Rear Axles....What Fails and Why (PART 1)

R-R Silver Dawn, Silver Wraith. BENTLEY MKVI, R type.

N.W.Geeson ver 1. 2006

The Problems

The writer declares quite openly an interest in Bentley and R-R post war axles up to R-R Shadow I, as it is a main line of business.

It is not the purpose of this article to describe the procedures for overhauling R-R rear axles but to highlight some of the simpler problems, which cause these axles to fail. In addition a few axle related points of interest are discussed at the end. These axles are fairly robust and their reputation over the years has caused both owners and specialists alike to be reluctant to admit that most are in need of a major overhaul. It has become apparent in recent years that they are deluding themselves. The now common spate of rear wheel bearing and axle failures is ongoing and can be catastrophic both in cost terms and accident risk. Perhaps those who still believe they are operating a sound R-R rear axle ought to peruse the images in this article most closely.

Unless otherwise stated it can generally be presumed that references to Bentley MKVI axles also encompass Bentley R type, R type Continental, R-R Silver Dawn and R-R SWB Silver Wraith axles.

Bentley SI includes R-R Silver Cloud I and Bentley SI Continental, but the user must be aware that this axle was extensively modified during service.

In a similar fashion references to Bentley S2 axles include Bentley S3, R-R Silver Cloud II & III. Phantom V & VI are generally similar to Bentley S2 except for the axle hypoid angle.

Phantom IV and R-R LWB Silver Wraith axles are virtually the same and share the hypoid angle of the other Phantoms but have an odd pinion bearing arrangement exactly the same as the pre-war R-R Phantom III, R-R Wraith and R-R 25/30.

In each instance different ratios are offered, but this does not really influence the problems the owner will experience, except for the Bentley SI Continental axle.

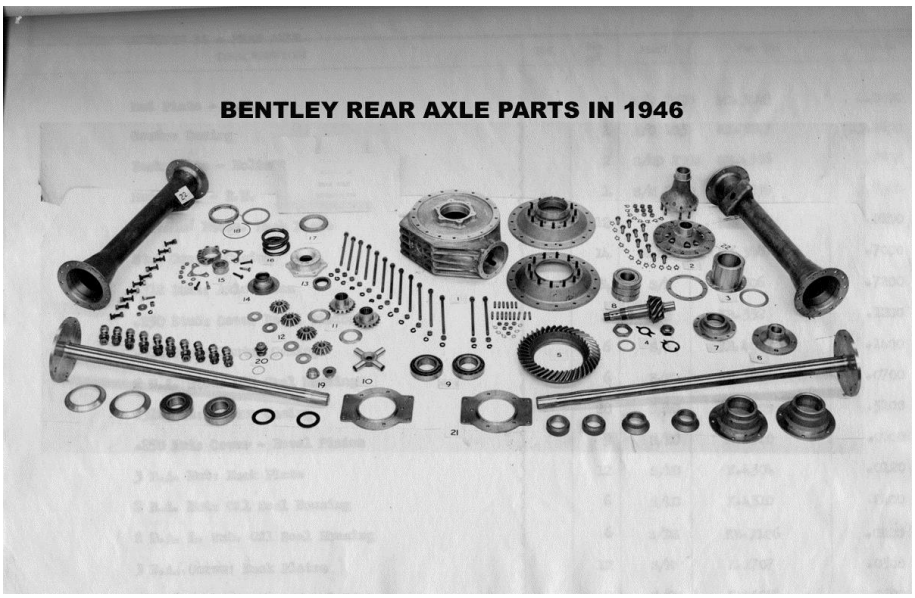

Fig 1. All the parts necessary to assemble a complete Bentley axle in December 1946. Many of the parts were modified for later axles.

The reader should be aware that for the sake of illustration some of the images shown are taken from Silver Cloud / Bentley S type axles that also suffer some of the maladies of the earlier axles. Most of the descriptive detail applies to most post war axles up to the Silver Shadow with the exception of specific sizes, on say oil seals. Fig 1 illustrates the complete axle parts as fitted to the Bentley MKVI 'A' series chassis of 1946, many of these parts were later superseded.

In a separate article I have covered a method of replacing the rear wheel bearings on these cars utilising a double row bearing. Unfortunately the design of the original rear wheel bearing had a long term effect on the axles. This bearing had axial end float of 0.010 to 0.012 inch and making things worse the diametric clearance was 0.0014 to 0.0020 inch. These figures relate to the bearing internal clearance and are nothing to do with the bearing end float in the bearing housing. These are new bearing specifications and you can only image what they are once wear takes place.

Some 50 years later these allowed clearances have taken their toll on the axle. The main axle side bearings are sprung loaded and are floating, they are therefore extremely sensitive to any wheel bearing wear. As most axles already have half shaft spline wear, and to some extent main axle case wear it is important to ensure that the rear wheel bearings are in tip top condition.

Another potential trouble is the overheating of the axle oil. This is more common than might be thought and fairly obvious once it is realised that the axles on these heavy cars hold no more oil that the MGB sports car of the 60's. In the case of a Silver Cloud I for instance the generous measure of 1.5 pints! Once the axle oil reaches a certain temperature the separation of the EP oil additives, in particular Sulphur, is automatic. This additive separation takes the form of a sludgy varnish and shows up when the oil is drained, in what most owners believe is rust in the oil.

Sludge and Dirt

Fig 2. The extent of the sludge depth is shown clearly on this R-R Silver Dawn axle.

Fig 2 shows sludge and additive build up in a R-R Silver Dawn axle; there is no better medium for blocking oil ways than this material. The consequences are just as bad as if it was rust!

The final nail in the coffin of rear axles is dirt and dust. The ingress of dirt is to some degree based on the number of times the axle is heated and cooled, a short journey car with little mileage can suffer just as badly as a much higher mileage car. Axles exhale hot air through the top breather when the axle case heats up, as

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the axle cools after the car stands the opposite happens. If the car is then in a dusty atmosphere or partial axle cooling happens on the road the breather will inhale dirt with the incoming air. Unfortunately the life of the axle bearings is governed very much by the "quality" of this incoming air, if it contains granite dust for example, life is very short. This inbound air can and does, also enter the axle through the front pinion bearing seal. At this location the dust combines to tear away the seal rubbing surface of the drive flange and destroys the felt seal. It is surprising how many seals comprise less than 50 % of the material of the original seal when oil leaks are investigated.

Pinion oil seals

Fig 3. About 66% of the old felt oil seal is missing from this seal carrier, this is quite normal!

Fig 3 illustrates what the owner normal sees when the seal carrier is removed, over half the seal is missing! The best fix on earlier axles is to fit a modern oil seal of 55mm x 45mm by machining from the inside face of the seal carrier and turning the drive flange rubbing area down to 45.25 mm diameter. On all the Silver Cloud and Bentley S series axles an oil seal of 55mm x 60 mm will perform the same duty. If you own a Phantom V / VI it is your lucky day as these cars were fitted as standard with a leather oil seal to the pinion housing, now you know why the Queen never stepped in axle oil!

Owners should be extremely aware of oil dripping from the axle pinion seal. As already pointed out the axle oil capacity is such that an oil seal leak is not a job to be put off for another day. Even the supposed oil capacity will be depleted, as any dirt present in the axle will have displaced the oil level. Adding to this problem is the fact that the given capacity is nominal, and in practice, even new axles will not accept the oil amounts listed. Dripping oil from the pinion seal can be a sign of worn pinion bearings. If some one suggests replacing the pinion bearings, and the axle is known to be old, be very aware. Most of these axles have received previous replacement pinion bearings, in the case of the Bentley MKVI type many times, and whilst in the past such replacement may have been acceptable, today it is doubtful. The side bearings on most axles will be original or possibly replaced misguidedly by the original type number, which has been modified over the years and is not suitable. In any event new pinion bearings fitted into 50-year-old axles normally produce some problems, as the gear set is almost sure to be worn. The most common problem arising is that any undue pinion movement is now prevented and all movement shifts onto the 'floating' crown wheel assembly, which still has original worn bearings. Pinions with new bearings will mesh with the Crown wheel in a different spot and on late axles are very likely to still exhibit over run noise.

The effect of sludge

Fig 4. Clearly shown on this Bentley SI Continental axle is how sludge has filled the bearing housing oil groove.

Fig 5. The pinion bearings on this axle will now receive oil again, compare it with the last image.

The amount of sludge that can accumulate can be seen from the pinion assembly in Fig 4, which has just been removed from a Bentley S1 Continental axle. Incidentally this axle has only completed some 87,000 miles from new! Fig 5 shows how it should look, note the difference in the absence of dirt around the belted bearing oil feed groove.

Fig 6. A collection of Bentley MKVI pinions, bearings and housings, all have or had the triple pinion bearing arrangement.

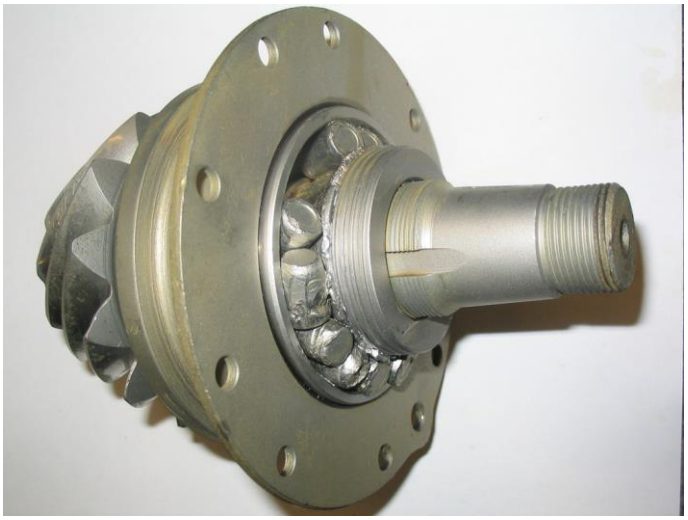

Fig 7. Even taper rollers on Bentley S2 axles depart from their nested tracks if they do not receive oil; this assembly is shown after having been cleaned. If this happens to your S2 axle you can only wish you have not tied the dog to the grab handles, because this car is going to stop……and quick!

Fig 8. The two oil feed holes on the triple bearing pinion of an early Silver Wraith are well and truly blocked.

All the pinion assemblies illustrated in Fig 6 are out of Bentley MKVI. The observant readers will note that they are all of the triple bearing type that tells a story in itself! The later taper bearings are much more reliable, but as shown in Fig 7 they do like more oil than dirt, or this happens. In this instance a blown bearing on a Bentley S2 showing what happens when the bearing rollers try to obtain a divorce from the track at high speed. Fig 8 shows the usual greeting facing any owner who is wise enough to withdraw the pinion on his early axle, complete blockage of the two oil feed holes.

Fig 9. Triple pinion bearing and the matching bearing housing.

Fig 10. Only the centre section of this type of bearing contacts the bearing housing. It might be said it was dreamed up on a bad day, R-R made some costly mistakes in their time!

These images illustrate one of the major failing and weakness of this early triple bearing assembly. Fig 9 shows the early bearing and bearing housing. In this instance the housing has been copper plated to prevent rust, this housing is used for demonstration purposes only and the copper should be ignored. FIG 10 shows how easily the first section of the bearing can be inserted into the housing, this also applies to the last section of the bearing. The reason for this is that only the centre segment of these bearing is designed to contact the bearing housing. This design lacks stability at the main bearing end of the pinion and places great reliance upon the integrity of the small pinion nose bearing. Luckily for owners of the later models R-R realised the error of their ways and utilised taper bearings.

Fig 11. The light brown colour is caused by oil additive; otherwise this case can be classed as "clean".

Continuing with the theme of sludging problems, the following few images are offered for the owners delight. Firstly Fig 11 is shown to illustrate just about the cleanest Bentley MKVI axle I have stripped in the last few years, the moral here is that your axle is likely to be in the mould of the axles shown from Fig 12 onwards where the captions explain all!

Fig 12. Ready for a good clean, the left hand side plate off a Bentley R type. Not much chance of the bearing surviving for long in this sludge.

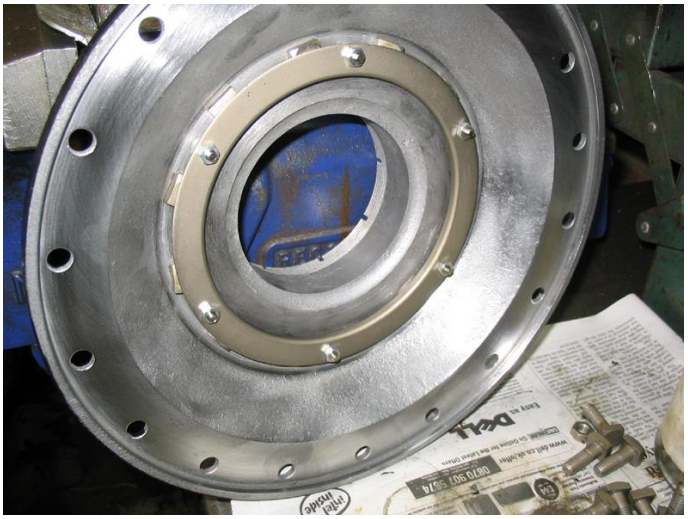

Fig 13. The side plate previously shown in Fig 12, now cleaned and assembled with nickel plated bolts and retaining ring. Looking much better!

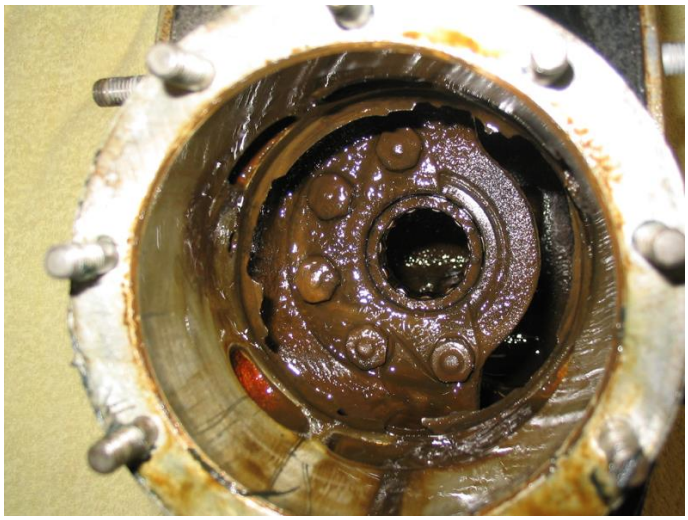

Fig 14. The normal view one faces after removing the pinion assembly on a Bentley MKVI. Owners are encouraged to remove the pinion assembly to assess the sludging on their axles.

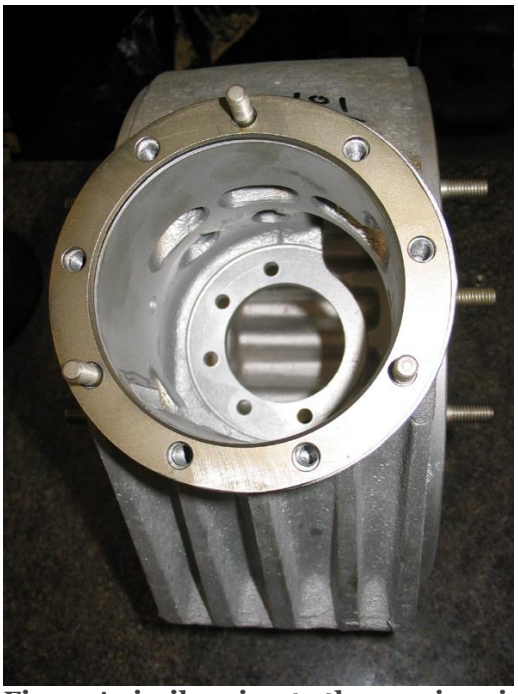

Fig 15. A similar view to the previous image, of the front of an axle case, now cleaned ready for rebuilding.

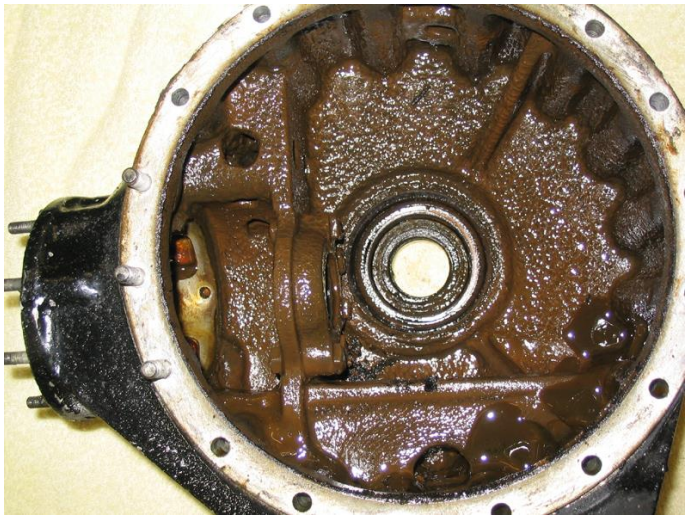

Fig 16. Just about the view you should expect after taking off the left side plate and removing the crown wheel assembly. Notice the labyrinth of holes at the 10 o'clock position which makes hard work of cleaning this Bentley R type case.

Fig 17. Similar to the previous view, note how the casting cores are inside of the Bentley MKVI axle case in comparison with the smooth internals of the Bentley SI axle case in Fig 20.

Fig 18. Yet another Bentley MKVI axle case, the amount of sludge is very consistent, just enough to finish off all the bearings!

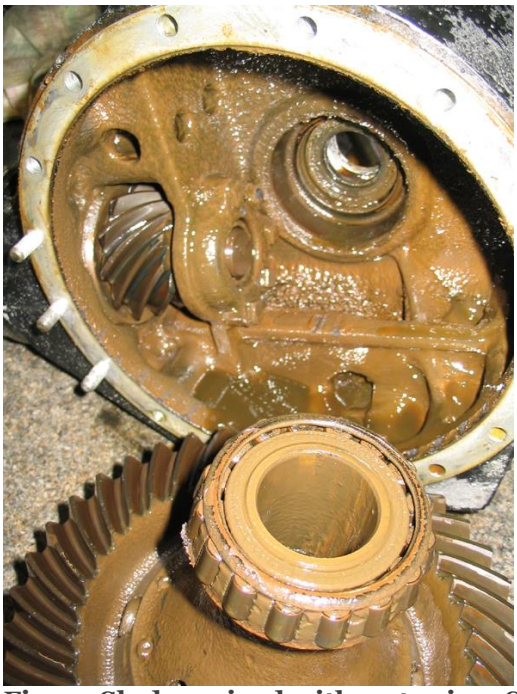

Fig 19. Sludge mixed with water in a Silver Dawn axle.

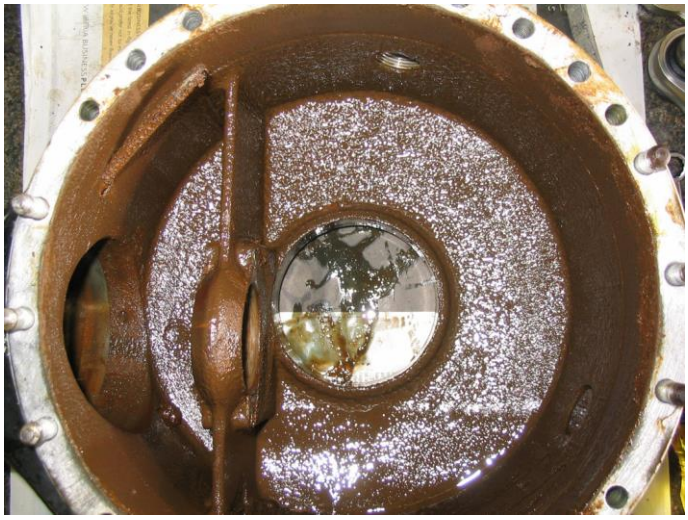

Fig 20. The smooth interior of the Bentley SI casing, unfortunately it does not stop sludge entering, and it stays unless the oil is changed frequently.

Fig 21. Strange, but the sludge tends to stay inside Bentley S2 axles as well as the Bentley SI.

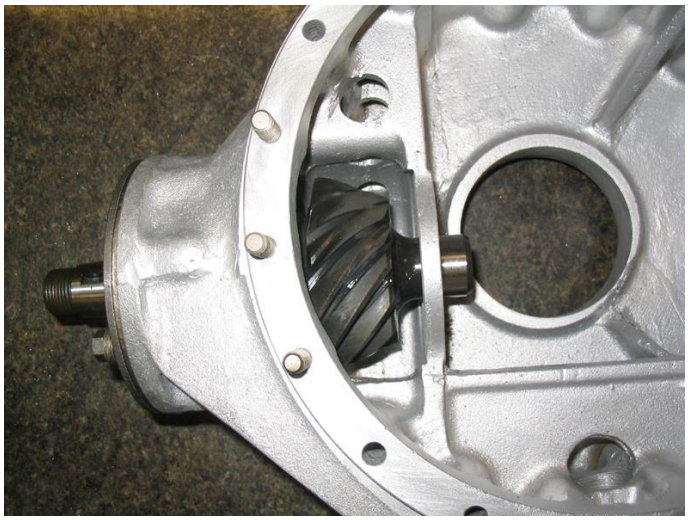

Fig 22. Ah, an R type axle case and actually clean.

Fig 23 Oh, and a Bentley SI Continental axle, also clean. Seen here with the nineteen bolt case from the intermediate axle. Count the holes and you will see how the nineteen arises. Very early cases had eleven bolts.

Fig 24. Sludged left hand side plate also from a nineteen-bolt case but in this instance a Bentley S3.

Fig 25. Just to prove the left hand side plates are cleaned before they are replaced. Bentley S3 again.

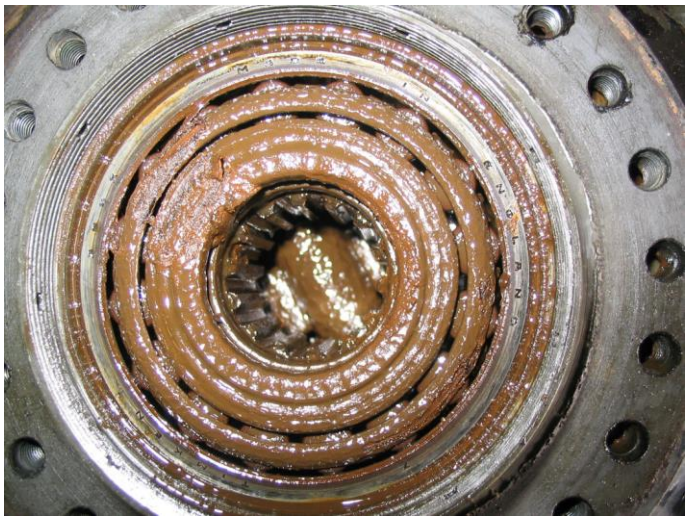

Fig 26. Clearly, the view through the left hand side shows this axle to be in trouble. At this stage of the game you should not be asking why? Counting the splines on the bevel gear shows this axle to be a Bentley S1 type before B590 FA.

Fig 27. Just to prove again that Bentley S2 owners do not always change the axle oil and that later cars also suffer bearing damage.

Fig 28. It is preferable to replace the Silver Dawn axle centre unit in this condition rather than leave it as shown in the former Bentley S2 image!

To recap, it has been explained how rear wheel bearing wear can have a detrimental effect on rear axle differential bearings, how the axle oil can overheat and the effect on oil additives, and how dirt enters the axle. Now we can see, using the following images, what axle damage occurs as a result of this foreign material being allowed to repose in the differential. If someone had changed the 1.5 pints of EP90 oil every year, instead of the ridiculous 20,000-mile period suggested by the factory, the problem would not occur. Unfortunately the clock cannot be turned back and we have axles failing at 70,000 miles instead of the 500,000 miles that they are capable of completing.

Axle Bearings

Fig 29. A close up of a Bentley SI right hand main axle bearing with a good quantity of axle destroying sludge.

Fig 30. Showing what point loading produces on bearings when the oil film breaks down. This damage is also known to occur when axles have stood and not been rotated.

Fig 31. These cups and inner cone track have suffered unnecessarily.

Fig 32. More bearing wear, felt as a vibration by the driver and sometimes the specialist and very frequently blamed on tyre flat spots. To the surprise of strangers to these R-R axles they cannot understand why the vibration seems to improve when the axle gets hotter, and therefore it must be the tyres. Wrong again, wait for the bang!

Fig 33. These bearings have been cleaned up for your enjoyment! A very common sight of the axle side bearings, and always the rear wheel bearings are equally worn. If the wheel bearings are not changed, how long before this is repeated again?

All the axle sludge has a habit of coating the bearings with a brilliant grinding paste as exemplified in Fig 29. If the rear wheel bearings are worn the upward force at the outer end of the half shaft has an opposite downward force on the axle side bearing. Fig 30 shows the commencement of axle bearing wear caused by worn wheel bearings, typified by the destruction the outer and inner tracks in one place. This galling in one spot, is caused by point loading and prevents the oil film acting in the proper manner between the bearing rollers and tracks.

The presence of sludge hastens the matter along, as does the nut holding the steering wheel that for some reason calls himself a driver instead of my more appropriate term of Motor Mover! This driver continues to motor along believing that either R-R axles are indestructible or that he is going to detect any axle noise before it self-destructs, neither being true. Most probably the axle has leaked from the pinion seal for some time whilst our owner R-R expert is making his mind up about curing the leak, or guessing how long it takes for 1.5 pint to drain away. The answer is extremely quickly if you are driving downhill. Failure to arrest the trouble when the first minor floor vibrations take place or the belief that in the early part of the journey it is only the flat spots on the tyres that is causing the trouble leads quickly to the situation showed in Fig 31 through Fig 33, when wear takes place at an alarming rate.

Fig 34. This bearing was pushed over the edge. The driver was either deaf or had no feeling, possibly both. It did the damage shown in the next picture.

Fig 35. The shiny bit is the thrust washer, which takes half a ton of side spring pressure. Our worn side bearing has not quite bored through the washer to unleash the 1000 lbs of spring pressure. Nonetheless this Bentley MKVI's can stop damn quickly when the axle bangs.

Some driver's pass through this stage that is they actually make it without shearing the gear teeth, if the teeth do not shear the situation develops……. Fig 34 shows a typical right hand axle side bearing, worn out because the rear wheel bearings are unserviceable; typically it has commenced to bore itself through the right hand bearing spacer. The highlighted section in Fig 35 shows the bearing to spacer contact point. The bearing shown in Fig 34, after being cleaned up, actually did this damage. If you were to remove some of these bearing, you would usually have no trouble, all the rollers normally drop out of their cage, absolutely impossible on a good bearing of course.

Do not worry about the bearing actually boring through the spacer, you will have more immediate problems, I can assure you no bearing has yet made it through that spacer! I have seen axles completely disintegrate the inner case come through the outer, the crown wheel studs act like a circular saw on the nearside side case and gear sets strip. Possibly the car might be resting on its roof, the axle detached, and it goes without saying that the main axle case will be scrap as that bearing outer track runs directly in the axle casing. But never has that bearing made it through that spacer!

Fig 36. Yet another loose side bearing and the inside gear set will be just as bad.

If the bearing wear has occurred on the left hand side that bearing will merely commence to spin on its spigot and finally bore itself into the inner case. At best the inner case may be repairable, at some cost, at worst another inner axle case will be needed. Fig 36 illustrates a bearing which has just started to spin on the inner case, the bearing can be moved sideways easily using a screwdriver. Normally these bearings are pressed onto the inner case bearing spigots and are immoveable unless a bearing puller is utilised. In this instance once again the rear wheel bearing on the left side was excessively worn.

Don't be fooled here, before you hand any R-R axle over to a repairer make sure that repairer has undersized and oversized bearings actually on hand to repair your axle. Certain of these axles nearly always need undersized bearings fitting and do not be put off by any repairer advising otherwise, if you wish to retain a reliable axle, walk away. Many an owner has been hoodwinked by being told oversize and underside bearings can be obtained fairly quickly, only to find out later standard bearings have been fitted when another size should have been selected. Fig 36 is typical of this situation.

Floating axle centre

Fig 37. This is the side spring mention in the note to fig 35, and when it is tight with 1000 lbs of pressure, it disappears into this little housing. In this instance the spring thrust washer is shown on the end of the spring.

Fig 38. Belleville spring disks or washers replace the side spring on Bentley SI onward; they are seen here in position on a Phantom axle case.

Ignoring for one moment any residue thrust loads the main reason that these bearings are inclined to move sideways and either bore into the inner case or spacer, is that they are heavily sprung loaded. In the immediate post war axles this takes the form of a coil spring, fig 37, some 1.650 inch long, whilst in the later axles up to Phantom VI the thrust is imparted by three belleville washers or spring disks. These spring disks, shaped like a dinner plate, are shown in fig 38 fitted to a R-R Phantom V axle case. Whatever the method used some 1000 lbs is imparted directly to the bearings at all times in addition to any working load. This sprung method has distinct advantages as it allows a constant bearing load regardless of the different expansion rates of the alloy main case and steel attachments. It is however a blessing in disguise, for it also allows the axle centre components to 'float' and is one of the main reasons that the axle is intolerant of rear wheel bearing wear.

Pinion and Crown Wheel Failure

Unfortunately examining one of these axles is not generally common practice for any of the specialists and they usually fail to recognise the trouble, and even worse are oblivious to the problems, which then arise with the worst post war design.....that of the Bentley S1 Continental. It always amazes me when Silver Cloud I and Bentley SI owners seek to re-gear their axle with the Continental gear set instead of using a sensible designed set and alternative ratio. Perhaps they have been driven in one of the odd Continentals, which run quietly, or believe in miracles!

Fig 39. Sheared pinion from a Bentley SI Continental, the worst of the R-R post war axle designs. The evidence is here to prove the owner's story that the pinion failed as the car was driven out of its garage!

Fig 40. Look carefully, the pinion shaft has been removed along with the bearings but it is possible to see how the pinion head was jacked rearwards partly through the nose bearing casing web. New gear set and nineteen-bolt case needed at least!!

Fig 39, shows a SI Continental axle pinion with a headache! This one broke when driving out of the garage, no kidding and easily proved, but it still managed to jack the pinion head against the bearings and then through the main case web, see fig 40. Notice the small jagged white line commencing at the base of the nose bearing; this is where the alloy case surrendered under the pressure.

Fig 41. Just a few axle pinions from the scrap heap, these represent most post war axles. Nearly all have been driven many miles whilst making a noise. If an R-R axle can be heard it is in far more serious trouble than your average Ford with a similar noise, and your local friendly mechanic is not going to fix it.

Fig 42. Showing Crown wheel wear on an R Type axle, caused by severe axle bearing wear. The resulting noise unfortunately does not give owners enough cause for concern. Very common on wedding cars when the owner thinks it is going to keep going. Wedding car, local run car, or not, the eventual bang is just the same!

If our intrepid motor mover should still pursue his weekend driving pleasure, ignoring the vibrations of the axle bearings that he has diagnosed must be flats spots on the tyres, he will eventually own an axle pinion just like one of those in Fig 41. All bear the evidence of trying to climb over the mating teeth of the crown wheel, of course they cannot, and usually loose two teeth in the fight. A number of other faults show up on these pinions, second from the left a later Silver Dawn pinion, notice the taper bearing rollers are worn so much they are dropping out of their cage, compare the bearing with the others on each side. Go back to fig 7

and see what eventually happens! All the nose bearing spigots are also worn heavily. These pinions represent R-R Silver Dawn, Bentley MKVI, R-R Silver Cloud I, Bentley SI and Bentley SI Continental.

I never knew so many Bentley and R-R drivers were deaf, or so they tell me, quite how they miss the little vibration through the floor pan I don't know. It is my serious belief that most owners have absolutely no idea how smooth one of these cars should really run.

Just before the gear set breaks, the out of alignment caused by worn side bearings will have attacked the crown wheel teeth, shown in fig 42. This Bentley R type crown wheel shows scuffing on each tooth where the pinion teeth have tried to climb up each tooth face. Most post war axles prior to the Silver Cloud II and Bentley S2 will not normally exhibit this wear, as usually the gear teeth will break off before heavy crown wheel wear takes place. The Silver Cloud II and Bentley S2, and later axles will however show this wear. In short, for reasons of design, the earlier axles will vibrate and break teeth and the later ones vibrate and are noisy over an extended period. The end result is the same, expensively busted, but with some variation in damage.

Just when precisely do these axles break or the damage happen?

When either the axle side, or pinion bearings wear, the gear set does not run in line, whether under driving load or during over run conditions. Image, looking down on an axle that has worn side bearings, from a bird's eye view. Under accelerating conditions the crown wheel is tilted to one side under the influence of driving thrust from the pinion. As soon as the driver eases off on the throttle the thrust reverses and the crown wheel tilts over the other way. The hypoid gear teeth are so intimately meshed that the acting side forces are trying to tear the teeth out of the components.....and they do!

It is of little use pretending that the car is used only a few hundred miles per year, this will not replace worn side bearings and when the right circumstances are presented the axle will fail and have no respect whatever of low annual mileage. Unfortunately axle failure is fatal in a component sense, an engine misfiring or a crunching gearbox will usually allow the car to proceed to home base. When an axle gear set breaks, the car stops where the axle set broke.

How to judge

If the average owner can hear an R-R axle, it is already in serious trouble. The axle design is almost unique and bears no relationship to other designs. This is one of its failings because owners try to judge them with their own past experience on Aston Martin, Jaguar, and even Cadillac. If an R-R axle is overhauled correctly, and oil changed at least annually, it will almost last forever, no so other designs. The present day failing of the R-R axles is caused by long term oil changing as originally recommended by the company, together with the use of old type EP oils. Adding to the oil problem is the most recent spate of rear wheel bearing failures. Low mileage cars still need annual axle oil changes, to ignore the facts is courting an expensive disaster.

Besides the vibration and noise other clues abound to a potentially sick axle. Cars, on which the axle case dirt has never been cleaned off, can provide a clue. In such cases, I judge that in volume terms, some 20% of the dirt seen on the outside of the axle is present inside the axle case. Although axle top breathers need cleaning about every second oil change, if other signs of wear are evident, a blocked breather merely confirms the internal axle state.

Axle Backlash

With the hand brake applied axle backlash can be judged by rotating the rear propeller drive flange back and forth. If the periphery of the drive flange moves more than 8mm internal wear is becoming evident, and

steps need taking to attend to the unit. If this movement reaches 10 mm gear set breakage is extremely likely. These figures are given for guidance only.

Axle backlash is the total of an accumulation of wear in three major axle areas, other minor wear areas will of course exist. Care must be taken for example that no movement is allowed to develop between the drive flange and woodruff drive shaft keys. Nearly every R-R axle suffers this malady, caused by people who will insist on tightening the drive flange retaining nuts against a “hand braked” applied axle. It is mandatory to tighten these nuts only against a bar secured between two heavy studs, which pass through two of the drive flange boltholes. The three major wear areas are:-

- Wear between the hypoid gear teeth.
- Wear of the differential pinion and bevel thrust washers.
- Wear in the half shaft splines.

The three areas of wear can actually be felt, and also in turn, if the drive flange is rotated steadily. Hypoid gear wear will normally be relatively small in comparison with the other two areas on axles prior to Bentley S2 cars.

Owners will usually associate axle backlash with wear of the hypoid or main axle gears, this is usually far from the truth in respect of post war R-R axles. The backlash of the axle gear set when new was 0.006 to 0.008 inch at an admittedly smaller radius than the drive flange periphery used in our example. However if the backlash of 8 mm (0.300 inch) was to be all the fault of the gear set, the gears would be falling out of the axle.

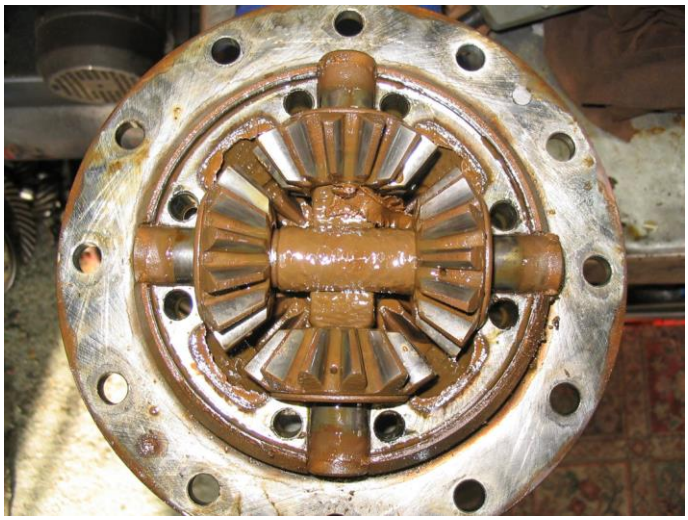

Fig 43. The normal sight when the centre differential case is opened up. This case is one of two dished shaped cases that are bolted together. Sludge cannot be flushed out of this inner case once it enters!

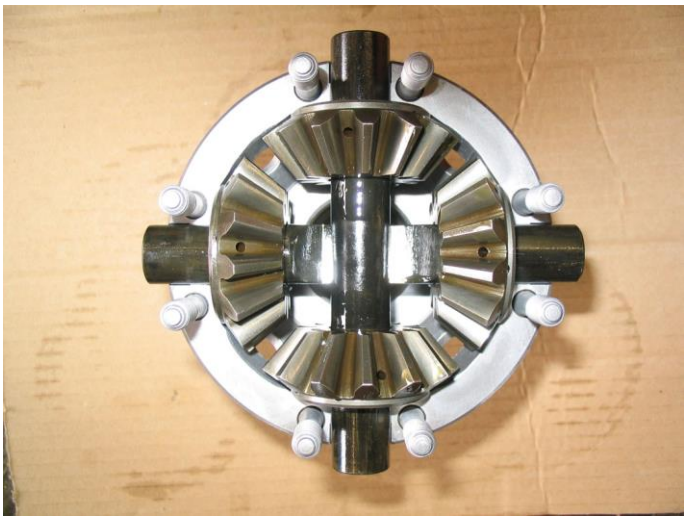

Fig 44. Change the oil at least annually, no matter what the mileage, and the centre differential will look about like this one after many thousands of miles.

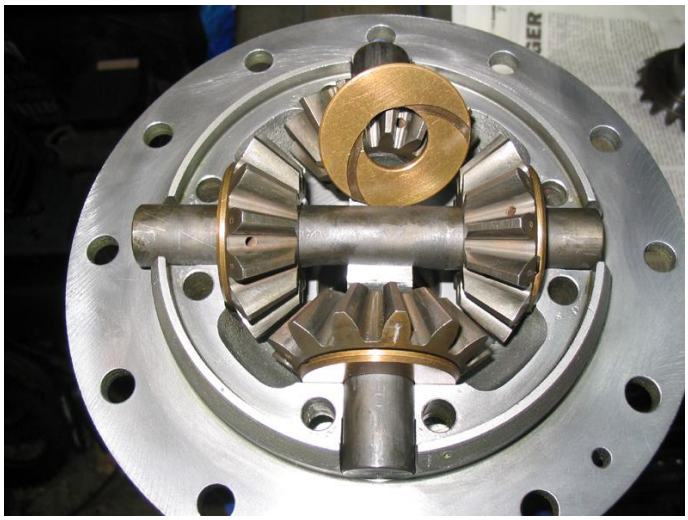

Fig 45. The inside of an R type inner differential case, showing the bronze thrust washers.

The average wear of differential pinion and bevel thrust washers is around 0.015 inch and this allows the differential taper gear wheels to move outwards. In taking up a position further out than normal they have in fact moved further out of mesh. In new condition the backlash in these gears was set at absolute zero, but when worn the backlash is tremendous. A major error by owner rebuilders is attempting to rebuild the axle with extremely worn trunnion shafts, which then support the differential pinions at an angle. Fig 43 and Fig 44 illustrate the potential pinion thrust washer wear. The thrust washers are position between each pinion gear and the inner casing, Fig 43 shows how the oil feed holes, in each gear, leading to the trunnion shafts and the thrust washers become blocked. There are six oil holes in each of these gears, from one position it should be possible to see at least four oil holes as shown in Fig 44. These images are not at all uncommon; they show the state of a set of typical differential gears as found on nearly all of these axles. Moral.... change your oil regularly. Fig 45 shows an R type assembly with one of the bronze thrust washers clearly in view whilst Fig 43 and 44 show an early Silver Cloud I with hardened steel thrusts.

Wear in the half shaft spline on these axles is almost entirely due to operation of the car when the rear wheel bearings or axle side bearings have worn. In either instance the shafts are being asked to transmit the drive whilst the shafts are running out of line and also with end to end plunging of the splines under the influence of side loads.

In the above instances the actual wear on the components is not really the crux of the matter but this wear does provide some idea of the potential of axle side bearing wear. The wear on the bearings will encourage very early failure of the main hypoid gear set and ignoring the warnings will cost the owner dearly, and that is up to three times the price of an early bearing swap.

Axle Ratios

It is possible to fit four ratios to the Bentley MKVI axle, at least three to Bentley SI with a further one possible with modification and two ratios to Bentley S2. Users must be aware that there are distinct physical differences for example between the 2.92:1 axles fitted to Bentley MKVI, Bentley SI and Bentley S2, although the ratios are identical.

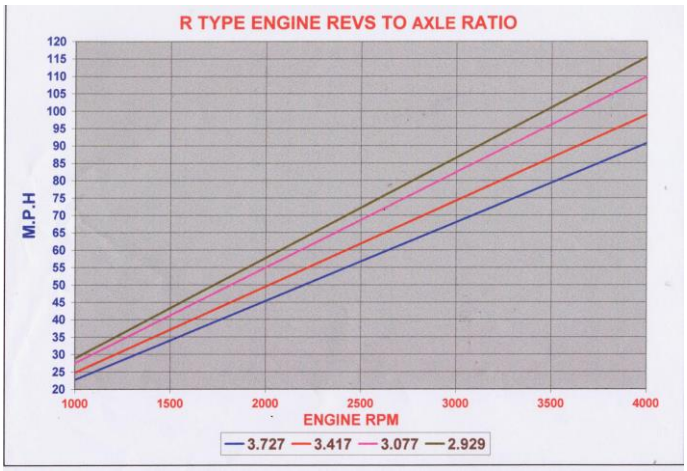

Fig 46. Road speed to engine revolutions graph with different axle ratios on Bentley MKVI.

Especially in the case of Bentley MKVI and often Bentley R type and Bentley SI the user feels that the car is under geared and considers higher gearing. On the earlier cars fitting an overdrive is sometimes considered and although they are quite successful on pre-war cars the post war cars are somewhat different. Unfortunately some engineers do not appreciate the differences between the pre-war and post war chassis, let alone an owner. However there are now signs that suppliers are more reluctant to fit overdrive to the post war chassis, perhaps they have realised the problem. For my own part I am neither for, nor against, overdrives as I supply many axles, which are fitted to cars when overdrives are removed and in almost every case an axle overhaul is required when an overdrive is fitted. In short a win and win situation.

Some owners will endeavour to obtain and study the engine BHP and Torque graph and select an axle ratio to match both the engine peak torque to the desired road speed at which they travel most of the time. This is a disastrous method of selecting the axle ratio and certainly not one used by any manufacture. Nevertheless the standard Bentley MKVI ratio of 3.72:1 is certainly under geared and can be raised with some advantage to the 3.42:1 ratio of the later R types, or even higher in the right circumstances.

We are witnessing today a reduction in availability terms of the original 6.50 x 16 tyre size fitted to the EPW cars, the replacements being currently offered are far less in diameter and any owner contemplating changing an axle ratio needs to keep the availability of tyre sizes in mind.

It should be pointed out that a number of other factors need considering when changing axle ratios, or for that matter fitting overdrives, in addition to road speed versa engine speed. These factors cover such items as water pump, fan and oil pump speeds. In addition, specifically, the brake servo speed and its effect on the braking along with any brake component that may benefit from alteration.

Fig 46 shows the effect of engine speed in comparison with road speeds with different axle ratios fitted. In this instance 6.50 x 16 Michelin radial tyres are fitted, and the graph in spite of being titled R Type includes all post war cars with that tyre size. It is generally true to say that these new gear sets, that will provide these ratios, will only be suitable for use with tapered pinion bearings, so any Bentley MKVI or early R type axle will need converting to taper bearings.

Fig 47. Showing position of serial numbers of the axle and gear set together with alternative 12/ 41 ratio.

Serial Numbers

Very often owners have little idea just where to find details of the axle currently fitted to their car.

Fig 47 shows a very late Bentley MKVI axle casing from a 'P' series chassis. At the position shown in (1) are two rows of letters and numbers. The top row of numbers identifies the actual axle serial number, in this case prefixed with a letter 'B' for Bentley. In the instance of R-R models the prefix is sometimes eliminated at this point on the earlier axles. The axle serial number is suffixed with the letters 'TB' when taper bearings are fitted to the pinion assembly on R type axles. The lower row of numbers show the serial number of the gear set originally fitted to that axle case.

The arrow showing point (2) indicates the position of the casting lug. Stamped onto this lug will be the numbers 12 / 41 if the axle has the higher 3.42:1 ratio. In other instances of early axles when only the 3.72:1 axle where fitted it was usual to find the letter 'W' for Silver Wraith or 'D' for Silver Dawn stamped on this lug. Later R-R axles had the code letter prefix the axle serial number.

In the instance of Bentley S type cars the axle serial numbers are stamped on the large vertical facing of the main axle case, just rearward of the drive flange. These axle numbers are preceded by the letter 'C' for Continental in the case of Bentley SI Continental and also the very early Bentley S2 Continental. After August 1960 the Continental axle gears were only fitted on Bentley S2 at specific customer request. Phantom V / VI axles are prefixed 'P' followed by the axle serial number. In each instance the gear teeth ratio numbers will be stamped in an adjacent location.

Fig 48. Intermediate type SI axle awaiting delivery.

Fig 49. Axle installed in an R type, in this instance a 3.08:1 Continental unit

Fig 50. Phantom V / VI axle awaits the re-anodised alloy pinion housing painting before delivery. The short front nose on the axle main case ensures that this could only be a Phantom axle, as does the forward location of the breather.

Fig 51. A standard 3.42:1 for a customer's late Silver Dawn axle or more correctly an early axle converted to that specification. A number of clues point to this having originally been a very early axle case with a triple pinion bearing. Note the authors newly stamped letters 'TB' suffixing the axle serial number and indicating taper pinion bearing fitment.

Fig 48 to Fig 51 are explained by their captions and provide some idea how each axle should look on your car. The message is that if you're axle has not been overhauled, it most likely needs it, and the sooner it's done the better.