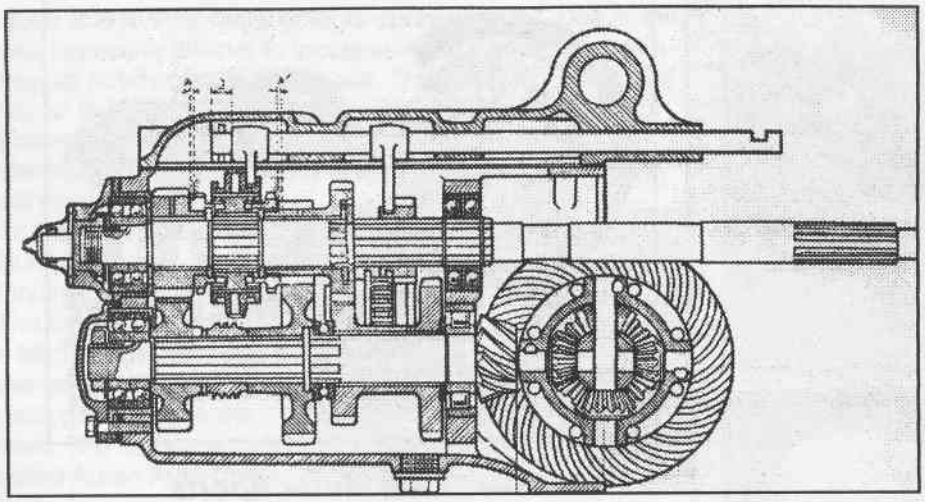
What about that second gear

by Bernie Hadaway



The "Traction Box"

Many of us listen to those disconcerting noises from the 'traction box' and wonder about the two possible sources. We all know about the main culprit but what about that 2ND GEAR that suddenly decided to disintegrate with often disastrous results?

Bad involute action, heavy scuff wear

Well, I've had two events over the years and decided to have a closer look at this failure before rebuilding my changeover box.

The problem could have started a long time ago when there was all that. confusion with the early tractions and swapping the overheating auto box for an improvised manual box.

Perhaps the communication between the hard-pressed designers in the drawing office and the blue collar lot in production was not quite up to scratch.

We all know about the main culprit but what about that 2ND GEAR that suddenly decided to disintegrate with often disastrous results?

Anyway, there appears to be three design/manufacturing shortcomings that add up to a less than optimum arrangement for 2nd gear longevity:

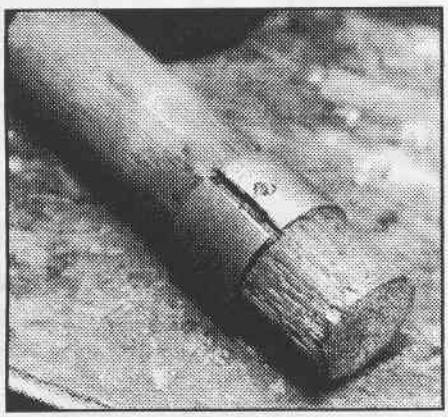
1. The main shaft 2nd gear journal is 0.09 mm. smaller than the adjacent spline which means that the bearing running clearance must be at least this amount from scratch.

2 The heavy press fit of the syncro cone locally closes the bore diameter of the gear by about .04 mm. (on the gear that I am using)

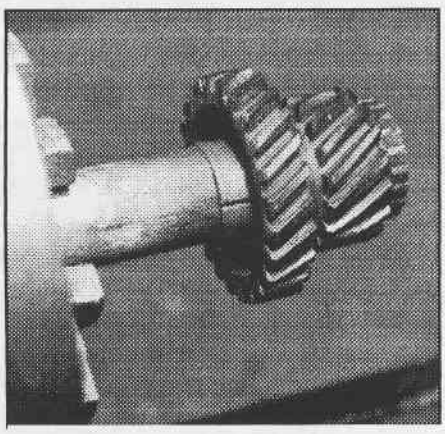
This does not help either when one has to fit the gear over the spline. When we manage to finally get the gear to its operational position it is a pretty wobbly fit even with the best of intentions.

3. The journal length does not exploit the opportunity for maximum stability of the 2nd and associated gear. I think that those blue collar lads years ago decided to reduce the shaft diameter at the spline run out and one wonders if the drawing office ever found out. The illustration in the manual suggests not.

All this makes a pretty unsatisfactory situation when things start to wear. The load applied in 1st and reverse operation aggravates an already unstable situation with high loads being applied at the end where a bearing should be - but ain't! (Inspection of worn gear bushes indicates this to be the areas of maximum wear).



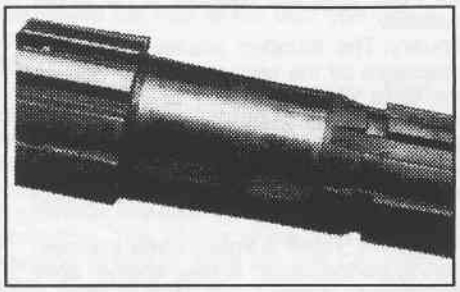
The improvised lapping tool



The lapping tool in the lathe with second gear pinion

I suspect the combinations of 1, 2 and 3 produce a condition when a worn bearing allows the 2nd gear teeth to ride high (out of mesh) adjacent to the maximum bush wear whilst still maintaining a satisfactory (in mesh) condition at the less worn bush (syncro end).

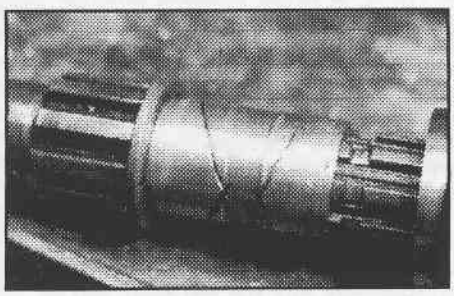
This would account for the mode of breakage that always occurs. A progressive tooth fatigue failure starting at the maximum wear end and running out progressively to surface before reaching the syncro end. Scrutiny of my worn 2nd gear tells the story. The heavy scuffing of the gear teeth where the breakages occur indicates poor involute action with high tooth flank contact - whilst the syncro end shows better contact with original surfaces still evident.



Mainshaft showing reduction of journal at spline runout

Eventually the stressed part of a tooth will get tired of all this and will drop off - hopefully to the bottom of the box. We could go on driving with the remaining syncro half doing a man-sized job for a while but more teeth will follow and noises should tell us that it's time to stop and have a look.

A possible fix-it idea was stimulated over a glass of red with Mel Carey when we realised that the IMPORTANT NOTE on page 52, para. 17 of the Repair Manual was not substantiated in fact. All bronze bushes removed from my 2nd gear pinions (I have a box full) are perfectly concentric, which suggests that the pinion bore is concentric with the gear teeth, pitch diameter. In contradiction to the Manual!



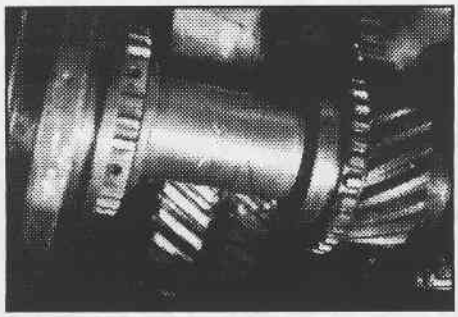
The new phos. Bronze bush installed

We considered fixing a full length bronze bush to the main shaft journal and running the bare pinion bore on the outer diameter of the bush. There are apparent advantages. One can choose an appropriate diametrical running (I've used 0.05 mm) and also get the full length bearing. Also, the greater bearing surface improve load carrying capability.

There are a few requirements. The brooched bore of the pinion will benefit from a smoother finish. This was rotary lapped in the lathe using an improvised lapping tool made from an old pinion bush, split, expanded and secured to a timber dowel. When loaded with a medium valve grinding paste it made short work of producing an accurate, excellent finish whilst fixing that closing down problem at the syncro end (No. 2). Very satisfactory.

The bore of the new bush was machined to be a reasonably tight; fit over the splines with small low-angle chamfers provided on both bore ends.

Assembly of the bush on to the main shaft, was proceeded by a good cleaning of surfaces with a fine grit wet and dry paper (used dry). The bush was then tapped over the spline onto the journal, after first positioning the thrust washer NOTE: The washer must be positioned to accept the small anti-rotation key and pre-wetteding with Loctite 680. Immediately float and wet the bush bore before it grabs (for good, we hope).



The new bush in position on the mainshaft

The chamfers are important in this process to assist with full fill of Loctite into the approximate 0.07 mm clearance which is just about right for this Loctite.

Oh, by the way, that thrust washer should be positioned to accept the small anti rotation key. The washer becomes a fixture and can't be budged.

After assembly, the four oil grooves can be filed to enter the central oil reservoir groove and that's the lot!

The box has been fully assembled but not yet installed - the original box always sounds better and the noises seem to subside as soon as one has a spare!!!

Next issue of Front Drive will feature another technical article by Bernie Hadaway based on the modified restoration of drive shaft CVs

The following article comes from "The MOTOR" October 14, 1936. I'm amazed with what surfaces from my archives occasionally. This article related to the 30th Annual British Motor Show 1936

CITROEN . . . 106

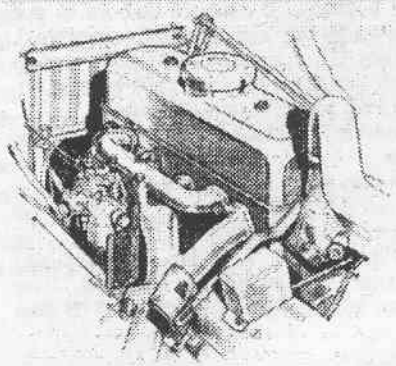
Front-drive and Rear-drive models, with Steel Coach-work, at Moderate Prices

WITH the single, exception of the saloon, which sells at £285, all these cars are front-wheel driven and are independently sprung at the front.

The coachwork is all steel and there is no frame in the accepted sense, the body being extended forward of the scuttle in two horns, between which the engine is suspended and which, extended, form supports for the front-wheel drive and suspension. An unorthodox feature is the facia-board position of the gear lever, an arrangement which leaves the front compartment free from obstruction. The cars are notable for modern lines and plenty of interior space.

The smaller models shown are the 12 hp saloon, the 12 hp fixed-head coupe and the sports twelve saloon, which model is virtually the 12 hp chassis with the 15 hp engine installed. Both 12 hp and 15 hp engines are of the four-cylinder overhead-valve type. In the "Fifteen" range the f.w.d. seven-seater saloon, which has occasional seats, and the new model, the "Family Fifteen" saloon, rear-wheel driven, is worthy of attention by anyone requiring a large and roomy, yet moderately priced, straightforward vehicle.

Amongst the many refinements to be noted on these cars are the wooden facia board, the new type of wheel, and the "Twin-Trim" upholstery, which is available as an alternative style on all models. This method of trimming is a combination of cloth and leather, the cloth being used for the centre and the leather for the edges of both seat and squab, where most wear takes place.Citroen Cars, Ltd., Trading Estate, Slough, Buckinghamshire.



In Answer to Bernie

In reference to Bernie Hadaway's informative article on second gears in the Traction Box, I posted the article on the Internet to fellow Traction enthusiasts. The following comments were returned from Roger Williams of the UK.

Dear Leon,
Many thanks for the article - here are my comments. Firstly the section in the repair manual covering the gearbox was translated from French in 1934 and referred to the A series gearbox. It was never corrected when they brought out the B series gearbox which was similar in principle but with many detail differences.

1. The majority of mainshafts I have measured have been 29.42mm diameter and the splined section should be nominally 30.00mm but is usually down to 29.97 or lower. I have never come across one that has been as much as 30.00mm diameter.
2. About ten years ago I measured approx 30 2nd and 3rd gear bores and found them all to be a little smaller at the synchro cone end usually between 0.04mm to 0.06mm.
3. I have not come across this taper on the bearing area at the end of the splines - the bearing area has usually been consistent at 29.92mm diameter.

One important point that Bernie has not mentioned are the bushes. The original specification was for two bushes, one with a left hand spiral groove and the other with a right hand one - the right hand spiral goes at the synchro cone end. They appear to have been pushed in from each end of the gear thus leaving a gap to allow the oil to be forced through the three holes drilled in the base of the teeth of the gear and out along the spiral grooves. I cannot remember a second gear where the two bushes have not crept together and closed off the oil holes drilled in the base of the teeth.

My approach has been to manufacture a new one piece bush which is a tight press fit in the bore of the gear - there is a slight undercut of about 7mm long under the holes in the base of the teeth between the two spirals. I press the bush in from the non synchro cone end, drill the oil holes through the bush and then chuck the gear in 'soft jaws' and true it before boring out the bush to suit the mainshaft. At the same time as I checked the bores of the gears I checked the angles of the synchro cones and of the eight I checked they were all different – varying from 1 in 8 to 1 in 11! Settled on a standard of 1 in 10 ie approx 6(and made a jig to this angle. Having got the bore true to the teeth of the gear I could now mount the gear on an expanding mandrel and grind the synchro cone to 6(. New inserts are put in the synchro hub and turned to the same angle.

After surface grinding the thrust washer that fits in the synchro cone end of the gear I press the gear along the shaft over the splines - in the main a clearance of 0.05mm can be achieved but what is quite difficult is getting the end float of between 0.05mm and 0.10mm for 2nd gear. Citroen never made celeron washers with a close enough tolerance to achieve this. Even if you can find original celeron washers they are unlikely to be thick enough to take up the wear that has occoured to the gearbox in the last 50 years or so. I have made a series of new thicker celeron washers which in combination with surface grinding the retaining washer allows the specified tolerance to be achieved. I must say I do not like the idea of using grinding paste to lap in the bronze bush - bits of grit will get imbedded in the bush and cause wear. Much better to bore it out which can be easily done to a tolerance of 0.01mm.

I am completely lost on the use of Loctite 680 on the anti rotation key and the 0.07mm chamfers/clearance. Could Bernie enlighten me please.

Hope the above is of interest.
Best wishes Roger Williams

Bernie's Response

Roger—you have obviously found my discussion on second gear problems with Traction gearboxes, and possible improvement, difficult to comprehend. This suggests a shortcoming in my descriptive material which I will try to put right—as follows:

1. The proposed improvement involves locking (with Loctite) a one piece bronze sleeve (on bush) to the mainshaft, its outer diameter providing a new, larger stable bearing surface, for the second gear to run on.
2. The second gear itself, <u>minus its pressed in bronze bushes</u> runs directly upon the outer diameter of the bronze sleeve (or bush) which has become a fixture and part of the mainshaft. The new running bearing surface of the second gear in its steel bore surface which is improved, both finish and dimension wise, by lapping with abrasive incorporated in a bronze lapping tool.

Bronze bushes are never lapped as you have rightly commented upon—where hard steel is OK.

Roger, I hope you can comprehend the above proposed change to the traditional design, and then upon re-reading the original discussion, become familiar with my attempt to find a practical way of improving the original, and promote improved second gear life.

Thanks for the interest and comments.
Bernie Hadaway

Roger's Retort

Hello Bernie, Leon et al,
Thanks for the above information - I now understand what you are doing but have to say I do not agree that it is a good idea
at all! The main reason the bushes on the second gear crept together was because at least one of them had been pressed through the synchromesh cone end of the gear which is slightly smaller than the rest of the bore and lost quite a bit of the intended interference fit. You will be achieving the same when you push the bush over the splines which are at least 0.05mm - 0.10mm (depending on how good the top shaft is) larger than the bearing area the bush is to be fixed to. Also the bore of the gear is fairly rough and I think you will find it difficult to get a good finish in here that is concentric with the gear teeth. At one time I honed out a few gears to a fine finish and pressed in a bush of finished size, allowing for the interference fit, and found it was not true to the gear teeth. It is much easier to press in a one piece bush with a good intereference fit and then bore it after truing up the gear in soft jaws in a lathe. I have to say that I have had no problems in the 50 plus gearboxes I have repaired in the last seven years or so using the above method. The gearchange is good and the gears quiet in operation. Thanks for keeping me posted and I hope we can continue to converse on matters technical!
Best wishes
Roger