MG P Type Differential Rebuild.

I'll start by saying that this document is a record of what I did to the differential on my PA.
Having never rebuilt a differential, I'm not implying that what I have done is correct, or cannot be improved upon in any way.

Early on I decided that I would apply recommended modifications during the rebuild, namely, fitting an oil seal into the pinion cover, replacing all the pinion assembly bearings with taper roller bearings and a similar replacement of the crown wheel assembly bearings with taper roller bearings.

However, some of the fine details could not be established, such as exactly how much and where machining was required for example.
Hence the record here, as much for myself, as for anyone else who may be considering such a rebuild.

The unit I started with.

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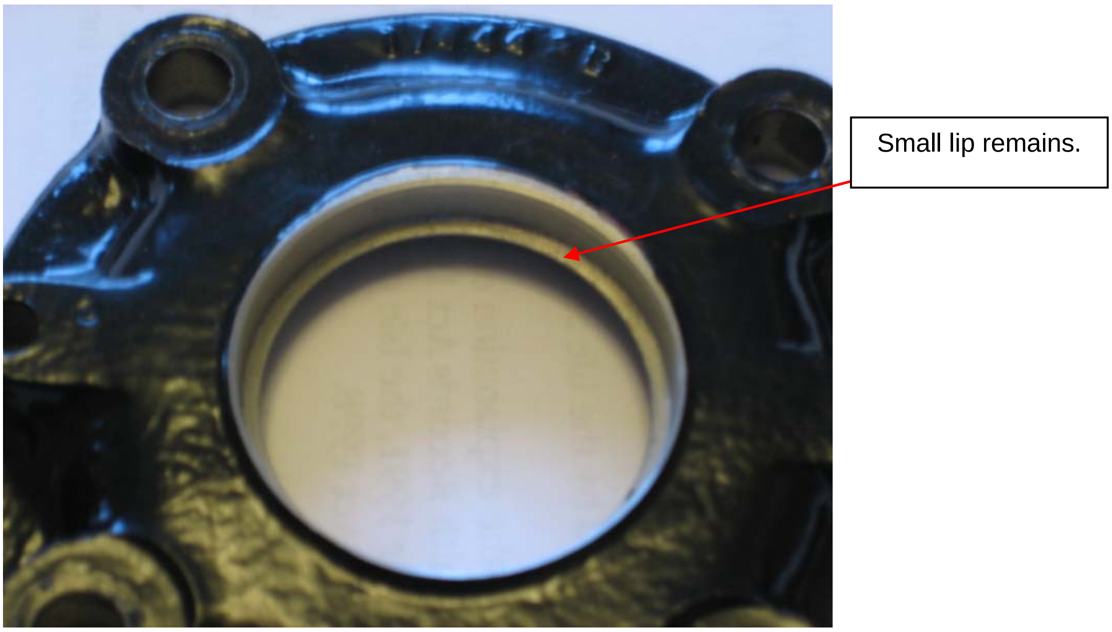
Cover Modifications to take oil seal.

Oil Seal Type.
The oil seal was a double lip, Viton oil seal purchased from Simply Bearings.

Size :	Outer diameter	40mm
	Inner diameter	30mm
	Thickness	5mm

Cover Machining.
The cover was mounted to a face plate on the lathe and turned to suit the oil seal.
A small lip was retained on the diff side of the cover of only about 0.5mm thick to stop the seal being pushed in too far.



Oil seal in place :

The propshaft flange was also turned down in diameter to 30mm to suit the Internal diameter of the oil seal.
The surface was polished as much as possible to ensure a smooth surface for the oil seal to run on. It should be noted that once the whole pinion assembly is together, only a very small area of the flange needs to be actually reduced in diameter. Only the first 15mm probably needs to be reduced in diameter. (furthest left 15mm in the photo below)

Bearings Used.

The Pinion Carrier assembly used SKF 30305 Taper Roller Bearings. Two off.

The Crown Wheel Assembly used SKF 30207 Taper Roller Bearings. Two off.

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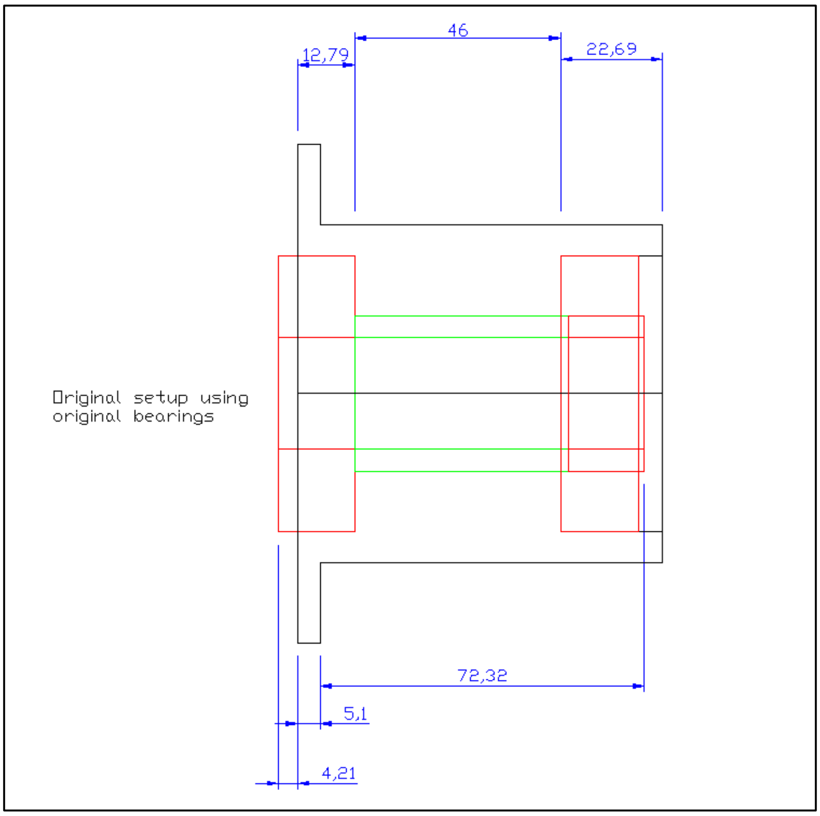
Pinion Carrier Modifications.

Original Setup Measurements.

Measurements of the original setup on my differential, using the original bearings and spacers gave the following :



In order to maintain the same position of the pinion gear, and the flange, I felt the important measurements were the 4.21mm from the carrier flange to the bearing, and the 72.32mm from the other side of the flange to the bearing.

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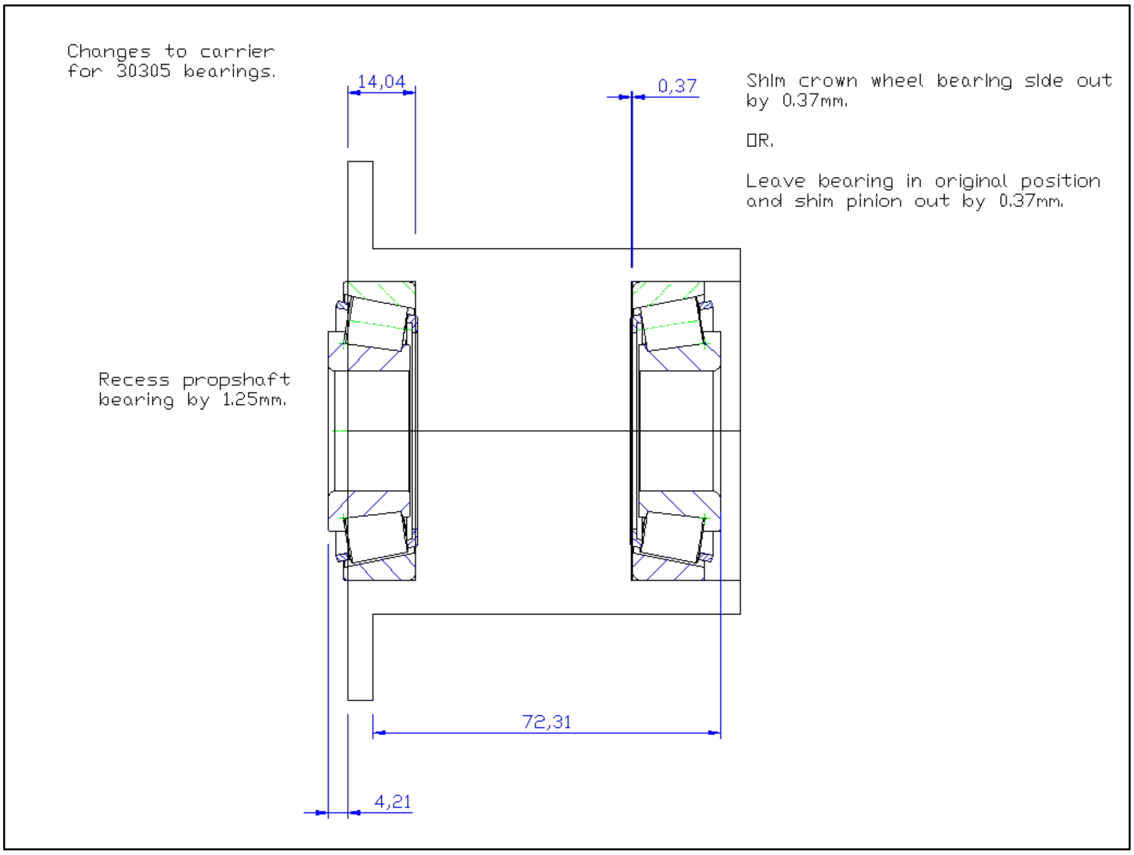
Modifications to use 30305 Bearings.

Using CAD drawings for the bearings from SKF, the following drawing showed that in order to maintain the 4.21mm dimension, the carrier would need recessing at the propshaft flange end, by 1.25mm. (From 12.79mm to 14.04mm)

The 72.31mm would only be achievable if the bearing was spaced out by a further 0.37mm, but as obtaining a shim of that thickness with the right OD and ID dimensions, would probably be hard, I decided to tap the bearing at the gear end fully down into the carrier and accept the 0.37mm discrepancy.

The drawing also shows the orientation of the tapers of the two bearings.



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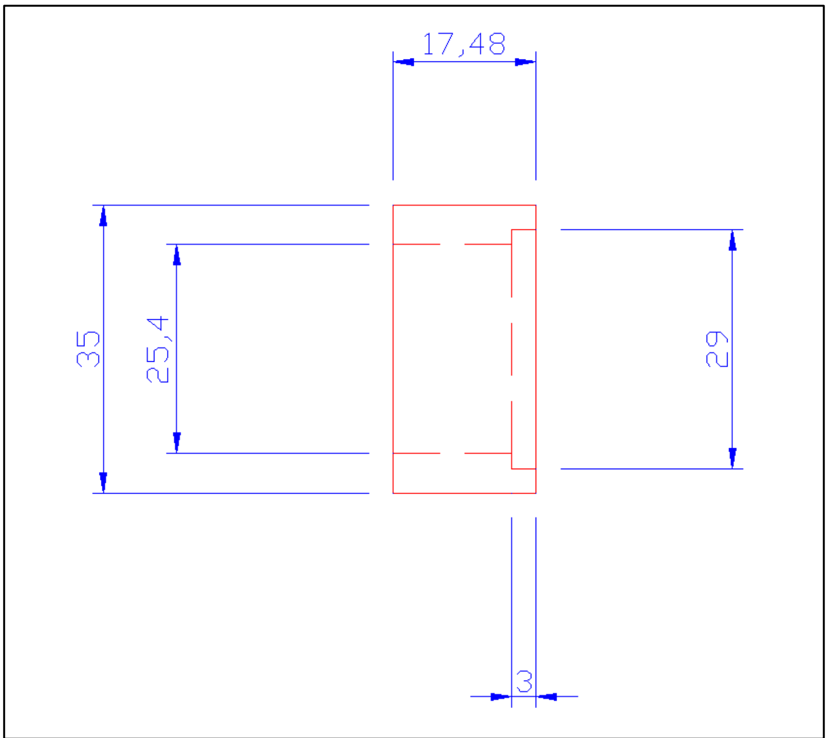
Collapsible Spacer and Spacer Carriers.

The spacer between the two bearings used was an MG Midget/Austin Healey Sprite differential collapsible spacer.
Part number BTA532, purchased from Moss. (www.moss-europe.co.uk)

As the collapsible spacer is only about 20mm long, two carriers were required to both hold the spacer centrally and longitudinally.
The length of these carriers sets the amount of crush that would occur when the assembly is tightened.

Two of the following were made :



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The collapsible spacer and the two carriers :

Assembling the Pinion Carrier Assembly.

There are all the parts of the pinion carrier assembly.

Stage 1 : Fit the two Bearing outers into the pinion carrier.

Stage 2 : Starting from the gear end, fit the small spacer, the bearing inner, the first collapsible spacer carrier, the collapsible spacer and finally the second collapsible spacer carrier to achieve the following :

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Stage 3 : Fit the pinion gear assembly into the carrier, and fit the second bearing inner.

Stage 4 : Fit the Cover, the Flange and the washer and nut to finish the assembly. Only tighten the nut up finger tight to start with.

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Tightening up the Pinion Assembly.

This is the area I found the most difficult as I could get no information from anywhere as to how tight it should be.
In the end I followed some advice I found on a Timken Taper Bearing Tech Tip sheet which, for wheel bearing setups, that it is tightened up until there is a slight bind, then it is backed off $^{1}/_{6}$ to $^{1}/_{4}$ of a turn.

In practice, I found that I could "see" any play in the assembly if I put some oil in the gear end bearing. I then held the whole assembly by the carrier and rotated the flange a few times (with the flange down) and then gently placed the flange on the table to allow the weight of the assembly drop down.
I could see movement of the oil between the bearing inner and the rollers when I had movement in the assembly.

I tightened it up until I could see no movement in the assembly, then backed it off between the $^{1}/_{6}$ to $^{1}/_{4}$ of a turn and the castellations of the nut lined up with the hole in the shaft for the split pin.
Don't forget to fit the split pin through the nut at the propshaft flange.

Tightening was achieved by using a couple of lengths of 1" square tube. One bolted to the carrier assembly, the other to the flange.
I could then use a long breaker bar on the flange nut and bear the flange bar against myself to tighten.

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Pinion Position Setting.

Gauge. (as detailed in 'MG Road Cars')
I struggled with the gauge method of determining the shims required for a variety of reasons.

I had one machined up as per the drawing on page 115 of 'MG Road Cars'. The only way I felt of attempting to get this accurate was by milling.
I saw four problems with using this gauge though –

1. The 'MG Road Cars' article wasn't terribly clear as to where the gauge actually was placed. In the end it only seemed to want to sit in the two curved recesses of the crown wheel assembly bearing locations on the nose piece casting.
The dimension tolerance statements on the drawings also didn't quite make sense to me.
One dimension (0.843") has a stated tolerance of +0.001/-0.000
The drawing then states "dimensions +-0.001 except where indicated", so as the only one indicated otherwise is the 0.843", all the other dimensions (0.375", 2.75" and 4.625") must be +-0.001" making the "Other dimensions not critical" statement superfluous.
I made the 0.843" the only accurate machined dimension.

2. How do you ensure the gauge is truly in the lowest point of the bearing recesses on both sides.

3. How do you hold the gauge in the right position on the nose piece, and the nose piece itself in such a way that you can then apply feeler gauges to get the required gap measurement ?

4. Unless the gap is equal to just one feeler gauge, you are going to need multiple feeler gauges, and I felt these would not all compact together adequately enough to get a true measurement without moving something.

In the end, I didn't use the gauge to get the shim measurement.

DTI measurement.
Initially I used a DTI and a magnetic base fixed to the side of the nose piece to get the measurement, but it didn't quite work out.

The DTI travel needs to be quite long without any shims.

Whilst I could easily find the lowest point of the bearing track and zero the gauge, swinging the gauge around when the base was attached to the nose piece, to the end of the pinion wasn't possible without inaccuracies.

I'm sure that with a surface plate and the DTI on the magnetic base it would be possible to get a good measurement, so long as the diff assembly is carefully setup on the surface plate so the two bearing tracks are completely parallel with the surface plate.

Fortunately I got the measurement done at the company I work at in the machine shop.
They have a surface plate and a very expensive looking measurement device that provided the distance between the pinion end and the lowest point of the bearing track very easily.

Taking the difference between that measurement and the 0.843" gave me the shims required.

I ended up with 0.063" worth of shims.

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Crown Wheel Backlash Setting.

'MG Road Cars' recommends putting the flange in a vice but the problem I found whether it was held in a vice, or sat on the flange on a table was that when rocking the crown wheel, the main diff casing would move in relation to the flange and affect the reading.

So I simply used a bolt just long enough to clear one of the pinion cover nuts, and then wound up a nut to lock the flange against one of the pinion cover nuts as shown below. This gave a reliable 'rock' of the crown wheel without anything else moving and affecting the reading.

The whole assembly could then be placed on a bench rather than in a vice.

I had a further question on how to achieve the correct loading of the taper roller bearings at the same time as setting the correct backlash.

After ensuring the 30207 bearing outers were properly tapped into position, and the two caps fitted with nuts torqued up to the correct setting of 25 to 28lb ft, I achieved a setting by measuring the side to side movement of the crown wheel.

The DTI base was placed on the nose piece gasket flange, and positioned to be on the side of the crown wheel gear.
I had to ensure the rough position of the crown wheel assembly was not tight up against the pinion, otherwise the assembly would be 'locked' and an incorrect figure would be achieved.

I tightened up the two large castellated nuts until the side to side movement of the crown wheel assembly was about 0.003". The lock tabs were not tapped over at this point.

I then moved the DTI to the teeth of the crown wheel gear as shown in the next photo.

I could find no engraved reference anywhere on the crown wheel as to what the backlash should be set to, so followed ‘MG Road Cars’ and set it to “at least 0.005”.

In order to attempt to maintain the taper roller bearing loading, every time I needed to make a backlash adjustment, the crown wheel assembly was moved by undoing one castellated nut by a set number of castellations, and tightening up the other by the same number of castellations.

The backlash was checked at multiple points around the crown wheel. I ended up going round the crown wheel several times making measurements and adjustments.

This took some time – unlocking the flange, rotating the crown wheel a bit, relocking the flange, taking the backlash measurement and adjusting as necessary.
I found a reasonably large variation, and set to a minimum of 0.005”

After I believed the backlash was set correctly, the side to side measurement (bearing loading) was re checked, followed by another check of the backlash.

Once happy, the lock tabs were knocked over.

Finally, the teeth were blued up to check position of the contact point.
I had been advised that the point of contact should be in the centre of the tooth when it is under load.
To achieve this, the point of contact, without load, should be a little lower than half way ie closer to the centre of the crownwheel.
The contact point will move outwards when load is applied.

I didn’t find this the easiest thing to observe, and ‘applying load’ with a unit on the bench wasn’t easy either. All I could do was apply finger load. But my end result looked reasonable, so I left it at that !

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And the end result -