# DIFFERENTIAL,

# REAR AXLES,

# AND

# DRIVESHAFT

## GREASE FITTINGS FOR REAR HUBS AND UNIVERSALS

Here is an alternative for the grease fitting problem cited in the previous article and in "Prolong The Life of Wheel Bearings And Make Maintenance Easier". It obviously is also applicable to axle and driveshaft universals.

I discovered a really bad axle joint on the way home from work and necessity dictated I take what my local import parts dealer had to offer. It was a GMB made in Japan. Now I don't think much of Japanese products, and especially things like bearings, but.... The up side was that it had a grease fitting and that fitting happened to be about 1/2" long - enough to reach in the hub discussed above. Most universals you get now do not have grease fittings and are "lubed for life". Personally I believe that their life is shorter without greasing. The box said it contained only preservative grease and should be fully lubricated. The down side is that all the grease came out of one of the caps next to the grease fitting and therefore little, if any, got to the other caps. Typical Japanese part. I suggest you keep the fitting and throw the u-joint away.

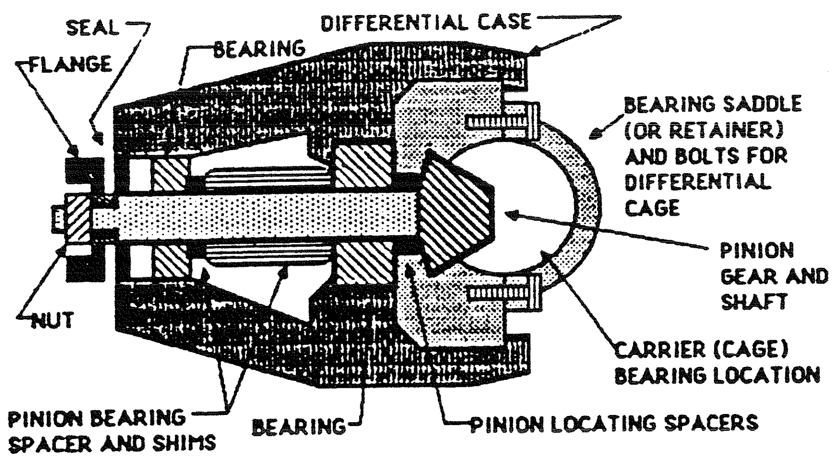
## DIFFERENTIAL REBUILD WITHOUT THE FACTORY TOOLS

Skill Level A/B

From the looks of the pile in the shed, I've used up about 8 to 10 rear ends since March 26, 1970 (the day my first TR 6 and I met). We've been together ever since and it and two stable mates have blown those rears. The interesting thing is that alway they break two pinion teeth and the teeth break off deep in the gear. That suggests perhaps insufficient hardening and or just plain metal fatigue. Unfortunately, we can't do anything about the metallurgy. However, another thing I've noticed in early rears is excessive "slop" when, for example, turning a wheel back and forth. It is very difficult to tell if this is in the sun gears or the pinion. I'm prone to thinking some is gear wear and a lot of it is in pinion bearing wear and associated end play (fore and aft movement of the pinion) which spells sure death for the gears if the play gets very big. I haven't had the opportunity to get into many differentials, but the bearings on most showed wear. Late differentials have a collapsible spacer and are bad news. I won't go into them. If you have any doubts whatever, the pinion bearings should be replaced, the bearing preload be adjusted, and the mesh with the ring gear checked. This same general measuring procedure can be used to set up a new ring and pinion.

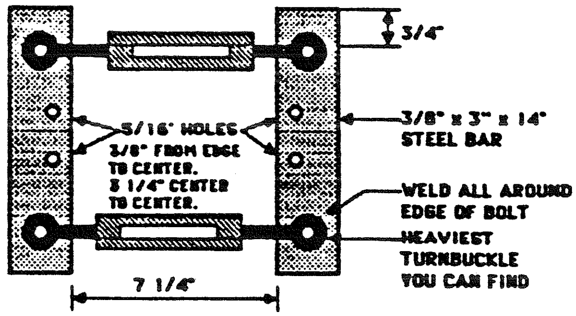
To do a check and rebuild you will not need any special tools but you will need a few tools not in the average tool box and some you'll have to make from the sketches below. You will need an inside micrometer (optional), a 1" micrometer to measure shims and a lot of new sorted and sized shims, a dial indicator, an OTC 1024 (or similar) 2 jaw gear puller for the carrier bearings, a means of removing the rear pinion bearing (usually your friendly machine shop), and a good torque wrench, plus an <u>inch</u> pound torque wrench that goes down to 12 in. lbs.

A section of the differential is shown below with the terms I tend to use. I suggest you also refer to a factory manual or the Bentley reprint. Also shown are the various home made tools and gauges.




SECTION THROUGH DIFFERENTIAL-
CROWN WHEEL AND CARRIER (CAGE)
ASSEMBLY AND REAR COVER NOT SHOWN

DIFFERENTIAL SPREADING TOOL

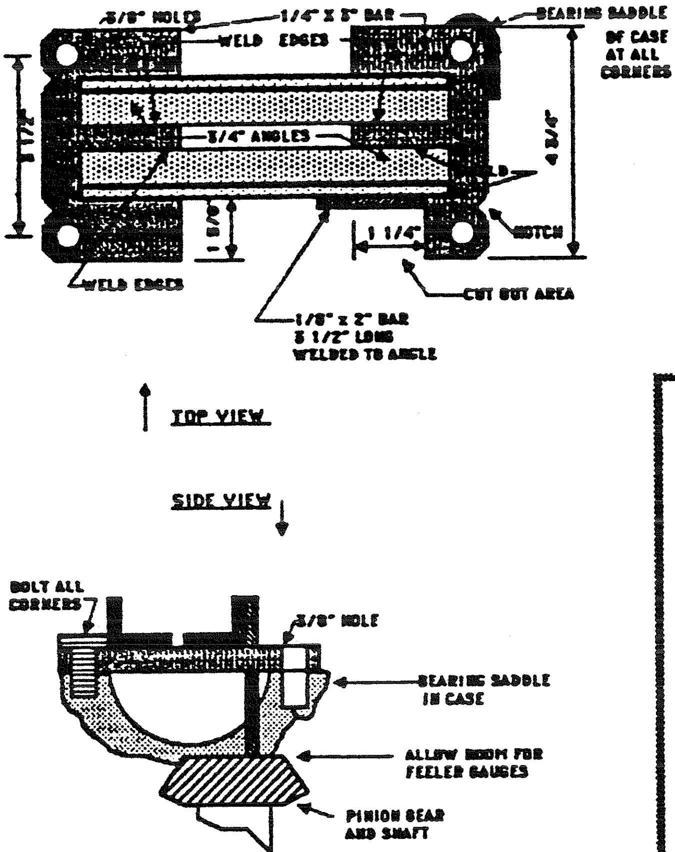



The first tool you will need to make is a spreader for the case. The drawing is rather self explanatory. It simply bolts to the case and you turn the turnbuckles to relieve the preload on the carrier assembly so you can remove it. Do not overdo this. In most cases about one turn past firm is required. This tool does not have to be a work of art! The only precision needed is in placing the 5/16" holes. Bolt the bars to the case before having the turnbuckles welded to them. Stuff the case with rags and cover the gears to prevent weld from getting in or sticking to a gear.

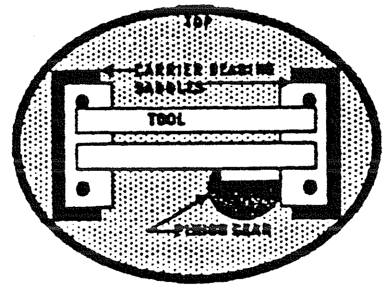
After you have removed the carrier and ring gear assembly you are ready for the next home made tool, the pinion depth gauge. Two methods are shown. The no inside micrometer method shown in three of the sketches below requires some fair cutting, drilling and welding but it should cost less than the micrometer. Cut and drill all your pieces at home and then have them welded. Make sure you don't get weld inside the case. The vertical piece must have a very straight lower edge and should be welded last with about .025" to .050" shims or feeler gauges under it to insure it is truely parallel to the pinion head. Hopefully, your gauge won't be too warped; but if it is, it should still bolt down true enough for our purposes. After everything has cooled, carefully measure the clearance to the pinion from both ends of your gauge and record it (it should be the same).

The second method is shown in the box and it requires only two small straight 1/2" square steel bars, three washers about .096" to .100" thick (all must be equal thickness), and the inside micrometer. The bars can be obtained in almost any hardware store in those racks of various sizes and shapes of metal or from an industrial bearing and fitting type supply. They are surprisingly straight but you will probably have to check a few in the store with a straight edge and give the ones

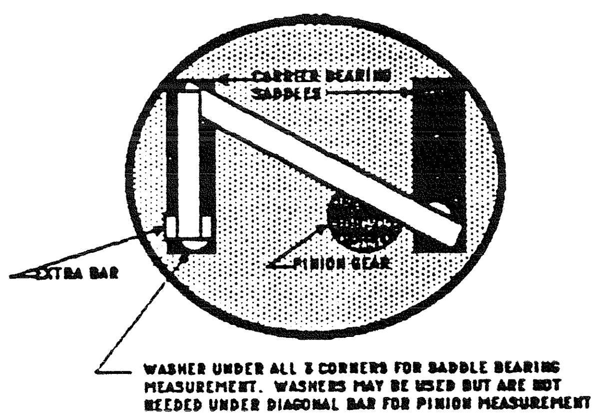
PINION DEPTH GAUGE FOR USE WITHOUT MICROMETER




REAR VIEW OF DIFFERENTIAL CASE SHOWING TOOL LOCATION



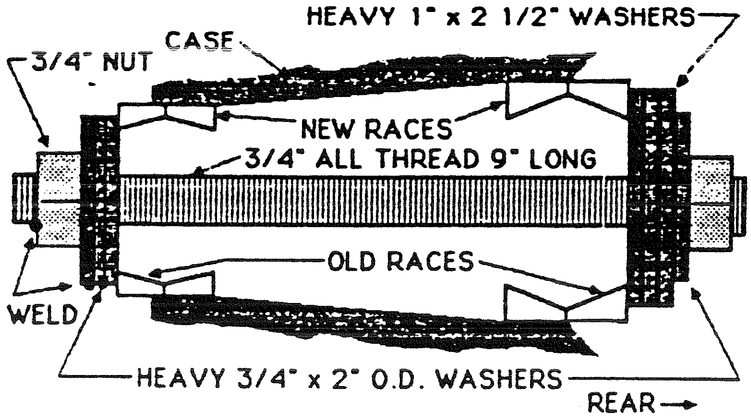

LAYOUT OF 1/2" STEEL BARS USING INSIDE MICROMETER MEASUREMENT METHOD




you buy a light once over with a file to remove high spots. They usually come in 12" lengths. Cut one to 7 3/4" and one to 4 1/4". You only need about 3/4" of the second one now, but we'll use it.

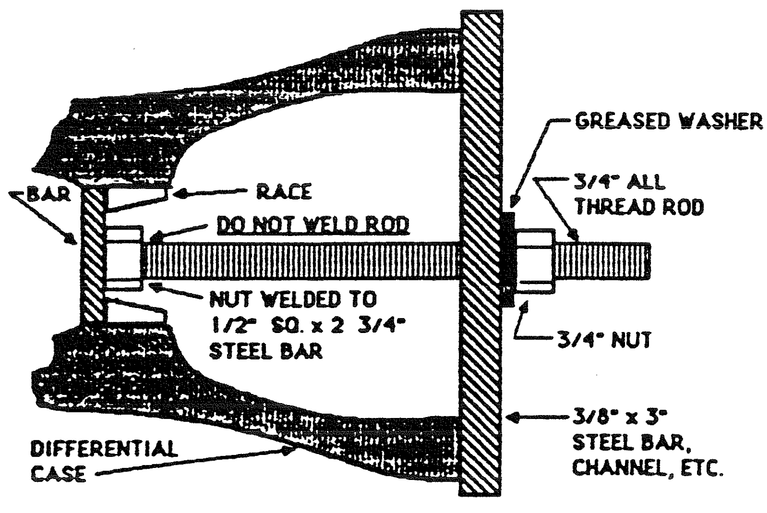
First measure from the bar laid diagonally (without washers) across the carrier bearing saddles to the pinion head with the inside micrometer. This should be <u>about</u> 2.154" or 2.155". Next check the depth of the saddle by placing washers under the ends of the diagonal bar, placing a washer and your 3/4" long piece of bar on the other end of the bearing saddle, and then placing your 4 1/4" bar on top. The measurement should be about 1.424" after subtracting the thickness of the washers and the bar. This subtracted from the other measurement should give a bottom of bearing saddle to pinion dimension of about .730" or .731". With your existing pinion gear, spacer, and new bearings it should be about the same. For those unfortunate enough to be setting up a new ring and pinion I have derived the .730" from only two used differentials. I suspect for a new set it might be .725". A "round number" seems logical, but then we're dealing with a British product here and logic never prevailed in British motor car design (no bitch, just fact!).

Once you have the pinion out the fun begins. With a new pinion you're just going to have to guess the first time and use the spacer from your old pinion. Here we come to one of those things that infuriate me with Brits, so bear with me through a tirade. It seems only the factory had access to the .040" more or less spacers. You'll notice the pinion head shims available from Roadster Factory come in .003", .005", .010". Why the difference? Because they are entirely different and must be placed behind the rear bearing race in the case. Now it is one hell of a job to pull that race and put it back in many times (which you may well have to do since even .001" in pinion depth makes a difference). Usually a used pinion will require about .002" or .003" less. To accomplish this, use a Torrington radial needle bearing race #TRA 2031 which is .030" ± in place of the factory spacer and then those damn thin ones behind the race. I wish I could tell you this is the last time you'll mess with these damn shims, but you'll probably be into them several times. See the tools for removing and replacing the race below. Truthfully, when installing the race you'd probably do better to weld a tube handle onto the washers and old race and drive it in. Freezing it will help a lot. Next, it is time to try to set the preload on the pinion bearings. Start by placing the original spacer and shims on the shaft plus about .010" of new shims. Put on the front bearing, driving flange, and nut. Torque the nut down a little at a time until the shaft no longer turns freely or you reach 90 foot pounds (ft. lbs.) of torque on the nut. However, in no case should it take more than 12 inch pounds (not foot pounds) to turn the pinion. If too tight, add shims; if too loose, take some out. Unfortunately, this is a trial and error job. It is eased a little if you have a way of pressing the shaft back through the front bearing as opposed to pounding it back with a lead or rubber (never steel) hammer. Hopefully, you will have about .730" saddle to pinion. If you don't, just record what you do have and come back to pinion depth later.




REAR PINION BEARING RACE
INSTALLATION TOOL

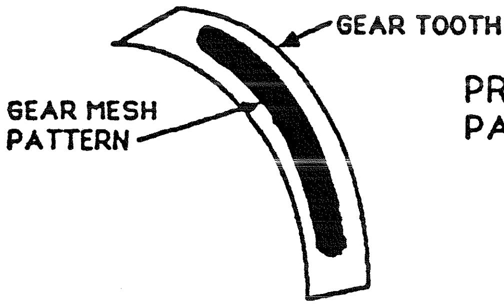
REAR PINION BEARING RACE
EXTRACTION TOOL



Next pull the carrier bearings with the OTC puller. You may find it keeps slipping off the bearing race due to the shims. In this case you will have to cut away the part of the shim in the recess of the carrier or bind the puller with a 'C' clamp so the jaws can't spread.

Take .003 " shim (which is the pre-loaded amount) off of the driven or "teeth" side and all shims off the other side. Use feeler gauges behind the bearing to take out all tranverse (side to side) movement. The manual calls it axial but I find transverse confuses less people. Check for transverse movement with feeler gauges until there is none.

Next check for backlash. Set a dial indicator in the longitudinal direction (front to back) against the outer end of a tooth. Press the ring gear firmly against the pinion in one direction and zero the dial indicator. Turn the ring gear in the opposite direction and note the dial indicator reading. It should be .004" to .006". If it is more you need to move the ring gear toward the pinion. Conversely, if you feel the teeth binding when you try to turn it, add shims on the "teeth" side of the carrier. Install the pre-load shim and shims equivalent to your feeler gauges and recheck. Before you get too deeply into this, check the meshing pattern of the teeth both in the driving and backlash directions. To check the mesh, coat both sides of a couple of ring gear teeth with machinists blue. With a friend's help, or whatever, place some resistance to turning on the ring gear, then turn the pinion in the driven direction. You will see a place where the bluing has been squeezed away along the center of the tooth and that is your pattern. It should look like the sketch. Reverse this to check the back side of the gears. Generally, contact toward the outer end of the gears indicates the pinion needs to be moved rearward and, of course, forward if the contact is at the other end. However, it is easier to try to make adjustments on the carrier assembly so try this first if you have too much or too little backlash. From here on it is purely trial and error drudgery. Hopefully, you'll be lucky. I can not emphasize too much how important the proper meshing pattern is. It may not be as big as the example but it must be in the center and as long and as wide as possible. Otherwise, your gears are doomed to an early death. Incredibly the factory manual never mentions checking this.




PROPER GEAR MESH PATTERN

Again, use this with the manual. The main purpose here is not to give you a different method, but to show you how to make the tools that at least give you a fighting chance.

Here are the bearing and seal numbers if you want to get them locally.
Differential bearings (all numbers are Timken):

| | |
|---|---|
| Front pinion cup 15100-SR | Front pinion cone 15245 |
| Rear pinion cup 3188 - S | Rear pinion cone 3120 |
| Carrier cone 16150 | Carrier cup 16283 |

Stub axle bearing: Nice 1652DC TNTG 18 (sealed both sides)

Pinion seal: National 470487-N (better) or CRI 15207

Stub axle seals: CRI 16054

Magnetic drain plug: Oil-Tite #65203 from Motormite Mfg. Div., 3400E. Walnut St., P.O. Box 1800, Colmar, Pa. 18915

Top photo shows gauge for use without micrometer below case with short bar for micrometer method. Bottom photo shows micrometer method bars in place.