REAR AXLE PINION OIL SEAL RENEWAL AND MODIFICATION

Applicable to all early post war cars up to and including Silver Cloud III / Bentley S3, but excluding all Phantom axles

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GENERAL

Unless stated otherwise.

- References to Bentley MKVI should be taken to include Bentley R Type Continental, Bentley R Type, R-R Silver Dawn and Silver Wraith SWB.
- References to Bentley SI include Bentley SI Continental and R-R Silver Cloud I.
- References to Bentley S2 or S3 included Continental Models and R-R Silver Cloud II / III.

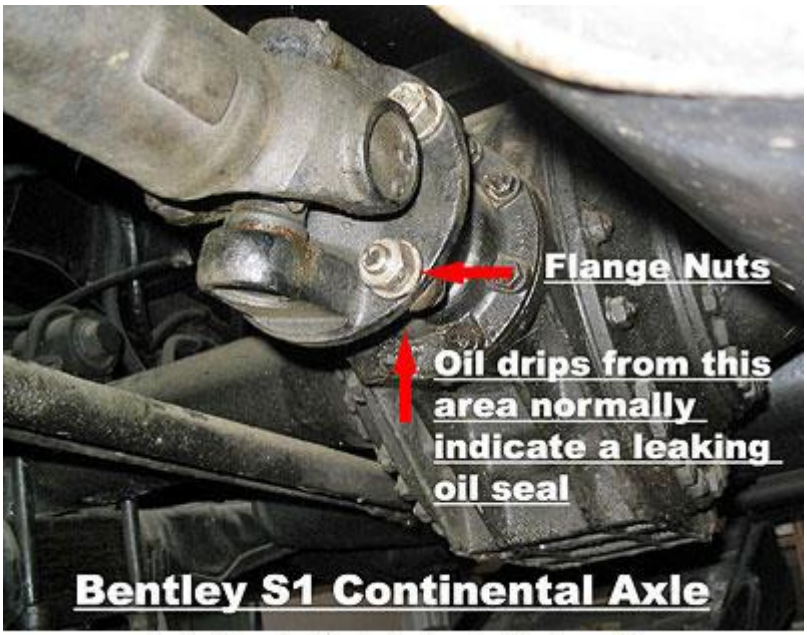


Fig 1. Showing the typical axle oil leak position

Most of the images used in this article and the text description refer to the Silver Dawn Bentley R Type rear axle however the principle is identical with all rear axles to which this article refers. Axles fitted to all Silver Clouds and Bentley equivalents use UNF or UN Special threads and therefore the appropriate UNF wrench sizes will need using.

It should be noted that the axle drive flange bolt pitch circle and sizes of the four retaining nuts and bolts are very slightly different between Silver Dawn /Bentley R Type axles and later Silver Cloud / Bentley S type axles. However in respect of the drive flange removal tool the flange differences are so small that the same puller will suffice on all the drive flanges.

OIL LEAKS, CHECKS, DRAIN AND BREATHER

A rear axle pinion seal oil leak may appear self-evident but it is advisable to carry out a few checks before tearing down the front of an axle to replace the oil seal.

Firstly all chassis with a working lubrication system will have some evidence of oil around the rear axle. Depending upon how often the chassis oil pump has been used and the relative car speeds attained either oil mist, or heavier oil deposits will have collected around the axle case.

Secondly, due to the axle oil sealing arrangement, or truthfully lack of it, some oil may be evident on the left hand side of all axles, or egressing from the axle tube drain. As long as these are minor drips compared with out and out leaks, there is no need for concern.

In the worst oil leaking situation the oil will be seen to readily drip from the oil seal housing just behind the axle drive flange, as shown in Fig 1.

If in doubt make sure the oil level is up to the full mark by unscrewing the 17/32nd hexagon filler plug and checking that the oil is level with the inside of the filler orifice. At that point make sure the front wheels are blocked and raise the rear wheels off the ground as far as possible. After a short period any faulty oil seal will be apparent when oil flows out of the seal housing. This exactly replicates the situation of a car parked facing downhill, and the speed of the oil flowing out of the axle will quickly show how many of these axles are ruined by lack of oil.

At this point many owners may decide to bite the bullet and fit a modern oil seal, but first check the condition of the pinion bearing(s). It is of no use renewing or converting the oil seal if the bearings are sloppy and worn. This article does not deal specifically with renewing the pinion bearings but some thought needs applying before attempting renewal of pinion bearings in 60 year old axles.

Often owners take advantage of the situation when changing an oil seal to change the axle oil. In this connection a few words of warning on a subject that even catches out some specialists.

All these cars have a 17/32nd hexagon drain/filler plug, or 0.530 inch across the flats, a 14mm hex (0.5512 inch) key filed down carefully will fit. What is not so well known is that although all these plugs are 16 TPI (16 threads per inch) all Silver Cloud axles have UNS (60 deg) threads but earlier cars like Silver Dawn /Bentley R Type are Whitworth threaded profiles (55 deg). The plugs are not interchangeable and to try swapping them around will ruin your day. Exactly the same comment applies to the axle top breather plug.

Having now taken out the drain plug you are having a bad hair day trying to get it back into the axle. Simple…..the reason is that you are trying to align the plug squarely with the axle case and the thread is cross threading. Rolls-Royce always worked on the principle of making things complicated and confusing the masses. Just for you they tapped the drain plug threads some 4.5 degrees off set to the axle case line. Why? So that when the axle was in position and slightly tilted the threaded hole was truly pointing directly downwards and you are able to drain the last drip of oil.

So, to recap before attempting the technical aspect of replacing the drain plug. The plug hexagon end is laying rearwards just 4.5 degrees to the axle casing when it has engaged the threads, this gives the impression it is not going in squarely. Replace as follows, wipe the thread end to check that the thread is good, fit a new alloy sealing washer to the plug, insert your index finger into the hexagon end and screw the plug into the axle case thread. Once you have revolved it one full turn and felt it engage you should be able to screw it in as normal.

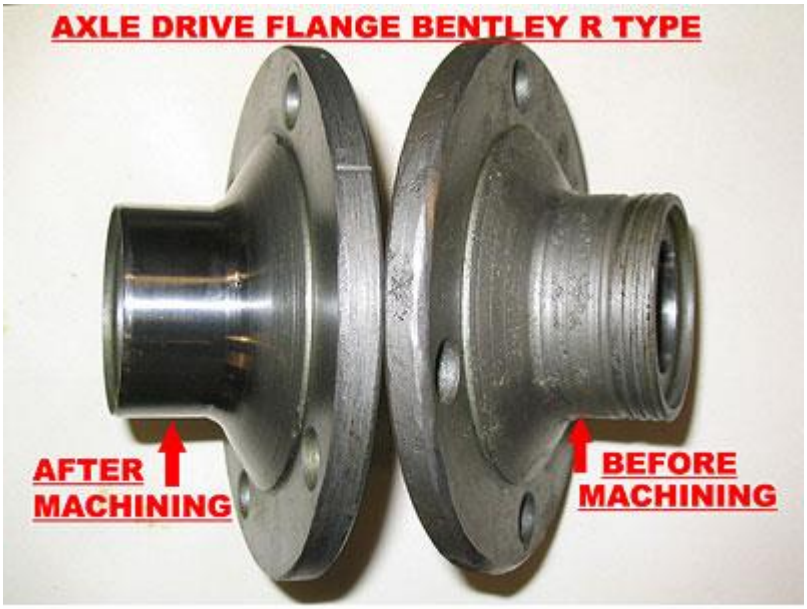


Fig 2. Comparison of old and remachined seal running surfaces on an axle flange

In any event the top mounted axle breather is likely to be blocked and needs removing to clean it out. The very early axle cases up to around 1951 were machined very close to the breather hexagon heads and this makes it difficult to engage a socket, beware of rounding off the hexagon corners and hold any tool squarely and firmly onto the breather. The Silver Dawn /Bentley R Type breather takes 11/16 Whit or 5/8 BSF sockets, the Silver Cloud / Bentley S type 1.125 inch AF.

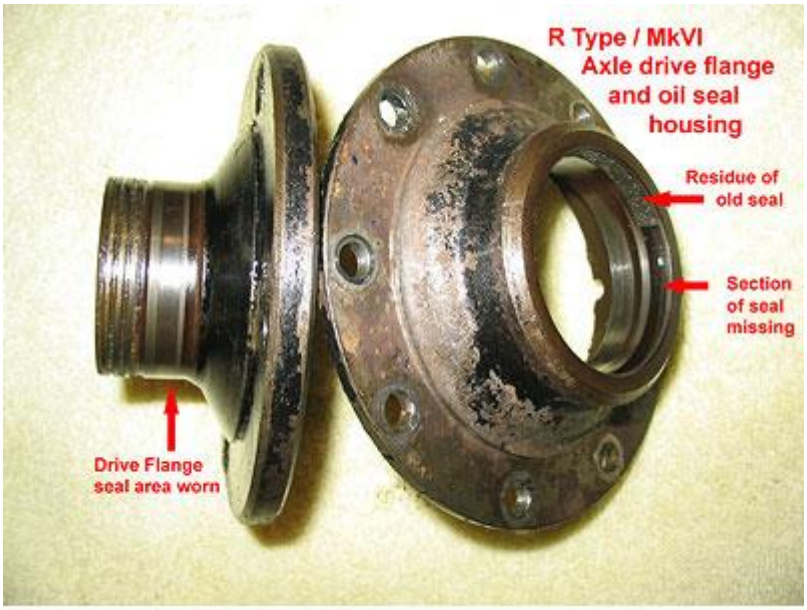


Fig 3. Typical felt seal deterioration

OIL SEALS

The original oil seals were felt and not the type of seal that is familiar to the majority of current owners. Reasons were simple in the extreme, until the early 60's modern rubber type oil seals perished very quickly and were not reliable, so felt did the job. The present day drawback is that the drive flanges have worn badly where the seal contacts the flange seal track and a straightforward felt seal replacement results in a torn up seal. Some oversize felt seals are available but they in turn suffer the felt seals original fate of trapping dirt and letting in water. In turn this wears the flange seal face quite quickly.

In any instance of the oil seal being replaced by a modern seal or oversize felt the drive flange will need machining, and depending upon the seal to be fitted, so will the seal housing. In practice there is little point in trying to replace an original type felt seal, even when new they would not pass an oil tightness test of inverting the axle on its flange end when the axle is full of oil. Fig 2 illustrates a comparison between a newly machined drive flange and one just taken out of service; the latter is in typical condition. Fig 3 shows the normal condition of the felt oil seal housing as removed from the axle, notice that most of the felt seal has been degraded or torn away.

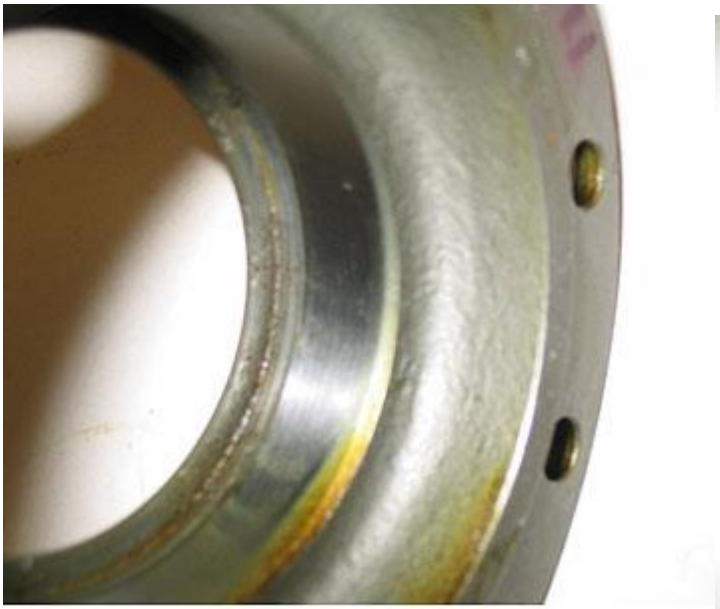
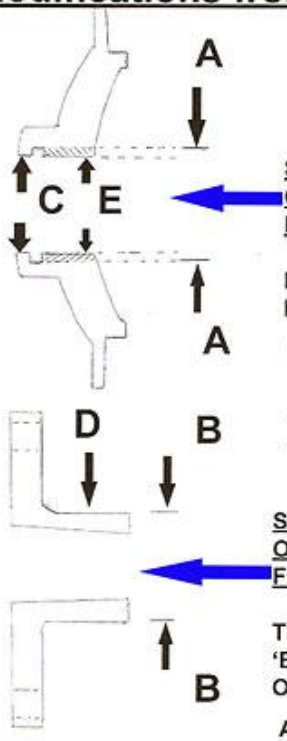


Fig 4. Oil seal housing machined from the inside face t
accept a modern seal

Fig 5. The housing after a modern oil seal has been fitted

Fig 6. Drive flange machined to accept a new seal, and repainted

R-R & Bentley rear axle pinion oil seal modifications from MkVI to S3 models



PHANTOM V / VI MODELS ALREADY HAVE MODERN SEALS

SCHEMATIC CROSS SECTION OF A TYPICAL AXLE OIL SEAL HOUSING.

DO NOT MACHINE AWAY AT POINT 'C' BUT AT POINT 'E'

WHEN FITTING THE OIL SEAL ENSURE THAT SEALER IS APPLIED BETWEEN THE SEAL AND THE HOUSING.

SCHEMATIC CROSS SECTION OF A TYPICAL AXLE DRIVE FLANGE.

THE SURFACE ACROSS POINT 'B' MUST BE EITHER GROUND OR VERY FINE TURNED.

AT 'D' MACHINE RIGHT ACROSS ANY ACME SCROLL RETURN

DIMENSIONS TO FIT OIL SEAL SIZES AS DETAILED BELOW

All from Bentley MkVI to Bentley S1. A= 55 mm. B= 45 mm

All Bentley 'S' Series inc. S1, S2 & S3 A= 60 mm B= 50 mm

Fig 7. Data showing details of sizes for flange and seal housing mods

MODERN OIL SEAL

Our objective here is to modify the oil seal housing and drive flange to accept a modern oil seal, without it being obvious that any alteration has taken place.

Fig 4 shows an image of an oil seal housing having been machined from the inside, and before the oil seal is fitted. Once the seal is fitted the outer appearance will be as shown in Fig 5. Note how the original front oil seal abutment has been left when the machining was done from the inside, so that the new modern seal fits snugly against this abutment. Fig 6 shows the final appearance of the drive flange after painting, the oil scrolls have been removed and if ever the sealing surface wears again it can be fitted with a seal recovery tube to make it as good as new. Fig 7 charts the sizes of the machined housing, flange and oil seals for axles from the Bentley Mark VI to Bentley S3 and their respective R-R models.

TOOLING

It is presumed that the repairer will have on hand a variety of correctly sized tools and will have facilities for raising the car and making safe.

The vast majority of axle drive flanges are bent, for very good reason. R-R were very accurate in machining both taper shafts, flanges and key ways. Unfortunately the average repairer seems to believe the drive flanges were fitted by some back street manufacturer and has no idea that a typical Bentley S2 drive flange will need upwards of 11 Tonnes of pressure to draw the taper alone. So we have a multitude of clowns who insist on trying to remove these drive flanges with a humble three legged puller. After bending the flange they then spend another few months searching for that elusive vibration….perhaps it's in the drive line…no we will rebuild the gearbox first!

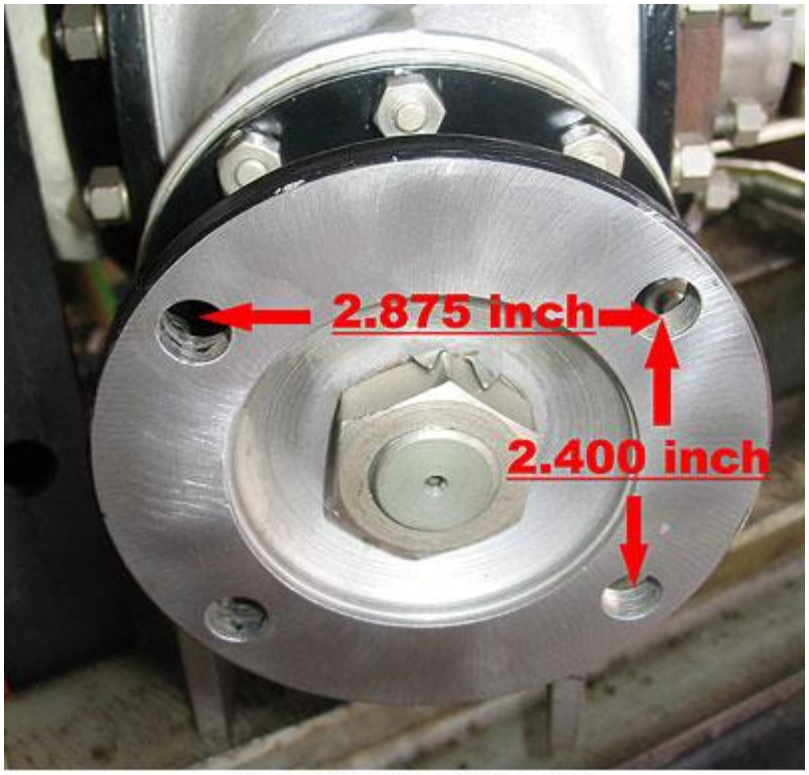


Fig 8. Drive flange hole spacing

The drive flange design changed when the Silver Cloud / Bentley S type were introduced but the same pitch centres were used as were roughly the shank diameters of the four bolts. Referring to Fig 8 will show the holes are staggered in pairs with holes of 0.4375 inch at 2.875 inch and 2.400 inch centres. This allows us to use the same flange puller, described later. In the same Fig 8 image the lock tab and flange retaining nut can be seen.

On Silver Dawn /Bentley R Type flanges this retaining nut is 1.300 inch across the flats and it will accept 33 mm. inch BSW, 7/8 BSF or 1-5/16th AF sockets

On Silver Cloud / Bentley S type flanges the relative sizes are 1.480 inch across the flats and it will take 38 mm, 7/8 BSW, 1.0 inch BSF or 1-1/2 inch AF sockets. The latter size being absolutely correct, as the axle is a Unified threaded unit.

Two bolts approximately 1.50 inch long and 0.375 diameter, with any suitable thread, and four nuts and four plain washers will also be needed. A large, preferably flat tyre lever or similar will be required to bridge the bolts eventually as shown in Fig 11.

Fig 9. Drive flange puller bolted end

A heavy hammer of around 1.75 kg will be needed to strike the end of the puller.

Previously the problem of removing the drive flange without distorting it any more than it may have already been damaged was mentioned. You don't want to bend it anymore because you definitely do not want to know the new price! The way to overcome the problem is to make a thick block puller similar to that shown in Fig 9 and fitted to the drive flange in Fig 10. A block of metal is used circa 1.25 inch thick. Notice in Fig 9 that there is quite a large diameter central relief around the puller screw. This relief is required to accept the slight protrusion above the flange face of the axle pinion shaft end and the flange retaining nut that stands proud of the flange face, when the tool is coupled as in Fig 10. This particular puller has been constructed from an old Ford rear hub puller which has the added advantage that it can be used as a pinion housing extractor by using it as a hammered extractor on its outer flange. The required pitch holes for drilling purposes are shown in Fig 8. As long as the block is firmly bolted to the axle drive flange first to prevent flange distortion, a three leg puller might be used to extract the flange together with the block, but a more permanent and useful puller can be made with a little more work.

Fig 10. Drive flange puller fitted onto the flange

Fig 11. Method of tightening drive flange

PARTS AND MISCELLANY

Assuming that all the machining is being done in a machine shop it would be sensible to perhaps consider having them fit the new oil seal. Otherwise it will be necessary to find or make a tool to drive the new oil seal into position. The tool diameter will depend on which oil seal size is due to be fitted, see sizes in Fig 7.

An oil seal, together with a drive shaft lock tab, and perhaps a spare of each, and a quantity of gasket sealer will be needed as a minimum. Oil seals and lock tabs can easily be damaged in this exercise, and is the reason for suggesting obtaining spares.

GAINING ACCESS TO THE OIL SEAL

The axle drive flange must be removed to gain access to the oil seal housing.

Mark the corresponding flanges on the axle flange edge and propeller shaft so that they can be eventually matched up correctly. Using the hand brake to lock up the propeller shaft at the required indexing positions, undo and remove the four nuts, special grover spring washers and bolts. The nuts are a special tight fit so be careful to use good tight fitting wrenches and do not round off the nuts corners. Observe that the square heads of the bolts are only just held from rotating and it is wise to hold the bolt heads to prevent damage to the rear of the flange.

Once the bolts are removed detach the shaft and immediately examine the shaft coupling flange and in particular the locating ring that locates in the groove marked ‘A’ in Fig 12. Ensure that the machined locating ring is not distorted and will engage the axle drive flange correctly. Before proceeding further check the drive shaft mating face with a straight edge or even the machined face of the block puller. The object being that the drive shaft will eventually mate up squarely to the axle drive flange. Now tie the shaft safely to one side.

Undo and remove the nine oil seal housing nuts and spring washers.

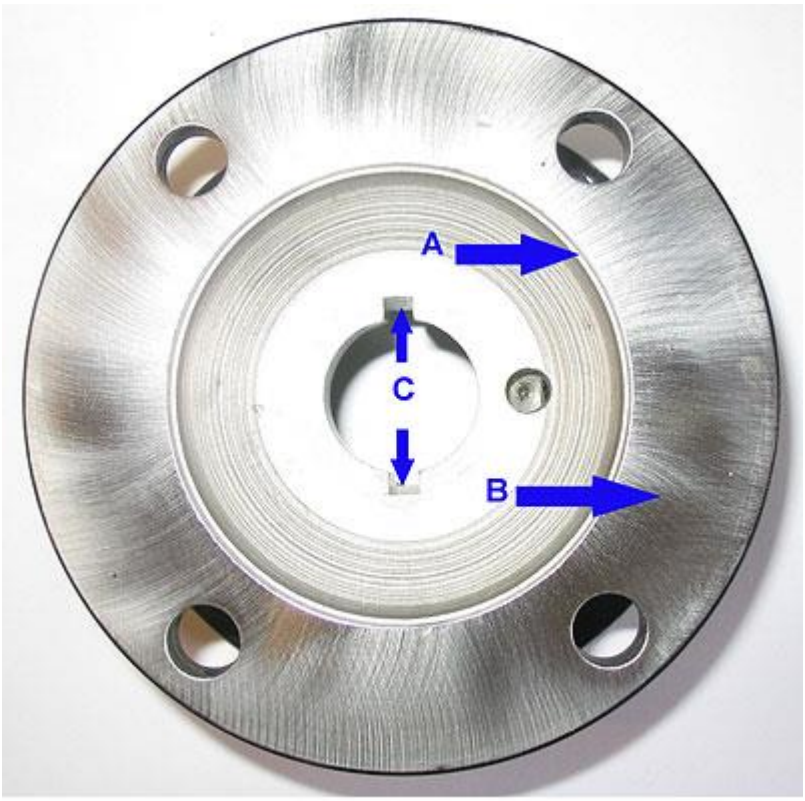


Fig 12 Drive flange locating groove, key ways and coupling face

Untab the drive flange nut lock tab with a small chisel. Attached the two misc bolts and nuts as clearly shown in Fig 11, and using the lever and socket undo and remove the flange nut. If it is intended to use the puller to extract the pinion housing, so that bearings can be changed, or a visual check is to be made on the pinion, then just loosen the flange nut three turns and do not remove it. Remove the old lock tab and bolt up the block puller to the face of the drive flange, make sure the centre screw is retracted enough to allow the puller face to be in full contact with axle flange. Tighten up the puller screw very tight and strike the puller end with a large hammer, if necessary retightening the puller screw. If the flange nut has been left in place keep good observation to ensure the puller pressure is immediately released when the taper releases.

Remove the puller, drive flange and oil seal housing. Note the seal housing hole at the 11 O'clock position is drilled out of pitch so that the housing can only be replaced in one position. Also note that the oil drain slot notched into the internal raised flange of the seal housing is positioned at the bottom.

If the axle is pre-1954 it is likely that it may be fitted with a triple type pinion bearing. The easiest way for the casual mechanic to check the bearing type is to refer to the view in Fig 13 to see if the unit is fitted with an oil thrower as shown here. If the oil thrower exists the unit has taper bearings, if not it is fitted with the old triple type bearing. For example all Bentley MKVI axles would originally have been fitted with triple bearings. The point that is important here is that in this triple bearing arrangement there is a hardened bearing pre-load spacer trapped between the oil seal housing and the outer track of the bearing. This spacer is apt to rotate and wear the oil seal housing, if this has happened the seal housing needs machining square and a thicker spacer fitting. This will entail setting the bearing pre-load by selecting a spacer that when clamped with the oil seal housing in

Fig 13. Showing taper pinion bearing oil thrower

position and nuts nipped up leaves a 0.003 inch clearance between the oil seal housing and pinion bearing housing. It is important at this stage to carry out such work and/or renew the bearing. On the other hand providing the axle is good it is possible to convert the pinion arrangement to taper bearings. In my own particular daily job of overhauling these axles on no account whatever do I refit triple bearing arrangement to any axle and all overhauled axles are automatically converted to taper bearings.

The next job is to machine the seal housing and fit a new seal. Check the woodruff keys and key way grooves for wear as shown at 'C' Fig 12. Worn grooves and keys can and do eventually scrap a pinion, or at the very least cause the pinion to be removed and re-machined. The moral is, if the parts are worn replace them correctly now. Machine the drive flange sealing face as shown in Fig 6 and machine until absolutely true the flange face at 'A' in Fig 14 and machine groove 'B' as detailed.

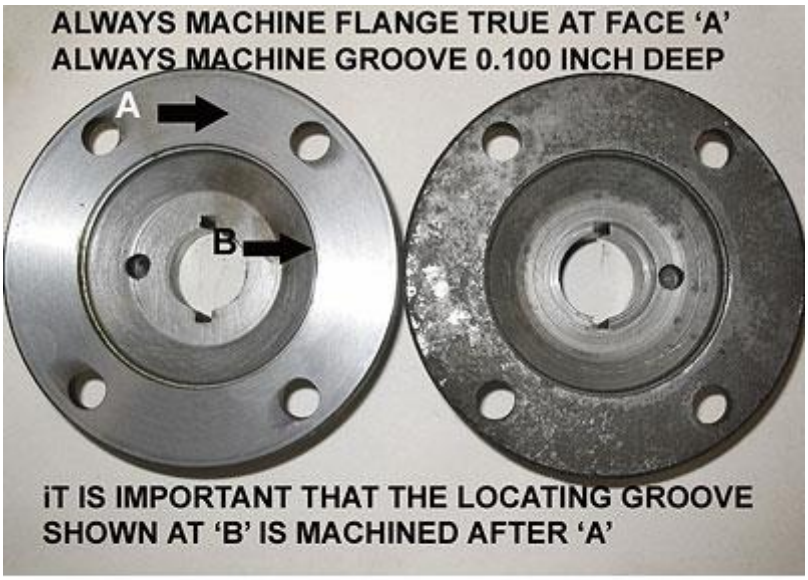


Fig 14. Drive flange machining details

Fig 15. Drive flange positioned into the oil seal housing, ready to refit

Fig 16. Sealer placed in the key way groove from the inside of the flange

Fig 17. Note how the sealer has spread along the groove after fitting the flange

Fig 18. Finally pull over the lock tab onto the nut

Clean the face of the pinion housing, it will probably look like the outer face of the axle as in Fig 13, but in fact that is the pinion housing face, not the axle face. Clean the seal housing face and after ensuring a new oil seal is fitted, push the newly machined drive flange into position in the seal as in Fig 15. Set the key ways in the flange directly top and bottom and ensure the oil seal housing drain slot is at the bottom. Refer to Fig 16 and smear sealer half way up and in the top of each key way from the axle side only, as shown. Apply sealer lightly to the oil seal housing face, position the axle pinion so that the keys are as show in Fig 13 and then engage the drive flange key ways and the oil seal housing simultaneously on the pinion and nine studs. Refit the nine washers and nuts and cross tighten evenly. Fit two studs and nuts to two of the flange holes, and the assembly should then look like Fig 17. Note how the key way sealer has now been driven up the key ways without encroaching on the pinion taper interface.

DO NOT fit the lock tab at this stage. Once the parts are located, oil the face of the nut and screw it into position on the pinion. Tighten the nut to approx. 125 lbs. ft. using the method shown in Fig 11. Once the flange is tight loosen the nut, remove it and fit the lock tab. Oil the nut face again, refit it and tighten to at least 140 ft. lb. Ensure the edges of the socket do not foul the lock tab and keep checking to ensure the tab does not turn and rip the tang. Pull the lock tab over the nut see Fig 18. The method described above should ensure that the tab washer tang is not ripped when the nut is initially tightened.

Refit the propeller shaft and align the previously inscribed mating marks, make sure that the propeller mating flange locates absolutely central and flush with the axle flange. Cross tighten all the nuts evenly and check and refill the axle with 80 EP Oil.