Of Double Yokes, Cardans and Spiders

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This article was prompted by the imminent arrival of the first set of reconditioned driveshafts imported by CCOCA from Europe. It is not intended to replace the information given in the factory workshop manual, but rather to supplement it...

The success of the introduction of volume-produced front wheel drive cars during the twenties and thirties was dependent to a large extent on the availability of efficient and reliable and efficient means of transmitting the drive to the front wheels.

The problem of driving through a wheel which is also steered and sprung has exercised the minds of engineers over many years. One can, of course, drive through fixed front wheels and steer the rears — a solution used for most fork lift trucks, but hardly suitable for even moderate speeds, and in any case, why not turn the drivers seat around and drive the other way? The advantages of front wheel drive (FWD) in terms of stability, traction and space utilisation have long been recognised by the more enlightened manufacturers, and the development of reliable front driveshaft designs has been vital to their success.

What is the problem? A typical driveshaft assembly in a FWD car fitted with independently suspended wheels (such as the Traction)

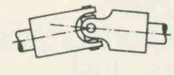

FIG.1. SINGLE HOOKES JOINT

consists three shafts — the gearbox output shaft, which is fixed relative to the hull, but free to rotate, the stub axle in the wheelhub which moves relative to the hull and also rotates, and finally the shaft that joins the first two together via universal joints.

As the wheel moves up and down over bumps and/or is steered away from the straight ahead position, these three shafts take up various angles to each other.

The most common means of transmitting power between two shafts that run at an angle is to use a 'Hookes' universal joint (Figure 1). This is the type that is almost invariably fitted to both ends of the prop-shaft of front engine/rear drive cars, and consists of two yokes at 90° coupled by a cross.

One unfortunate characteristic of the Hookes joint is that, as it runs at an angle, the output speed increases and decreases during each revolution, even though the input speed may be constant. The greater the angle, the higher the speed variation. Two such joints are able to be used in a conventional prop-shaft (Figure 2) as this shaft system only runs at angles in one plane (vertical) with the input and output members substantially parallel. By correct phasing of the two joints, the speed variations can be arranged to be self cancelling.

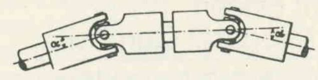

FIGURE 2. THREE SHAFT SYSTEM USING TWO HOOKES JOINTS

In a FWD driveshaft, however, the output shaft (the stub axle) moves in two planes — vertically during suspension movement, and horizontally about the steering axis during steering. If single Hookes joints are used, then the speed variations during rotation would give unacceptable vibration and kickback through the steering during cornering under power.

Despite this drawback, the early 2CV used such a system due to its simplicity, lower cost, and minimal power.

The solution to the problem is to use an outer universal joint that does not produce speed variations during rotation — a *constant velocity* joint. Many types of CV joints have been designed, and the Traction was fitted with most of them during the prototype and early production stage.

The design eventually adopted uses two Hookes joints back to back with a centralising spigot ball and cup as the outer CV joint and a single Hookes joint at the gearbox (inner) end.

A sliding splined coupling at the inner end accommodates changes in driveshaft length during suspension movement.

"All good joints come to an end" — Griffith farmer.

And so do Traction driveshafts, usually deteriorating until finally crying 'enough!'.

Problems encountered include:

1. Shearing of hub keys — rendering car immobile.
2. Excessive wear of universal joint cross bearings causing vibrations, snatching and clonking on lock. If allowed to continue, this can lead to breakage of the universal joint yokes with dramatic consequences, i.e. the car is immobile again.
3. Wear of splines causing noise, snatch and vibration.

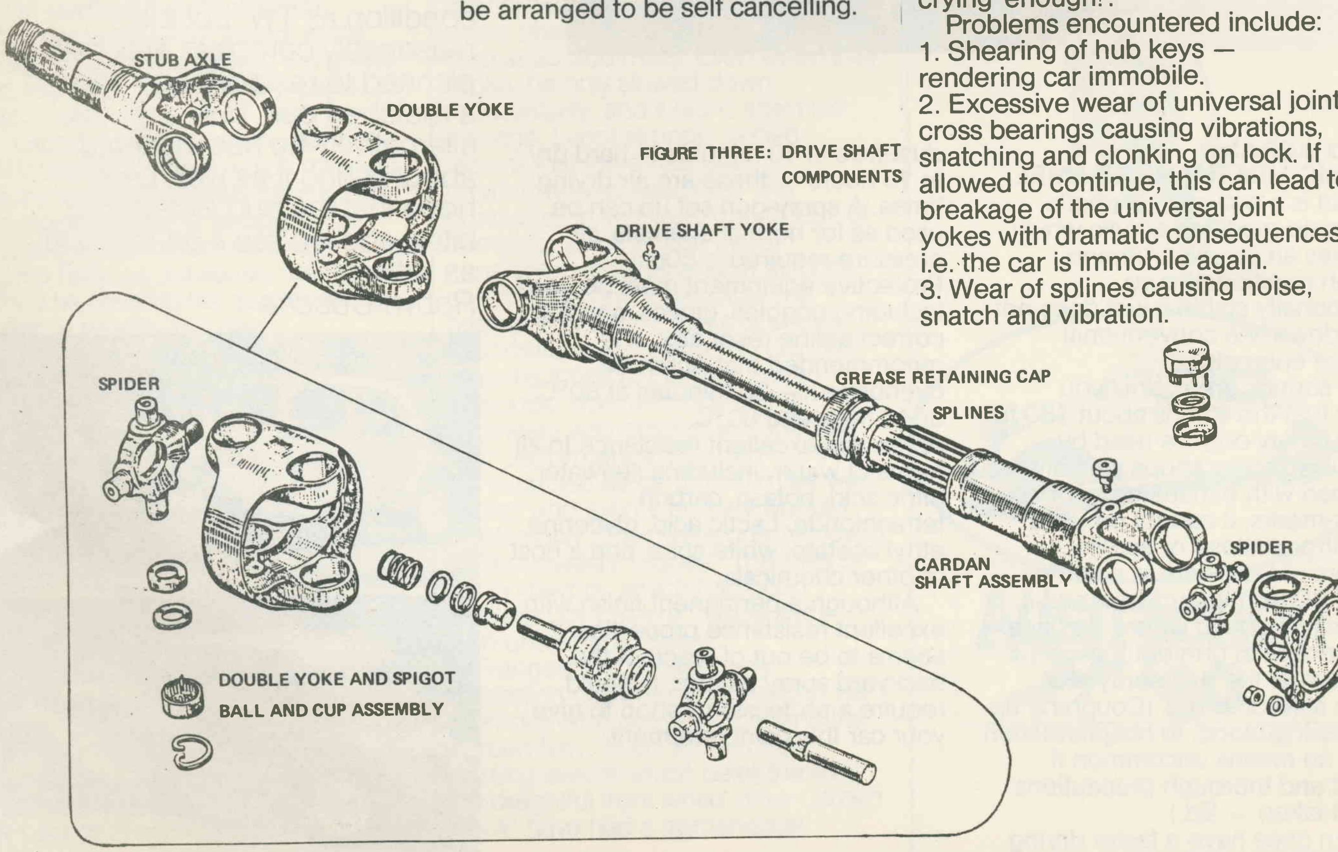

FIGURE THREE: DRIVE SHAFT COMPONENTS

Replacing Drive Shafts

The first point to be made regarding replacement is that it is impossible without the use of an number of special tools, namely:
38 mm or 1½" AF socket,
Hub puller,
Outer wheel bearing extractor (if bearing tight on shaft),
Inner ring nut spanner,
Lower ball joint extractor.

Second point is that it helps to read the workshop manual before getting your hands dirty.

Removal:
1. Slacken hub nut (38mm/1½" socket) — **Remember** RH side — LH thread; LH side — RH thread!
2. Jack car under lower link arm and just slacken 4 inner universal coupling bolts (14mm).
3. Remove road wheel.
4. Remove brake drum using puller.
5. Unscrew outer ball race slotted ring nut (using proper tool if available or by drifting with square ended bar) after removing small lock tab.
6. Withdraw outer ball race with extractor if necessary. Have seen somewhere that an extractor can be improvised from 2 large exhaust clamps, but jury-rigged tools should be used with care as the pulling lip on the bearing is rather fragile. Remove distance piece and as much of the grease inside the hub as possible to reveal the inner ring nut.
7. Turn back the locking tabs of the inner ring nut and assemble inner ring nut spanner on the stub axle. Next step is to firmly prevent the drive shaft from turning as the inner ring nut can be reluctant to budge. If the special tool (1830T) is available, fine; if it isn't, then select first gear and have a helper prevent the gearbox mainshaft from turning using an adjustable spanner on the starter dog. Again, unless the wrong side shaft has been fitted at some time, RH shafts have LH threads and vice versa, for the inner ring nut.
8. Separate swivel hub assembly from lower link arm by removing lower ball joint using extractor.
9. Separate steering arm from tie rod end.
10. Unscrew sheet metal grease retaining cap from spline coupling and disengage driveshaft/swivel hub assembly from cardan shaft by swinging it outwards.
11. While a helper supports the swivel hub assembly, carefully drift the drive shaft inwards through the inner wheel bearing with a copper hammer.
12. Prise out inner oil seal and drift the inner wheel bearing outwards through the hub bore.
13. Remove cardan shaft assembly from gearbox flange.

Assembly:

Examine replacement driveshafts and check that stub axle tapers are not scored, that stub axle keyways are not chipped or enlarged, that the slines are reasonable and threads are OK. Determine which shaft is for which side of vehicle and check the fit of the stub axle taper in the mating taper of the relevant brake drum hub. This step, although time consuming, is essential if sheared keys are to be avoided in future.

Lightly blue the stub axle with engineers blue and fit into hub. The key need not be fitted but locate the stub axle as it would be if the key was present. Tighten hub nut, then unscrew and check that outer face of the hub protrudes by a small amount from the shoulder of the small diameter of the stub axle taper. (If it doesn't, find another hub that does!)

Remove hub carefully so as not to disturb the blue markings on the bore. There should be continuous contact over bands at both ends of the bore. If not, then lightly lap the tapers together using fine grinding paste and repeat the bluing procedure until the hub is well seated. After lapping, clean both tapers with meths until wiping with a Kleenex produces no dirtying of the tissue.

Reassembly is basically a reversal of the dismantling procedure, but a few points should be noted.
1. The cardan shaft/gearbox flange bolts have a habit of working loose. When assembling, clean the threads thoroughly with a degreasing solvent and apply Loctite, Grade 242 before tightening.
2. Fit new inner and outer oil seals and wheel bearings. You don't want to go through all this again for the sake of a few dollars.
3. Pack wheel bearings and oil seal recesses with a multi-purpose lithium-based grease such as BP Energrease L2. The bore of the hub between wheel bearings should not be packed with grease, but should have a moderate coating only.
4. Do not use a locking washer under the inner ring nut — just tighten as much as possible.
5. When engaging splines of driveshaft into cardan shaft, coat the splines liberally with a grease containing molybdenum disulphide (such as BP energrease LMS 210) To ensure constant velocity it is essential that one axis of spiders in the outer universal should line up with one axis of the spider in the inner universal joint.
6. Always fit new keys between stub axle and hub. These are a fairly common general engineering item and can be obtained at most engineering supply houses. Try to but keys wider that required, then reduce width by filing until the key is a snug fit in both stub axle and hub.
7. Tighten hub nuts to 216 lb-ft and fit new split pins.

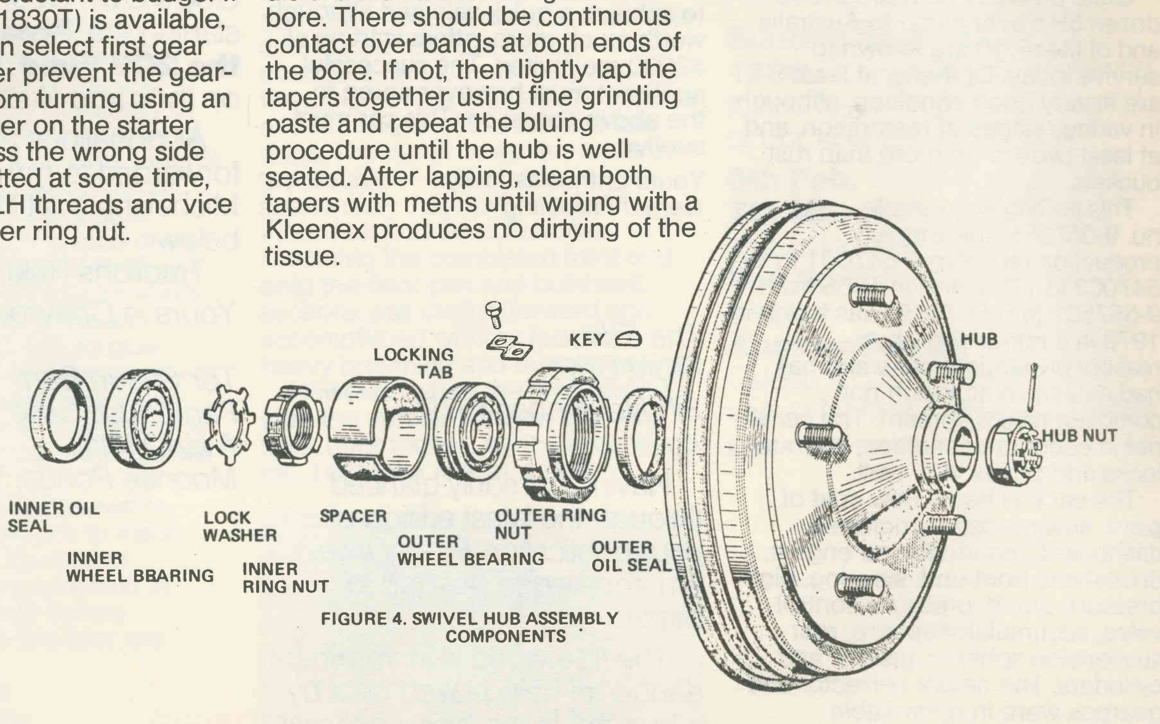

FIGURE 4. SWIVEL HUB ASSEMBLY COMPONENTS