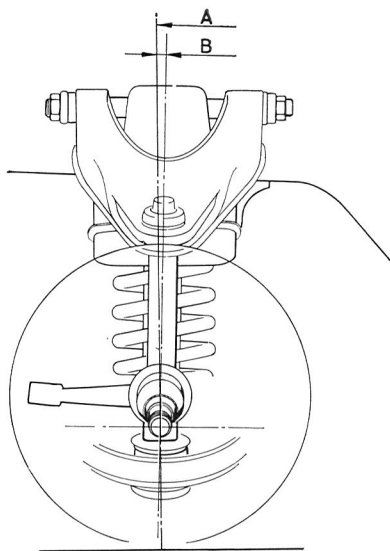


Fig. 6-6. Caster  
A=Vertical line  
B=Caster

## CAMBER

Camber is the inclination of the wheel itself outwards or inwards. It is positive if the wheel is inclined outwards (see C, Fig. 6-7) and negative if the wheel inclines inwards. Incorrect camber causes uneven tire wear.

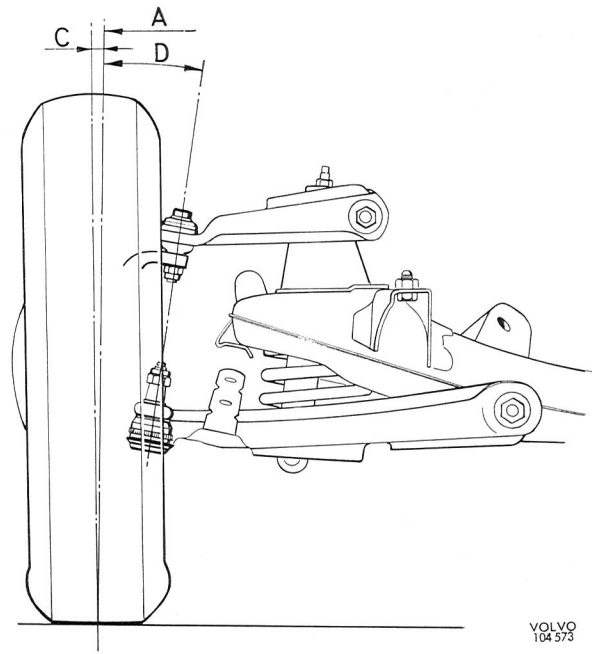


Fig. 6-7. Camber and king pin inclination

A=Vertical line C=Camber D=King pin inclination

## KING PIN INCLINATION

King pin inclination means the inclination of the king pin inwards. Since this car does not have a king pin, the inclination is represented by an angle made between a vertical line and a line through the center of the ball joints (D, Fig. 6-7).

King pin inclination causes the center lines of the ball joints and the wheel to approach each other towards the road surface. This makes the wheel easier to turn. The inclination also assists the tendency of the wheel to run straight forwards since the car lifts very slightly when the wheels are turned.

## TOE-OUT

To be in correct relative alignment, when negotiating a turn, the inside front wheel travels in a circle having a smaller radius than the circle traveled by the outside front wheel.

This relationship is determined by the design of the steering knuckle arms and the steering rod, see Fig. 6-8.

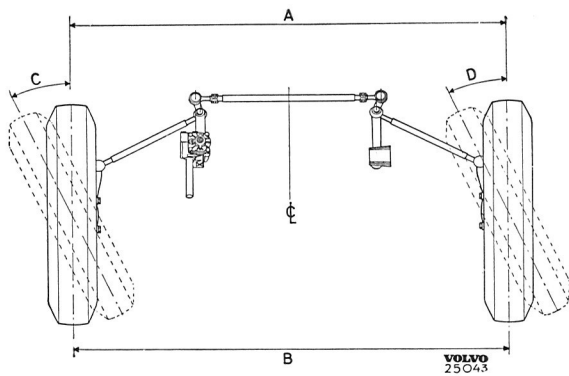


Fig. 6-8. Toe-out and toe-in

### CHECKING WITH WHEEL ALIGNMENT INDICATOR (Master Toe Gauge)

The wheel alignment indicator should be calibrated between  $-2$  to  $+5$  m/km and is used as follows: Straight line with the indicator when the car is about 2 meters ( $6\frac{1}{2}$  ft) from the indicator. **Let go** the steering wheel and slowly drive over the indicator plate ( $2-4$  kmph= $2\frac{1}{2}$  miles). **NOTE:** The steering wheel must **not** be touched until the front wheels have come on the other side of the indicator.

If one of the red lamps lights, and a buzzer starts buzzing, then there is something wrong with the front wheel alignment and it should be adjusted.

### PROCEDURE BEFORE ADJUSTING WHEEL ANGLES

Wheel angles can be influenced by the factors listed below. Therefore, before measuring and adjusting, any faults should be remedied.

1. Check tire pressure and wear.
2. Play in front wheel bearings.
3. Play in ball joints or control arm attachments.
4. Broken springs.
5. Abnormal (temporary) equipment or loading.

Other factors which can influence the steering during driving without being revealed when measuring the wheel angles are:

1. Wheel out-of-true more than 2.5 mm ( $.1''$ ).
2. Defective shock absorbers.
3. Incorrect steering gear adjustment.
4. Play in intermediate arm journaling or steering rod parts.

### MEASURING WHEEL ANGLES

The wheel angles are measured with special measuring instruments of which there are many different types. No general description can, therefore, be given as to how measuring should be made.

The measuring principle is that camber is measured directly with the wheels pointing straight forwards. Caster and king pin inclination cannot be measured directly. Instead, the angular alteration which occurs when the wheel is turned from  $20^\circ$  outwards to  $20^\circ$  inwards is measured on the instrument.

Many types of modern wheel alignment measuring instruments require that the wheels are locked with, for example, the help of a pedal jack. When measuring the toe-in, the so-called "wheel spreader" should be applied at the front between the wheels at a spring force of 100—150 N (22—33 lb). When measuring the wheel angles, follow the instructions for the measuring instruments concerned.

### CHECKING KING PIN INCLINATION

The king pin inclination, which on this vehicle is represented by the inclination of the centerline of the ball joints, should be  $7.5^\circ$  at a camber of  $0^\circ$ . This cannot be adjusted and is difficult to measure exactly due to the tension and resilience in the parts, so that the angle read on the instruments will not be the exact king pin inclination but can serve as a guide.

### CHECKING TOE-OUT

1. Before running the vehicle front wheels onto turntables, set the turntables to zero and lock them. Make sure the wheels point straight ahead.
2. Turn the wheels to the left until the right wheel has turned  $20^\circ$  inwards. The scale on the left turntable should then read  $22.5 \pm 1^\circ$ .
3. Check the position of the right wheel in the same manner by turning the wheels to the right until the left wheel has turned  $20^\circ$  inwards, when the right turntable scale should give the same reading previously indicated on the left. Both measurements should thus lie within the above mentioned tolerances, otherwise it means that the steering gear or front end is distorted.
4. There are no adjusting possibilities, but if the toe-out is incorrect, the steering arms and steering rods should be checked. Replace any parts that are damaged.

## ADJUSTING WHEEL ANGLES

**NOTE:** The front wheel angles are always adjusted in the following order:

1. Caster
2. Camber
3. Toe-in

To save time and labor, caster and camber should be adjusted at the same time, see under "Adjusting the camber".

**FRONT END ALIGNMENT** (camber, caster, toe-in, check and adjust, incl. tire wear check=Volvo Standard Times Op. No. 60152.

### CASTER

The caster for each wheel should be within a tolerance range of  $1^{\circ}$  to  $+2^{\circ}$ , that is min  $1^{\circ}$  and max.  $2^{\circ}$  positive. The difference between both sides should not, however, exceed  $\frac{1}{2}^{\circ}$ .

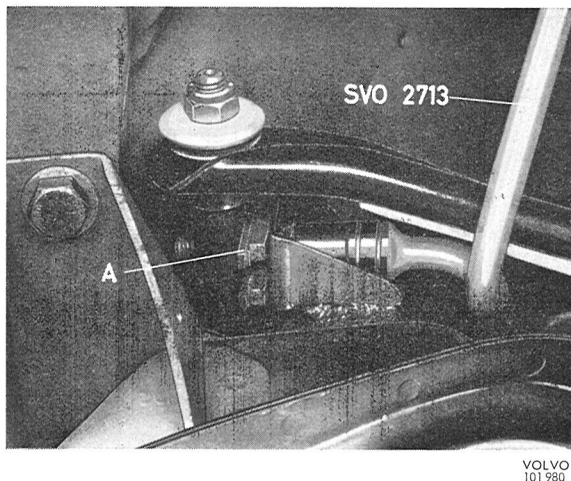


Fig. 6-9. Adjusting caster and camber  
A=Shims

To adjust, slacken the special bolts at the upper control arm shaft with tool 2713 (Fig. 6-9). Use one end of the tool for the front bolt and the other for the rear bolt. After the bolts have been slackened several turns, the requisite number of shims can be either removed or added, whichever is the case. Positive caster is obtained by either **adding** shims to the **rear** bolt or **removing** shims at the **front** bolt.

The diagram in Fig. 6-10 shows the shim thicknesses required for a certain alteration in angle. Shims are stocked in thicknesses of .15—.5—1.0—3.0 and 6.0 mm (.006—.020—.039—.12 and .24"). The caster is altered to the same extent by either

1. removing a shim at one of the bolts,
2. adding a shim to the other bolt,
3. moving over half of the required shim thickness from one bolt to the other.

For proper camber, adjustment should be according to alternative 3.

After adjustment has been made, tighten the bolts to a torque of 55—70 Nm (40—50 lbft).

### CAMBER

The camber for each wheel should be within a tolerance range of  $0^{\circ}$  to  $+\frac{1}{2}^{\circ}$ , that is, it should be min.  $0^{\circ}$  and max  $\frac{1}{2}^{\circ}$  positive.

To adjust, slacken the special bolts at the upper control arm shaft several turns with tool 2712 (Fig. 6-9). Use one end of the tool for the front bolt and the other for the rear bolt. Then either increase or reduce the number of shims equally for both bolts. More **positive** camber is obtained by **removing** shims, and **negative** camber by **increasing** the number of shims.

The shim thickness required for a certain alteration in angle is shown in the diagram in Fig. 6-10. Shims are stocked in thicknesses of .15—.5—1.0—3.0 and 6.0 mm (.006—.020—.039—.12 and .24"). The camber is altered by removing or adding an equal number of shims at both the bolts. After adjustment torque the bolts to 55—70 Nm (40—50lbft).

To save time and labor, adjust the caster and camber at the same time by removing or adding shims for the camber and altering the number of shims for the caster. If, for example, the camber is increased  $.6^{\circ}$  and the caster  $1/4^{\circ}$ , first remove 2.5 mm (.1") in shims at both the bolts and move .3 mm (.012") in shims from the front to the rear bolt.

### TOE-IN

Check and adjust toe-in=Volvo Standard Times Op. No. 60106

Toe-in should be 2—5 mm ( $\frac{1}{8}$ ") with the wheel spreader. Incorrect toe-in is adjusted by slackening the lock nuts on the tie rod, after which the rod is turned in the required direction. The distance between the tires at the front is reduced, that is to say, toe-in is increased by turning the tie-rod in the normal direction of rotation of the wheels.

After adjustment torque the lock nut to 75—90 Nm (55—65 lbft).

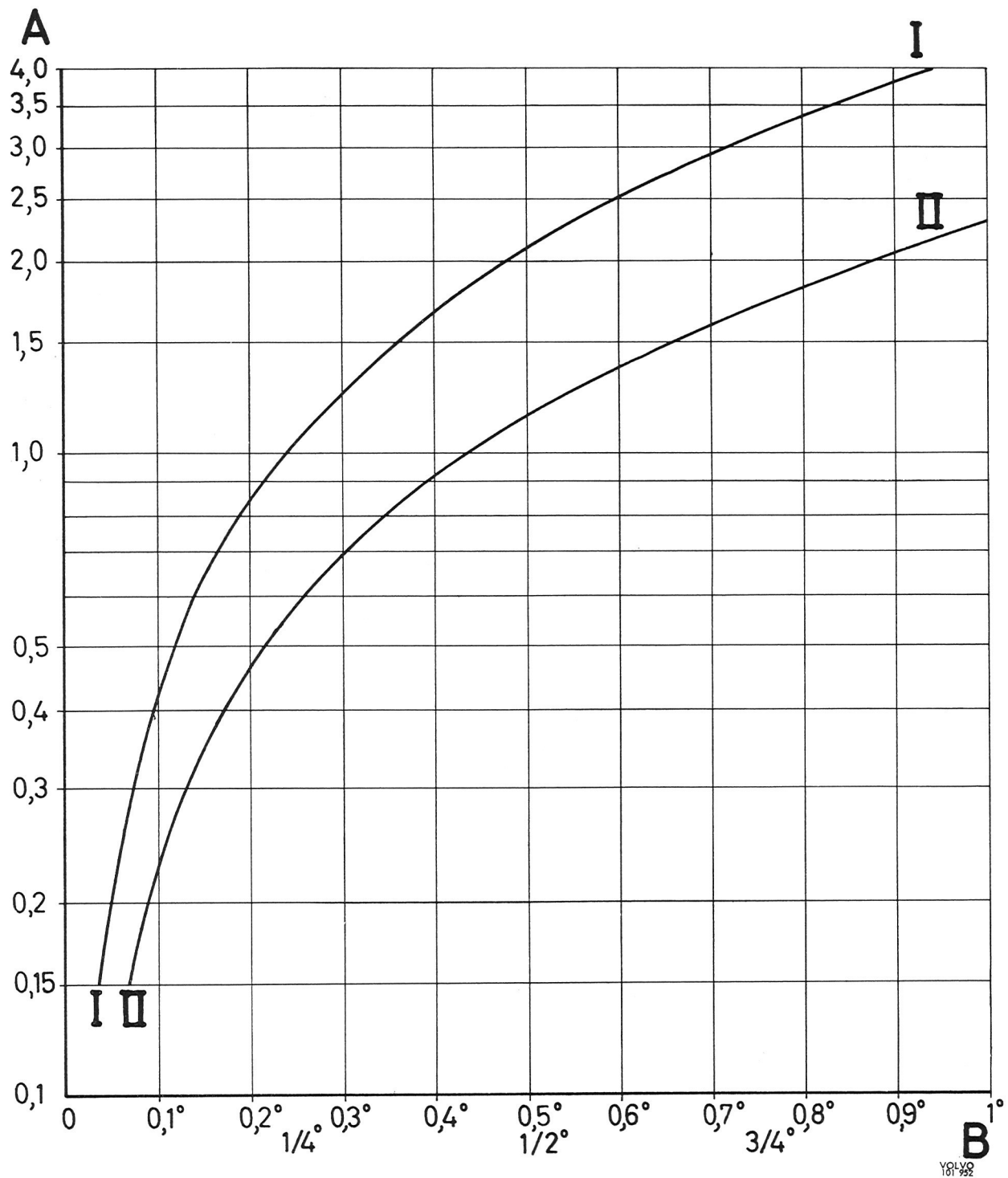


Fig. 6-10. Diagram for alteration of caster and camber

I=Camber  
 II=Caster  
 A=Shims (mm)  
 B=Alteration of angle



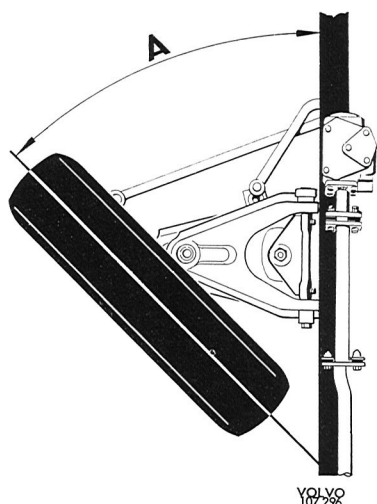


Fig. 6-11. Adjusting max. wheel lock

A=40—41° without power steering  
38—39° with power steering

### ADJUSTING STEERING LIMITS

Turning of the wheels is limited by stop screws at the pitman arm (Fig. 6-12) and at the relay arm. Adjust as follows:

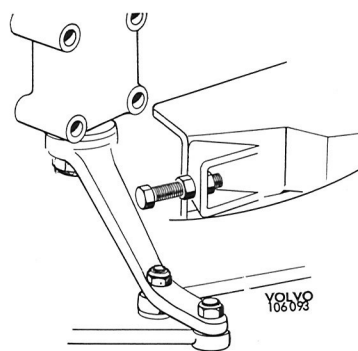


Fig. 6-12. Adjusting screw, max. wheel lock

1. Turn the left wheel for a left hand turn as far as it goes. Check the wheel lock according to Fig. 6-11. If the lock is not as in this figure, then adjust to this angle with the adjusting screw (Fig. 6-12).
2. Repeat this procedure with the right wheel and the stop screw on the other arm.

**NOTE:** Check that brake hoses are clear at full wheel lock.

## GROUP 62

# FRONT AXLE

## GENERAL INFORMATION

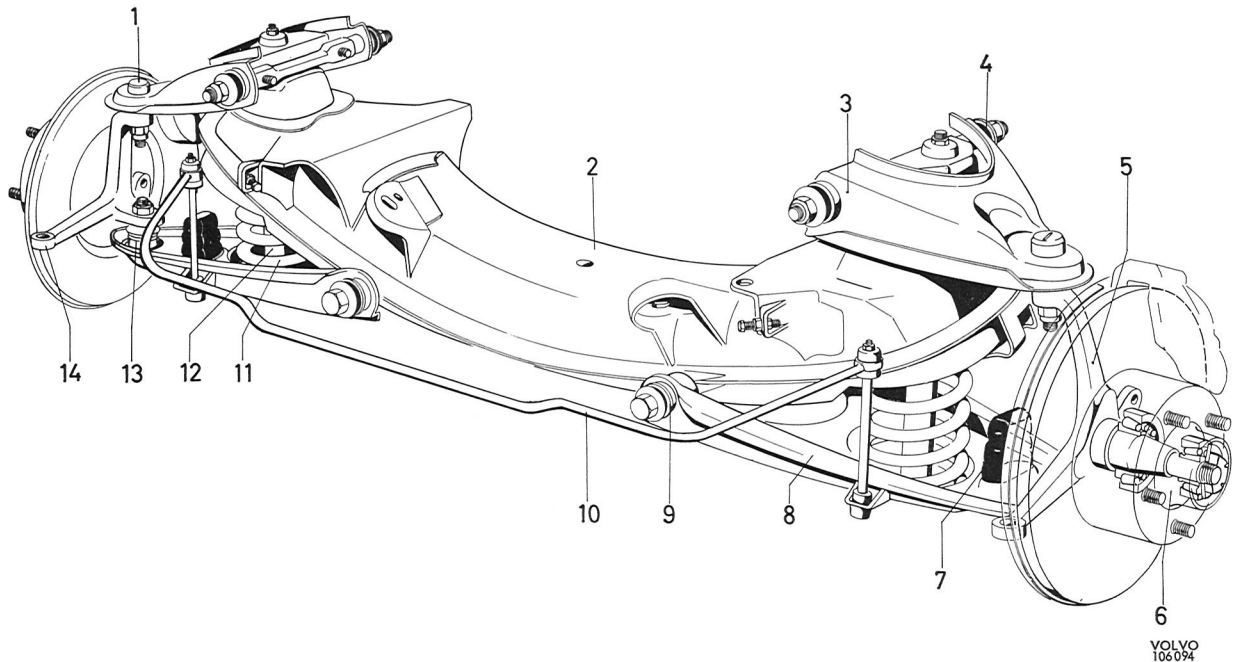


Fig. 6-13. Front axle

- |                                   |                              |
|-----------------------------------|------------------------------|
| 1. Upper ball joint               | 8. Lower control arm         |
| 2. Front axle member              | 9. Lower control arm bushing |
| 3. Upper control arm              | 10. Stabilizer               |
| 4. Upper control arm bushing      | 11. Coil spring              |
| 5. Steering knuckle (hub carrier) | 12. Shock absorber           |
| 6. Hub                            | 13. Lower ball joint         |
| 7. Rubber buffer                  | 14. Steering arm             |

The vehicle has independent front wheel suspension. This means that there is no actual front axle, this being replaced by a robust box-section front axle member, which is bolted to the self-supporting body. The front wheel suspension and springs are attached at the ends of the member. The construction is illustrated in Fig. 6-13.

The steering knuckle (hub carrier) is pivoted on the upper and lower control arms by ball joints (1 and 13) which are pressed into the control arms. The control arms shafts are carried in rubber bushings

(4 and 9), which are journaled in the control arms. Camber and caster are adjusted by shims between the upper control arm shaft and its attachment in the front axle member (see Fig. 6-9).

The front wheels are carried in taper roller bearings Fig. 6-13. The front spring assembly consists of coil springs (11) inside which telescopic shock absorbers (12) are installed. In order to increase its anti-roll properties, the car is equipped with a stabilizer (10) which is attached partly to the lower control arm and partly to the body.



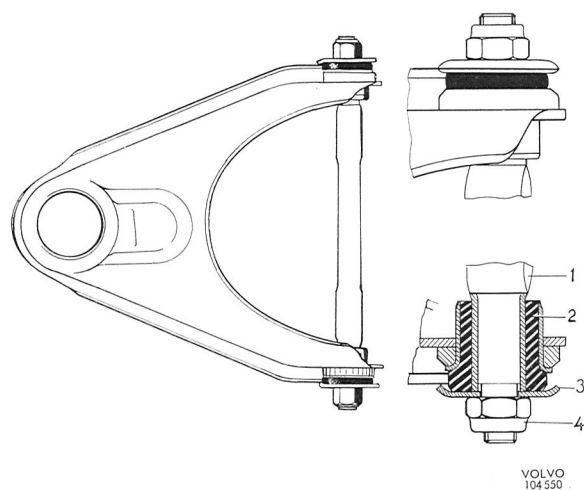


Fig. 6-14. Upper control arm

1. Control arm shaft 2. Bushing 3. Washer 4. Nut

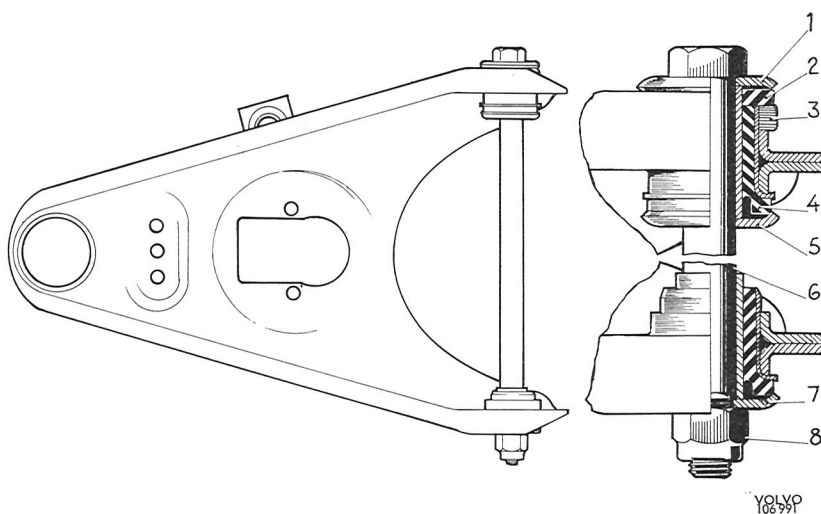


Fig. 6-15. Lower control arm

- |                |                      |
|----------------|----------------------|
| 1. Washer      | 5. Washer            |
| 2. Rubber ring | 6. Control arm shaft |
| 3. Spacer ring | 7. Washer            |
| 4. Bushing     | 8. Nut               |

## SERVICE PROCEDURES

### GENERAL

The ball joints require no lubrication and are therefore not equipped with lubricating nipples. However, the rubber seal should be inspected every 10 000 km (6 000 miles). The ball joint should be replaced if the seal is defective.

The control arms may only be straightened to a minor extent and then only in a cold condition. If the old part deviates to any great extent when compared to a new one, it should be replaced. No straightening whatsoever is permitted for stub axles with steering knuckles.

The **tightening torque** is given in the "Specifications". Otherwise the standard torque applies for the respective bolting.

## FRONT END COMPLETE REMOVAL

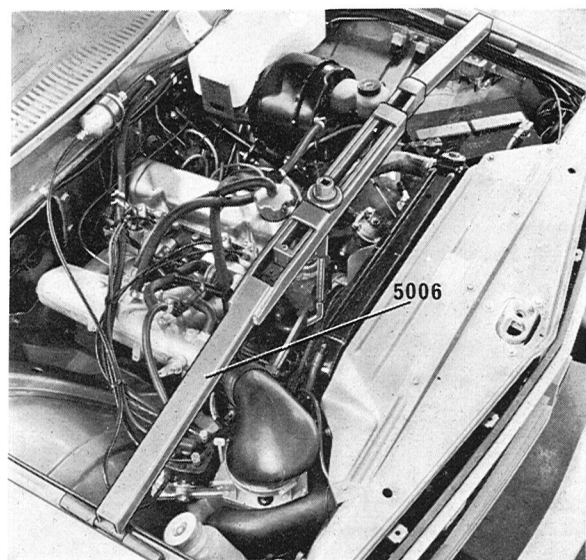


Fig. 6-16. Lifting tool for engine

1. Install the lifting tool 5006 according to Fig. 6-16. Hook it under the alternator bracket, as close as possible to the engine block. Raise the engine until the weight is taken off the front motor mount. Temporarily block the vent hole in the brake fluid container cover to reduce leakage. Remove the hub caps and loosen the nut for the front wheels a couple of turns.
2. Jack up the vehicle under the front jack attachment. Remove the front wheels.
3. Disconnect the steering rods from the steering arms with tool 2294 according to Fig. 6-21.
4. Remove the brake hose clamps from the stabilizer screws and remove the screws.
5. Remove the brake hoses from the bracket at the support member.
6. Remove the lower nuts for the front engine mountings.
7. Remove the front axle member attaching screws, lower and remove the front end.

## DISASSEMBLY AND ASSEMBLY

Fixture 2560 and stand 2520 can suitably be used for work on a removed front end.

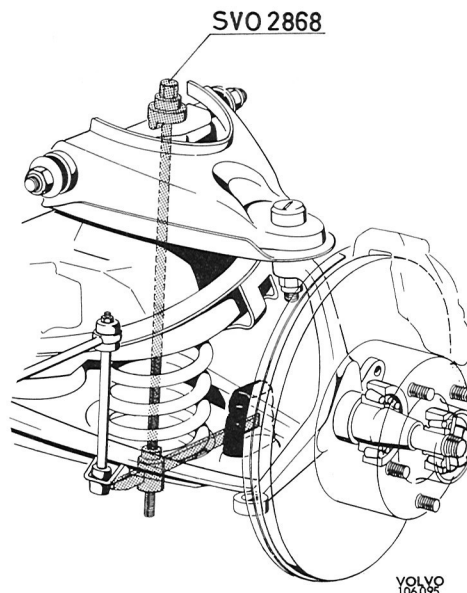


Fig. 6-17. Compressing spring

After the shock absorber has been removed, place tool 2868 as shown in Fig. 6-17. Compress the spring by screwing the spindle until there is clearance at the rubber buffer of the upper control arm.

Instructions, see under "Removal" and "Installation" for the various components.

If the rubber buffer which limits the engine mounting stop is to be replaced, place the new buffer on the rear side of the front axle member as shown in Fig. 6-18.

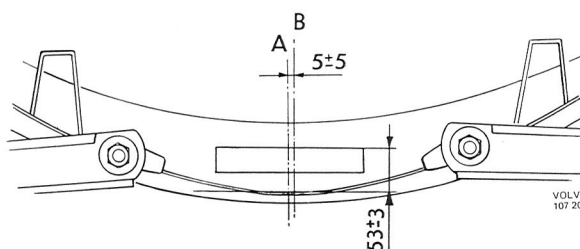


Fig. 6-18. Locating rubber buffer

A. Member centerline B. Buffer centerline

## INSTALLATION

1. Fix the guide pins in the front holes for the front axle member.
2. Place a jack under the front end and raise the front end to position. Install rear bolts provided with plastic plugs. Remove the guide pins and install the front bolts (also those with plastic plug).

3. Tighten the engine mountings.
4. Install the brake hoses according to Fig. 5-15 (Section 5). Install the bolts for the stabilizer. Firmly secure the brake hoses.  
NOTE: Check the location of the brake hoses according to Fig. 5-15 (Section 5).
5. Install the steering rods.
6. Bleed the brakes according to the instructions given in Section 5. Remove the temporary seal from the brake fluid container cap.
7. Install the front wheels. Lower the vehicle and remove the lifting device. Then install the timing gear cover screw with the flat washer.

## STEERING KNUCKLE

### REMOVAL

1. Remove the front wheel brake unit according to Section 5, "Removing the front wheel brake unit", points 1—4.

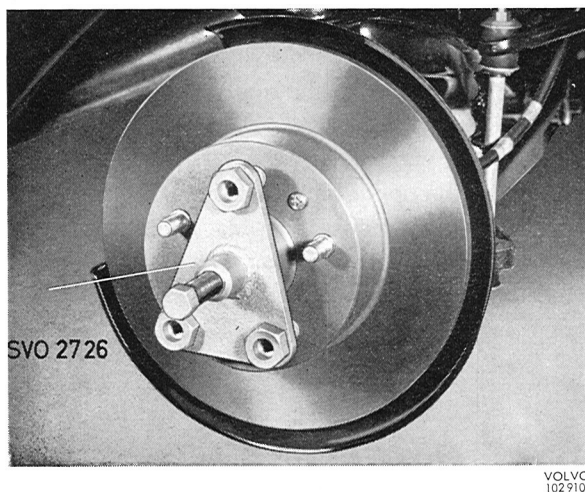


Fig. 6-19. Removing front wheel hub

2. Remove the grease cap with tool 2715. Remove the split pin and castle nut. Pull off the hub with puller 2726, see Fig. 6-19. Pull off the inner bearing for the steering knuckle with tool 2722, see Fig. 6-20.
3. Remove the steering rod from the steering arm with tool 2294, see Fig. 6-21.
4. Slacken, but do not remove the nuts for the ball joints and knock on the axle with a hammer until the ball joint pins loosen. Raise the lower control arm a little with the jack. Remove the nuts for the ball joints and then the steering knuckle.

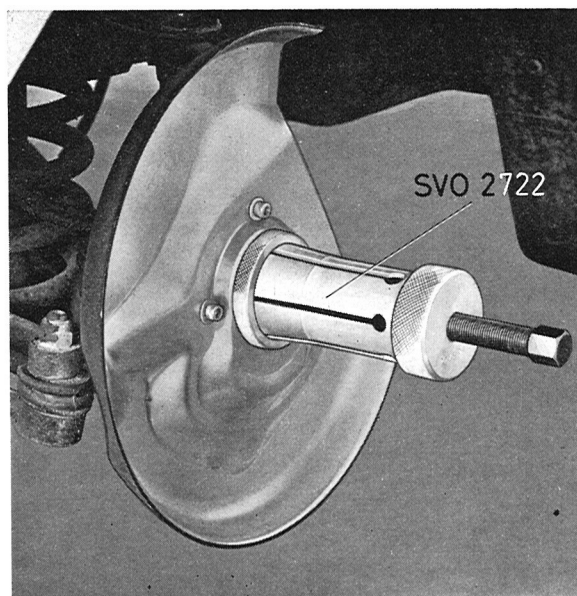


Fig. 6-20. Removing inner bearing

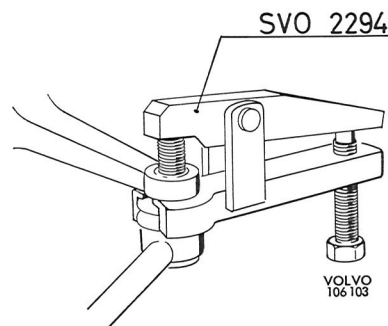


Fig. 6-21. Removing steering rod

### EXAMINING BEARING COMPONENTS

Clean the hub and grease cap thoroughly. Make sure that all the old grease, even inside the hub is removed. Compressed air can suitably be used for a comprehensive cleaning of the bearings. Then wash the bearing components and allow them to dry. Drying by compressed air should be avoided since the air often contains water and dust particles. Accessible bearing components are dried with cotton or cloth rags (but not waste). The bearing surfaces must be dry of cleaning fluid in order not to reduce the adhesion of the grease which is applied later. A new bearing taken directly from its packing container should not be cleaned.

After the cleaning, inspect the parts. If the bearing races or rollers are damaged, rusted or are blued,

replace the bearing. If the outer or inner ring is loose in its seat, try a new ring. The seals should be replaced if they are worn or damaged.

For lubrication of the wheel bearings, use only a high-class, durable grease for wheel bearings. Pack the bearings by hand with as much grease as possible between the roller retainers and the inner race. Grease also on the outside of the rollers and container. The intermediate spaces in the hub between the outer and inner bearing should be filled with grease, see Groups 46 and 77. Before installation, the wheel hub felt rings should be oiled generously with, for example, light engine oil.

Cleanliness of the bearings is of major importance for their lifetime. For this reason, do not let bearings not greased remain unprotected. Observe the greatest cleanliness.

## INSTALLATION

1. Place the inner bearing in position in the hub and press in the sealing washer (1, Fig. 6-20) until it goes against the bearing outer ring. Use drift 5005 and standard handle 1801.
2. Place the steering knuckle in position and tighten the ball joint nuts. If the ball joint twists, hold it firmly in position with a screw vise (see Fig. 6-22). Install the steering rod to the steering arm.

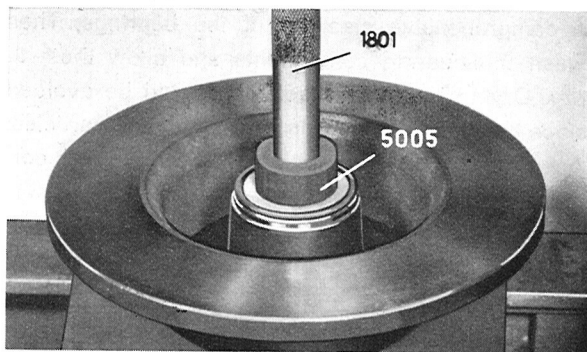


Fig. 6-22. Seal installation

3. Press the seal (2, Fig. 6-20) on the steering knuckle, without the tool, until it bottoms. It is important that the ring is not fitted at an angle.
4. Place the hub on the steering knuckle, the outer bearing, washer and castle nut.
5. Adjust the front wheel bearings by tightening the nut to 70 Nm (50 lbft). Then slacken the nut one third of a turn. If the slot in the nut does not coincide with the cotter pin hole in the steering knuckle, slacken the nut further until the cotter pin can be installed. Check that the wheel rotates easily but without any play.
6. Fill the grease cap half full of grease and tool 2715 for installation.
7. Install the front wheel brake unit and wheel according to Section 5, "Front brake caliper, installation".

## UPPER BALL JOINT

### CHECKING WEAR

This check can be made with the front end either jacked up or lowered. However, the upper control arm should not be against the rubber stop.

Check to see whether the ball joint has any **radial** clearance by bending up the wheel. If there is radial clearance, the upper ball joint should be replaced. NOTE: Do not confuse possible play in the wheel bearings with clearance in the ball joint.

Axial clearance should not be measured for the upper ball joint.

### REMOVAL

UPPER BALL JOINT, replace, one side, =Volvo Standard Times Op. No. 62150.

(62123 is the same operation, but wheel removed)

1. Remove the hub cap and slacken the wheel nuts slightly.
2. Jack up the front end of the vehicle under the front jack attachments. Remove the wheel.
3. Slacken but do not remove the nut for the upper ball joint. Knock with a hammer on the steering knuckle round the ball joint pin until it loosens from the axle. Remove the nut and suspend the upper end of the axle with a wire to avoid straining the brake hoses. See Fig. 6-23.
4. Loosen the nuts for the control arm shaft a 1/2 turn. Lift up the control arm slightly and press out the ball joint with press tool 2699 and sleeve 2701, see Fig. 6-23.

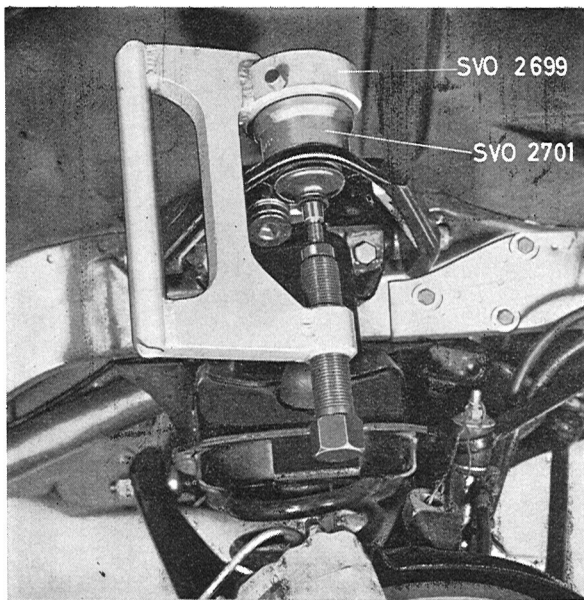


Fig. 6-23. Removing upper ball joint

## INSTALLATION

1. Before installing the ball joint, check that the rubber cover is filled with grease. Bend the pin end over the slot, see Fig. 6-24. Check that the grease forces its way out. If necessary top up with multipurpose grease.

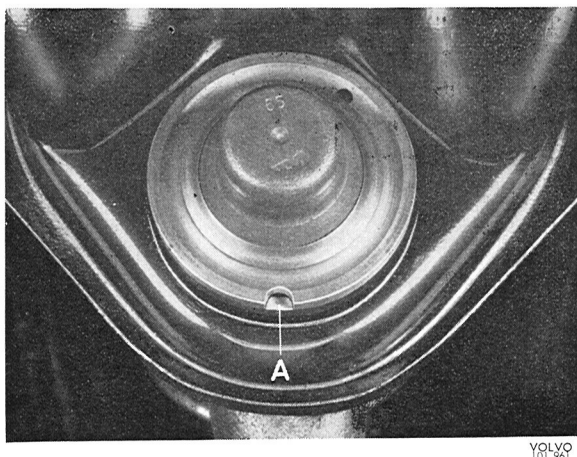


Fig. 6-24. Location of upper ball joint  
A=Slot

2. Press the ball joint into the control arm with press tool 2699, sleeve 2701 and drift 2704, see Fig. 6-25. Make sure that the ball joint recess comes in line with the longitudinal shaft of the control arm (Within  $\pm 8^\circ$ ) either externally or internally, see Fig. 6-24, as the pin has maxi-

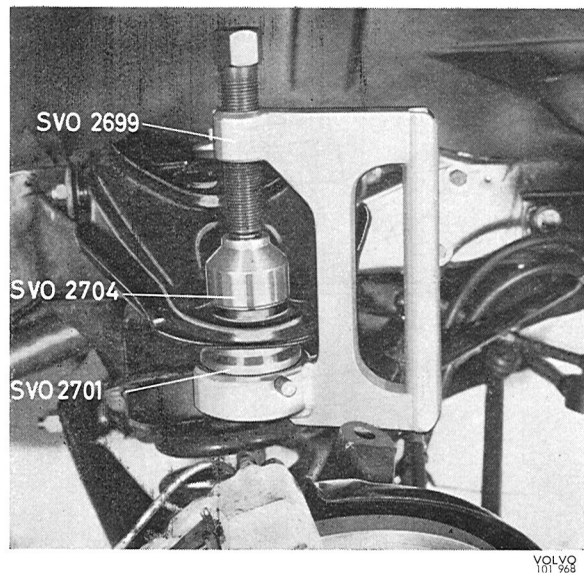


Fig. 6-25. Fitting upper ball joint

mum movement along this line. Should the ball joint be incorrectly installed when being pressed in, turn the tool 2699 half a turn and then press the ball joint into the correct position.

3. Turn down the control arm and tighten the nuts for the control arm shaft. Tighten the ball joint against the steering knuckle. If the pin rotates, hold it firmly with a screw vise, see Fig. 6-26.

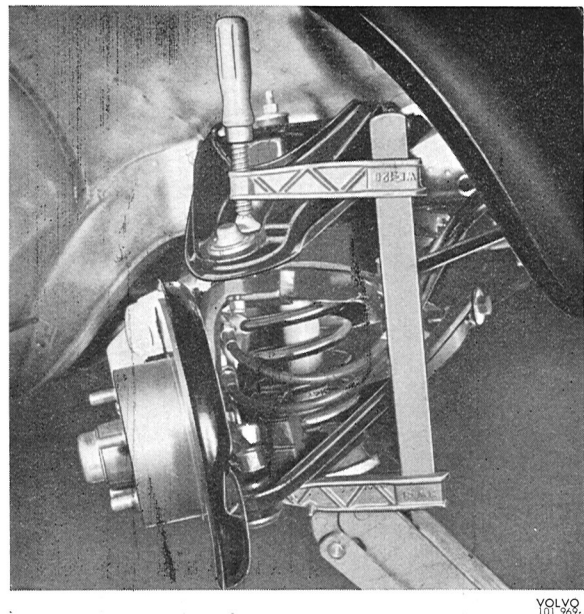


Fig. 6-26. Upper ball joint securely held by vise

4. Install the wheel and wheel nuts. Lower the vehicle and torque the wheel nuts to 100—140 Nm (70—100 lbft). Install the hub cap.

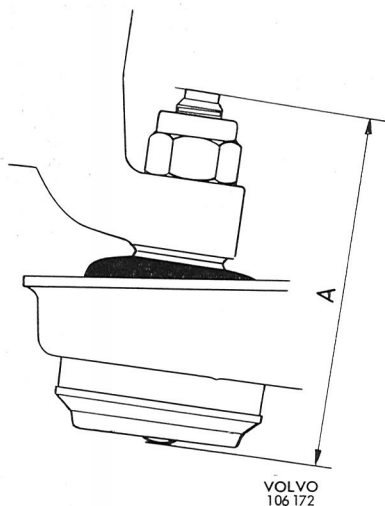


Fig. 6-27. Lower ball joint, type 1 (without spring)  
A=Max. 99.3 mm (3.91")

## LOWER BALL JOINT CHECKING WEAR

There are two types of lower ball joints. Type 2 (Fig. 6-28) has a built-in spring, while type 1 (Fig. 6-27) does not have such a spring.

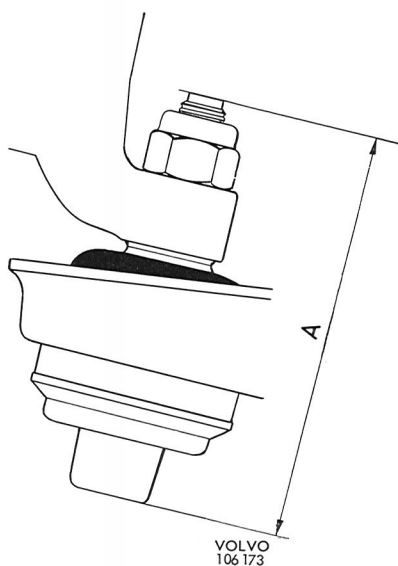


Fig. 6-28. Lower ball joint, type 2 (with spring)  
A=Max. 113 mm (4.5")

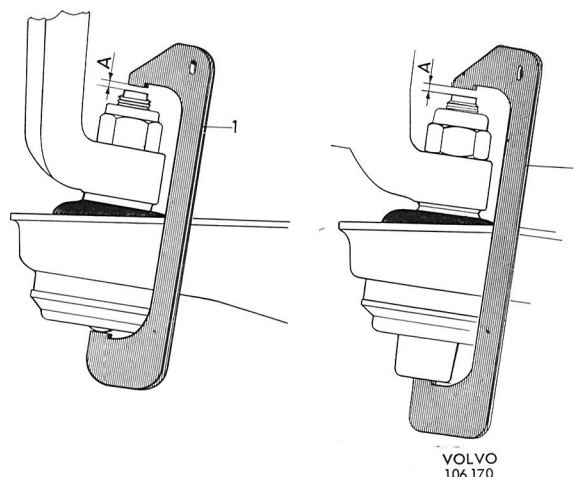


Fig. 6-29. Approved ball joints  
1. 2967 for ball joint type 1  
2968 for ball joint type 2  
A=Clearance

## BALL JOINT CHECK TOOLS

This tool is for a quick check on the lower ball joint in its operating position. The check should be made with normal load on the wheels, that is, with the vehicle standing on the ground, or a platform or similar. The wheels should point straight forwards. The tool cannot be used when jacking with a jack or hoist, which off-loads the ball joint.

The check is made as follows: Place the gauge over the ball joint. If the gauge (see Fig. 6-29) can be fitted over the ball joint, then the joint can be approved. If the length of the ball joint is greater than the tool span (see Fig. 6-30), the ball joint should be replaced.

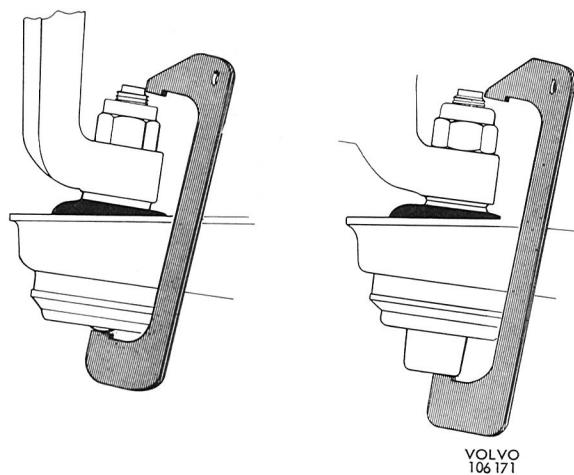


Fig. 6-30. Worn ball joints



## REMOVAL

LOWER BALL JOINT, one side, replace=Volvo Standard Times Op. N. 62154

(62125 is the same operation, but wheel removed)

1. Remove the hub cap and slacken the wheel nuts slightly.
2. Jack up the vehicle under the front jack attachment. Remove the wheel.
3. Disconnect the steering rod from the steering arm with tool 2294, see Fig. 6-21, and disconnect the brake lines from the stabilizer bolt.
4. Loosen the nuts for the upper and lower ball joints, but do not remove them. Knock with a hammer until the ball joints loosen from the axle. Raise the lower control arm with the jack. Remove the nuts.
5. Remove the steering knuckle with hub and the front wheel brake, unit, and place them on a stand or similar.

## INSTALLATION

1. Press the ball joint out of the lower control arm with press tool 2699 and sleeve 2700, see Fig. 6-31.

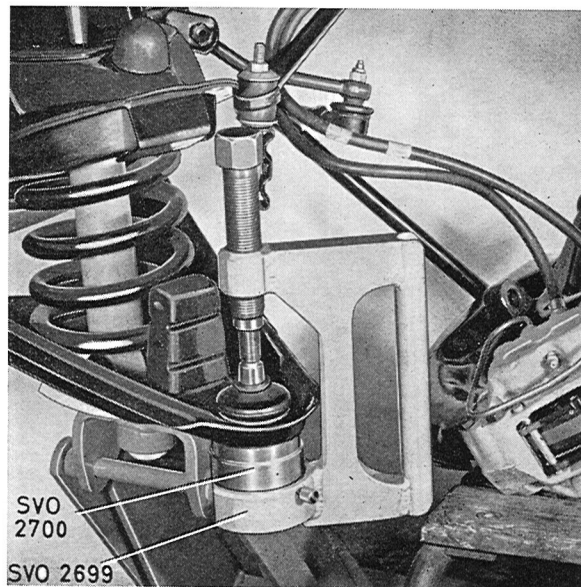


Fig. 6-31. Removing lower ball joint

2. Check that the rubber cover is filled with grease by breaking the pin to the side so that grease is forced out. If this does not happen, then fill the rubber cover with grease.

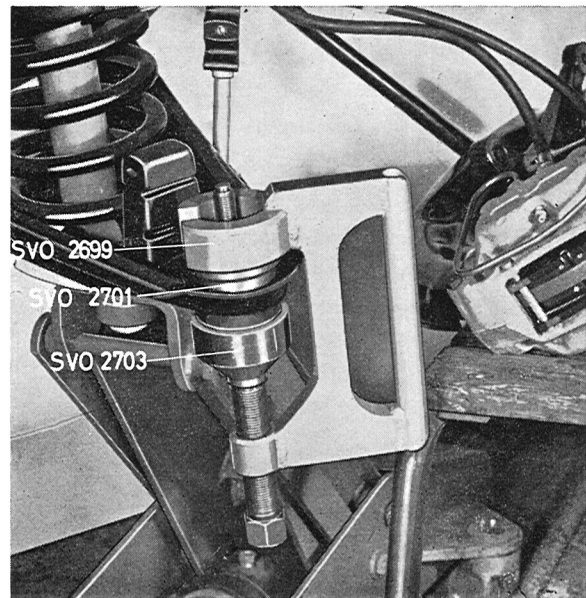


Fig. 6-32. Installing lower ball joint

3. Press the ball joints into the control arm with tools 2699+2701+2703, see Fig. 6-32. Should the ball joint not fit correctly, turn the tool 180° and tighten finally with the tool in this position. The ball joint must not be loose in the control arm.
4. Install the steering knuckle and tighten the nuts of the upper and lower ball joints. If the pins rotate, fix them securely with a screw vise, see Fig. 6-26. Install the steering rod and lower the jack in order to take the load off the control arms. Point the wheels straight forwards and fasten the brake hoses to the stabilizer screw.
5. Install the wheel. Lower the vehicle and tighten the wheel nuts. Install the hub cap.

## UPPER CONTROL ARM (A-FRAME)

Replace, one side=Volvo Standard Times Op. No. 62212

### REMOVAL

1. Follow operations 1—3 described in "Replacing upper ball joint".
2. Remove the screws for the control arm shaft with tool 2713, see Fig. 6-9.

NOTE: Keep the shims in a safe place. Lift off the control arm.

## REPLACING BUSHINGS

UPPER CONTROL ARM pivot shaft and/or bushing, replace, one side=Volvo Standard Times Op. No. 62230

1. Remove the nuts (4, Fig. 6-14) and the washers (3) for the control arm shaft.
2. Fix the control arm shaft securely in a vise. Carefully bend out the control arm ends so that tool 2729 can be attached, Fig. 6-33. Drive out



Fig. 6-33. Removing control arm shaft. 1. Removal of tool 2729

one of the bushings with a mallet and tool 2702, see Fig. 6-34. Turn the control arm, move

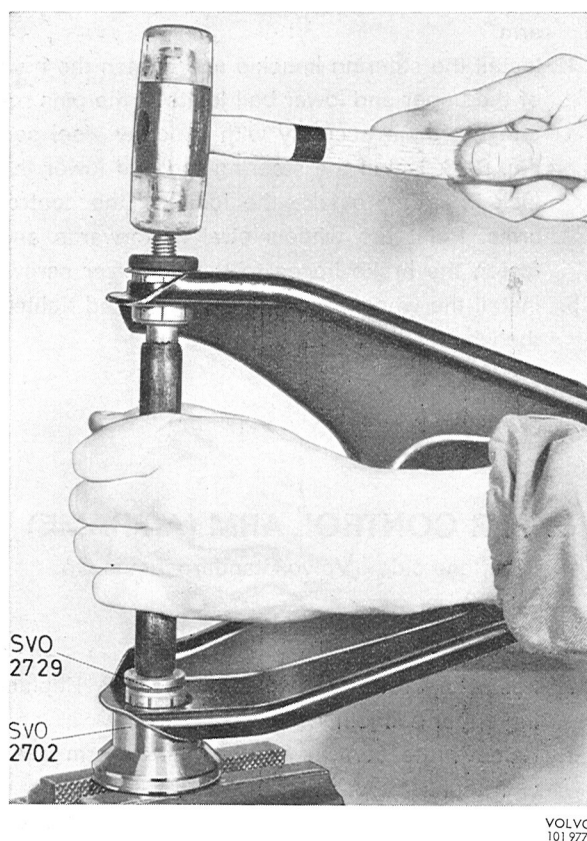


Fig. 6-34. Removing control arm shaft. 2. Driving out shaft

tool 2729 over to the other side and drive out the other bushing in the same way as for the first one.

3. Hold press tool 2699 firmly in a vise. Press in one of the bushings with tool 2702 and tool 2706, see Fig. 6-35.

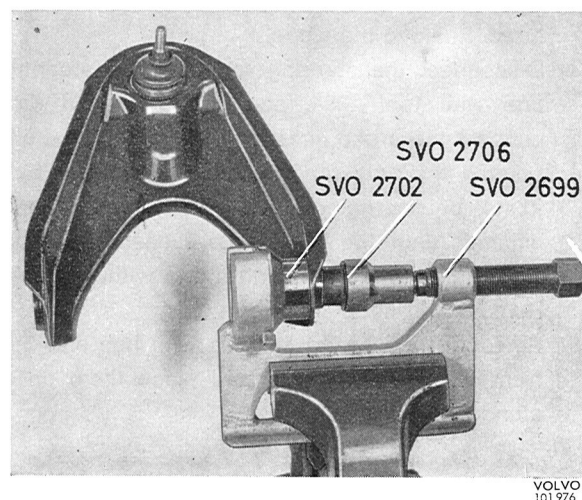


Fig. 6-35. First rubber, upper control arm

4. Install the control arm shaft and press in the other bushing with the sleeve 2702 + drift 2706, see Fig. 6-36. Make sure that the shaft fits the recess of the tool 2702.

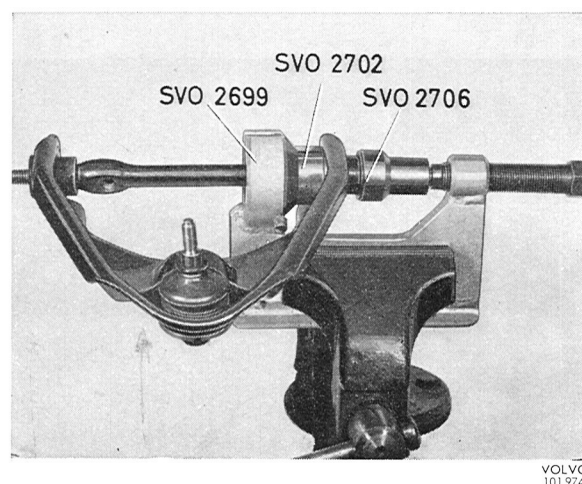


Fig. 6-36. Second rubber, upper control arm

5. Install the washers (3, Fig. 6-14) and the nuts (4). Tighten the nuts when the control arm is installed.

NOTE: The control arms is fixed with a special screw containing a nylon plug.

1. Place the control arm in position and install the screw by hand. Install the shims in the position they occupied previously. Tighten the screws with tool 2713. Torque the nuts for the control arm shaft to 55—62 Nm (40—45 lbft).



2. Install the upper ball joint in the steering knuckle and tighten the nut.
3. Install the wheel and wheel nuts. Lower the vehicle and torque the wheel nuts to 100—140 Nm (70—100 lbf·ft). Install the hub cap.

## LOWER CONTROL ARM (A-FRAME)

Replace, one side=Volvo Standard Times Op. No. 62208

### REMOVAL

1. Remove the hub cap and loosen the wheel nuts a couple of turns.
2. Jack up the vehicle at the front jack attachment. Remove the wheel.
3. Remove the shock absorber, see Section 7, "Removing shock absorber".
4. Disconnect the steering rod from the steering arm with tool 2294, see Fig. 6-21. Loosen the clamp for the brake hoses. Remove the screw for the stabilizer.
5. Place the jack under the lower control arm. Loosen the nuts for the ball joints, and knock with a hammer until the ball joints loosen from the steering knuckle. Remove the nuts and lower the jack. Remove the steering knuckle with the front brake wheel unit and place them on a standard or suchlike.
6. Then lower the jack and remove the spring.
7. Remove the nut from the control arm shaft and take off the latter. Turn the relay arm with the tie rod so that the control arm shaft is free and thus can be removed. Take off the control arm.

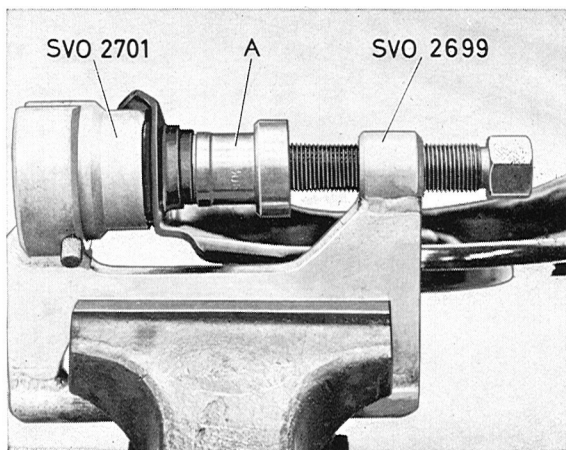


Fig. 6-37. Removing bushing, lower control arm  
A=2904 for bushings intended for diagonal tires and  
2905 for radial tires

## REPLACING BUSHINGS

Lower A-frame pivot shaft and for bushing, replace, one side=Volvo Standard Times Op. No. 62228

Note that there are special bushings intended for radial tires. When replacing bushings, observe if the vehicle is with radial or diagonal tires.

1. Tension the press tool 2699 in the vise. Remove the washer (1, Fig. 6-15), the rubber ring (2) and the spacer ring (3). Press the bushings out with counterhold 2701. Use drift 2904 for bushings where diagonal tires are installed and 2905 for radial tires. The tools are placed as shown in Fig. 6-37. The bushings are pressed out in the direction towards their flanges.
2. Press in the bushing with control arm and drift (A, Fig. 6-37) facing in the opposite direction.

NOTE: Both the bushings should be faced with the flange towards the rear in the vehicle, see Fig. 6-15. If it concerns a bushing for radial tires, its recess must also be turned downwards at right angles to the longitudinal direction of the control arm, see Fig. 6-38.

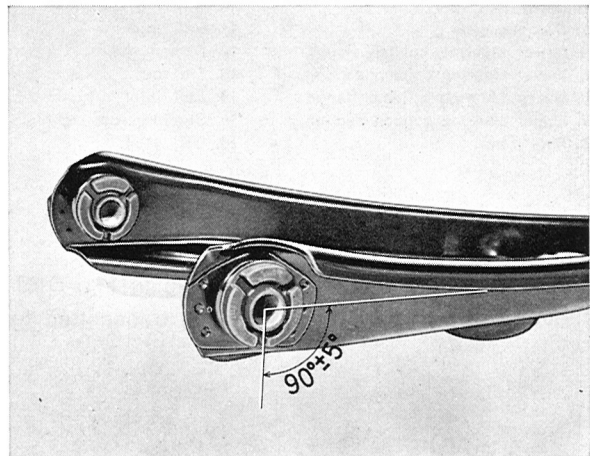


Fig. 6-38. Bushings for radial tires

## INSTALLATION

1. Supplement the control arm with rings and washers as shown in Fig. 6-15. Position the control arm.  
Install the control arm shaft. Keep the control arm fairly horizontal and tighten the nut for the control arm shaft.
2. Install the spring. Raise the jack and install the steering knuckle according to point 8 in "Replacing ball joint, lower control arm".
3. Install the shock absorber according to "Installing shock absorber".
4. Install the wheel. Lower the vehicle. Tighten the wheel nuts. Install the hub cap.

# STEERING GEAR

## GENERAL INFORMATION

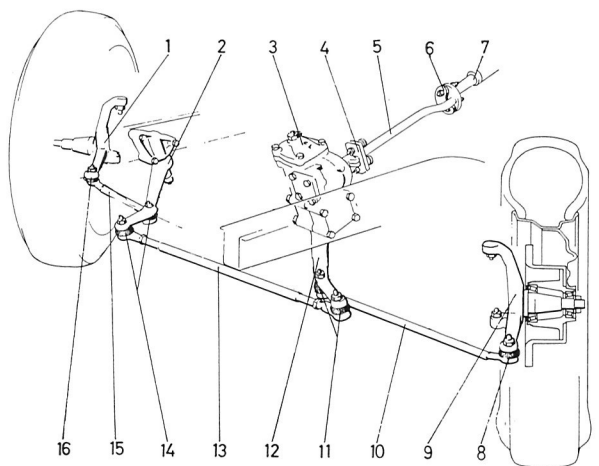


Fig. 6-39. Steering gear

- |                                  |                           |
|----------------------------------|---------------------------|
| 1. Steering knuckle, right       | 9. Steering knuckle, left |
| 2. Relay arm                     | 10. Steering rod, left    |
| 3. Steering gear                 | 11. Ball joint            |
| 4. Lower steering column flange  | 12. Pitman arm            |
| 5. Lower steering column section | 13. Tie rod               |
| 6. Upper steering column flange  | 14. Ball joint            |
| 7. Upper steering column section | 15. Steering rod, right   |
| 8. Ball joint                    | 16. Ball joint            |

### GENERAL

The layout of the steering is shown in Fig. 6-39. Movement of the steering wheel is transmitted to

the wheels via the divided column (7 and 5), the steering gear (3), the pitman arm (12) the tie rod (13), the steering rods (10 and 15) as well as the steering knuckles (1 and 9).

The vehicle may have a mechanical steering gear or power steering. In the latter case, the steering gear also includes power pump and oil reservoir.

### STEERING COLUMN JOURNALING

The steering column is divided. Its upper section is journaled by two ball bearings in a jacket, which is attached to the body by a rubber bushing (4, Fig. 6-40) and slide (6). The lower and upper sections of the steering column are linked by a safety device (1). In a frontal collision, causing compression of the front end, the lower steering column flange breaks loose from that of the upper section and the lower section pushes upwards. The upper section remains in position and this eliminates possibility of the steering wheel being forced backwards and upwards inside the car.

On the other hand, the entire steering column journaling can be pushed forwards-downwards if, e.g., the driver is thrown against the steering wheel.

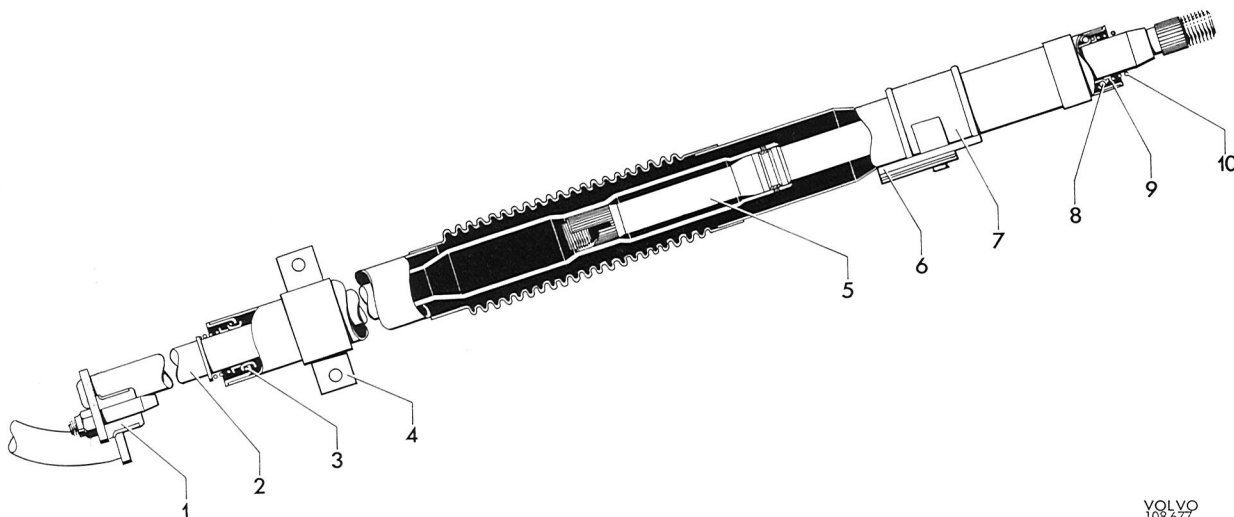


Fig. 6-40. Steering column journaling

- |                                  |                        |
|----------------------------------|------------------------|
| 1. Safety mechanism              | 6. Upper attachment    |
| 2. Upper steering column section | 7. Steering wheel lock |
| 3. Lower bearing                 | 8. Upper bearing       |
| 4. Lower attachment              | 9. Seat                |
| 5. Steering column jacket        | 10. Spring             |

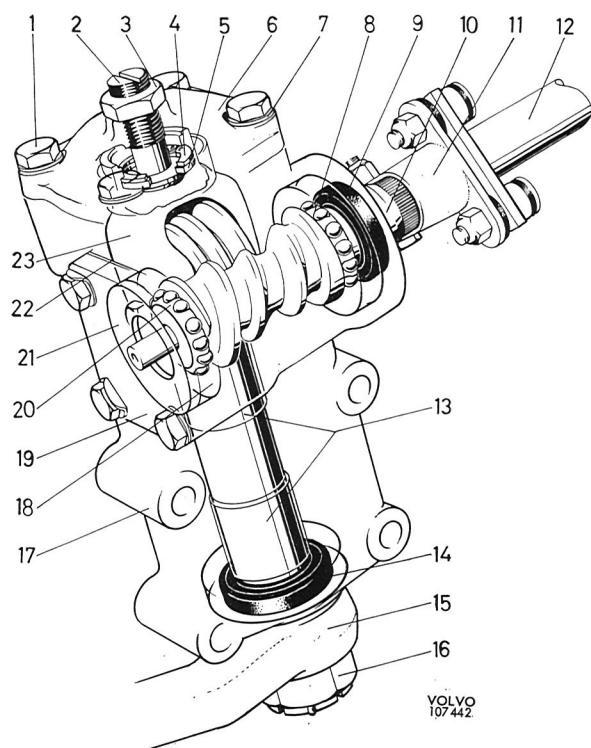


Fig. 6-41. Manual steering gear

1. Bolt
2. Adjusting screw, sector shaft
3. Lock nut
4. Circlip
5. Adjusting washer
6. Cover
7. Tab washer
8. Upper ball bearing worm
9. Oil seal, worm
10. Worm
11. Flange
12. Lower steering column section
13. Bushings, sector shaft
14. Oil seal, sector shaft
15. Pitman arm
16. Nut
17. Steering housing
18. Lower bearing race, worm
19. Worm cover
20. Lower ball bearing, worm
21. Washer
22. Spacer
23. Sector shaft

## MANUAL STEERING GEAR

The steering gear is of the "worm and roller" type and its construction is shown in Fig. 6-41. It has a ratio of 17.5:1. The worm (10) is journaled in two ball bearings (8 and 20) and it is tensioned by shims (22). The pitman arm shaft (sector shaft) is journaled in two bushings (13) and its roller in two needle bearings. Since the roller mesh in the steering worm is determined by the axial position of the pitman arm shaft, the adjusting screw (2) regulates the steering gear clearance. The steering gear is lubricated with hypoid oil.

## STEERING RODS AND RELAY ARM

The ball joints of the steering rod are plastic-lined, which makes maintenance lubrication unnecessary. The tie rod (13, Fig. 6-39) has replaceable ball joints while the ball joints of the steering rods (10 and 15) are made in one piece with the rod.

The relay arm (Fig. 6-67) is journaled by a bushing on a pin in the bracket. The bushing consists of three parts, a rubber bushing with an outer sleeve of plate and an inner one comprising a spacer sleeve. The outer sleeve has a press-fit in the relay arm hole. When the relay arm is turned, there is movement between the outer sleeve and rubber bushing, the space between them is permanently lubricated. The journaling is, in other words, "lubricated for life".

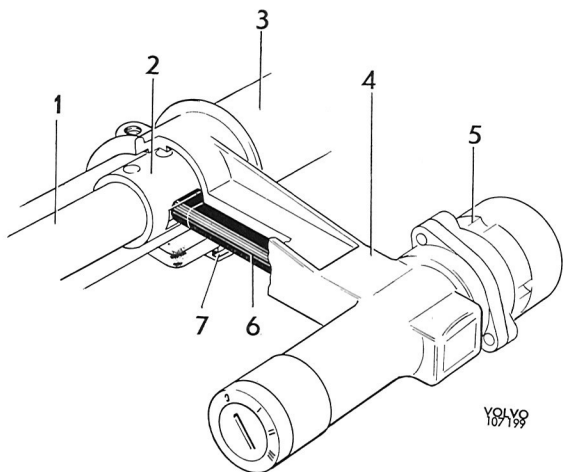


Fig. 6-42. Steering wheel lock

- |                        |               |
|------------------------|---------------|
| 1. Steering shaft      | 5. Contact    |
| 2. Lock sleeve         | 6. Lock pin   |
| 3. Steering column     | 7. Attachment |
| 4. Steering wheel lock |               |

### Steering wheel lock

The vehicle has been made tamperproof by the installation of a steering wheel lock, which is integrally built with the ignition switch. The ignition switch has four positions, 0-I-II-III. Removing the ignition key, which can only take place when it is in position "0", releases a catch and lock pin (A) is

pressed forwards by a spring. When the steering wheel is turned, so that a slot coincides with the lock pin, the lock pin enters the slot and locks the steering column so that the front wheels cannot be turned.

When the ignition key is inserted and switched to position "I", the lock pin is pulled back and this releases the steering column which is secured in a withdrawn position. At position "I" the vehicle can be moved with the ignition switched off.

At position "II" the ignition is connected and in position "III" the starter motor can be engaged. The ignition switch and steering wheel lock can only be replaced as a unit.

The steering wheel lock is attached to the column by two shear-off bolts, and to the dashboard by two screws.

### POWER STEERING

This vehicle can be equipped with the ZF recirculating ball and nut type power steering. The main components of the power steering gear are: steering gear, power pump and oil reservoir with filter. These are connected to the various oil lines, see Fig. 6-43. The number of steering wheel turns from lock to lock is 3.7.

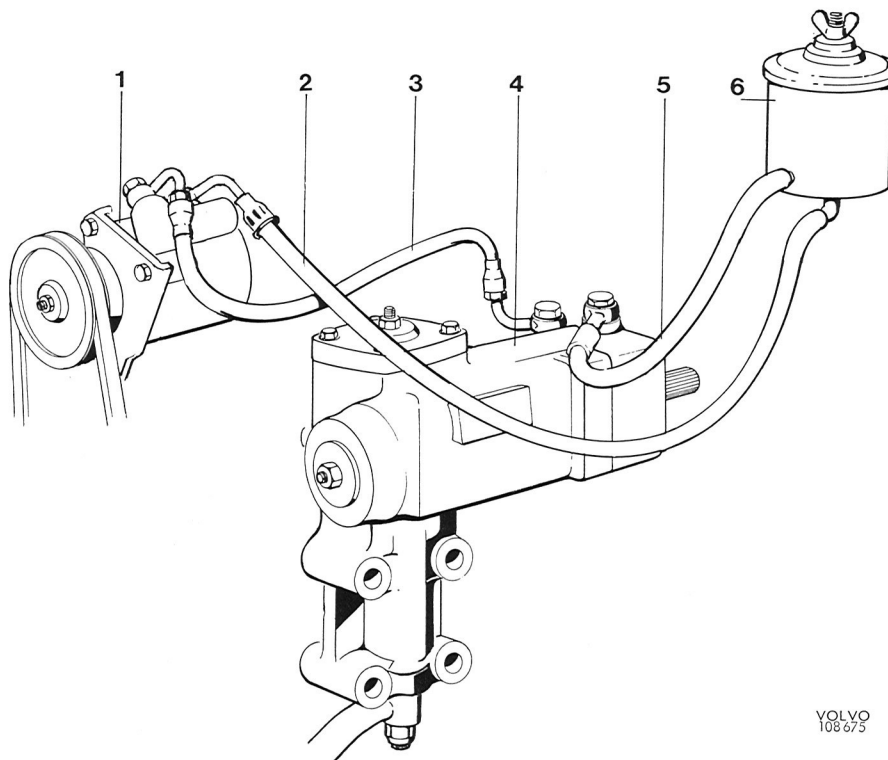


Fig. 6-43. Power steering

- |                      |                              |
|----------------------|------------------------------|
| 1. Power pump        | 4. Steering gear             |
| 2. Pump suction line | 5. Return oil line           |
| 3. Delivery oil line | 6. Oil reservoir with filter |

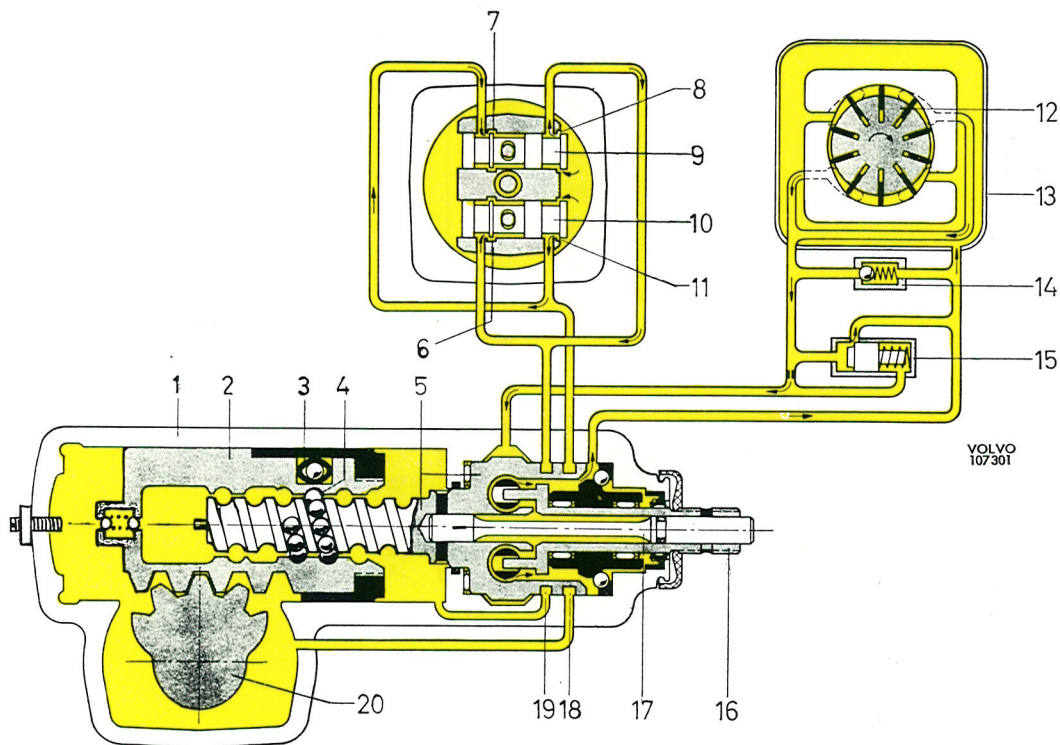


Fig. 6-44. Function, neutral position

- |                                |                   |                        |
|--------------------------------|-------------------|------------------------|
| 1. Steering housing            | 7. Return groove  | 14. Safety valve       |
| 2. Piston                      | 8. Intake port    | 15. Flow control valve |
| 3. Recirculation pipe ball nut | 9. Control valve  | 16. Steering spindle   |
| 4. Balls                       | 10. Control valve | 17. Torsion bar        |
| 5. Worm                        | 11. Intake port   | 18. Annular groove     |
| 6. Return groove               | 12. Power pump    | 19. Annular groove     |
|                                | 13. Oil reservoir | 20. Pitman arm shaft   |

## Power steering gear CONSTRUCTION

The power steering gear is of the ball nut type. In addition to the mechanical section, the power cylinder and control valves are built into the steering housing. The lower part of the steering housing (1, Fig. 6-44) is in the form of a cylinder in which the piston (2) is fitted. The piston is on one side formed as a rack gear which meshes with the tooth segment of the sector shaft (20).

The axial movement of the piston, which determines the direction the wheel turns, is obtained via the worm (5) and ball nut. The recirculating balls (4) are located in annular grooves and form the thread for the nut. Movement of the worm comes from the steering column at the steering spindle (16) and the torsion bar (17) secured in the spindle. The worm is journaled in the upper section of the steering housing partly by an axial thrust needle bearing and partly by a taper ball bearing. The inner race of the taper ball bearing also is an

outer race for the double needle bearings of the steering spindle.

The worm head has two control valves (9 and 10): they are drawn out in the figures. These valves are influenced by two pins in the lower end of the steering spindle (16).

The pitman arm shaft (20) is journaled in the steering housing and side cover by needle bearings, see Fig. 6-46. Sealing between the valve housing and the upper section of the housing as well as between the intermediate piece and steering cam is catered for by O-rings and plastic rings. The steering gear reduction ratio is 15.7:1.

The construction of the steering gear differs with regard to a left-hand steered and a right-hand steered vehicle in the location of the sector shaft and the steering cam thread. Fig. 6-43 shows the steering gear for left-hand steering while Figs. 6-44—6-46 show that for right-hand steering. The following description of the function applies to both.



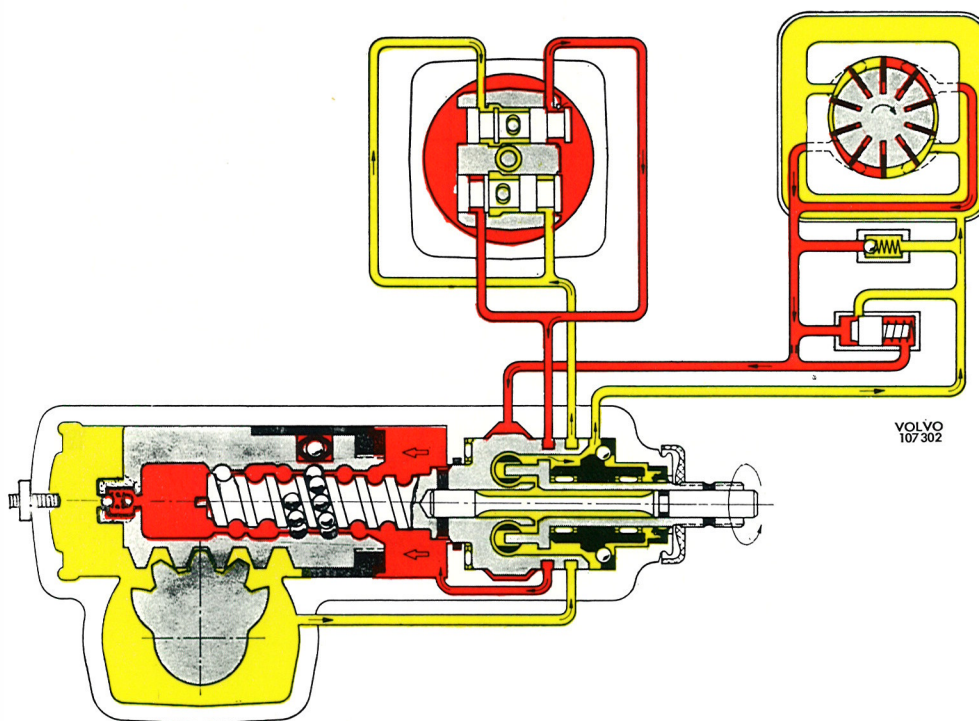


Fig. 6-45. Principle of function, left-hand turn  
Concerning references to numbers, see Fig. 6-44

## FUNCTION

The location of the steering valves as well as that of the oil flow are shown schematically in Figs. 6-44, 6-45 and 6-46. In order to illustrate more clearly how the valves are connected to the part of the housing where the power piston operates, a cross-section has been made through the steering valves in addition to the longitudinal section. Moreover, extra channels have been drawn to link up both sections.

Oil is conveyed under pressure from the pump into an annular chamber round the valve housing (the large circle in the cross-section). In the neutral position (Fig. 6-44) the valves (9 and 10) are so adjusted that oil can pass the intake ports (8 and 11) and flow on to the annular grooves (18 and 19) in the valve housing. From here the oil is led partly to both sides of the piston (2) through the channels (18 and 19), and partly — as long as the valves are in the neutral position — to both the return grooves (6 and 7) at the control valves. From the return grooves oil flows through the return channel back to the reservoir.

When the steering wheel is turned to the left movements is transmitted via the control spindle (16) and the torsion bar (17) to the worm (15), so that the piston (2) is screwed to the left in the figure (downwards in the vehicle). Since the torsion bar is resilient, the steering spindle will be turned in relation to the worm and thus influence

the valves placed in the worm. The greater the turning movement, the greater will be the valve displacement. One of the control valves (9) is then displaced to the right and opens the intake port (8) wider, while at the same time the other control valve (10) is displaced to the left and closes the intake port (11). The delivery line of the control valve (9) is linked with the annular groove (19) in the valve housing. This also applies to the return groove (6) of the control valve (10). The delivery line of the control valve (10) is connected to the annular groove (18) and to the return groove (7) for the control valve (9).

Under such conditions, oil under pressure flows in through the intake port (8) to the annular groove (19) and then on to the cylinder on the right-hand side of the piston (2). Oil also flows to the return groove (6). Since the outlet port is blocked, pressure will rise and assist in pressing the piston (2) to the left.

Oil in the left-hand section of the cylinder is forced away via the annular groove (18) in the valve housing to the intake port (11) which is closed. At the same time, oil flows to the return groove (7) and then through the return line to the oil container.

As soon as the front wheels are turned to the desired angle and the forces operating on the steering wheel become less, the control valve returns to neutral position as a result of the influence of the torsion bar.

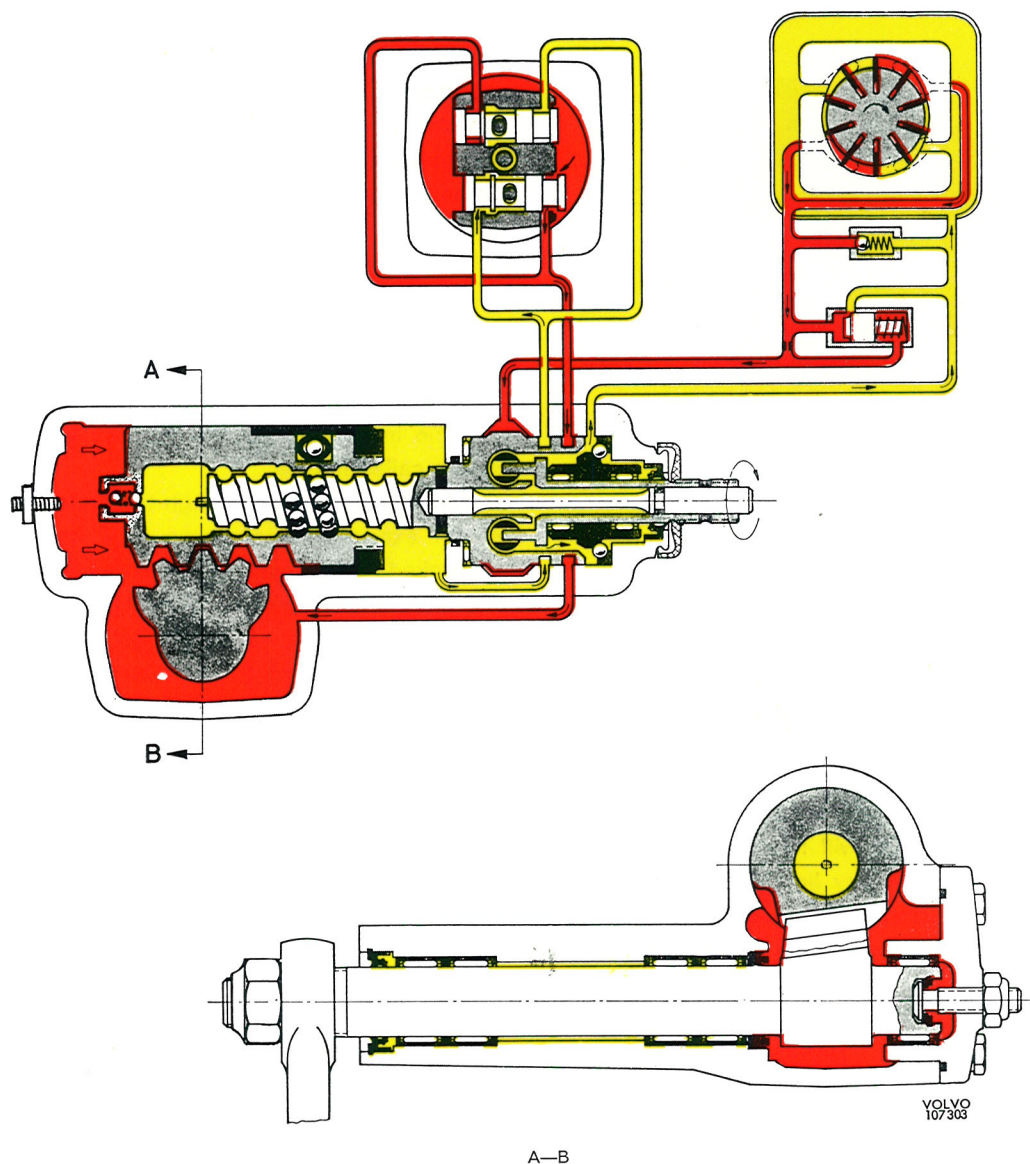


Fig. 6-46. Function, right-hand turn

Turning the steering wheel to the right (see Fig. 6-46) will screw the piston (2) to the right on the figure. The control valve (10) is displaced to the right and permits oil under pressure to pass to the annular groove (18) of the valve housing and from there on to the left-hand side of the cylinder. Oil under pressure also flows to the return groove (7) which, however, is closed so that oil pressure on the left-hand side of the operating piston (2) rises and facilitates the turning of the lever shaft. Oil at the right-hand section of the cylinder is pressed by the piston via the annular groove (19) through the return groove (6) of the control valve (10) back to the oil reservoir (13).

### Power pump

The power pump (Fig. 6-47) is of the vane type. It is mounted on a bracket on the left-hand side of the engine and is pulley-driven by the engine at engine speed.

The pump rotor is provided with 10 loose vanes and rotates in a circular-shaped intermediate piece. The vanes are pressed against the wall of the intermediate piece partly by centrifugal force and partly by oil pressure.

The space in the intermediate piece is oval, see Fig. 6-46. This permits the area between the rotor, the wall of the intermediate piece and two of the vanes to alter when the rotor rotates. When a couple of vanes are moved from the suction side to the pres-



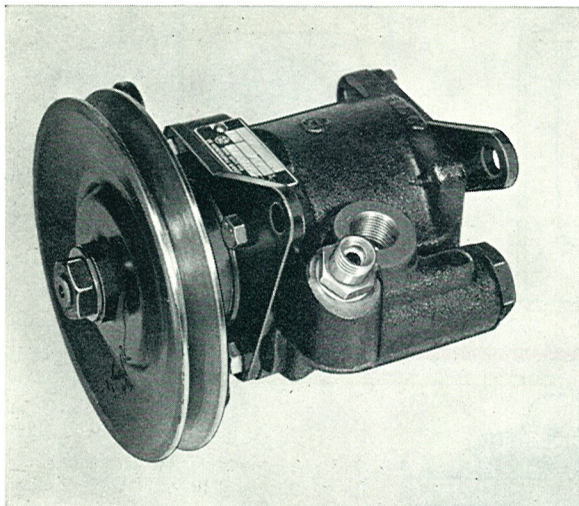


Fig. 6-47. Power pump

sure side, the area between them and the sucked-in oil increases to start with. When the connection with the suction side has been passed, a link-up with the pressure side is then attained instead. Since the space between the vanes contracts at the same time, the pressure will rise and oil will be forced out into the delivery line. Due to the fact that there are two inlet and two outlet channels, the pump has double capacity.

### CONTROL VALVE

The pump housing contains a control valve which regulates partly the oil flow and partly the maximum pressure.

When the pump starts functioning, the valve (5, Fig. 6-48) maintains the valve pressed to the left of the spring (7). The oil supplied by the pump passes through the delivery channel (3) via the check valve (2) out into the delivery line (1) and from there to the steering housing. The space to the right of the

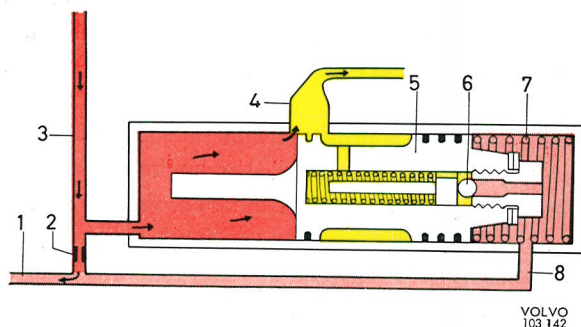


Fig. 6-48. Control valve, normal position

- |                     |                  |
|---------------------|------------------|
| 1. Delivery line    | 5. Control valve |
| 2. Check valve      | 6. Safety valve  |
| 3. Delivery channel | 7. Spring        |
| 4. Return channel   | 8. Link channel  |

control valve is linked-up with the delivery line (1) by the link channel (8) and has, therefore, the same pressure.

The check valve's (2) function is to ensure that the pressure on the left-hand side of the control valve piston is higher than that in the line and also to the right of the piston is therefore, displaced to the right. And when the speed is sufficiently high in relation to the counterpressure, the piston has been displaced so much that the surplus oil can flow back to the inlet side of the pump, see Fig. 6-48. Since the pump should deliver a quantity smaller than the maximum capacity, this valve adjustment can be called normal.

Should the pump flow through the outlet be stopped, for example, because the front wheel turning is blocked, the pressure in the delivery line (1), will rise and the pressure difference between both ends of the control valve will be equalized. This will cause the spring to be moved to the left, the connection with the return channel to be closed and the pressure to rise even more. At approx. 75 kp/cm<sup>2</sup> (1065 psi) the spring pressure on the safety valve (6) is overcome, that is, the inner part of the control valve, and oil can then pass out to the return channel (4). See Fig. 6-49. The pressure on the

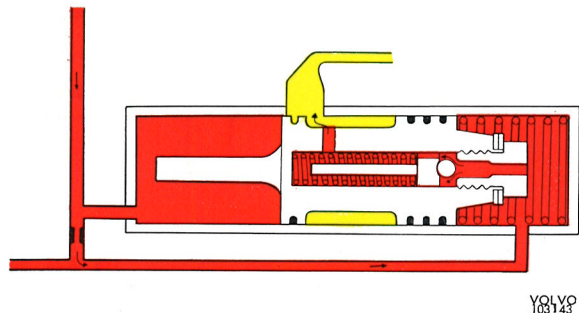


Fig. 6-49. Control valve, maximum pressure

right-hand side of the piston will then drop and the entire control valve will be moved to the right so that the connection with the return channel opens. When the pressure drops to its normal value, the safety valve closes and the control valve returns to its normal position.

### Oil reservoir

The oil reservoir is placed in the engine compartment where it is easily accessible. It is provided with a filter, from the center of which oil is sucked to the pump. By means of the by-pass valves, oil can flow past the filter should it become blocked. The oil level can be seen against the level line after removing the cap.

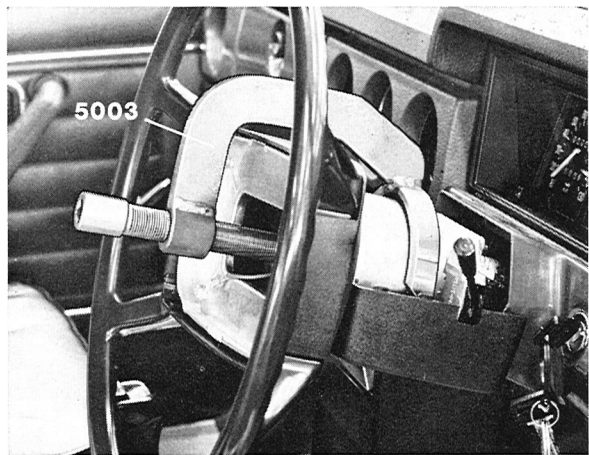


# SERVICE PROCEDURES

## GENERAL

The ball joints for the tie rod and steering rods are plastic-lined. For this reason, they do not require any maintenance. Since sealing is most important for the life of these ball joints, the ball joints should be checked every 10 000 km (6 000 miles) to make sure that their rubber seals are intact. If they are cracked or damaged in any other way, the ball joint should be replaced.

**Tightening torque**, see "Specification". Otherwise the standard torque for the respective bolts apply.



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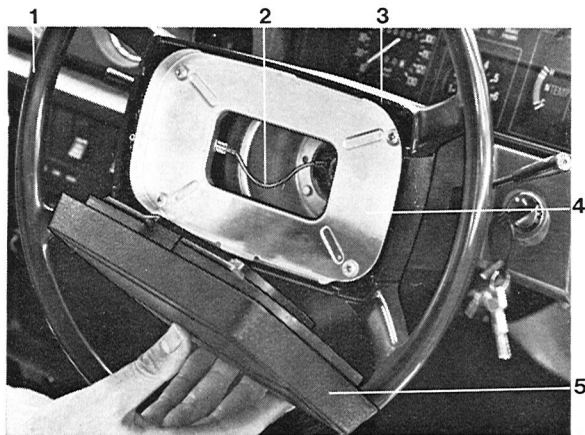
Fig. 6-51. Removing steering wheel

## REPLACING STEERING WHEEL

Volvo Standard Times Op. No. 64104

### Removal

1. Lever loose the impact guard (5, Fig. 6-50).



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Fig. 6-50. Steering wheel components

- |                       |                 |
|-----------------------|-----------------|
| 1. Steering wheel     | 4. Horn ring    |
| 2. Collapse mechanism | 5. Impact guard |
| 3. Housing            |                 |

### Installation

1. Make sure that the wheels are pointing straight forwards.
2. Place the steering wheel in position with the slip contact to the left.
3. Install the steering wheel nut. Tightening torque is 30—40 Nm (20—30 lbft).
4. Install the impact guard and test the horn.
5. Install the upper part of the turn signal switch housing.

## STEERING COLUMN JOURNALING

The upper bearing can be replaced separately. If the lower bearing is damaged, the steering column shaft must be replaced complete.

### Replacing upper bearings

2. Remove the attaching screws for the upper part of the directional indicator switch housing and lift it off.
3. Remove the steering wheel nut.
4. Set the wheels straight forwards. Use steering wheel puller 5003 according to Fig. 6-51, to pull off the steering wheel.
1. Remove the steering wheel, see under "Replacing steering wheel". Remove the upper part of the turn signal switch housing.
2. Remove the turn signal switch from its attachment on the steering wheel column.
3. Remove the attachment from the steering column.

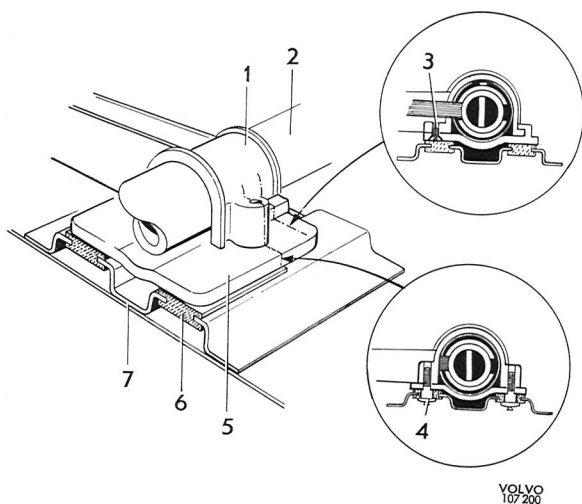


Fig. 6-52. Upper attachment

- |                        |                       |
|------------------------|-----------------------|
| 1. Steering wheel lock | 5. Attaching plate    |
| 2. Steering column     | 6. Slide              |
| 3. Slotted screw       | 7. Side member (dash) |
| 4. Shear bolts         |                       |

4. Pull out the spring and seat.
5. Remove the bearing.
6. Install the new bearing after having greased it with universal grease.
7. Restore.

## Replacing complete journaling

1. Remove the steering wheel and steering wheel lock, see the instructions for this.
2. Remove the turn signal switch and the other components from the steering column.
3. Remove the nuts at the coupling between the upper and lower steering shafts. Remove the nut and clamp for the lower attachment.
4. Pull forward both the upper and lower steering shafts complete.
5. Install the new components in reverse order to removal. Check all functions before shearing off the shear bolts for the upper steering column attachment and steering wheel lock.

## STEERING WHEEL LOCK

With damage to the steering column or the steering shaft lock lug, replace the steering shaft complete. The following instructions apply to replacement of the steering wheel lock.

### Removal

Replace=Volvo Standard Times Op. No. 64108

1. Remove the combined instrument, see Section 3.
2. Remove the contact piece (5, Fig. 6-42) of the steering wheel lock.

3. Drill off the collars on the shear bolts (4, Fig. 6-52). Start with a small drill and finish with, for example, a 13 mm ( $\frac{1}{2}$ " ) one. The bolt guide has a diameter of 12 mm ( $\frac{15}{32}$ " ).
4. Remove the attaching bolts and take off the left impact guard and side member (7) with slide piece (6).
5. Screw out the screw (3) and unhook the attaching plate (5).
6. Turn back the lock pin and lift up the steering wheel lock.

### Install

1. Install the new steering wheel lock and the electrical part in position. Hook on the attaching plate (5, Fig. 6-52) and screw in the screw (3). Check the locking function.
2. Install the side member (7) with the slide piece (6) which must be in good condition. Install the impact guard.
3. Install the shear bolts (4) but do not shear off the heads.  
Install the contact piece.
4. Check all the functions of the steering wheel lock. Thereafter tighten up the bolts until the heads shear off.
5. Install the combined instrument and the other parts, see Section 3.

## MANUAL STEERING GEAR

Replace=Volvo Standard Times Op. No. 64226

### Removal

1. Jack up the front end of the vehicle.
2. Release the bolt (A, Fig. 6-53) at the lower flange. Remove the nuts (B) and push the lower part of the flange as far down as possible on the guide bolt.

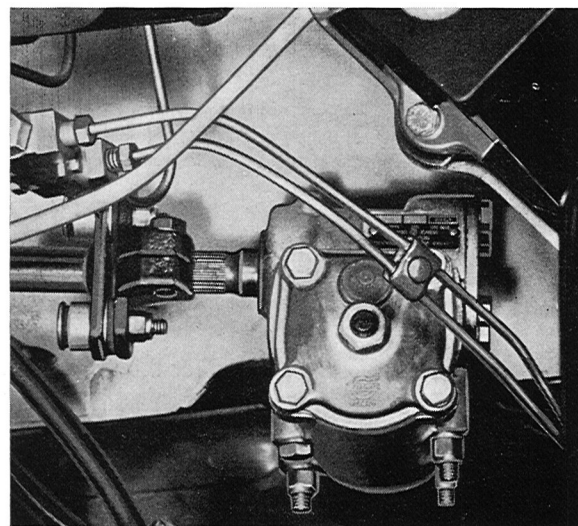


Fig. 6-53. Steering gear

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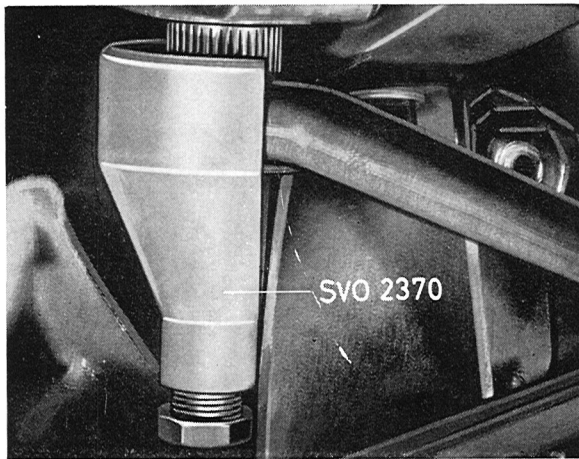


Fig. 6-54. Removing pitman arm

- |                     |                     |
|---------------------|---------------------|
| 1. Circlip          | 3. Adjusting screw  |
| 2. Adjusting washer | 4. Pitman arm shaft |

3. Remove the lock nut for the pitman arm. Pull off the pitman arm with 2370. When the puller has been placed there, turn the wheel completely to the left (Fig. 6-54).
4. Remove the nuts and bolts and lift off the steering gear.

## Disassembly

### Volvo Standard Times:

Re-build steering gear=Op. No. 64202 includes removal and installation

Op. No. 64275 excludes removal and installation

1. Mark up and remove the flange if it is still on the shaft of the steering worm.
2. Place the steering gear in the middle position (Fig. 6-62). Remove the four bolts (1, Fig. 6-41) for the upper cover (6). Pull up the cover and pitman arm shaft a bit and drain the oil. Pull out the cover and pitman arm shaft.
3. Remove the bolts and lower cover (19). Take care of the spacers (22).
4. Carefully knock on the steering worm shaft (10) so that the lower bearing outer races come loose from the housing. Take out the steering worm with bearings.

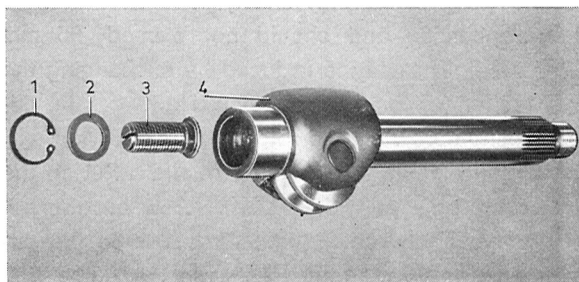


Fig. 6-55. Pitman arm shaft

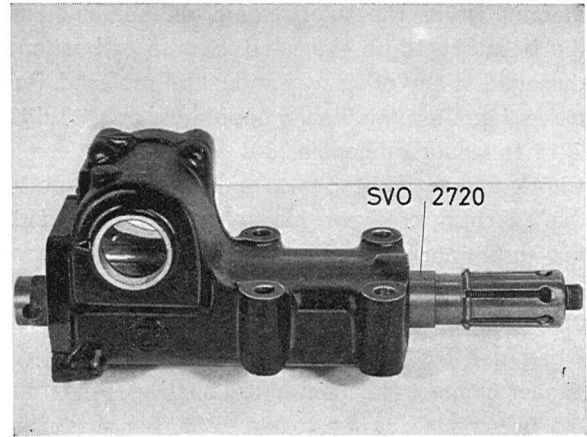


Fig. 6-56. Installation tool 2720

5. Remove the lock nut (3) and screw the adjusting screw (2) out of the cover. The adjusting screw can be removed from the pitman arm shaft after the circlip has been removed, see Fig. 6-55.
6. Remove the seals (9 and 14, Fig. 6-41) from the steering worm and pitman arm shaft with a screwdriver. Take care not to damage the steering gear housing.

## Inspection

Clean all the parts, except gasket and seal, which should be replaced when reconditioning. Check the pitman arm shaft. The roller may not be scratched, scored or heavily worn on contact surfaces or be loose in the pitman arm shaft. If this is the case or if the pitman arm shaft has any other kind of damage, replace the shaft. Examine the contact surfaces of the steering worm against the roller and the inner races of the ball bearings. Scoring or heavy wear, etc., are reasons for replacing the

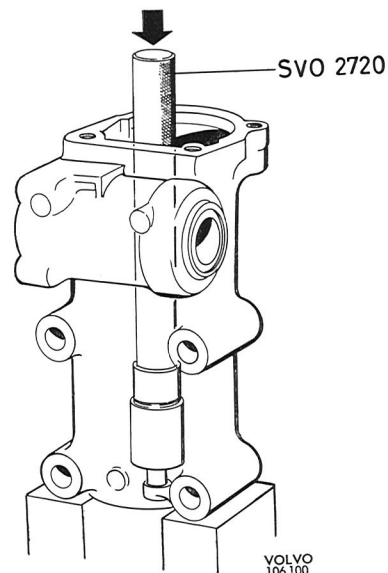


Fig. 6-57. Removing bushings, pitman arm shaft

steering worm. The outer rings of the bearings and the balls should be examined. Scored or bearings damaged in any other way should be replaced. Remove the outer ring for the upper bearing with drift 2718 and standard handle 1801.

Check to see if the pitman arm shaft is loose in the bushings or if the bushings are damaged. If this is the case, replace the bushing in the steering housing, in which case they are removed by tool 2720. Insert the tool with the expander sleeve, loose, see Fig. 6-56. Pull in the tool until the expander comes in position in the bushing. Press out the bushing according to Fig. 6-57. For the other bushing, fit the tool in from the opposite direction. The bushing in the pitman arm shaft cover cannot be removed so that the cover must be replaced complete.

## Assembly

1. Press the bushings of the pitman arm shaft from opposite directions with drift 2716 and standard handle 1801, see Fig. 6-58. Ream the bushing

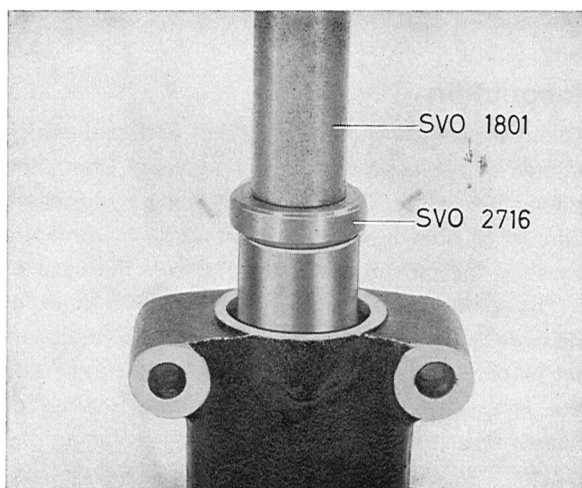


Fig. 6-58. Installation of pitman arm shaft bushing

with reamer 2254. Use the guide 2254, which is attached to the housing by two bolts, see Fig. 6-59. Clean the housing carefully from metal chippings after the reaming.

2. If the outer race of the upper bearing has been removed, it is pressed back into position by tool 2717. Press in the bearing so that it is against the shoulder in the housing. Install the seal for the guide bolt.
3. Install the guide bolt with bearing in the housing carefully so that the sealing ring is not damaged. Fix the housing in a vise so that the guide bolt is horizontal. Install the lower cover and washer together with shims of the same thickness as previously. The two bolts with the through-going holes should be coated with a

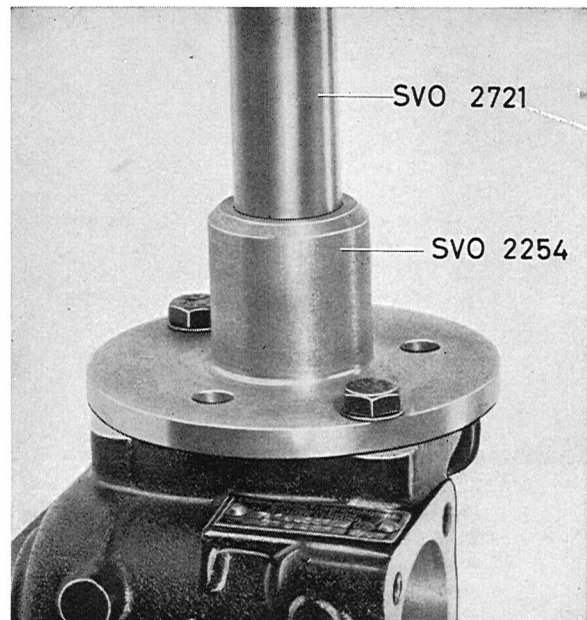


Fig. 6-59. Reaming

non-hardening sealing agent. Tighten the cover while checking that the guide bolt rotates easily without any play. If properly located the bearings should require a torque of .1—.25 Nm (1—2 lbin) in order to rotate the guide bolt. The torque is measured with a cord and spring balance as shown in Fig. 6-60. The balance should give

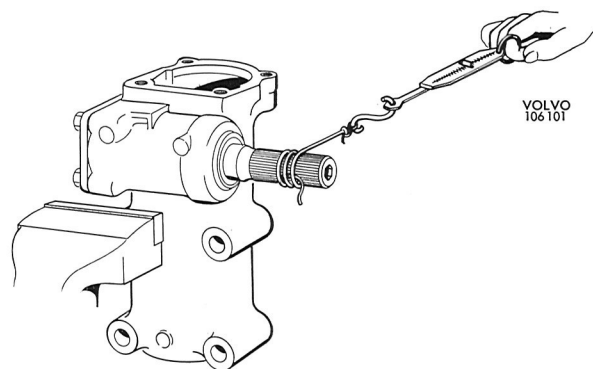


Fig. 6-60. Checking bearing location

a reading of 10—25 N (2.2—5.5 lbs. If this is not the case, adjust by inserting or removing shims.

4. Install the adjusting screw, washer and lock ring on the pitman arm shaft, see Fig. 6-55. The adjusting screw play axially should be as little as possible and should not exceed .05 mm (.002"). The play is reduced by exchanging the washer (2) for a thicker one. However, the adjusting screw should rotate easily afterwards.
5. Oil and install the pitman arm shaft. Put on the cover together with gasket. Screw out the adjusting screw so far that the roller on the pitman arm shaft goes free from the guide bolt when the bolts for the cover are tightened. Install and tighten the bolts.



Fig. 6-61. Fitting sealing ring, pitman arm shaft

6. Coat the seal with oil and install it with tool 2719 as shown in Fig. 6-61.
7. Locate the steering gear centrally (see Fig. 6-62). Screw in the adjusting screw so far that

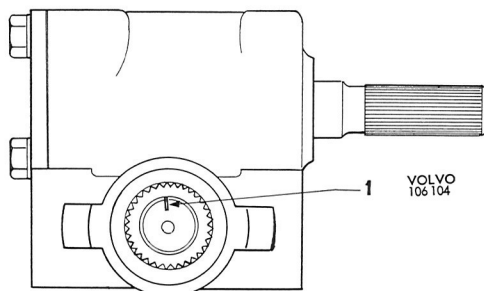


Fig. 6-62. Center position

a noticeable resistance is felt when rotating it forwards and backwards over the center position. The adjustment of the "pressure point" can be measured in different ways. The measurement, for example, can be done with a cord and balance, see Fig. 6-60, in which case the balance should give a reading of 80—140 N (18—31 lbs) when it pulls the guide bolt over the center position. With the swing iron and spring balance position as shown in Fig. 6-63, the balance should give a reading of 4—7 N (9—15 lbs). When the gear is properly located, lock the adjusting screw by the stop nut. Repeat the test after the stop nut has been tightened securely.

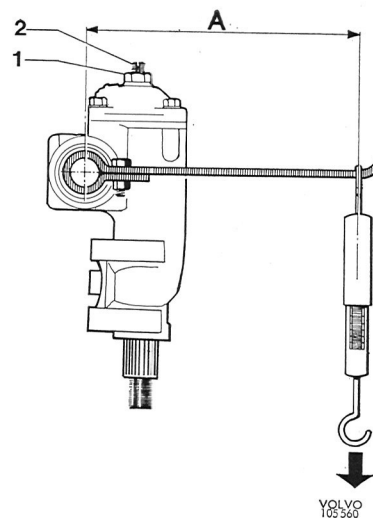


Fig. 6-63. Checking tensioning, cam — roller

A=210 mm (8 1/4")  
1. Lock nut  
2. Adjusting screw

8. Install the flange on the steering column in the same position it had before being removed.
9. Fill .25 dm<sup>3</sup> (1/2 pint) hypoid oil SAE 80 in the steering housing.

## Installation

1. Install the steering gear in position and secure it.
2. Install the pitman arm so that the line-up mark on the pitman arm shaft coincides with that on the pitman arm and tighten the nut.
3. With the steering wheel set the wheels so that they point straight forwards, and secure both halves of the lower flange. Check that the distance between the steering housing and lower flange is  $27 \pm 5$  mm ( $1 \pm 3/16$ "). Check that the flange spines coincide with the shaft splines.
4. Lower the vehicle.

## STEERING RODS AND TIE ROD

### Volvo Standard Times:

Op. No. 64304=replace tie rod

Op. No. 64310=replace one steering rod

Op. No. 64311=replace an additional steering rod

If bent, the steering rods and tie rod may not be straightened but should be replaced. This also applies if they are damaged in any other way.

The ball joints cannot be disassembled or adjusted so when worn or damaged they must be replaced. The ball joints of the tie rod can be replaced individually. When removing, first take off the cotter



pins and crown nuts. Then place tool 2294 on the ball joints as shown in Fig. 6-64. Press in the tool well and make sure that the thread on the ball joint enters the recess in the tool. Screw in the bolt until the ball joint loosens.

Then remove the lock nut on the rod and the ball joint. From the beginning, the new ball joint is screwed in the same number of turns and this facilitates adjusting toe-in. Lock the ball joint with the rod.

The steering rod ball joints are made in one piece with the steering rods and for this reason the steering rod and ball point are replaced complete. To make sure that the steering rods are not mixed when installed, the left one is marked "L" and the right steering rod "R" at their outer ends. The marked end should be attached to the steering knuckle.

After having reconditioned the rods and ball joints, the toe-in should always be checked.

## RELAY ARM

### Replacing as complete unit

1. Jack up the front end of the vehicle.
2. Disconnect the steering rod and tie rod ball joints from the relay arm with puller 2294 as shown in Fig. 6-64.

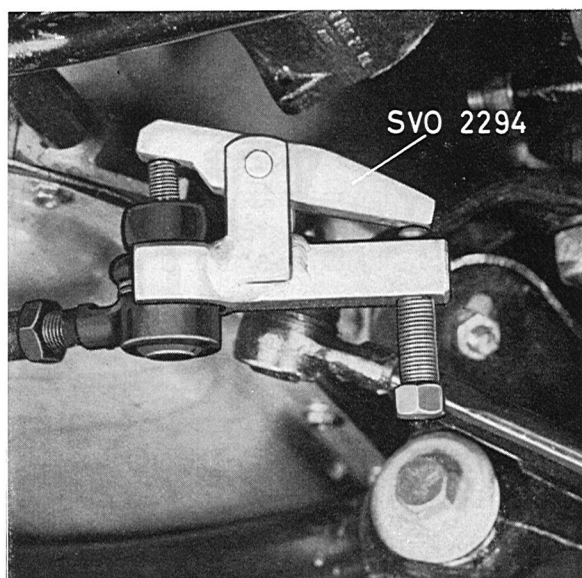


Fig. 6-64. Removing ball joint

3. Remove the three attaching bolts for the bracket (2, Fig. 6-67) and lift out the unit.
4. Install the new complete unit.
5. Connect and lock the ball joints for the rod. Lower the vehicle.

6:30

## Replacing bushing

1. Jack up the front end of the vehicle.
2. Disconnect the ball joint for the steering rods and tie rod from the relay arm with puller 2294 as shown in Fig. 6-64.
3. Remove the nut and washer (7, Fig. 6-67) and take down the relay arm (1).
4. Secure the press tool 2699 in a vise and press out the bushing with counterhold 2736 and drift 2734 (Fig. 6-65).

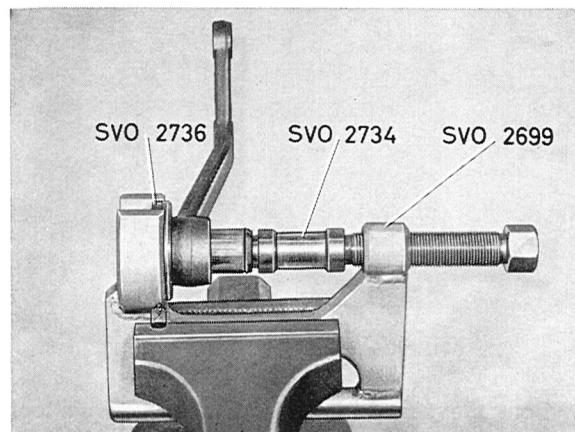


Fig. 6-65. Removing rubber bushing, relay arm

5. Turn the relay arm and press in the new bushing with 2699 + 2736 and drift 2735 (Fig. 6-66).
6. Place the relay arm in position. Install the washer (7) and nut.
7. Connect and lock the ball joints for the rods. Lower the vehicle.

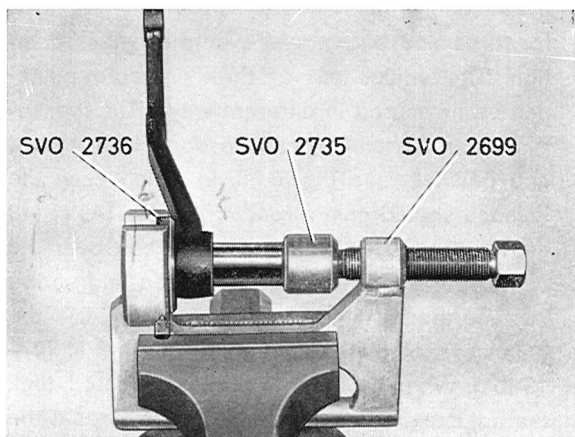


Fig. 6-66. Installation of rubber bushing, relay arm

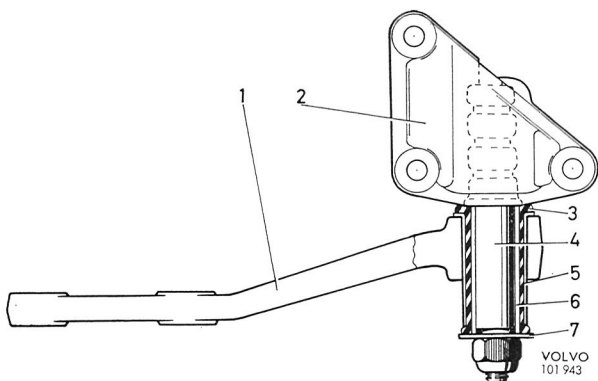


Fig. 6-67. Relay arm journaling

- |                   |           |
|-------------------|-----------|
| 1. Relay arm      | 5. Sleeve |
| 2. Bracket        | 6. Sleeve |
| 3. Rubber bushing | 7. Washer |
| 4. Bearing pin    |           |

## POWER STEERING

### Work on power steering in vehicle

NOTE: The utmost cleanliness should be observed for all work on the power steering equipment. Always clean the connections before disconnecting them, also the outside of the oil container before removing its cover.

Only Automatic Transmission Fluid, Type A or Dexron may be used for the power system.

### CHECKING OIL LEVEL

The oil level should be checked every 10 000 km (6 000 miles). The level should first be checked with the engine stationary in order to see whether there has been any loss of oil. The oil level should then come about 5—10 mm ( $\frac{1}{4}$ " ) above the level mark. If the level is lower than this, fill with oil with the engine stationary: this will eliminate risk of air being sucked in. Start the engine and then check the oil level again, which should now fall to the maximum mark, see Fig. 6-68. When the engine has stopped, the oil level may rise to 5—10 mm ( $\frac{1}{4}$ " ) above the level mark.

### DRAINING OIL

Change oil, incl. replace oil filter=Volvo Standard Times Op. No. 64416

With the power steering pump complete, oil is drained as follows:

Jack up the front end. Screw out the drain plug (6, Fig. 6-74). Turn the steering wheel to the left to the stop position. Remove the cover on the container.

Start the engine and allow it to run max. 10 seconds until the oil is emptied out of the reservoir and pump. Stop the engine and turn the steering wheel from full lock to full lock until all the oil has run out.

## FILLING OIL AND BLEEDING

NOTE: The oil capacity is approx 1.2 dm<sup>3</sup> (2.1 Imp. pints=2.5 US pints). Drained oil may not be put back into the system.

1. Fill oil up to the edge of the oil reservoir.
2. With oil within easy reach, start the engine. Gradually fill the reservoir with oil as the level drops. When the level has stabilized itself, proceed to the next operation.
3. Turn the steering wheel repeatedly and evenly in both directions. The steering wheel should be turned slowly so that the pump operates at low pressure. If necessary, fill more oil.
4. Open the bleeder screw (4, Fig. 6-74)  $\frac{1}{2}$ —1 turn. Close it when oil starts flowing out.
5. Continue turning the steering wheel until the oil in the reservoir is practically free from air bubbles.
6. Stop the engine. The oil level should then rise 5—10 mm ( $\frac{1}{4}$ " ) above the level mark. If it rises further than this, there must be air still in the system, in which case continue bleeding.
7. Lower the front end.

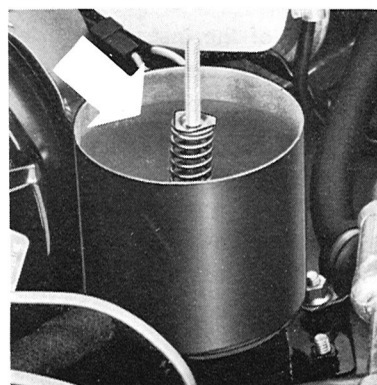
After bleeding, a small number of air bubbles may remain in the system. When the pump causes pressure to be applied to the oil during driving, these air bubbles will eventually disappear in the reservoir.

## INSPECTING POWER STEERING

The inspection procedure described below can be applied to diagnose or prevent possible faults.

### 1. Checking outer sealing

1. Check to make sure that all screw unions are not damaged. Re-tighten if necessary.
2. Check the hoses for damage. Replace those that are damaged.



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Fig. 6-68. Oil level

## II. Checking oil level and bleeding

1. Connect the test instrument 2864 to the delivery line at the steering housing, see Fig. 6-69. The inlet hose of the instrument is connected to the banjo nipple with tool 2865 (Fig. 6-69) and the

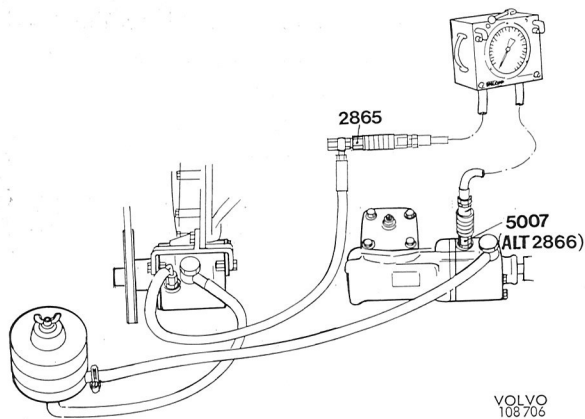


Fig. 6-69. Pressure gauge connected

- outlet hose to the steering housing with tool 5007 alt 2866 (r-h steered vehicle, tool 2990). Check to make sure that the operating lever of the instrument is in the open position (to the left).
2. Jack up the front end of the vehicle. Check that the oil level is 5—10 mm ( $\frac{1}{4}$ " ) above the level mark with the engine stationary.
3. Start the engine. Check the level and fill oil if the level has fallen below the level mark with the engine running. Turn the steering wheel from full lock to full lock as long as air bubbles are visible in the container. With the engine idling, the oil level should be at the level mark.
4. When the engine is stopped, the oil level should rise 5—10 mm ( $\frac{1}{4}$ " ).

## III. Checking hydraulic function for steering housing and pump

Volvo Standard Times Op. No. 64428

1. Run the engine warm.
2. **Pump testing:** With the engine idling, move the operating lever of the instrument briefly (max. 10 seconds) to the closed position. Read the max. pressure on the pressure-gauge. This should be maximum 10 % below the indicated maximum pressure of the pump, that is, at least 67 kp/cm<sup>2</sup> (950 psi). If pressure less than this is obtained, examine pump and drive as follows:
  - a) Check the tension and condition of the drive belt. Replace the belt if defective.
  - b) Remove the pump control valve, see Fig. 6-70. Observe the utmost cleanliness. Wash and blow clean before screwing out the plug (4, Fig. 6-67), which should be done from

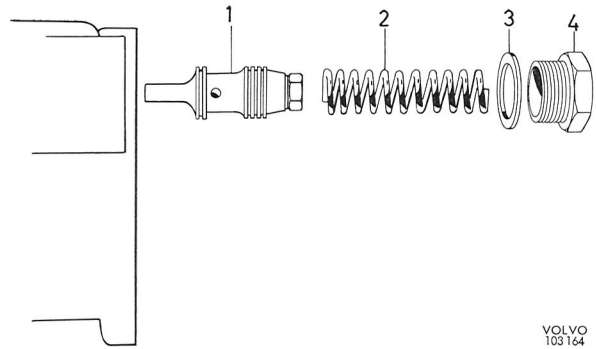


Fig. 6-70. Removing control valve

1. Piston 2. Spring 3. Gasket 4. Plug

underneath. Check the valve piston and drilling in the housing. The hole in the valve piston must not be blocked. The piston should run easily in the housing and not jam. If necessary, install a new valve. If this does not help, replace or recondition the pump.

3. **Steering gear test.** Place a 6 mm (.24") thick shim on each stop bolt limiting the full steering wheel lock. With the engine at idle and the instrument open, turn the steering wheel to the left until there is resistance from the shim on the stop bolt. Increase the force on the steering wheel by about 100 N (22 lbs) and maintain this for about 5 seconds while reading the gauge. If the oil pressure in the steering gear agrees with the previously determined oil pressure for the pump, continue the test. If the pressure is lower, first check to make sure there is no external leakage. Thereafter adjust the unloading valve according to below. If this does not remedy the fault, the pressure drop may be due to another internal leakage and this means that the steering gear must be replaced or reconditioned.

Turn the steering wheel until it is stopped by the shim on the right-hand side and repeat the test. Even here the pressure should coincide with that of the pump, the only difference being that the opening point for the unloading valve cannot be adjusted.

Replace the shims with 1 mm (.04") thick ones and repeat the test. In this case, the unloading valve should open, that is, the power effect should not be obtained at the end positions.

**Adjusting unloading valve.** The unloading valve should be open in both directions about 3° before stop.

The function of the valve can therefore be checked with shims as above.

The valve's opening point in the left end position can be adjusted. To do this release the lock nut for the adjusting screw at the front end of the housing. Screwing out the nut delays the opening point,



screwing it in advances it. Lock the screw after adjustment.

#### IV. Checking mechanical function

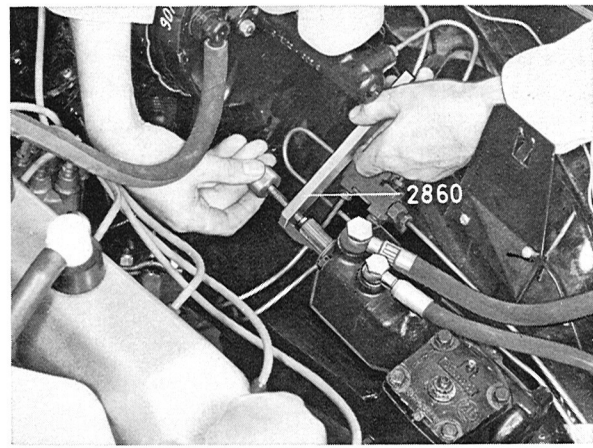
1. Check the mechanical components of the front end and steering such as ball joints, rods, bearings, steering housing and flanges concerning play. Re-tighten attaching bolts and replace damaged or worn components.
2. Adjust the pressure point between the piston of the steering housing and pitman arm shaft as follows:

(NOTE: This adjustment should only be made if there is reason to suspect a fault. Accurate adjustment is made in connection with reconditioning.)

- a) Remove the lock nut for the pitman arm. Pull the pitman arm with tool 2370. When attaching the puller, turn the wheels fully to the right, see Fig. 6-54.
- b) Place the steering housing in the middle position (count the number of steering wheel turns).
- c) Slacken the nut for the adjusting screw (5, Fig. 6-74).
- d) Turn the adjusting screw clockwise until a light resistance is felt in the flange device when it is turned to the left or to the right on both sides of the center position.
- e) Tighten the lock nut while holding the adjusting screw firmly.
- f) Check the adjustment by turning the steering wheel several times more past the center position. In the center position a slight increase in resistance should be felt.
- g) Set the front wheels straight forwards and install the pitman arm with the steering gear in the center position. Torque the nut to 175—200 Nm (125—145 lbft).

#### REPLACING STEERING SPINDLE SEAL

1. Disassemble the flange device by removing the two nuts and the screw. Move the rubber disc and lower steering column section to the one side.
2. Mark up the location of the flange on the steering spindle. Slacken the clamping bolt and pull off the flange.
3. Remove the rubber cover as well as the circlip for the seal.
4. Carefully apply tool 2860 to the seal. Tighten the screw (Fig. 6-71). This also tightens the seal. If the ring sticks in the circlip groove, carefully turn the tool backwards and forwards.
5. Fill the space between the new sealing ring



VOLVO  
106982

Fig. 6-71. Removing seal

lips with multipurpose grease. Install the sealing ring on to installation tool 2863 with the help of the loose guide. Remove the guide and install the sealing ring in the steering housing, see Fig. 6-72

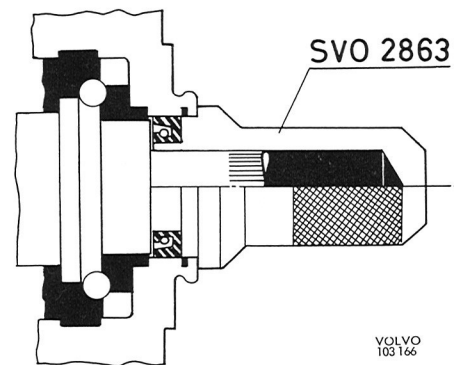


Fig. 6-72. Installing seal

6. Install circlip and cover.
7. Re-install the flange according to the line-up marks. Check that the distance between the steering housing and the lower flange is  $7 \pm 5$  mm ( $.28 \pm .20$ "). Assemble the other parts.

#### Replacing steering gear

Volvo Standard Times Op. No. 64438

#### (Power steering)

##### REMOVAL

1. Jack up the front end.
2. Drain the oil, see under "Draining the oil".
3. Remove the lock nut for the pitman arm. Pull the pitman arm with tool 2370. When attaching the puller, turn the wheels fully to the right, see Fig. 6-54.
4. Disconnect the oil lines (1 and 2, Fig. 6-74) from the steering housing after the connections have been cleaned. Slacken the clamping bolt.
5. Remove the attaching bolts (8) and pull the steering gear forwards.

## INSTALLATION

1. Place the steering gear in the middle position. A slight increase in resistance should then be felt and the position of the pitman arm shaft lands should be as in Fig. 6-73 and the line-up marks on the steering spindle and gear housing should coincide.

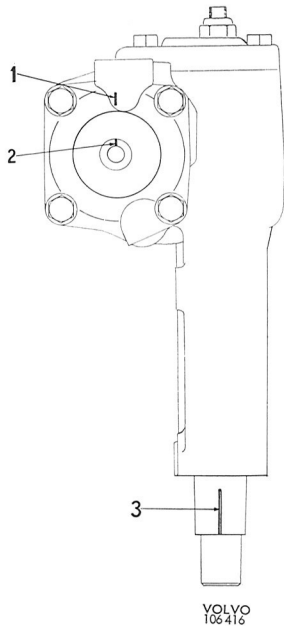


Fig. 6-73. Steering gear in middle position  
1—3 Line-up marks

2. Check to make sure that the steering wheel is pointing the front wheels straight forwards.
3. Install the steering gear spindle in the flange of the lower steering column section. Install and tighten the attaching bolts (8, Fig. 6-74). Tighten the clamping bolt. Check that the distance between the steering gear and the lower flange is  $12 \pm 3$  mm. Connect the oil lines.
4. Point the front wheels straight forwards and install the pitman arm. Torque the nut to 175—200 Nm (125—141 lbft).
5. Fill oil and bleed, see under the heading "Oil filling and bleeding".

## Reconditioning steering gear

Volvo Standard Times Op. No. 64479  
(Steering gear removed)

In the instructions below the figures in brackets refer to those on Illustration A, at the end of this Section. Work which can be made with the power steering in the vehicle and also removal and installation, see the previous pages.

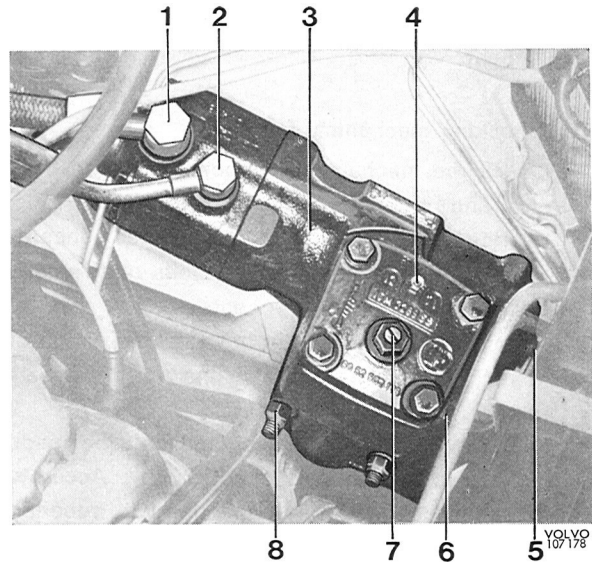


Fig. 6-74. Steering gear installed

- |                  |                    |
|------------------|--------------------|
| 1. Return line   | 5. Adjusting screw |
| 2. Delivery line | 6. Drain plug      |
| 3. Housing       | 7. Adjusting screw |
| 4. Bleeder screw | 8. Nut             |

## DIASSEMBLY

1. Secure the steering gear in a vise as shown in Fig. 6-59.
2. Remove the lock nut (17) and the attaching bolts (19) for the cover. Screw in the adjusting screw (11) through the cover and remove the cover (16). Take out the loose needles in the cover bearing (14).
3. Remove the circlip (13) and adjusting screw (11), see Fig. 6-76. Adjust the pitman arm shaft (10) to the center position and lift it up, see Fig. 6-73. With a magnet remove the loose rollers in the bearings (3 and 7).

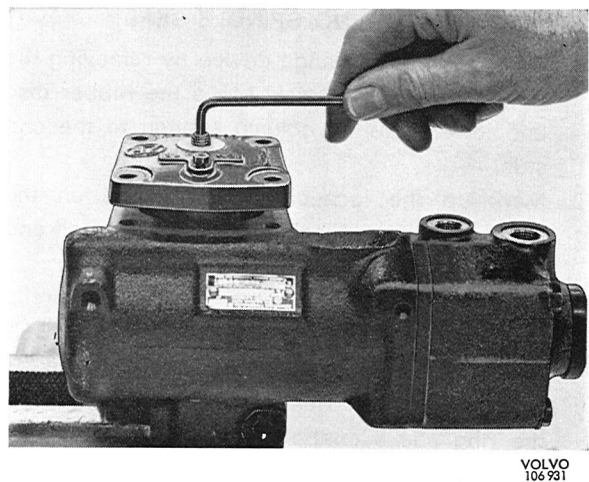


Fig. 6-75. Removing cover

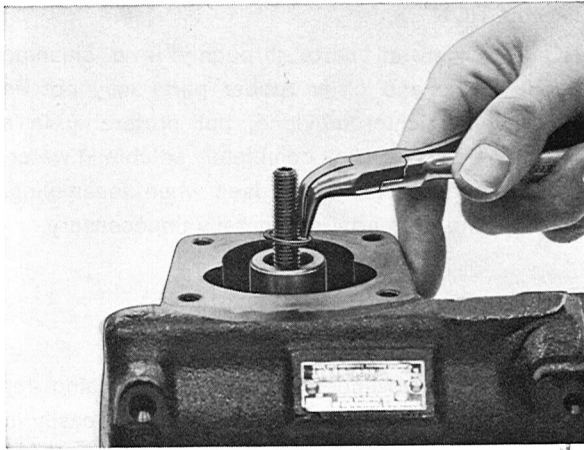


Fig. 6-76. Removing circlip

4. Remove the rubber cover (51) and the attaching bolts (50 and 52). Pull off the valve housing (56), see Fig. 6-77. Remove the circlip (53) and press out the seal (54).
5. Pull out the worm (68), cover (30) and piston (22), see Fig. 6-78.
6. Lift the piston and screw out the worm, see Fig. 6-79. Take care when the 23 balls drop out that they do not get damaged. Remove the cover (30), needle bearings (36) and bearing washer (35). Remove the gasket (34) and O-ring (33), shims (32) and O-rings from the cover.

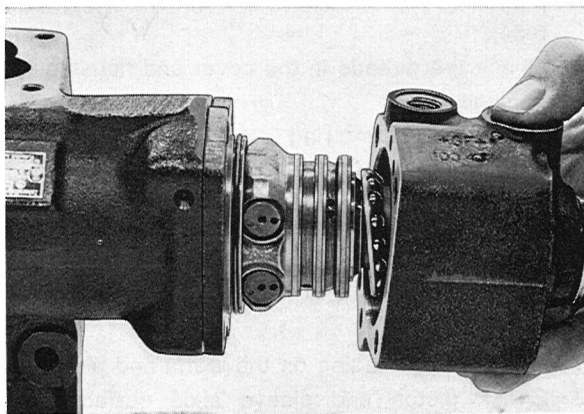


Fig. 6-77. Removing valve housing

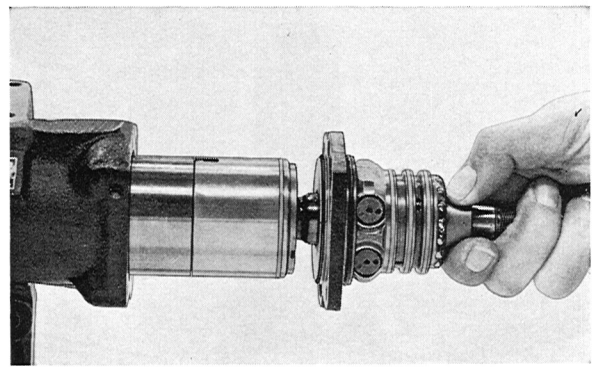


Fig. 6-78. Removing worm

7. With a screwdriver remove the upper seal (9) in the housing. The seal should be demolished but carefully in order not to damage the bearing in the housing. Turn the housing and remove the circlip (1), see Fig. 6-80. Remove the seal (2) with a chisel. The retainer (3) for the needle bearings should only be removed if the bearing is to be replaced, see under "Inspection".

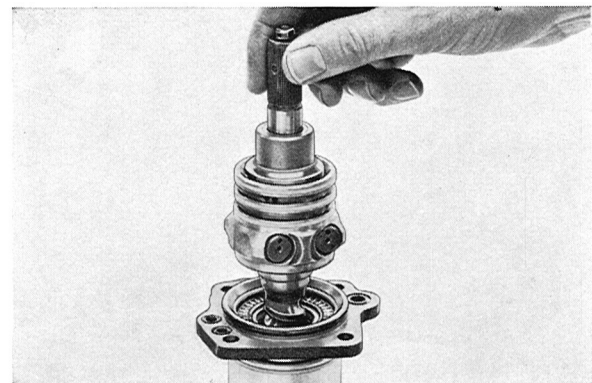


Fig. 6-79. Removing piston

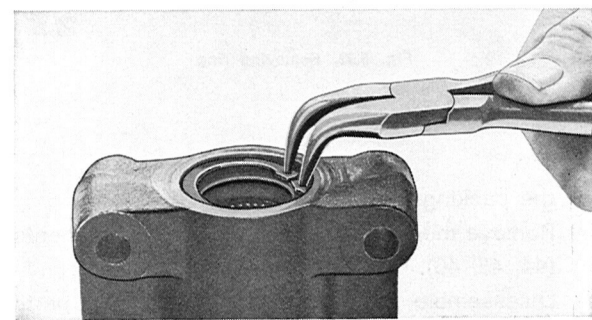


Fig. 6-80. Removing circlip

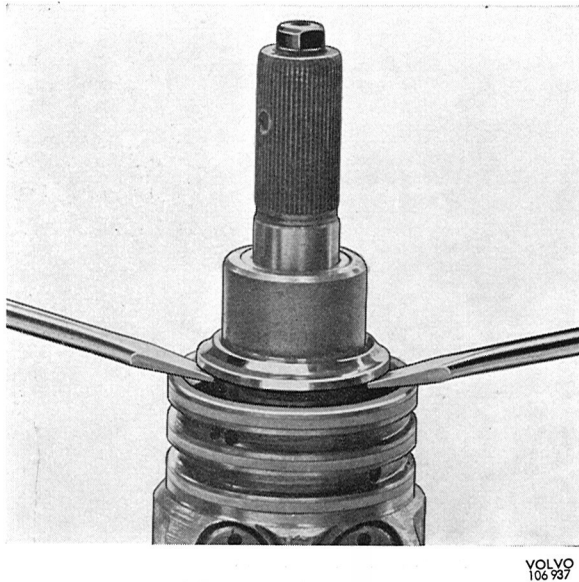


Fig. 6-81. Removing bearing sleeve

8. Clamp the worm between, for example, copper jaws in a vise. Remove the inner bearing sleeve (60) and the bearing (61), see Fig. 6-81. Remove all rings (62—67) from the worm.
9. Secure the piston between soft vise jaws and the ring nut (27) with a hook spanner, see Fig. 6-82. Remove the sleeve (24) and its ring (25),

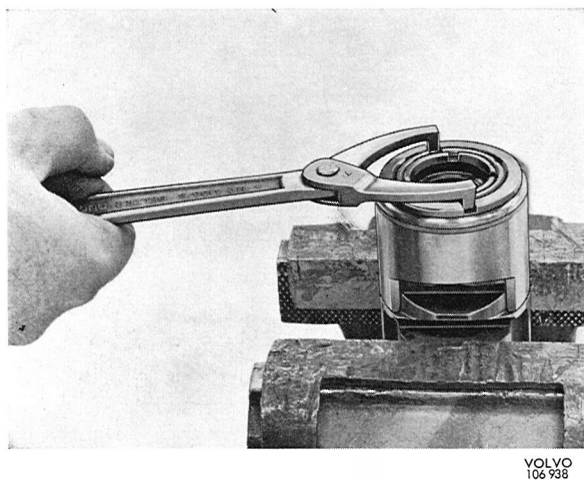


Fig. 6-82. Removing ring

the packing (41) and the pipe halves (42). Remove the plug (21) and the valve components (44, 45, 46).

Disassemble the worm valve head. The parts are installed and fixed in special apparatuses and their mutual position must not be altered.

## INSPECTION

NOTE: Clean all parts thoroughly in a cleaning agent. Seals and other rubber parts may not be washed in trichloroethylene, but preferably in a cleaning agent which is completely soluble in water. Since new seals are to be used when assembling, washing the old parts is generally unnecessary.

## Housing and cover

1. Check the cylinder bore in the housing for wear and scoring. The piston must run easily in the cylinder.
2. Check the sealing surfaces and threads in the connections for the delivery and return line for damage.

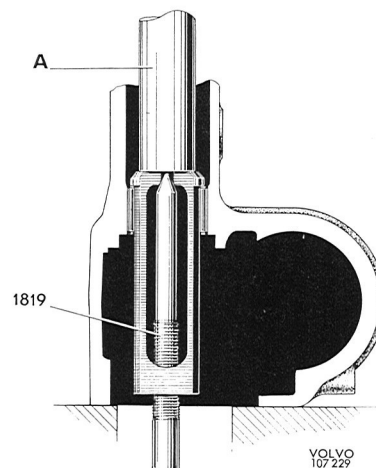


Fig. 6-83. Removing needle bearing  
A=Drift

3. Check the needle bearings in the housing and the cover for damage. Replace if necessary. For removal, use tool 1819 (Fig. 6-83) and for pressing in, drift 2995 and handle 1801 (Fig. 6-84).
4. Check the threads in the cover and housing for damage.
5. Check the bearing ring in the valve housing. If it is to be replaced, knock it out with a chisel and install the new one with tool 2013.

## Piston and worm

1. Check the threading on the worm and piston.
2. Check piston and sleeve slide surfaces for scoring.
3. Check the piston teeth for damage.

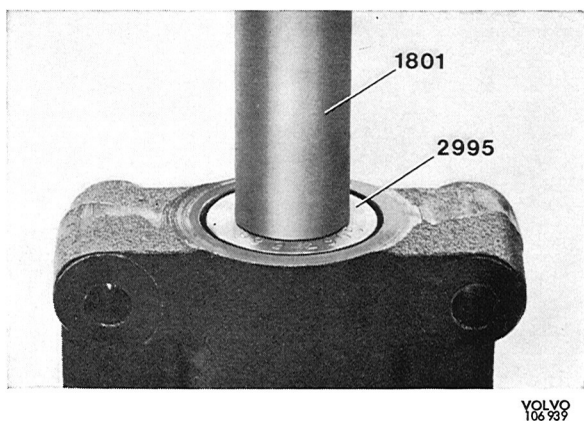


Fig. 6-84. Installing needle bearing

### Steering shaft

1. Check steering shaft for cracks.
2. Check gears for wear and scoring.
3. Check bearing surfaces for wear and scoring.
4. Check seals for wear and corrosion.
5. Check the serration for damage.
6. Check the adjusting screw threads and the two flat surfaces for damage. Check sealing surfaces for damage and paint residues. Remove the paint.

### ASSEMBLY

Before assembling the parts, wash them well and oil them lightly. All seals should be replaced.

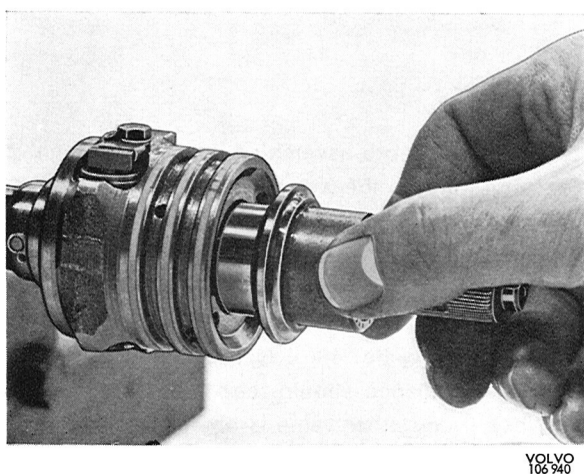


Fig. 6-85. Checking bearing

1. Install the needle bearings (61) in the bearing sleeve (60) and test it on the worm spindle (Fig. 6-85). The sleeve should turn easily without any noticeable play. If there is any noticeable play, test with thicker needles in the needle bearing. These are available in four sizes with a difference between each of  $2\mu\text{m}$  ( $.002\text{ mm} = .0008''$ ), see "Specifications". Bearing sleeves are available with external diameter  $28.0\text{ mm}$  ( $1.102''$ ) and  $28.015\text{ mm}$  ( $1.103''$ ). Use tool 2481 for installing the sleeve.
2. Tighten the valve housing (56) with the large bore facing upwards (see Fig. 6-86). Install

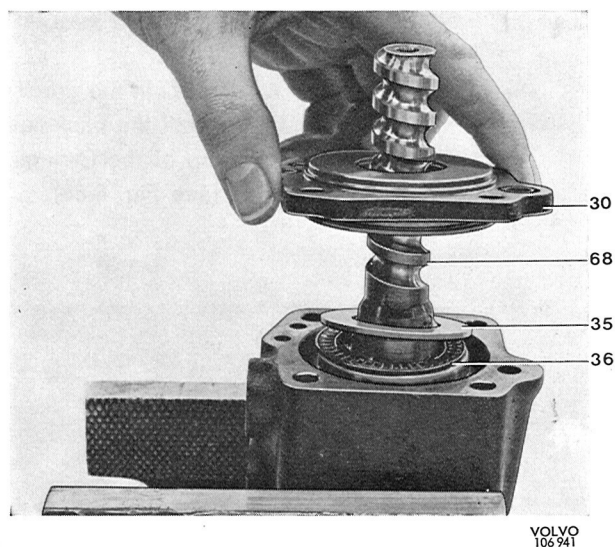


Fig. 6-86. Installing cover

- |                    |                    |
|--------------------|--------------------|
| 30. Cover          | 36. Needle bearing |
| 35. Bearing washer | 68. Worm           |

the preassembled worm in the housing. Install the needle bearing (61), the bearing washer (35) and the cover (30), see Fig. 6-86. Secure the cover with the bolt (50 and 52) and four nuts M8. Tightening torque is  $34\text{ Nm}$  ( $25\text{ lbft}$ ). Check to make sure there is no looseness in the journaling. A torque of  $.15\text{—}.25\text{ Nm}$  ( $1.3\text{—}2.2\text{ lbin}$ ) is required to turn the worm. If this is measured according to Fig. 6-87, the scale should read  $17\text{—}29\text{ N}$  ( $3.7\text{—}6.4\text{ lbs}$ ).

NOTE: The test should be done without seal. The preload can be regulated by replacing the bearing washer (35).

There are bearing washers in 6 different thicknesses between  $1.9\text{ mm}$  ( $.075''$ ) and  $2.4\text{ mm}$  ( $.094''$ ).

When the correct pre-load has been obtained, remove the valve housing.



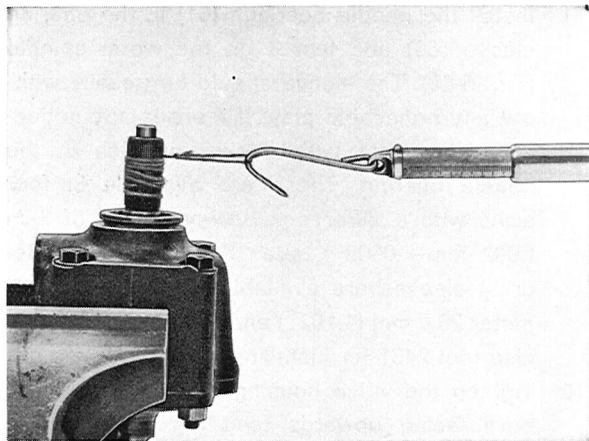
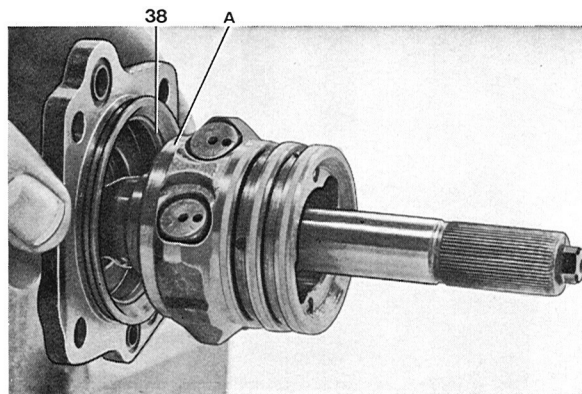


Fig. 6-87. Checking torque

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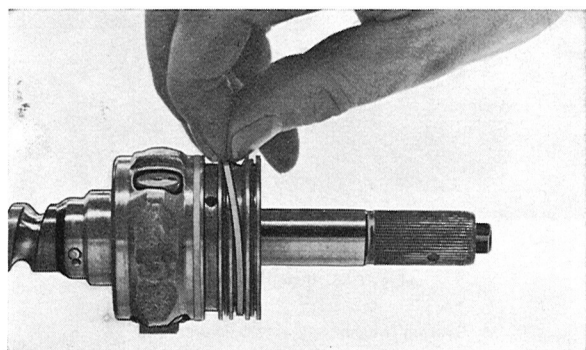


VOLVO  
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Fig. 6-89. Checking packing

38. Packing A. Contact surface

3. Place the O-rings (63, 65 and 67) in the grooves on the worm. Carefully install the packings (62, 64 and 66) in position top of the O-rings, starting with the inner one (see Fig. 6-88).



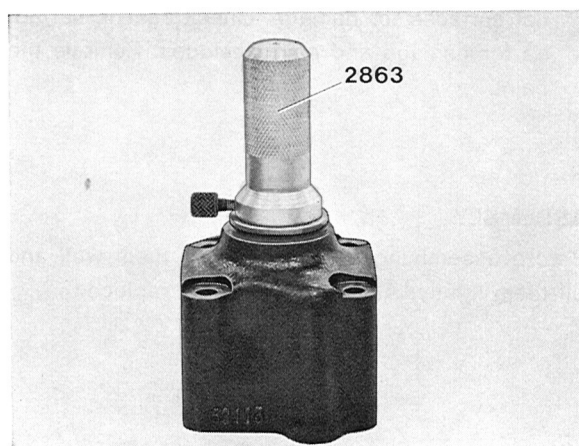
VOLVO  
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Fig. 6-88. Installing packing

4. Place the O-ring (37) in position in the cover (30). A 1.7 mm (.067") packing (38) is placed on the O-ring.

Apply marking color to the contact surface (A) and install the worm (Fig. 6-89). Rotate the worm. Lift it out and check its contact against the packing. If the worm has not made a perfectly satisfactory sealing against the packing, replace the packing with a 1.8 mm (.071") one. Remove and clean the worm. Install all the O-rings on the cover's valve housing side. Install the same number of shims (32) previously there. Install the O-ring (33) and then the packing (34). Oil the packings in the cover. Place the bearing washer (35) and bearing (36) in the cover.

5. Install seal (54) on the installation tool 2863 with the loose guide. Remove the guide and install the seal in the valve housing, see Figs. 6-90 and 6-72. The seal should face inwards. Install the circlip (53).



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Fig. 6-90. Installing seal

6. Install the pre-assembled cover and valve housing onto the worm with the help of the fitting sleeve 2863. Screw the cover and valve housing together with the four bolts and nuts. Tightening torque 34 Nm (25 lbft).

Check the worm torque (see Fig. 6-87). This should now be .4—.6 Nm (3.5—5.2 lbin), that is, the balance should read 45—70 N (10—15 lbs). If any other value is obtained, adjust with the shims. Remove the worm and bearing from the valve housing.



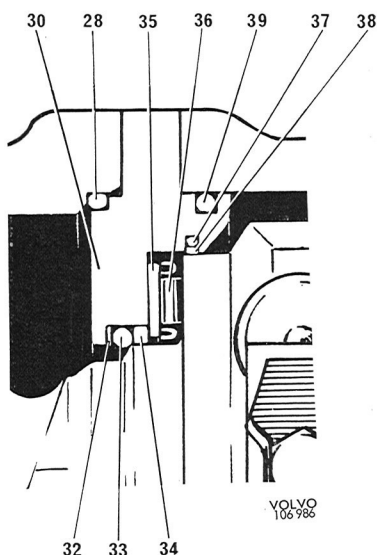


Fig. 6-91. Sealing components

- |             |                    |
|-------------|--------------------|
| 28. O-ring  | 35. Bearing washer |
| 30. Cover   | 36. Needle bearing |
| 32. Shims   | 37. O-ring         |
| 33. O-ring  | 38. Packing        |
| 34. Packing | 39. O-ring         |

7. Clamp the piston between soft jaws in a vise. Slide the sleeve (24) onto the worm. Insert the worm far enough into the front piston bore that its top comes opposite the first recess for the pipe half. Fill the bore (Fig. 6-92) with

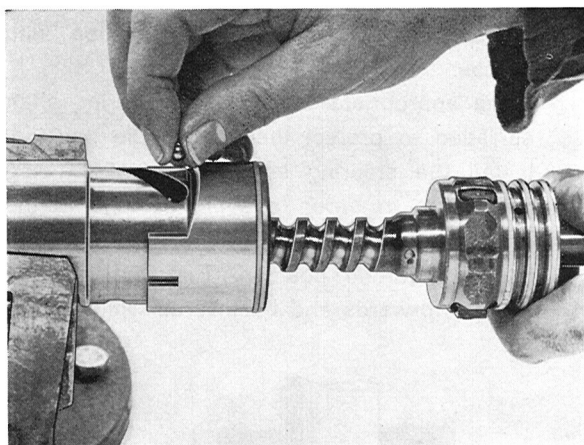


Fig. 6-92. Inserting balls

the balls. Screw the worm further down by hand so that the balls are carried up to the rear piston for the recirculating pipe. When 16 balls have been inserted, the first ball should appear at the other recess. Thereafter insert the remaining 7 balls. The balls should be greased in order to facilitate installation. Place the halves together and install them, see Fig. 6-93.

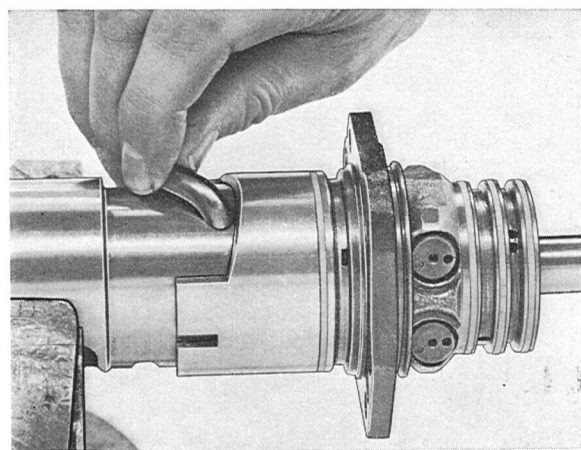


Fig. 6-93. Installing pipe halves

Check the torque required to turn the worm in the piston. The correct value is .2—.4 Nm (1.7—3.5 lbin). If the torque is measured with a cord (see Fig. 6-94), the balance should give a reading of 23—46 N (5—10 lbs). If any other value is obtained, all 23 balls should be replaced. Sets are available with balls in 5 different sizes.

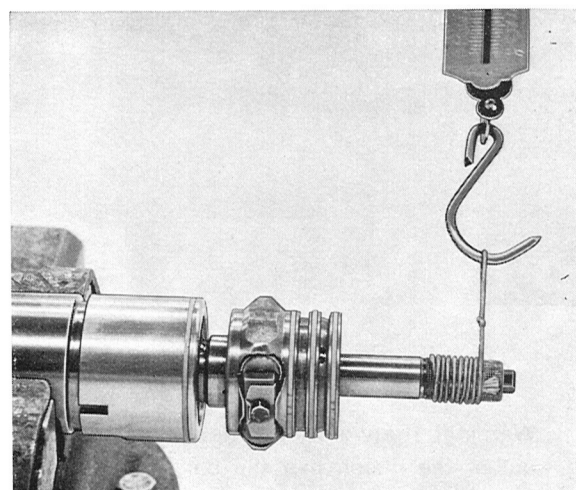


Fig. 6-94. Checking torque

After the correct value has been obtained, remove the 23 balls and keep them in a safe place.

8. Place the O-ring (26) and the piston ring (25) in the recess on the sleeve (24). Install the pre-assembled cover (30) with bearing washer (35), bearing (36), ring (27) and sleeve (24) on the worm, see Fig. 6-95.

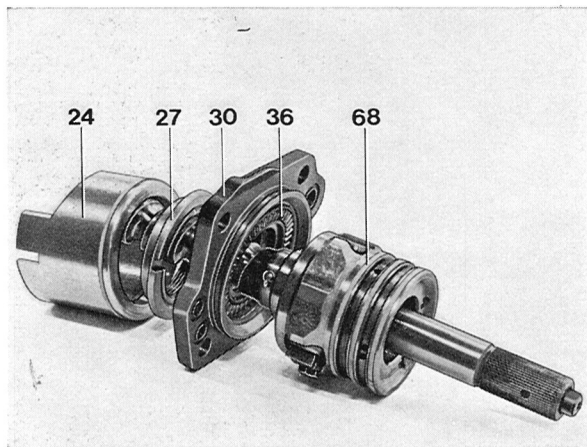


Fig. 6-95. Worm components

- |              |                    |
|--------------|--------------------|
| 24. Sleeve   | 36. Needle bearing |
| 27. Ring nut | 68. Worm           |
| 30. Cover    |                    |

Move the worm into the piston while installing the 23 balls, see point 7. Install the packing (41), see Fig. 6-96. Assemble the piston and sleeve and install the pin (23) if it has been removed. The sleeve recess should be on the gear side.

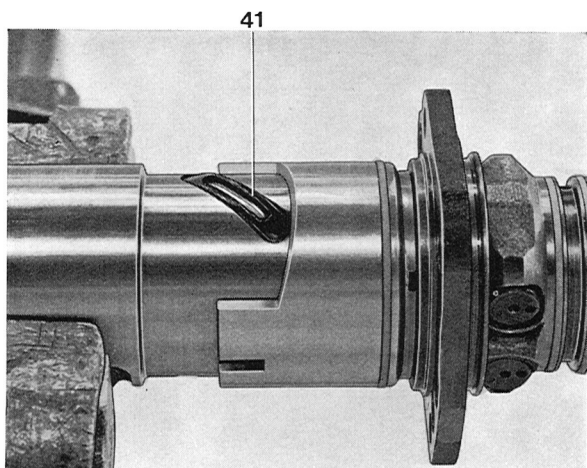


Fig. 6-96. Packing installation

41. Packing

Warning! The worm must not be pulled so far out of the piston that the balls run out (into the piston). Tighten the circlip (27) and lock it, see Fig. 6-97. When doing this, protect the worm to make sure that no metal fillings get into the piston.

Install the valve components (44, 45 and 46) and the plug (21) in the piston.

- 9) Tighten up the housing (4) with the neck facing downwards. Install the washer (8) in the housing. Install the seal (9) with the sealing lip facing upwards. Use tools 2010 and 1801, see Fig. 6-98.
10. Oil the O-ring (28) and install it together with the other O-rings in position in the cover with

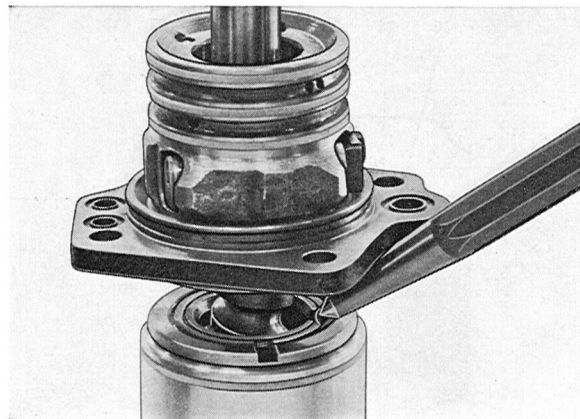


Fig. 6-97. Locking circlip

the help of grease. Move the piston complete in with cover and worm into the housing, see Fig. 6-78.

11. Tension out the seal (54) with tool 2863. Place the bearing (59) in position. Install the valve housing (56), see Fig. 6-99. The tightening torque for the bolts (50 and 52) is 34 Nm (25 lbft).
12. Place the piston teeth in the center position, that is, the opening between the second and third teeth about opposite the steering shaft hole (Fig. 6-100). Fine-adjust by setting the worm scribe mark to coincide with that on the housing (Fig. 6-58).

If the bearings (3 and 7) have not been replaced, place the needle in position with grease.

Place appropriate tape on the steering shaft serration to protect the seal in the housing. Install the steering shaft (Fig. 6-101) using great care in order to avoid damage to the seal in the housing. Push the steering shaft into the bottom position. Turn the steering spindle forwards and backwards while press-

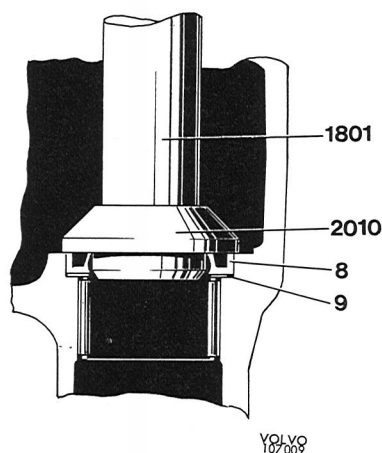


Fig. 6-98. Installing sealing ring

8. Washer 9. Sealing ring

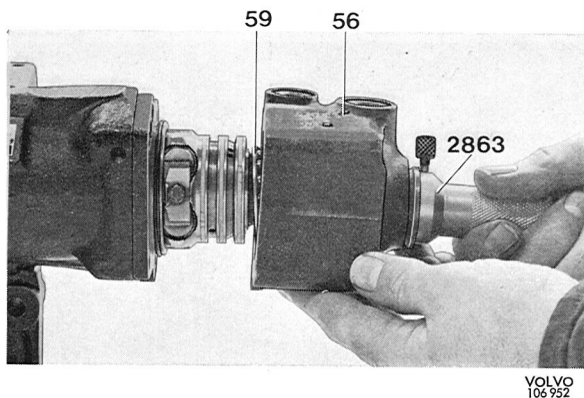


Fig. 6-99. Installing valve housing  
46. Valve housing 59. Ball bearing

ing in the steering shaft at the same time so that the steering shaft and piston take up the correct position in relation to each other.

Install the adjuster screw (11), and adjuster washer (12) and lock ring (13) on the steering shaft (10). Check the adjuster screw play on the shaft. This may go up to a maximum .05 mm (.002"). The play is adjusted by replacing the adjuster washer (12). This washer is available in 7 thicknesses between 2.15—2.45 mm (.085—.096"). Start with the thicker washers and choose the first dimension which gives a clearance after the lock ring has been installed.

13. Install the needles in the bearing (14). Place the O-ring (15) on the cover. Install the cover by screwing up the adjuster screw (11) until the cover fits. Install the nut (17) temporarily. Install washers (20) and bolts (19). The tightening torque is 31 Nm (22 lbft). Install the protective casing (51).
14. Install the seal (2) with tool 4028. Install the lock ring (1) in position. Remove the tape.

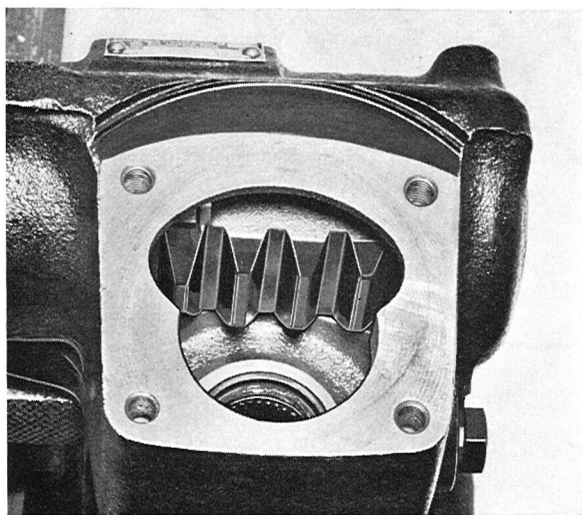


Fig. 6-100. Center position

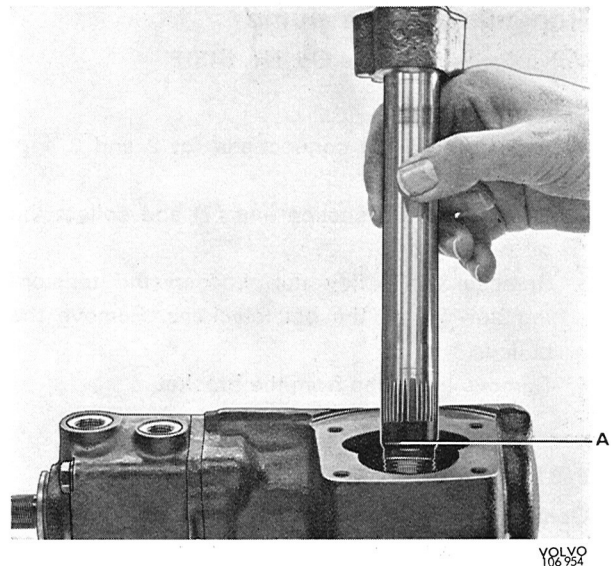


Fig. 6-101. Installing steering shaft  
A. Tape

15. Turn the steering spindle to the end position. Check for sufficient torque about 1/2 turn from the end position (Fig. 6-102). Adjust the steering spindle to the center position. Screw in the adjuster screw (11) so that a noticeable pressure point is obtained. Measure the torque and adjust so that the balance gives a reading of 45—60 N (10—13 lbs) greater than at the end position, but max. 185 N (40 lbs). Torque the nut (17) to 25 Nm (18 lbft) while holding the adjuster screw in position.

## FUNCTION TEST

After assembling test the function of the power steering and to make sure that it does not leak. When doing this, follow the instructions on page 6-32.

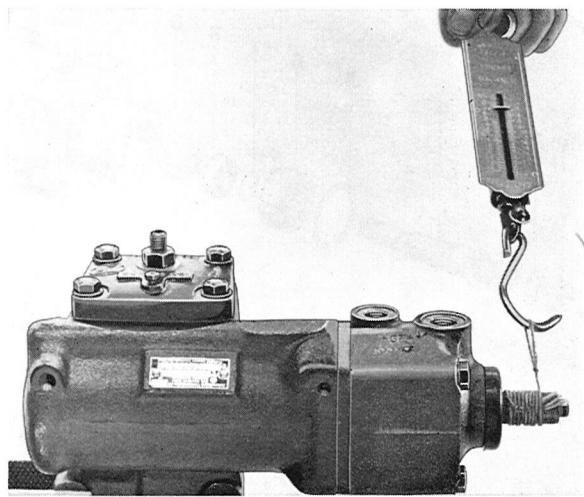


Fig. 6-102. Checking torque

## Replacing power pump

Volvo Standard Times Op. No. 64518

### REMOVING

1. Clean round the connections (at 2 and 3, Fig. 6-103).
2. Disconnect the suction line (2) and collect the oil running out.
3. Remove the pulley nut. Loosen the tensioning bolt (4) so the belt slackens. Remove the pulley.
4. Remove the pump from the bracket.

### INSTALLING

Concerning replacement of pump, supplement the new pump with brackets, pulley and other parts, see Fig. 6-103. When installing the pulley, the tolerances may be such that the pulley cannot be pressed on by hand. In these cases, press on the pulley with care. It must not be hammered on, otherwise the bearings might easily get damaged, this resulting in noise in the pump.

1. Place the pump in position and connect the oil lines with new seals installed.
2. Install the attaching bolts and other components, see Fig. 6-103. Tension the drive belt so that it can be pressed in about 5 mm (3/16") halfway. Tighten bolts, connections and pulley nut.
3. Fill oil and bleed, see under "Oil filling and bleeding".

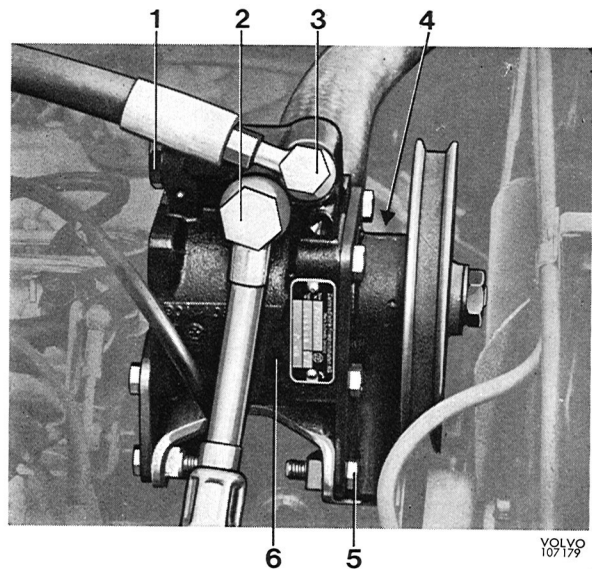


Fig. 6-103. Power pump

- |                           |                    |
|---------------------------|--------------------|
| 1. Plug for control valve | 4. Tensioning bolt |
| 2. Suction line           | 5. Attaching bolt  |
| 3. Delivery line          | 6. Power pump      |

## Reconditioning power pump

Volvo Standard Times Op. No. 64512

### DISASSEMBLY

1. Remove the nut (1, Fig. 6-104) and pull off the pulley. If necessary use puller 2279. Remove the brackets.

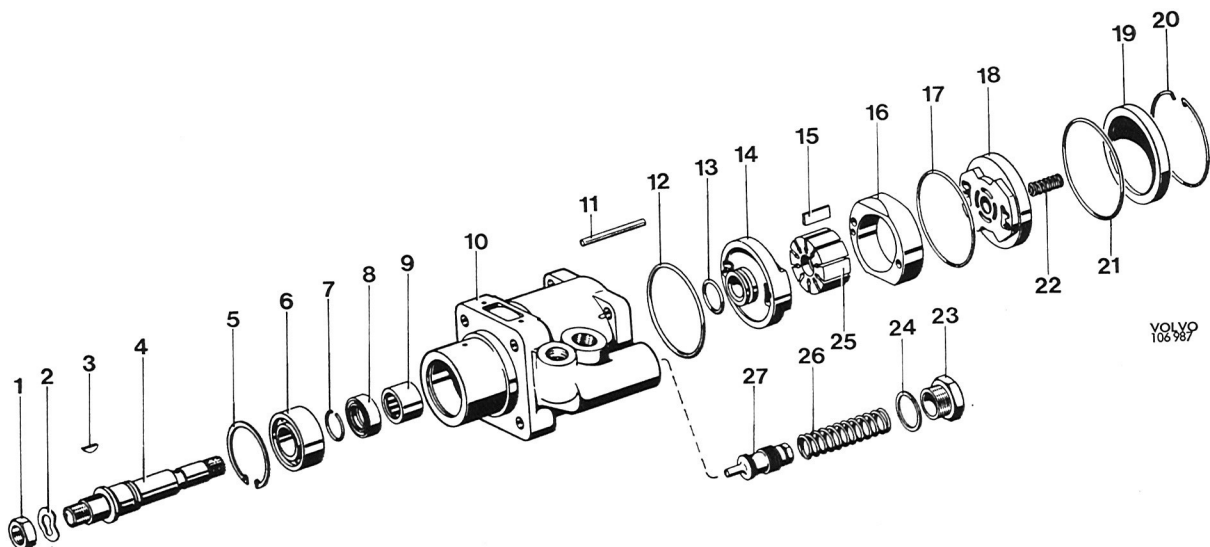


Fig. 6-104. Power pump disassembled

- |                   |                        |                          |
|-------------------|------------------------|--------------------------|
| 1. Nut            | 10. Housing            | 19. Cover                |
| 2. Washer         | 11. Pin                | 20. Circlip              |
| 3. Key            | 12. O-ring             | 21. O-ring               |
| 4. Shaft          | 13. O-ring             | 22. Spring               |
| 5. Circlip        | 14. Inner plate        | 23. Plug                 |
| 6. Bearing        | 15. Blade              | 24. Packing              |
| 7. Circlip        | 16. Intermediate piece | 25. Rotor                |
| 8. Seal           | 17. O-ring             | 26. Spring               |
| 9. Needle bearing | 18. Outer plate        | 27. Control valve piston |



2. Remove the circlip (20).
3. Remove the cover (19), spring (22) and plate (18).
4. Shake out the intermediate piece (16) and rotor (25), see Fig. 6-105. If it is not easy to remove the intermediate piece, allow it remain until later on.

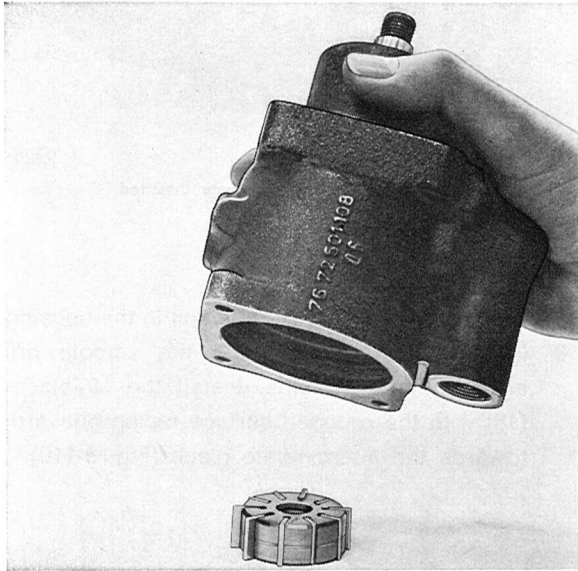


Fig. 6-105. Removing rotor

5. Remove the circlip (5) at the drive end.
6. Carefully press out the shaft (4).
7. Press the plate (14) out of the housing. The intermediate piece should follow at the same time, if not already removed.
8. Screw out the plug (23) and shake out the spring (26) together with the valve (27).
9. Press out the needle bearing (9) and seal (8) at the same time with tool 2996, see Fig. 6-106.
10. Take the O-rings out of the housing.

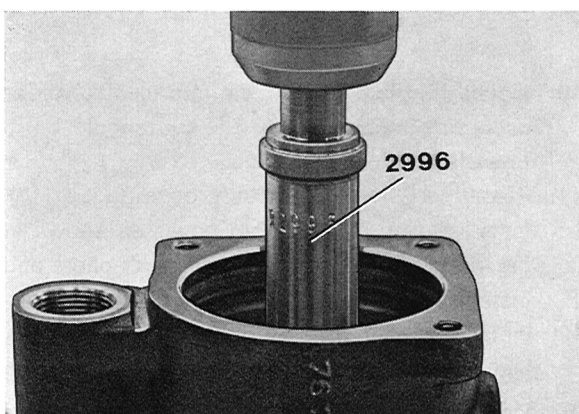


Fig. 6-106. Removing seal

## INSPECTION

### Clean all parts

1. Check the shaft (4, Fig. 6-104) for scoring from seal and needle bearing. Check threads and lands for damage. If the bearing (6) is damaged, it can be removed after the circlip (7) has been taken off.
2. Check the needle bearing (9) and replace if necessary.
3. Check the plates (14 and 18) for wear and scoring.
4. Check the rotor (25), intermediate piece (16) and blade (15) for wear. The blade should go easily into the rotor. These parts are replaced together in sets.
5. Check that the control valve piston (27) does not jam in the housing bore. Make sure that the piston has the same tolerance group as the housing, that is, that the numbers agree ("1" and "2" or "11").

Screw the control valve piston apart. When doing this, do not hold round the steering surfaces but use pliers at the holes. Take care of the parts, clean and inspect. If there is any damage, replace the piston complete.

Assemble the parts. The number of washers will determine the opening pressure.

6. Blow all channels in the housing clean.

## ASSEMBLY

Before assembling, all parts should be well cleaned and lightly oiled. All seals should be replaced.

1. Press the needle bearing (9, Fig. 6-104) into the housing with the help of drift 2996, see Fig. 6-107. The bearing should be pressed in until the tool bottoms so that the needle bearing outer edge is 37.0—37.2 mm (1.45—1.46") from the edge of the housing.





Fig. 6-107. Installing needle bearing

2. Apply universal grease between the lips of the seal (8) and press it in with drift 2997.
3. Place the O-ring (12) in position in the inner groove of the housing.
4. If the bearing (6) has been removed, press the shaft into the bearing. Install the circlip (7) in its groove.
5. Install the shaft with bearing. Install the circlip (5) in its groove.
6. Place the O-ring (13) in its groove on the plate (14). Install the plate as shown in Fig. 6-108.

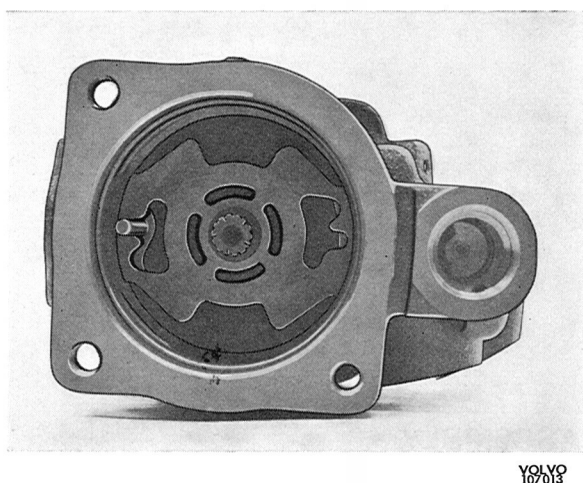


Fig. 6-108. Inner plate installed

7. Install the intermediate piece (Fig. 6-109). The small hole on the pin and the other two opposite the plate holes.

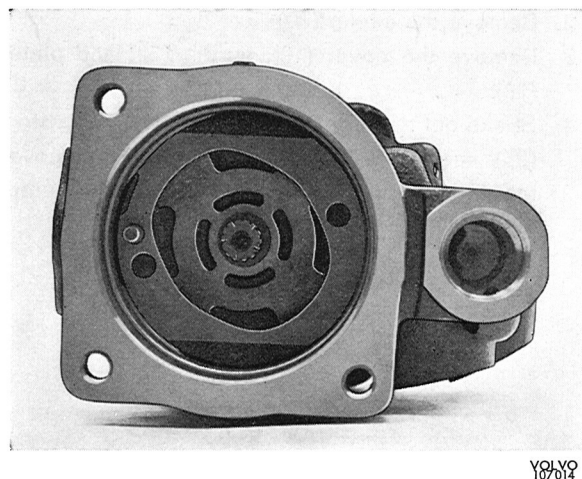


Fig. 6-109. Intermediate piece installed

8. Place the O-ring (17) in position in the housing.
9. Install the rotor (25) with the smooth drill against the drive side. Install the 10 blades (15) with the rounded surface facing outwards towards the intermediate piece (Fig. 6-110).

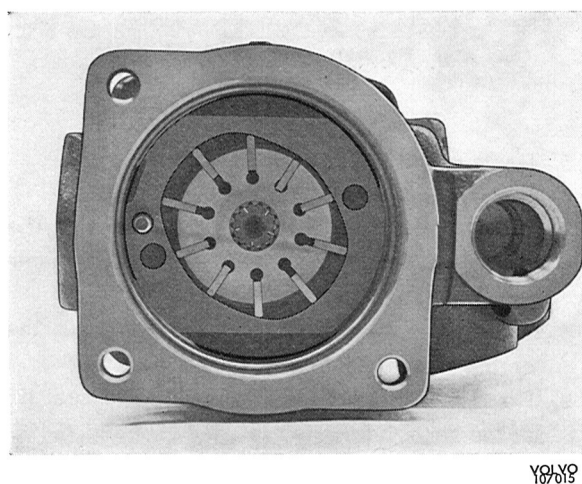
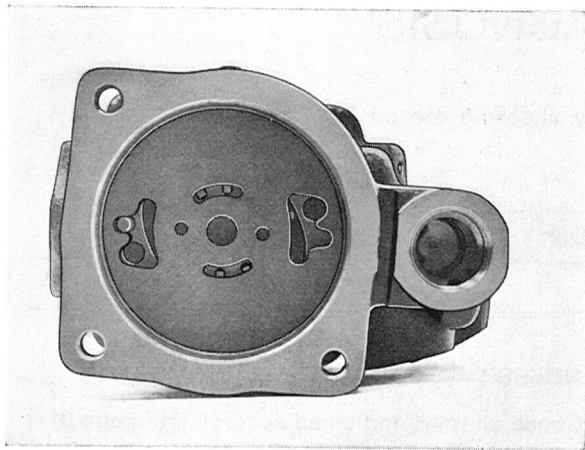


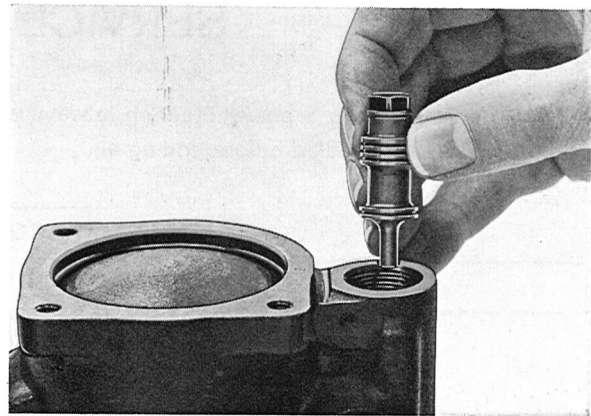
Fig. 6-110. Rotor blade installed

10. Install the plate (18) on the intermediate piece according to Fig. 6-111. The pin should be in one of the two outer holes.
11. Place the O-ring (21) in its groove (Fig. 6-112). Install the spring (22) and cover as shown in Fig. 6-112. Hold the cover down with pliers and install the circlip (20) in its groove.
12. Install the control valve piston (Fig. 6-113). Install the spring (26), packing (24) and plug (23).
13. Install the nipple brackets and pulley, see Fig. 6-47.



VOLVO  
107016

Fig. 6-111. Outer plate installed



VOLVO  
107018

Fig. 6-113. Installing control valve



VOLVO  
107017

Fig. 6-113. Installing cover

### Replacing oil filter

When changing the oil, which is normally done only in connection with replacement of the power steering components, the filter should also be replaced. This is accessible after the spring and retainer in the oil container have been lifted off. Clean the container before installing the new filter. Also replace the gasket in the outer cover.

# SERVICE DIAGNOSIS

When trouble shooting a power steering, always start by checking the oil level, see page 31. Any leakage must be remedied before adding oil.

CONDITION	
CAUSE	CORRECTION

## THE CAR WANDERS

Too low oil level or air in system.	Check oil level and bleed according to page 31.
Abnormal loading.	Distribute loading.
Unsuitable tire equipment.	Shift wheels.
Incorrect wheel adjustment.	Check and adjust wheels.
Loose steering parts.	Check and tighten up.

## THE CAR PULLS TO ONE SIDE

Too low or uneven air pressure in tires.	Check air pressure (see Section 7).
The front spring have fatigued or have different height.	Remove and check spring (see Section 7).
A roller bearing is too tight.	Check the bearings. Replace damaged bearings and adjust (see Section 7).
Incorret tracking.	Check-measure the body and straighten up if necessary. (See Section 8).
Bent steering rod.	Replace damaged rod.
Incorrect camber.	Check and adjust the camber. Pulling can be influenced by giving the wheels different inclination with the tolerance.

## STEERING STIFF TO RIGHT AND LEFT

Too low oil level or air in system.	Check oil level or bleed according to page 31.
Pump control valve jams or is blocked.	Remove, clean and check control valve.
Filter blocked, channel blocked.	Remove filter, clean channel.
Excessive caster.	Check and adjust caster.
Jamming ball joints.	Replace ball joint.
Damaged seals in power steering gear.	Recondition or replace steering gear.

## STEERING HEAVY EITHER TO LEFT OR TO RIGHT

Pressure builds up only on one side of the power piston.	Recondition or change power steering gear.
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## HEAVY STEERING WITH RAPID STEERING WHEEL TURNS

Pump pulley belt slips.	Tension or replace pulley belt.
Pump control valve blocked.	Remove, clean and check the control valve.
Pump has too little capacity.	Recondition the pump.
Air in the power system.	Bleed the system, fill oil according to page 31.

### FRONT WHEEL SHIMMY

Air in system.	Bleed the system.
Unbalanced or warped wheels.	Balance the wheels, check for warp. (see Section 7).
Incorrect wheel adjustment.	Check the wheel adjustment.
Loose or worn front wheel bearings.	Adjust or replace bearings.

### SCHOCKS AND JARRING IN THE STEERING WHEEL

Too low oil level or air in the system.	Check the oil level or bleed according to page 36.
Axial play on steering shaft.	Adjust the pressure point.
Worm loose.	Recondition worm.
Looseness in other steering components.	Tighten or replace worn component.

### THE STEERING WHEEL CONTINUES TO FULL LOCK

Incorrect adjustment on steering valve.	Recondition steering gear.
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### NOISE FROM OIL PUMP

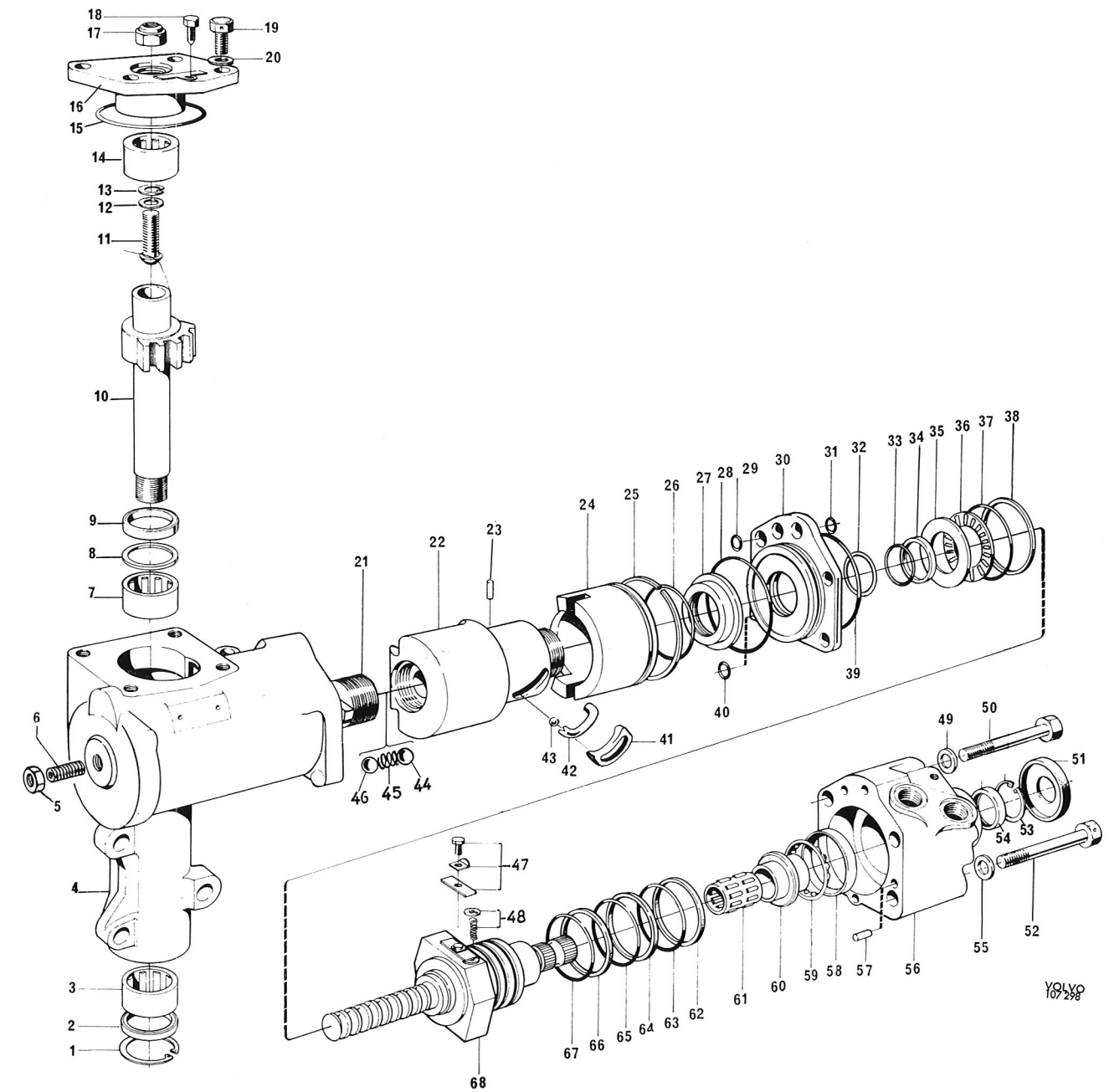
Too low oil level or air in the system.	Check the oil level or bleed according to page 36.
Worn pump.	Recondition the pump.

### OIL LEAKAGE

Defective seals or bad connections.	Clean and wipe dry the steering gear on the outside. Test-run and load the steering gear. Locate the leakage.
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- |                     |                   |                    |                   |                                  |
|---------------------|-------------------|--------------------|-------------------|----------------------------------|
| 1. Circlip          | 15. O-ring        | 29. O-ring         | 43. Ball          | 57. Guide pin (only early prod.) |
| 2. Lower seal       | 16. Cover         | 30. Cover          | 44. Valve ball    | 58. Bearing ring                 |
| 3. Needle bearing   | 17. Lock nut      | 31. O-ring         | 45. Spring        | 59. Ball bearing                 |
| 4. Housing          | 18. Bleeder screw | 32. Shim           | 46. Valve ball    | 60. Bearing sleeve               |
| 5. Lock nut         | 19. Bolt          | 33. O-ring         | 47. Lock parts    | 61. Needle bearing               |
| 6. Adjuster screw   | 20. Washer        | 34. Packing        | 48. Valve parts   | 62. Packing                      |
| 7. Needle bearing   | 21. Plug          | 35. Bearing washer | 49. Washer        | 63. O-ring                       |
| 8. Washer           | 22. Piston        | 36. Needle bearing | 50. Bolt          | 64. Packing                      |
| 9. Upper seal       | 23. Pin           | 37. O-ring         | 51. Rubber cover  | 65. O-ring                       |
| 10. Steering shaft  | 24. Sleeve        | 38. Packing        | 52. Bolt          | 66. Packing                      |
| 11. Adjuster screw  | 25. Piston ring   | 39. O-ring         | 53. Circlip       | 67. O-ring                       |
| 12. Adjuster washer | 26. O-ring        | 40. O-ring         | 54. Seal          | 68. Worm                         |
| 13. Circlip         | 27. Ring nut      | 41. Packing        | 55. Washer        |                                  |
| 14. Needle bearing  | 28. O-ring        | 42. Pipe halves    | 56. Valve housing |                                  |

**Illustration A. Steering gear disassembled**

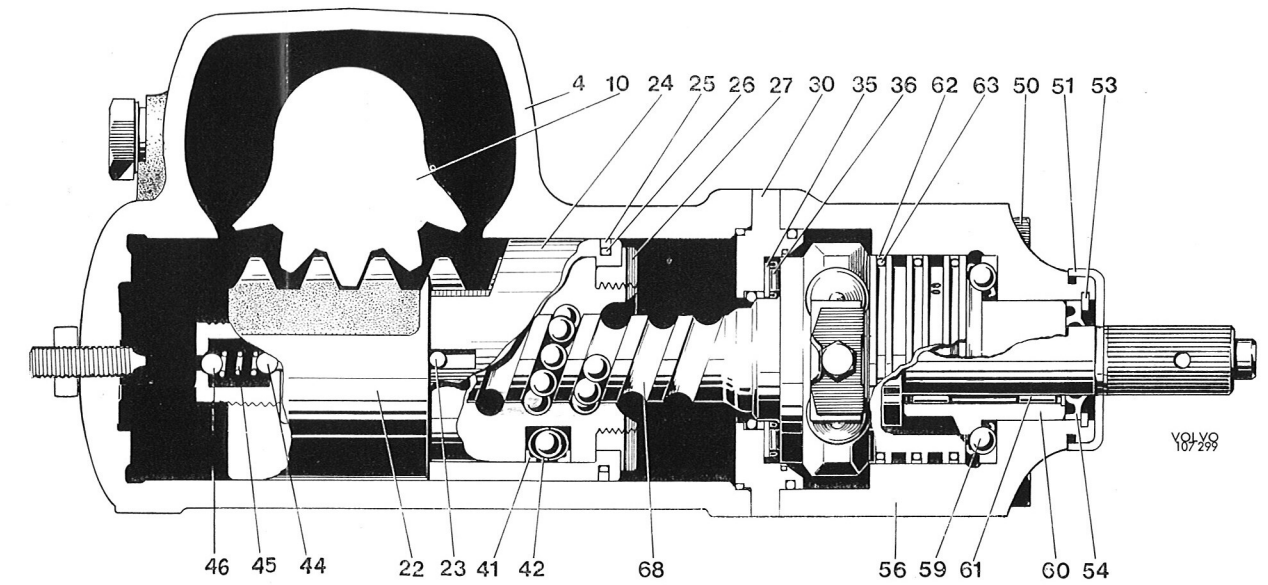
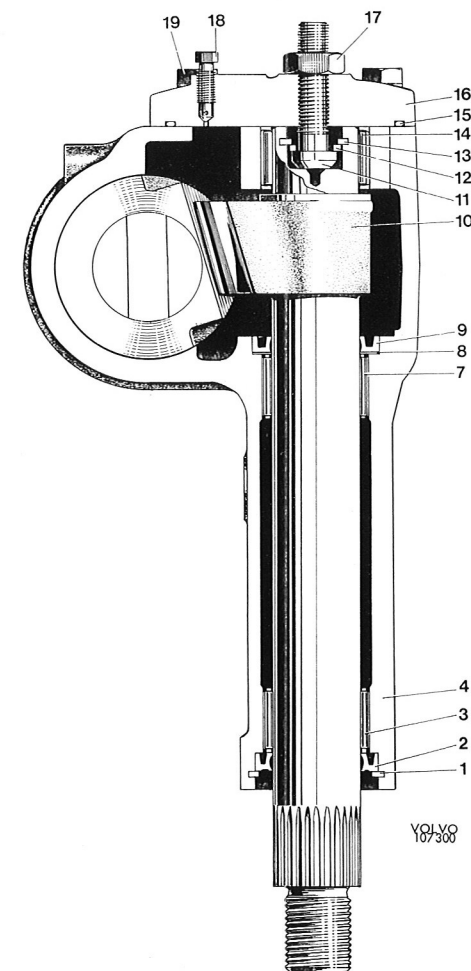


Illustration B. Steering gear assembled



1. Circlip
2. Lower seal
3. Needle bearing
4. Housing
7. Needle bearing
8. Washer
9. Upper seal
10. Steering shaft
11. Adjuster screw
12. Adjuster washer
13. Circlip
14. Needle bearing
15. O-ring
16. Cover
17. Lock nut
18. Bleeder screw
19. Bolt
22. Piston
23. Pin
24. Sleeve
25. Piston ring
26. O-ring
27. Ring nut
30. Cover
35. Bearing washer
36. Needle bearing
41. Packing
42. Pipe half
44. Valve ball
45. Spring
46. Valve ball
50. Bolt
51. Rubber cover
53. Circlip
54. Seal
56. Valve housing
59. Ball bearing
60. Bearing sleeve
61. Needle bearing
62. Packing
63. O-ring
68. Worm