Repairing the Roadster Marles steering box by Paul Alting van Geusau

Introduction

Over the past years quite a number of articles about the Marles steering box appeared in the Roadster Review, mostly concerning the (part) overhaul of the unit and the correct adjustment procedures so as to reduce play and improve the steering. In the TRCL archive these documents are available on-line and thanks to the Technical Index they can easily be found under the heading "Steering".

The lack of any new spare parts for this type of Marles box has put the Roadster drivers in an awkward situation and in particular the absence of new steering worms and their race rings is a growing problem because in all the boxes I have had at hand the ball bearing races were found defective. When checking the steering of some other Roadsters I also found that quite some people have not even noticed that the bearings in their boxes are gone….

In the steering box article written by Bob Fitsall, published in the March 2007 Review, it was stated : " Do not under any circumstances use a hammer to remove the drop arm; the shock of the blows will be transmitted to the worm and roller, which are very hard, and likely to chip. Replacements are scarce and very expensive (sic)". I think that most of the damage I found was initiated by such wrong practise.

Apart from some unavoidable repetition of what has been said in the earlier Marles steering box articles, the present article concerns suggestions for refurbishment of defective steering box parts.

The Roadster Marles steering box

Marles steering boxes were produced in a number of different types and the P 3841 used in the Roadster is the smallest one and unfortunately not of a particularly favourable design when friction and wear is considered. All period Marles boxes have a worm fixed on the steering wheel shaft on which worm a roller, mounted on a roller assembly (see picture below), runs. The roller assembly carries the drop arm 9 for transferring the steering movement. The worm is carried at its ends by ball bearings with races integral with the worm and two bearing rings mounted in the housing. Not much larger than a bicycle bearing it will be clear that these ball bearings are highly stressed.

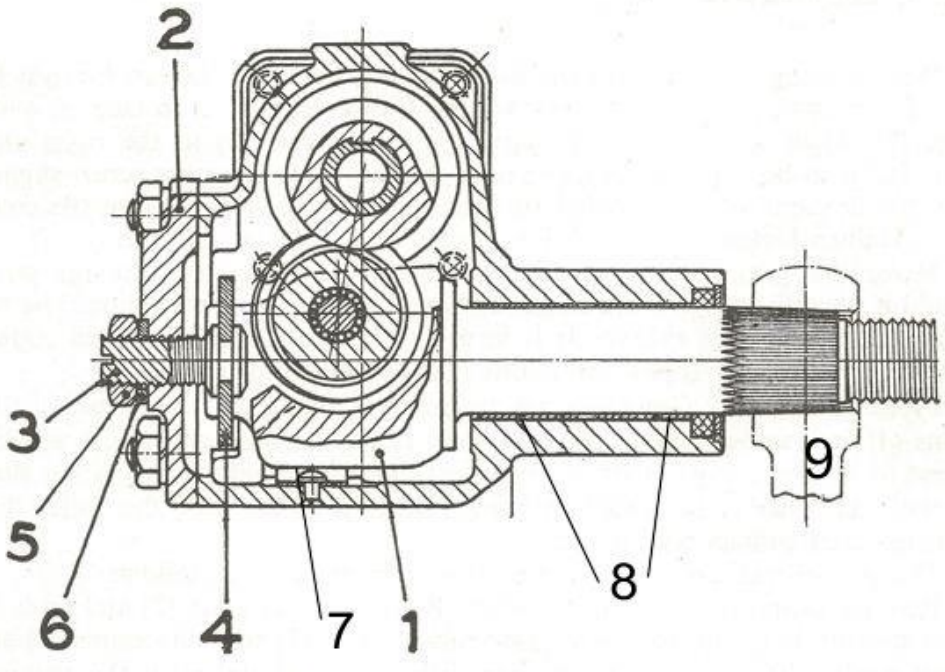


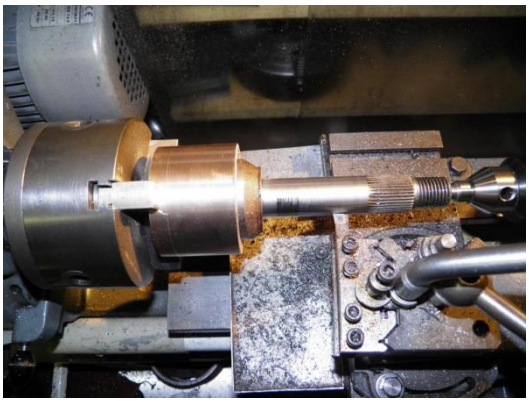
FIG. 3.—MARLES TYPE "320" STEERING GEAR

1, Roller assembly. 2, Cover plate. 3, Adjusting screw. 4, Thrust plate. 5, Locknut. 6, Lock washer.

A particularity of this type of Marles box is that radial force on the roller is taken up by a brass guiding strip 7 contacting the cylindrical upper surface of the roller assembly. These parts are prone to wear and when play develops, the roller assembly starts swivelling in the bearing bushes 8 which by this effect are unevenly loaded and uneven wear of the roller assembly shaft and bearing bushes is the result.

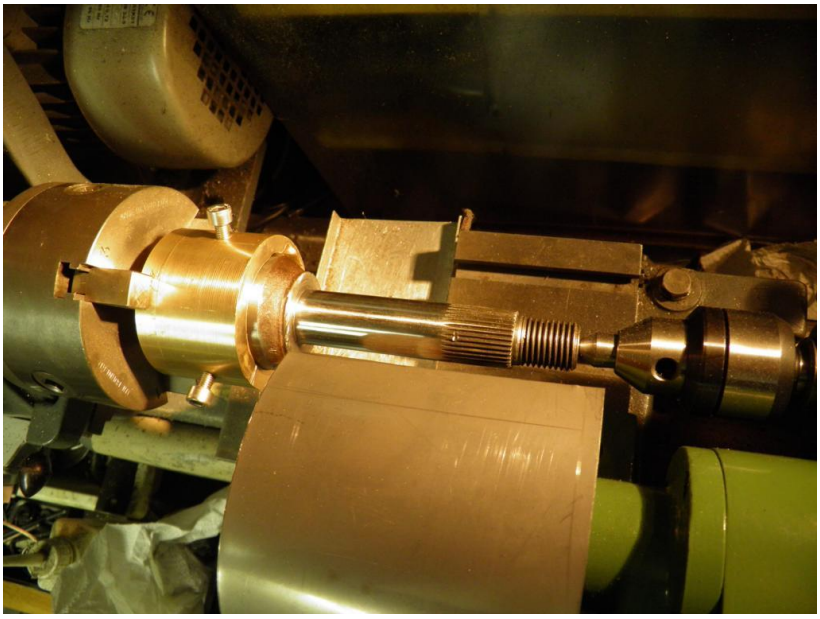
Repairing the Roadster Marles steering box

The earlier articles describe the refurbishment of the roller assembly and its bearings. Machining is easier when the roller is taken off the roller assembly but since in most case the roller and its bearing are in good condition (when using oil as a lubricant!) I preferred to leave the roller in place and prepared an adapter to allow the roller assembly to be clamped in the lathe chuck (see pictures below).



You will notice that the adapter has three radial screws for centering the roller assembly in the lathe chuck.

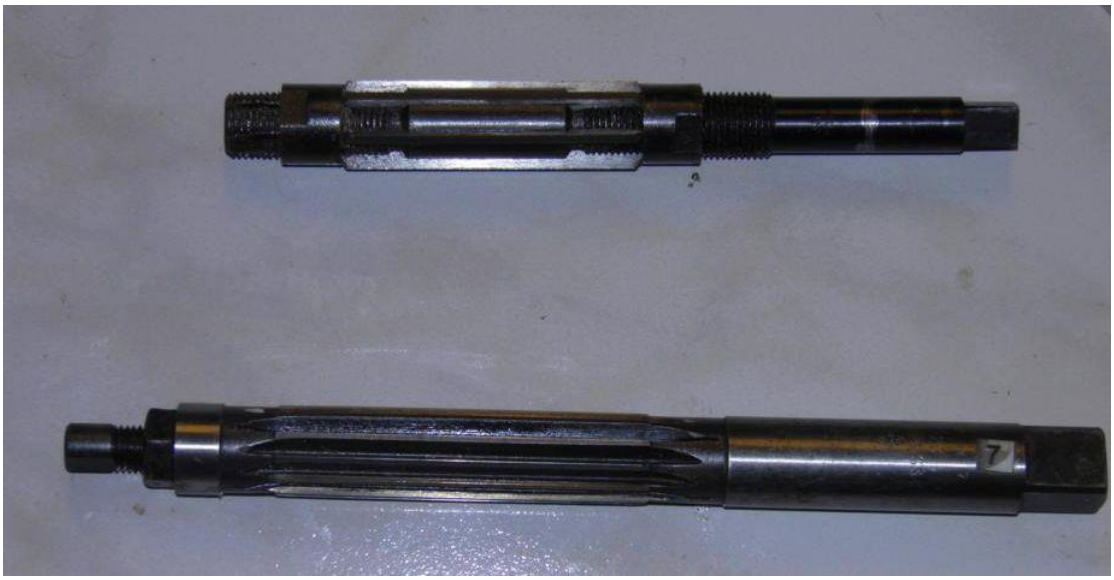
Although good results are obtainable by machining with a cutting tool bit, I prefered grinding which gives a smoother bearing surface.



Machining the bushes (or bush) is very well described in the March 20007 article and will not be repeated here.

Reaming the bronze bush to the new diameter of the roller assembly shaft may be problematic. An adjustable reamer must be used because when machining the shaft only a small amount of material should be taken off and the resulting diameter is not a standard reamer diameter. The common type

of adjustable reamer (upper, first type, in the picture below) is unsuitable when bronze is concerned because due to insufficient circumferential support it tends to chatter heavily. I found that the adjustable reamer (lower, second type in the picture below) in which an adjustable wedge forces the cutting edges (many more than in type 1) outwardly, did an excellent job.



From the first picture (Figure 3) you can see that the roller of the roller assembly is supported by a needle bearing. Luckily, in the boxes I have repaired the rollers and their bearings were in good order. If however the needle bearing or roller is damaged in both cases a new roller is needed and I have not found a company that, because of the peculiar shape and material, is prepared to manufacture a roller at a reasonable price. The same is true for worms and their races. Currently, I found no company able or willing to manufacture these parts with the required quality. So let that be again a warning to those wanting to disassemble the steering arm with a hammer! This is how the roller looks like when a hammer is used to dismantle the drop arm: (thanks for the picture Ossip!)

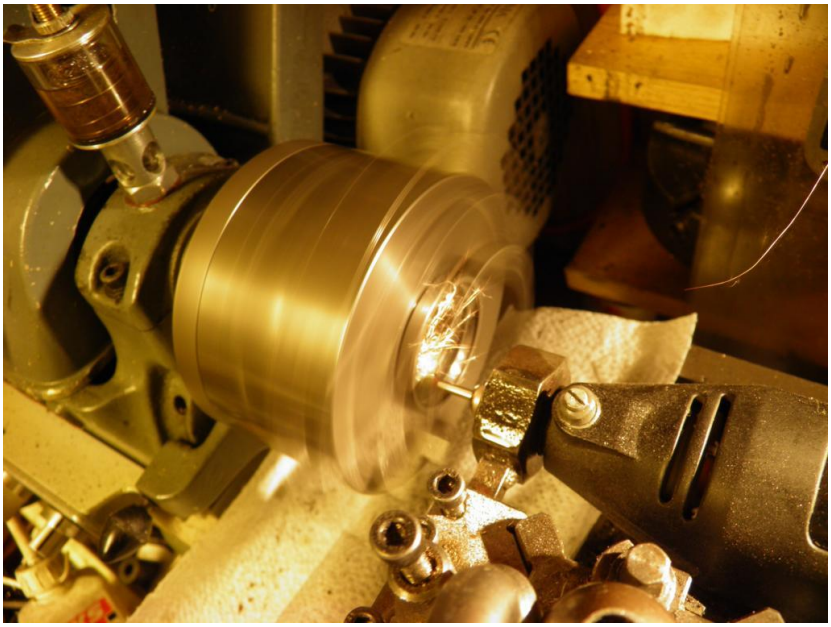
Below is a picture of the typical damage of the worm bearing race. This is not a problem limited to Marles boxes because on the internet you can find a variety of pictures showing the same damage in many different steering box worms.

If the damage is not very deep it is possible to regrind the races and use, when they are in good condition, the old bearing rings and original size bearing balls (7/32”, about 5,5mm) and cages. However, this is seldom the case….so mostly using slightly bigger bearing balls is necessary. I found that the bearing rings are more robust than the worm races so in one of the boxes I could use the old rings with 7/32” balls and their original cages. In other boxes use of 6mm bearing balls became necessary for which no cages in the required race diameter are available. For a low speed application like a steering box, cages are not essential and many manufacturers of steering boxes do without them. However, assembly of the bearings is more difficult with loose bearing balls.
Using balls larger than 6mm may lead to problems with the filling of the bearing and, because the total axial length of the worm assembly becomes longer, the mid-position of the worm with respect to the roller shifts from its original centred position when assembling the worm assembly in the housing.

Some companies regrind worms but I did not find a company that would also grind the bearing rings! One proposed to make new complementary bearing rings but at a cost of over 1500€. I understand such a price because setting up the machinery to do the job takes many hours in itself and so only larger quantities can be produced at a reasonable unit cost.
However, what at first sight looked like a very challenging model engineer’s problem proved not that difficult after all. First extensions have to be machined for accurately supporting the worm in the lathe. The material of the worm is not so hard that it cannot be machined on the lathe and with a carbide tip the damaged races were machined to the correct diameter (for the 7/32” ball or 6mm balls). I tried both grinding and turning but found that for the material of the worm, cutting on the lathe gives excellent surface smoothness.

Of course accuracy is essential but starting from exactly measured new inner and outer diameters of the worm and ring races (I started with grinding the ring inner diameter) the curves were not too difficult to cut to a very high degree of complementary shape to the ball surface. Measuring a curve is almost impossible but taking a ball and looking at the light coming through the slit (if any) between the ball and race surface it is just a matter of trial and error to get the same quality (or better) as the original assembly: getting the first right takes ages but the last takes just a few minutes.

Here is a picture of grinding the ring race inner surface.



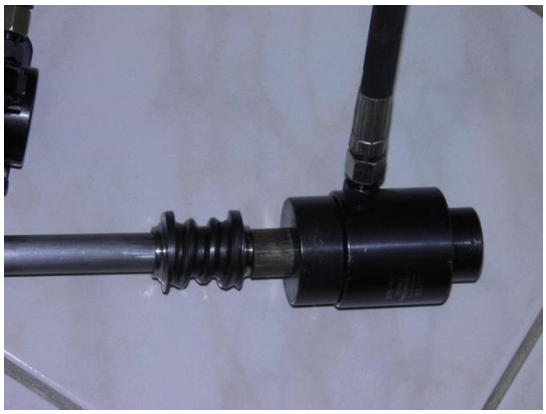
I understand that machining exercises described above are not within everybody's reach or capability. The above example is merely given to show the possibilities when you are stuck with a damaged steering box and do not know how to proceed further. If you cannot do it yourself you might find a model engineer or machinist who can do the repair along the lines as here described. Because of small size of the parts I suggest the aid of a model engineer.

Disassembly and assembly

The steering box disassembly, assembly and adjustment are extensively described in the earlier articles but nevertheless some points might need further consideration.

The worm is pressed on the shaft with quite some force so that you need a hydraulic press to get it off the shaft. I used a small 12 ton vertical press that I can be laid on its side so that the long steering shaft is not in the way.

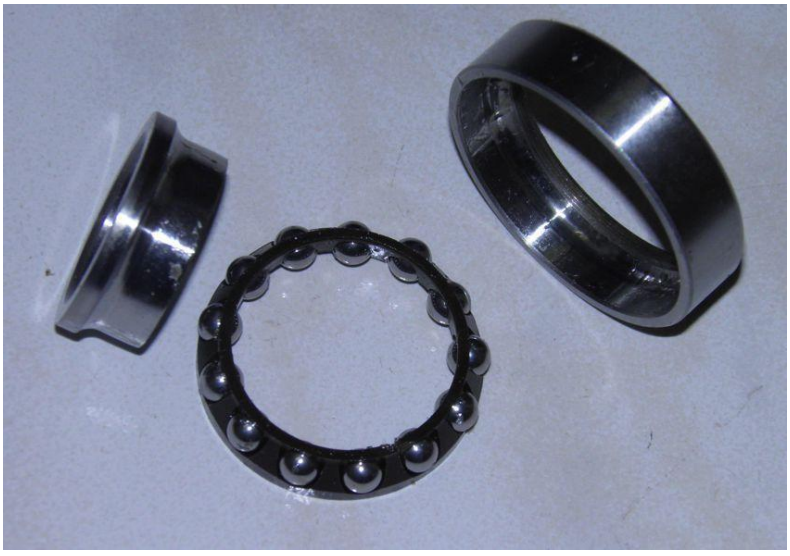
More difficult is it to press the worm back on the shaft. It might be possible to use a long threaded bar going through the steering shaft and nuts on both sides to clamp and push the worm back on the steering shaft. I used a hydraulic puller in similar manner: a long rod going through the steering shaft, fastened at the puller on one end and on the other side pressing with a nut against the steering shaft end.



When assembling the worm ball bearing without ball cages there is a risk that balls fall out of the races when pushing the steering shaft with the worm into the housing. I manufactured a plastic ring (Teflon) for better support of the balls during assembly into the steering housing. The pictures below show perhaps better what words can say.

Important!
Perhaps most you know that the design of the worm and roller is such that only in the steering mid-position there is zero backlash. Therefore when mounting the worm in its housing ensure that it is in the mid-position with respect to the roller; otherwise you may find inequalities in backlash in the steering end positions and probably you won't be able to adjust zero backlash in the mid steering position! Shims can be placed between the bearing ring race and housing for adjustment of the axial worm position.

Further suggestions for repair.
The problem of damaged worm bearing races is quite common for all kind of steering boxes and it can be observed on the internet that many have thought about solutions involving alternative support of the worm. For example, it was suggested to support the worm on the steering shaft itself.
However, first there is not sufficient space in the Roadster box to fit such a bearing assembly and second, the steering shaft is not fully concentric with the worm because one of the worm splines is somewhat thicker than the others.
The only other solution is to use parts of readily available angular contact bearings and cut and machine them and the worm to a form a new bearing assembly. Unfortunately for the Roadster Marles box the choice is not very big and in fact only one size 25x48x12 would be suitable for such a conversion. I have not tried it out myself yet but mention it here just for completeness of all the repair possibiities considered.



I further noticed that the upper bearing (the bearing at the incoming side of the steering shaft) is not protected against dust or rust that may fall down the steering column tube. I inserted a Teflon bush in the steering tube just before the bearing but probably also a felt washer at this position will do the job equally well.

A last remark

Remember well that the steering is a major safety issue and when working on the box you should never cut corners. So if you do not feel sufficiently qualified have your box overhauled by a specialist. However, because of the problems and lack of spare parts described hereabove it is currently very hard to find a specialist doing a complete overhaul of the Roadster Marles box.