Rear Axles....What Fails and Why (part 2)

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As in part 1, 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. Although the article is directed towards the early post war cars most of the points highlighted may be useful when working on other models.

Rear Axle Removal

From time to time it is either necessary or indeed advantageous to remove a rear axle for one reason or another. It therefore seems appropriate to at least discuss problems that may be found during such a task, together with methods of removal. There is more than one method of removing the rear axle and the workshop manual describes one method where the axle is removed in one piece, albeit needing three people to accomplish the job. Very few of us can rely upon the assistance of two helpers but we might muster one. The R-R axle assemble does differ from most other types in that it is constructed and assembled in a bolted fashion comprising three main sections of two side tubes and one centre differential assembly.

On most occasions it will be found easier to remove the axle in three separate pieces and some jobs can be completed by only removing one, or two, of the sub assemblies. If the axle is removed in one piece it will usually need stripping down into sections after removal and it therefore makes sense to remove the axle in individual sections. In the instance of the Bentley MkVI and other EPW variants with a single circular rear exhaust silencer it can be a positive advantage to remove the axle in separate pieces compared with trying to manoeuvre a complete heavy axle beam around the exhaust system.

Removing the axle by unbolting the side tubes from the centre differential is the method described here and for safety reasons the writer believes the most appropriate method.

Considerations and supporting the Chassis

It is necessary to jack the rear end up quite high, some 18 to 20 inches (500mm) at the differential. To attain this and reduce the slope on the car / jack to a reasonably safe angle, it helps if both front wheels can be lifted and placed on large wooden blocks so that the wheels are at least 6 inch off the ground and preferably more, before the rear end is lifted.

The necessity to have the car as level as possible becomes obvious when it is realised that the rear brakes and drive shaft will eventually be disconnected. This means that there is no means normally of preventing vehicle movement, as even the drive shaft removal will counter any assistance provided by a parking lock on automatic transmissions. However besides keeping the vehicle slope to a minimum, once the final vehicle jacking, raising and blocking has been accomplished then screw up the front brake adjusters to lock the front wheels solid and chalk on the front tyres "BRAKES LOCKED". The latter will remind you after the job is finished to reset the front brakes.

Fig 1 Supporting the axle directly under the chassis. A good firm and well located support just forward of the front end spring shackle

A number of methods are possible to support the chassis. The simplest is to place a trestle or axle stand under and near the rear end of each rear spring and take the weight of the chassis at these two points. The disadvantages are that it is not possible to complete any work on the rear springs whilst the chassis is supported at these points, the spring gaiters can be damaged and the trestle supports may not be level and safe at their contact point with the springs. The distinct advantage is that this supporting method does prevent the spring shackles from moving over centre, (this is described later).

The second method is to support the chassis directly adjacent to the rear spring front shackle as shown in Fig 1. This leaves a substantial rear chassis overhang and the car is only just supported rearwards of its C of G, for this reason I prefer to remove everything from the boot including tools and spare wheel and if possible have a nearly empty fuel tank. This method does provide the freedom to work on the rear springs, but also requires additional support to prevent the rear shackles moving over centre.

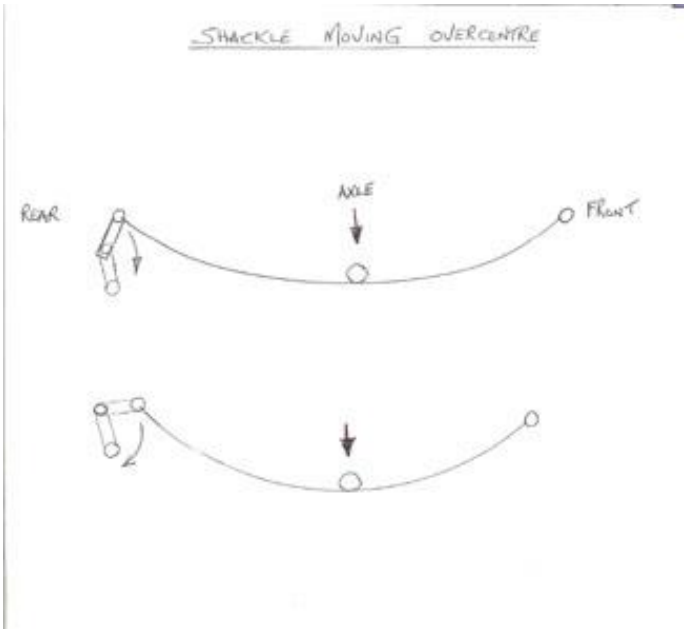
Rear Shackles moving over centre

To understand how this can happen and the dangers of this situation take a moment to study the following section and compare the points directly by reference on the car. On no account attempt this job until the following is firmly understood by everyone working on the car.

On all early post war R-R and Bentley chassis the rear spring shackles can re-position themselves over centre under certain conditions of dismantling. Observation of the rear axle and its attachments will show that the shock absorber arms will normally come into contact with a one inch deep hard and heavy rubber rebound stop when the rear axle is lowered, or for example when the car is driven fast over a hump back bridge. This rubber rebound block is bolted to the inside of the shock absorber bracket and the rubber is frequently missing, excessive strain is placed on these blocks if ever the chassis is jacked up and the rear axle left hanging against the rubber blocks.

At all times the axle needs some support during servicing or maintenance. When the rear axle is to be removed it is necessary to remove at least one shock absorber link bolt on each side. Removing a link bolt eliminates at a stroke any safety factor of having the rubber block restraint the axle downwards movement. Therefore, if the chassis is supported on axle stands or blocks say adjacent to the front spring shackle of the rear spring, the shock absorber link bolts are removed and the axle weight is unsupported, the axle will swing violently downwards and the rear shackles will go over centre.

Fig 2 Rear offside spring shackle R type. An R Type rear spring shackle showing the normal position



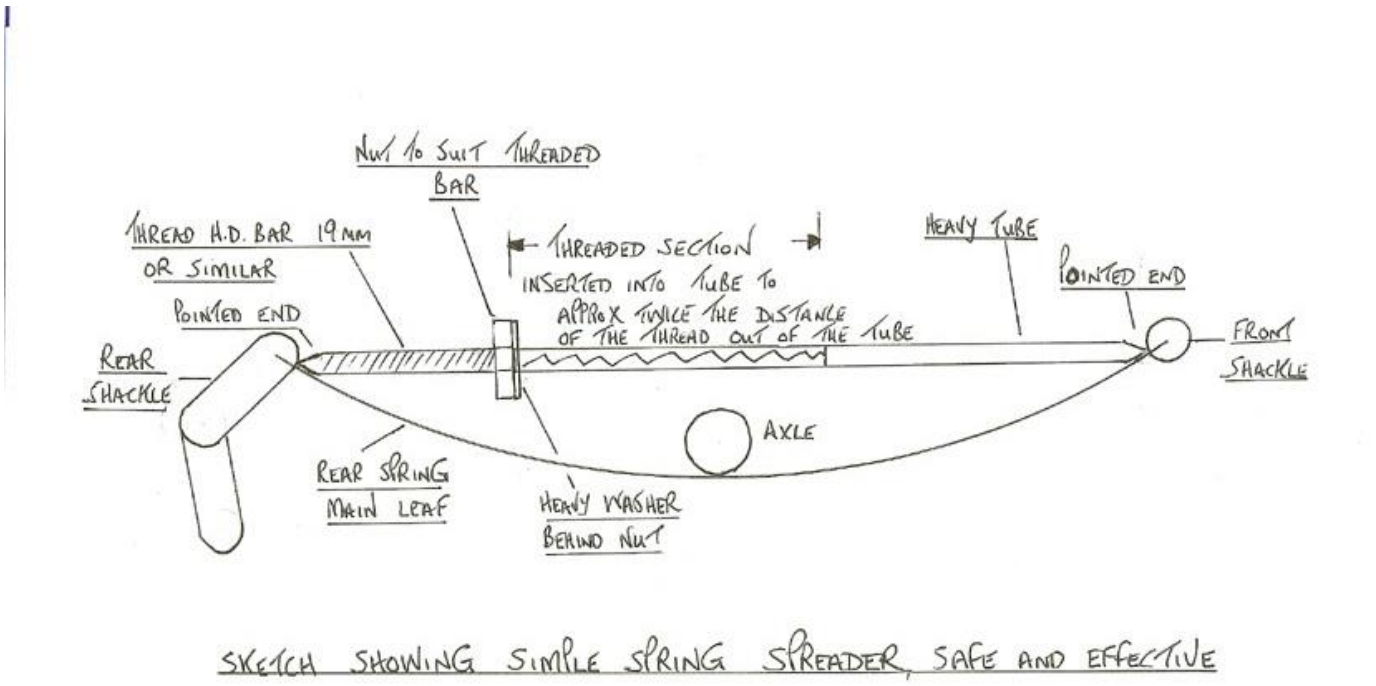
Showing how one of these shackles commences to move over centre as the axle beam is lowered"

As an example taking the right or offside rear spring rear shackle into consideration, see Fig 2 and Fig 3. Normally the shackle will be position at about the 1 o'clock position, as the axle drops the spring bows and shortens, bringing the rear shackle to the 3 o'clock position, further spring and axle drop takes the shackle towards the 6 o'clock position. Finally the shackle moves to the 8 o'clock position. Thus, this shackle has moved clockwise from 1 o'clock to 8 o'clock. If the axle beam is removed at this point the situation becomes even worse, as the spring will straighten itself out when the axle weight is removed and the shackle will jamb hard backwards into its unnatural position at approximately the 9 o'clock position.

Although the above over shackle centre has been described in sequence, in practice this movement can be so rapid and violent that the car can be lifted physically off its support stands. The reason for this is that as the axle lowers it turns the threaded shackles and shackle bracket until an almost equilibrium state exists but as the axle is lowered further and any jack is removed there can be a delaying action in shackle movement. After a very short time, a minute or so, the unsupported axle weight overcomes the threaded shackle pin resistance and the shackle goes over centre at the 6 o'clock position in the most violent manner.

Examination of the shackles on a car will show that once the shackles have moved over centre it is very hard to reposition the shackles forward. In fact any such positioning means that the springs must be made to bow whilst the shackles are moved forward and the owner will be faced with having to reposition both rear shackles. The action of bowing a spring either singularly or together with the opposite side spring means that the springs can impart considerable energy, which is released as the springs are repositioned again. In real terms when the springs move the shackles over centre or the owner has to reposition them, the actions cannot be controlled and the movement is rapid and violent as the spring energy is released. If it is necessary to recover a spring shackle from an over centre position the spring can be quickly stripped of its secondary leaves as described below, or the rear shackles will need removing from the springs. The moral is do not allow the spring shackles to move over centre.

Spring Spreader



A sketch showing a simple spring spreader

To avoid the over centre malady the rear end of the springs can be propped firmly with 2 x 2 (50mmx50mm) wooden props, or better still, steel spring spreaders can be used to force the spring hanger ends apart whilst the axle weight is supported and axle jacked upwards. Steel spreaders, see Fig 4, two are needed, can be made cheaply and easily from lengths of thick steel tube into which are placed heavy 19mm minimum HD threaded bar, utilising a 19 mm nut and heavy 19mm steel washer the threaded bar can be adjusted to expand from the tube. Provided one end of the tube is cramped to a point and a suitable point is ground at one end of the threaded bar, the points can be placed between the top spring leaf and its end wrap around the shackle. Thus a simple threaded jack is made to keep the spring ends spread apart.

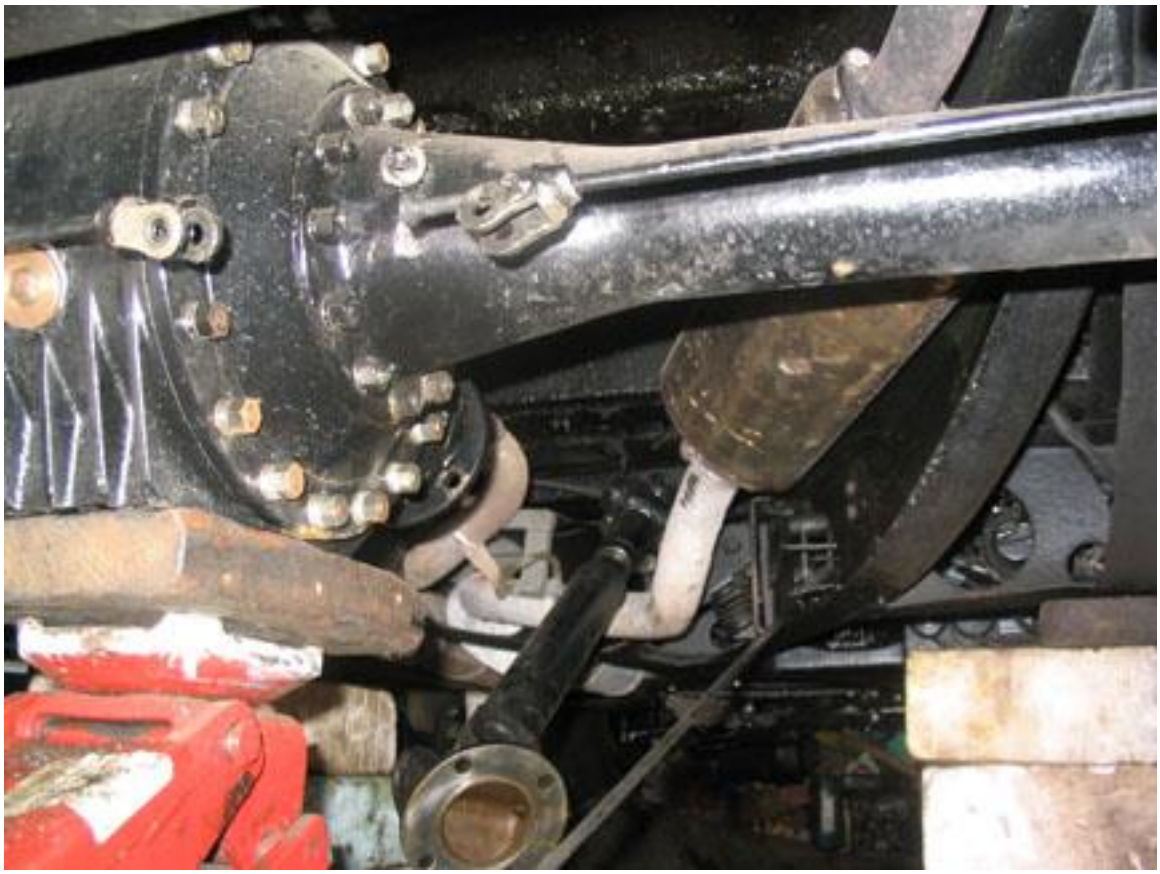
Axle Removal Sequence

Remove rear wheel disks and just crack the wheel nuts loose. Jack up and place the front wheels on blocks preferably at least some 6-inch (180mm) off the ground. Securely block both of the front wheels, front and rear to prevent the wheels rolling too far. Raise the rear wheels by carefully jacking under the axle using a rolling or floor jack. Once the rear wheels are some 6 inches off the ground, block under the wheels temporary and adjust up the front brakes solid until the front wheels are firmly locked. Chalk on the front tyres “Brakes Locked” as a reminder to adjust the brakes correctly when the job is finished. Continue jacking up the rear axle, secure the chassis, and arrange to prevent the shackles going over centre as previously described.

Leave the jack in position if possible to support the rear axle and prevent the shock absorber arms from damaging the rebound rubbers. Remove the rear wheels, release the hand brake and place the gear lever,

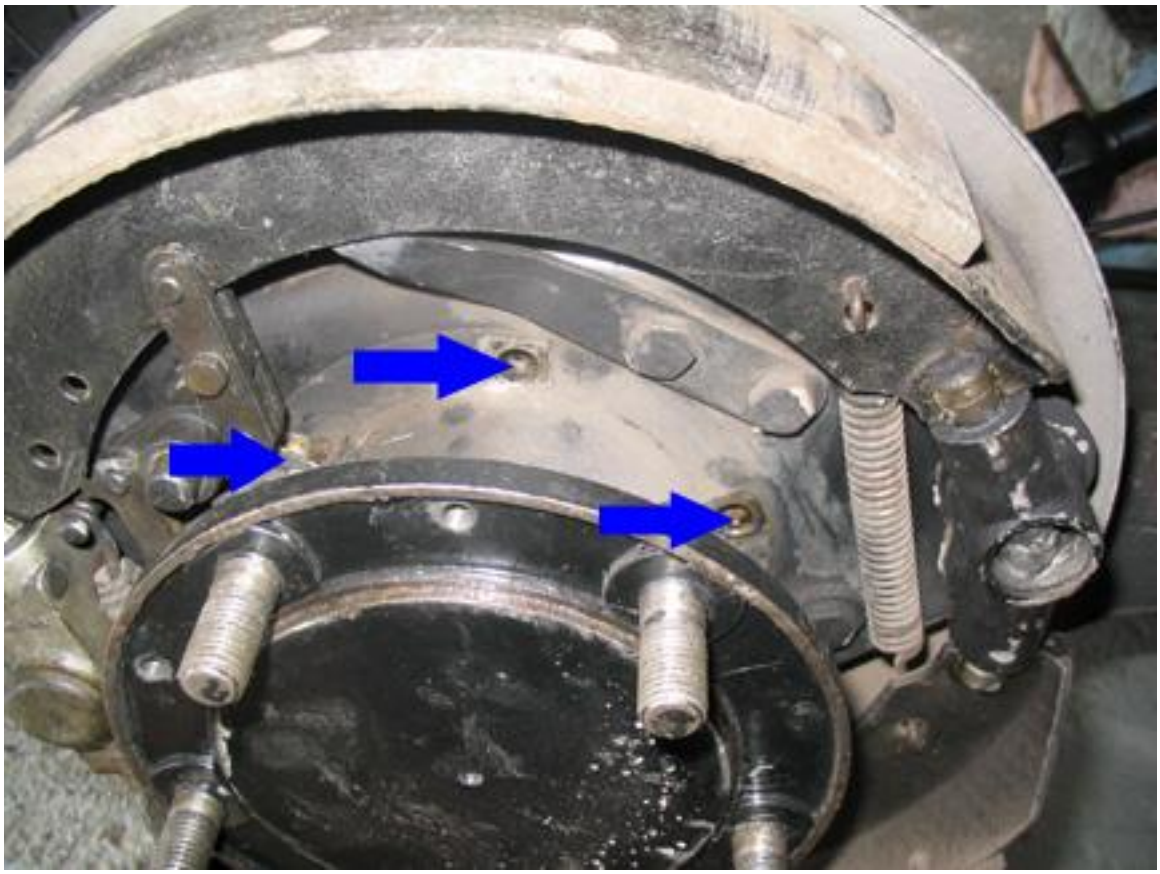
manual or automatic, in neutral. Turn the propeller shaft and slacken off the rear flange retaining nuts, apply the hand brake as required to hold the drive shaft in any position desired. Disconnect the shaft and tie it up out of harms way.

Remove the axle drain plug and drain off the 1.75 pints (1 litre) of oil into a drain pan, replace and tighten the drain plug and remove the filler plug, fit a piece of paper over the filler plug between the plug and axle and replace the plug loosely, this is the warning tag to state the axle has no oil! Or attach a label to one of the drive flange bolt holes.



In this view the drive shaft has been disconnect and the brake equaliser removed

Release the hand brake and disconnect the brake rod, which runs from the intermediate operating lever at its forward end, rearwards to the rear axle mounted brake equaliser, complete the rod disconnection at its rear end. Then either unlock the nut on the fork at the forward end of this brake rod and turn the rod out of the fork or remove the fork clevis pin. Disconnect the left hand side brake rod at the axle brake equaliser, swivel the equaliser and disconnect the right hand rod. Disconnect and remove the brake equaliser assembly complete with support bar from the right hand axle tube, after carefully removing the split pin and retaining nut on the axle tube. To remove the equaliser it will be necessary to remove the clevis pin that retains the equaliser support bar to the chassis forward of the axle, ensure any special washers are recovered from the mounting clevis where the bar connects to the chassis. These special washers are to side load the bar so that it does not rattle on the road and yet allow some side movement. Fig 5 shows the equaliser assembly removed and the forward running brake rod still requiring removing.



Half Shaft retaining bolts have been removed

Remove the brake drums; this lightens the load when the axle tubes are finally removed. If it is desired to remove the half shafts, do so at this stage. Once the brake drums are removed undo and remove the five special headed bolts, nuts and washers on each side, that retain the half shaft assembly. Two of these five bolts have been removed in Fig 6. It is quite feasible to remove a half shaft and an axle tube unit as one assembly in which case the five bolts mentioned above will not need removing.

The R Type models will only have two shock absorber links but earlier cars will have three and they will be narrower than the R type but have the same 0.500 inch bore.

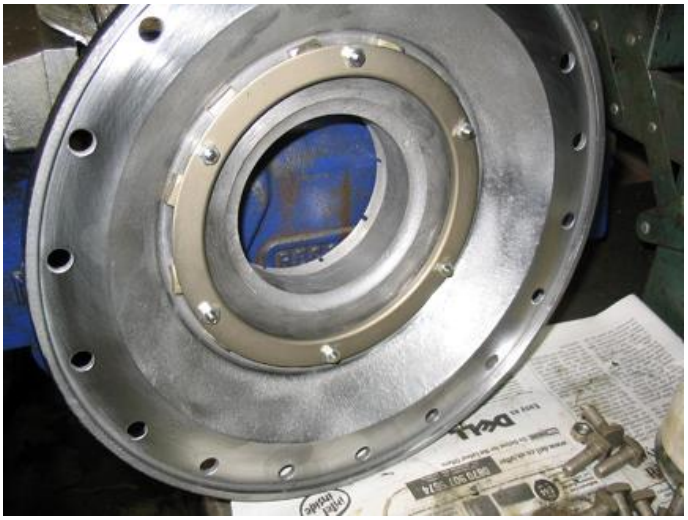
Remove the split pins and remove the securing nuts/bolts in the lower shock absorber mounting, one on each side. On R types and later MKVI the shock absorber linkage will have four silent bloc couplings, on earlier chassis there are six. The object is to disconnect one link mounting on each side, preferably at the road spring U bolt plate, but if this is inconvenient then at the end of the shock absorber arm as shown in Fig 7. These bolts can be very difficult to remove if the bolt has turned inside of the steel inner bush section for this reason it is advisable to soak these bushes and bolts in WD40 or similar for some time before carrying out the job.

Also, renew at least the bushes in the bottom spring plates whilst these plates are removed. Note that MKVI bushes are slightly shorter by about 0.100 inch (2.5mm) than R type bushes, but the former can be used on R types utilising packing washers. Note the warning about the shackles moving over centre, and take steps to prevent it, and then lower the axle and remove the jack.

The last nut being removed on these "U" bolts

Remove the split pins from the spring U bolts and remove the U-bolt nuts, see Fig 8. Note in this view how the spring has been supported to hold the shackle and that the spring is getting adequate oil lubrication from the Bijur. Collect the bottom spring plates and alloy packing plates. Carefully store the alloy packing plates noting how many are in the pack and from which side they were removed. Carefully lift up the axle beam from the road spring on each side and remove the saddle rubbers and top and bottom saddle support tin plates. Once the U bolts are removed note that the axle is nose heavy, support the front if required. Owners may prefer to undo the axle tube to axle centre nuts as described below, before removing the U bolts.

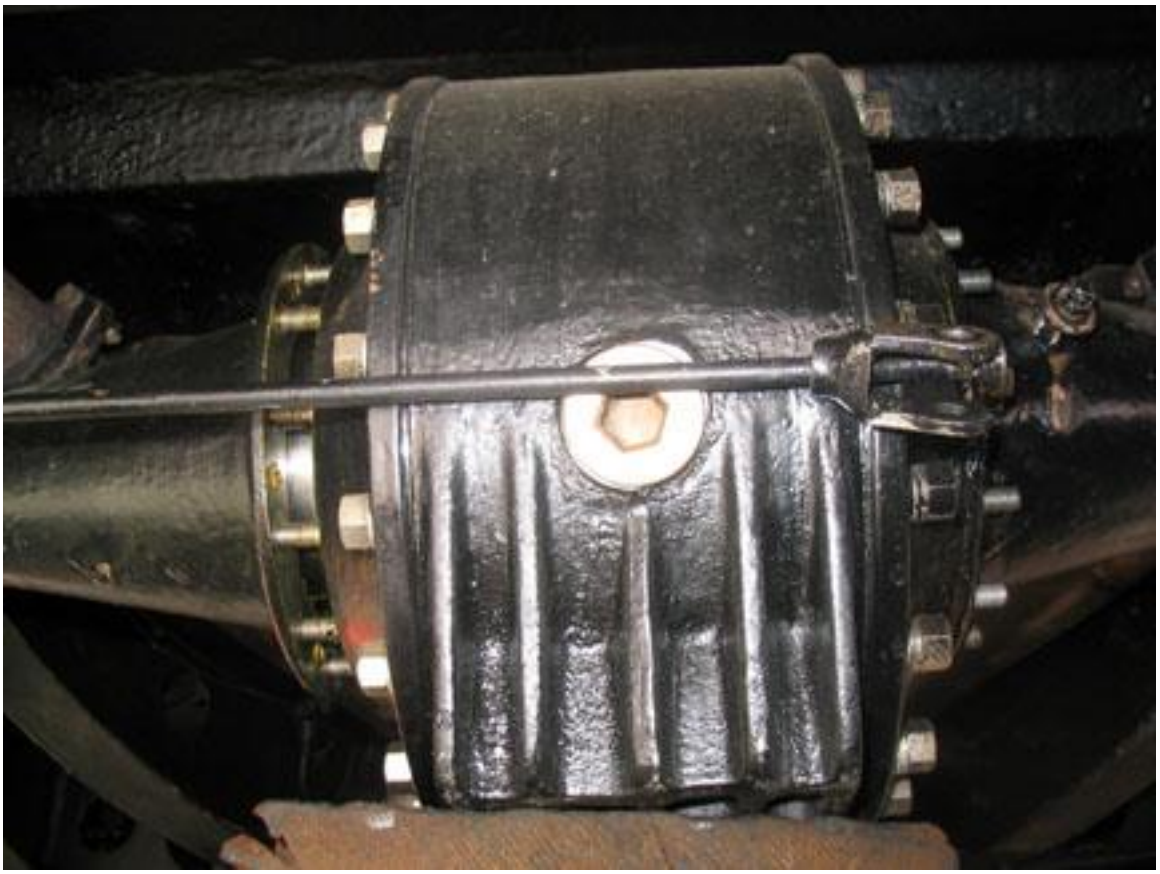
The axle side plate square headed bolts before fitting a locking plate



The locking plate fitted to the square bolt heads, not a sight you will see unless you are unlucky or careless

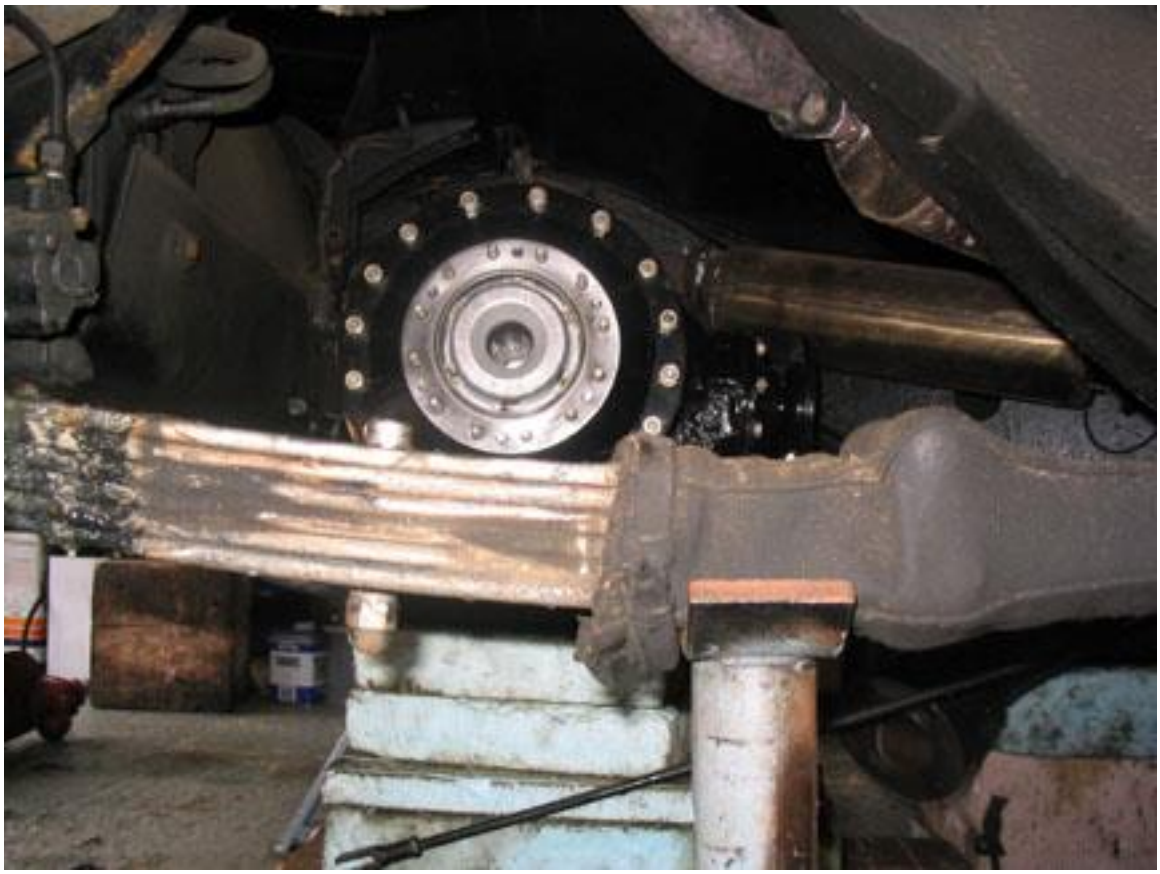
If you do not clean the end of the bolt threads this is sure to be the result

Clean, wire brush and oil the ends of the axle tubes to differential retaining studs, there are twelve each side, where the axle tube bolts onto the axle. This cleaning is necessary to prevent the inner ends of the retaining nuts from turning when the nuts are slackened, these inner ends form a square that is only held by a thin pressed steel plate. Fig 9 shows these square heads from inside of the axle and Fig 10 illustrates the retaining plate in position. If you should turn one of these bolt heads Fig 11 shows clearly what happens, and at that point you can only cut off the relevant nut, it is much easier to make sure the stud ends are very clean and oiled! If you are intending replacing the same axle, and you have turned one of these bolt heads, you will at the very least need to remove the relevant axle side plate and rectify the situation. This is not impossible, but is a job on which further advice should be sort before removing the side plates.



Here the left hand axle side tube can be seen as it is drawn away from the differential

Support the axle centre as shown in Fig 5 and Fig 12 and after removing the twelve tube to differential nuts / washers, remove the left hand tube, actually either side can be removed first. If only one tube is to be removed, the left hand side is to be preferred and in that instance the brake equaliser bar can be left in position on the right hand axle tube. It will be necessary to lift the axle tube over the road spring and the axle can be jacked up slightly to help. Obtain assistance for this procedure. If the axle is old, worn or has been neglected the half shaft splines may obstruct a clean withdrawal from the inner bevel gear. The design at the inner shaft end means that the ends of the splines may be very dirty and they will have to be pulled through the bevel gear splines. If resistance is felt, persevere; the half shaft will eventually pull clear with some effort.



Now seen after the right hand axle tube has been withdrawn

Once one axle tube has been removed, either the other side can be removed and then the differential centre section lowered or the centre section can be manoeuvred to one side and out of the other set of splines. Beware that the axle centre is front end heavy and will try to tip forward off the jack. Fig 13 shows the view when the right hand tube has been removed.

Now collect the alloy spring to axle spacers from each side and note their thickness and position, either top or bottom of the spring. Locate and secure the spring saddle rubbers and their steel support plates from each spring. The upper steel rubber support plate is likely to have rusted to the axle tube and the plate will need removing.

At this juncture it is easier to discuss the actual replacement of an axle before discussing other points, although this will alter the normal sequence order. It will also be necessary to read the sections in “Axles and What Fails Part 3 to achieve a complete picture of the replacement process.

Axle replacement

At this point it should be pointed out that the manufacturing specification for the road springs is plus or minus 0.62 inch from the front shackle centre to the spring centre bolt, and also 0.125 inch plus or minus

between the shackle centres. It is therefore sensible to check the shackle to shackle measurements and front shackle centre line to spring centre bolt position accurately on both springs before the axle is refitted and mark the exact centre line of each spring.

When the axle has been remounted, checks should be made and adjustments made by moving the axle within the confines of the bottom plate centre boltholes to achieve true axle tube centre positioning to the spring centre lines. It is important the axle is not crabbing and a good secondary check is to observe and measure the distance between the end of each shock absorber arm and the axle tube. This distance is usually around 0.375 inch (10 mm), but it is the variation side to side that is important. The centre positioning should be rechecked once the springs are taking the weight of the car.

Sequence

Place the right hand axle tube in position on top of the road spring, ensuring that the saddle rubbers and supporting plates are in position. Check that the spring centre bolt has located correctly in the bottom spring plate then fit the ”U “ bolts and nuts and loosely tighten. Coat the inner end of the axle tube with a suitable sealer to prevent oil leaks.

Taking care, obtain the assistance of a helper and jack up the axle differential centre unit to a point adjacent to the axle tube. Providing the differential is mounted on a thick piece of timber it can be moved sideways some 2.00 inches (50mm) so that the twelve side studs engage the axle tube holes. Ensure to check that the holes have mated the parts in the correct orientation. The drain hole that is located at the inner lower end of the axle tube should be in line with the axle differential drain plug. Once correct alignment is achieved replace two opposite washers and nuts, followed by all the others and nip these up to just secure the units. It will be necessary to leave the jack under the axle.

If by any chance it is intended to replace the heavy thackery spring washers with modern ones, between axle and axle tubes, it will be essential to also use flat washers in addition. Unfortunately modern spring washers are too thin for this location and also need a flat washer to prevent the nuts bottoming onto the shanks of the studs. It may appear that the nuts are tightened correctly, but that will not be the case….you have been warned.

Once the right hand axle tube and the axle have been located, replace the rear brake back plate, if you forget you are going to strip the rear end yet again! Then refit the brake assemble and enter and locate the right hand half shaft. Firstly wipe some clean oil around the shaft splines and area where the oil seal contacts, on no account use grease as this will definitely block the oil holes in the thrust washers for the axle bevel and pinion gears. Take extreme care when the splines are due to enter the axle, as the shaft must slide through the leather seal. If the shaft is forced in without regard for some care it is feasible to displace the oil seal, especially if the seal is new and tight. Rotate the shaft continually whilst attempting engagement of the splines. Once the half shaft is fully engaged then finally tighten the twelve nuts that are securing the axle tube to the axle on the right side.

Fit the five half shaft retaining bolts and nuts and secure at the wheel end, refit the brake drum and adjust the brake with the adjuster.

Repeat the above exercise for the left hand side axle tube. Once the axle tubes, axle differential and half shafts have been fitted, continue to tighten the “U” bolts. Make sure the axle centre bolts are exactly centred in the bottom brackets. The spring packs are obviously held in the rubber blocks at this point and it is essential to tighten the “U” bolts without displacing the rubbers, which themselves may provide a false impression of tightness. Although torque poundage’s were not used on these cars for good reasons, this case is an exception in my view and some 30 / 35 lbs. ft is the figure to use for this location. Take care to note the points regarding axle centre positioning before finally tightening and pinning the U bolts.

It is desirable to take some care regarding fitting the split pins. At this point access will be easy and the brake back plate will not yet have been fitted to the axle. This situation may lead to the split pins being inserted from the road wheel side. In fact the pins must be entered from the car centre line in order that they may be extracted easily in the normal course of events when the brake back plate is fitted. The split pins will need to be removed whenever the rear “U” bolts need tightening. Firstly select split pins, which are just a hand push fit in the holes, then divide and wider out the legs of the split pin with a screwdriver. At that point dip each pin in some grease and close the legs of the pin, following by fitting it in the normal way. This method will deter rusting of the split pin that in its self will be held tight in its locating hole because the pin was pre-spread before final fitting, and yet extraction will be easy.

Reconnect the shock absorber links, loosely on each side. Once the “U” bolts are tight and each shock absorber link is attached, it is possible to remove the support jack temporary to afford better access to the area.

Refill the axle with approximately 1.75 pints (1 litre) of EP 80 / 90 oil at this juncture. If the axle is new it will be found that some time is needed to enable the oil to fill the entire bevel wheel cavity. Take time to refill the axle with oil and rotate the axle 90 degrees a few times during the refill sequence. This allows the inner case four access holes leading to the inside axle bevel gears to submerge in oil and supply the inner workings with oil. If the oil is replaced at this point it can be checked again later when the level has stabilised.

Refit the brake equaliser bar and compensator, followed by the drive shaft. Refit the road wheels and arrange for the wheels to be lowered onto support blocks. Ensure the wheels are blocked to stop the car from moving but do not apply the hand brake. At this point bounce the rear suspension to centralise the shock absorber bushes. Finally tighten each shock absorber link and split pin using the method previously described. Apply the hand brake, check the axle oil level and finally tighten the road wheel nuts. At this stage fully check the brake linkages according to the manual. It is likely that the brake equaliser rubbers and possibly the rear brakes have received attention, and the axle is located in a slightly different position in the new rubber saddles, all of which will require the brake linkages to be reset. Do not be tempted to just adjust the rear brake rods.

Further axle data is available in: Axles and What Fails Part 3