

From the Classic Workbench:

STEERING BOX OVERHAUL AND ADJUSTMENT 120, 1800, 140

By JOHN FLEMING

The steering boxes used in the 122, 1800 and later 140 Volvos are of the GEMMER pattern, originating prewar in the USA. Those on the Volvos and some other European cars were made by the famous precision German gear firm of ZF. They are of an exceedingly high quality and are long wearing PROVIDED lubricating oil is maintained in the housing and the gear mesh is correctly adjusted. Sadly, most folk have no idea of the general principles of the design and butchery ends up destroying the box.

Another reason for this article is that after nearly 40 years of rebuilding these boxes, there has been such a demand for steering worms lately that I now have no useable secondhand steering worms. What I want everyone to do upon reading this is to go out to your car and check if there is oil in your steering box! Pre about 1965 cars have a square headed taper plug as oil filler, post '65 have a red plastic push on cap...lift off with a screwdriver blade. If you are lucky, or have been getting decent service done, oil will be present up to bottom of the filler hole threads. If empty (OH DEAR!) Fill the box slowly and carefully with 90 grade EP gear oil...the same as used in differentials. Keep an eye on the box for a few days or more, and maybe park over a sheet of newspaper or an oil pan of some sort to see if it refrains from leaking. If the box was empty though, it will leak through worn seals, and most certainly will have suffered damage running dry.

Do NOT try stuffing the box with grease, as some odd types seem all too willing to do. It will not work as the finely machined parts must run in an oil bath, and they remain unlubricated. Also, if stuffed full of grease, the steering box become as heavy as a 1930 10 tonne truck! So, when checking your oil, if you see signs of grease poked into the filler,

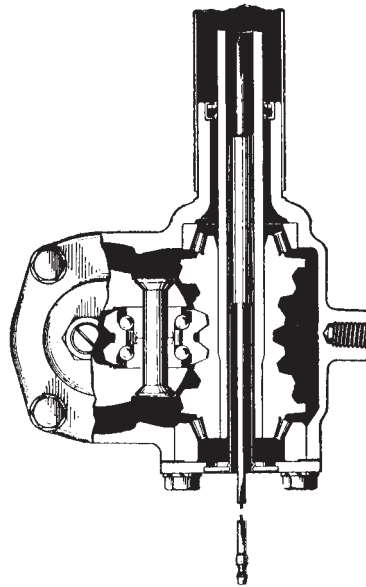
another reason the box must come apart and be overhauled.

Unless you have reasonable home workshop facilities, and considerable background in general auto engineering, it may be wise to leave the box dismantling and overhaul to a specialized service. But here follows some guidelines should you feel confident enough to undertake the task.

You will need a proper scissor type tie rod "popper" tool to get the tie rod and track rod off their tapers on the steering arm. On the 120 and 1800, cut the horn wire below the steering box, allowing 150 mm or so from the bottom of the box to reconnect it later with a screw-type connector. The narrow tube

up the steering box will only allow the wire to pass through. Undo the steering disc coupling, remembering to mark for reassembly relation of steering column shaft to box shaft, and also mark the steering flange-to-steering box shaft with small centre punch marks. Care taken here may well forestall you having to remove and straighten up your steering wheel in the straight ahead position after overhaul. Remove the bolts and nuts holding the box to the chassis, and slide the box out. Usually, it can be lifted up past the side of the motor...at worst; you may have to loosen off the fan belt and generator a bit. On the 120 and 1800 the horn wire pulls up out of the column (how to put this down the column again later!) and on 140s, the worm is solid as the horn wire does not go through the box.

With the box off, drain the oil (if any!) and put the box, held by the steering arm, in a substantial vice. You will need a sturdy U-shaped steering arm puller to remove the arm from the splined, tapered shaft. Most bearing shops or good auto tool stores have something suitable, keeping in mind the jaws of any puller must fit in the small space between back of arm and the steering box seal area. UNDER NO CIRCUMSTANCES USE ANY TYPE OF PRY BAR OR TAPER BAR. This destroys the steering box seal area and generally will not remove the arm anyway as its tightened to over 100 ft/lbs or more. I have in the immediate past purchased a very suitable and strong puller of the U shaped style from a bearing retailer...about \$30 cost, and so good, we went back a week later and bought two more. But, it must have a solid thread of at least 3/4 or 1 inch. Leave the nut partially on (as with all pulling operations off tapers) so the arm doesn't fly off when it frees. At very worst, you may have to apply a little gentle heat to the boss of the steering arm whilst the



AMERICAN ORIGINS:
Cross-section of prewar Packard Gemmer box. Note it differs to our ZF/Volvos by having taper rollers on the worm shaft (ZF has balls) and ball bearings for the roller wheel (ZF has needle rollers).

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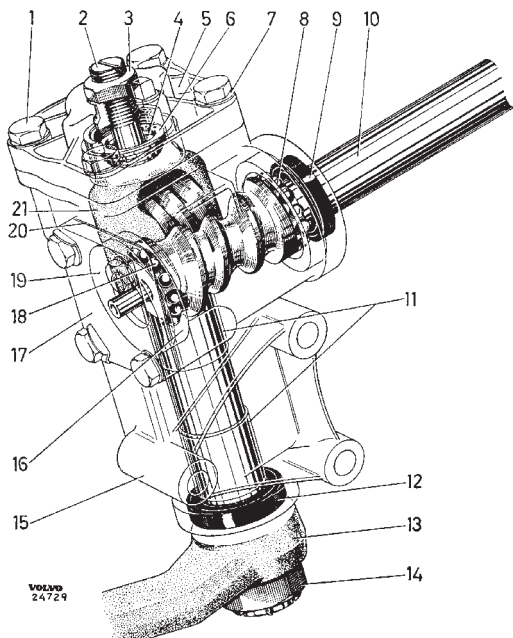


Fig. 21. Steering box.

1. Bolt
2. Adjusting screw
3. Locknut
4. Pitman arm shaft bush
5. Cover
6. Circlip
7. Tab washer
8. Steering column bearing, upper
9. Steering column oil seal
10. Steering column
11. Pitman arm shaft bush
12. Pitman arm shaft seal
13. Pitman arm
14. Nut
15. Steering box body
16. Steering column bearing shell, lower
17. Steering column cover
18. Steering column bearing, lower
19. Washer
20. Shim
21. Pitman arm shaft with roller

box US parentage. THEY ARE NOT METRIC! Next step is to carefully remove the old oil seals. The new seals are easily available from most bearing suppliers or included in a special steering box kit Part No. 54929 from some of the Volvo parts suppliers. Seal sizes are for the 120 and 1800 22x32x7 mm (top steering worm shaft) and 25x36x7 (bottom, Pitman shaft). The 140 box is larger and you will need to measure

play here is end float of the steering arm and will give noises and clunking as well as lost movement of the steering wheel. Here, too, is where so many don't understand the principles of the box, and screw the lid adjuster screw down in the mistaken belief it corrects end float. WRONG! This adjuster is for gear engagement backlash of the steering worm and the roller wheel on the Pitman shaft. You will note from the diagram the gear diameters intersect and lowering the Pitman shaft (by screwing down the adjuster on the lid) closes the gear meshing. Pitman shaft end float is done by selecting suitable hardened ground steel washer held in by the circlip. Here again, a good selection of used washers of this type is handy. They were once available in six different thicknesses from Volvo. Even carefully measuring a stack of circlips can often gain an extra quarter or half thousand of an inch to help compensate. Another idea is to perhaps use a suitable very thin shim steel under the head of the Pitman shaft captive suspension bolt.

puller is tightened.

With the arm off (and note it's already factory alignment marked with a punched line across arm and bottom of shaft) undo the adjustment hex nut at the lid with a 3/4 inch (or 19 mm) and then the 4 lid bolts. Interestingly, these bolts and the bottom plate bolts are 13 mm rather than 1/2 inch...remember the box is German made, even if of US origins.

Screw the slotted big adjustment screw down as you lift the top lid off. Next, securely clamp the steering column in the vice (but don't damage the column outer surface) and remove the locking clamp bolt and nut and drift the flange off the top of steering shaft. Undo the four bolts and remove the bottom plate, then gently tap the worm shaft out and the bearings in their keeper rings will fall out. Wash and clean the whole box in solvent and inspect.

Pitting or break through must not be evident on the rolling surfaces of the worm gear on the Pitman shaft assy., nor on the top or bottom ball bearing race areas of the steering worm/shaft. Also, there should be no visible damage or break through the surface of the steering worm itself. Any damage will need replacement, from good secondhand units that have always been lubricated.

Overhaul to more than acceptable condition involves replacing the 24 ball bearings with new balls...they snap out and in the circular keepers easily.

The size of hardened steel bearing balls is 5/16 inch, keeping in mind the

and take samples. Please also note the 140 steering worm is also totally different, and really the only interchangeable bits between 140 and the 120/1800 boxes are the lids, a few bolts and a hardened adjuster washer! Coat your new seals on the edges and the insides of the seal housings with semi-drying gasket cement No. 3 (NOT SILICONE) and tap them into position, using a suitable sized socket or other mandrel.

Wire brush and clean up the steering shaft/worm and also file smooth any nicks or vice marks which could damage the oil seal. Refit the shaft and the new bearings, with a light smear of oil. Use the original shims that came out of the bottom plate for a trial setup. Chances are you will need to adjust this to give no play, but with no stiffness either. Remove or add shims to achieve just the right play. This is where you need a selection of the base shims. They come in thicknesses ranging from 4 and 5 thousands of an inch (0.10/0.12 mm) through 7 and 12 thou etc.

Using combinations measure the stack with a micrometer and determine what is required. This is a slow process at best, but worth the effort. When you are happy with the end float (or lack of!) pull the end plate off again and coat all shim surfaces AND THE TWO BOLT THREADS with gasket cement No. 3 (the brown sticky stuff you should now have a bottle of) and finally assemble and tighten.

Next step is also fiddly, but vital. Using good fitting, angled circlip pliers, remove the Pitman shaft suspension bolt out of the Pitman shaft top, together with the hardened ground washer. This bolt must have zero end float, whilst still allowing the Pitman shaft to turn. Any

Having removed all end float from the Pitman shaft suspension bolt, squirt a few drops of oil into it, grease the shaft a little and carefully lower it into the box and past the bottom seal. Make a new lid gasket from thin gasket paper (or use one in the kit) and again smear gasket cement No.3 on the mating surfaces and thread the lid down on the suspension bolt until it fits the housing. Screw the bolt counter clockwise a bit to lift the worm and roller well clear of each other initially,

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then fit the four lid bolts and flat washers with a smear of sealant on the threads to stop leakage. Now, you are ready for final adjustment!

First, mount the box in the vice, then wind the box back and forth and count number of turns end to end. Divide these in half and turn back to the dead centre position (e.g.: straight ahead). You MUST only ever set gear mesh in the centre, straight ahead position, as the worm is hourglass shaped. Fit the 3/4 inch locknut loosely on the adjuster screw on the lid, then slowly screw down with a big screwdriver until some resistance is felt. Now, as you rock the steering shaft column back and forth over centre, a

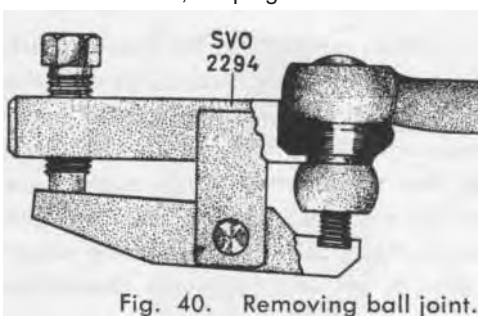


Fig. 40. Removing ball joint.

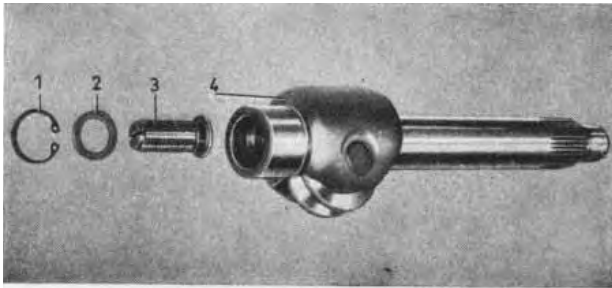


Fig. 37. Pitman arm shaft.

column shaft. You will have noted when the box was apart how this inner horn wire tube is, and the impossibility of threading a wire DOWN without a pull through. I bare the wires and twist well together and even wrap one layer of masking tape over the join and always get the wire threaded back down the column without drama. With the box installed and everything lined up, I use

slight resistance should be felt. That is the correct setting, and then carefully lock the nut, making sure the screw doesn't turn. I always mark with a small punched dot the centre position on the steering column shaft opposite the cast in mark on the box housing near the oil seal. This is a good aid when refitting in the car too and for future gear mesh adjustment. Refit the steering arm to the Pitman shaft, making sure you align the factory marks. Tighten the Nyloc nut with a socket and a long bar to at least 125 Ft/lbs. That is, quite tight!

Refitting is reverse of removal, with hint that you first thread a thin wire from the BOTTOM of the box upward (in cases of 12 and 1800) to allow the original horn wire to be pulled down through the centre of the coupling disc and steering

a small household type 240 volt barrier strip grubscrew connector to rejoin the horn wire at base of steering box. This enables future removal of the wire quickly without further cutting or removal of crimped connectors.

Carefully fill the box with 90 EP gear oil, and with luck even your steering wheel is still aligned in the straight ahead position. If not, don't panic, you simply remove horn ring or button, pull steering wheel and move a spline or two either way to correct. After a day or two when the oil settles a bit, you may need to add a drop more. From then on, just check at each service.

*John Fleming
Classic Volvo Service*

POSTSCRIPT: The steering box overhaul article has to be somewhat abridged due to space limitations and also the general availability of specialized tools and jigs. Thus I will just note that the box lids do have an integrally cast in bronze bush that does wear, but one can only try a selection of other lids that may have less wear or have always had lubricant. Note that the later 140 lid is same as 120/1800. The thin wall bushes in the main housing do wear slightly, and can be replaced BUT require specially made mandrels, press gear and line reaming to a precision fit. This is well out of the reach of the average enthusiast home workshop. Of interest is the fact the roller wheel on the Pitman shaft assembly runs on miniature needle rollers and the hardened steel shaft is welded at both ends to make the unit fully encapsulated. Again, wear does occur, but provided oil has always been present (SEE HOW IMPORTANT LUBRICATION IS!) mostly very small play develops even after very high mileages. All one can do if a Pitman shaft assembly is excessively worn due to lack of lube or excessive over tightening of gear mesh adjuster screw is to try a selection of others which may have lived their full service life immersed in oil. JF

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