JAGUAR

2·4 LITRE AND 3·4 LITRE

SERVICE MANUAL

SECTION H

REAR AXLE

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SECTION H

REAR AXLE

(including Thornton "Powr-Lok" Differential)

2·4 litre and 3·4 litre models

ISSUED BY

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Thornton " Powr-Lok " Differential

REAR AXLE

Both the 2.4 litre and the 3.4 litre models are fitted with a Salisbury axle ; the 2.4 litre axle is of the 3.HA type and the 3.4 litre is of the 4.HA type.

DESCRIPTION

The rear axle assembly (Fig. 1) is of the semi-floating type with shim adjustment for all bearings and meshing of the hypoid drive gear and pinion matched assembly. The axle shafts are splined at the inner ends, which engage splines in the differential side gears, while the outer ends have tapers and keys to fit the rear wheel hubs. The hubs are supported by taper roller bearings pressed on to the axle shafts and located in the ends of the axle tubes. Outward thrust on either wheel is taken by the adjacent hub bearing, whilst inward thrust is transmitted through the axle shafts and slotted axle shaft spacer to the opposite bearing. Thus, each hub bearing takes thrust in one direction only.

A cover on the rear of the gear carrier housing permits inspection without dismantling the axle.

The axle gear ratio is stamped on a tag attached to the assembly by one of the rear cover-screws. The axle serial number is stamped on the gear carrier housing.

1. Drive pinion oil seal.
2. Drive pinion oil seal gasket.
3. Drive pinion oil slinger.
4. Gear carrier.
5. Hypoid drive pinion. } matched
6. Hypoid drive gear. } assembly.
7. Differential case.
8. Differential side gear.
9. Differential bearing shim.
10. Gear carrier cover.
11. Differential bearing.
12. Axle shaft spacer.
13. Pinion mate shaft.
14. Differential bevel pinion mate.
15. Pinion mate shaft lock pin.
16. Drive pinion bearing (inner).
17. Drive pinion bearing shim (inner).
18. Drive pinion bearing spacer.
19. Drive pinion bearing shim (outer).
20. Drive pinion bearing (outer).
21. Universal joint flange.

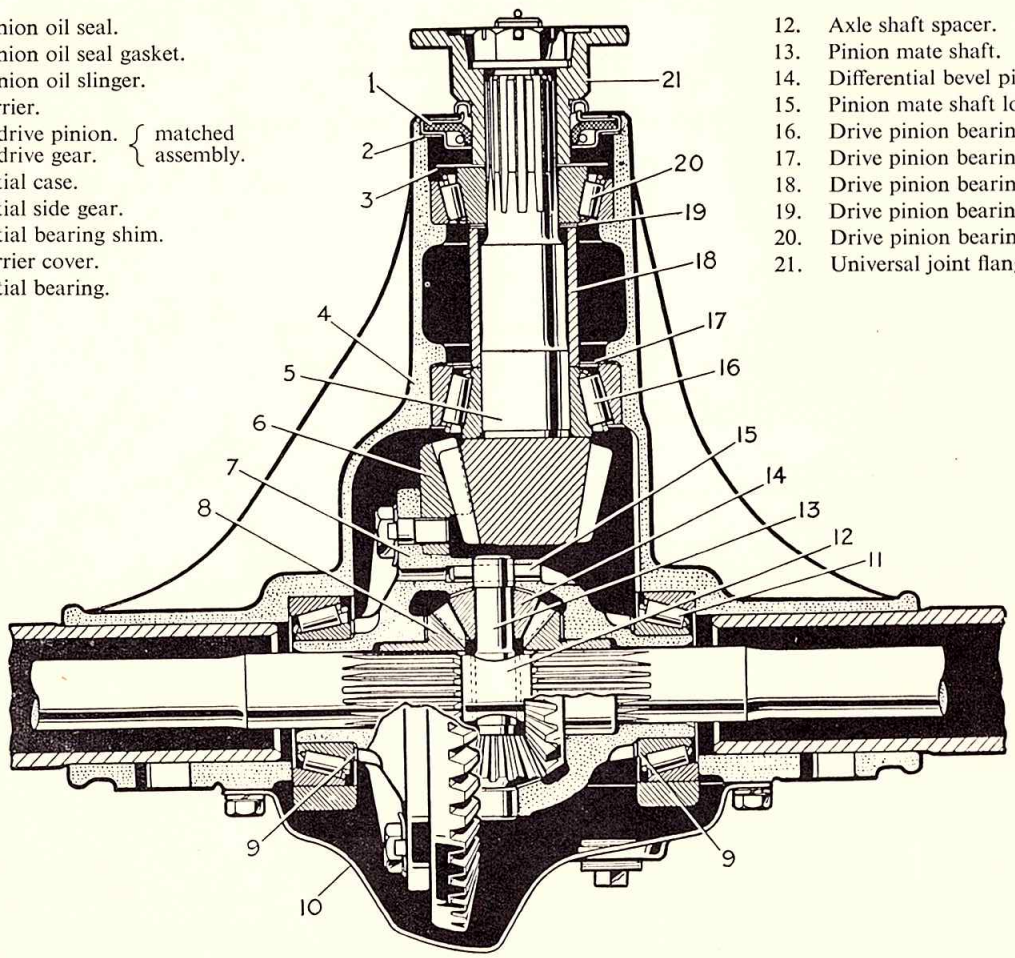


Fig. 1. Sectioned view of the differential.

DATA

Axle Shaft End Float —drum brake cars	.006″ to .008″ (.15 to .20 mm.)
—disc brake cars	.003″ to .005″ (.08 to .13 mm.)
Differential Bearing Preload	.005″ (.13 mm.) shim allowance
Pinion Bearing Preload	8 to 12 lbs/in. (.09 to .14 kg/m.)
Backlash	As etched on drive gear —miminum .004″ (.10 mm.)
Tightening Torque	
—Drive Gear Bolts	
$\frac{3}{8}$″ (9.5 mm.) diameter bolts	50 to 60 lbs/ft.
$\frac{7}{16}$″ (11.1 mm.) diameter bolts	70 to 80 lbs/ft.
—Differential Bearing Cap Bolts	60 to 65 lbs/ft.
—Pinion Nut	120 to 130 lbs/ft.
Thornton " Powr-Lok " Differential Bolts	35 to 45 lbs/ft.

Axle Ratios

2.4 litre (Type 3.HA)	3.4 litre (Type 4.HA)
4.27 : 1 (47 × 11) Standard	3.54 : (46 × 13) Standard
4.55 : 1 (50 × 11) Overdrive models	3.77 : 1 (49 × 13) Overdrive models

Note : 2.4 litre Standard transmission cars prior to 901582 R.H. Drive and 940606 L.H. Drive were fitted with 4.55:1 ratio rear axles.

Special Tools

For efficient servicing of the rear axle, the special tools listed below and illustrated in this section are necessary.

The tools are manufactured and supplied by V. L. Churchill & Co. Ltd., Great South West Road, Feltham, Middlesex.

	Churchill Tool No.
Axle Shaft Extractor	SL.13A
Pinion and Differential Bearing Cone Puller	SL.11PD/AB
Gear Carrier Stretching Fixture	SL.1
Pinion Bearing Cup Extractor	SL.12
Bearing Cup Installation Tool	SL.12
Pinion Cone Setting Gauge	SL.3P.
Pinion Oil Seal Installation Collar	SL.4P/B
Rear Hub Extractor (for disc wheel hubs)	J.1

Reconditioning Scheme

Although full servicing instructions for the rear axle are given in this section it is recommended that, wherever possible, advantage is taken of the factory reconditioning scheme particularly in view of the intricate adjustments and the number of special tools required.

Reconditioned axles are supplied on an exchange basis and comprise an axle complete less hubs and brake details ; rear axles for overhaul should therefore be returned in this condition.

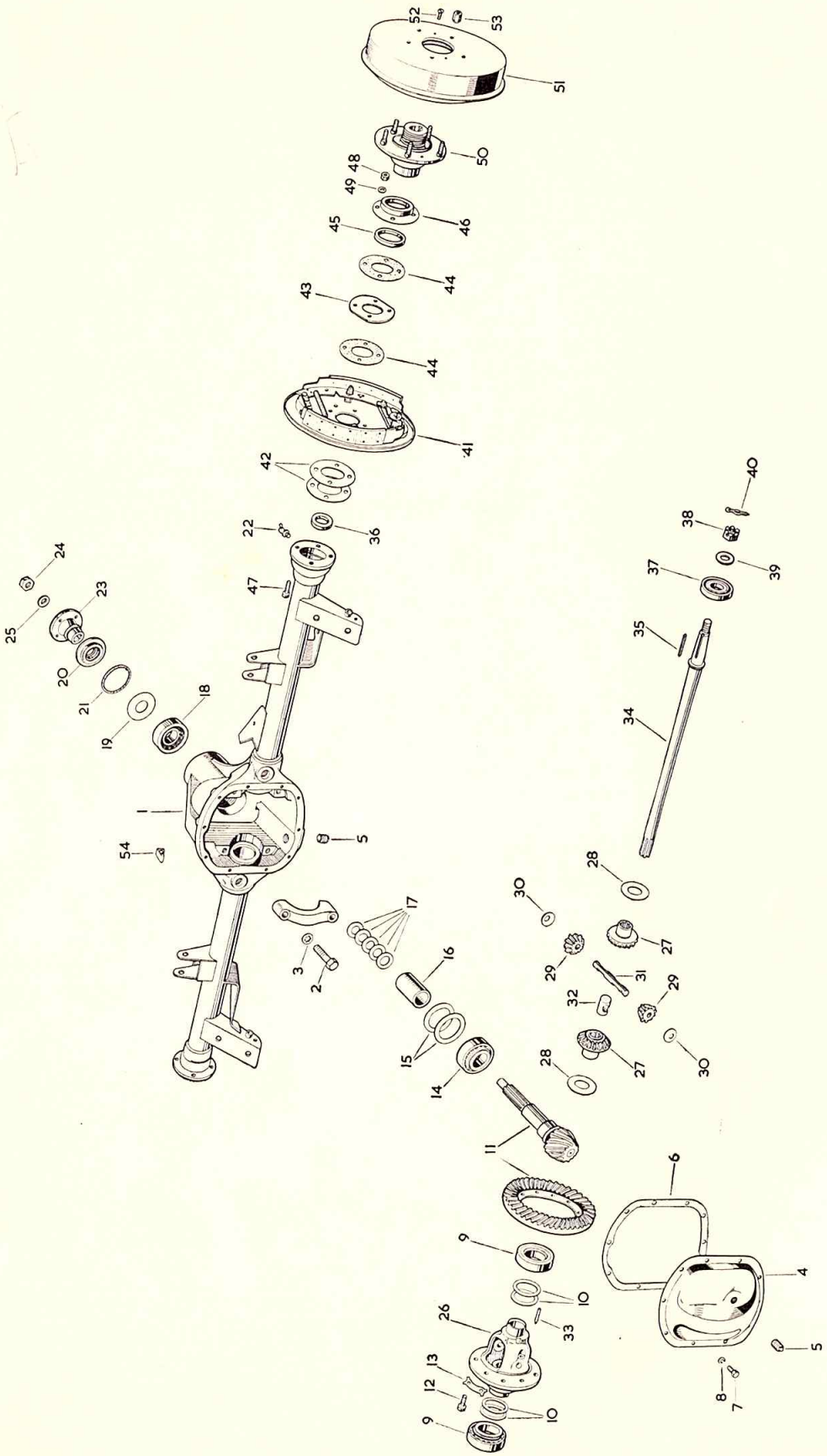


Fig. 2. Exploded view of the rear axle.

Annotations for Fig. 2

1. Carrier and tube assembly.
2. Set screw.
3. Shakeproof washer.
4. Cover.
5. Drain and filler plugs.
6. Gasket.
7. Set screw.
8. Lock washer.
9. Roller bearing.
10. Shim.
11. Drive gear and pinion.
12. Set screw.
13. Lock strap.
14. Roller bearing.
15. Shim (inner).
16. Pinion bearing spacer.
17. Shim (outer).
18. Roller bearing.
19. Oil slinger.
20. Oil seal.
21. Gasket.
22. Grease nipple.
23. Universal joint flange.
24. Nut.
25. Washer.
26. Differential case.
27. Side gear.
28. Thrust washer.
29. Differential pinion mate gear.
30. Thrust washer.
31. Pinion mate gear shaft.
32. Spacer.
33. Pinion mate shaft lock pin.
34. Axle shaft.
35. Key.
36. Oil seal.
37. Taper roller bearing.
38. Slotted nut.
39. Washer.
40. Split pin.
41. Rear brake assembly.
42. Shim.
43. Retainer.
44. Gasket.
45. Oil seal.
46. Oil seal retainer.
47. Bolt.
48. Nut.
49. Washer.
50. Wheel hub.
51. Brake drum.
52. Set screw.
53. Nut.
54. Brake pipe retaining clip.

ROUTINE MAINTENANCE

Every 2,500 miles (4,000 km.) check the level of the oil in the rear axle when the car is standing on level ground. A combined level and filler plug is fitted to the cover plate. Top up, if necessary, to the bottom of this plug with the recommended grade of lubricant. Since hypoid oils of different brands may not mix satisfactorily, draining and refilling is preferable to topping up if the brand of oil in the axle is unknown.

Every 5,000 miles (8,000 km.) lubricate the rear wheel bearings sparingly with recommended lubricant through the nipples provided. The nipples are situated at the ends of the axle tubes. A bleed hole is provided in the axle casing opposite the nipple to indicate when sufficient lubricant has been applied.

Every 10,000 miles (16,000 km.) drain and refill with the recommended grade of lubricant. The drain plug is situated at the base of the differential. The oil will drain more readily if the operation is carried out at the end of a journey when the oil is hot and will therefore flow more freely.

Every 10,000 miles (16,000 km.) it is desirable at this mileage to check and correct, if necessary, the axle shaft end float.

Recommended Lubricants

	Mobil	Wakefield	Shell	Esso	B.P.	Duckham	S.A.E. Viscosity
Rear Axle	Mobilube GX 90	Castrol Hypoy	Spirax 90 E.P.	Expee Compound 90	Energol E.P. 90	Hypoid 90	Hypoid 90
Rear wheel bearings	Mobilgrease MP	Castrolease WB	Retinax A	Esso High Temp. Grease	Energrease N.3	LB 10	

Capacities

	Imperial pints	U.S. pints	Litres
2.4 litre	2¼	2¾	1.3
3.4 litre	2¾	3¼	1.6

REAR AXLE (Disc brake cars)

Removal

Jack up the car under the rear axle and place blocks forward of the road spring front mounting. Remove wheel spats, nave plates and road wheels. Release handbrake.

Disconnect the handbrake cables by removing the clevis pins at brake calipers.

Disconnect hydraulic pipes from the brake calipers and blank off open connections, to ensure cleanliness when reassembling.

Remove the two bolts securing the brake caliper to caliper mounting plate and detach the caliper. Note the shims fitted between the caliper and mounting plate ; these must be refitted in their original positions otherwise the centralisation of the caliper will be upset.

Withdraw the split pin and slotted nut with washer securing each hub to axle shaft and draw off hubs with suitable extractor (see Fig. 3).

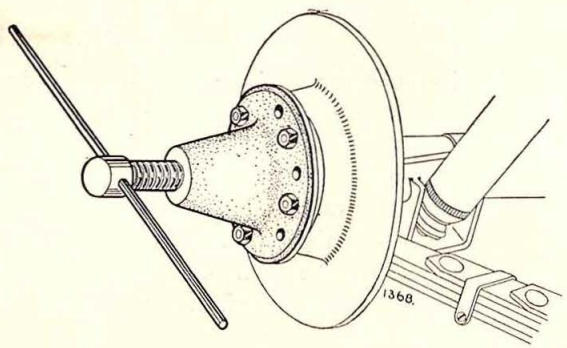


Fig. 3. Withdrawing the rear hub with an extractor

Remove split pins and four slotted nuts securing rear axle companion flange to propeller shaft. Withdraw bolts, spring propeller shaft out of register and place clear.

Remove the clips securing hydraulic pipes to the rear axle. Remove the bolt securing the three-way connection to the rear axle casing and tie up the hydraulic pipe to the body underframe.

Remove the two bolts securing the handbrake compensator assembly to the rear axle and remove compensator assembly and cables.

Remove the two nuts, the inner and outer washers and the rubber buffers from the damper attachment bracket on the rear axle. Compress the hydraulic damper clear of the rear axle.

Release the torque arms by removing the self-locking nuts from the bolts securing the arms to the rear axle ; remove the plain washers and drift out the bolts.

Remove the nuts securing the panhard rod to the rear axle and withdraw the rubber buffers and washers.

Lower the axle as far as possible on the jack before removing the spring eye bolts.

Remove the nuts securing the road spring eye bolts and drift out the bolts.

Slide axle assembly clear of the exhaust tail pipe (s). Lower to floor and withdraw from underneath the car.

Refitting

Refitting is the reverse of the removal procedure, but it will be necessary to check the centralisation of the brake calipers and bleed the hydraulic system, as described in section L " Brakes ".

Check the setting of the panhard rod as described in Section K " Rear Suspension ".

REAR AXLE (Drum brake cars)

Removal

Jack up the car under the rear axle and place blocks forward of the road spring front mounting. Remove wheel spats, nave plates and road wheels. Release handbrake.

Remove the two screws locating each brake drum to the hub and withdraw drums. Withdraw the split pin and slotted nut with washer, securing each hub to the axle shaft and draw off the hubs with suitable extractor.

At the rear of the back plates disconnect the hydraulic pipe unions to the wheel cylinders and remove the clevis pins securing the hand brake cables to the operating levers.

Remove the clips securing the hydraulic pipes to the rear axle. Remove the bolt securing the three-way connection to the rear axle casing and tie up the hydraulic pipe to body underframe.

Remove the four bolts and nuts securing each back plate to the ends of the axle casing and withdraw back plate.

Note the oil seal, bearing retainer plate and two gaskets at the front of each back plate, and the shims fitted between the back plate and the flange of the axle tube.

Remove the split pins and four slotted nuts securing the rear axle companion flange to propeller shaft. Withdraw bolts, spring propeller shaft out of register and place clear.

Remove the two bolts securing the handbrake compensator assembly to the rear axle and remove the compensator assembly and cables.

Remove the two nuts, the inner and outer washers and the rubber buffers from the damper attachment bracket on the rear axle. Compress hydraulic damper clear of the rear axle.

Release torque arms by removing the self-locking nuts from the bolts securing the arms to the rear axle ; remove plain washers and drift out the bolts.

Remove the nuts securing the panhard rod to the rear axle and withdraw rubber buffers and washers.

Lower the axle as far as possible on the jack before removing spring eye bolts.

Remove the nuts securing the road spring eye bolts and drift out bolts.

Slide the axle assembly clear of the exhaust tail pipe(s). Lower to floor and withdraw from underneath the car.

Refitting

Refitting is the reverse of the removal procedure, but it will be necessary to bleed the brake hydraulic system as described in Section L " Brakes " and to check the setting of the panhard rod as described in Section K " Rear Suspension ".

AXLE SHAFTS (Disc brake cars)

Removal

Jack up car and remove wing valance and road wheel. Remove split pin and slotted nut and with a suitable extractor withdraw the hub and disc from the axle shaft.

Before proceeding further check the combined end float of the axle shafts which should be .003″ to .005″ (.08 to .13 mm.) ; if necessary adjust end float when refitting by adding or subtracting shims between caliper mounting plate and end of axle tube.

At the rear of the brake calipers remove clevis pins securing handbrake cable to operating lever. Disconnect hydraulic pipes and blank off open connections to ensure cleanliness when reassembling.

Remove the two bolts securing the brake caliper to caliper mounting plate and detach the caliper. Note the shims fitted between the caliper and mounting plate ; these must be refitted in their original positions otherwise the centralisation of the caliper will be upset.

Withdraw the axle shaft with its taper roller bearing from the end of the axle tube, using Tool No. SL.13A (see " Special Tools " on page H.5).

Examine the hub bearing and if a replacement is necessary withdraw the inner race from the axle using Tool No. SL.11 PD/AB (see " Special Tools " on page H.5).

Examine the oil seal which is pressed inside the axle tube and if necessary withdraw and fit a replacement.

Refitting

Refitting is the reverse of the removal procedure but it is important to observe the following points :—

Wash the hub bearing so that the axle shaft end float may be determined accurately. Install the shaft with the taper roller inner race taking care not to damage the oil seal. Assemble the bearing outer race, making absolutely sure that the race enters the housing squarely. Examine the hub oil seal and replace if necessary.

Check the axle shaft end float as shown in Fig. 5. with a dial indicator, after gently tapping with a rawhide mallet on each axle shaft to ensure that the

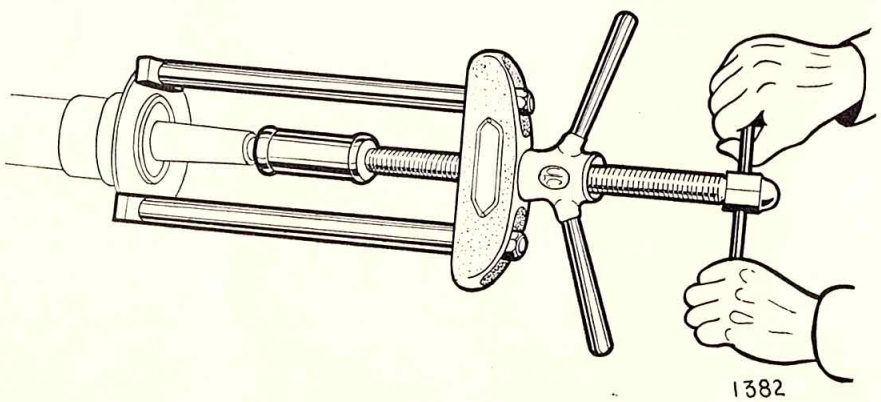


Fig. 4. Axle shaft removal.

bearing cups are butting against the caliper mounting plate.

Add or subtract adjusting shims available in thicknesses of .003", .005", .010" and .030" (.08, .13, .25 and .76 mm.) until the correct axle shaft end float of .003" to .005" (.08 and .13 mm.), which is just perceptible by hand, is obtained. Adding shims increases end float, subtracting shims decreases end float. Remove or install approximately an equal thickness of shims at each end of the axle in order to retain the axle shaft spacer in a central position.

Refit hubs and caliper assemblies ; reconnect hydraulic pipes and handbrake cables. Check the centralisation of the discs within the brake calipers and " bleed " hydraulic system as described in Section L. " Brakes ".

Refit road wheels and wing valances. Grease hub bearings with the recommended lubricant until grease exudes from the bleed hole.

AXLE SHAFTS (Drum brake cars)

Removal

Jack up the car and remove the road wheel. Remove the split pins and slotted nut, and with a suitable extractor withdraw the hub from the axle shaft.

Before proceeding further check the combined end float of the axle shafts which should be .006" to .008" (.15 to .20 mm.) ; if necessary adjust end float when refitting by adding or subtracting shims fitted between back plate and end of axle tube.

At the rear of the back plate disconnect the hydraulic pipe from wheel cylinder. Remove the clevis pin securing the hand brake cable to the operating lever which protrudes through the back plate.

Remove the four bolts and nuts securing the back plate to the end of axle tube and withdraw back plate.

Note the bearing retainer plate, two gaskets and oil seal at the front of back plate and the shims fitted between the back plate and the flange of the axle tube. Do not lose or transpose these shims to the other side of the axle case as they control the end float of the axle shafts.

Withdraw the axle shaft with its taper roller bearing from the end of the axle tube, using Tool No. SL.13A (see " Special Tools" on page H.5).

Examine the hub bearing and if a replacement is necessary withdraw the inner race from the axle shaft using Tool No. SL.11PD/AB (see " Special Tools " on page H.5).

Examine the oil seal which is fitted inside the axle tube and if necessary withdraw and fit a replacement.

Refitting

Refitting is the reverse of the removal procedure but it is important to observe the following points :—

Wash the hub bearing so that the axle shaft end float may be determined accurately. Install the shaft with the taper roller inner race, taking care not to damage the oil seal. Assemble the bearing outer race, making absolutely sure that the race enters the housing squarely. Examine the hub oil seal and replace if necessary.

Fit the shims, back plate, bearing retainer plate with two new paper gaskets, and oil seal.

Check the axle shaft end float as in Fig 5 with a dial indicator assembly, after gently tapping with a rawhide mallet on each axle shaft to ensure that the bearing cups are butting against the brake back plates or retaining plates.

Add or subtract adjusting shims available in thicknesses of .003", .005", .010", and .030" (.08, .13, .25 and .76 mm.), until the correct axle end float of .006" to .008" (.15 to .20 mm.), which is just perceptible by hand is obtained. Adding shims increases end float, subtracting shims decreases end float. Remove or install approximately an equal thickness of shims at each end of the axle in order to retain the axle shaft spacer in a central position.

Reconnect the handbrake cable and hydraulic pipe connections. Refit hubs and brake drums ; " bleed " the hydraulic system as described in Section L "Brakes."

Refit road wheels and wing valances. Grease hub bearings with the recommended lubricant until grease exudes from the bleed hole.

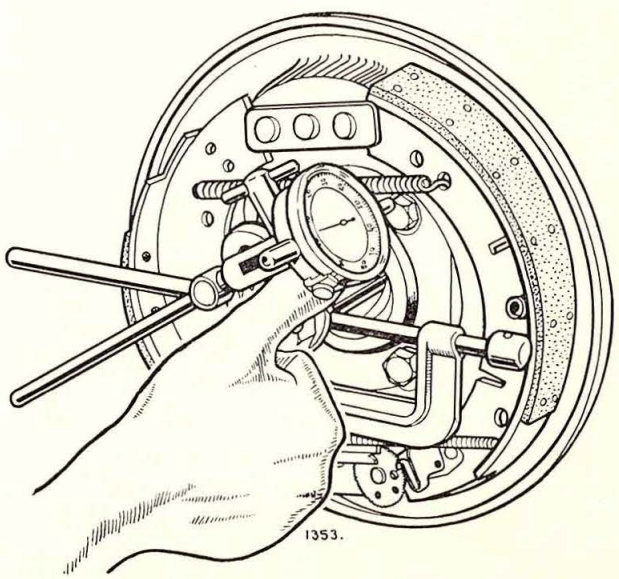


Fig. 5. Checking the axle shaft end float.

DISMANTLING THE DIFFERENTIAL ASSEMBLY

Remove the axle assembly as described on page H.9.
Remove the axle shafts as described on page H.10.

Removing the Differential with Service Tools

First drain the lubricant from the gear carrier housing and then remove the gear carrier rear cover. Flush out the unit thoroughly so that the parts can be carefully inspected.

To remove the differential, proceed as follows :—

(1) Withdraw the four bolts securing the two differential bearing caps and remove the two caps.

(2) Before attempting to remove the differential assembly, fit the stretching fixture, Tool No. SL.1. Fig. 6 (see " Special Tools " on page H.5).

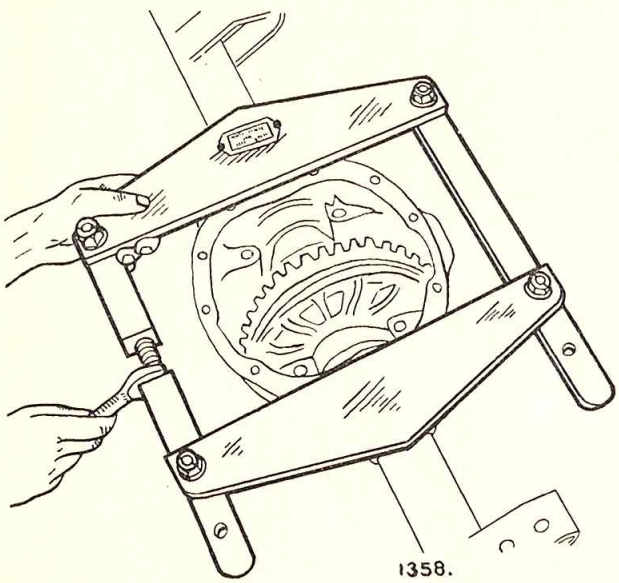


Fig. 6. Stretching the gear carrier prior to removing the differential.

The fixture should be adjusted to suit the model being serviced, a series of holes being provided in the member opposite the turn-buckle for this purpose. Open the fixture by means of the turn-buckle until it is hand tight, then spread the case by using a spanner. DO NOT OVER-SPREAD, OR THE AXLE CASING WILL BE DAMAGED BEYOND REPAIR. The correct spread does not exceed a half turn on the turn-buckle, and this figure should not be exceeded even if the differential is still stiff to remove.

(3) The differential assembly may now be prised out by means of two levers, one on each side of the differential case opening. During this operation use suitable packing between the levers and the gear carrier.

Removing the Differential—Emergency Method

First drain the lubricant from the gear carrier housing and then remove the gear carrier rear cover. Flush out the unit thoroughly so that the parts can be carefully inspected.

To remove th differential, proceed as follows :—

(1) Withdraw the four bolts securing the two differential bearing caps and remove the two caps.

(2) The differential assembly should now be prised out by means of two levers, one on each side of the differential case opening, taking care not to tilt the assembly and so wedge it more tightly than it is held by the preload. During this operation use suitable protective packing between the levers and the gear carrier.

Remove the pinion

(1) Remove the pinion nut and washer.

(2) Withdraw the universal joint companion flange with a suitable puller.

(3) PRESS the pinion out of the outer bearing. It is important that the pinion should be pressed and not driven out to prevent damage to the outer bearing. The pinion, having been pressed from its outer bearing, may now be removed from the gear carrier housing. Note : Keep all shims intact.

(4) Remove the pinion oil seal together with the oil slinger and outer bearing cone.

(5) Examine the outer bearing for wear and, if replacement is required, extract the bearing cup, using Tool No. SL.12 shown in Fig. 8.

(5a) If the correct tool is not available, and the old bearing cup is to be scrapped, it is possible to drive out the cup, the shoulder locating the bearing being recessed to facilitate the operation.

(6) Remove the pinion inner bearing cup, as shown in Fig. 8, using Tool No. SL.12, if the bearing requires replacement or adjustment of the pinion setting is to be undertaken. Take care of the shims fitted between the bearing cup and the housing abutment face.

(6a) If the inner bearing is to be replaced it may be driven out, but the correct service tool should be used when the bearing is removed in order to carry out pinion setting adjustment.

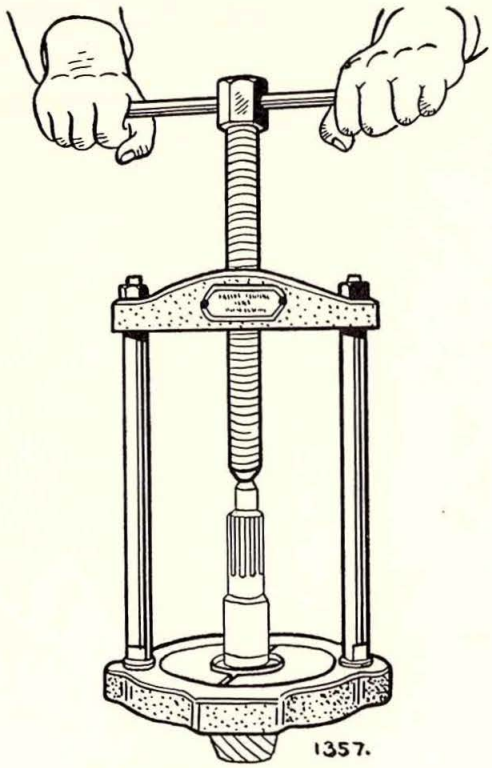


Fig. 7. Withdrawing the pinion inner bearing.

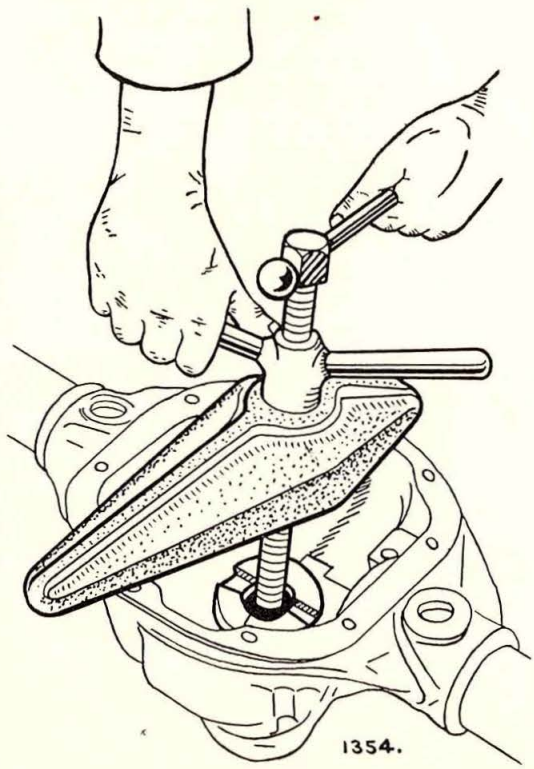


Fig. 8. Removal of the inner bearing cup.

Dismantling the Differential

(1) Bend down the tabs on the drive gear screws locking straps and remove the drive gear screws.

(2) Remove the drive gear from the differential case by tapping with a rawhide mallet.

(3) Using a small punch, drive out the pinion mate shaft locking pin, which is secured in place by peening the case, and remove the pinion mate shaft. Fig. 9 indicates the direction in which the locking pin is removed ; it is not possible to drift the pin in the opposite direction.

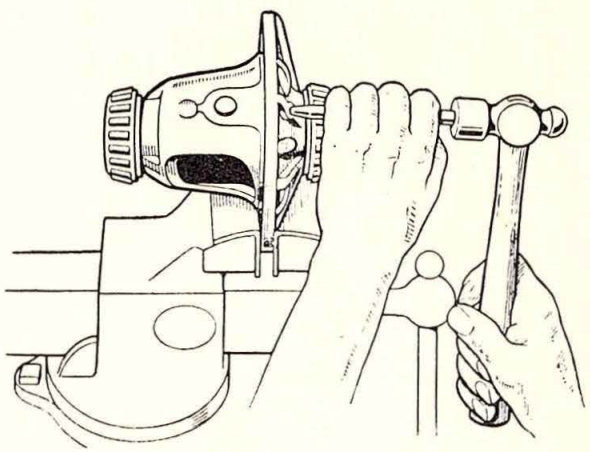


Fig. 9. Removal of the pinion mate shaft locking pin.

(4) Remove the axle shaft spacer.

(5) Rotate the side gears by hand until the pinions are opposite the openings in the differential case, then remove the differential gears, care being taken not to lose the thrust washers fitted behind them.

(6) If the drive gear setting is to be altered, it will be necessary to withdraw the differential bearings, using the extractor Tool No. SL.11PD/AB, to gain access to the shims located between the bearing and the abutment face on the differential case.

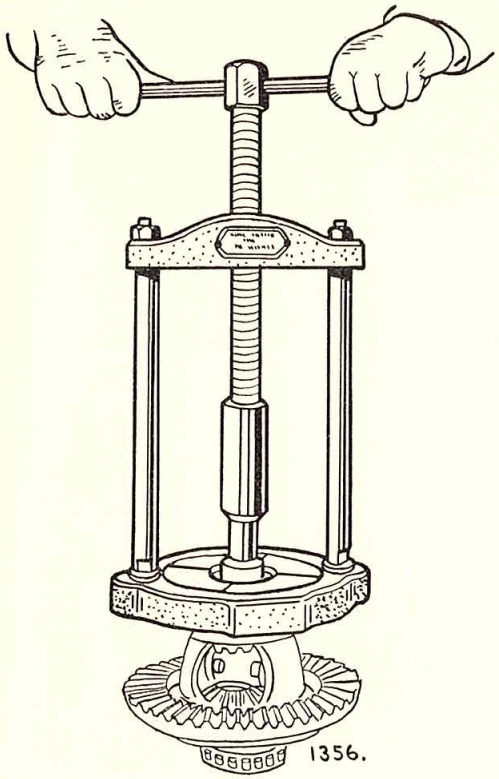


Fig. 10. Withdrawing a differential bearing.

ASSEMBLING THE DIFFERENTIAL

(1) Assemble the side gears with the thrust washers in position.

(2) Insert the differential pinions, through the openings in the differential case, and mesh them with the side gears. Hold the pinion thrust washers on the spherical thrust faces of the pinions whilst rotating the differential gear assembly into its operating position by hand.

(3) Line up the pinions and thrust washers, then install the pinion mate shaft with the axle shaft spacer in position.

(4) Line up the cross hole in the shaft with the hole in the differential case, then fit the pinion mate shaft lock pin.

(5) Using a punch, peen some of the metal of the differential case over the end of the lock pin to prevent its working loose and thereby causing extensive damage to the axle assembly.

(6) Clean the drive gear and differential case contacting surfaces and carefully examine same for burrs.

(7) Align the drive gear attaching bolt holes with those in the flange of the case, and gently tap the drive gear home on the case with a hide or lead hammer.

(8) Insert the drive gear bolts, with NEW locking straps and tighten them uniformly, preferably with a torque spanner to the reading given on page H.5.
Then bend the locking tabs round the bolt heads to prevent their working loose.

The procedure for fitting the differential case assembly into the gear carrier is given under the heading "Differential Bearing Adjustment".

Differential Bearing Adjustment

The thickness of shims required in the installation of the differential bearings is determined as follows :—

(1) Fit the differential bearings, without shims, on the differential case, making sure that the bearing cones and cups and the housing are perfectly clean.

(2) Place the differential assembly, with the bearing cups in their housing, within the gear carrier, the pinion not being assembled.

(3) Install the dial indicator set on the gear carrier with the button against the back face of the drive gear.

(4) Inserting two levers between the housing and the bearing cups, move the differential assembly to one side of the carrier, as shown in Fig. 11.

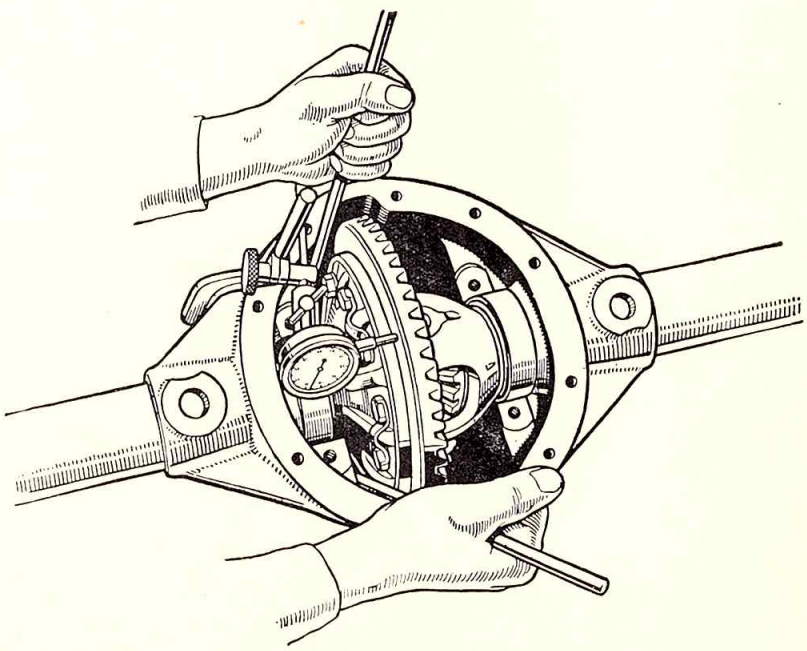


Fig. 11. Differential bearing adjustment.

(5) Set the indicator to zero.

(6) Move the assembly to the other side and record the indicator reading, which gives the total clearance between the bearings as now assembled and the abutment faces of the gear carrier housing.

Add .005" (.13 mm.) more to the clearance reading to give preload ; this thickness of shims to be used in the installation of the differential bearings, the shims being divided to give the gear position with correct backlash as detailed under " Drive Gear Adjustment " on page H.18.

(7) Remove the differential assembly from the gear carrier.

Pinion Adjustment

Re-install the pinion outer bearing cup with Tool No. SL.12. Re-install the pinion bearing inner cup with the original adjusting shims positioning same. Press the inner bearing cone on the pinion, using an arbor press and a length of tube, contacting the inner race only and not the roller retainer.

The hypoid drive pinion should be correctly adjusted before attempting further assembly, the greatest care being taken to ensure accuracy.

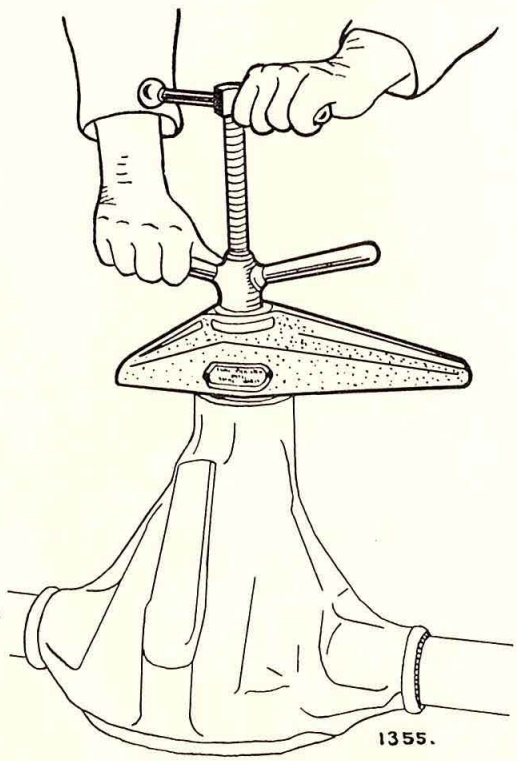


Fig. 12. Replacing the pinion bearing inner cup.

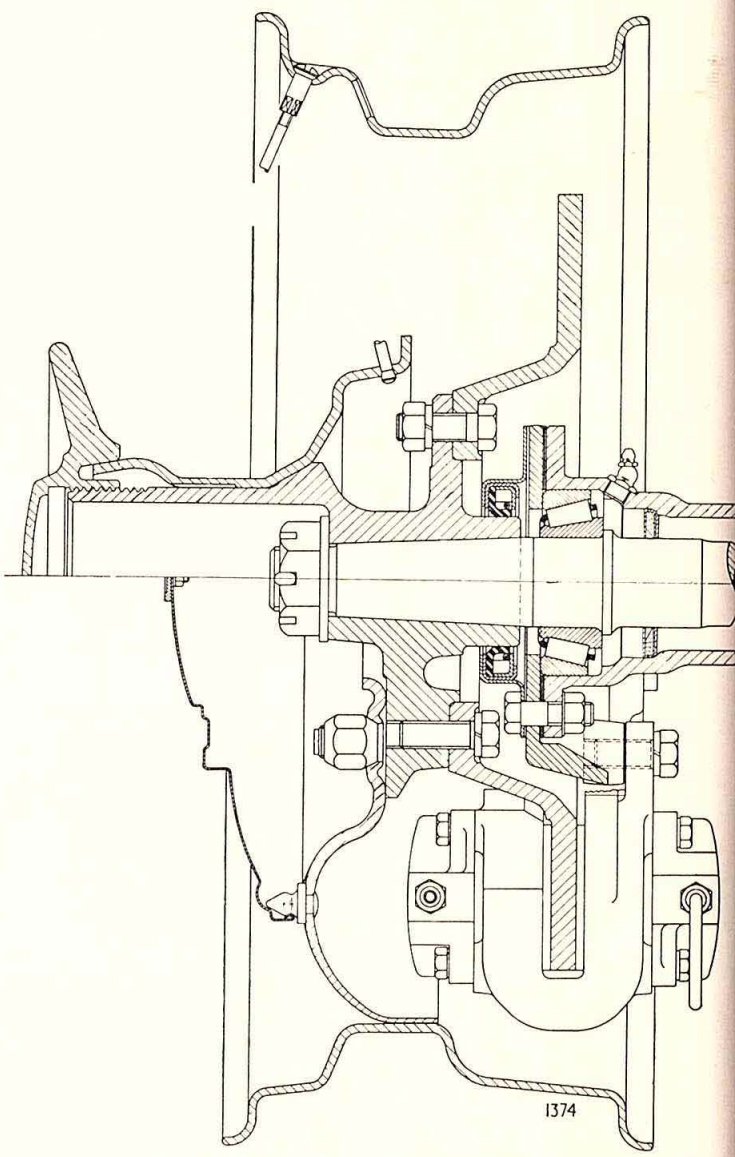


Fig. 13. Sectioned plan view of the disc brake hub arrangement. The upper half of the illustration shows a wire spoke wheel hub; the lower half shows a disc wheel hub.

The correct pinion setting is marked on the ground end of the pinion as shown in Fig. 14. The matched assembly serial number at the top is also marked on the drive gear, and care should be taken to keep similarly marked gears and pinions in their matched sets, as each pair is lapped together before despatch to the factory. The letter on the left is a production code letter and has no significance relative to assembly or servicing of any axle. The letter and figure on the right refer to the tolerance on offset or pinion drop dimension " A " in Fig. 15 which is stamped on the cover facing of the gear carrier housing. When ordering spares, specify the offset required if the best performance is to be obtained. Thus, L.1 carrier requires L.1 gears or H.2 carrier requires H.2 gears.

The number at the bottom gives the cone setting distance of the pinion and may be Zero (0). Plus (+) or Minus (—). When correctly adjusted, a pinion marked Zero will be at the zero cone setting distance, dimension " B " in Fig. 15 from the centre line of the gear to the face on the small end of the pinion ; a pinion marked Plus two (+2) should be adjusted to the nominal (or Zero) cone setting plus .002", and a pinion marked Minus two (—2) to the cone setting distance minus .002".

The zero cone setting distance (" B " Fig. 15) for the various axles are given below.

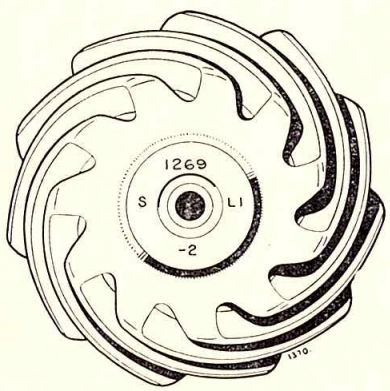


Fig. 14. Pinion setting marks.

Thus for a pinion marked Minus two (—2) the distance from the centre of the drive gear to the face of the pinion should be 2.623" (that is, 2.625"—.002") and for a pinion marked Plus three (+3) the cone setting distance should be 2.628".

When the pinion bearing cups have been installed in the gear carrier, with the original pinion inner bearing adjusting shims, as described in the first paragraph of this section, proceed with pinion as follows :—

(1) Place the pinion, with the inner bearing cone assembled, in the gear carrier.

(2) Turn the carrier over and support the pinion with a suitable block of wood for convenience before attempting further assembly.

(3) Install the pinion bearing spacer if fitted on the unit under repair.

(4) Install the original outer bearing shims on the pinion shank so that they seat on the spacer or a shoulder on the shank, according to the construction of the unit.

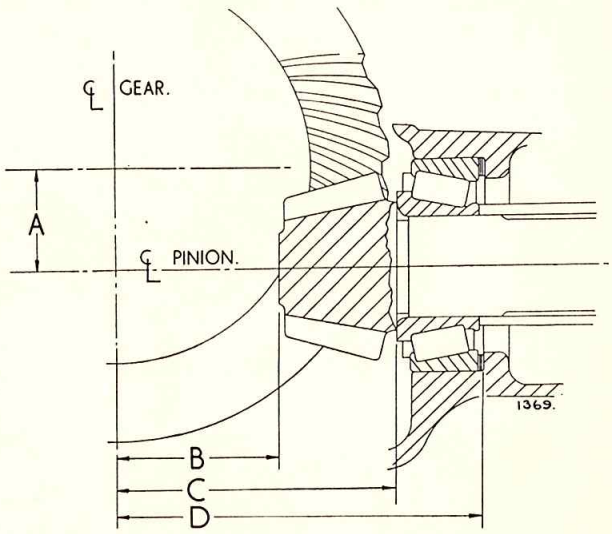


Fig. 15. Pinion setting distances.

		3 HA (2.4 litre)	4 HA (3.4 litre)
A.	Pinion Drop	1.375" (34.92 mm.)	1.5" (38.1 mm.)
B.	Zero Cone Setting	2.250" (31.75 mm.)	2.625" (66.67 mm.)
C.	Mounting Distance	3.937" (100.00 mm.)	4.312" (108.52 mm.)
D.	Centre Line to Bearing Housing	5.120" (130.05 mm.) to 5.130" (130.30 mm.)	5.495" (139.57 mm.) to 5.505" (139.83 mm.)

(5) Fit pinion outer bearing cone, companion flange, washer and nut only, omitting the oil slinger and oil seal assembly, and tighten the nut.

(6) Check the pinion cone setting distance by means of the gauge, Tool No. SL.3P, as shown in Fig. 16. The procedure for using the gauge is :—

(a) Adjust the bracket carrying the dial indicator to suit the model being serviced, then set the dial indicator to zero with the setting block.

(b) Place the dial indicator assembly on the fixed spindle of the gauge body.

(c) Fit the fixed spindle of the gauge body into the centre in the pinion head, slide the movable spindle into position, locating in the centre in the pinion shank with the gauge body underneath the gear carrier, and lock the spindle with the screw provided

(d) Check the pinion setting by taking a dial indicator reading on the differential bore with the bracket assembly seated on the ground face on the end of the pinion. The correct reading will be the minimum obtained ; that is when the ind cator spindle is at the bottom of the bore. Slight movement of the assembly will enable the correct reading to be easily ascertained. The dial indicator shows the deviation of the pinion setting from the zero cone setting and it is important to note the direction of any such deviation as well as the magnitude.

(7) If the pinion setting is incorrect it is necessary to dismantle the pinion assembly and remove the pinion inner bearing cup. Add or remove shims as required from the pack locating the bearing cup and re-install the shim pack and the bearing cup. The adjusting shims are available in thicknesses of .003″, .005″ and .010″. Then carry out the operations (1) to (6) detailed on page H.16.

(8) When the correct pinion setting has been obtained, check the pinion bearing preload, which should afford a slight drag or resistance to turning, there being no end play of the pinion. The correct preload for the pinion bearings gives a torque figure as listed in " Data " on page H.5. Less than the correct range will result in excessive deflection of the pinion under load, whilst too much preload will lead to pitting and failure of the bearings. To rectify the preload, adjust the shim pack between the outer bearing cone and

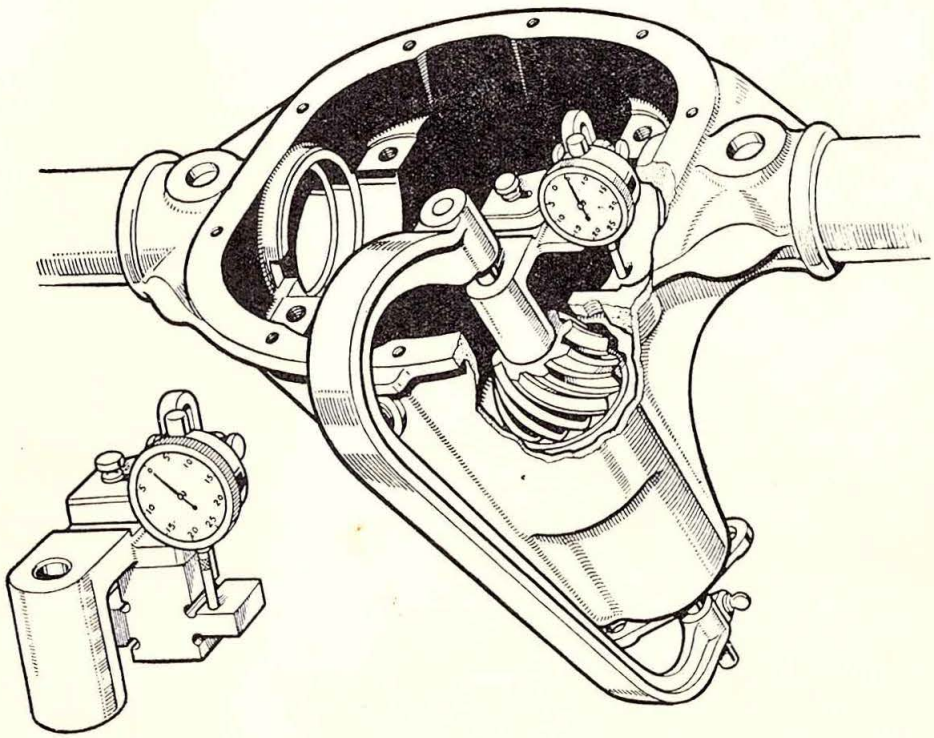


Fig. 16. Checking pinion cone setting.

the pinion shank or spacer, but do not touch the shims behind the inner bearing cup, which control the position of the pinion. Remove the shims to increase preload and add shims to decrease preload.

Installation of pinion oil seal assembly and oil slinger is usually effected after fitting differential assembly, see operations (1), (2) and (3) under " Final Assembly " on page H.19.

Drive Gear Adjustment

(1) Place the differential assembly with bearing cups, and less shims, in the housing, being sure that the bearing cones, cups and housing are perfectly clean.

(2) Install a dial indicator on the housing with the button on the back face of the drive gear as shown in Fig. 17.

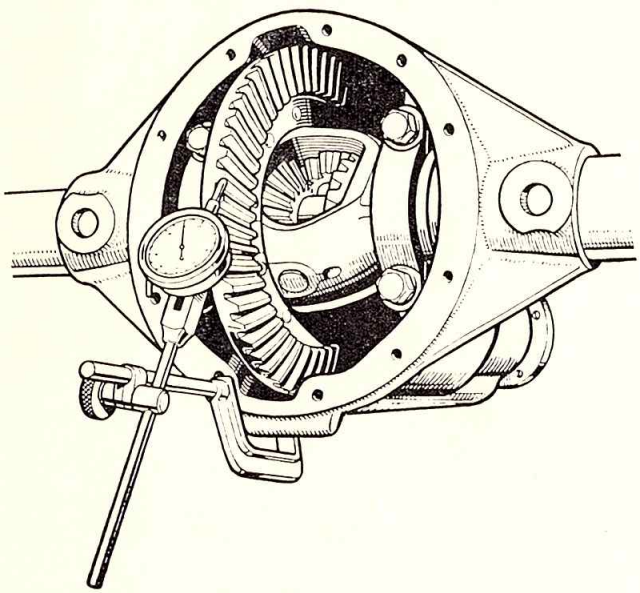


Fig. 17. Checking backlash between gears.

(3) Inserting two small levers between the housing and bearing cups, move the differential case and drive gear assembly away from the pinion until the opposite bearing cup is seated against the housing.

(4) Set the dial indicator to zero, then move the differential assembly towards the pinion until the drive gear is in metal to metal contact deeply in mesh with the pinion.

The indicator reading now obtained (clearance between drive gear and pinion) minus the backlash allowance as etched on the drive gear (e.g., B/L.007) denotes the thickness of shims to be placed between the differential case and the bearing cone on the drive gear side of the differential.

(5) Install the thickness of shims, determined in operation (4), on the drive gear side of the differential, taking the shims from the pack determined previously ; see " Differential Bearing Adjustment " on page H.14.

(6) Install the balance of the total shims required on the opposite side of the differential case.

As an example of differential and drive gear adjustment, assume that the total indicator reading obtained, as described under " Differential Bearing Adjustment ", is .080". This figure, plus .005" for the recommended preload, equals .085", which denotes the total thickness of shims to be used. Also assuming the clearance between the drive gear and pinion to be .042", determined as in operations (1) to (4) as above subtract the backlash as etched on the gear, say .007", from the .042" clearance. The .035" difference denotes the thickness of shims to be placed between the differential case and bearing cone on the drive gear side of the differential. Then subtract the thickness of shims (.035") inserted on the drive gear side of the differential case from .085" and the .050" difference denotes the thickness of shims to be installed on the opposite side of the case.

(7) To facilitate installation of the differential assembly, fit the stretching fixture as shown in Fig. 6. Stretch the gear carrier, being sure not to exceed the half turn specified on the turnbuckle or the axle casing will be damaged beyond repair.

(8) Lower the differential assembly into position, lightly tapping the bearings home with a hide hammer, whilst ensuring that the gear teeth are led into mesh with those of the pinion. Careless handling at this stage may result in bruising the gear teeth, and removal of the consequent damage can only be partially successful and result in inferior performance.

(7a) **Emergency Operation.** In an emergency it is possible to install the differential assembly by slightly tilting the bearing cups and tapping same lightly into position with a hide hammer. Naturally, this method increases the difficulty of avoiding damage to gear teeth, and extreme care is necessary to prevent damage to the differential bearings. This procedure is not recommended and should be strictly reserved for emergencies.

(8a) Install the differential bearing caps, taking care to ensure that the position of the numerals marked on the gear carrier housing face and the caps correspond, as indicated in Fig. 18. Finally tighten the bolts securing the bearing caps.

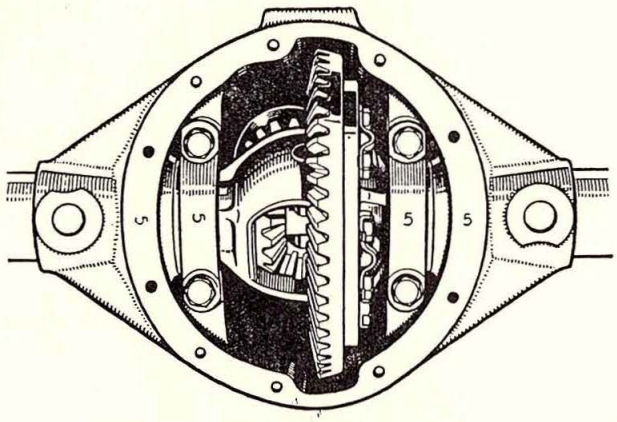


Fig. 18. Differential bearings cap markings.

(9) When refitting the bearing caps, be sure that the position of the numerals marked on the gear carrier housing face and the caps correspond as indicated in Fig. 18. Tighten the caps lightly, remove the stretching fixture, then finally tighten the bolts securing the bearing caps. Then continue with operation (10).

(10) Mount a dial indicator on the gear carrier housing with the button against the back face in a similar manner to that employed for differential bearing adjustment, as shown in Fig. 17. Turn the pinion by hand and check the run out on the back face, which should not exceed .005″ (.13 mm.). If there is excessive run out, strip the assembly and rectify by cleaning the surfaces locating the drive gear. Any burrs on these surfaces should be removed.

(11) Remount the dial indicator on the gear carrier housing with the button against one of the drive gear teeth, as nearly in line with the direction of tooth travel as possible (see Fig. 17). Move the drive gear by hand to check the backlash which should be as etched on the gear. If the backlash is not in accordance with the specification, transfer the necessary shims from one side of the differential case to the other to obtain the desired setting. To increase backlash, remove shims from the drive gear side of the differential and install on the opposite side. Backlash is decreased by transferring shims to the drive gear side from the opposite side of the differential case.

(12) After setting the backlash to the required figure, use a small brush to paint eight or ten of the drive gear teeth with a stiff mixture of marking raddle, used sparingly, or engineers blue may be used if preferred. Move the painted gear teeth in mesh with the pinion until a good impression of the tooth contact is obtained. The resulting impression should be similar to Fig. A in Fig. 20. Refer to the section on tooth contact and to Fig. 20 for instructions on correction of tooth contact if the impression obtained is not satisfactory.

Final Assembly

To complete the rebuilding of the unit :—

(1) Remove the drive pinion nut, washer and companion flange.

(2) Install the oil slinger, and then fit the pinion oil seal assembly, using Tool No. SL4P/B, as shown in Fig. 19. Place the oil seal with the dust excluder flange uppermost (not omitting the oil seal gasket used with the metal case type seal on later models), fit the installation collar, Tool No. SL.4P/B, and then tighten down the pinion nut and washer to drive the assembly home. Remove the installation collar.

(3) Fit the companion flange, washer and pinion nut, tighten securely.

(4) Fit the rear cover gasket, renewing it if required, and rear cover, securing same with set bolts and lock washers, not omitting the ratio tag which is attached by one of the set bolts.

(5) Re-install the axle shafts and hub bearings, etc., as described on page H.10 under " Axle Shafts To Refit ".

(6) Check that the drain plug is securely tightened, then fill with the appropriate quantity of one of the hypoid lubricants recommended on page H.8.

(7) Replace the filler plug and check that the cover set bolts are tight.

(8) Check for oil leaks at the cover, pinion oil seal and where the differential cap bolt holes break through.

(9) Finally grease the hub bearings.

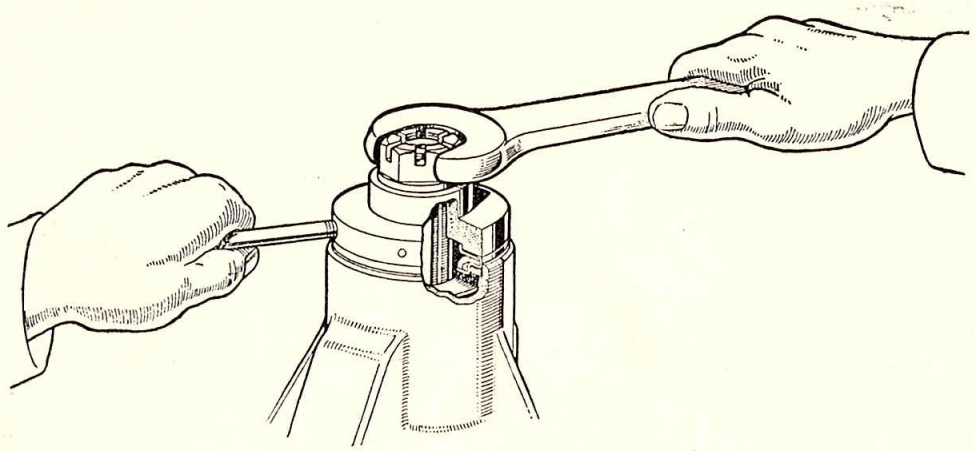


Fig. 19. Fitting the pinion oil seal.

TOOTH CONTACT

(Refer to Fig. 20)

The illustrations referred to in this section are those shown in Fig. 20 which indicates the tooth bearing impression as seen on the drive gear.

The HEEL is the large or outer end of the tooth.
The TOE is the small or inner end of the tooth.
The FACE top or addendum is the upper portion of the tooth profile.
The FLANK or dedendum is the lower portion of the tooth profile.
The DRIVE side of the drive gear tooth is CONVEX.
The COAST side of the drive gear tooth is CONCAVE.

(a) Ideal Contact

Fig. A. shows the ideal tooth bearing impression on the drive and coast sides of the gear teeth. The area of contact is evenly distributed over the working depth of the tooth profile and is located nearer to the toe (small end) than the heel (large end). This type of contact permits the tooth bearing to spread towards the heel under operating conditions when allowance must be made for deflection.

(b) High Tooth Contact

In Fig. B it will be observed that the tooth contact is heavy on the drive gear face or addendum, that is, high tooth contact. To rectify this condition, move the pinion deeper into mesh, that is, reduce the pinion cone setting distance, by adding shims between the pinion inner bearing cup and the housing and adding the same thickness of preload shims between the pinion bearing spacer, or the shoulder of the pinion shank and outer bearing cone. This correction has a tendency to move the tooth bearing towards the toe on drive and heel on coast, and it may therefore be necessary after making this change to adjust the drive gear as described in paragraphs (d) and (e).

(c) Low Tooth Contact

In Fig. C. it will be observed that the tooth contact is heavy on the drive gear flank or dedendum, that is, low tooth contact. This is the opposite condition from that shown in (b) and is therefore corrected by moving the pinion out of mesh, that is, increase the pinion cone setting distance by removing shims from between the pinion inner bearing cup and housing, and removing the same thickness of preload shims from between the pinion bearing spacer or the shoulder on the pinion shank and the outer bearing cone. This correction has a tendency to move the tooth bearing towards the heel on drive and toe on coast, and it may therefore be necessary after making this change to adjust the drive gear as described in (d) and (e).

(d) Toe Contact

Fig. D. shows an example of toe contact which occurs when the bearing is concentrated at the small end of the tooth. To rectify this condition, move the drive gear out of mesh, that is, increase backlash, by transferring shims from the drive gear side of the differential to the opposite side.

(e) Heel Contact

Fig. E. shows an example of heel contact which is indicated by the concentration of the bearing at the large end of the tooth. To rectify this condition move

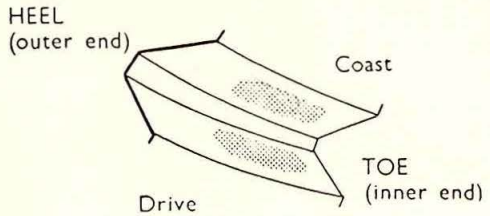
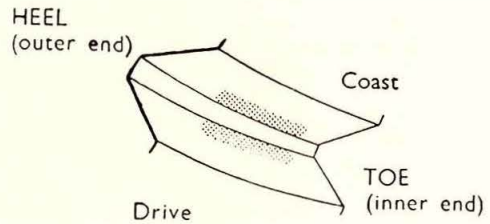
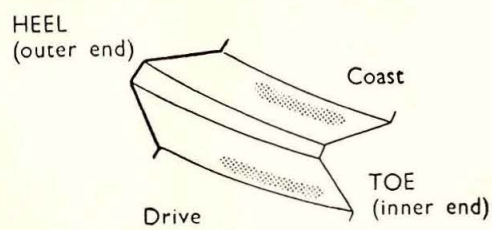
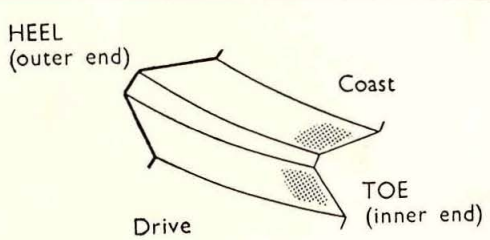
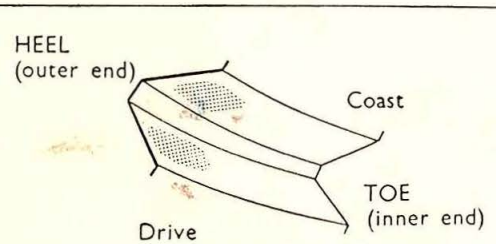
	TOOTH CONTACT (*DRIVE GEAR*)	CONDITION	REMEDY
A		IDEAL TOOTH CONTACT Evenly spread over profile, nearer toe than heel.	o — o
B		HIGH TOOTH CONTACT Heavy on the top of the drive gear tooth profile.	Move the DRIVE PINION DEEPER INTO MESH. *i.e.*, REDUCE the pinion cone setting.
C		LOW TOOTH CONTACT Heavy in the root of the drive gear tooth profile.	Move the DRIVE PINION OUT OF MESH. *i.e.*, INCREASE the pinion cone setting.
D		TOE CONTACT Hard on the small end of the drive gear tooth.	Move the DRIVE GEAR OUT OF MESH. *i.e.*, INCREASE backlash.
E		HEEL CONTACT Hard on the large end of the drive gear tooth.	Move the DRIVE GEAR INTO MESH. *i.e.*, DECREASE backlash *but* maintain minimum backlash as given in "Data"

Fig. 20. Tooth contact indication (contact markings on drive gear).

the drive gear closer into mesh, that is, reduce backlash, by adding shims to the drive gear side of the differential and removing an equal thickness of shims from the opposite side.

Note : It is most important to remember when making this adjustment to correct a heel bearing that sufficient backlash for satisfactory operation must be maintained. If there is insufficient backlash the gears will at least be noisy and have a greatly reduced life, whilst scoring of the tooth profile and breakage may result. Therefore, always maintain a minimum backlash requirement of .004″ (.10mm.).

Backlash

When adjusting backlash always move the drive gear as adjustment of this member has more direct influence on backlash, it being necessary to move the pinion considerably to alter the backlash a small amount—.005″ (.13 mm.) movement on pinion will generally alter backlash .001″ (.025 mm.).

Gear and Pinion Movement

Moving the gear out of mesh moves the tooth contact towards the heel and raises it slightly towards the top of the tooth.

Moving the pinion out of mesh raises the tooth contact on the face of the tooth and slightly towards the heel on drive, and towards the toe on coast.

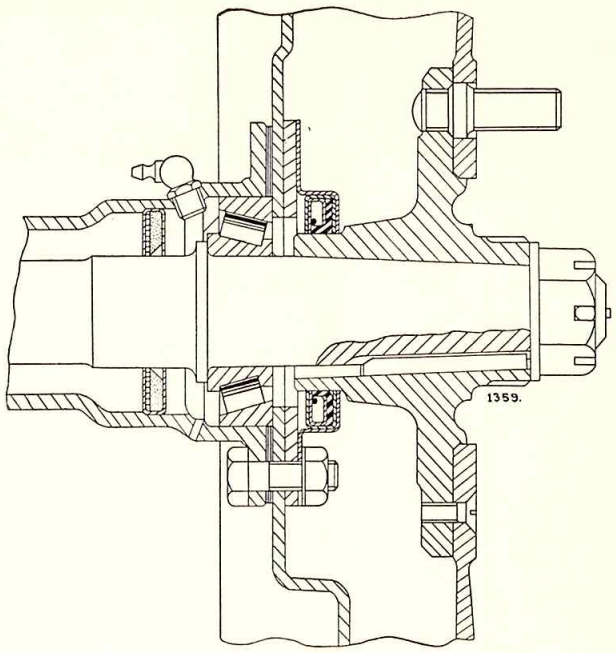


Fig. 21. Sectioned view of drum brake hub arrangement.

THORNTON "POWR-LOK" DIFFERENTIAL

GENERAL

The Thornton " Powr-Lok " limited slip differential is specified as an optional extra for the 4.HA type of axle as fitted to the 3.4 litre model.

Identification

New cars fitted with a Thornton differential have a metal tag stamped P/L attached to one of the rear axle cover bolts. If a tag is not fitted, remove the filler plug when if the differential case can be seen in close proximity to the filler hole it can be assumed that a Thornton differential is fitted.

Warning

When a car is equipped with a Thornton " Powr-Lok " differential the engine must NOT be run with the car in gear and one wheel off the ground otherwise, owing to the action of the differential, the car may drive itself off the jack or stand.

If it is desired to turn the transmission by running the engine with the car in gear **both** wheels must be jacked up clear of the ground.

DESCRIPTION

The limited slip differential has two pinion shafts with two mates to each shaft. The pinion shafts are mounted at right angles to each other but do not make contact at their intersection. Double ramps with flat surfaces at each end of the pinion shafts, mate with similar ramps in the differential case. Clearance in the differential case permits slight peripheral movement at the ends of the pinion shafts.

When a driving force is applied to the differential case, the pinion shafts, pinion mates and differential side gears splined to the axle shafts, rotate as a unit. Resistance to turning at the wheels forces the pinion shafts to slide up the differential case ramps, pushing the pinion shafts apart. As the pinion shafts move apart they apply load to the clutch plates thus restricting turning between the axle shafts and the differential case. Both axle shafts have now become clutched to the differential case to a varying degree dependent upon the amount of torque transmitted. This in effect locks the axle shafts to the differential case, in the normal straight ahead driving position, which prevents spinning of either rear wheel should it leave the road or encounter poor traction such as ice, snow, sand, loose gravel or oil patches.

Due to the lateral movement of the pinion shafts in the differential case, a little more backlash may be apparent in a limited slip rear axle. Slight chatter may also occur when one wheel is on a slippery surface, this is due to surge torque.

PRINCIPLE OF OPERATION

The conventional differential, divides the load equally between both driving wheels. In this connection, it should be remembered that the conventional differential will always drive the wheel which is easiest to turn. This is a definite disadvantage under adverse conditions of driving where the traction of one wheel is limited.

The main purpose of the limited slip differential is to overcome this limitation. Many times the torque of the slipping wheel is provided to the driving wheel, thus permitting improved operation under all conditions of driving. The torque is transmitted from the differential case to the cross pins and differential pinions to the side gears in the same manner as torque is applied in the conventional differential.

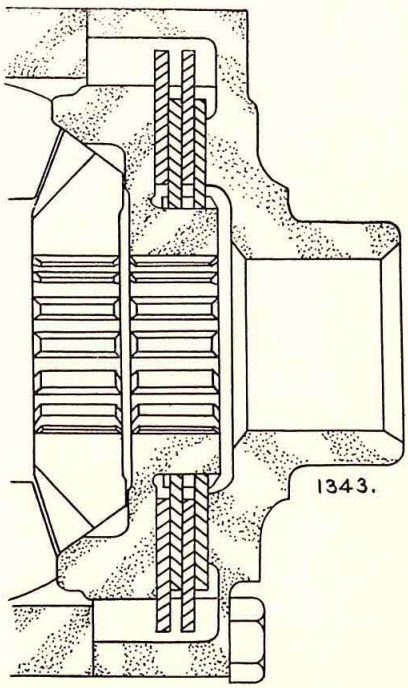


Fig. 22. Sectioned view showing friction discs and plates.

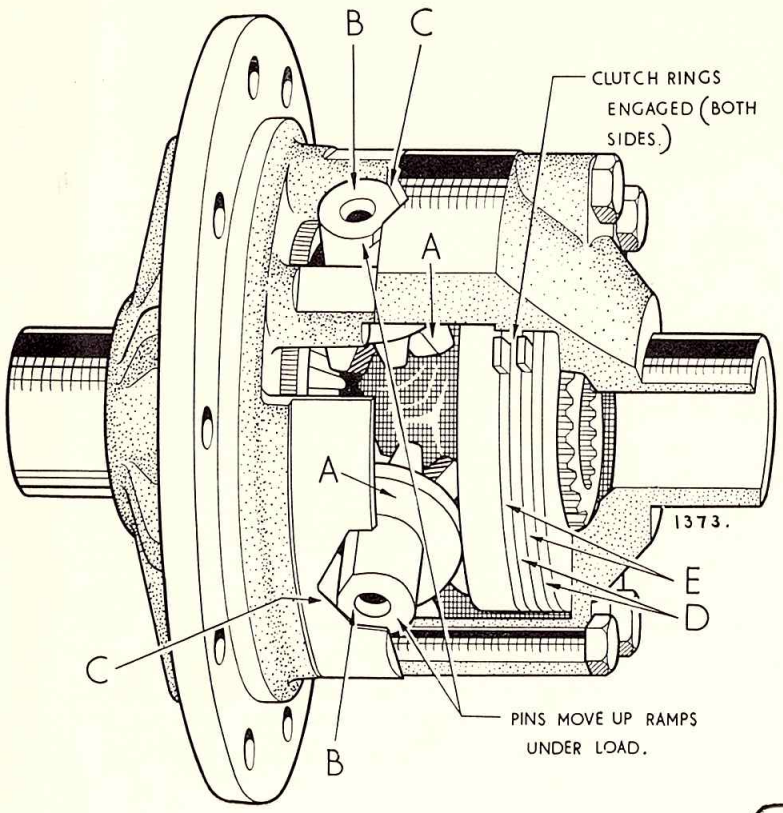


Fig. 23.

The driving forces moves the cross pins B, Fig. 23, up the ramp of the cam surfaces C, applying a load to the clutch rings D and restricts turning of the differential through the friction clutches E. This provides a torque ratio between the axle shafts which is based on the amount of friction in the differential and the amount of load that is being applied to the differential.

When turning a corner, this process is in effect partially reversed. The differential gears become a planetary set, with the gear on the inside of the curve becoming the fixed gear of the planetary. The outer gear of the planetary over-runs as the outside wheel on the curve has a further distance to travel. With the outer gear over-running and the inner gear fixed, the pinion mates A (see Fig. 24) are caused to rotate, but inasmuch as they are restricted by the fixed gear, they first must move pinion mate shafts B back down the cam surface C relieving the thrust loads on the plate clutches E. Thus when turning the corner, the differential, for all practical purposes, is similar to a conventional differential and the wheels are free to rotate at different speeds.

On straight driving, the clutches are engaged and thus prevent momentary spinning of the wheels when leaving the road or when encountering poor traction. In turning a corner, the load is relieved from the clutch surfaces so that wear is reduced to a minimum.

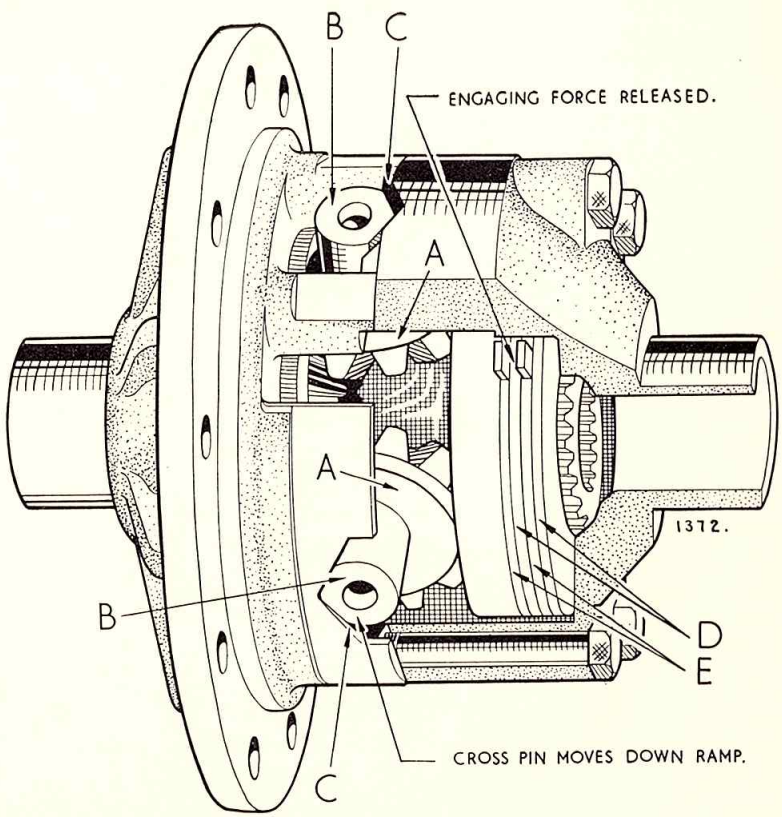
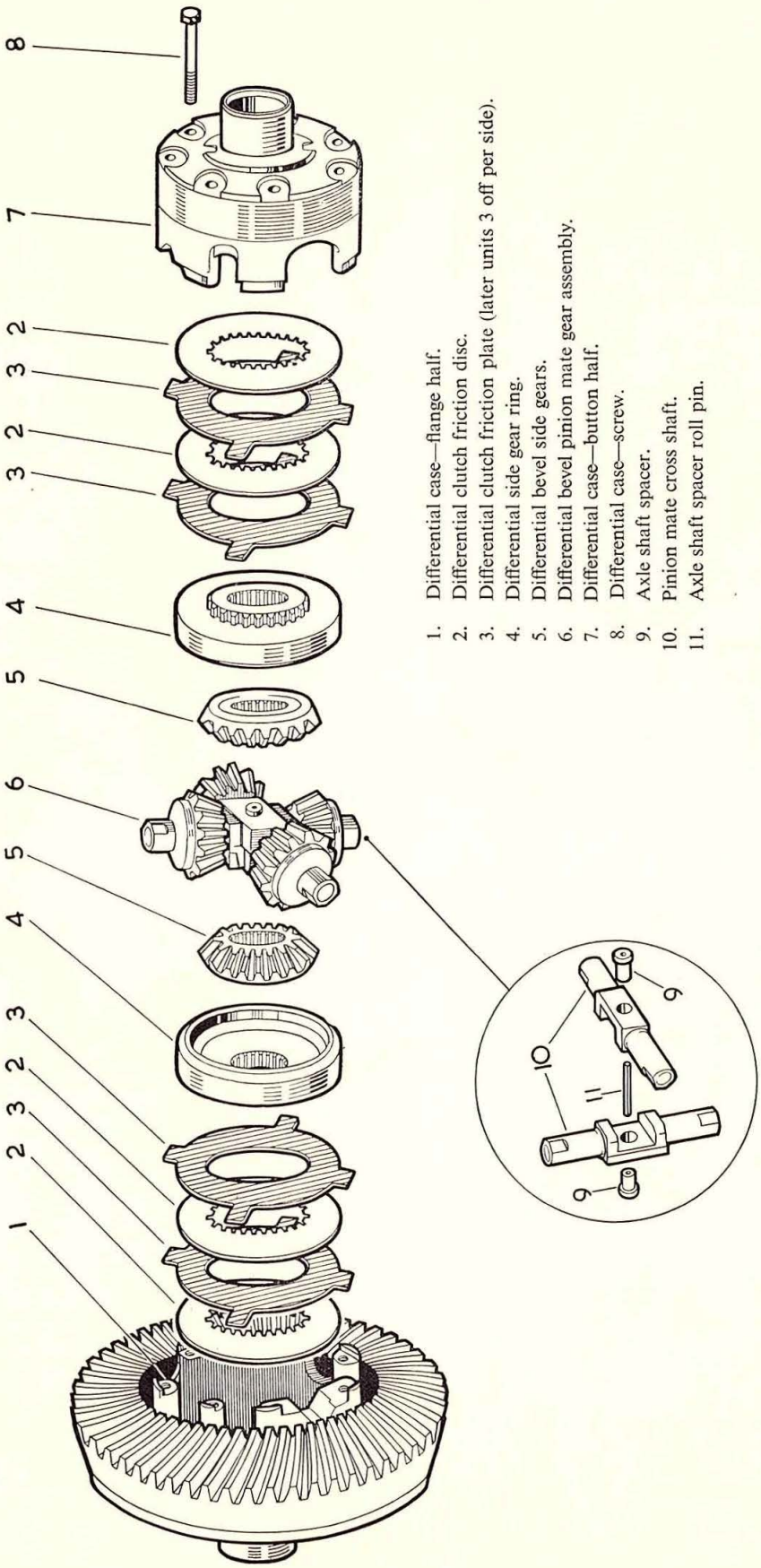


Fig. 24.



1. Differential case—flange half.
2. Differential clutch friction disc.
3. Differential clutch friction plate (later units 3 off per side).
4. Differential side gear ring.
5. Differential bevel side gears.
6. Differential bevel pinion mate gear assembly.
7. Differential case—button half.
8. Differential case—screw.
9. Axle shaft spacer.
10. Pinion mate cross shaft.
11. Axle shaft spacer roll pin.

Fig. 25. Exploded view of the Thornton "Powr-Lok" differential.

POWER FLOW IN FORWARD DRIVING

Under normal starting and operating conditions the torque or power flow in both the limited slip and conventional type differential is transmitted equally to each axle shaft and wheel. However, when sudden patches of ice, loose gravel or oil are encountered, the limited slip differential will not permit the wheel with the lesser traction to spin, gain momentum and swerve the car when a dry surface is regained.

POWER FLOW IN TURNS

In turning, the limited slip differential gives normal differential action and permits the outer wheel to turn faster than the inner wheel. At the same time the differential applies the major driving force to the inside rear wheel, improving stability and cornering.

POWER FLOW WITH POOR TRACTION

When traction conditions under the rear wheels are dissimilar, the driving force with an ordinary differential is limited by the wheel with the poorer traction. Typically, in this situation, the wheel with the poorer traction spins and the vehicle remains immobile. The limited slip differential enables the wheel with the better traction to apply the major driving force to the road.

ACTION ON ROUGH ROADS

Bumps do not adversely affect wheel action when wheels are controlled by the limited slip differential. The free wheel does not spin and gain momentum. There is no sudden wheel stoppage to cause car swerve or tyre scuffing and wheel hop is reduced.

REMOVAL FROM AXLE ASSEMBLY

The removal of the Thornton " Powr-Lok " differential from the rear axle is exactly the same as detailed in this section for the conventional type of differential.

DISMANTLING

Remove the eight bolts (8 Fig. 25) securing the two halves of the differential casing.

Split the casing and remove the clutch discs (2) and plates (3) from one side.

Remove the differential side gear ring (4).

Remove the pinion side gear (5) and the pinion mate cross shafts (6) complete with the pinion mate gears.

To separate the cross shafts (10) extract the shaft spacers (9) from the spacer roll pin. (11).

Remove the remaining side gear and the side gear ring.

Extract the remaining clutch discs and plates.

REASSEMBLING

Refit the clutch plates and discs alternately into the flange half of the casing.

Fit the side gear ring so that the serrations on the gear mesh with the serrations in the two clutch discs.

Place one of the side gears into the recess of the side gear ring.

Fit the cross shafts together.

Enter one axle shaft spacer with a new spacer roll pin attached through the hole in the cross shafts and press the other spacer on to the roll pin.

Refit the pinion mate cross shafts complete with pinion mate gears ensuring that the ramps on the shafts coincide with the mating ramps in the differential case.

Assemble the remaining side gear and side gear ring.

Refit the remaining clutch plates and discs to the side gear ring.

Offer up the button half of the differential case to the flange half so that letters stamped on each half are opposite each other.

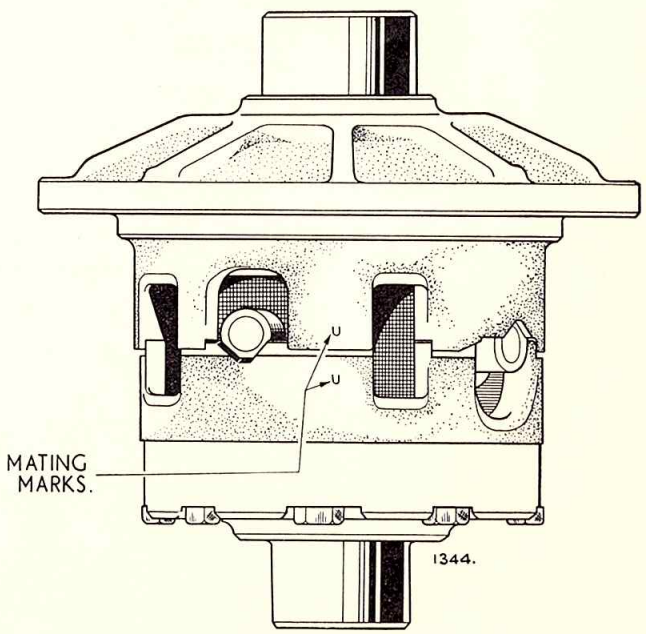


Fig. 26. Alignment marks on the differential case.

Position the tongues of the friction plates so that they align with the grooves in the differential case.

Assemble the button half to the flange half of the differential case and secure with the eight bolts. Tighten the bolts to a torque of 35 to 45 lbs. ft.

CHECKING FOR WEAR

With one axle shaft and the drive pinion locked, the other axle shaft must not turn radially more than $\frac{3}{4}$" measured on a 6" radius.

ADJUSTMENTS

The bearing preload and drive gear and pinion adjustments for an axle fitted with a Thornton " Powr-Lok " differential are exactly the same as detailed in this section for the conventional type of differential.