The Power Steering Rack (Refer to Fig. 23).

The power steering rack is similar to normal rack type mechanisms except that the rack shaft is fitted with a single piston which operates in an enclosed sealed chamber. By means of the spool type control valve/pinion assembly, pressurised oil from the engine driven hydraulic pump is directed to one or other side of the rack piston, thus providing power assistance to deflect the front road wheels as required.

Dismantling Power Steering Rack (Refer to Fig. 24)

1. Remove rack complete from vehicle.
2. Slacken clips securing bellows seals and slide bellows seals along tie rods to expose inner ends of tie rods.
3. Wipe inner ends clear of grease and straighten tab ends of innermost lock washers.
4. Unscrew tie rods from rack. Care must be taken not to disturb adjustment of the inner ball joint.
5. Disconnect unions connecting rack pipes to control valve and rack chamber, and remove pipes.
6. Slacken lock nut on rack plunger adjusting screws and withdraw adjusting screw, spring and plunger.
7. Remove the three nyloc nuts and washers securing control valve flange to rack and withdraw control valve and gasket.
8. Withdraw seal housing and washer from rack.
9. Disconnect unions securing rack balance pipe and remove balance pipe.
10. Using a suitable "C" spanner, release screwed ring securing end-housing to rack cylinder and withdraw end-housing.
11. Remove union from centre of rack cylinder.
12. Withdraw rack shaft complete with piston in direction of end-housing.

Note: This operation invariably results in the rack teeth being drawn through the lip type seal in the cylinder sleeve. It is essential that this seal is renewed when the rack shaft is removed. It is recommended that *all* seals are renewed once they have been disturbed.

13. Withdraw cylinder sleeve from bore of cylinder.
14. Remove circlips and extract piston from rack shaft. Take care that circlips do not score rack shaft.

Assembling Power Steering Rack (Refer to Figs. 24 and 25)

1. Thoroughly clean all components.
2. Fit new seal and nylon backing ring to cylinder sleeve. Note that seal lip must be fitted adjacent to tapped locating hole and that square edge of nylon ring must abut against seal.
3. Fit new "O" rings to cylinder sleeve and lubricate cylinder bore with hydraulic oil.
4. Lubricate seal lip and enter cylinder sleeve (seal leading) over rack shaft at opposite end to rack teeth.

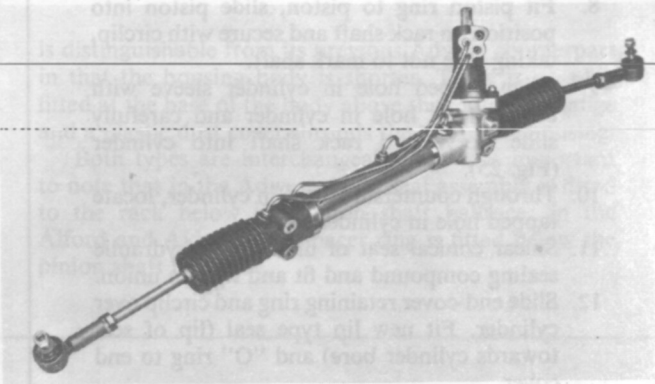
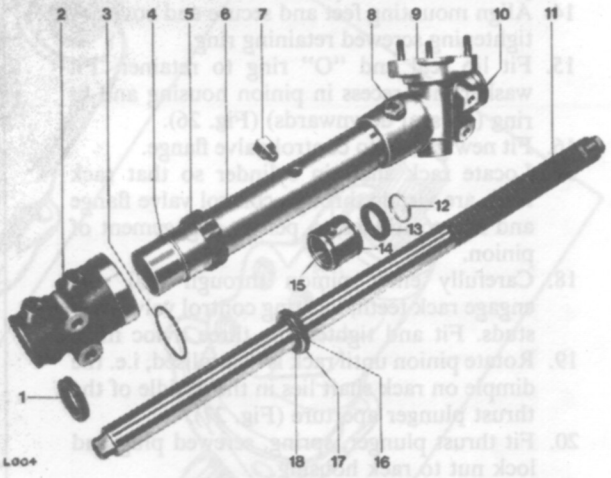


Fig. 23. The power steering rack and control valve



1 Seal — end housing
2 End housing
3 'O' ring — end housing
4 Circlip (limiting stop)
5 Slotted nut — end housing
6 Cylinder (ram chamber)
7 Union — cylinder sleeve
8 Union — balance pipe
9 Mounting flange — control valve
10 Mounting feet
11 Rack shaft
12 Backing ring — seal — cylinder sleeve
13 Seal — cylinder sleeve
14 'O' ring — cylinder sleeve
15 Cylinder sleeve
16 Piston — rack shaft
17 Piston ring
18 Circlip

Fig. 24. The power steering rack dismantled

5. Fit piston inner "O" ring to rack shaft.
6. Carefully slide cylinder sleeve (seal end first) along plain end of rack shaft beyond location of piston. *Do not* slide cylinder sleeve over rack teeth.
7. Fit piston inner circlip to rack shaft, taking care not to score rack shaft.

8. Fit piston ring to piston, slide piston into position on rack shaft and secure with circlip, taking care not to mark shaft.
9. Align tapped hole in cylinder sleeve with countersunk hole in cylinder and carefully slide sleeve and rack shaft into cylinder (Fig. 25).
10. Through countersunk hole in cylinder, locate tapped hole in cylinder sleeve.
11. Smear conical seat of union with hydraulic sealing compound and fit and tighten union.
12. Slide end-cover retaining ring and circlip over cylinder. Fit new lip type seal (lip of seal towards cylinder bore) and "O" ring to end cover.
13. Lubricate seal lip and slide end-cover into position.
14. Align mounting feet and secure end cover by tightening screwed retaining ring.
15. Fit lip seal and "O" ring to retainer. Fit washer into recess in pinion housing and fit ring (lip seal downwards) (Fig. 26).
16. Fit new gasket to control valve flange.
17. Locate rack shaft in cylinder so that rack teeth are visible through control valve flange and are positioned to permit engagement of pinion.
18. Carefully enter pinion through seal and engage rack teeth, locating control valve over studs. Fit and tighten the three nyloc nuts.
19. Rotate pinion until rack is centralised, i.e. the dimple on rack shaft lies in the middle of the thrust plunger aperture (Fig. 27).
20. Fit thrust plunger, spring, screwed plug and lock nut to rack housing.
21. Remove the small hexagonal plug from the screwed plug and using a dial gauge tighten screwed plug until plunger end-float (i.e. side movement of the rack shaft) does not exceed 0·007 in (0·178 mm). This measurement must not be confused with backlash or axial movement. Tighten locknut.
22. Fit grease nipple to screwed plug and grease rack.
23. Remove grease nipple and replace hexagonal plug.
24. Fit new end washers complete with "D" plates to rack ends (recessed side of washer towards rack).
25. Fit and tighten tie-rod inner ends to correct torque figure. Both tie rod inner ends should be tightened simultaneously to prevent stress to pinion. Secure by bending over lock tabs on "D" plates, care being taken not to disturb ball housing tabs. Ball joints must be checked for free articulation following assembly to rack.
26. Grease rack ends and inner ball ends, slide bellows seals into position, and secure with clips.
27. Fit Bundy tubing to control valve and rack housing. If necessary, during assembly of rack, the pinion lower needle bearing and rack shaft bush in end-cover can be renewed.

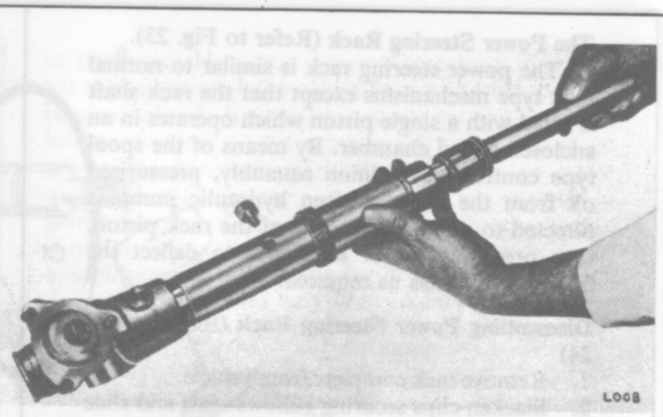


Fig. 25. Assembling rack shaft to cylinder

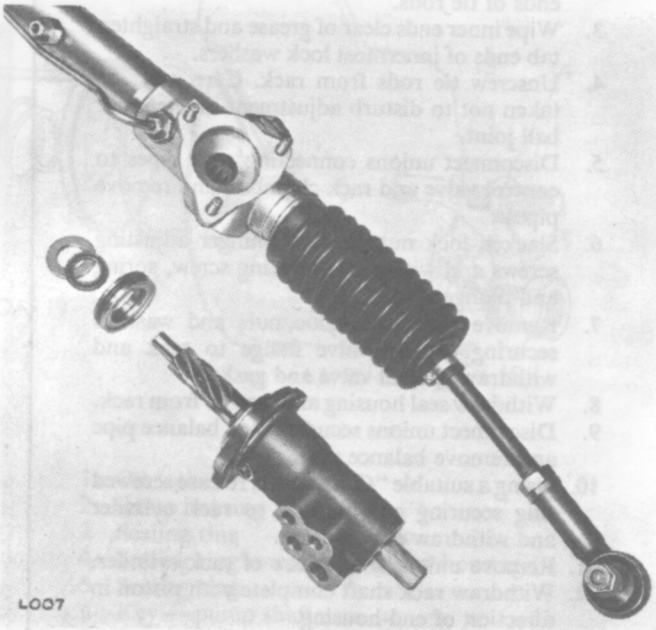


Fig. 26. Rack/control valve seats

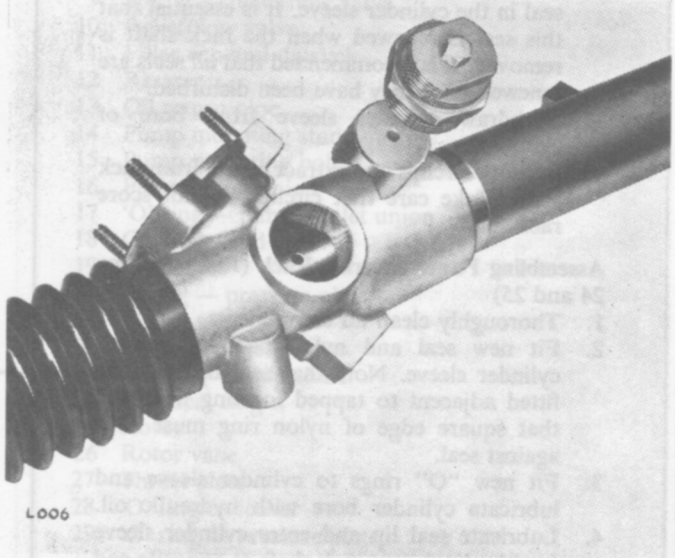


Fig. 27. Rack shaft central location

CONTROL VALVE/PINION ASSEMBLY

Two types of control valve/pinion assembly have been fitted.

Up to Commission Numbers ME 21016/MG 9681 — Adwest type; from these Commission Numbers — Alford and Alder type.

IDENTIFICATION AND INTERCHANGEABILITY

The Alford and Alder control valve/pinion assembly is distinguishable from its previous Adwest counterpart in that the housing body is shorter. There is no plug fitted at the base of the body above the mounting flange and a plastic dust cover shrouds the top of the housing.

Both types are interchangeable but it is important to note that in the Adwest unit a seal assembly is fitted to the rack below the pinion shaft ballrace: in the Alford and Alder unit a spacer ring is fitted below the pinion shaft ball race.

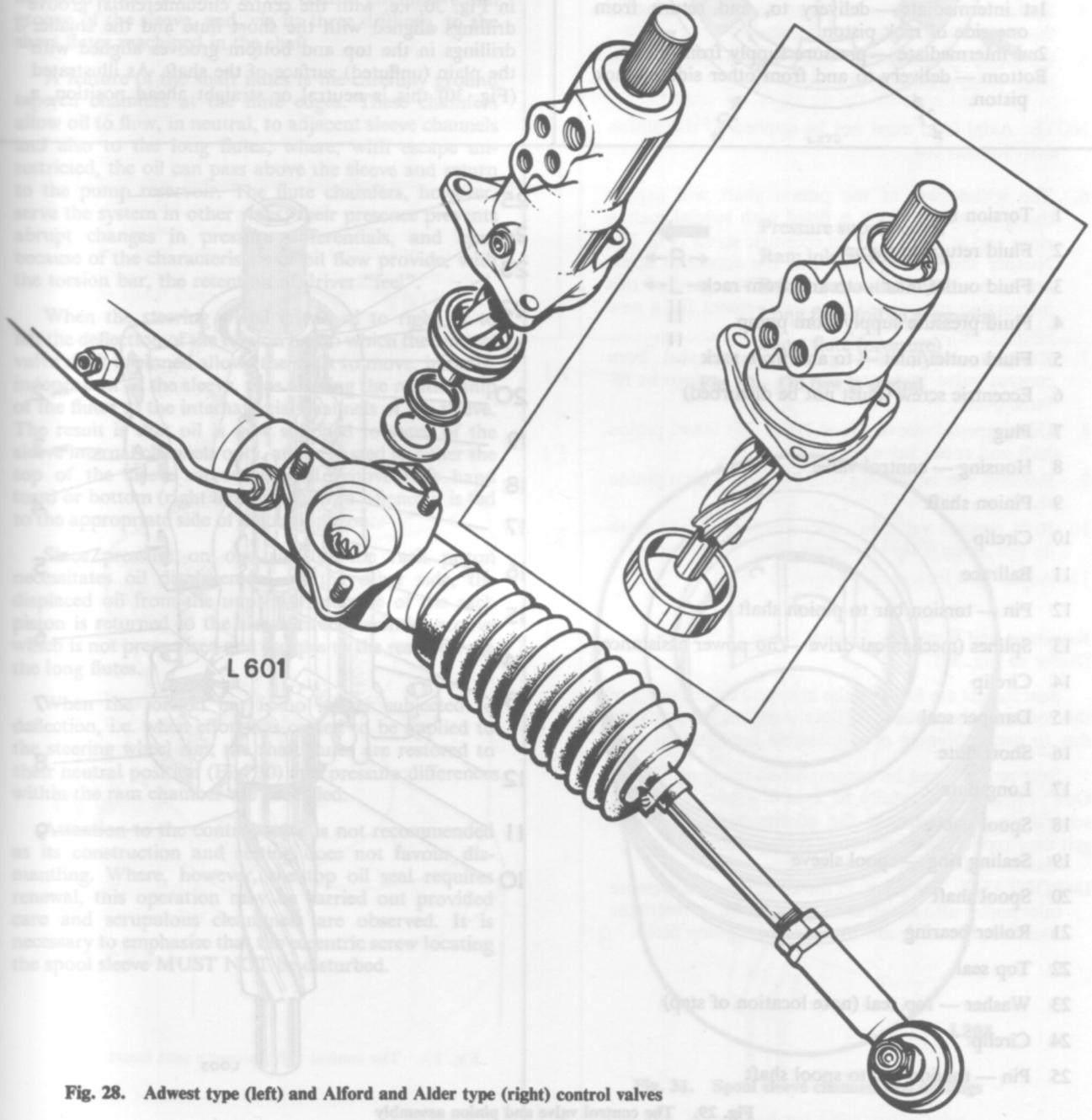


Fig. 28. Adwest type (left) and Alford and Alder type (right) control valves

THE CONTROL VALVE — ADWEST TYPE

Description and Operation

The steering rack control valve is a combined pinion shaft and spool assembly, through which oil flow from the hydraulic pump is directed to either side of the rack piston as required. A cutaway view of the control valve is shown in Fig. 29 together with a sectioned plan view (Fig. 30). From these illustrations the construction and principle of operation can be seen.

The ports in the control valve body are connected, in order of descent, as follows:

Top — return to reservoir.
1st intermediate — delivery to, and return from one side of rack piston.
2nd intermediate — pressure supply from pump.
Bottom — delivery to and from other side of rack piston.

Forming the spool valve is a shaft with six flutes, three long and three short, alternately disposed. This shaft is encased by a sleeve which has six internal axial channels, and on its external surface, three circumferential grooves interspaced with sealing rings. The centre circumferential groove has three drillings at 120° which penetrate the plain area of the internal bore. The top and bottom circumferential grooves also are drilled, but these holes (three at 120° each groove) are smaller than those of their centre counterpart and penetrate the top and bottom respectively of the internal axial channels as shown in Fig. 31.

When assembled, the shaft and sleeve are as shown in Fig. 30, i.e. with the centre circumferential groove drillings aligned with the short flute and the smaller drillings in the top and bottom grooves aligned with the plain (unfluted) surface of the shaft. As illustrated (Fig. 30) this is neutral or straight ahead position, a

1 Torsion bar
2 Fluid return to pump
3 Fluid outlet/inlet — to and from rack
4 Fluid pressure supply from pump
5 Fluid outlet/inlet — to and from rack
6 Eccentric screw (must not be disturbed)
7 Plug
8 Housing — control valve
9 Pinion shaft
10 Circlip
11 Ballrace
12 Pin — torsion bar to pinion shaft
13 Splines (mechanical drive — no power assistance)
14 Circlip
15 Damper seal
16 Short flute
17 Long flute
18 Spool sleeve
19 Sealing ring — spool sleeve
20 Spool shaft
21 Roller bearing
22 Top seal
23 Washer — top seal (note location of step)
24 Circlip
25 Pin — torsion bar to spool shaft

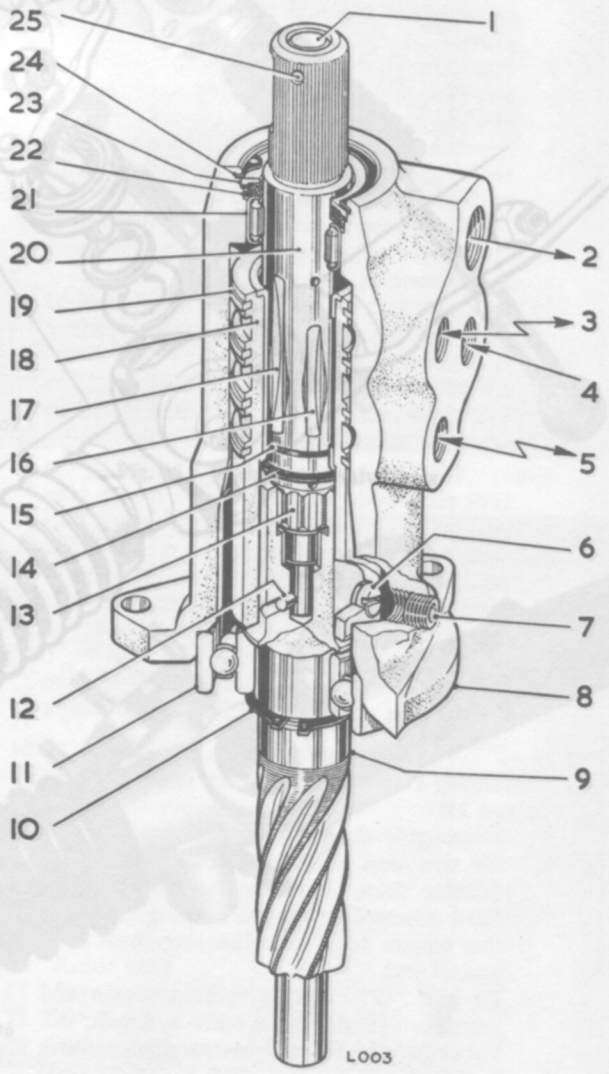


Fig. 29. The control valve and pinion assembly

position which provides no steering assistance. This delicate relationship of sleeve and shaft is the responsibility of the eccentric screw shown in Fig. 29. *No adjustment* must be made to the eccentric screw in service.

So long as the hydraulic pump is running, oil is delivered under pressure to the central circumferential groove of the sleeve, and, via its three drillings, to the short flutes machined in the shaft.

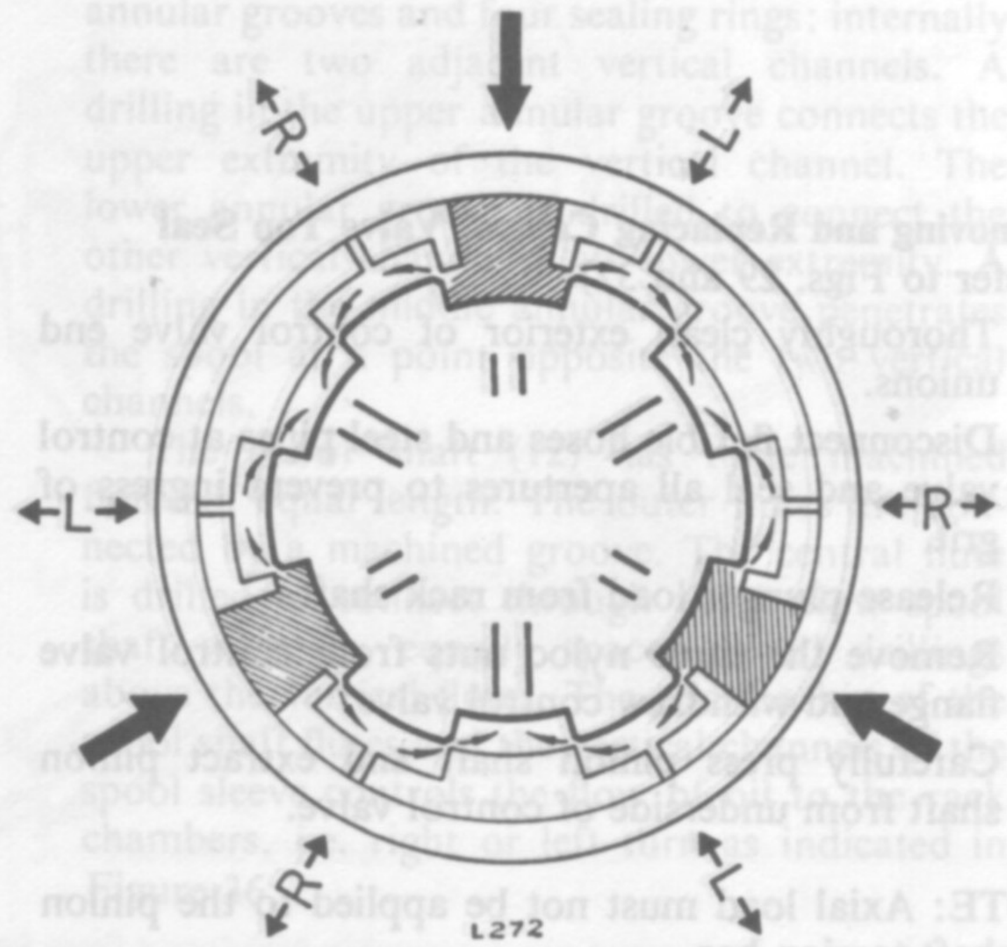
A feature of the shaft flutes is the carefully ground tapered chamfers at the flute edges. These chamfers allow oil to flow, in neutral, to adjacent sleeve channels and also to the long flutes, where, with escape unrestricted, the oil can pass above the sleeve and return to the pump reservoir. The flute chamfers, however, serve the system in other ways; their presence prevents abrupt changes in pressure differentials, and also, because of the characteristics of oil flow provide, with the torsion bar, the retention of driver "feel".

When the steering wheel is turned to right or to left the deflection of the torsion bar to which the control valve shaft is pinned allows the shaft to move, initially, independent of the sleeve, thus altering the relationship of the flutes to the internal axial channels of the sleeve. The result is that oil is now supplied to three of the sleeve internal channels only, and is passed to either the top of the sleeve circumferential groove (left hand turn) or bottom (right hand turn) from whence it is fed to the appropriate side of the rack piston.

Since pressure on one side of the rack piston necessitates oil displacement on the other side, the displaced oil from the unpressurised side of the rack piston is returned to the sleeve circumferential groove which is not pressurised and escapes to the reservoir via the long flutes.

When the torsion bar is no longer subjected to deflection, i.e. when effort has ceased to be applied to the steering wheel rim, the shaft flutes are restored to their neutral position (Fig. 30) and pressure differences within the ram chamber are cancelled.

Attention to the control valve is not recommended as its construction and setting does not favour dismantling. Where, however, the top oil seal requires renewal, this operation may be carried out provided care and scrupulous cleanliness are observed. It is necessary to emphasise that the eccentric screw locating the spool sleeve MUST NOT be disturbed.



Pressure supply ports
←R→ Ram inlet/outlet R.H.
←L→ Ram inlet/outlet L.H.
Long flute (oil to reservoir)
Short flute (pressure)

Fig. 30. Oil flow in neutral

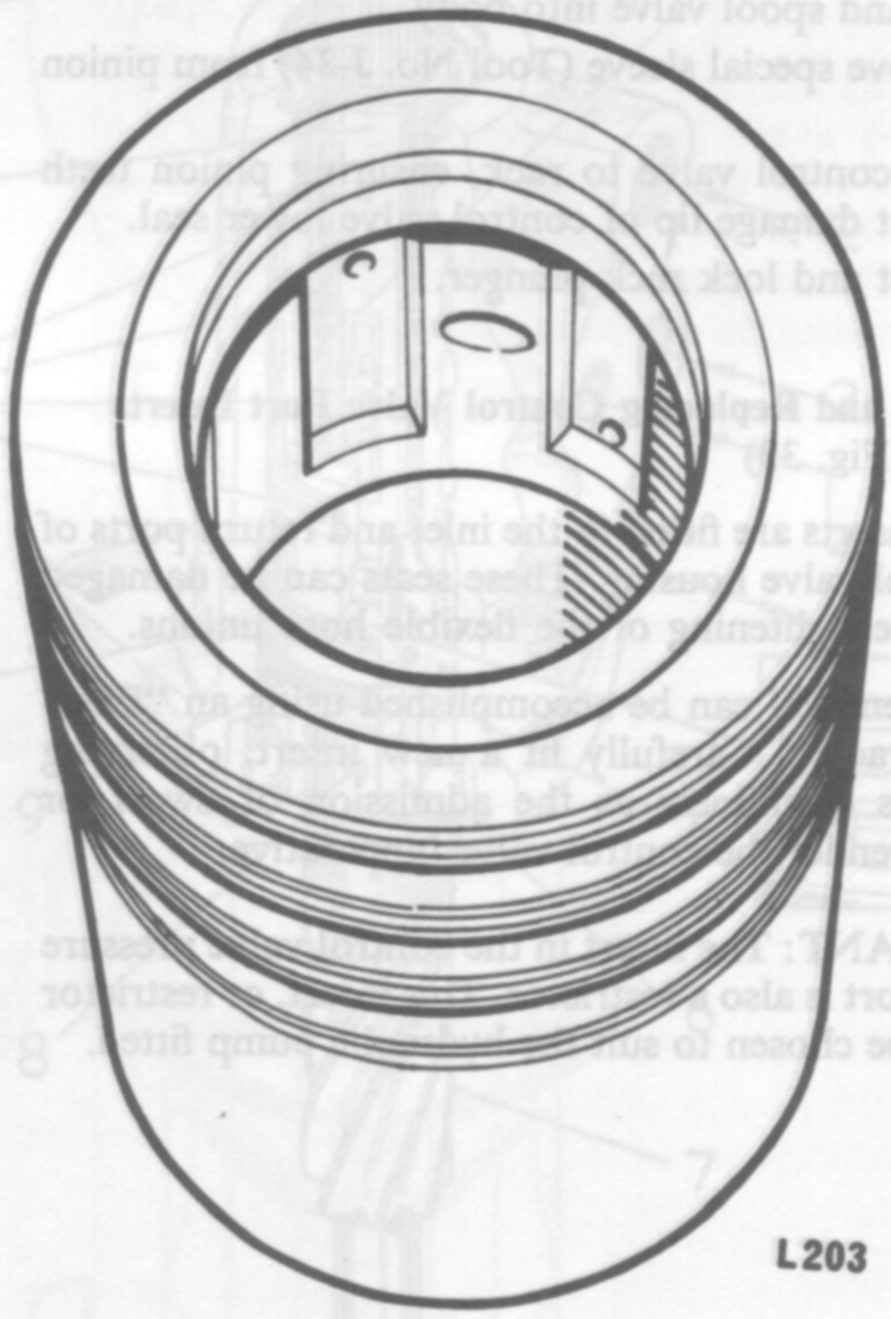


Fig. 31. Spool sleeve channels and drillings

Removing and Replacing Control Valve Top Seal
(Refer to Figs. 29 and 32)

1. Thoroughly clean exterior of control valve end unions.
2. Disconnect flexible hoses and steel pipes at control valve and seal all apertures to prevent ingress of grit.
3. Release plunger load from rack shaft.
4. Remove the three nyloc nuts from control valve flange and withdraw control valve.
5. Carefully press pinion shaft and extract pinion shaft from underside of control valve.

NOTE: Axial load must not be applied to the pinion shaft torsion bar.

6. The withdrawal of the pinion shaft will expose the spool valve which is fitted with special sealing rings and is located by an eccentric screw (Fig. 29). Neither the sealing rings nor the eccentric screw are to be disturbed in any way. Disregard of this instruction may result in a requirement for a new control valve.
7. Remove circlip, backing washer and seal from control valve body, renew seal and replace in reverse order.
8. Using special sleeve (Tool No. J-34) insert pinion shaft and spool valve into body.
9. Remove special sleeve (Tool No. J-34) from pinion shaft.
10. Refit control valve to rack, ensuring pinion teeth do not damage lip of control valve lower seal.
11. Adjust and lock rack plunger.

Removing and Replacing Control Valve Port Inserts
(Refer to Fig. 33)

Seat inserts are fitted to the inlet and return ports of the control valve housing. These seats can be damaged due to overtightening of the flexible hose unions.

Seat removal can be accomplished using an "Easy-Out" extractor. Carefully fit a new insert, observing scrupulous cleanliness as the admission of swarf or grit may render the control valve inoperative.

IMPORTANT: The insert in the control valve pressure inlet port is also a restrictor. This insert, or restrictor must be chosen to suit the hydraulic pump fitted.

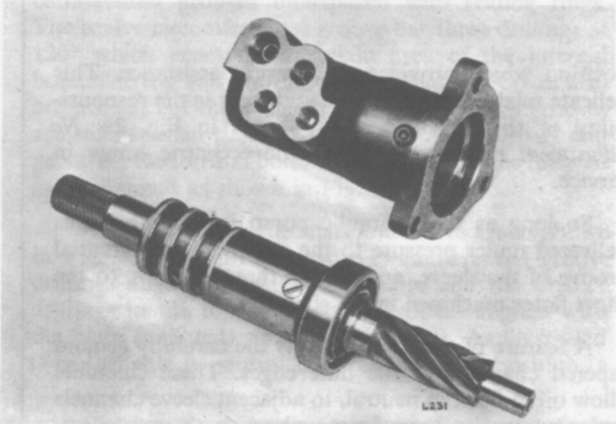


Fig. 32. Spool sleeve and pinion removed from housing

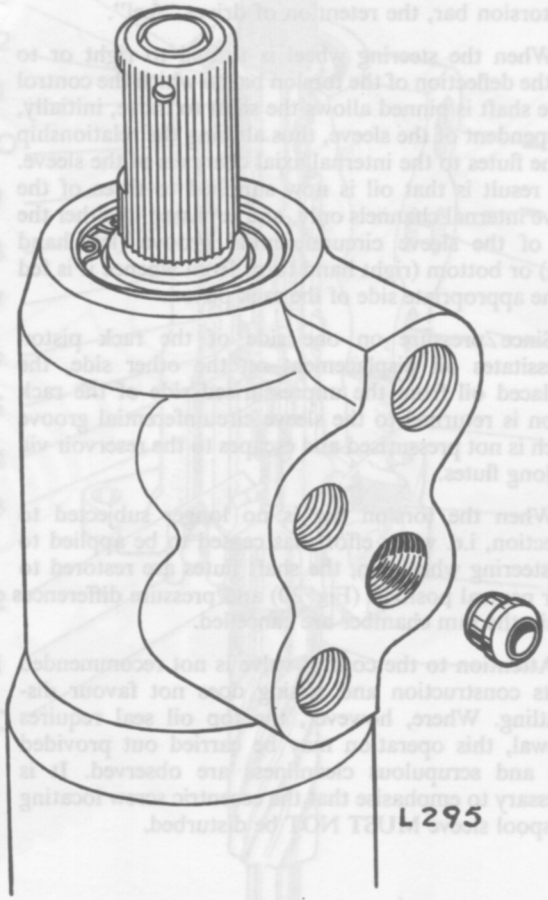


Fig. 33. The control valve pressure port insert

THE CONTROL VALVE — ALFORD AND ALDER TYPE

An Alford and Alder control valve unit was introduced from Commission Nos. MG 9682 and ME 21017.

Figures 34 to 36 show the construction and the oil flow through the Alford and Alder control valve. The spool shaft (12, Fig. 34), spool sleeve (11) and the pinion shaft (7) are connected by dogs (inset). The dogs positively locate the spool sleeve (11) to the pinion shaft (7) but provide backlash to permit slight (approximately 11°) rotation of the spool shaft (12) in relation to the spool sleeve (11) before direct mechanical torque is transmitted to the pinion shaft (7). The spool shaft (12) and pinion shaft (7) are also connected by a torsion bar (14) pinned at its ends to each shaft. Thus, while movement imparted to the steering wheel results in rotation of the spool shaft (12), spool sleeve (11) and pinion shaft (7), the spool shaft (12), – due to the backlash provided in the dogs (inset) and to the action of the torsion bar (14), – always leads in relation to the spool sleeve (11). The significance of this pre-movement becomes apparent on examination of the spool sleeve (11) and spool shaft (12).

The spool sleeve (11) has three external annular grooves and four sealing rings; internally there are two adjacent vertical channels. A drilling in the upper annular groove connects the upper extremity of the vertical channel. The lower annular groove is drilled to connect the other vertical channel at its lower extremity. A drilling in the middle annular groove penetrates the spool at a point opposite the two vertical channels.

The spool shaft (12) has three machined flutes of equal length. The outer flutes are connected by a machined groove. The central flute is drilled to connect through the hollow spool shaft with six, equally spaced radial drillings above the vertical flutes. The relationship of the spool shaft flutes and the vertical channels of the spool sleeve controls the flow of oil to the rack chambers, i.e. right or left turn as indicated in Figure 36.

1 Flutes—spool shaft
2 Fluid outlet—to pump reservoir
3 Fluid inlet—from pump
4 Outlet/inlet ports—to and from rack
5 'O' ring
6 Ball race
7 Pinion
8 Pin—torsion bar
9 'O' ring
10 Circlip
11 Sealing rings—spool sleeve
12 Spool shaft
13 Pin—torsion bar
14 Torsion bar

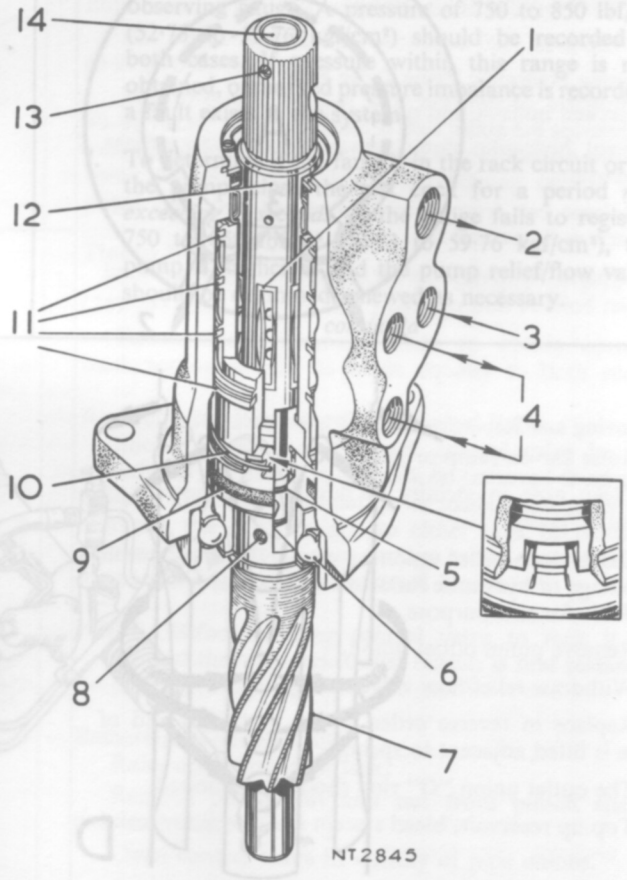


Fig. 34. Alford and Alder control valve