More about the Marles Roadster steering box and the track rods adjustment procedure.

by Paul Alting van Geusau (with thanks to Bob Cakebread and Ron Cromar for their input)

Introduction

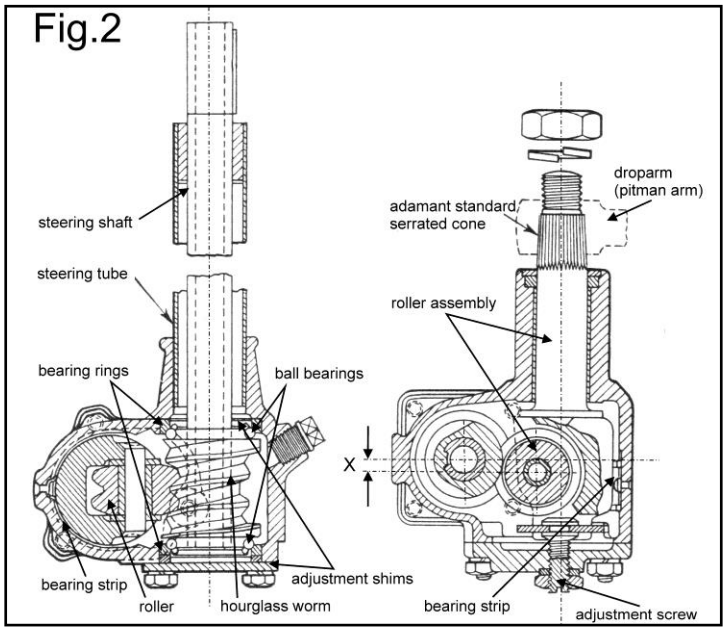
In my article about overhauling the Marles steering box (see Roadster Review May 2014, in particular paragraph 4.4 “Attention please”) some short comments were made about the set-up of the Marles worm and roller arrangement. In the present article I will go a bit more in detail because this set-up is important to ensure minimum steering backlash in the middle position of the steering wheel i.e. the straight forward running position of the car.

Some design history

In an attempt to reduce friction and wear a British engineer, Henry Marles, developed in 1919 a worm-and-roller steering gear design, i.e. the first design to substitute pure rolling with sliding contact between the meshing elements of a worm-and-follower design. Further development took place before it evolved to its most popular form, which has an hourglass-shaped worm that engages with a double-toothed roller that is carried on a roller assembly for actuating the drop arm. The earliest Marles patent describing such an embodiment is GB 411,758 .

As can be seen from Fig. 1, the periphery of the roller was formed into the contour of a worm gear tooth. While in the straight-ahead position of the steering wheel, the worm thread bore on the inner flanks of the double-toothed roller, as either lock was approached, it began to bear on the appropriate outer flank of the roller. In the Marles Roadster box, the helix angle of the threads reduces as the pitch diameter increases; thus, the internal leverage of this type of steering remains relatively constant (some other boxes may have a constant helix angle and consequently a variable steering ratio!).

The design with a changing roller/worm bearing characteristic leads to the effect that **only in the middle position of the worm can the roller backlash be minimal**. In fact, approaching the end stops, play becomes quite large. This is not a disadvantage for this type of steering box. Most of the steering movements occur in the middle position so this is the region of the worm where wear is highest. If the backlash initially were to be the same over the whole worm length, any adjustment of the roller for compensating wear would cause binding of the roller in the left and right outer worm regions where wear is less. Moreover the outer left and right worm regions are essentially used for parking and play is irrelevant in such a situation. Also, when cornering the roller contacts the worm only on one side and when returning the steering wheel this contact is maintained because of the steering reaction forces during cornering.



Initially the roller was positioned at the same level as the worm and backlash adjustment was made by moving the roller horizontally in the direction of the worm. Later on the roller was positioned slightly above the worm and adjustment was made by moving it vertically to the worm. This is also the case in the Roadster box (Modell P3481, distance “X” in Fig. 2).

The factory set-up of the Marles Roadster steering box

Having overhauled four Roadster Marles steering boxes and one Town and Country box (differing only in that the steering column is shorter), I can now say with some certainty that the original set-up of the steering box middle position, the position for driving straight ahead, is one in which the steering wheel spokes are horizontal and from which middle position equal revolutions to the right and left can be made (total from left to right is about 3.5, therefore from the middle position, 1.75 to the right and 1.75 to the left). This also allows proper functioning of the direction indicator return mechanism, provided that it is placed in the correct position, i.e. vertical with the indicator switch at the top and the headlight switch at the bottom.

This conclusion, (also apparent from the explanations in the Marles patents) is based on the following peculiarities of the Marles Roadster steering box.

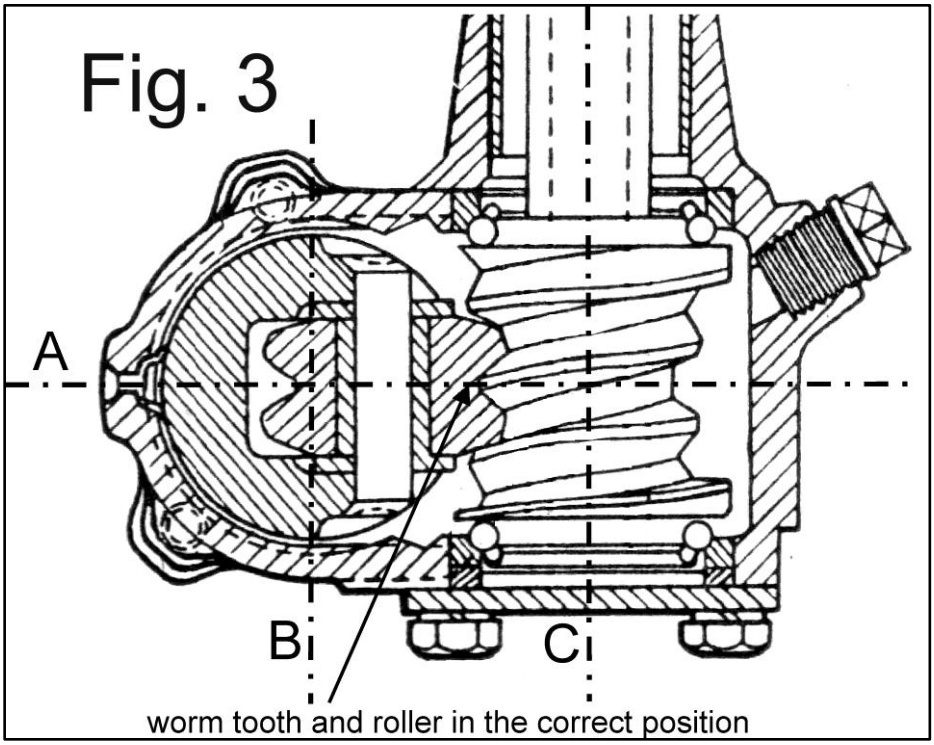
The hourglass shaped worm is mounted on the steering shaft in a well-defined position resulting from a single, more pronounced, spline in the worm bore, cooperating with a slot in the steering shaft. The steering wheel is also mounted in a well-defined position on the steering shaft resulting from a cut-out in the steering shaft for the steering wheel hub traversing mounting bolt.

This leads to the following configuration: an imaginary plane through the horizontal steering wheel spokes and steering shaft centreline gives an image of worm teeth in this plane which have a specific axial position with respect to the centreline of the roller assembly. As is shown in Fig. 3 below, this rotational position of the worm is set so that the roller of the roller-assembly can engage the worm exactly in the middle of its smallest diameter whereby the roller assembly arm is square to the steering shaft centreline. Any other position would only allow teeth engagement a bit further from the middle position, either to the left or to the right making it impossible to have minimum backlash at the smallest diameter of the worm

It has already been explained in the earlier article that the axial position of the worm-gear itself has to be adjusted correctly with respect to the roller assembly centreline so that in the straight ahead steering position the roller sits exactly in the middle of the worm-gear. The bearings of the worm gear can be axially adjusted by inserting or removing shims thereby allowing shifting of the worm to its correct axial position (see Fig.2).

To summarise, two conditions have to be met at the same time for a correct set-up:

- the specific rotational position of the worm, allowing the roller teeth to engage the worm exactly in its middle position (horizontal steering wheel spoke position)
- the worm middle position should lie in the plane going through the roller assembly centreline which plane should be perpendicular to the worm centreline (adjustment with shims).

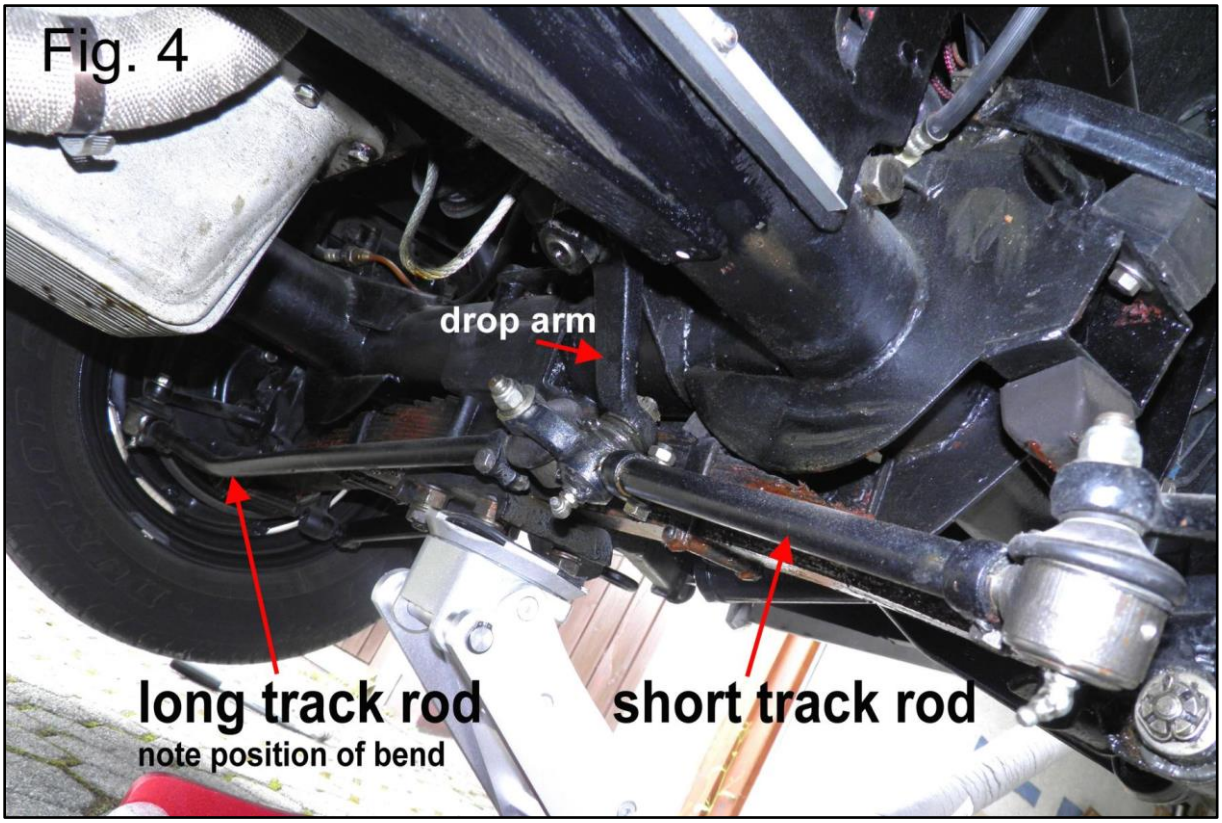


Since the diameter of the hourglass shaped worm is smallest in the middle of the worm, only with such a correctly set-up steering box is it possible to adjust the roller backlash to be minimal in this middle position for straight ahead running. The middle position backlash should be as small as possible because play will have the effect that the car starts wandering over the road and constantly steering corrections will be needed to keep a straight path. Minimal play will make quite a difference on the car behaviour and steering will be a lot more relaxed
Furthermore, the drop arm (pitman arm) is mounted on the splines of the roller-assembly shaft so that it also moves equal amounts to the right and left of its middle position (the drop arm middle position is parallel to the centre line of the car).

Adjusting the track rods
Starting from a correctly set-up steering box **all the corrections** to ensure that steering wheel spokes are horizontal for straight ahead running of the car should be done by adjusting the track rod lengths.
The procedure is as follows: (car should rest on its wheels)

- Start with adjusting the long track rod. The factory setting for the long bent track rod is 25 17/32 inches (648mm) between the steering ball joint centres. This dimension is given in both the 1800 and 2000 technical handbooks.
- With the steering wheels spokes in the horizontal position adjust the short track rod to obtain the required front wheels toe-in (zero toe-in, thus the wheels should be parallel according to the handbook).
- Drive the car to determine the deviation of the steering wheel spokes from the horizontal plane when driving straight ahead.
- Normally adjustment of the short rod will lead to a satisfactory result (see also *remark* below), but if necessary, adjust the long track rod by loosening one side and turning it 360°, either to the left or right, depending on the position of the steering wheel spokes, ensuring that the bend is again the lowest point. Readjust the short track rod to reset the required toe-in. Check again on the road.
- Repeat adjustment of the track rods as often as necessary.

Remark: If very small corrections are still necessary the short rod may be adjusted to allow a small amount of toe-in, with insignificant effect on the steering properties.



Loosening one side of the long track rod for adjustment is necessary because the bend allows adjustment only in full revolution increments. The smallest change of the long track rod length then corresponds to the pitch of the steering ball joint screw thread. With one end loose adjustment can still be made on both ends by screwing the ball joints equal amounts in or out, if that is necessary.
For measuring the toe-in I use an adjustable bar made of the telescoping tubes of an old parasol.

Further remarks
Given that in a Marles Roadster steering box the worm and roller running backlash can be adjusted to be minimal only in a correctly set up middle position, then trying to reduce play by means of the adjustment screw in any other position of the roller on the worm will inevitably lead to either regions of stiff steering or excessive play, provided of course that all the individual steering box components are in good shape.
As most of you have perhaps experienced, the increase of play when the roller leaves the worm middle position is small when having a sound steering box and even a 90° wrong steering wheel position (steering wheel spokes vertical instead of horizontal) will not have a dramatic increase of play or negative effect on the steering for straight ahead running. However, this may be different on a worn steering box, so better keep to the factory set-up of the steering arrangement. Perhaps also a good occasion here to remind Roadster owners that in the straight ahead position, play at the end of the drop arm should, according to the members technical handbook, not be more than 1/32in. (0.8mm)!
In the steering boxes I overhauled I found evidence that some mechanics changed the position of the steering wheel on the steering shaft instead of adjusting this position by means of the track rods. Inevitably the new straight ahead steering wheel position can no longer be in the exact middle position of the worm and thus more steering play than necessary is encountered. Moreover the amount of steering-wheel rotations to the right or left from new the middle position is no longer the same. I also found that some mechanics apparently mounted the drop arm in the wrong position which leads to the same effects as a wrong steering wheel position.
Some people may prefer to have a steering wheel position in which the spokes extend vertically. Of course such modification is possible while maintaining a correct steering box set up: a new cut-out turned 90° with respect to the factory cut-out for the steering wheel locking bolt should be provided.
In fact any other steering wheel position is possible when providing a new steering shaft cut-out. But again, simplest is to maintain the factory set-up.