

## **Fitting modern drive shafts – not as simple as it seems!**

This document is the outline of a presentation by Ian Macdermott at a CCOCA meeting in 2019.

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### **Issues with drive shafts, and why they needed to be replaced**

- Badly worn splines
- Shot universals (inner and outer)
- Bearing seal surfaces worn
- If overhauling, possibility that eyes in yokes are worn, possibly holes in flange worn too
- Related problems include:
  - Suspect tapers in drums and also on shafts
  - Brake drums worn towards upper limit of diameter
  - Threads on stub axle and nut get distorted

### **Not a simple repair job**

- Either remove engine and gearbox and take shafts out via engine bay, or leave engine and gearbox in place and remove shafts by breaking lower ball joint
- Special tools required to repair outer joints
- I lack skills to make the tools to rebuild the universals, rectify eyes of yokes, etc.
- Cost to repair original shafts vs. cost of new shafts
- Expect shorter life of refurbished originals vs. new shafts with today's CV joint design

### **Originality or not?**

- La Traction Universelle, in France, has been getting original Citroen drive shafts rebuilt by a company called Dupa. If wanting strict originality, and prepared to pay the costs, that could be an option.
- An article in Traxion, the Dutch club's magazine, says one of their suppliers hasn't bothered with refurbishment since 1990, because it is too expensive, given shorter life of the shafts.

### **Options for replacing shafts**

- Refurbish original Citroen shafts, or find refurbished ones.
- Fit new shafts made by Morrisons in Bendigo.
- Buy shafts from an overseas supplier, e.g.
  - Roger Williams (UK)
  - CTA, CAS, Jose Franssen (now owned by CTA) or other European supplier
- Fit Austin 1800 shafts, plus machine splines in hubs
- Find a current car which has suitable shafts which would fit without too much trouble

### **Decision: Morrisons**

- Cheaper than importing new shafts
- Quality of new shafts available in Europe is an unknown

- I had two decent stub axles, and two good inner halves of inner universal joints, so I had parts required by Morrisons.
- Local manufacturer to deal with if there are problems with manufacturing quality
- Universal joints should be serviceable in Australia – Neapco/Spicer inner universal, and Corolla outer CV joints
- Morrisons had already done 26 sets, and only problem Wayne knew about was one set which were too long. That car had an ID19 gearbox (wider than a Traction 3-speed box) and Wayne wasn't told about it. Shafts were shortened using a local engineering company, and have performed OK.
- Not sure how Wayne attaches the Citroen stub axle to new Corolla CV joint, but even if that connection fails, the stub axle will stay attached to the car.

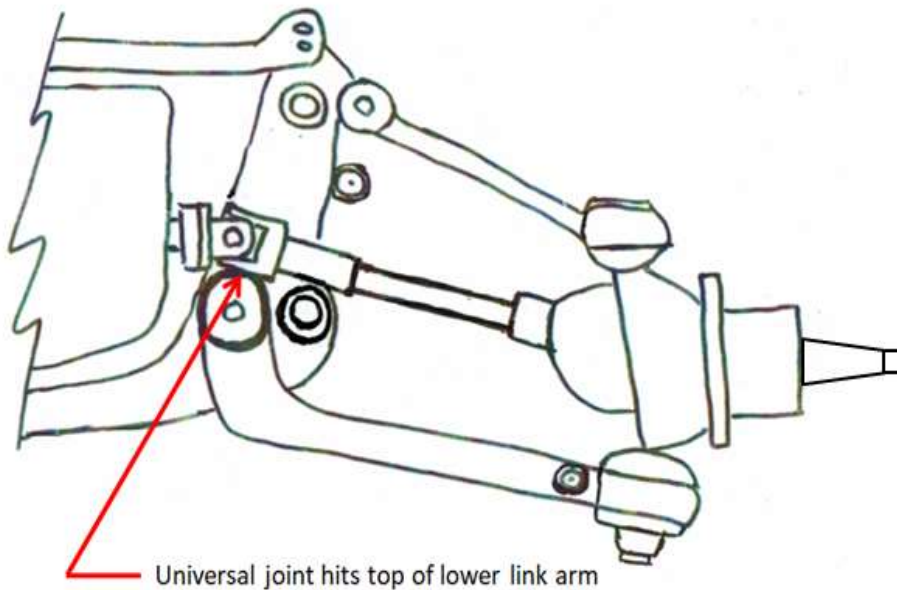


**So what didn't work out as easily as expected?**

- I noted the shape of the new inner joints when I picked the shafts up, and assumed they were OK based on nobody reporting trouble.



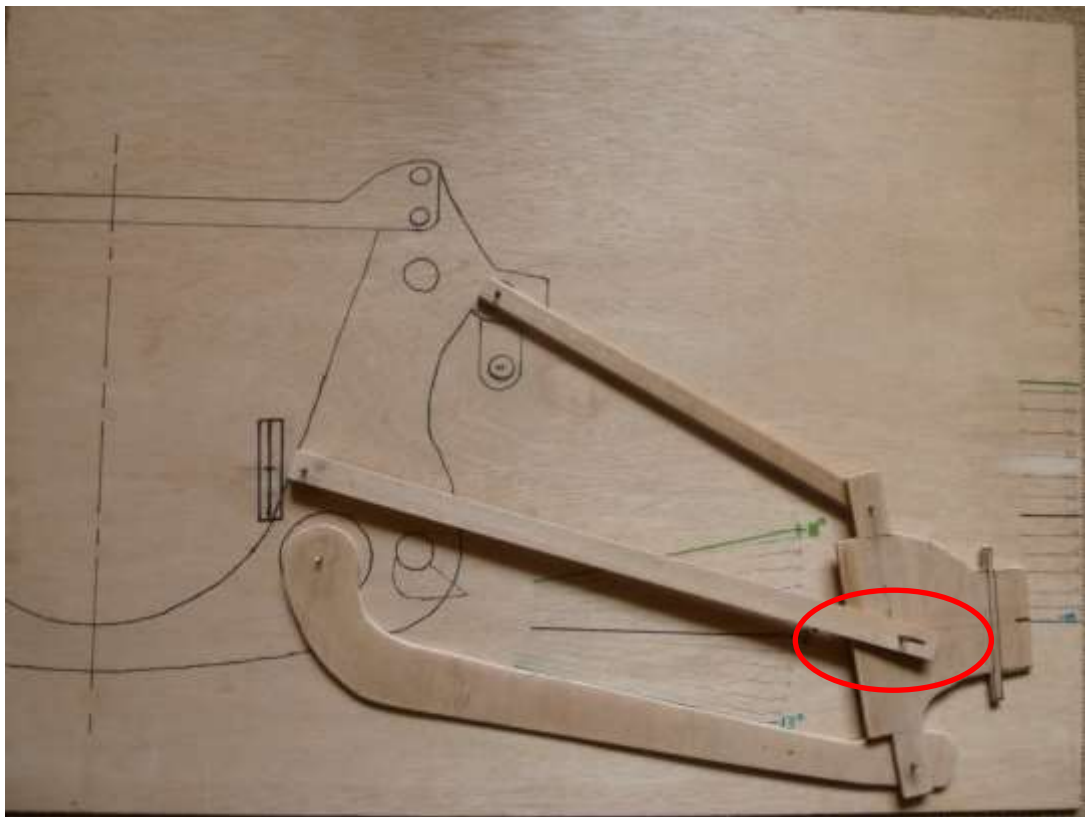
- I had lent my engine stand to another club member, so I fitted the shafts by breaking ball joints as per the procedure outlined in the workshop manual, rather than by removing the engine and gearbox and working from the inside of the cradle.
- The result: Clunk, clunk, .... Click on link to play a YouTube clip.  
[Traction drive shaft conversion](#)
- The inner universal fouled on the lower link arm of the suspension when the suspension was hanging down.

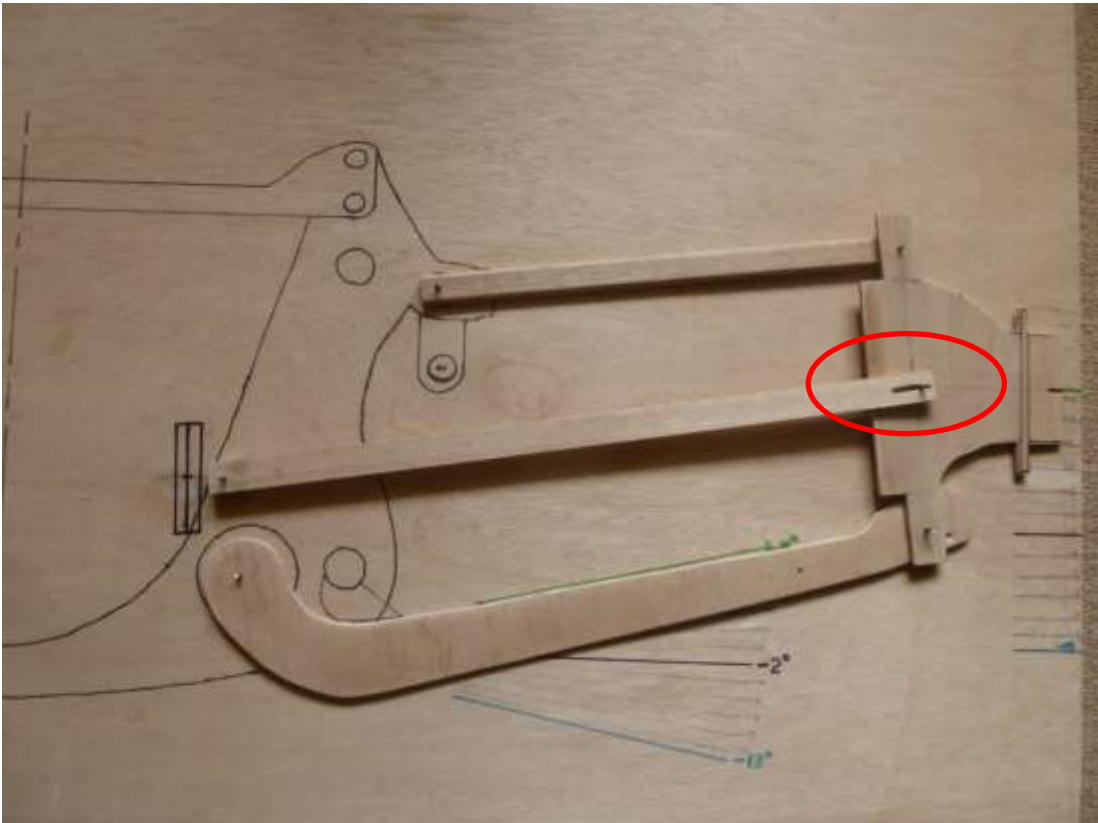
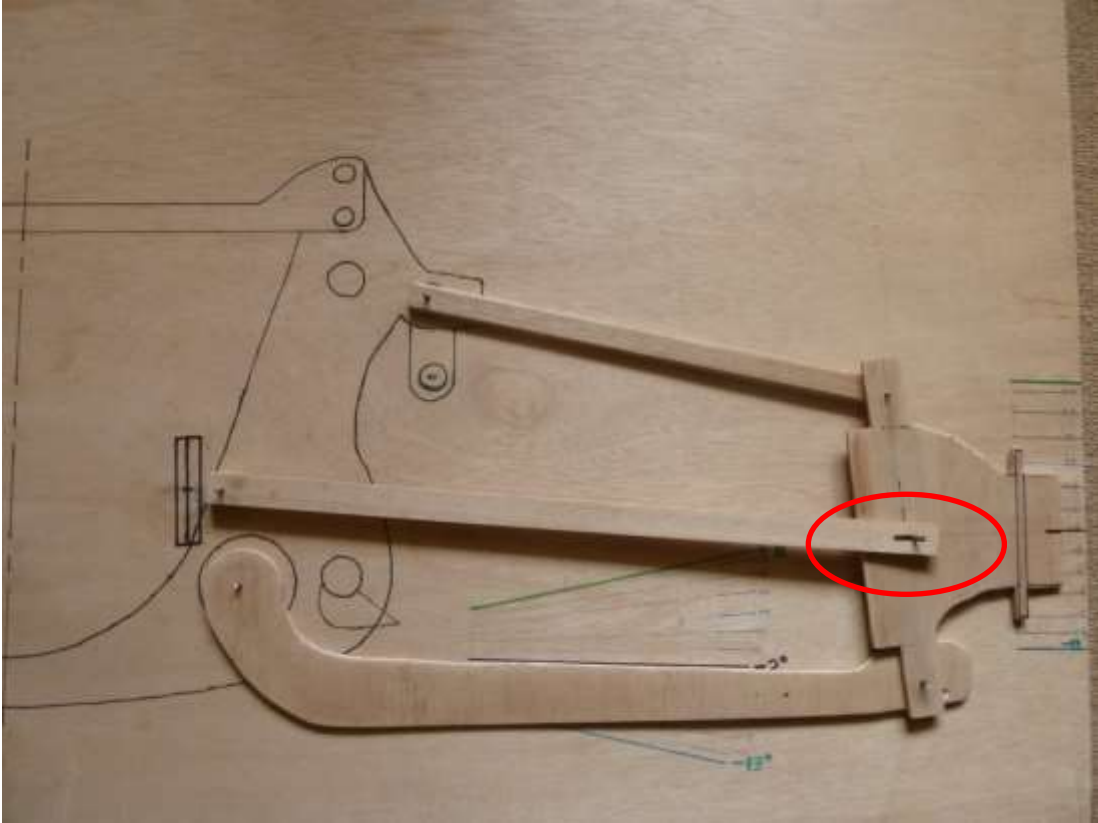


- I noticed that if I lifted the swivel housing, the clunk disappeared.

**Next question: If lifting the swivel eliminates the “clunk”, what stops suspension travel?**

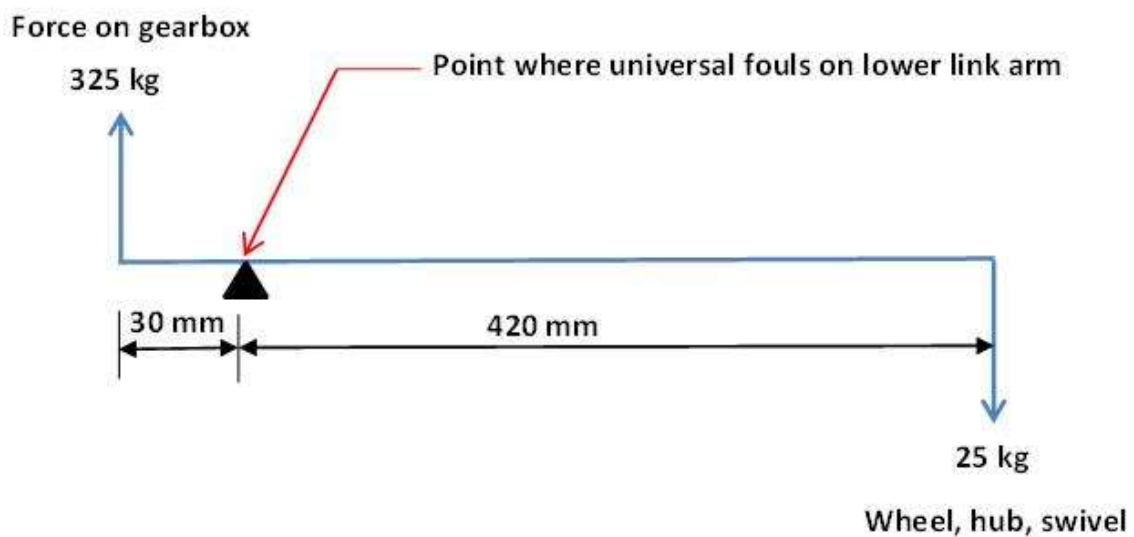
- Up
  - Rubber buffer on lower link arm, and design of axle cradle
- Down –
  - Some people said it was the shock absorber reaching maximum length. That is not so (60 mm travel left when suspension is hanging down).
  - It turns out to be drive shaft shortening to its minimum length is what limits suspension travel.
- Wooden model.
  - Demonstrate length of shafts as suspension goes up and down.
  - Demonstrate length of shock absorber.
  - 1 mm difference in shaft length makes a huge difference to travel distance of suspension.





### Options to solve the problem:

- Lengthen the shafts to reduce travel of the suspension. I didn't think this is a good idea:
  - Suspension needs to be allowed to travel to its design maximum without doing any damage to something else. Chances of needing maximum suspension travel are slim, but one day it might be necessary.
  - If interference is not removed, forces exerted on the aluminium gearbox housing are likely to cause catastrophic damage.

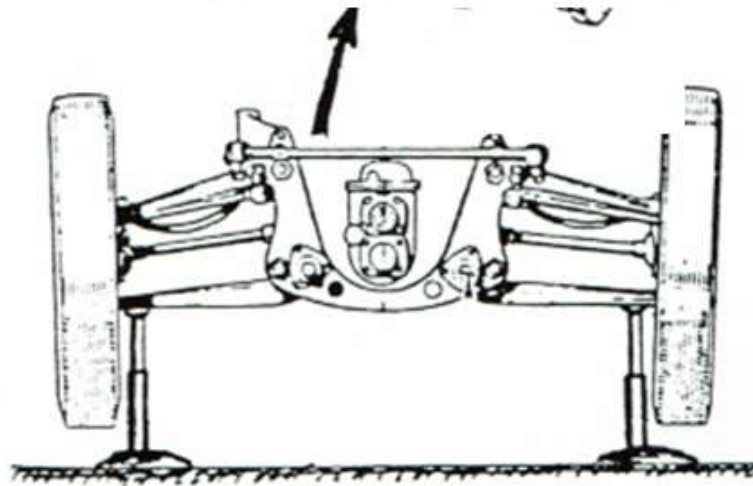


At 85 km/hr, force is hammering on gearbox at 50 Hz

- Limiting suspension travel increases risk of losing contact with the road, leading to no steering and no front brakes until the car hits the road again.
- Longer shafts would make it difficult, if not impossible, to disengage the shafts from the gearbox far enough to lift out the engine and gearbox.
- Remove metal from the yokes, at the place where the interference was happening, to create clearance and stop the "clunking."

Let's digress for a moment – how do you disengage shafts in a Traction so you can lift the engine and gearbox out?

## Removing engine and gearbox



Jack up at ends of lower link arms:

- Wheels off the ground so drive shafts can be rotated to provide access to nuts on gearbox
- Drive shafts are at maximum length
- Inner universals can be then disengaged from gearbox and slid away, so engine can be lifted

Sketch taken from early edition of Front Drive – so nothing new!

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### What happened next?

- Options for removing metal
  - Wayne Morrison offered to grind it off, but I had no idea how much to remove
  - Use a lathe – I haven't got one, and it would require some dismantling to set the parts up for machining
  - Use a half round file. If you are getting into trouble, at least you are doing it slowly!
- Question was how much metal to remove? Impossible to measure anything in a really confined space inside the cradle, and it is almost impossible to see what is going on.
- The trouble with experimenting is you have to assemble the shafts in the swivels, and install the ball joints to see if you have taken enough metal off.
- Assembling bottom ball joints is a pain. A small tab of steel bolted onto the lower link arm to hold the spring and ball in place while inserting the key and screwing on the nut makes the job much easier!



- I took a conservative approach, taking 1 mm off at a time, and finished up doing the first one 5 times before noticing something about original Citroën shafts.
- I had some old inner universals which were relieved at exactly the point where I was having trouble. (Leads one to suspect that Citroën knew about this interference problem, and maybe not all suppliers made identical length shafts)?
- Photos from Dave Gilbert show that there are several variations of universal joints – maybe from different years or different suppliers.





- I even found one universal in which the plug had been removed, which would allow the shaft to shorten even further than as originally built.
  - Might be convenient for removing the shaft from the car
  - Potentially dangerous if it allows the universal joint to hit the lower link arm.
- The diagonal measurement of the Citroen yokes at the interference point was 64 mm. I had reduced from 76 to 71, and still hadn't eliminated the interference.
- OK, go for it! Got down to 67 mm and thought things were starting to look a bit too thin, so I stopped and fitted them the car. No Clunking!



- Took the other one down to 68 mm. No clunking on that one either. After driving 1,000 km since refitting the shafts, including all sorts of terrain, they haven't broken. I think they will be OK.
- Answer seems to be a diagonal measurement somewhere between 68 and 71 mm.

#### **Is this a problem which other people might have?**

- It probably is not a problem with an 11B / Big 15, because the cradle is some 30 mm wider than on a narrow-bodied car (11BL or Light 15). The outer end of the yoke might be able to go past the lower link arm. But it would be worth checking – just jack up under the cradle, let the wheels hang down, and rotate them. If there is a clunk, there is a problem!
- 4-speed ID19 gearboxes are wider than Traction 3-speed gearboxes. That means the shaft length needs to be shorter, anyway. That means the inner end of the yokes might clear the lower link arm.
- I think Morrisons shaft length is exactly the same as the original Citroen shaft length when the shaft is at its minimum length. But if not, the problem could be better or worse than I had.

#### **What can be done to prevent this problem for future purchasers of new drive shafts?**

- Different inner universal. Wayne Morrison reckons he doesn't make much out of doing these shafts, so a redesign would probably add cost, if he even wanted to spend time on researching it. (Rob Little is going to talk with Wayne).
- Buy new shafts from a supplier in Europe, like CTA or CAS. Landed cost would work out to about \$1,000 each, depending on whether the GST man gets interested vs. about \$800 from Morrisons. But you get a new stub axle included in that price. CTA and CAS joints have a CV or tripod inner joint, which is better than a Hooke joint, because it provides constant velocity at all angles. There must be a question mark about quality, given some of the horror stories coming out of Europe about new parts being sold for Tractions. Rob Little is making inquiries with Rob Koffijberg, and it would be worth hearing what he has to say before spending the best part of \$2000.
- Grind a section off the top of the lower link arm (approximately 4 mm deep). Apparently this is necessary if fitting some types of CV joint. It would also be an effective solution for the Morrison shafts. It would be much easier to do if working from inside the engine bay, rather than from the wheel side. If rebuilding a front end, it would probably be a good "future-proofing" idea even if fitting standard Citroen universal joints.



## European shafts with two CV joints



- If neither of these options is attractive:
  - Roger Williams – if he is still in business. He wouldn't be cheap, but I've never heard a complaint about quality.
  - Austin 1800 shafts – getting hard to find, need the right model Austin 1800 (auto and manual are different) and the right model Citroen (wide body or narrow body) for them to match. In the longer term, serviceability of Austin 1800 shafts is not likely to get any easier. Still takes a fair bit of work to machine splines in hubs to get them to fit. (Warren Seidel produced an excellent document on this about 30 years ago). [Warren Seidel Austin 1800 drive shaft conversion](#)
  - Other car makes' shafts – will take some hunting to find something compatible and able to be adapted to suit Traction at a competitive price. (Roger Williams adapted Range Rover shafts, and it seems someone in Europe had adapted Audi shafts).
  - Rebuild original Citroen shafts
    - Worn splines are a problem without a simple solution
    - Aforementioned problem regarding tooling and skills

## Other problems with Morrison shafts

- **Lubrication difficulty**

- Difficult to fit grease gun on straight nipples without interference from the cradle. Convoluted collection of fittings is required to allow grease gun to attach to nipples.
- Threads on grease nipples are odd balls, and I haven't found a suitable angled nipple to get better access for greasing.

## Lubricating splines and inner universal



Greasing the cross

Greasing the spline

Vehicle jacked up under cradle, suspension hanging down

- A 45-degree (or other angle) outer nipple (for the splines) will probably foul on the tube containing the lower bolts which hold the power train onto the hull.
- **Oil seal surfaces on stub axle**
    - Wayne Morrison was not keen on fitting a Speedisleeve. Not clear why. Maybe because sleeve needed reducing in length, and risk of it not sitting squarely on the shaft.
    - He did build up the sealing surface and machine it to the right diameter
    - I fitted a sealed inner bearing as additional protection. Not expensive vs. a conventional bearing.

## Other rebuilding issues in future

- **Tapers of drums and stub axles**
  - Can only grind hub taper a certain amount before it goes too far up the stub axle
  - I'm not aware of any way to rebuild the taper in hub
  - Good stub axles are not easy to find
  - CTA offers new drums, claimed to provide better braking than original materials

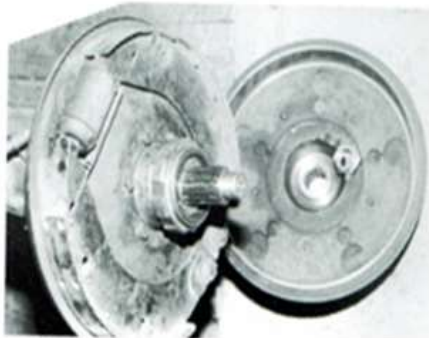
BUT

- There have been stories about bad quality reproduction drums (without knowing who the supplier was), so caution is advised

## Splined axles and hubs

- When all other options are exhausted for using original hubs and stub axles, splined shafts and hubs would be an option.
- In principle, the shaft and bearing design looks simple enough, and would have fewer stress concentrations than original design. Probably better materials and hardening processes available, too. Tapered roller bearings have about three times the load bearing capability of the ball bearings currently used.
- Roger Williams has used splines to connect the stub axle to the outer CV joint, to avoid welding.

## Roger Williams splined drive shafts



Light 15 drive shaft (splined hub fitting)



Component parts and complete driveshaft for L15 with spline drive and CV joints at each end

- Not sure what the process would be for getting approval from Australian authorities for new shaft design.
- No point doing it unless the brake drum diameter is within specification.
- If good quality new shafts with tapered stub axles and new brake drums are available, it would not be worth messing around with splining. (Put ideas about splines in the bottom drawer for now).