

B.M.C. /AUST./ PTY. LTD.



SERVICE TRAINING NOTES

REAR AXLES

TP665

1. DESCRIPTION.

These rear axles are of the hypoid type, that is, the pinion centre line is below that of the crown wheel. The housing is of the "banjo" type so that the gear unit may be detached from the axle housing whilst this unit is still fitted to the vehicle. The housing provides for $\frac{3}{4}$ floating axle shafts.

There are three sizes of this basic design which are called "A", "B" and "C" and these are fitted to the vehicles listed below. It should be noted that a particular size of axle may be available with several different ratios and specifications to suit various vehicle application.

A TYPE	B4 TYPE	B6 TYPE	C TYPE
Austin A30	Austin A50 Austin A40 GV5 Van Ute.		Austin A90
Austin A35 Austin A40 (A256)	Austin A55 Austin A50 Van & Ute		Austin A95 Austin A105
Austin Lancer Series 1	Austin A60 Morris Oxford 11.		Austin A99 Austin A120
Austin Lancer Series 11	Morris Oxford 111. Morris Oxford V		Austin A152 Van Morris Isis
Austin Healey Sprite Morris Minor 11 Morris Minor $\frac{1}{4}$ Ton.Ute,Van Morris Minor 1000	M.G.Magnette M.G.A.		Morris $\frac{1}{2}$ Ton Ute Series 11 Morris Marshall Morris J2 Van
Morris Major Series 1 Morris Major Series 11	Wolseley 15/50 Wolseley 15/60		Wolseley 6/90 Wolseley 6/99 Wolseley 6/110
Morris Major Elite			Riley Pathfinder (late types)
Wolseley 1500 M.G. Midget Riley one point five	Riley 4/68 4/72	Austin Freeway Wolseley 24/80	Riley two point six Gipsy Austin 110

2. PRINCIPLES FOR SETTING UP.

After manufacture, the crown wheels and pinions are set-up to standard settings on a testing machine and are tested for tooth contact. If a setting other than standard is required to make the gears mesh correctly various markings will be made on the parts concerned. We will refer to these markings later. If we can now take the gears from the production plant and put them in the customer's vehicle in exactly the same relation as on the test machine, the gears should be correctly meshed. It is also necessary to have them mounted on rigid bearings in good condition and to ensure that these bearings are rigid, we allow for a small amount of pre-load. To enable us to set the gears in the customer's job in exactly the same relation to each other as when on the testing machine, we are provided with a gauge which tells us when the pinion is set to the correct depth of mesh. The one gauge supplies this information for A, B and C sizes of B.M.C. rear axles, and also for the Al25 and Al35. The crown wheel position is set by shim or spacer size calculation and backlash measurement.

3. PINION ASSEMBLY.

Firstly, look at the components of the pinion assembly as shown in Figs. 1 and 2. No.2 is the pinion locating spacer, which comes in various thicknesses as follows,

"A" TYPE	"B" 4 TYPE	"B" 6 TYPE	"C" TYPE
.116" - .130" in steps of .002"	.112" - .126" in steps of .002"	.119" - .130" in steps of .001"	.208"-.222" in steps of .002"

NOTE: "A", "B", and "C" type spacers are of different diameters.

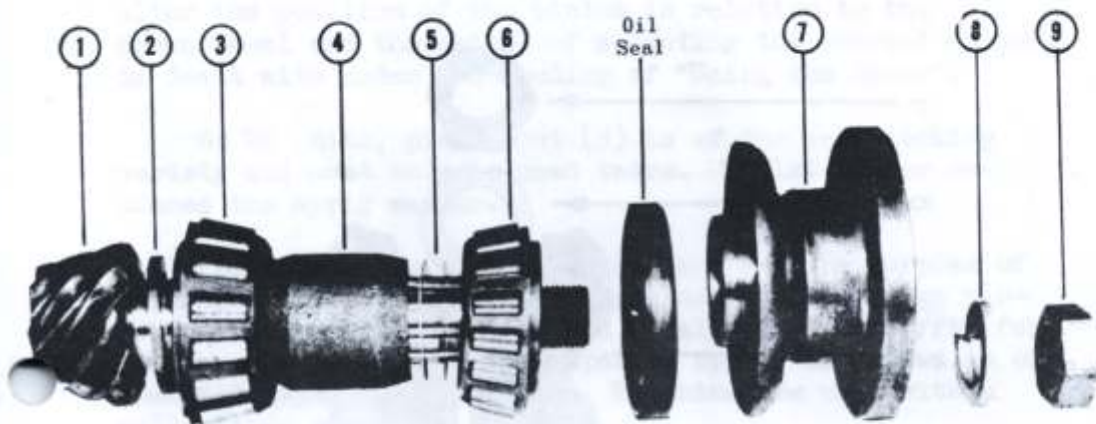


Fig. 1.

TYPICAL PINION ASSEMBLY

- | | | |
|---------------------------|---------------------------|------------------|
| 1. Pinion | 4. Spacer | 7. Flange |
| 2. Pinion Locating Spacer | 5. Preload Shims | 8. Spring Washer |
| 3. Pinion Bearing (Rear) | 6. Pinion Bearing (Front) | 9. Pinion Nut |

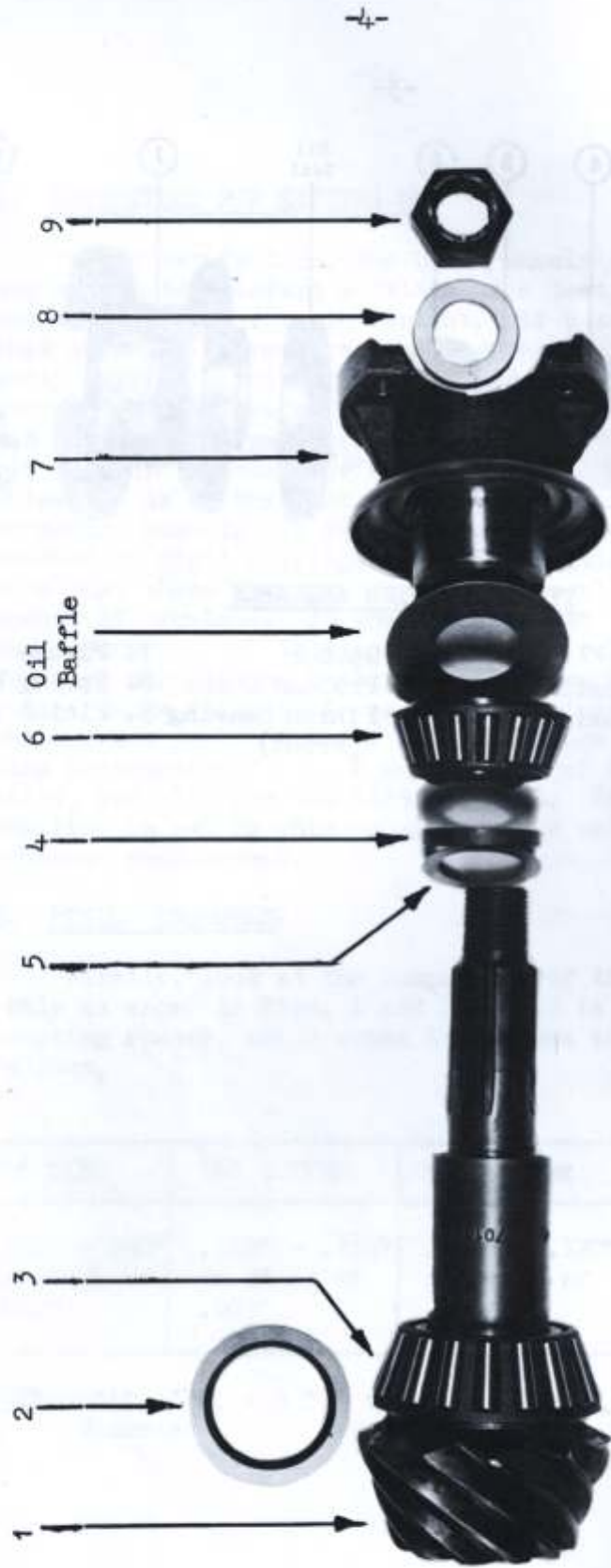


Fig. 2. B6 Pinion Assembly.

By selecting spacers from the ranges shown, we can alter the position of the pinion in relation to the crown wheel and the method of selecting the correct spacer is dealt with under the heading of "Using the Gauge".

On B6 units, pinion nut (9) is of the self locking variety and must only be used twice. A flat washer replaces the sprig washer.

The shim washers shown at (5) are for the purpose of obtaining adjustment of pinion preload and the large pinion nut (9) should be tightened finally to 140 lbs/ft. for all types except when a collapsible spacer is fitted as on some "A" types. (See Fig. 3.) No shims are used with a collapsible spacer.

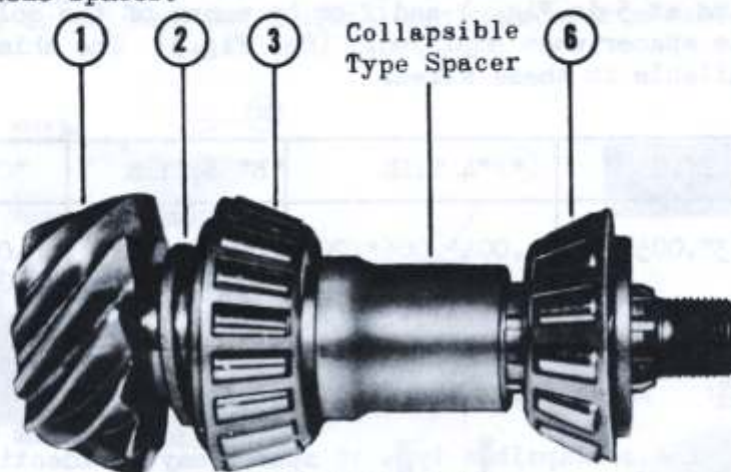


Fig. 3.

COLLAPSIBLE SPACER

- | | |
|---------------------------|---------------------------|
| 1. Pinion | 3. Pinion Bearing (Rear) |
| 2. Pinion Locating Spacer | 6. Pinion Bearing (Front) |

The oil seal should be fitted to the housing so that it is just flush with the face and care should also be taken to see that it is true with the machined end surface of the pinion housing. The seal should always be lubricated before proceeding with the assembly, as a seal that is assembled dry may ruin itself in the first mile.

4. PINION PRELOAD.

Preload on the pinion bearings is employed to allow for bedding in and to ensure that the bearings are truly seated on their tracks under all operating conditions. Thus the pinion is always held at the correct attitude to the crown wheel.

NOTE: Pinion position on B6 units must be obtained before Pinion Preload because of Pinion Assembly Design.

The Preload figures are as follows:-

"A" TYPE	"B"4 TYPE	"B"6TYPE	"C" TYPE
11-13 lbs/inch (without seal)	11-13lbs/inch (without seal)	15-25 lbs/inch (without seal) 20-30 lbs/inch (with seal)	16-18lbs/ inch. (without seal)

Adjustment of preload is effected by altering the shims at 5 in Fig. 1 and 2 or by means of the collapsible spacer when employed. (See Fig.3) The shims are available in these sizes.

"A" TYPE	"B"4 TYPE	"B" 6 TYPE	"C"TYPE.
.003".005"	.004".006".008"	.004".005" .006".010"	.004".006" .008"

NOTE: These shims are of different diameters.

The collapsible type of spacer may be identified by the fact that it is of steel construction and machined all over as in Fig. 3. With this type, the pinion nut is tightened to such an extent that the spacer is caused to collapse slightly and give us the correct preload. The tension figure of 140 lbs/ft. will not normally be exceeded in obtaining the correct preload.

The preload figure should be adjusted to the figure given, and when taking readings, the bearings should be thoroughly cleaned and lubricated. If the oil seal is fitted, it should also be in a lubricated state and an allowance of 3-5 lbs. in should be made for it. (For seal in new condition).

The preload on the pinion bearings (or effort required to turn the pinion) is measured by means of a special tool, 18G207. This tool reads 0-20 inch/lbs. but if the sliding weight is replaced by Adaptor No. 18G207A, the readings are doubled. i.e. the gauge reads 0-40 inch/lbs.

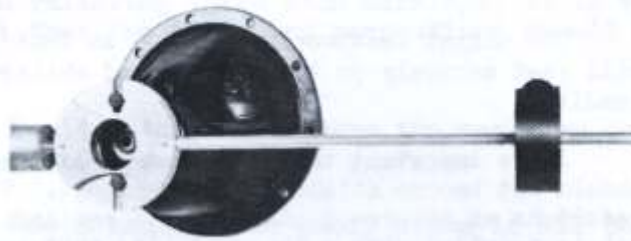


Fig. 4 Tool No.18G207

5. PINION SETTING.

Pinion depth is measured by means of a gauge. If the setting is in correct the gauge will tell us how much thicker or thinner the pinion locating spacer should be.

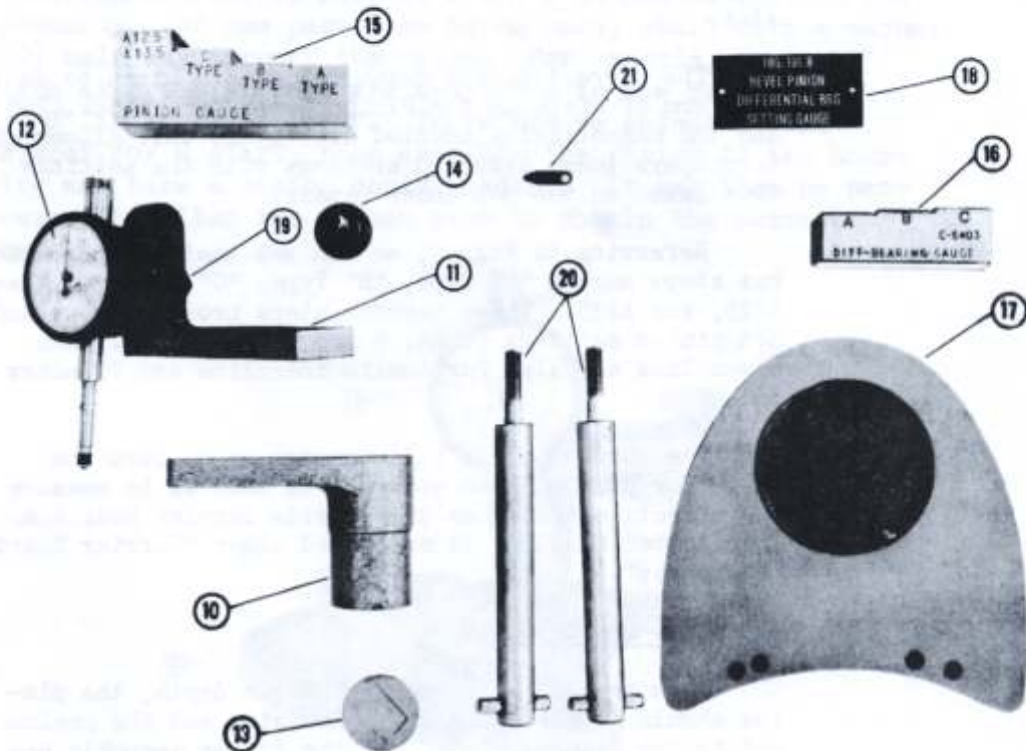


Fig. 5

PINION SETTING GAUGE

TOOL No.18G191B

- | | |
|-------------------------------|------------------------------------------|
| 10. Magnet | 16. Carrier Bearing Thickness Zero Block |
| 11. Angle Bracket | 17. Surface Plate |
| 12. Dial Gauge | 18. Tool Identification Tag |
| 13. Keeper for Magnet | 19. Dial Gauge Mounting Screw |
| 14. Angle Bracket Thumb Screw | 20. Surface Plate Mounting Screws |
| 15. Pinion Depth Zero Block | 21. Foot for Dial Gauge |

The magnet section is provided so that the gauge will rest securely on the pinion head whilst taking readings.

It is important that minute magnetic particles should not become attached to the magnet. These could result in an incorrect pinion depth setting. The magnet is provided with a "keeper" (13) that is, a flat mild steel disc which should be placed on the end of the magnet when not in use. The keeper renders the magnet ineffective so that it will retain its power.

The angle bracket is of cast iron or steel and is secured to the magnet by means of a knurled thumb screw (14) which operates in a slot in the angle bracket.

The dial gauge is mounted on the angle bracket by a $\frac{1}{4}$ " bolt and nut (19) which operates in a vertical slot.

The correct pinion depth values are given to us in the form of steps on the Pinion Depth Zero block (15) and the magnetically mounted dial gauge unit allows us to compare these standard settings with the settings that exist on the job under repair.

Referring to Fig. 5, we can see that the zero block has steps marked "A" Type, "B" Type, "C" Type and also A125, and A135. These various steps provide the standard pinion settings for A, B and C Type B.M.C. axle assemblies and also for Austin Sheerline and Princess models.

The surface plate (17) permits us to zero the gauge for pinion depth readings as well as to measure the effective thickness of the side carrier bearings. This latter facility is explained under "Carrier Bearing Tolerances".

6. USING THE GAUGE.

When preparing to measure pinion depth, the pinion should be assembled in the housing and the preload set to the figures given. If the pinion assembly has been dismantled, it is not necessary to rebuild it completely for the purpose of this check. The spacer (4) and shims (5) Figs. 1, 2 and 3 may be left out and the nut (9) should be tightened only sufficiently to enable the prescribed preload to be obtained. The pinion head has various figures etched on it, and these should be carefully stoned down so that the magnet of the gauge tool will sit squarely and accurately on the pinion head.

When relieving these etch markings, it is very important that the following precautions should be observed.

1. Don't attempt to remove the markings completely - just enough to provide a flat surface.

2. Use a small, fine emery stone in NEW condition. A stone that is worn concave will cause the pinion surface to be slightly convexed and an accurate reading will be impossible.

3. Never rub the pinion head down on a sheet of emery cloth on the bench or other flat surface, as this leads to convexing.

If a check only is required, the original pinion locating washer (2) Fig. 1, 2 and 3 should be left in the assembly. If new parts are being used, start with a washer (2) half way through the range. For example, on an "A" type axle the spacers are available in the range .116" - .130" in steps of .002". Therefore we select a .124" spacer for a start, then assemble the pinion to the housing and take a pinion depth reading. It may then be necessary to alter the spacer size to obtain the correct setting.

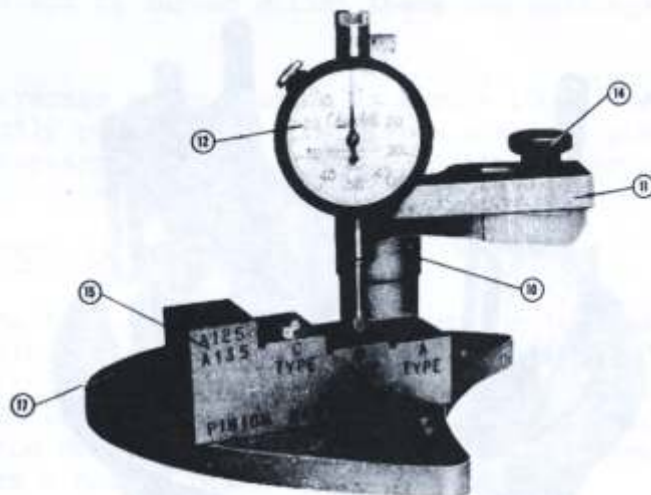


Fig. 6 Zeroing the gauge.

- | | |
|-------------------|-------------------------------|
| 10. Magnet | 14. Angle Bracket Thumb Screw |
| 11. Angle Bracket | 15. Pinion Depth Zero Block |
| 12. Dial Gauge | 17. Surface Plate |

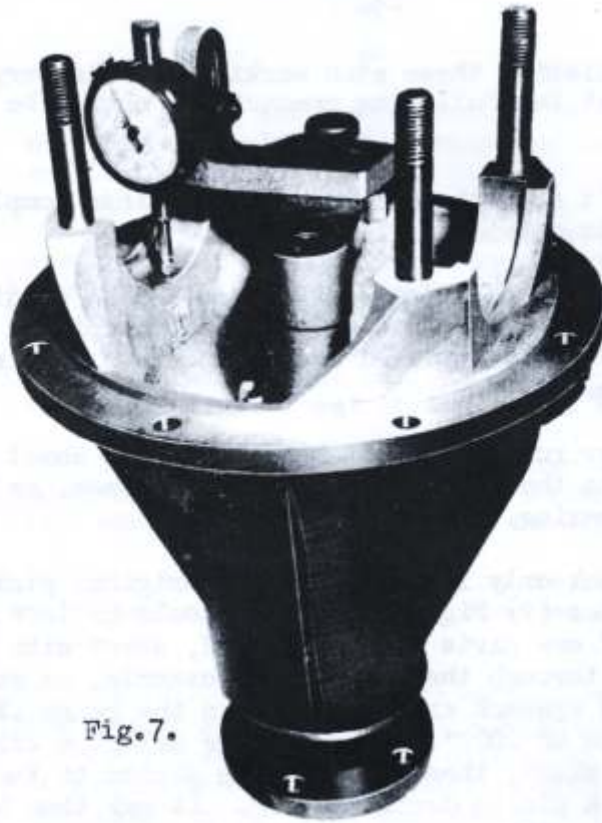


Fig. 7.

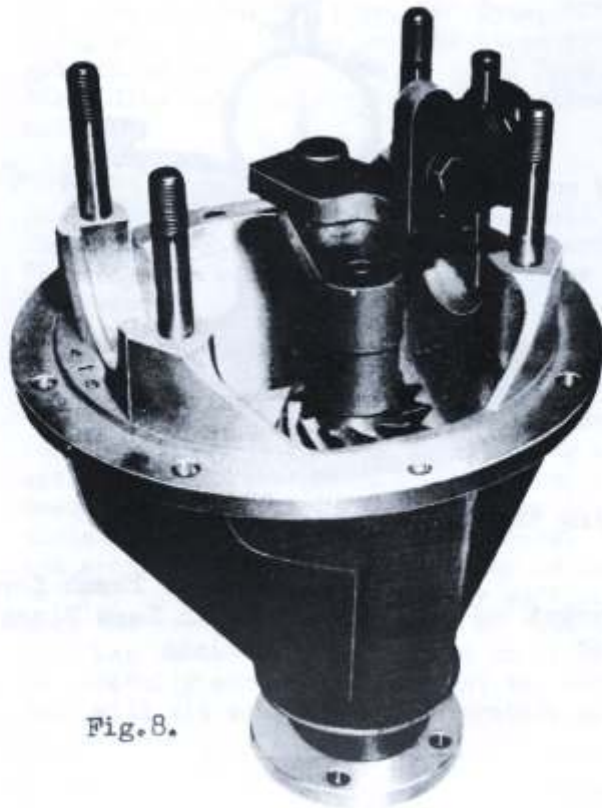


Fig. 8.

Set the gauge up as shown in Fig. 7 so that a reading may be obtained on the carrier bearing bore. Tighten the knurled thumbscrew. Transfer the gauge to the surface plate and zero the dial indicator on to the surface plate and zero the dial indicator on the appropriate step of the Pinion Depth zero block.

Return the gauge to the differential as in Fig. 7. As the bearing bore is circular we will obtain a varying reading as we move the gauge. We require the minimum reading. Be careful to maintain the magnet in the centre of the pinion head.

Set the gauge up to read on the other bearing bore as in Fig. 8. Remove the gauge from the differential and place it on the surface plate and zero block as before. If necessary re-adjust to zero. Return the gauge to the differential and read off the pinion depth.

Because of manufacturing tolerances, the head of the pinion may be very slightly out of true with the axis of the pinion (usually only .0005" - .001" will be enough to cause differences of .002" - .005" in gauge readings. To overcome this difficulty, it is only necessary to take the two readings - one on each bearing bore as shown and take the average of the two readings. It is essential that the pinion should not be turned whilst these two readings are being taken.

If the average gauge reading is Zero \pm .001" the pinion is correctly positioned - i.e. for a standard pinion. It may be necessary to select a pinion depth spacer of different thickness to obtain this condition.

9. PINION MARKINGS

Referring back to our remarks concerning the testing machine for crown wheels and pinions, we said that if a setting other than standard is required for a particular gear set, markings would be placed on the parts concerned, i.e., in addition to the number which indicates that the crown wheel and pinion are a marked pair.

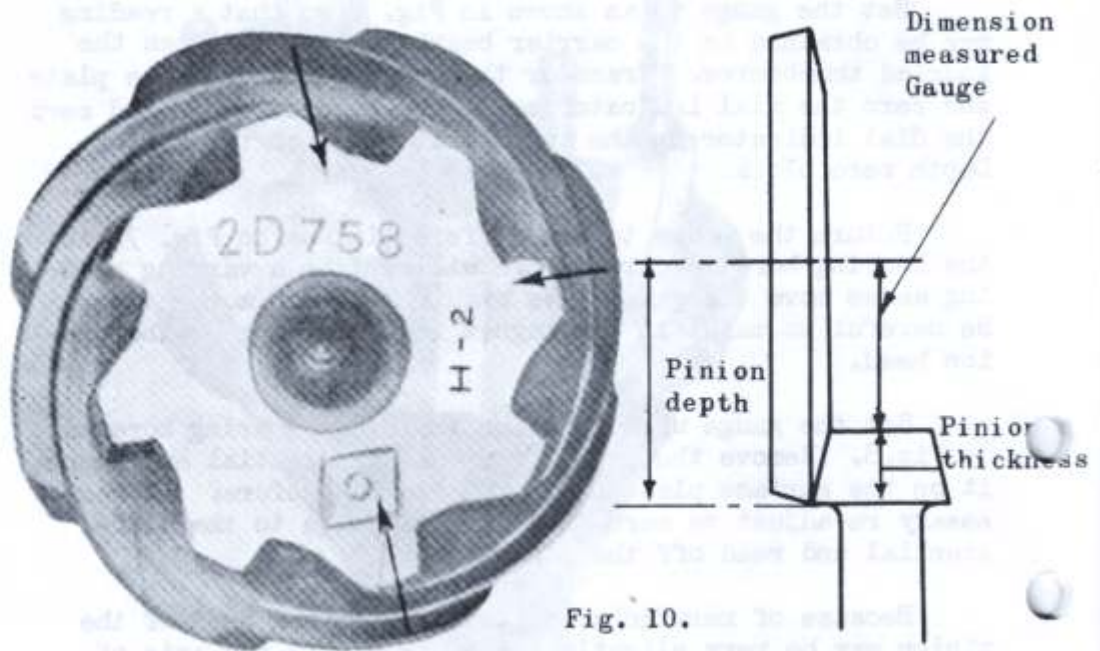


Fig. 9. PINION MARKINGS

If a standard pinion depth setting on the test machine gives the desired result, a zero mark will be etched on the pinion head. This is known as the lapping marking. If it is necessary to move the pinion out, say .002" from its standard depth setting in order to make the gears mesh correctly, the lapping marking becomes +2. Likewise, if the pinion has to be moved, say .001" closer into mesh than standard, -1 will appear on the pinion head. These figures apply to the "Pinion Depth Dimension" depicted in Fig. 10

NOTE: Lapping markings are placed in a rectangle or square, e.g.:

- + .001" is usually marked +1
- Zero is usually marked 0
- .002" is usually marked -2

RULE: These markings will affect our gauge reading so that if we have a:

- + .002" pinion marking, the average gauge reading should be +.002"
 - .002" pinion marking, the average gauge reading should be -.002"
 - Zero pinion, the average gauge readings should be Zero.
- Bear in mind that we are allowed a tolerance of $\pm .001$ " on pinion position.

Some pinions have a second variation marking as shown in Fig. No.9. This marking relates to variations in pinion thickness. If this marking is present, it must be accounted for by adjusting the dial gauge to that figure instead of zero (as shown in Fig. No.6.) On late type pinions this figure is shown with the figure H on the pinion head.

Once the pinion depth spacer has been selected, the pinion assembly may be completed as per Fig. 1, 2 or 3. The pinion nut should be tightened to 140 lbs./ft for A, B, and C types and the preload should be re-checked. If the collapsible type pinion spacer is used, the nut should be tightened sufficiently to obtain the correct preload setting.

10. CHECKING OF PINION SETTING GAUGE.

If there is any reason to doubt the accuracy of the gauge, it should be returned to the manufacturers for repair. The manufacturers are Healing (Sales) Pty.Ltd. who have branches in each state.

The gauge will be rendered inaccurate if:

1. The magnet is loosened from its bracket.
2. Burrs are present on magnet surface.
3. The magnet surface has been reground (Early type gauges only)
4. Damage to dial gauge.
5. Damage to Zero blocks.

11. SETTING THE CROWN WHEEL LOCATION.

Having set the pinion to its correct position, it is now necessary to set the crown wheel location so that we have:

1. The correct backlash.
2. The correct preload on the side carrier races.

The adjustment of backlash and carrier bearing preload is by means of shims or spacers as follows:-

.002" .004" .006" shims	.002" .004" .006" shims.	.128" - .146" in steps of .001" spacers.	.175" - .185" in steps of .002" spacers.

NOTE: A and B Type shims have different diameters

The amount of shims or size of spacers can be determined by:-

- a. Backlash measurement.
- b. Feeling the interference fit as the hemisphere and bearings are pressed into the housing.

As an alternative method, the shim and spacer sizes may be calculated from markings on the housing and hemisphere but firstly crown-wheel run-out must be checked.

12. CROWN WHEEL RUN-OUT

Fig. 11 demonstrates the set up for checking crown wheel run-out which should not exceed .002" in all cases and must be checked before proceeding with backlash measurements.

Excessive crown wheel run-out may be due to burrs or dirt between the crown wheel and its mounting flange or can even be caused by uneven tightening of the crown wheel bolts. The tension for all types is 55-60 lb/ft. Always use new lock washers.

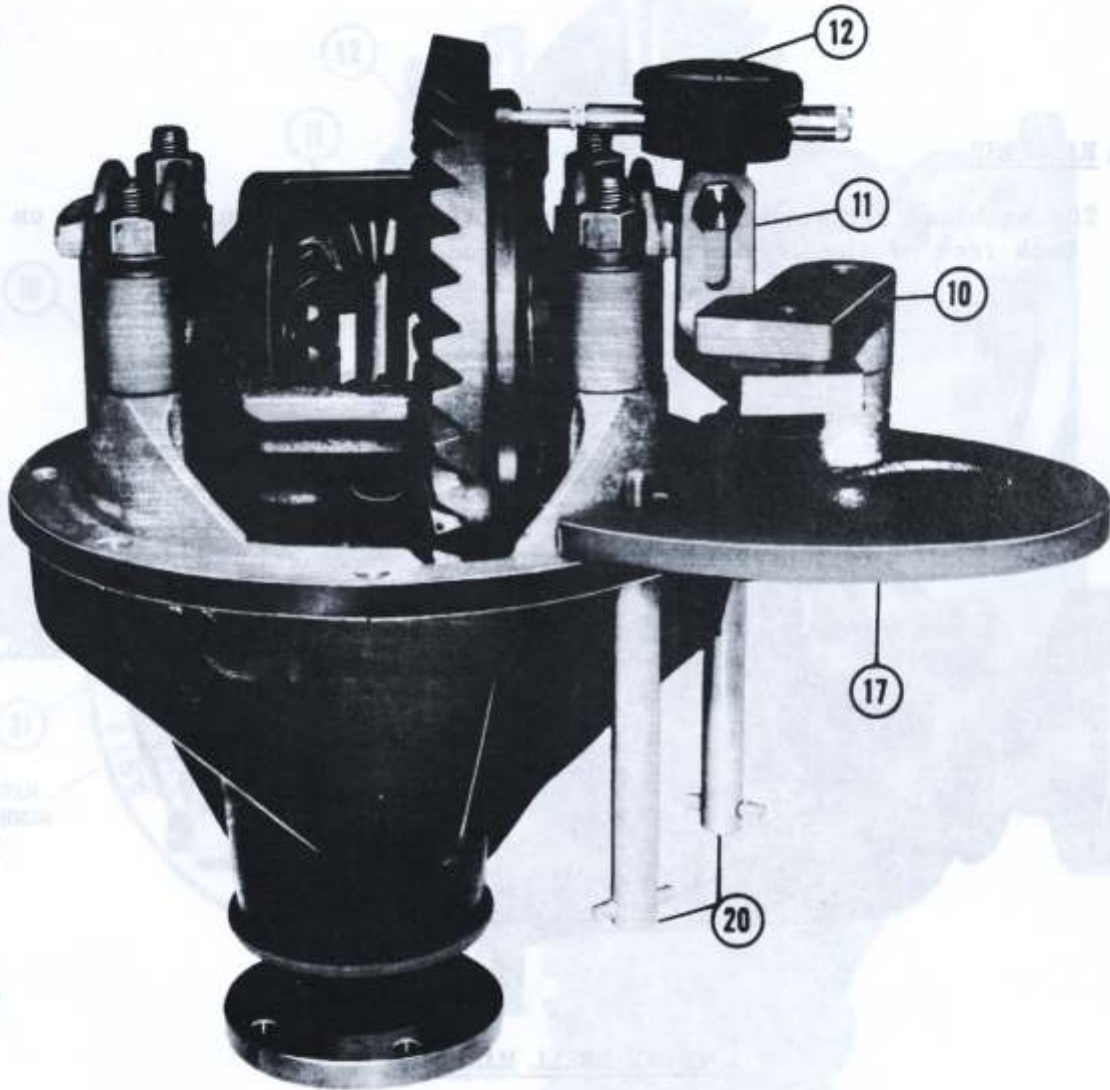


Fig. 11. CHECKING CROWN WHEEL RUN-OUT

On B6 Types Crown wheel bolts are of the self locking variety and must only be used once.

13 BACKLASH

The backlash for each individual crown wheel and pinion is marked on the back face of the crown wheel.

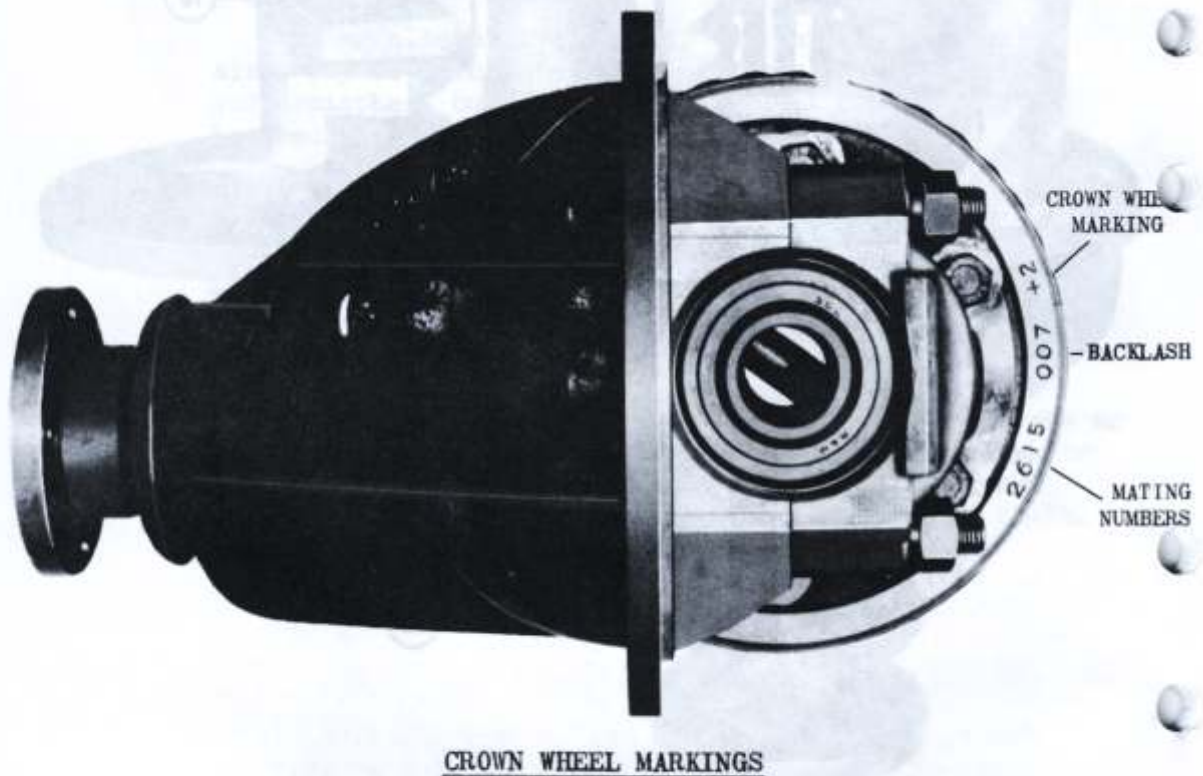


Fig. 12

CROWN WHEEL MARKINGS

The Tolerance on backlash is $+.001''$
 $-.001''$

If the backlash is incorrect the amount of error should be noted and by moving $.001''$ of shims from one side to the other, the backlash will vary approximately $.001''$.

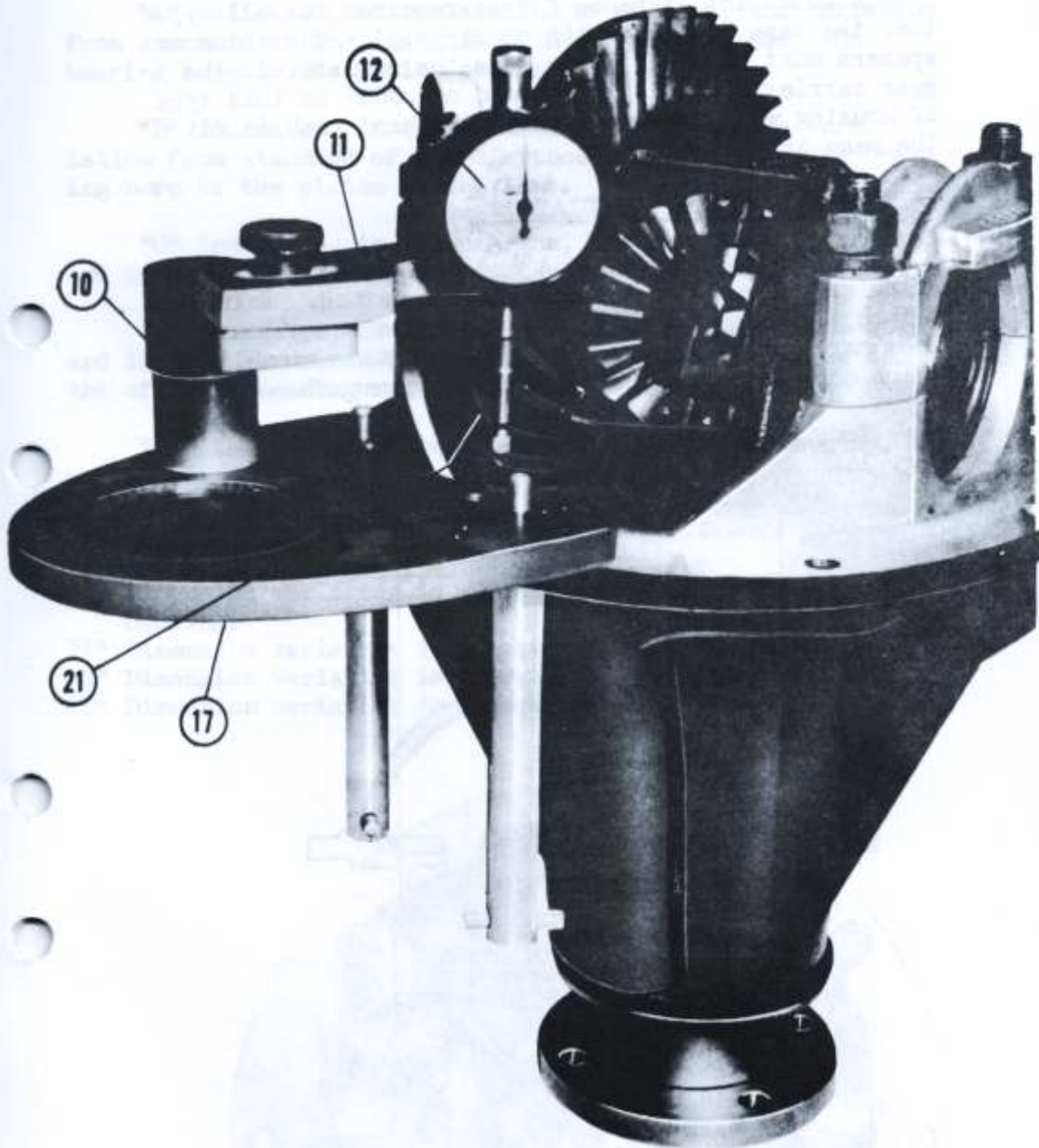


Fig. 13

MEASURING BACKLASH

Fig. 13 shows the set up for measuring backlash. The foot is fitted to the dial gauge spindle during this operation. Backlash readings should be taken at 3 places around the crown wheel; a variation of .001"-.002" is satisfactory.

14. PRELOAD ON CARRIER BEARINGS

A .004" interference fit is required for all types i.e. the cage complete with bearings plus the shims or spacers must be .004" wider than the register in the gear carrier housing. A preload of .004" on this type of housing will require a very firm hand push to fit the cage into the housing.

15. SHIM OR SPACER CALCULATION

Except for very early A and B type, all B.M.C. axles are marked for the calculation method. This method allows us to calculate the shims or spacers from markings on the various parts of the assembly which correlate all the tolerances concerned.

Four such tolerances are A, B, C and D, as in fig. 14.

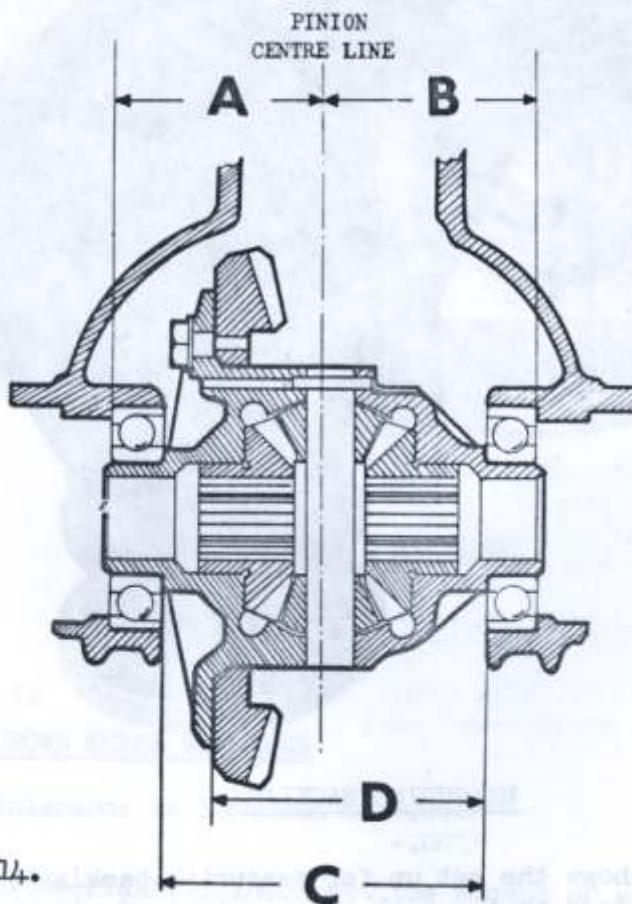


Fig. 14.

16. MEANING OF A,B,C and D

"A" indicates, in thousandths of an inch, the variation from standard in the distance from the crown wheel side bearing bore to the pinion centre line.

"B" indicates, in thousandths of an inch, the variation from standard of the distance from the off side bearing bore to the pinion centre line.

"C" indicates, in thousandths, the variation from standard in over-all measurement across the cage.

"D" indicates, in thousandths, the variation from standard in the measurements from the crown wheel back face to the off side bearing register on the hemisphere.

Thus A and B are dimensions relating to the housing, whilst C and D refer to the hemisphere.

17. MARKINGS ON GEAR UNIT

"A" Dimension variation is stamped on crown wheel side of housing.

"B" Dimension variation is stamped on off side of housing.

"C" Dimension variation is stamped on Hemisphere

"D" Dimension variation is stamped on Hemisphere.

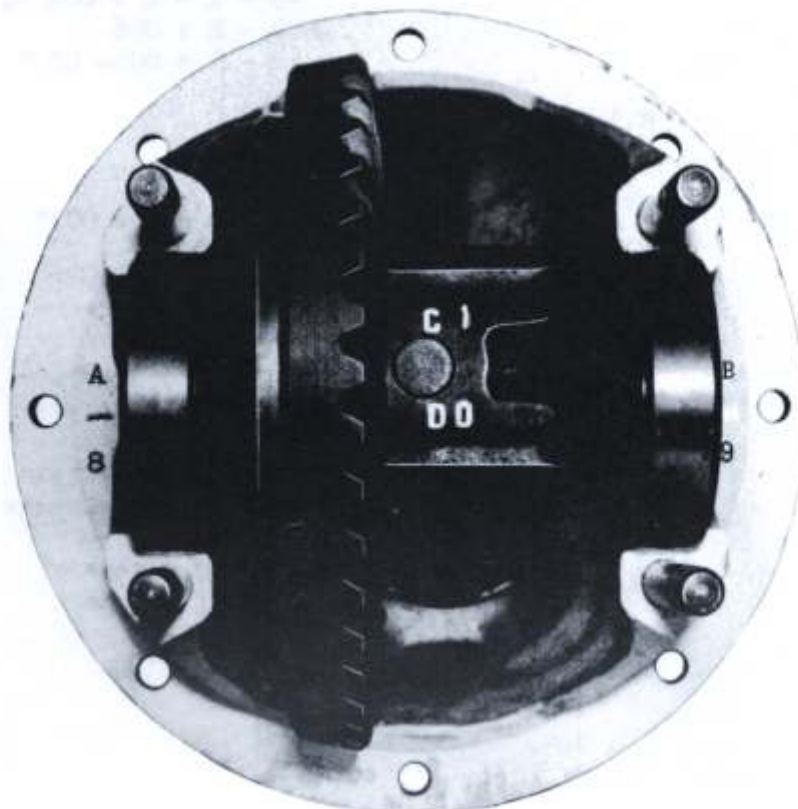


Fig. 15

18. CALCULATION FORMULAE.

The formula for "A" type units.

$$\begin{aligned} \text{Crown wheel side shims} &= A + D - C + .002'' \\ \text{Offside shims} &= B - D + .006'' \end{aligned}$$

"B4" type units.

$$\begin{aligned} \text{Crown wheel side shims} &= A + D - C + .007'' \\ \text{Offside shims} &+ B - D + .006'' \end{aligned}$$

"B6" type units.

$$\begin{aligned} \text{Crown wheel side spacer} &= A + D - C + .133'' \\ \text{Offside spacer} &= B - D + .130'' \end{aligned}$$

"C" type B.M.C. axles;

$$\begin{aligned} \text{Crown wheel side spacer} &= A + D - C + .181\frac{1}{2}'' \\ \text{Offside spacer} &= B - D + .182\frac{1}{2}'' \end{aligned}$$

19. EXAMPLES OF CALCULATION.

"A" type

A+3
B+2
C+4
D+1

$$\begin{aligned} \text{CWS} &= A + D - C + .002'' \\ &= 3 + 1 - 4 + .002'' = .002'' \\ \text{OS} &= B - D + .006 \\ &= 2 - 1 + .006 = .007'' \end{aligned}$$

"B4" type

A-1
B+2
C+1
D+0

$$\begin{aligned} \text{CWS} &= A + D - C + .007'' \\ &= -1 + 0 - 1 + 7 \\ &= .005'' \\ \text{OS} &= B - D + .006'' \\ &= .008'' \\ &= 2 - 0 + .006'' \end{aligned}$$

"B6" type.

A-1
B+2
C+1
D+1

$$\begin{aligned} \text{CWS} &= A + D - C + .133'' \\ &= -1 + 1 - 1 + .133'' \\ &= .132'' \\ \text{OS} &= B - D + .130'' \\ &= 2 - 1 + .130'' \\ &= .131'' \end{aligned}$$

EXAMPLES OF CALCULATION (Cont'd)

"C" type B.M.C. A+3
B-1
C+2
d+1

$$\begin{aligned} \text{CWS} &= A + D - C + .181\frac{1}{2}" \\ &= 3 + 1 - 2 + .181\frac{1}{2}" = .183\frac{1}{2}" \\ \text{OS} &= B - D + .182\frac{1}{2}" \\ &= -1 - 1 + .182\frac{1}{2}" = .180\frac{1}{2}" \end{aligned}$$

Preload is allowed for in the formula but in all these calculations we must make allowances for variations in crown wheel mounting and also carrier bearings, as these are not of the controlled width type.



20. CROWN WHEEL VARIATION MARKING.

The earliest issues of B.M.C. axle units did not contain this marking and variations in crown wheel mounting distance were corrected from the results of the backlash check. On later types however, we are provided with a marking so that the variation may be allowed for at the time of the calculation.

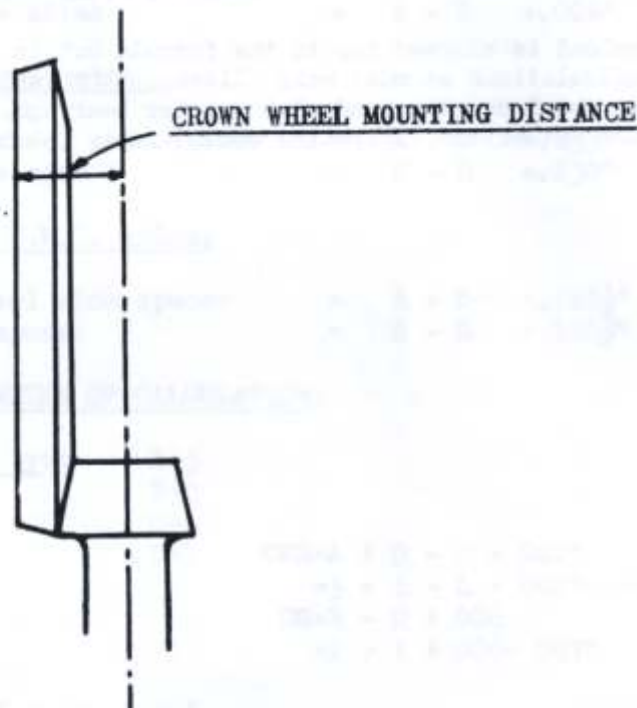


Fig.16

After the calculation is completed, the crown wheel marking should be considered so that:

RULE:

If the marking is $+002''$, the crown wheel should be moved out of mesh $.002''$

If the marking is $-001''$, the crown wheel should be moved into mesh $.001''$

If the marking is ZERO the crown wheel should not be moved.

When altering the crown wheel position as above, bear in mind that whatever change is made in the shims on one side, it must be compensated for on the other side. For example, $.002''$ added to the crown wheel side will require $.002''$ to be removed from the off side.

If the crown wheel marking is not considered as above the error will be shown in the backlash result. The primary requirement is that the backlash be correct as marked on crown wheel.

21. CARRIER BEARING TOLERANCES.

We measure the actual variation by using the dial gauge to compare the bearings to be used, with standard dimensions given by a zero block (16) (Fig.17). This block should not be confused with the Pinion Depth Zero block.

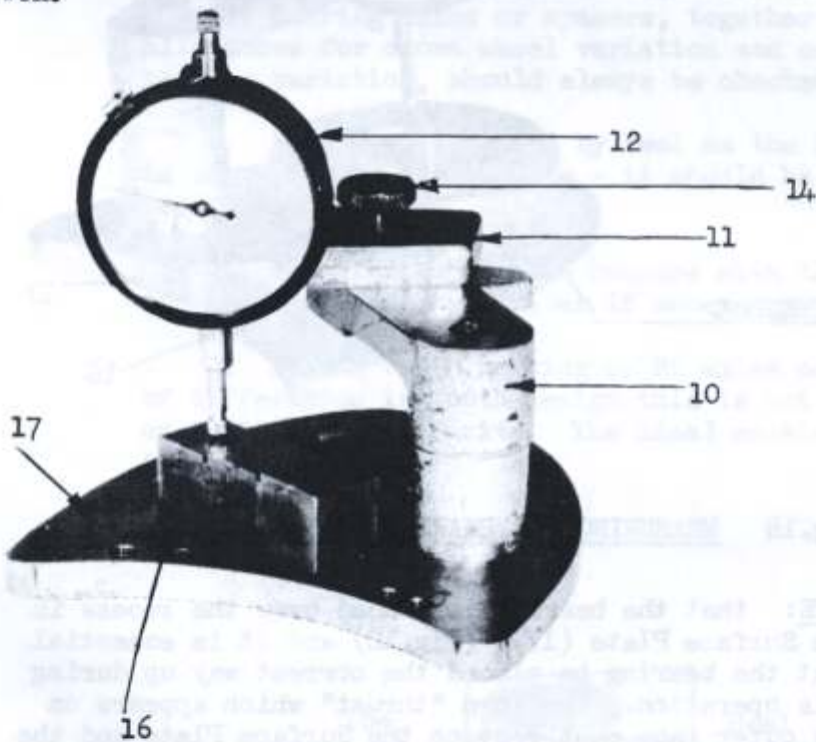


Fig. 17 ZEROING THE GAUGE.

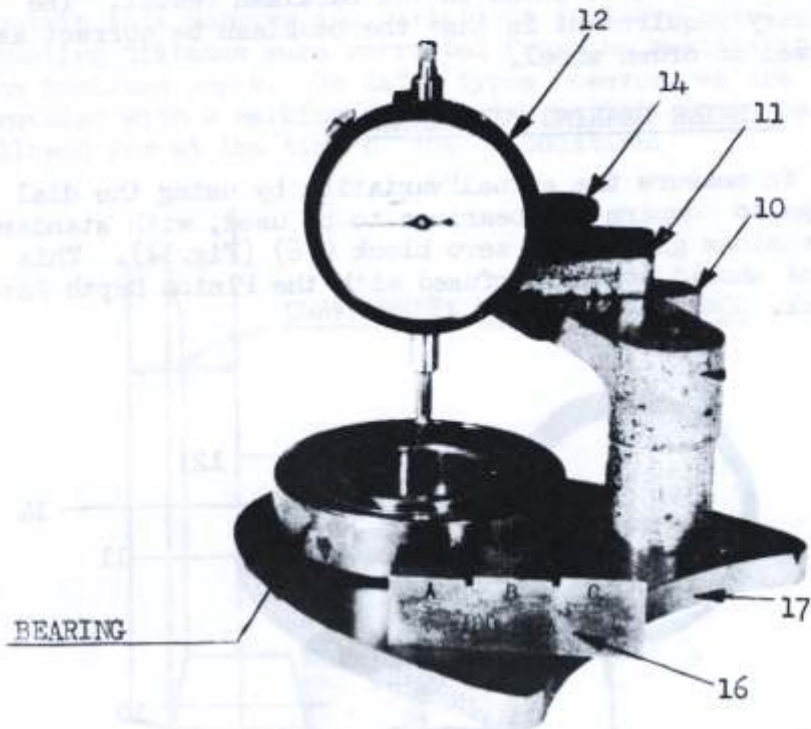


Fig.18 MEASURING THE BEARING THICKNESS.

NOTE: that the bearing is placed over the recess in the Surface Plate (17) (Fig.18) and it is essential that the bearing be placed the correct way up during this operation. The word "thrust" which appears on the outer race must rest on the Surface Plate and the dial gauge reading should be taken on the inner race as shown and fingers should be applied to the inner race to offset any tendency to cocking.

The bearings, when new, normally vary between zero and minus .005" tolerance. The measuring operation may reveal a reading of, say -.003". This means that this particular bearing is .003" under-size, therefore .003" of shims are required to be added to the bearing to bring it up to standard size.

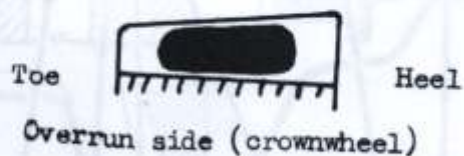
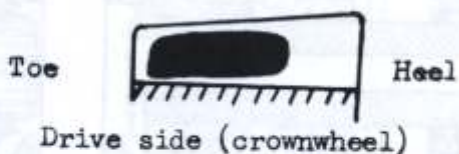
We take the cage and fit to it, the calculated number of shims (from the formula) and then fit the bearing complete with any shimming necessary to correct a variation in the bearing.

In the case of "C" type axles which use spacers, we must allow for bearing variation by adding to the calculated size of the spacer (if necessary).

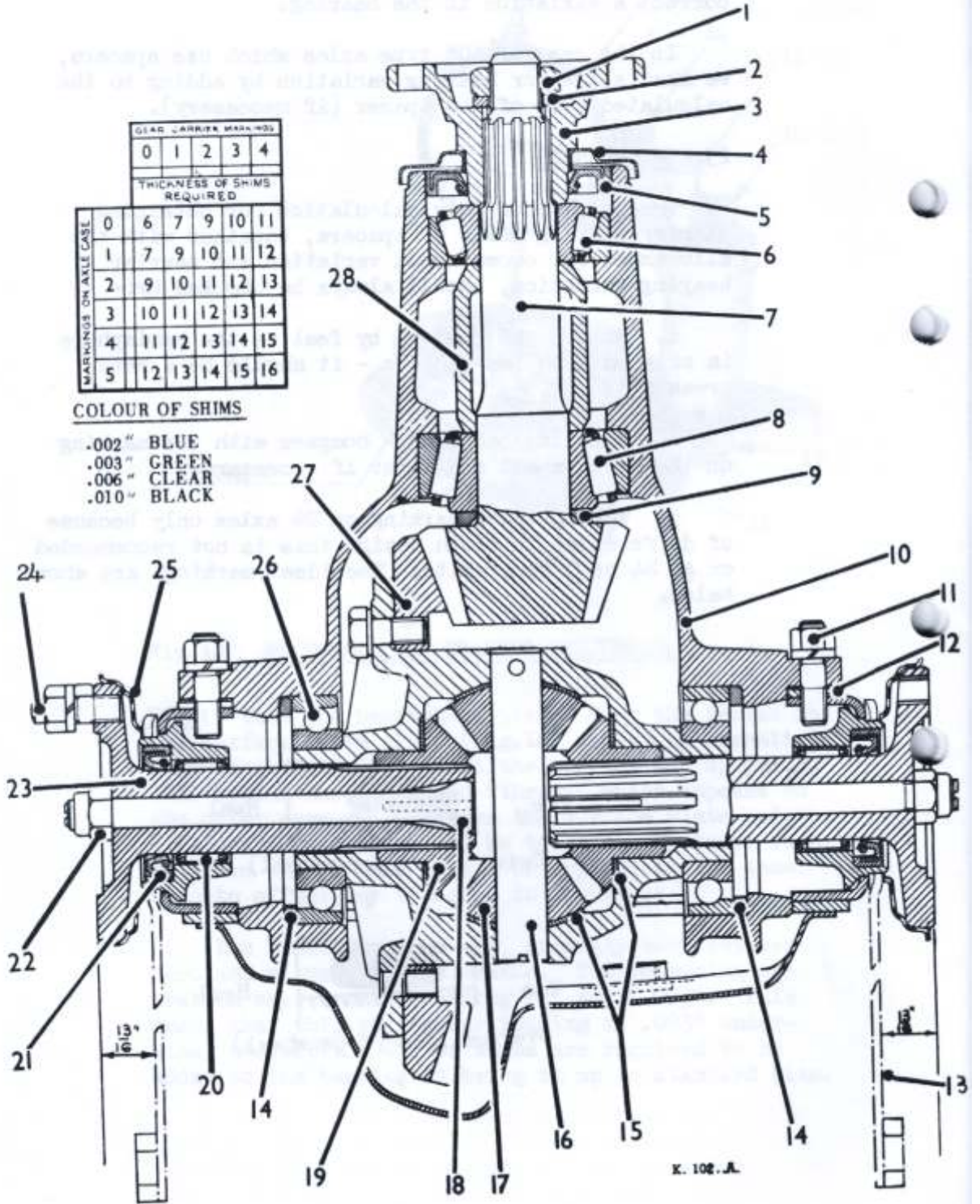
23. FINAL NOTE

The results of this calculation for obtaining carrier bearing shims or spacers, together with the allowances for crown wheel variation and carrier bearing variation, should always be checked by:-

1. Noting the preload by feel as the hemisphere is pressed into the housing - it should be a hand press fit.
2. Checking backlash - compare with the marking on the crown wheel and alter if necessary.
3. Taking tooth marking on B6 axles only because of differences in tooth design this is not recommended on A, B4 or C type units. The ideal markings are shown below.



THE B.M.C. GIPSY AXLE UNIT IN SECTION



		GLAC LAMINAR MARKING				
		0	1	2	3	4
		THICKNESS OF SHIMS REQUIRED				
MARGINS ON AXLE CASE	0	6	7	9	10	11
	1	7	9	10	11	12
	2	9	10	11	12	13
	3	10	11	12	13	14
	4	11	12	13	14	15
	5	12	13	14	15	16

COLOUR OF SHIMS

- .002" BLUE
- .003" GREEN
- .006" CLEAR
- .010" BLACK

K. 108. J.