

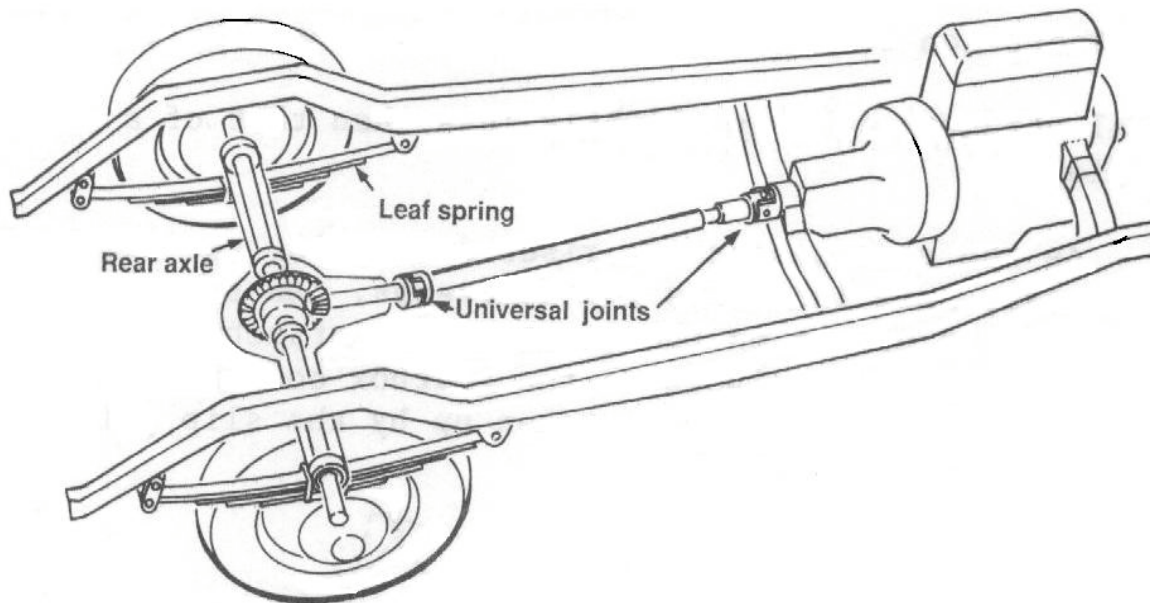
PIG IN A POKE

Clive Elliott describes how constant velocity joints work with particular reference to the Humber Pig, by drawing on official documents, offers solutions for those Humbers which have 'broken axles'.

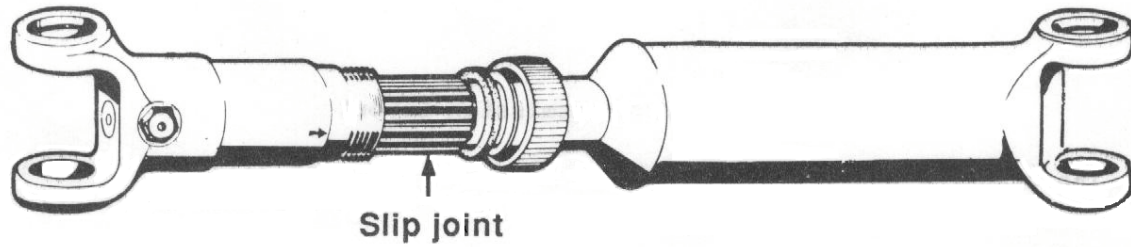
The dictionary defines a 'pig in a poke' as 'goods purchased without being seen beforehand'. It would seem most unwise to ever buy a vehicle over the phone without satisfying oneself that the vehicle is indeed up to the standard described by the vendor. Unfortunately most interesting vehicles are never in the same county, they always seem to be several hundred miles away, add to this the rarity of the vehicle, and you can end up buying something which you later regret. This happened to me when I purchased a very rare variant of a Humber Pig, I soon discovered when I was stuck in a ditch, that I had in effect purchased a 4x2 rather than a 4x4! But it is not unusual for Pigs to have 'broken axles' and in fact records show that during the early 1970s the British Army in Northern Ireland had about 80 Pigs off the road at any one time due to such problems.

I have traced through the REME reports of the time and the related modifications in EMERs, and with the parts list for the different Humbers came up with some ideas, which may help others. The Humber 1 Ton has used three types of constant velocity couplings in the wheel stations, Tracta, Chobham and Birfield, which functioned with varying degrees of success. But first a description of more simple joints and their purpose.

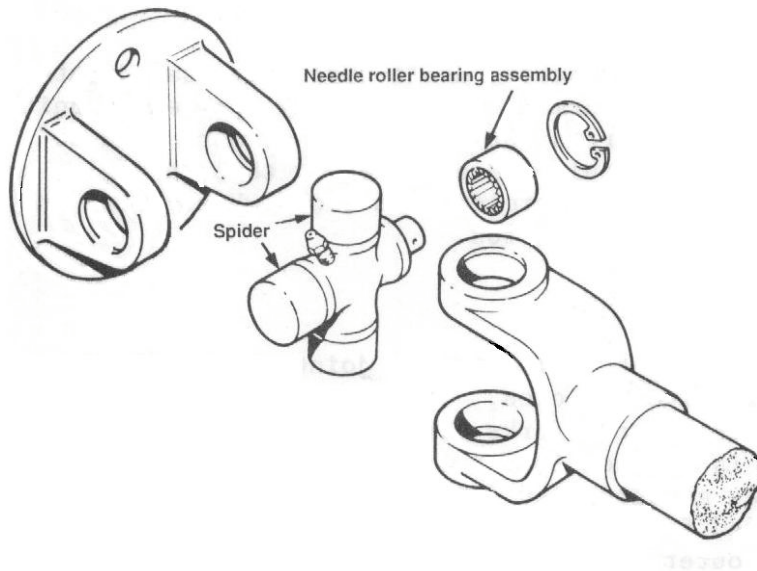
The expression Universal Joint generally refers to the joint used to transfer power from the gear box of a front engined, rear wheel drive vehicle, via the propeller shaft and then to the differential. It provides a constant velocity by the use of two such joints, and allows for movement of the suspension by a slip joint in the propeller shaft.



Propeller shaft

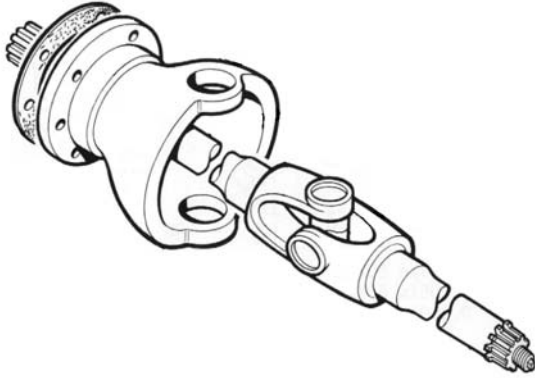


Hardy-Spicer Universal Joint



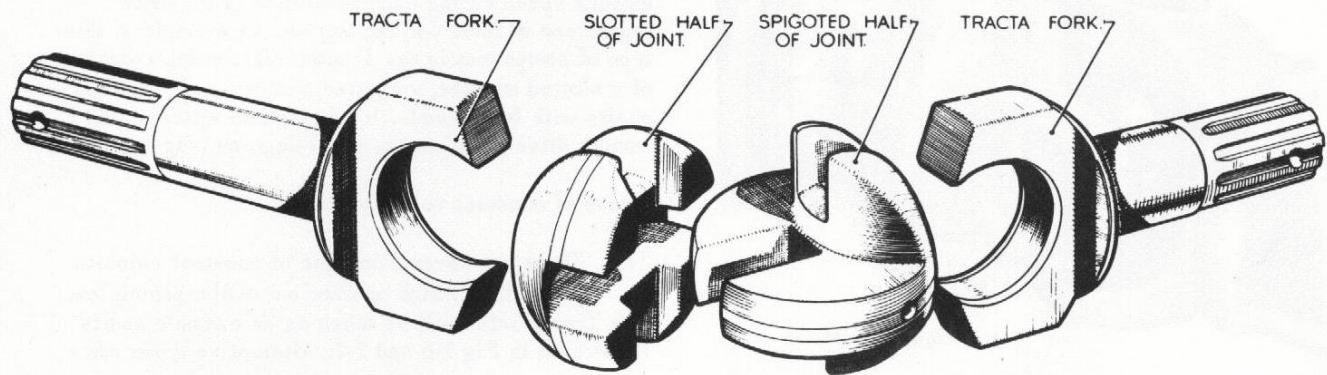
Generally Universal Joints would not transfer steering and driving forces through angles of more than 20° . Although Universal Joints provide a constant velocity coupling, the term Constant Velocity Joint is reserved for joints that operate efficiently through angles of up to 40° , such units are fitted on front wheel drive vehicles and armoured cars with independent suspension. Although Land Rovers do use a modification of the Universal Joint in the front wheel stations.

Land Rover 'Swivel Pin' joint and housing

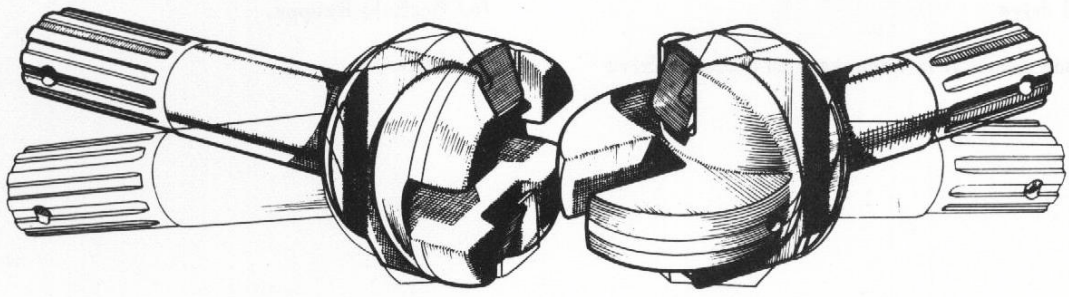


Tracta Joints

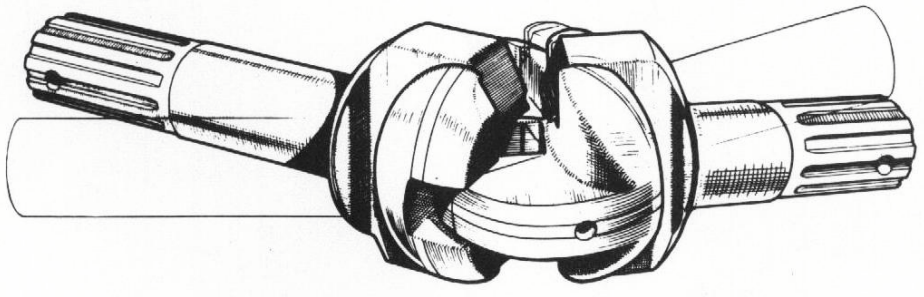
For joints that have to transmit more substantial forces, the Tracta joint is often used. Each joint consists of two Tracta forks which are able to move together through a knuckle comprising a slotted half and a spigoted half i.e. a tongue and groove arrangement. For vehicles that have independent suspension such as the Humber 1 Ton two joints are required for each of the four wheel stations.



(a)

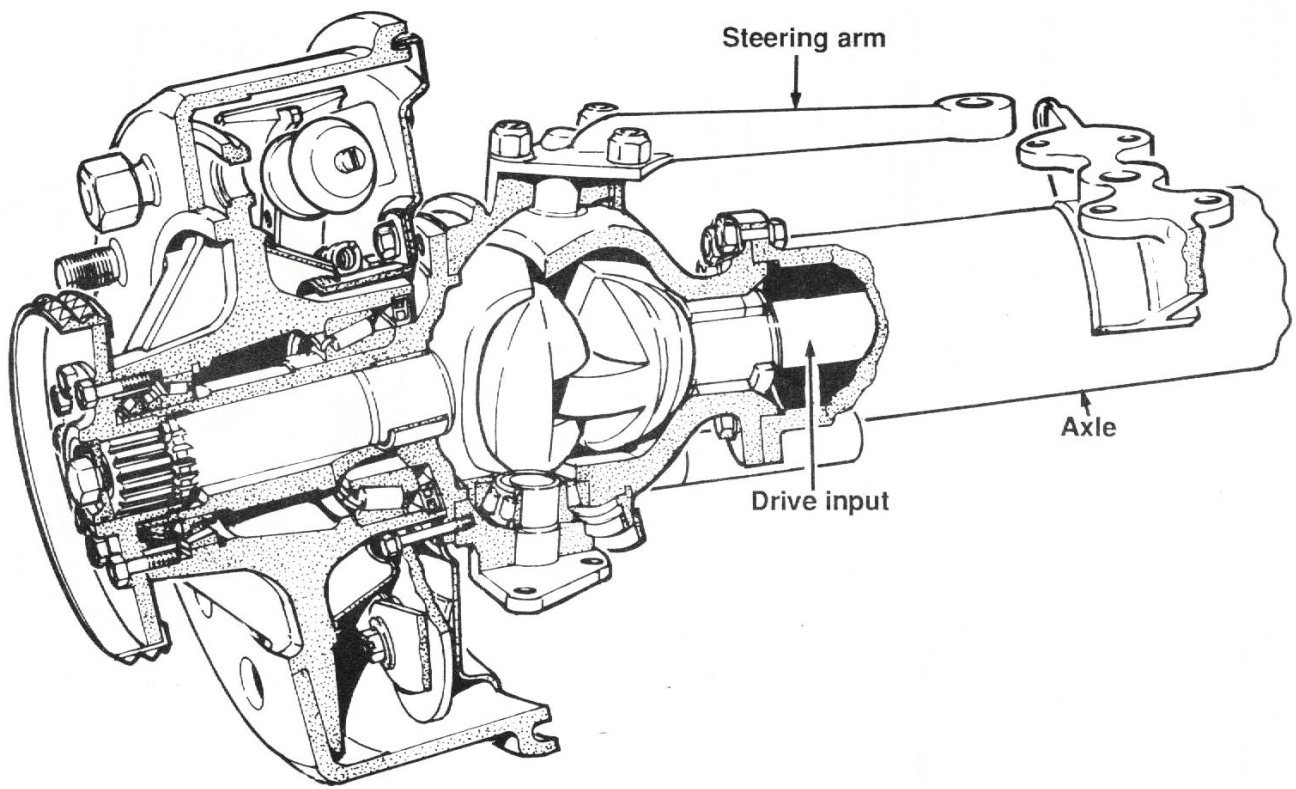


(b)

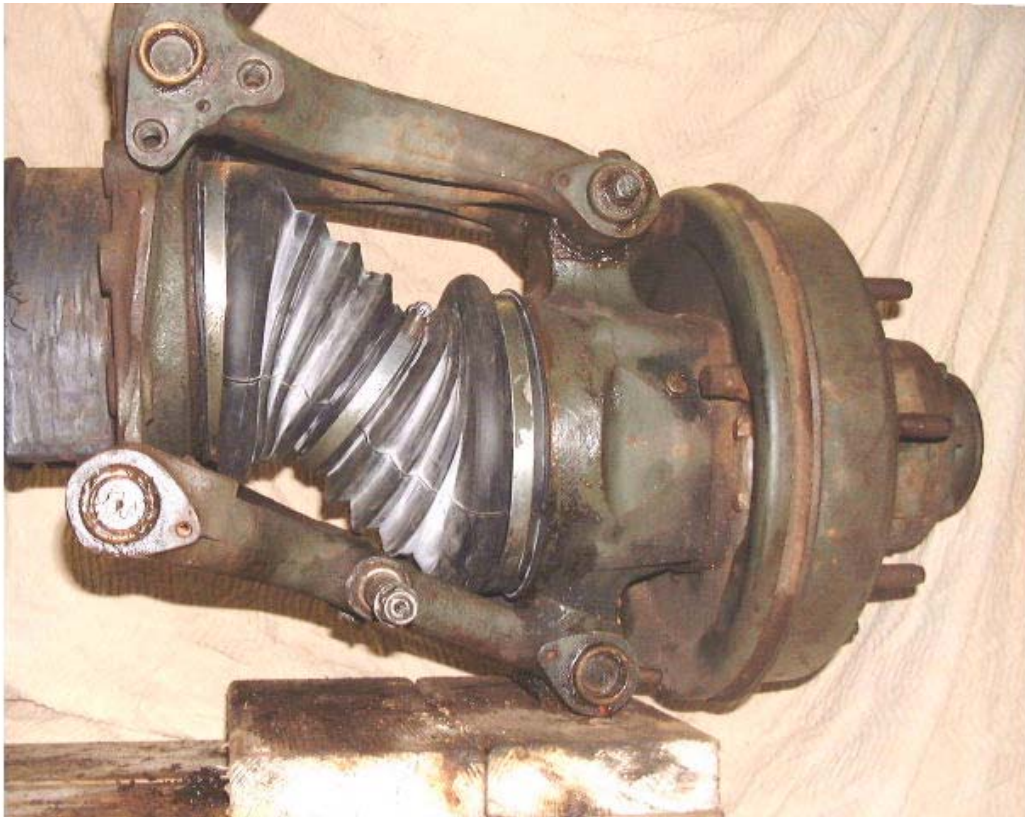


(c)

Diagram (a) shows the joint separated, (b) how each articulating half fits into its Tracta fork, (c) the assembled joint showing the range of movement.

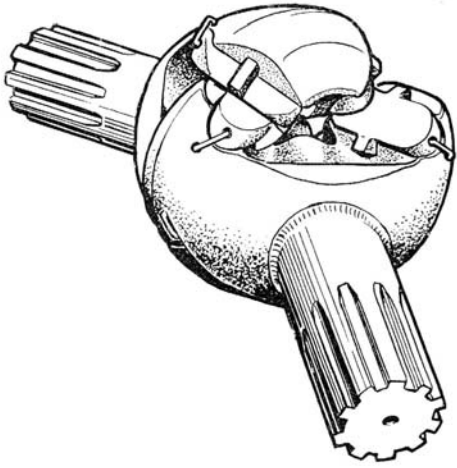
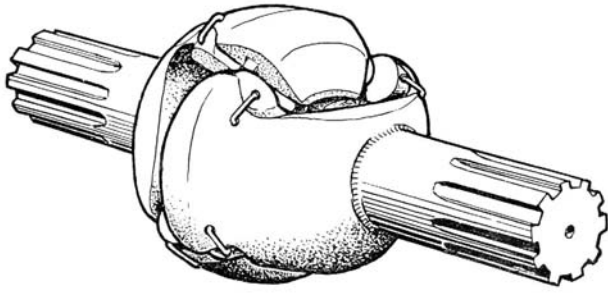


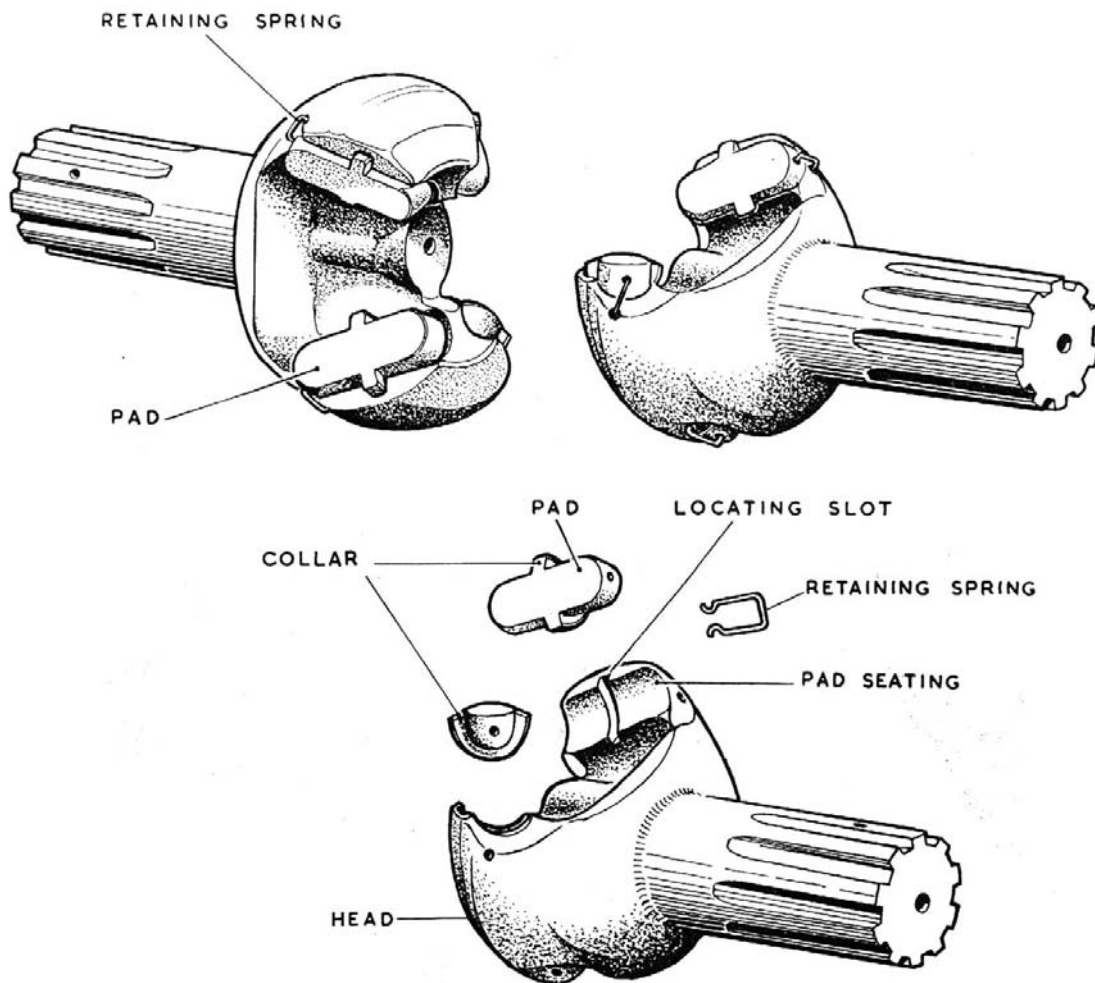
A single Tracta joint used in the front wheel of a typical four-wheel drive vehicle, without independent suspension. Independent suspension means a system where each wheel station is sprung independently, so that each wheel is free to move without necessarily being affected by another wheel.



The photograph shows the versatility of the wheel station of the Humber 1 Ton. Drive from the differential on the left is transferred through the Tracta joints, contained within the rubber gaiter, down to the hub, which allows the wheel to still remain at right angles to the ground. As this particular wheel station is not yet fitted back on the Humber there is no suspension, so the wheel station is free to drop at least four inches. It has the capacity to rise level with the differential and by four inches above the axis of the differential. The front wheel stations of all Humber 1 Ton Trucks were also fitted with Tracta joints giving the FV1600 series useful off-road capabilities.

The Humbers GS Trucks used the same drive shaft and associated Tracta joints front and rear. In 1956 twenty armoured trucks were developed for troop trials, these were designated FV1609, and were the forerunners of the Pigs. They lacked armour protection for the rear crew compartment, although having larger wheels, and a different ratio transfer box they still had the same gearbox and wheel stations. The result of these trials was the development of the famous Pig, which was now fully armoured at the rear and used a lower ratio gearbox. The rear axles of Pigs (FV1611/2/3) required Chobham type axle joints, which were considered to be more robust than the Tracta type. The Hornet missile launcher (FV1620) being based on the automotive components of the Pig also used Chobham joints in the rear.





Each half of the Chobham joint consists of a spherical slotted knuckle incorporating hollows to accommodate steel pads, these articulate against similar pads in the other half of the joint. The steel pads have polished surfaces and are retained by spring clips; it was these clips that were to later cause serious problems for the serviceability of the Pig. Pads were never to be replaced individually, instead a complete axle shaft with Chobham joints should be fitted. It is unhelpful that official descriptions of the joints often use the term Tracta, to include Chobham as well as Tracta joints. Although one REME document refers to “tractor” joints!

The Humber 1 Ton chassis was introduced into service in 1952, and there were 3,700 of them. The various models were phased out of service to be stockpiled during 1963. The exceptions were the Humber's associated with Malkara missile system, which although introduced in 1963, went out of service in 1968. When the Army moved in to “support the civil power” in Northern Ireland in 1969 the Humber Pig seemed the most appropriate vehicle, within a year about 200 Pigs were deployed, including ten requisitioned from the RUC. The view at the time was that these old vehicles might have to remain in service until perhaps 1975 when presumably the “troubles” would have been resolved. Although regarded as fairly old they did have relatively low mileage for ‘B’ vehicles, but it was of concern that in a four month period, of these 200 odd Pigs, 139 of them needed workshop repair.

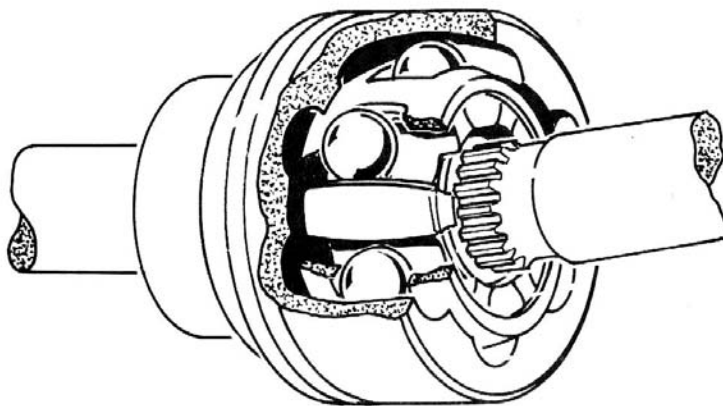
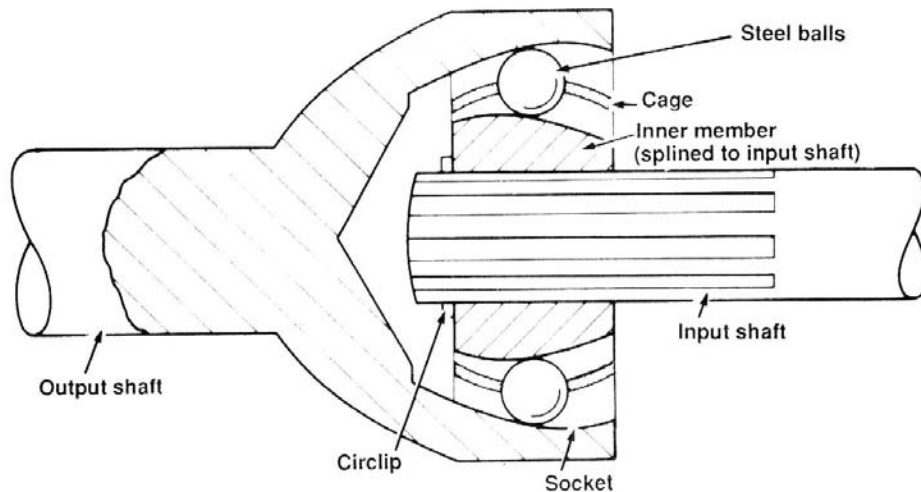
The most frequent problems related to the rear axles and their wheel stations, the ratio of rear axle to front axle failure was 40 to 1. It was found that some Pigs did not have modifications to the Tracta/Chobham joint housings which allowed the effective flow of oil to the joint, these modifications should have been carried out to front and rear axles of all Humbers in the 1950's. Also the lubrication points should have changed when Chobham joints were fitted (i.e. when the GS Humbers were made into Pigs), by early 1972 there were 60 Pigs found not to have this modification. An investigator from Vehicles Branch REME was concerned that axles may not have been correctly aligned, and this was causing joint failures, in order to assess the extent of the problem, 10% of the fleet were to be checked. The CREME (Commander of REME) Northern Ireland refused to do this, as it would have caused a further work load on an over-stretched workshops, and he believed all the alignment problems could be traced back to one relatively inexperienced workshop. However five vehicles were randomly selected and checked for centre axle alignment, all were found to be within tolerance. A simpler axle alignment procedure was adopted, which also allowed for the fact that some axle centres were not accurately marked and some not marked at all.

The Chobham joint proved to be unreliable, the main problem was the failure of the retaining spring for the steel pads within the joint knuckle. The springs sometimes broke or became dislodged but experience showed a noisy joint promptly repaired could avoid joint failure. Consideration was given to replacing the Chobham joint with the Tracta joint, a trial was set up to test the serviceability of the Tracta joint. By May 1972 Tracta joints had been fitted to eleven trial vehicles, in effect returning to a GS rear axle. The purpose of the trial was to assess if the "weaker" Tracta joint was indeed more reliable than was once thought. If so it would alleviate the shortage of spare joints, because the front axle from scrapped Humbers of any sort would provide a source of spares. There was an expectation that the impending up-armouring programme would include the replacement of Chobham joints with the Tracta type. The trial was hindered by the reduction in mileage by greater usage of Saracens, which were being used as a stopgap until the fleet of Humbers could be up-armoured. In one month the number of Saracens had risen from 70 to 298. But the use of the RPG7 prompted the need to up-armour the Saracen itself. By the summer of 1972 there were 437 Pigs in Northern Ireland.

The development of the up-armoured Pig was the responsibility of mV. The process of providing that extra armour was "Operation Bracelet" which was carried out by 34 Central Workshops at Donnington and commenced in September 1972. Whilst these Pigs were out of circulation being modified, the shortfall of vehicles was taken up by 200 Pigs which were repurchased from scrapyards as far away as Libya. But the work required getting these Pigs serviceable far exceeded the original estimate of 125 hours per vehicle. The up-armouring programme also included the replacement of Chobham joints by Tracta joints. But at the same time nearly half of the eleven Pigs in the trial had had a Tracta joint failure, this was disappointing as the joint was less reliable than expected and it seemed that there would not be enough Tracta joints for the up-armoured vehicles. This was despite the manufacture of new Tracta joints, although even this was disrupted by the gas workers strike of February 1973. The supply of Tracta joints was already critical with the Northern Ireland workshops trying to keep the Pigs roadworthy and mainland workshops up-armouring and refurbishing wheel station with Tracta joints.

Two months into the Tracta trial eight of the eleven vehicles had had a Tracta joint fail; the average failure rate was after 3,692 miles, although there was no correlation between failure and mileage rate. But whatever the outcome of the trial there were simply not enough Tracta joints available. Each month there were about 150 wheel station failures, due to the shortage of Tracta joints, workshops were having to fit the even more troublesome Chobham joints from scrapped vehicles and recovered from the Pigs being refurbished in the up-armouring programme on the mainland.

After much deliberation MOD (E Man 2) announced the Birfield joint had been chosen as the replacement for the rear axle.



The Birfield joint was basically a self-aligning ball bearing, allowing drive transmission through 40°. A splined input shaft engages a member with a series of cages, each with a steel ball able to move within cages contained in the output shaft. A Royal Armoured Corps document states that because of the relatively small contact area of the balls, the joint is not well suited to heavy-duty use. It was therefore very important that the reliability of the Birfield joint was thoroughly tested. Unfortunately the trials surrounding this joint went on far longer than expected, in fact long after the production of the Tracta joints had ceased!

There was also an expectation that the Birfield joint would have been available sooner. To add to these problems was discovery of a defective batch of 400 suspension unit housings which slowed the process of workshop repair even more, replacement of these was to take six months. These were desperate times, but it is ironic that the Chobham joints which had proved to be so troublesome were now being put back into circulation which in due course would only make the crisis in the workshops even worse.

Operation Bracelet was completed on 29 June 1973 when 487 Pigs had been up-armoured, but the Birfield joints were not yet fitted. During June 1973 wheel station failure was running at 120 per week. Despite MVEE's assurances, the Pigs did not like carrying an extra 2000 lb of armour and it was taking its toll. The Implementation Instruction for the Birfield modification was not issued until 8 March 1974, even then there had to be a training period for fitters, and after that a delay whilst a stock of assembled Birfield wheel stations could be built up. The policy was to fit the Birfield wheel stations as a repair, and then during routine servicing, by October 1974 the task was nearing completion, and there were no wheel station failures! At this point the supply of Birfield kits ceased due to a lack of steel from West Germany for the drive shafts. With the apparent success of the Birfield joints a new problem started to emerge, the half shafts started breaking! A few breakages occurred during reversing, so instructions were issued to drivers to engage four wheel drive when reversing. By December 1974 twenty failures had been identified. A pattern was emerging:

Outer Drive Shaft	LV6 MT10 (2520-99-822-1935)	7 failures
Inner Drive Shaft (short)	LV6 MT10 (2520-99-822-1930)	8 failures
Inner Drive Shaft (long)	LV6 MT10 (2520-99-822-1776)	5 failures

The outer drive shaft failure seems high, but bear in mind there is one each side. The short inner shaft seemed to be more vulnerable as it is less able to twist than the longer shaft. Careful driving technique was emphasised, but an investigation revealed that some differential cases had been filled with the wrong lubricant, in fact a mixture of OEP 220 and OX 320. It was reported that in one case it caused the pinion to fail, I have now discovered an identical failure in my Pig! This non-pouring greasy mixture was not intended for the rear axle, OEP 220 alone should have been used. The Servicing Schedule required the wheel station housings, on re-assembly, to be filled with premixed lubricants in the ratio OEP 220 (1 pint) to OX 320 (1/8 pint). Subsequent topping-up to be OEP 220 only.

The half shafts for the Tracta and Chobham joints formed part of the joint itself whereas the Birfield joint is separate with splines to accommodate separate half shafts. This meant that the time and cost of repairing a half shaft on a Birfield joint was relatively small, and MVEE thought it better to leave the shafts as they were, rather than upgrade them and run the risk of putting extra loading on the Birfield joint.

It is of enormous credit to the REME Workshops in Northern Ireland that working under such difficult conditions, they were able to repair and modify so many vehicles at times without the proper supply of spares. It is of no surprise to read in reports of Workshops in a "hand to mouth existence" and at times in a "tug of war" with the mainland trying to obtain the necessary parts to do their job. So I have to admit that me spending several months rebuilding two wheel stations seem rather pathetic in comparison.

About 30 Mk 1 Pigs were retained and not up armoured, of the 487 Mk 2 Pigs only 383 were subsequently fitted with Birfield joints. So if you had a Pig that served in Northern Ireland you will not know for certain what type of wheel joint you have. The best way to never have to find out is to drive the thing with care and make sure you lubricate everything with the correct lubricant regularly. Remember that despite the wheel station lubrication points having grease nipples, do not use grease, you must top up with OEP 220. The only reliable way to lubricate the suspension arms is to take the wheel off and get looking for the nine (it can vary) associated grease nipples. If you don't do this your suspension will not work properly, and when you drive along will get a rumble from the flat spots on your tyres.

If something in your rear axle fails, then you may be able to find a scrap Pig to do the necessary transplantation, but bear in mind that if Birfield joints were fitted they were pretty reliable so it is likely to be one of the drive shafts that has failed. The drive shafts are in short supply, as the Army frequently had to replace them; enthusiasts sometimes experience the same problem.

A scrap rear axle seems to cost at least £250, consider fitting the Tracta joints from a GS Humber, we know from the Army experience that Tracta was a more reliable proposition than the Chobham originally fitted to Pigs. Besides there are unlikely to be many scrap vehicles that have Chobham joints. The other great attraction is that if you have Tracta joints at the rear, should a failure occur a source of supply is from the front axle of any Humber 1 Ton. It is unusual to have a front joint fail and there will be a relative glut of Humber both GS and Pigs Mk 1 & 2 that have long since had their rear wheel stations robbed, but their front wheel stations have been abandoned as useless. Looking at the parts book:

LV9/BOE/FV174720 SHAFT, driving right hand

LV9/BOE/FV174721 SHAFT, driving left hand

These parts are for the front of any Pig and are identical for front and rear of the GS Humber. It would seem from the figures that there were about 134 Pigs Mk 1 & 2 that served in Northern Ireland that would have still had Tracta joints. So if your Pig was one of these then you have a good source of supply from the front units on any Pig or GS Humber. If you have a Mk 2 Pig with Birfield joints, and have a broken drive shaft, it would be worth looking around for the rear axle of a GS Humber rather than another Birfield axle, so when drive shafts break there are more spare Tracta ones around than Birfield. There is a belief that it would be foolhardy fit a rear axle from a GS Humber to a Mk 2 Pig, as it would not be strong enough. Bear in mind when the Mk 2 Pig hit the streets of Northern Ireland it was the Tracta joints that had been retrofitted, the Birfield came a bit later. It is unlikely that our Pigs will ever be loaded with troops and equipment of a serving Pig. Away from the heat of battle our driving techniques will hopefully be more sympathetic, and coupled with regular servicing, there should be little need to do major repair work unless you are foolish enough to buy a Pig in a Poke!



A warning to us all! The twisted splines on a broken shaft from a Birfield joint.

Disclaimer and acknowledgement

The information given here is provided in good faith it has been drawn from technical documents of the time and my own experiences. It is up to an individual to verify for themselves the suitability of the information provided and take professional advice before embarking on modifications. Much of the statistical information was drawn from the REME Museum Arborfield who hold a vast stock of archive and technical material. I have found that if you have a genuine interest in a particular subject they will go to great lengths to assist you.

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