

CHAPTER 10

THE STEERING GEAR

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- 10:3 Steering linkage
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10:1 Description

Worm and roller steering gear is fitted to all models covered by this manual. Motion from the steering column assembly is transmitted to the worm shaft in the steering gear through a lower shaft equipped with two universal joints. The roller is moved up or down the worm according to the amount and direction of steering wheel movement, the roller turning a shaft to which is attached the steering Pitman arm. The Pitman arm operates the steering linkage. This linkage consists of the centre tie rod to which the Pitman arm and idler arm are connected and the outer tie rods which connect between the centre tie rod and the steering arms at the wheel hubs. Ball joints are used at the tie rod connections. Threaded adjusters are provided on each outer tie rod, to allow for adjustment of front wheel toe-in settings. The layout of the steering gear and front suspension components are shown in **Chapter 9, FIG 9:1**.

Some models are equipped with power assisted steering gear, a belt driven pump supplying fluid under pressure to the steering gear assembly to assist the effort applied by the driver to the steering wheel.

A steering damper unit may be installed between the steering linkage and the bodywork on some models, and can be installed on standard models not so equipped if

desired. However, as the damper assembly operates to progressively resist movement of the steering linkage, it should not be installed on models equipped with power assisted steering gear.

10:2 Routine maintenance

The necessary items of routine maintenance should be carried out at the intervals specified in the manufacturer's service schedule. On models fitted with standard steering gear, the oil level should be maintained at the edge of the filler plug hole, using an approved grade of lubricant. On models fitted with power assisted steering gear, the fluid level in the system should be checked and topped up as necessary and frequent checks on the tension of the pump drive belt should be made and adjustments carried out as necessary. Instructions concerning the last two items will be found in **Section 10:6**.

In all cases, the ball joints in the steering linkage are sealed for life and no routine maintenance is required.

Steering gear adjustment:

If the steering gear is stiff to operate, or if excessive slackness is noted, the checks and adjustments described in this section should be carried out. Note, however,

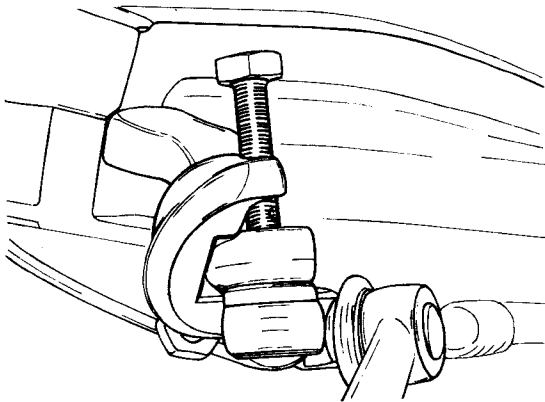


FIG 10:1 Detaching ball joint from Pitman arm

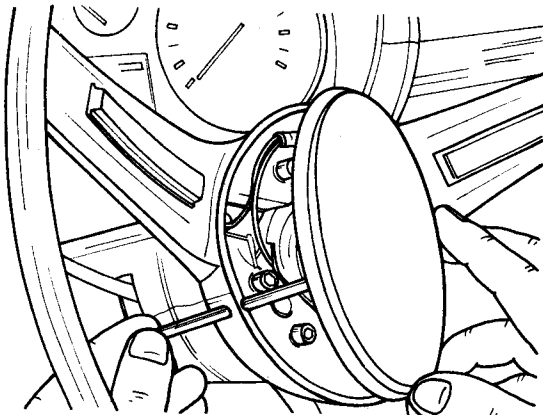


FIG 10:2 Removing steering wheel pad

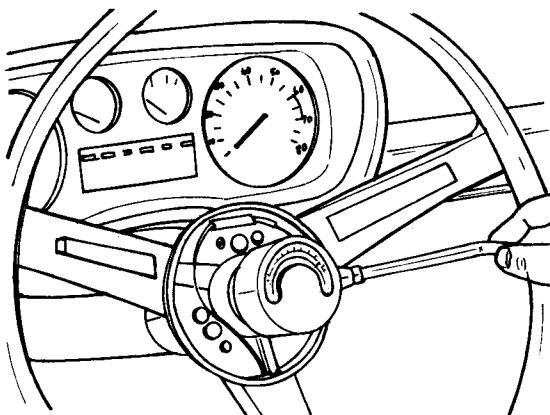


FIG 10:3 Checking turning torque

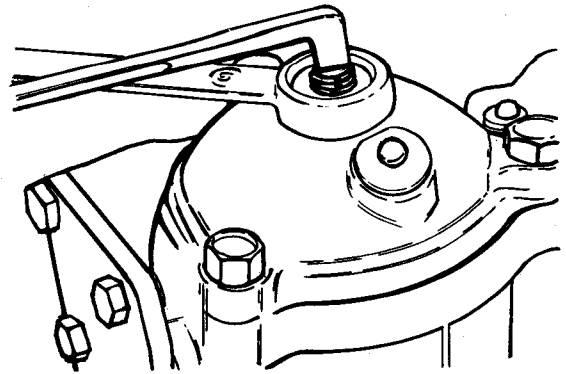


FIG 10:4 Steering gear adjustment

that heavy steering on models fitted with power assisted steering gear can be caused by a slack drive belt, air in the fluid system or possibly more serious faults in the system components. In order to check steering gear adjustment the use of a special tool is necessary. If this is not available, the work should be carried out by a service station.

Raise the front of the car and support safely on floor stands. From beneath the car, remove the splitpin and slotted nut securing the ball joint to the steering Pitman arm, then press out the ball joint using tool 7009 or other suitable puller, as shown in FIG 10:1. Use a thin rod to push off the steering wheel central pad as shown in FIG 10:2. Turn the steering wheel fully in one direction, then turn fully to the opposite lock while counting the number of turns and part turns taken to do so. Do this gently, as rapid movement to the lock stops may damage the steering gear. Calculate the exact centre point of the steering gear by halving the total number of turns, then move the steering gear to this position. Now turn the steering wheel one complete turn to the left and fit the friction meter over the steering wheel retaining nut as shown in FIG 10:3. Move the arm on the meter to turn the steering gear to the right through the central position and read the effort needed to do this on the meter. The correct reading is 8 to 12kgcm for all 2500, 2800 and 2800A models, or 10 to 12 kgcm for other 2800 models, 3.0 and 3.3 models. If incorrect, turn the steering gear back to the central position then slacken the locknut on the steering gear housing with a ring spanner and turn the adjuster with a suitable screwdriver as shown in FIG 10:4. The illustration shows standard steering gear components, but that for power assisted assemblies is very similar. Turn the adjusting screw a little at a time until the meter reading is correct under the conditions stated. Tighten the locknut and recheck.

On completion, press the steering wheel central pad back into position and reconnect the steering linkage to the Pitman arm. Tighten the slotted nut to the specified torque, then tighten a little more if necessary to align the splitpin holes and lock using a new splitpin.

10:3 Steering linkage

Checking ball joint assemblies:

If the front of the car is raised for access, support safely on floor stands. Grasp each ball joint in turn while

having an assistant turn one of the front wheels gently in and out in the steering directions. If excessive free play is noted at any ball joint position, the appropriate tie rod or tie rod end should be renewed. Take care not to confuse front wheel bearing play with play in ball joint assemblies. Wheel bearing play will be felt by rocking the front wheel both horizontally and vertically, ball joint play will be evident only when rocking the wheel horizontally. Front wheel bearing adjustment is described in **Chapter 9, Section 9:2**.

Outer track rods:

Remove the splitpin and slotted nut, then press the outer ball joint from the steering arm using tool 6056 or other suitable puller as shown in **FIG 10:5**. If the outer ball joint only is to be renewed, slacken the clamp on the tie rod sleeve and unscrew the ball joint assembly, carefully counting the number of turns taken to do so. Screw the new ball joint assembly into the sleeve by the number of turns previously counted, then temporarily tighten the clamp to secure. Tighten the ball joint securing nut to the specified torque, then tighten a little more if necessary to align the splitpin holes and lock with a new splitpin. Check front wheel alignment as described in **Section 10:7**. If the entire outer tie rod is to be removed, remove the splitpin and slotted nut and press the inner ball joint from the centre tie rod. When installing an outer tie rod, screw the inner part and the outer ball joint into the threaded sleeve by equal amounts, until dimension **A** shown in **FIG 10:6** is 330mm (13in). Temporarily tighten the sleeve clamps and refit the ball joint assemblies to the centre tie rod and steering arm. Tighten the slotted nuts to the specified torque, plus a little more if necessary to align the splitpin holes, then lock with new splitpins. Check front wheel alignment as described in **Section 10:7**.

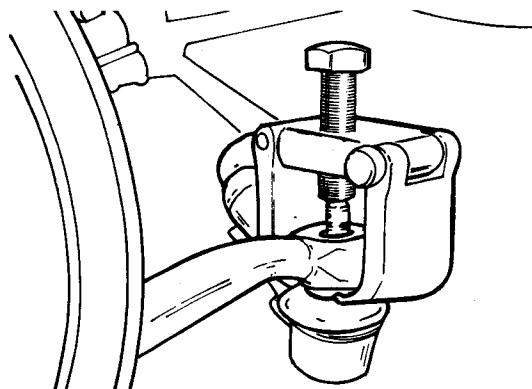


FIG 10:5 Disconnecting outer tie rod from centre tie rod

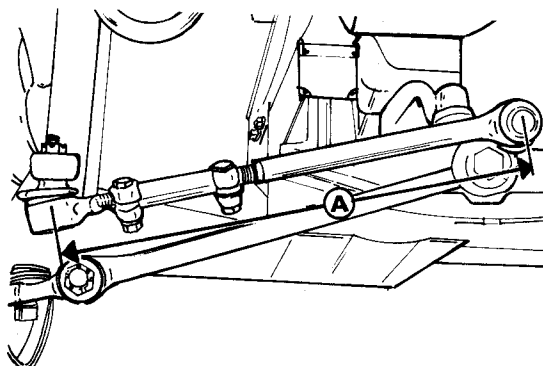


FIG 10:6 Outer tie rod installed length **A** is 330mm (13in)

Centre tie rod:

Detach the outer tie rods from the centre tie rod as described previously. Disconnect the steering damper, if fitted. Disconnect the centre tie rod from the Pitman arm as described in **Section 10:2**, then disconnect the centre tie rod from the idler arm in a similar manner. When installing, soak the sealing ring shown at 1 in **FIG 10:7** with oil to prevent premature failure of the joint due to the ingress of water. Note that the installed length **A** should be $574 \pm 1\text{mm}$ ($22.60 \pm 0.04\text{in}$). Install in the reverse order, tightening the slotted nuts to the specified torque plus a little more if necessary to align the splitpin holes. Lock with new splitpins. Reconnect the steering damper, if fitted. Note that the shim 3 shown in **FIG 10:8** must always be properly installed. The steering damper mounting bolt must be in a vertical position. The clamping piece must be attached to the tie rod so that there is sufficient distance **a** between the clamp and dust cover to allow for free movement of the steering linkage over its full travel. The clamping piece attachment must be tightened to 2kgm (14.5lb ft). On completion, check front wheel alignment as described in **Section 10:7**.

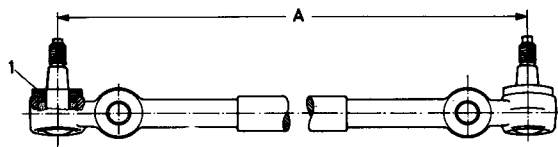


FIG 10:7 Centre tie rod showing location of sealing ring 1

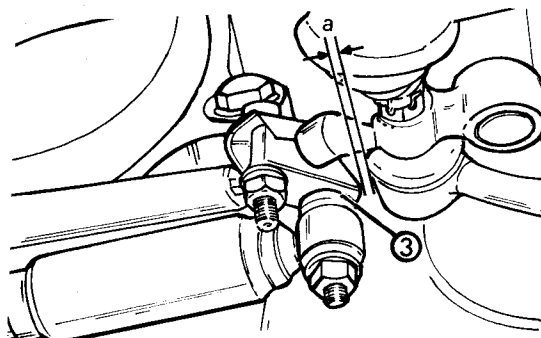


FIG 10:8 Steering damper installation

Idler arm:

To remove the idler arm assembly, disconnect the centre tie rod ball joint as described previously. Remove

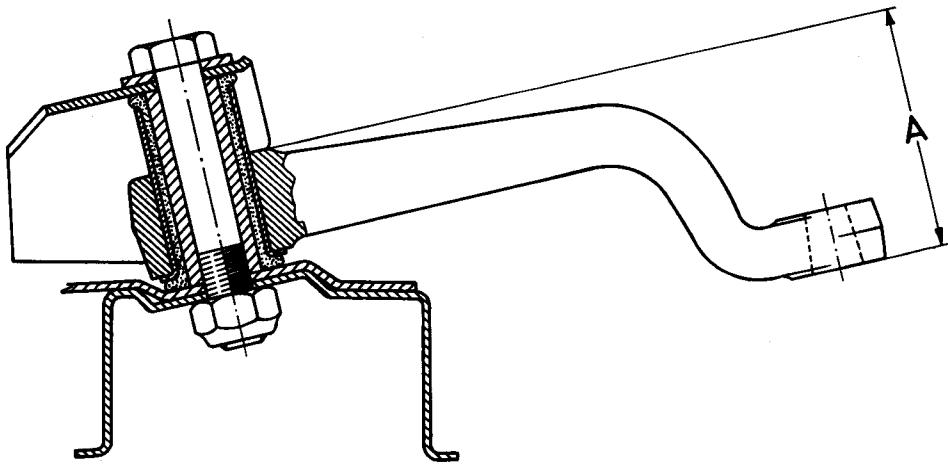


FIG 10:9 Section through idler arm assembly

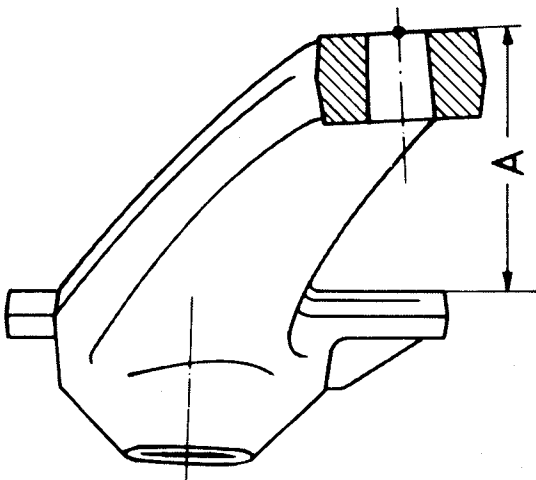


FIG 10:10 Checking steering arm for distortion

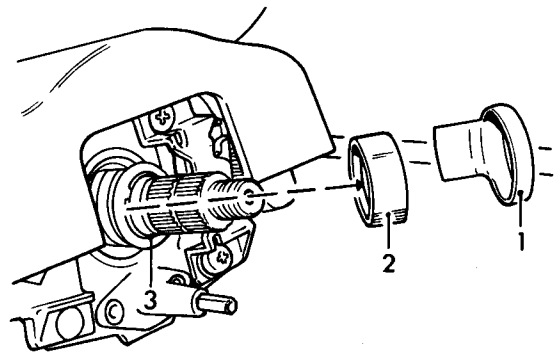


FIG 10:12 Cancelling cam 1 and collar 2

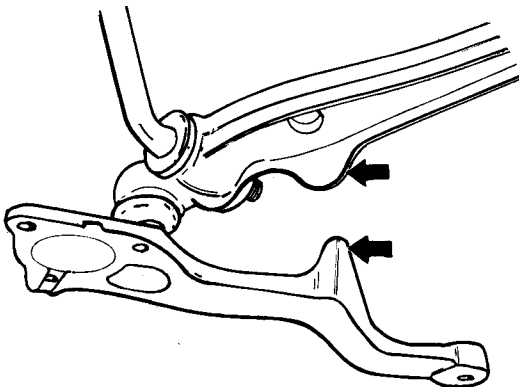


FIG 10:11 Boss locations on steering arm and control arm

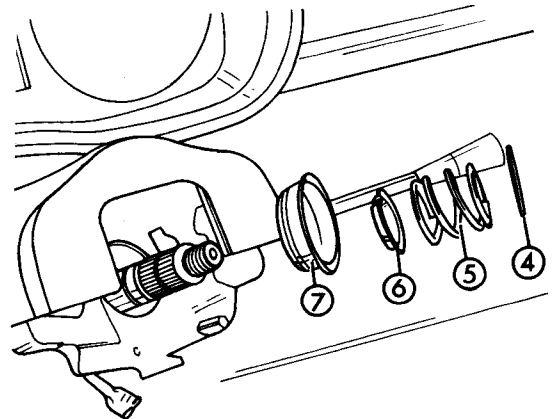


FIG 10:13 Column upper bearing removal

the fixing nut and detach the idler arm assembly from the crossmember. Check the idler arm and bearing assembly for wear or damage and renew if necessary. The arm must also be renewed if it is distorted. Check by measuring dimension **A** as shown in **FIG 10:9**. This should be 42 to 42.5mm (1.6535 to 1.6732in). Refit the idler arm assembly in the reverse order of removal.

Steering arms:

To remove a steering arm, disconnect the outer tie rod ball joint from the arm then detach the arm from the suspension strut assembly as described in **Chapter 9, Section 9:5**. Check the steering arm for faults and renew if necessary. Check for distortion by measuring dimension **A** shown in **FIG 10:10**. This should be 53.5mm (2.1063in). If the suspension control arm has a boss as shown in **FIG 10:11**, only steering arms with a corresponding boss may be installed. Never use a steering arm with a boss together with a control arm without a boss. However, a steering arm without a boss may be used if the control arm has a boss.

Refit the steering arm in the reverse order of removal.

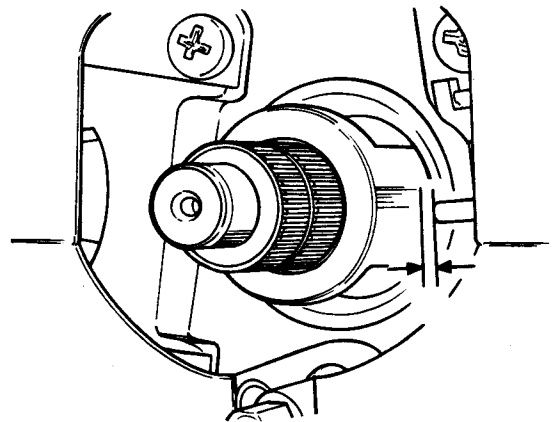


FIG 10:14 Cancellling cam installation

10:4 Column bearings and universal joints

Renewing upper column bearing:

Remove the pad from the centre of the steering wheel as shown in **FIG 10:2**. Disconnect the wiring for the horn pushes in the steering wheel. Make sure that the steering gear is in the straightahead position, then remove the retaining nut and pull the steering wheel from the shaft. Remove the lower part of the steering column housing.

Refer to **FIG 10:12** and pull off cancelling cam 1 and collar 2. Carefully prise circlip 3 from the groove and remove from the column. Refer to **FIG 10:13** and remove washer 4, coil spring 5 and ring 6. Drive upper bearing 7 from the housing.

Drive the new bearing into position, then fit the ring with shank towards the bearing, spring and washer. Fit the circlip over the shaft splines. Fit the collar shown in **FIG 10:12** the wrong way round, and use it to press the circlip down against the spring until it snaps into its groove. Remove the collar and refit the correct way round making sure that the recess in the collar locates over the circlip. Make sure that the turn indicator switch is in the central position, then install the cancelling cam as shown in **FIG 10:14**. Check that the distance shown is approximately 0.3mm (0.012in). If necessary, adjust at the turn indicator switch. Locate the steering wheel in the straightahead position and press on to the shaft splines. Fit and tighten the retaining nut then reconnect the wiring. Refit the column lower housing and the steering wheel central pad.

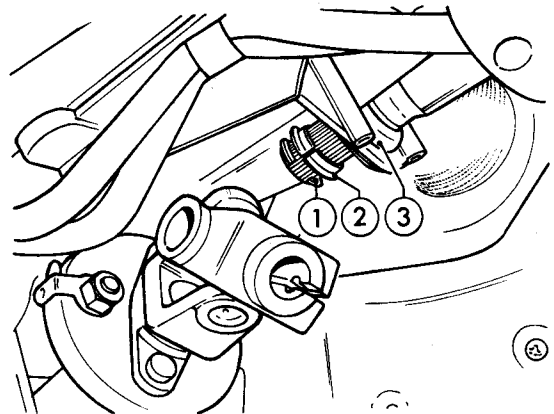


FIG 10:15 Removing steering column lower bearing

Renewing column lower bearing:

Detach the steering column housing for access to the bearing. Pull the cable from the rear fog lamp warning light switch and swing the housing to the right. Mark the relationship of the universal joint coupling to steering shaft, then loosen the clamp bolt on the upper part of the universal joint. Detach the upper section of the housing from the instrument panel, then pull the steering column upwards to disconnect the steering shaft from the universal joint.

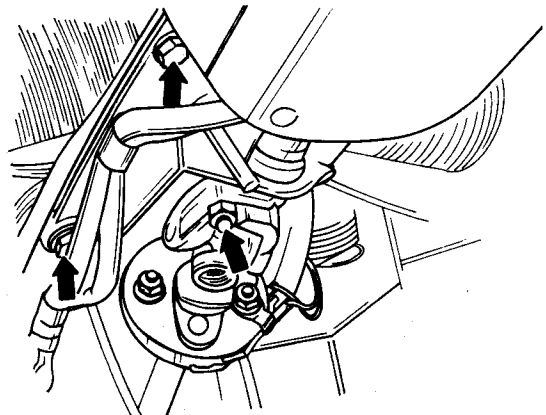


FIG 10:16 Upper universal joint removal

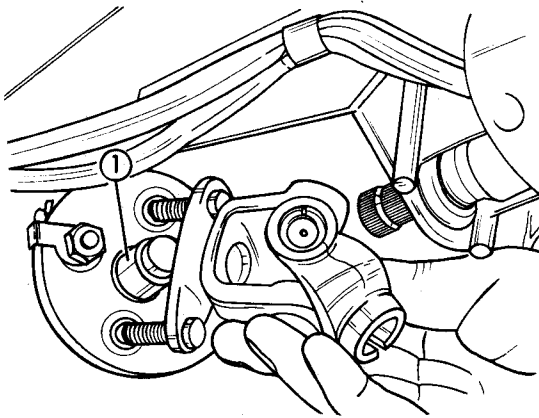


FIG 10:17 Location of plastic bush

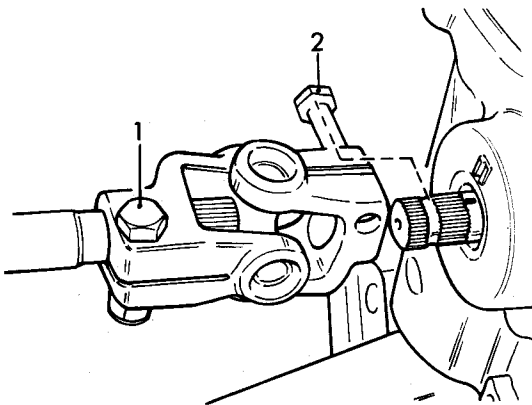


FIG 10:18 Lower universal joint removal

Loosely attach the upper section of the housing with two screws, then press down on the steering wheel to expose circlip 1 (see FIG 10:15). Remove the circlip and collar 2, then drive out bearing 3.

Drive the new bearing into position, then install collar 2 with shank towards bearing and retain with circlip 1. Refit the remaining components in the reverse order of removal, using the marks made previously to align universal joint and steering shaft. Fog lamp warning light switch connections are + yellow/white, S grey/violet and 31 brown.

Renewing upper universal joint:

Detach the steering column housing, then pull the cable from the rear fog lamp warning light switch and swing the housing to the right. Refer to FIG 10:16. Remove the clamp screw and unscrew the stop nuts, then detach the upper section of the housing from the pedal pivot bracket. Pull the universal joint away from the steering shaft and out of the joint disc. Avoid turning the steering wheel or shaft, so that the original relationship of shaft to universal joint will be maintained.

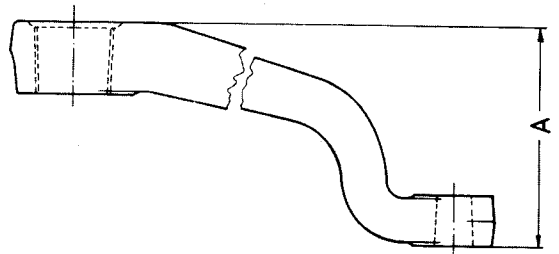


FIG 10:19 Checking Pitman arm for distortion

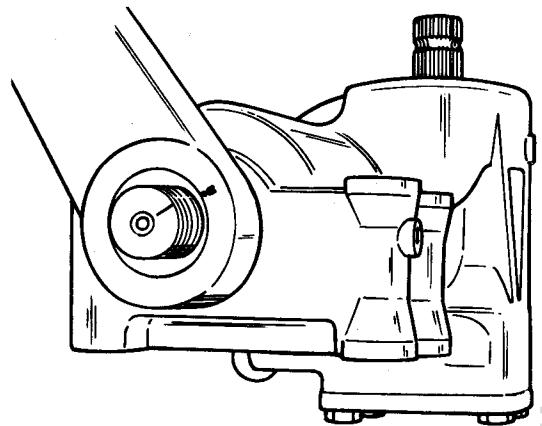


FIG 10:20 Pitman arm installation

Check condition of plastic bush 1 (see FIG 10:17) and renew if worn or damaged. Install the new universal joint and refit the remaining parts in the reverse order of removal. Reconnect the wiring to the warning switch as described previously.

Renewing lower universal joint:

Remove the housing and disconnect the warning light switch as described previously. Make sure that the steering gear is in the straightahead position. Detach the upper section of the housing from the pedal pivot bracket.

Refer to FIG 10:18. Remove clamp bolt 1 and pull the steering shaft from the universal joint. Remove clamp bolt 2 and disconnect universal joint from steering gear.

Make sure that the mark on the steering gear shaft is aligned between the marks on the steering gear housing. Fit the new universal joint to the steering gear and tighten clamp bolt 2. Make sure that the steering wheel is centralised, then fit the steering shaft to the universal joint and tighten clamp bolt 1. Make sure that the clamp bolts are correctly engaged in the shaft grooves. Note

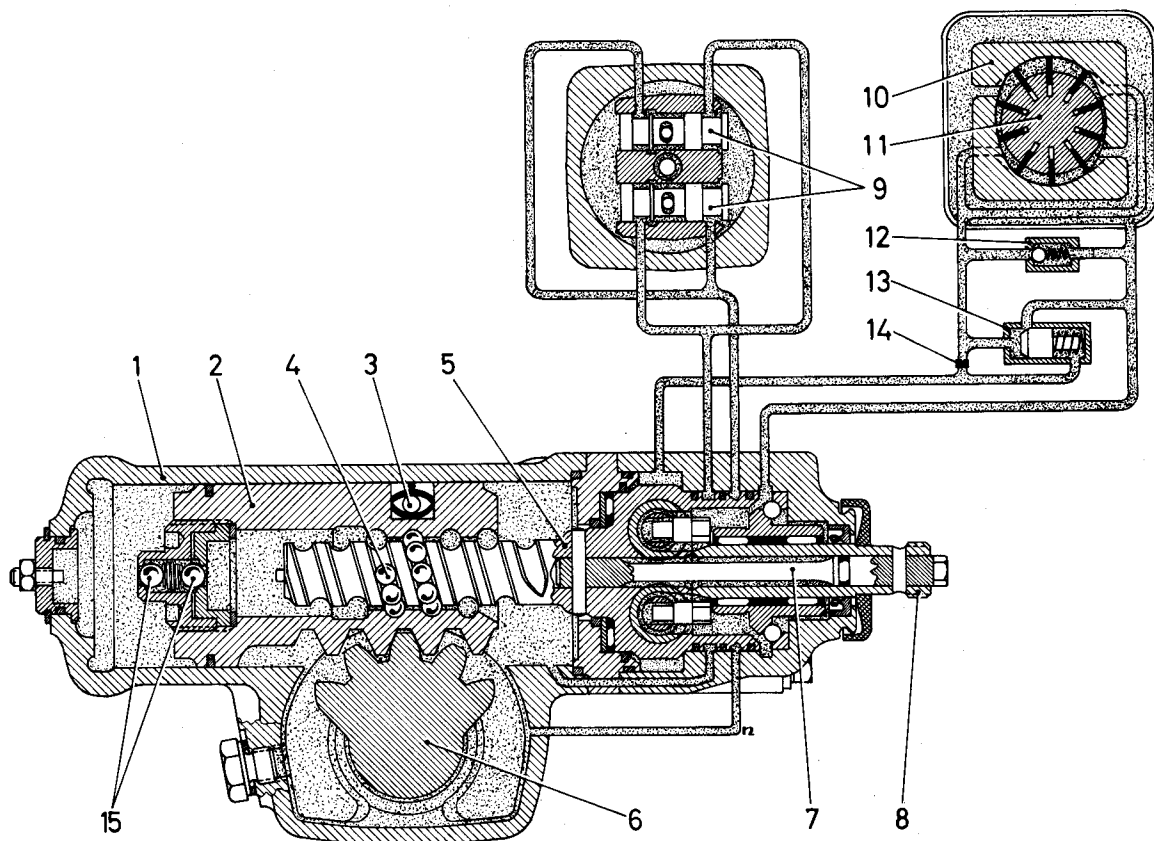


FIG 10:21 Layout of power assisted steering system

Key to Fig 10:21 1 Housing 2 Piston 3 Circulation tube 4 Balls 5 Worm 6 Steering worm sector shaft 7 Torsion bar 8 Steering shaft 9 Valve piston 10 Curved ring 11 Impeller 12 Pressure relief valve 13 Pressure check valve 14 Throttle element 15 Locking valve

that the longer yoke of the universal joint must face towards the steering column. Refit the remaining parts in the reverse order of removal, connecting the warning switch wiring as described previously.

10:5 Steering gear

Instructions for the removal and installation of the steering box are given in this section, but it is not recommended that the owner attempt to dismantle the unit. Special tools are needed to remove and install certain internal components and for setting the necessary friction values and preloads. For these reasons, it is recommended that steering box overhaul procedures are carried out only by a fully equipped service station.

Removal:

Make sure that the steering is in the straightahead position. Refer to FIG 10:18. Loosen clamp bolt 1 and remove clamp bolt 2, then push the universal joint upwards as far as possible to disconnect from the shaft. Disconnect the centre tie rod from the Pitman arm on the steering gear as described in Section 10:3. Remove the

three bolts securing the steering box to the front cross-member then remove the steering box downwards.

Refitting:

This is a reversal of the removal procedure. Before connecting the universal joint to the steering box splined shaft, make sure that the mark on the shaft is aligned between the two marks on the housing as shown in FIG 10:18. Check that the steering wheel is in the central position then reconnect the universal joint to the shaft and install the lower clamp bolt, making sure that it aligns correctly in the locating groove. Tighten both clamp bolts.

Pitman arm removal:

Disconnect the centre tie rod from the steering gear Pitman arm as described in Section 10:3. Release the tab washer and remove the nut, then pull the Pitman arm from the steering shaft using a suitable puller tool.

If the Pitman arm is damaged or distorted it must be renewed. Check for distortion as shown in FIG 10:19. Dimension A should be $89.5 + 0.5\text{mm}$ ($3.524 + 0.020\text{in}$).

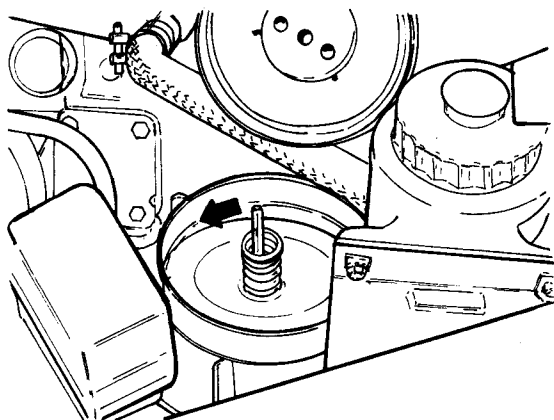


FIG 10:22 Correct level of fluid in reservoir

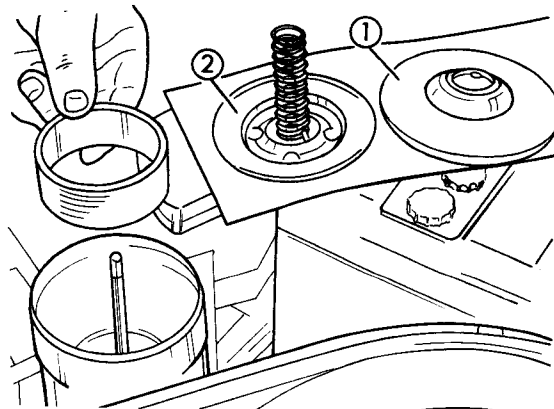


FIG 10:25 Reservoir fluid filter renewal

Refitting:

This is a reversal of the removal procedure, using a new tab washer. Make sure that the arrow on the Pitman arm is aligned with the mark on the steering shaft as shown in FIG 10:20. Tighten the securing nut to the specified torque and lock with the tab washer.

10:6 Power assisted steering

Layout of the recirculating cam and ball nut steering gear and hydraulic pressure system is shown in FIG 10:21. The items of maintenance and adjustment which can be carried out by a reasonably competent owner/mechanic are given in this section, but due to the complexity of the system and the need for special tools and equipment to carry out repairs and overhaul, it is recommended that any work requiring partial or complete dismantling of system components be carried out only by a fully equipped service station.

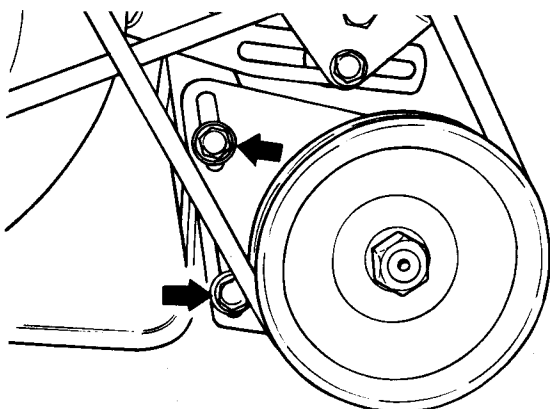


FIG 10:23 Pressure pump front mounting bolts

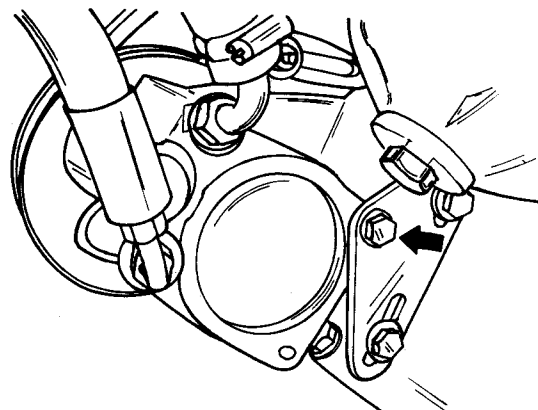


FIG 10:24 Pressure pump rear mounting bolt

Checking fluid level:

Remove the filler cap from the fluid reservoir, wiping dirt from around the cap before doing so. The fluid level should be at the mark arrowed in FIG 10:22. Top up if necessary using an approved grade of automatic transmission fluid, then refit the cap.

Bleeding the system:

The system will require bleeding only if the fluid level has been allowed to drop so low that air has been drawn into the system, or if hoses have been disconnected.

Remove the reservoir filler cap and top up with an approved grade of automatic transmission fluid to the level shown in FIG 10:22. Disconnect the central HT lead from the ignition coil to prevent the engine from starting, then have an assistant operate the ignition key to crank the engine on the starter motor. Continue to add fluid to maintain the correct level in the reservoir. When the level no longer drops, reconnect the ignition lead and start the engine. With the engine running at idle speed, turn the steering wheel rapidly from one full lock position to the other and back until no further air bubbles

can be seen rising through the fluid in the reservoir. During this operation, continue to add fluid as necessary to maintain the correct level. Refit the filler cap.

Drive belt tensioning:

The tension of the belt driving the high pressure pump for the system is correct when the belt can be deflected by 5 to 10mm (0.2 to 0.4in) when firm thumb pressure is applied in the centre of the longest belt run. If tension is incorrect, slacken the two front mounting bolts shown in **FIG 10:23** and slacken the two mounting bolts which are in similar positions at the rear of the unit. Push the pump assembly downwards until belt tension is correct, then firmly tighten all mounting bolts. To remove the belt, slacken all mounting bolts and push the pump unit upwards as far as possible. Remove the belt from the pulleys. Refit in the reverse order, tensioning the belt correctly as described previously.

Pressure pump removal:

Place a suitable container beneath the pump to collect any spillage of fluid, noting that any fluid drained from the system must be discarded and new fluid only used for topping up later. Slacken and remove the drive belt as described previously. Remove the single fixing bolt arrowed in **FIG 10:24** and the two fixing bolts arrowed in **FIG 10:23**, then lift the pump unit from the engine. Do not disconnect the fluid pipes unless pump renewal or overhaul is necessary. Instead, wire the pump unit to an adjacent component so that the hoses are not strained.

Refitting:

This is a reversal of the removal procedure. On completion, tension the drive belt and bleed the hydraulic system as described previously.

Reservoir filter renewal:

Remove the filler cap from the reservoir, then refer to **FIG 10:25** and remove end cap 1, filter cover 2 and the filter element. Discard the element. If the fluid in the reservoir is not absolutely clean, it should be siphoned from the reservoir and discarded. Install the new filter in the reverse order of removal, then refill and bleed the hydraulic system as described previously.

10:7 Front wheel alignment

The front wheels should be set so that the distance between the rear of the wheels is $1 \pm 1\text{mm}$ ($0.04 \pm 0.04\text{in}$) more than the distance between the front of the wheels, when the car is correctly loaded as described in **Chapter 9, Section 9:4**. Adjustment is carried out by slackening the tie rod clamps on each side of the car (see **FIG 10:6**), then rotating the sleeves by equal amounts until the toe-in setting is correct. It is not recommended that owners attempt this work themselves, as great accuracy is essential. Instead, the work should be entrusted to a BMW service station or a wheel and tyre specialist having optical setting equipment, the complete procedure taking only a short time under these conditions.

10:8 Fault diagnosis

(a) Wheel wobble

- 1 Unbalanced wheels and tyres
- 2 Slack steering connections
- 3 Incorrect steering geometry
- 4 Excessive play in steering gear
- 5 Faulty suspension
- 6 Worn or loose hub bearings

(b) Wander

- 1 Check 2, 3 and 4 in (a)
- 2 Uneven tyre pressures
- 3 Ineffective dampers
- 4 Uneven tyre wear

(c) Heavy steering

- 1 Check 3 in (a)
- 2 Very low tyre pressures
- 3 Lack of lubrication
- 4 Wheels out of track
- 5 Steering gear adjustment too tight
- 6 Tight or damaged bearings
- 7 Faults in power assisted steering system

(d) Lost motion

- 1 Loose steering wheel connection
- 2 Worn steering gear
- 3 Worn steering ball joints
- 4 Worn suspension ball joints
- 5 Worn steering gear bearings
- 6 Steering gear out of adjustment

NOTES