Rebuilding the XJS independent rear axle

Many owners, like me, are quite happy to replace front axle bearings and adjust them, but find the rear hubs and UJs in the driveshafts something of a mystery, and their replacement, rebuild and setup quite daunting. In my case, circumstances forced me to take some brave pills and get stuck in. Although my car is a 1985 V12 XJS coupe, this procedure will be the same for any model of Jaguar that has the inboard-braked independent rear axle.

I had a very annoying steering wheel shimmy – which eventually was traced to a faulty differential, and cured by its replacement, as described in the August 2022 edition of Jaguar Enthusiast. However, this success was not achieved before first eliminating all other possibilities!

First a few clarifications of terms:

Hub carrier: this is the large aluminium casting that surrounds the outer end of the driveshaft.

Hub bearings: There are two bearings, not the same size, the outer races of which fit into the hub carrier's interior.

Hub: this is the machined steel forging that has the wheel studs in it on its outer end. It has female splines machined into its interior. The tube-like outer surface of the hub has the inner races of the bearings pressed onto it. These run on their outers in the hub carrier.

Driveshaft: this is the double UJ'd shaft that transmits drive from the differential to the hub and therefore road wheels. It has a male splined end that slides into the female hub splines.

A photo or two to make things clear:

Photo 1: Hub carrier

Photo 2: hub with outer bearing's inner race still in place. The inside of the hub tube is machined with female splines

Photo 3: the male splined end of the driveshaft that fits into the female splines of the hub, and thus transmits drive to the hub and road wheels. Note the two spacers on it against the UJ yoke. These are important and must be carefully retained.

Photo 4: the entire assembly laid out in order.

Tools: apart from the normal socket set and other tools most home mechanics have, only two special tools were required, a UJ tool, as shown in photo 9 below and a bearing puller and spacer kit. These are about 30 UK pounds (about the same USD) and both are needed.

Starting the job:

I thought that bad UJs might be the cause of the rear axle's odd snatching symptoms, so decided to change them for new ones. With the help of my friend Michel we looked at the axle, but realised immediately that the outer UJ cannot be accessed without removing the splined driveshaft from the hub – which is where the hard work started!

The preliminary job is to remove the hub and driveshafts from the car, which is not too hard. First the car must be up off its rear wheels, and the wheels removed. This allows the inner end of the driveshaft to be unbolted from the differential output shaft, four nuts and done. Then support the hub on a Workmate or something similar, and remove the pin that holds the lower eyes of the shock absorbers. Note that this pin can only be driven out towards the

engine. Now there is access to the radius arm where it is fixed to the outer end of the axle lower wishbone, and this must be unbolted too.

At this point the sole connection remaining between the driveshaft/hub assembly and the rest of the car is the hub carrier fulcrum, see photo 5.

In photo 5 the red arrow marks the hub carrier lower fulcrum pin. At this point in the process, it is the final attachment point of the assembly to the car. It must be unbolted and CAREFULLY driven out with the hub assembly supported on a table or bench so it cannot drop. *Very important*: as soon as the hub assembly is free of the suspension arm, refit the pin into the hub. Use a short length of rubber hose on one end to keep everything in place. If you look again at Photo 1 you can see the fulcrum pin replaced in the hub carrier with a length of old coolant hose to take up any slack. There are bearings and spacers inside the fulcrum and these will drop out of place if the pin is not replaced.

Now the assembly is free, the first thing to do is to remove the splined driveshaft from the hub. To do so you undo the castellated split-pinned nut on the outside, and if you are lucky, pull the hub and carrier off the driveshaft splines. My car was 35 years old, I am the second owner, and it has passed

most of its life in the UK. Therefore the driveshaft was well rusted/gunked into the hub. I tried a puller, it broke. I tried a bigger one, it did nothing. So I went down to the local heavy vehicle repair place and asked the cousin of my son's best friend to help. Photo 6 shows the procedure:

Photo 6: 40 tonne hammer-action hydraulic press. The driveshaft retaining nut is on the threads to protect them, it required all 40 tonnes to shift the splined shaft from the hub, and it gave at about 4mm a thump. The driveshaft is hanging down below the press table. Both sides needed the same treatment.

Once the driveshaft is out of the hub, if the hub itself and the bearings are in good shape, no further work needs to be done on the hub or carrier or its bearings. You can just keep it ready for reassembly once the UJs are renewed. However, in my case, because of the huge force needed to remove the splined driveshaft, the bearings were damaged and had to be replaced. The hub has a bearing each end, one by the UJ and one at the wheel stud end. The outer races are driven into the hub carrier, the inner races are on the hub itself, and the bearing at the hub's UJ end traps the hub into the carrier. The hub therefore has to be carefully driven out of the carrier, which forces the inner race free, as shown in photo 7.

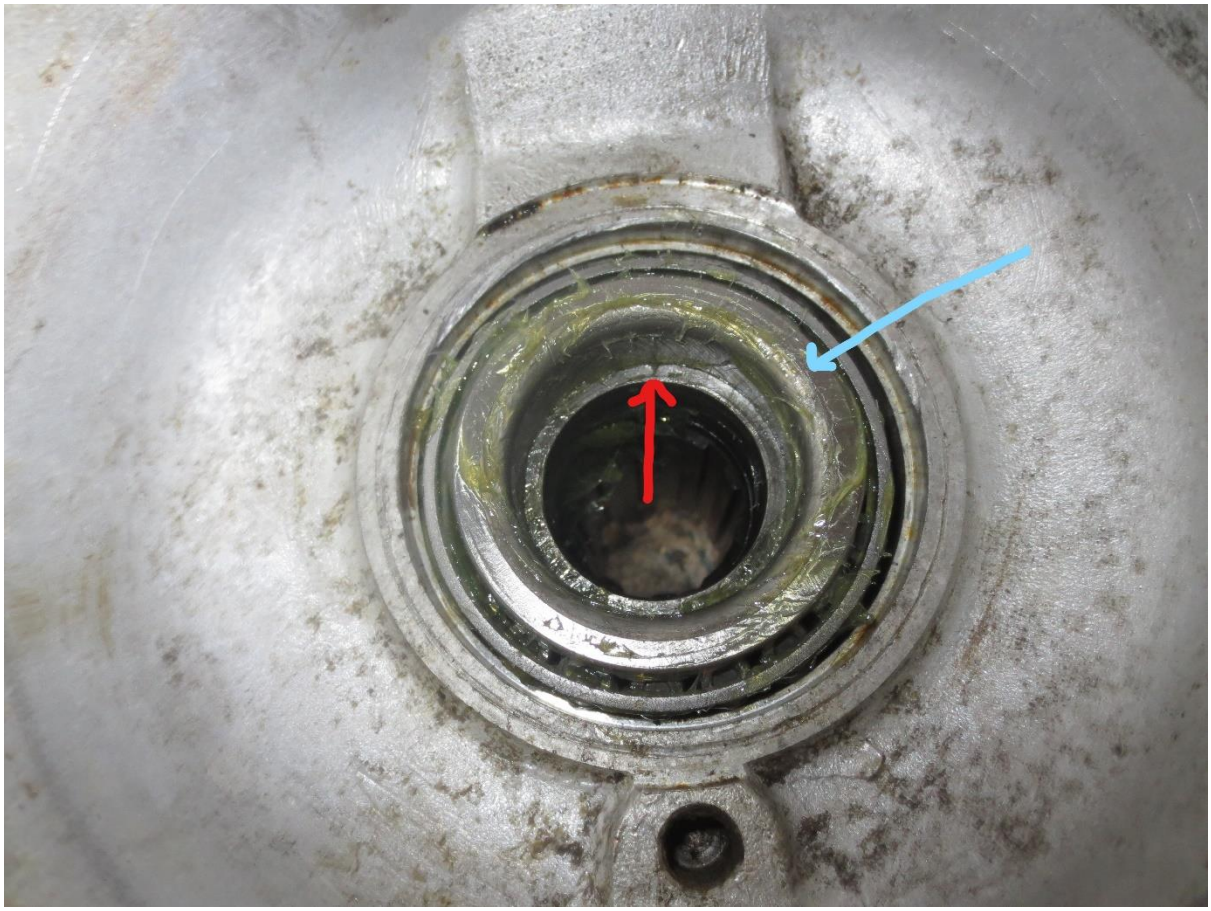

Photo 7: The blue arrow shows the inner race of the inner hub bearing. The red arrow shows the hub tube, which the race is pressed onto, in the process of being driven out of the hub carrier. A steel tube, just slightly smaller in diameter than the bearing race must be place against the hub tube, and the tube firmly hammered to drive the hub out. Photo 2, above, shows the hub having been driven out of the carrier, the shiny part shows where the inner race used to be.

With everything now separated, it needs to be given a good clean up to remove the years of grease, grit and road grime. I soaked the hub carrier, which had old grease all over it in paraffin and white spirit for several days before cleaning it. More importantly, the splines in the hub itself and on the driveshafts needed de-rusting and proper cleaning. I treated them with 75% phosphoric acid which removes all rust and does not attack the steel, and afterwards carefully dressed the splines with a diamond file. This rendered them a nice tight sliding fit together.

The task of replacing the UJs is easy to understand in principle, but quite hard in practice. Each UJ has four arms, two go into each yoke, one yoke on each end of the driveshaft. As shown in photo 8.

Photo 8: close up of the old UJ in the hub carrier showing the arms in each yoke. Also illustrating why the driveshaft has to be removed from the hub to change it.

The UJ arms fit loosely into the holes in the yoke, and are held tightly in place by caps pushed into the yoke and over the arms. The cap in turn is held into the yoke by a circlip that fits into a groove in the yoke. The following photos show the detail:

Photo 9: the arms of the new UJ are clearly shown, and also one of the caps being pushed into the yoke and over the UJ arm. There are needle roller bearings inside the cap (grease them to hold them in place while the cap is pushed into the yoke). The tool being used is cheap to buy from Amazon or motor parts places.

Photo 10 shows the finished new UJ in place with the grease nipple screwed into it. The circlip holding the cap into the yoke is also clear to see.

Photo 10: the new UJ fitted into the driveshaft yokes.

Although rather out of sequence, now that the way UJs fit is clear, a few words about removing the old ones. First the circlips have to be removed, then, the tool shown in photo 9 is used to push one cap inwards, which pushes the opposite cap out of the yoke. Once poking out enough, a large pair of grips is needed to prise it right out, or, good tip this, grip the cap in a vice and use the leverage of the driveshaft to wriggle it out. Repeat this four times until the caps are all off and the UJ is free. If trouble is encountered, the UJ can always be cut with a small angle grinder just below the cap between it and the centre.

Photo 11 shows the badly worn UJ, this wear in spite of regular greasing, probably because the grease nevr got to that part of the UJ, a common problem with a single grease nipple serving multiple places.

Photo 11: worn UJ.

Sourcing new Universal Joints

The dimensions of the UJ and cap are critical, and as I found out, not all new ones are accurately made. Once the new UJ is fitted and the circlip is in place, the arms must not be able to move back and forth across the yoke, equally it must be possible to fit the circlip. I bought some allegedly correct UJs from a reputable place, and tried to fit them. With both cups pressed in it proved impossible to fit the circlip at one end. You could just see the circlip groove - which is about 2 mm wide - in the yoke end, but the cap protruded about 1 mm too much and the circlip could not be installed. The caps' interior surfaces were hard against the UJ arm ends and so no amount of pressure would have any effect.
After struggling for ages and thinking I was stupid, I consulted a very experienced friend in Australia, the great XJS Prophet of the Southern Cross, Grant Francis. He advised me to measure the overall length of the UJ arm end to arm end without the bearing caps installed, and then the overall length of the with the bearing caps installed.

The results were as follows:

Bought crosspiece with no caps installed: 99.95 mm
Bought crosspiece caps installed: **107 mm**

The correct factory spec is an overall length with bearing caps fitted of between 106 mm and 106.4 mm. Therefore the UJs I had bought were incorrectly made. I consulted the Rockauto.com catalogue and they have a wide selection of UJs in various quality grade specifications. Not wanting to do this job again, or indeed wishing it on my heirs, I ordered DANA/Spicer part DANA 514101X which are made to the correct spec according to their specsheet, link here:
https://www.rockauto.com/en/moreinfo...78647&jsn=1624

Their comparative specification is:

OEM and Dana/Spicer with no caps fitted: 99.95 mm
OEM and Dana/Spicer caps installed: **106.2 mm**
Quite obviously, the slightly shorter overall length would allow the circlips to be fitted.

The Dana Spicer 514101X is a heavy duty UJ and the quality of the items when received was superb. Very fine needle rollers in the caps, very well designed grease paths to the caps too. Additionally they come with a selection of circlips in various thicknesses. These UJs come in greaseable (with the grease nipple in the end of the cap itself as shown in photo 10) and sealed for life versions. A word of advice here: I bought all greaseable versions, but the UJ at the outboard end cannot be easily greased, the nipple being in the end of the arm, as the carrier body is too close to it. In fact I fitted a 90° nipple and it is just, and only just, accessible. I very strongly recommend the greased for life version is used in the outboard position.

Reassembling the hub and driveshaft

At this point the driveshaft has its new UJs installed and is ready to be replaced in the hub, see photo 12

Photo 12: the clean driveshaft with derusted splines and shiny new UJs, ready to be refitted to the hub.

As mentioned above, if the driveshafts came out of the hub assembly easily, and the hub bearings are all good, the driveshaft and original spacers can just be refitted to the hub and all is ready to go. In my case however, the hub bearings had to be replaced as they were damaged in the effort to remove the driveshafts. The removal of the hub inner bearing, inner race, is described above, the hub outer bearing inner race (shown in photo 2) needs to be pulled off using part of the bearing puller kit. Photo 13 shows this being done:

Photo 13: the bearing puller kit pulling the old outer hub bearing inner race from the hub.

The hub carrier is now empty of the hub but must have the old outer races driven from it, prior to installing the new bearings. This is quite easy to do with a hammer and a brass drift, as there are indents in the carrier for this purpose, see photo 14.

Photo 14: the empty hub carrier showing the indents that allow the outer races fitted to it to be driven out.

The new bearings' outer races are driven carefully into the clean empty hub carrier, using suitable tools from the bearing puller kit. Photo 15 shows the outer bearing outer race being driven into the carrier:

Photo 15: the new outer bearing race being driven into the carrier.

The inner bearing race has to be wound into the carrier using threaded rod and suitable sized bearing pusher pieces, as a hammer cannot be used, see photo 16.

Photo 16: The inner bearing's outer race is being installed into the carrier using a suitable diameter driver, some spacers and a threaded rod to push it into place. Out of shot the other end of the threaded rod goes through a bit of square steel tube across the carrier, so the clamping force can be applied. After race has been wound in, use a brass drift and just tap it down round its circumference to ensure it is 100% seated. Photo 17 shows the carrier with both outer races installed, all ready for the next stage of assembly.

Photo 17: the new bearings' outer races in place in the clean carrier. Note the outer bearing's oil seal has to be installed at this point, as shown in the photo. Now the hub has to be fitted to the carrier. First the new outer bearing, inner race is driven onto the hub, see photo 18.

Photo 18: driving the new outer bearing inner race onto the hub. Next the hub is fitted into the hub carrier and the inner bearing's inner race placed in position. The inner race cannot be fitted to the hub tube by hand pressure, it too has to be wound in place. Photos 19 and 20 show the stages required:

Photo 19: the inner hub bearing inner race placed in position, it is against, but not yet fitted over, the hub tube, which can just be seen inside.

Photo 20 shows the inner race being wound down over the hub tube. Again threaded rod and suitably sized drivers are needed.

Photo 20: winding the inner bearing race over the hub tube.

When all is properly seated the hub is firmly held in the carrier by the bearings. Photos in the following section show the finished carrier/hub assembly.

Setting the rear hub endfloat/preload

In my view, having looked at all sorts of videos and instructions, this is a very poorly explained procedure, which I will try to make clearer! To summarise, we have a hub carrier and hub all ready to fit; we have a driveshaft with cleaned splines and new UJs. In principle, the splined driveshaft is shoved into the hub splines and that is that. BUT, in practice the bearing endfloat has to be set correctly. This is precisely analogous to the adjusting of the front wheel bearings on Jaguars of this era, using the nut on the end of the stub axle. Too tight and the bearings jam and overheat, too loose and the assembly is sloppy.

The problem is that the nut on the end of the driveshaft (see photo24) HAS to be seriously tight at 120 ft/lbs! This clamping force cannot be taken through the bearings, it has to be transmitted through the hub tube to the machined flat on the yoke-end of the splined driveshaft. Photo 10 shows the bare part in close up, and photo 3 shows it with the two spacers in place. The first silver

coloured spacer is also the track for the inner bearing oil seal, and all assemblies have this fitted. The purpose of the second smaller phosphor bronze spacer shown in photo 3, is to fill up the remaining space between the end of the hub tube and the silver spacer. This second spacer therefore comes in many thicknesses, because the exact gap to be filled may vary by a few thou. Obviously the required thickness in any individual case must be measured.

Additionally, there must be a very slight amount of endfloat in the setup (i.e. looseness) so the bearings are not quite clamped at all. The factory specification for rear hub bearing endfloat is 0.001 to 0.003 thousandths of an inch.

Now look at the following photo 21: the hub tube on which the pointer is placed is ***below*** the level of the bearing inner race:

Photo 21: the pointer is on the hub tube which is below the level of the bearing race. Therefore, if the driveshaft was to be fitted with only the large silver spacer/oil seal track in place, when the outer castellated nut was done up to its specified torque, the large silver spacer would crush the inner bearing race into its outer, and the entire thing would be jammed tight and unable to rotate.

Obviously, a second, small diameter spacer is required to fill the gap between the hub tube and the bearing, so when the outer nut is done up, the bearings are not crushed as the hub tube carries the torque through the spacers to the driveshaft machined flat, just below the yoke. The question is, how big a spacer? In photo 22 the pointer is on the bearing race.

Photo 22: In this photo the pointer is on the bearing race, it is the difference between the height of the pointer in photos 21 and 22 that needs to be carefully measured and a spacer selected of this precise thickness plus 0.001 to 0.003 thou to give the endfloat Jaguar specifies.

The easiest and most accurate way to measure this distance is by using an electronic micrometre as shown in photo 23.

Photo 23: ensuring the bearing is properly seated, and taking three measurements at points around the circumference, the gap between the bearing and the hub tube is easily and accurately measured. In my case it came to 136 thou, so I needed a spacer of thickness 138 thou to be in the middle of the specified range. This would then give a bearing endfloat of 2 thou.

These spacers in all the many required thicknesses were originally made of phosphor bronze and are still available from Jaguar Heritage Parts. Sadly, and in my view foolishly, Jaguar require customers to buy a minimum of 5 of any one size at a time, and they are not cheap! SNG Barratt sell steel ones singly. In my case I lucked into a huge motherlode of genuine factory ones, in almost all sizes, on Ebay for a very small outlay.

The remaining assembly is very straightforward. First install the oil seal into the carrier on top of the inner bearing. Now look carefully at photo 24.

Photo 24: the blue arrow shows the speciality steel oil seal track, the red arrow shows the phosphor bronze spacer of the correct thickness. These two items MUST be in place before the driveshaft (suitably coated in nickelslip in my case) is slid into the female splines of the hub. If the hub bearings have not been changed, just re-use the original spacer and track.

Now, finally, fit the thick washer to the end of the driveshaft poking through the centre of the hub by the wheel studs, and do up the outer hub nut to the specified torque of 120 ft/lbs and fit the split pin. Job done (apart from refitting it all to the car, that is!).

Photo 24: outer thick washer, nut and split pin fitted.