Adjusting an Austin Seven back axle Bob Garrett

This note is a more comprehensive follow-up to a brief article published in the Hereford A7 Club magazine 'Crankhandle' in March 2017 that described a method of setting the pre-load on differential carrier bearings. The following is an attempt to describe a complete approach to setting-up the correct meshing of an A7 back axle for anyone who doesn't own an original Longbridge setting-gauge.

Before attempting to build a later type (1933 – 1939) 'D'-Type back axle for my Seven some years ago, I read a number of different articles to find-out how to adjust the meshing of a crown wheel and pinion. My reading list comprised:

- The Austin Seven Manual by Doug Woodrow (Section E5)
- 'Meshing the crown wheel and pinion (CWP)' by Jack French, in the Austin Seven Companion, pp 169-170
- 'Austin Seven back axle adjustments' by Malcolm Watts, in the Cambridge A7C Seven Focus magazine Aug 2004 pp 26-29
- 'Adjusting back axle crown wheel/pinion back lash, in the Bristol A7 Club magazine 1983
- 'Transmission noise' by Malcolm Watts on the Cornwall A7 Club Website
- Austin Seven Specials by L M (Bill) Williams – Chapter 5

The above publications provided an abundance of useful advice that was mostly consistent and made sense, but there were some interesting differences and some areas that seemed (to me at least) a little unclear. So, these notes were originally cobbled together for my own use to record the approach I proposed to adopt – also to avoid forgetting exactly what I had done, in the event that the exercise was a success. I am happy to tell the reader that my efforts created an axle that has now covered over 6,000 miles, is quiet on both drive and overrun, doesn't leak oil, the backlash seems to have remained OK, and happily there are no metal particles in the oil. So, although it may be a dangerous thing to say - the exercise seems to have been successful. I have subsequently built and adjusted a second axle using the same approach and this one is also nice and quiet in operation.

The following, assumes the back axle is on the bench with hubs, drums and brakes removed. Also, that the axle is clean and contains sound bearings, undamaged crown wheel & pinion teeth, a nice clean set of shims and freely moving lateral (castellated) differential adjusters with their cover plates removed. Some axle builders advocate removing the differential oil seals whilst carrying-out meshing adjustments but mine are modern lip seals that are working well – so, I was reluctant to disturb them. Anyway, I seem to have managed perfectly well without their removal.

The process of Crown Wheel and Pinion (CWP) meshing adjustment, effectively comprises the following five steps …..

1-Marking, 2-Assembly, 3-Rotation, 4-Dismantling & examination and 5-Adjustment

These steps are repeated as necessary until satisfactory meshing is determined at Stage 4, when the axle can be finally assembled ready for use. The five steps are described in the following notes but please remember, this is an account of what I do (which happily seems to work), I am NOT saying 'this is how it should be done'. For example, I am aware that my approach differs somewhat from that suggested by others.

1. Marking

The traditional engineering method of marking gear teeth to determine areas of contact is called 'Blueing' using a dye known as 'Engineers Blue'. It is often used to check valve seat contact or to determine where to scrape when fitting a white metal bearing - a small tin or tube is not expensive and seems to last for ever. However, I use thinned 'Humbrol' model enamel because it seems to work just as well, and I have quite a collection of these small tins in the workshop.

After degreasing the crown-wheel and pinion teeth, I apply a light coat of thinned paint to both sides of five or six consecutive crown wheel teeth in three separate groups, roughly 120° apart.

2. Assembly

The torque tube is fitted into the differential case using the same shim configuration that prevailed prior to disassembly (or three shims top and bottom if the previous arrangement is not known) and firmly secured with a pair of diametrically placed setscrews over plain washers. Strangely, Woodrow and others suggest using lock washers at all times but this is clearly unnecessary for repeated temporary assembly – arguably, even a nuisance. Of course, final assembly *does* require all bolts to be in position together with (preferably new) spring washers. Incidentally, it is important that the shims are fitted immediately adjacent to the differential housing (i.e. in the gap in the photo) and not next to the torque-tube flange; otherwise, correct longitudinal tooth meshing will never be achieved.

Torque-tube & shims

The differential assembly complete with crown wheel and half-shafts is fed into the off-side (D-shaped) axle case and the near-side casing popped into position using a new, dry paper gasket. The axle cases are then gently secured together, and carefully tightened, whilst ensuring the CWP can still turn freely. If the gears bind, then the near-side lateral castellated adjuster will have to be slackened. I encountered a variety of suggestions for the repeated temporary assembly of the axle casings and torque tube between meshing tests. This is probably not critical so long as the assembled components are firmly attached each time but I used just two diametrically spaced bolts to secure the torque tube, and four (the front and back pairs) to hold the axle cases together, and this proved satisfactory.

Index marks used to check 1/16" of backlash at 7" radius

Once the casings are firmly secured together, both lateral adjusters can be brought just into contact with the differential carrier bearings and the backlash adjusted. Backlash (the clearance between the pinion and crown-wheel teeth) for an A7 should be one sixteenth of an inch at a radius of seven inches on the pinion shaft. I check this by temporarily securing a simple index arm under the spherical bearing grease nipple, and comparing it against a moving pointer attached to the pinion flange – see photo.

Clearly, slackening the off-side castellated adjuster and tightening the near-side - will reduce the amount of backlash ….. and vice versa.

Next, the pre-load on the differential bearings can be set. Several articles agree the pre-load should be three to four thou', Jack French recommended 'considerable pre-load' and the Austin factory reckoned 'slightly slack'. I didn't find words like *'considerable'* and *'slightly'* particularly helpful so I decided to go for the more specific *'three to four thou'* but none of the articles I read explained exactly how this might be achieved. It then dawned on me that the adjusters are threaded 20 TPI and each has fourteen castellations, therefore simple arithmetic (1/14 x 1/20 = 1/280 or 0.00357") tells us that a tightening rotation of one castellation on a single adjuster gives a pre-load of 3.6 thou. So, tightening both adjusters by half a castellation, each from a position of just touching the bearings, gives us the desired pre-load. This approach happily doesn't interfere with the backlash setting.

3. Rotation

The pinion shaft is rotated by hand to transfer the crown-wheel markings to the pinion teeth and this process gives much more consistent results if a small load can be introduced between the teeth. One way of achieving this, is to press a hard-wood dowel through the oil filler hole so that it drags on the periphery of the crown-wheel. The pinion shaft is then rotated in one direction, about twelve turns and back a similar amount. Most of these axles have a ratio of 5.25:1 and twelve turns will ensure the pinion teeth all make at least two contacts with the marked crown-wheel teeth.

4. Dismantling and examination

Next, the axle casings are separated and the differential, complete with both half shafts is withdrawn. We can now inspect the markings transferred to the pinion, and see where tooth contact has been made. You will be very lucky if it's in the right area at this first attempt.

The marking will almost certainly be a 'slightly ill-defined splodge' and often a little different on each tooth. However, the ideal position for this 'splodge' is …….

a) Radially - half way between the root (bottom)edge and the free (top) edge of the tooth, and -
b) Longitudinally - about two-thirds of the way from the large-end of the tooth i.e. a little nearer the smaller (rear) end of the pinion

These ideal meshing positions are designed to minimise axle noise and thus wear. The reason for setting-up the longitudinal contact off-centre is that the enormous power of the A7 engine causes a very slight distortion of the pinion shaft, which in-turn, moves the tooth contact to a more central position under operating conditions.

An added complication is that these ideal tooth markings apply to both the 'drive' and 'over-run' sides of the teeth and again, it is unlikely that both sides have markings in the desired position.

5. Adjustment

a) To move contact marks radially outward i.e. closer to the edge of the gear teeth -

The crown-wheel needs to be moved away from the pinion by slackening the near-side adjuster and tightening the off-side adjuster.

b) To move contact marks radially inwards i.e. closer to the root of the gear teeth –

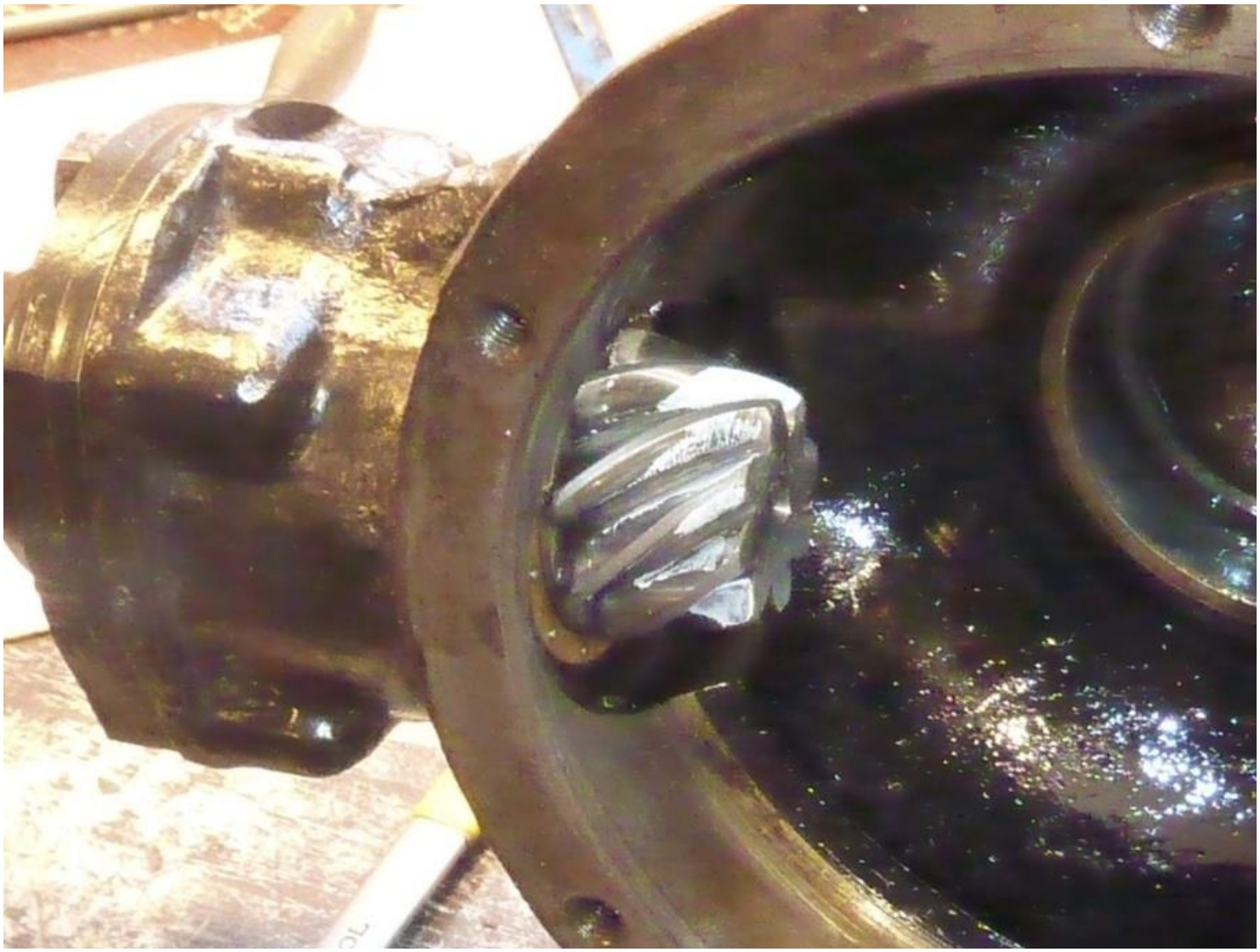
The crown-wheel needs to be moved towards the pinion by slackening the off-side adjuster and tightening the near-side adjuster.

c) To move the contact marks longitudinally towards the narrow end of the gear teeth i.e. closer to the differential –

The pinion needs to be moved further into mesh with the crown-wheel by removing a shim.

d) To move the contact marks longitudinally towards the wide end of the gear teeth i.e. away from the differential –

The pinion needs to be moved further out-of-mesh with the crown-wheel by adding a shim.



Pinion markings at first assembly

I found that each of these adjustments had a quite noticeable effect on meshing and although it is a tedious process, it seems a good idea to make small adjustments, one at a time whilst carefully recording each change made and the results. I have heard of others who claim to have made significant adjustments but experienced minimal effect on meshing. I'm not sure where you would go from there, except maybe to re-check the torque-tube and differential bearings for wear - also perhaps review your marking technique.

The photo shows pinion markings on first assembly where the contact areas look too close to the edges, and a little too far back i.e. too close to the differential. Both my axles required six or seven iterations of cleaning, marking, reassembly, examination and adjustment before I found a comfortable compromise between the longitudinal marking position for 'drive' and 'over-run'. Eventually, I settled for a 'drive' contact marking that was just about spot-on with the 'over-run' somewhat closer to a central position. Good radial meshing was achieved, with markings pretty much mid-way up the teeth and backlash very close to the required specification.

I hope some of this helps if you decide to have a crack at re-building or adjusting an A7 back axle.