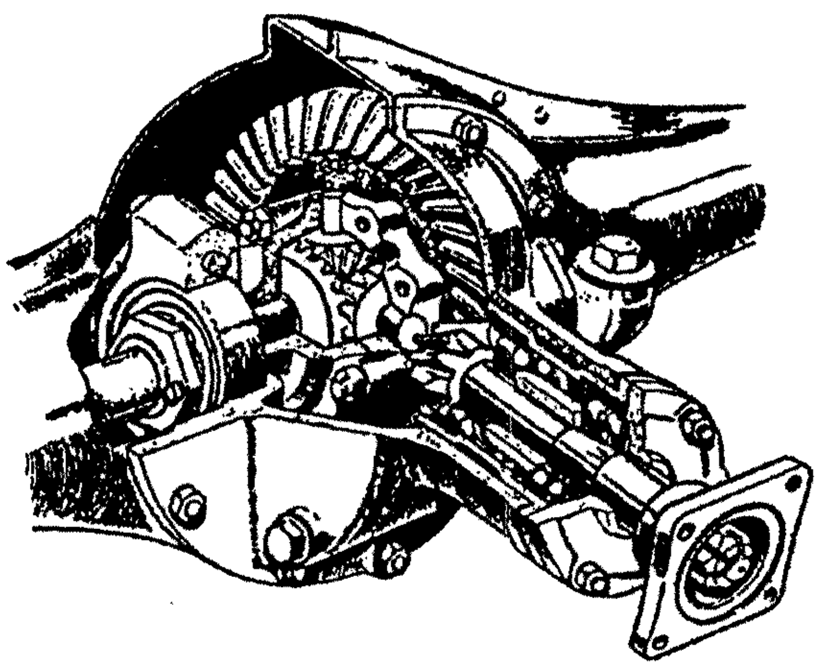
Tech Tip:

CH110 - DIFFERENTIAL REBUILD & SET-UP

TA/TB/TC Differential Modification & Setting-up



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TA/TB/TC DIFFERENTIAL: MODIFICATION & SETTING-UP

One of the worst aspects of this differential is the front thrust bearing. This was originally a double row ball bearing, the Ransomes & Marles **3MDJT25** with split outer race, bronze cages and 24 balls. These are now obsolete, although I have a (very) few new old stock, over 50 years old but in perfect condition! They are usually replaced by the modern 5305 or 3305, which have steel or even plastic cages and contain only 16 balls.

All goes well until these bearings start to wear out (and the 16-ball types will wear out faster) since the pinion can then float longitudinally in the housing, because the rear bearing is a cylindrical roller type which gives only lateral support. This allows the teeth of the Crown Wheel & Pinion to move out of their proper mesh, even in bad cases to bottom-out. Noise levels increase, and unless something is done, total destruction inevitably follows. Having the CW&P destroy themselves is bad enough, but in some cases the shock loadings as teeth strip off and jam between the gears, causes the diff. housing to fracture as well, nearly always on the CW side. Repair is possible, but pricey: however I have now had a batch of new housings made, machined from solid.

The main reason for the failure of the front thrust bearing lies in the design of the oil scroll in the pinion housing cap: this does a reasonable job of keeping oil inside the diff. casing, but will also drag any dust or grit on the boss of the drive flange into the bearing. Many of these flanges show some scoring caused by grit which has actually jammed in the scroll.

The two main improvements that can be made are therefore:

1) Replace the original bearings with Taper-roller types. These have a **much** longer life because the two bearings each take the longitudinal thrust, in both directions, as well as the lateral thrust of the pinion in the case of the rear one, and in addition the tapered rollers have a greater surface area compared to the balls of the original front thrust bearing.

2) Improve on the oil scroll by fitting a lip-type seal. This can be done by modifying the original cap, or by purchasing a new cap incorporating a seal (which costs more than twice as much).

DISASSEMBLY

Start by removing the two small locking bolts in the two large Crownwheel adjuster nuts, followed by the nuts themselves. These can be very tight, and the correct sized socket should be used, with a tubular spanner as second choice. The nuts are 1 ¼" BSW size (although not thread), which is 52mm, and can sometimes be found at autojumbles. Follow these with the four nuts at the front: insert a half-shaft to hold the diff. steady. Now undo the four bearing cap bolts: these are also tight, so use the half-shaft again. The caps can now be knocked off and the Crownwheel assembly removed.

To remove the pinion assembly, press on the head of the pinion with the diff. well supported by the mounting flange. A proper press is preferable for this and several other jobs: quite often your local small friendly garage will let you use theirs. Failing that, put a short length of 2" x 2" hardwood on the pinion head and hit it with heavy hammer: some almost fall out, but the majority are quite tight!

The only way to properly hold the drive flange to remove & replace the pinion nut, is with a length of steel bar which has been drilled to take two 5/16" bolts . These must be spaced to pick up two of the flange holes: between them file away enough metal to give clearance for a socket.

With the nut removed, quite often the pinion can be knocked out quite easily. Now remove the large snap-ring holding the roller-bearing outer race. The only tool for this is a large pair of bent-nose snap-ring pliers, aided by a small screwdriver: squeeze the ends together and slip the screwdriver under one side. Lever it up enough to grip it with pliers and pull: hold a rag over it to prevent an accident. The bearing outer races can now be drifted out from the opposite end: the internal flanges are provided with two cut-outs to facilitate this.

The fiddliest job is removing all the split pins from the Crownwheel bolts! For some reason when people install these, they never think to line up the bolt holes to make our job easier! If they refuse to budge, just break off the tails, put a 5/16" BSF socket over, and twist off.

The front cap is held on with two countersunk screws which can also be rather difficult to remove! If an ordinary screwdriver won't shift them, use one of the flat blades you get in those kits containing a dozen or more points. Put it in the holder with a 6" extension and use a press to force the blade into the slot, then twist.

FITTING TAPER ROLLERS

Taper-roller bearing types used are the **32305** replacing the front 3MDJT25, and the **30305** replacing the rear MRJ25 roller bearing. Most MMM cars & very early TAs had a single row front thrust bearing, which should be replaced by a 30305. Taper-rollers have an offset of 1.25mm between the inner and outer races, so to maintain the correct positioning of the pinion, some modifications are needed. In the first edition of this booklet, written in 1998, I described how to machine the pinion housing inner flange, but of course not everyone has access to a lathe. The alternative is simply to space the whole pinion assembly forward by using more shims, but as the thicker ones are often unavailable, and they are rather expensive, I have now had some special thick ones made by laser-cutting.

Press outer cones into the pinion housing, the smaller 30305 to the rear. The good news is that you don't need to refit the snap ring! If they are not a good press fit, use Loctite Bearing Fit (# 641). Before applying it, degrease with Brake Cleaner aerosol. Taper-rollers must be installed with absolutely no end-float, or slack, and the best way to achieve this is to arrange for a very small pre-load of 5-7 lbf. ins. Between them the two bearings have an offset of 2.5mm. between inner & outer cones, so we have to increase the length of the spacer by this amount. Making a new longer spacer, as previously advocated, is rather time consuming: using shims makes life much simpler!

Use the old pinion to set up the pre-load, because the new bearings should slide easily onto it. Push the 30305 up to the head of the pinion, followed by the spacer & 2.5mm. of shims. Place the housing, with the outer cones, over the pinion, then the 32305 and the drive flange (no need for the cap at this stage). Using a socket large enough to clear the pinion thread, squeeze the whole assembly, preferably using a press, but a vice could be used. Some trial & error is needed: with too few shims, it will be tight, too many and there will be end-float. Normally, slightly more than 2.5mm of shims are required. When the pre-load is correct, the torque to turn it is a mere 5-7 lbf. ins. and it will spin freely. I use a Britool "Torque Limiting Screwdriver", but without one the simplest method is to bolt a steel strip to the drive flange: measure exactly 5 inches from the centre and file a small notch. Then a 1lb. weight hung on it equates to 5 lbf. ins. whereas 1lb. 6oz. gives 7 lbf. ins. Or you can use a small spring balance of the type fishermen use.

When correct, reassemble using the new pinion. You will need a length of steel tubing of 1" bore as long as the shaft of the pinion to press the 30305 down to the head of the pinion. Again, a press makes life easy, but a large vice can be used. This time install the cap after pressing the 32305 on: put a thin film of instant gasket on the flat face of the cap, but keep it away from the bearing area. Grease inside the lip-seal if the modification is used. The two countersunk screws don't need to be too tight, although hopefully it will be many years before anybody needs to remove them.

LIP-SEAL MODIFICATION

As noted above, the original oil scroll actually draws dust & grit into the front thrust bearing, and quite often grit lodged in the scroll can cause a lot of scoring of the drive flange boss. By modifying the original cap (my preferred approach), or buying a new aluminium cap from Moss for over twice the price, a rubber lip-seal keeps oil in and dust out. The other advantage is that, because the seal is forward of the scroll position, it runs on an undamaged part of the flange boss.

Check the drive flange for flatness: if only slightly out of true, cleaning up on a linisher will suffice. If it is worse, mount it on a mandrel in the lathe and take off the least amount which gives a cut all round. Then reverse on the mandrel and polish the boss with emery paper to give a smooth surface for the seal.

For really bad drive flanges (and I have seen a few, including one savaged by a hacksaw when somebody had trouble getting the bolts off!) I have now had a batch of new ones made.

Grease the boss of the drive flange before pushing it over the pinion splines, followed by the thick washer (chamfered face outwards) and the (preferably new) castellated nut. With the flange bolted to the steel bar used in disassembly, tighten the nut to 100 lbf. ft and see if the hole and slots line up. If it is close, tighten further until a split pin goes in: if the nut has just gone past the hole, take it off and remove a few thou. from the back and try again. Aim for a final figure of 100-120, but never back the nut off to get the split pin in and leave it too loose.

Re-check the 5-7 lbf. ins. of pre-load before putting in the split pin.

INSTALLING THE CROWNWHEEL

Split the centre housing and examine carefully: cracks can start between the three small oil holes, eventually leading to complete fracture. A simple way to test is to hold a half housing at the thread between finger & thumb, then strike the flange lightly with a small hammer: good ones will ring like a bell. The four spider gears (also known as the Planet gears) have a tendency after high mileages to wear into the housing, but a few thou. is normal. More modern diffs. have thin bronze thrust washers, but I have not found any of the correct inner & outer diameters.

It is probably best to keep the gears on the same arms of the spider: you can also mark one leg of the spider so it goes back into the housing the same way. The two halves of the housing are always stamped with numbers which must be realigned.

Always use new crownwheel bolts: the old ones, even if not actually "necked", will have been stretched. I always use all-metal self-locking nuts ("Aerotights") to avoid the tedious business of getting the bolts torqued correctly **and** lining up the split pin holes. Hexagon headed bolts in 5/16" BSF size of a high enough quality are almost impossible to find nowadays, so use M8 bolts of 10.9 grade. Cap-head bolts can also be used, but half-height heads are necessary to give clearance.

Bolt up the crownwheel using four bolts only, moderately tightly, using standard nuts, and mount between centres on a lathe to check run-out. Using a dial-gauge on the outer edge of the flat face, you ideally want to see a maximum of ± 0.1mm. If it is much more than this, unbolt and turn to a new position. If you cannot find a good position, inspect the mounting face for damage: in extreme cases the housing will have to be machined, but this is a job for experts!

With the run-out minimised, install all eight bolts and tighten up two opposites, then move round so that the crownwheel is pulled up evenly. If you cannot get the highest tensile bolts, tighten to 27 lbf. ft. or go to no more than 30 with good HT ones.

The crownwheel thrust bearings were originally LJT35, and usually give no trouble, but it is a simple matter to replace them with **30207** taper rollers, which will not only last much longer, but are cheaper! They are often supplied with a very thick preservative, so dissolve this out with Gunk or WD40, and apply a small amount of light oil. The bearings are installed with the large end of the rollers facing outwards, outer cone inwards. If they don't go on with thumb pressure, use the old bearing to press them on (it stays over the thread so lifts off easily). Inspect the locking washers carefully (they sometimes crack), and put them on followed by the adjusting nuts. These have often been mangled by previous owners who did not possess the correct socket, so clean them up with a file.

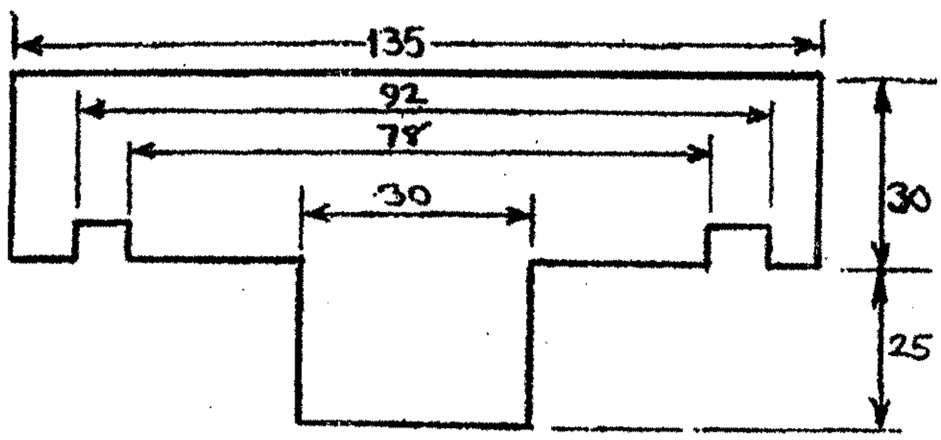
The correct position of the bearings will leave the outer surface of the nuts just outside the end of the housing threads. Now drop the whole assembly onto the upturned outer casing, install the caps, noting the position markings, but leave the washers off the bolts for now. The crownwheel should be very loose, i.e. be sure the bearings are not pinched up as you tighten the bolts. You now need to reduce the backlash to zero by doing up one or both adjusting nuts, with the one on the crownwheel side done up a little more. Put the small locking screws into the nuts and do up the non-crownwheel side finger-tight. Turn the nut so that the spigot on the end of the screw goes easily into one of the slots of the washer. Now tighten the crownwheel side adjuster nut until the whole assembly spins for a couple of turns when you spin it. I use my Britool Torque setting screwdriver to arrive at the correct 5-7lbsf. ft. but you can use the method used above for the pinion.

You want to aim for a compromise between too loose (backlash in the bearings, spins for several revolutions) and too tight (it will just **feel** tight, and will not spin). It is tricky, because the locking washers have only 12 slots which does not allow for fine adjustment. When you are happy with it, put the locking screw in, and put marks next to the slots in the threaded ends with a permanent marker pen.

SETTING UP THE CROWNWHEEL & PINION

The first adjustment is the pinion "mounting distance", which is the distance between the front face of the pinion and the centre-line of the crownwheel. New CW&P sets supplied by me all have the mounting distance engraved on the top face of the pinion. It varies slightly from batch to batch, and between ratios: typical values are 96.86mm & 3.808ins (96.72mm). Measure the height of the pinion head with a Vernier caliper: it is nominally 35mm. Make this calculation:
(mounting distance) – (pinion head height) – 36 (half the bearing o.d.) = D
The easiest way to set this is to make a template as follows:

Use thin steel sheet.
Only the 25mm.
dimension needs
to be accurate: use
a Vernier caliper.
Then G = D - 25mm



Push the pinion housing assembly into the diff. casing, hold the template firmly against the bearing journals, and gently tap the top of the pinion until feeler gauges to the value of G can just be inserted. Measure the gap between the front flange of the casing, and the housing flange, remove pinion assembly and install shims totaling this value. With taper-rollers installed and no machining of the pinion housing, use the special thick shim which I supply with new CW&P sets, plus normal thin shims.

Put two of the four nuts onto the studs with flat washers, tighten up, and re-check the gap G with the template: it will probably now be a little small, so increase the front shim thickness to correct it.

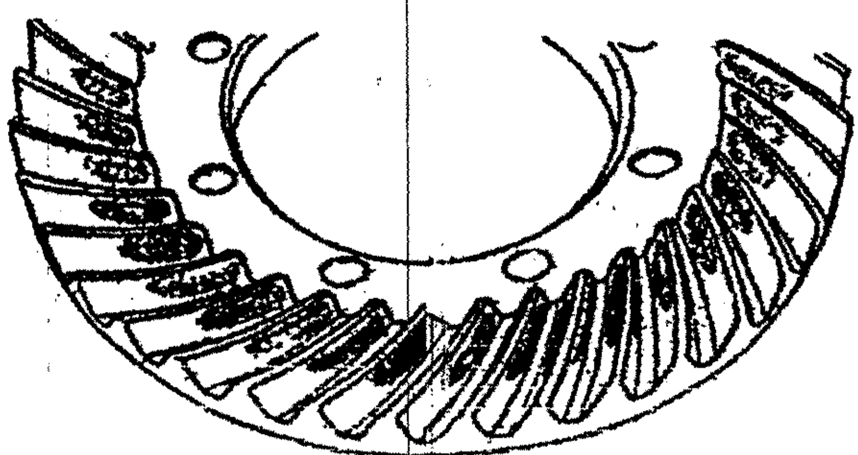
The second adjustment is the backlash between the teeth. Stand the whole diff. up on the drive flange (you will need a base with a hole for the pinion nut: I use an old front cap with the boss machined off). Carefully drop the pre-assembled crownwheel onto the bearing journals: providing that you do not have the crownwheel too far to the centre, the teeth will mesh together without binding.

If they do, loosen the adjuster nut on the side opposite the crownwheel by say 3 slots of the lock washer, and tighten the other one by 3 slots. If the first bearing is not a sliding fit, use a little ingenuity to move it outwards against the lock washer.

Bolt down the bearing caps, ensuring that they are correctly located (they are nearly always numbered), this time using new thick spring washers, and torque up to 45lbs f. ft.

A dial gauge must be used to check the backlash: either bolt a piece of steel to the casing flange and use the magnetic base, or make a simple support with a hole angled to clamp the mounting rod directly. Draw the crownwheel closer to the pinion by releasing and tightening the adjuster nuts by equal amounts. By rocking the crownwheel, the backlash is determined: it should be **0.13-0.18mm (5-7thou).** Check this at intervals by rotating the whole diff. 4 or 5 times. If there is excessive run-out on the crownwheel, the backlash will be uneven, maybe varying from 0.1-0.2mm, which might cause it to be noisy, but will otherwise not be a problem, although not ideal! When you are happy, do up both locking screws.

To double-check correctness of gear meshing, a mixture of red-lead & oil was traditionally used, but it is easier to use a small tube of artists oil paint: Prussian blue shows up well. There is also marking blue in paste form, but it is more expensive.



Before reinstalling the diff. in the car, squirt some Castrol EP140 gear oil into the bearings with the diff. stood up on the drive flange, to ensure the front bearing does not run dry initially. Check the 10 bolts in the axle casing for tightness, put on a new paper gasket (use blue Hylomar as sealant) and replace the nuts with new spring washers. Fill the axle with EP140 until it just begins to overflow from the level plug on the offside. Replace this with a new fibre washer. Bolt the propshaft to the drive flange with new bolts, preferably using aerotight nuts.

TA/TB/TC BACK-AXLE RATIOS

The standard ratio as fitted to the TB & TC is 41:8, or 5.125:1

This gives the following speeds with the TC gearbox:

	mph/1000 rpm	speed @ 5200 rpm
Top:	15.84	82
3rd.	11.73	61
2nd.	8.12	42
1st.	4.69	24

The **new alternative** ratio which I now have available is 37:8 or 4.625:1, which is 10% higher than standard and gives:

	mph/1000 rpm	speed @ 5200 rpm
Top:	17.55	91
3rd.	13.03	68
2nd.	9.0	47
1st.	5.2	27

Another way to compare things is to look at the revs. at 70 mph:

	5.125	4.625
Top:	4420	3988
3rd.	5968	5372

The reason that 5200 rpm was used, is that that is the engine speed at which the XPAG develops it's maximum power of 54.4 bhp.

Thus we see that, far from 4.625 being too high a ratio, it enables the U.K. legal maximum speed to be reached in third gear at just over the peak of the power curve (a good engine of course, will rev to much more than this). Then on changing up, the revs drop to just under 4000 rpm (road speed will fall a little during the gear change), giving a far more relaxing cruising at 70 mph compared to the standard ratio, which requires almost 500 rpm more.

The net result is better fuel economy, less wear on the engine internals, and quieter running. Anyone who thinks that this ratio is too high should look again at the figures above - the higher 3rd. gear falls almost exactly half-way between the standard top & 3rd. which means that it can be held longer, and the higher top gear used more like an overdrive on today's roads, with their much higher overall speeds than in years gone by.