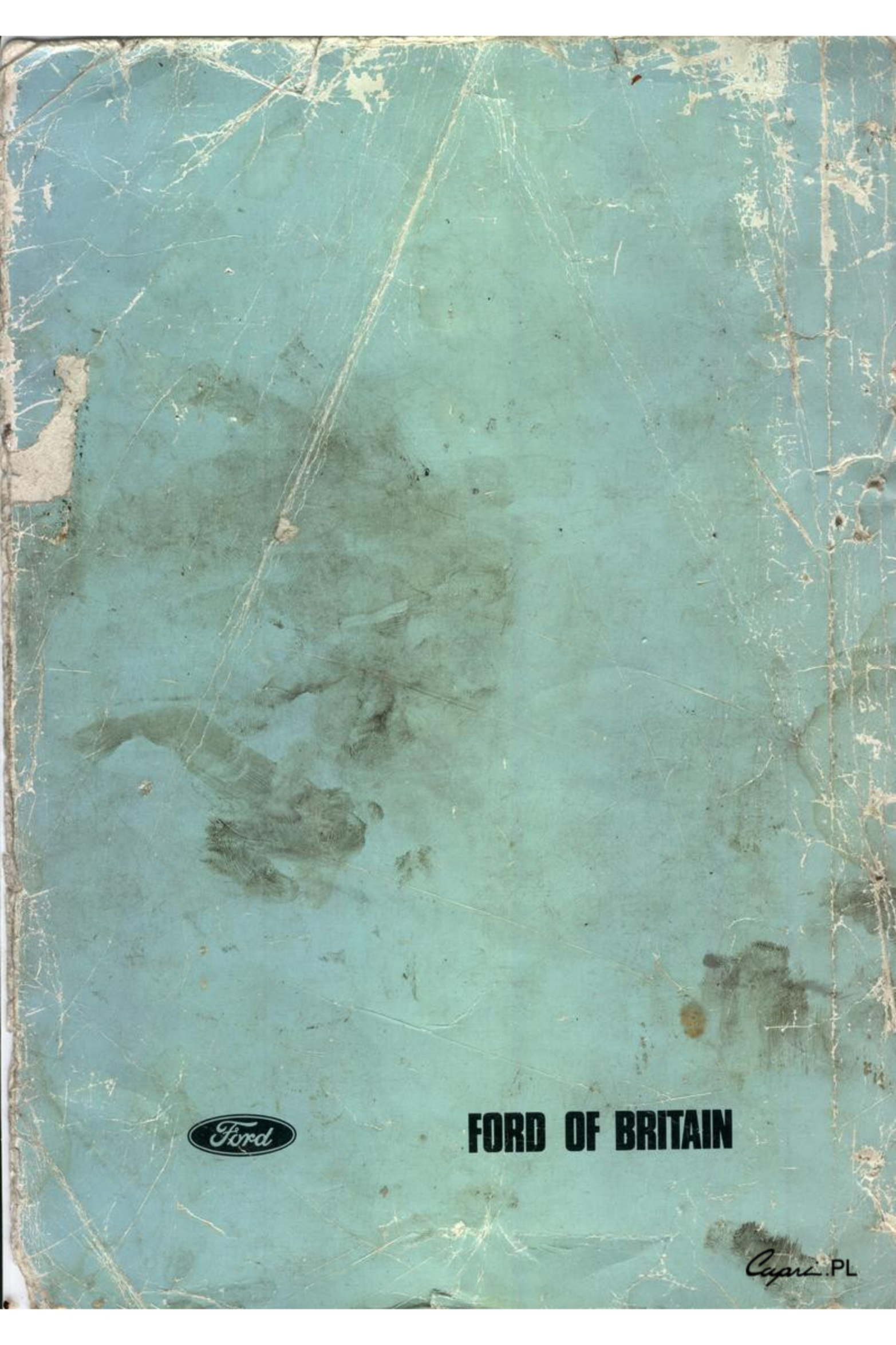
Ford

TRANSIT

WORKSHOP MANUAL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TRANSIT

Shop Manual

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December 1970

Printed in England by Valentine Press Ltd.

Ref. No. CG426/235759/1270

FOREWORD

This Shop Manual has been prepared as a guide for repair and adjustment procedures applicable to the Transit range of vehicles.

Each operation is self-contained and sufficient details and illustrations are given to ensure that unnecessary dismantling is avoided.

Where special tools are required, their numbers are quoted and if necessary their use is described in detail.

A brief description on the operating principles of many of the major assemblies is given so that the function of their components is understood.

Where practical, fault diagnosis procedures are given, but efficient diagnosis is largely a matter of experience.

With the introduction of a new model, the opportunity has been taken to incorporate the revised model identifications in the body of the text. A table showing the old identifications, together with their new equivalents, is given overleaf.

All necessary specifications are quoted and will be of assistance when deciding whether parts are suitable for further service.

Service Publications
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Ford policy is one of continuous improvement, and the right to change prices, specifications and equipment at any time without notice is reserved.

The following table gives the old model identifications together with their new equivalents:—

Previous Identification	*Revised Equivalents*	*Model Type*
V 10	'75'	'LCX' 106 in. (Short Wheelbase)
V 20	'90'	
V 30	'115'	
—	'125' (New Model)	
V 40	'130'	'LCY' 118 in. (Long Wheelbase)
V 50	'150'	
V 60	'175'	

In the manual text, reference is made throughout to the new identifications.

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Section 1

WHEELS AND HUBS

CONTENTS

SUBJECT

WHEELS AND HUBS

MAINTENANCE AND OVERHAUL PROCEDURES

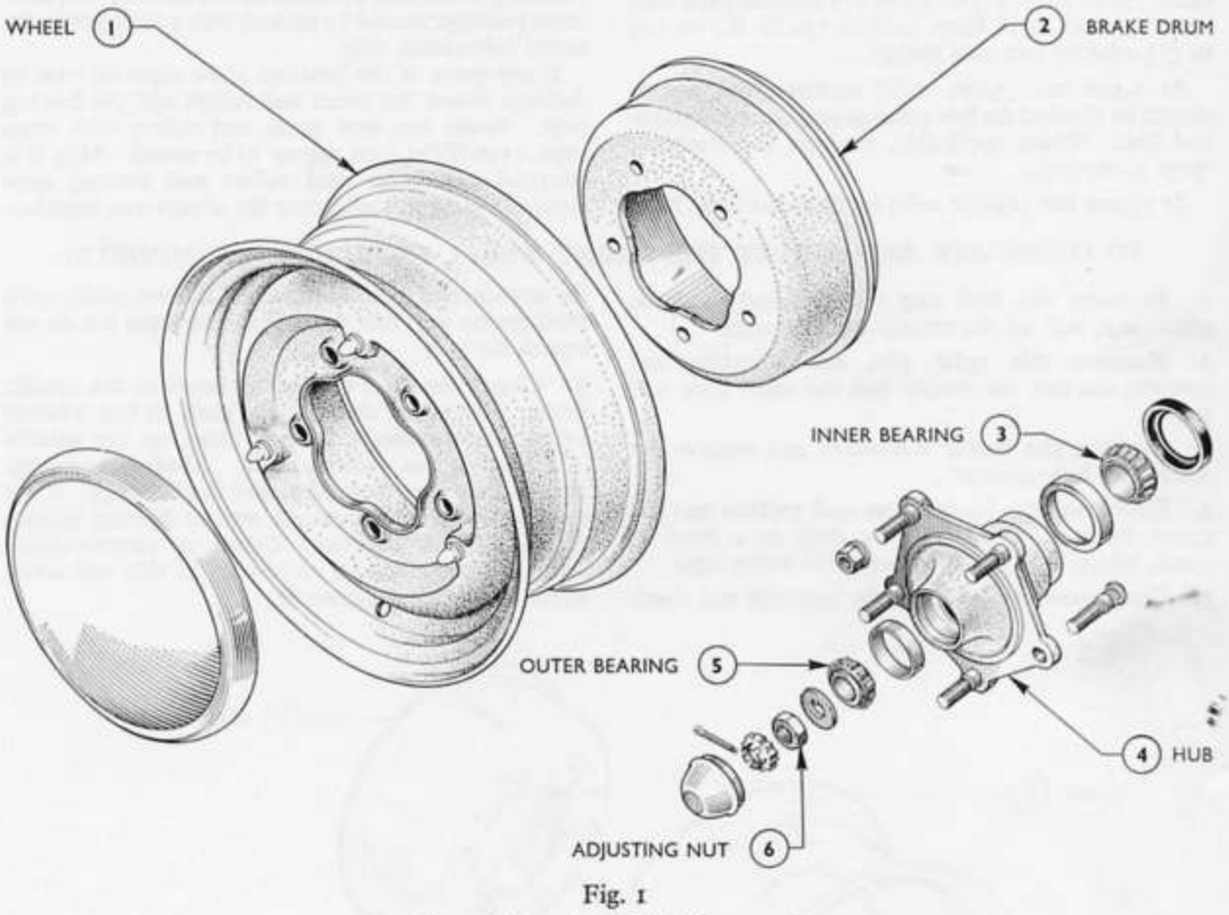


Fig. 1

Front Wheel and Hub (75 - 115)

DESCRIPTION

All vehicles in the Transit range are equipped with 35.6 cm. (14 in.) diameter pressed steel wheels. On the short wheelbase vehicles, single wheels are fitted all round, secured to the hubs by five studs and nuts on the 75, 90 and 115 models, and 6 studs on the 125 model. The long wheelbase vehicles have a six stud fixing with twin rear wheels. Tyres of various sizes and ply ratings are specified to accommodate the various G.V.Ws.

Each front hub is mounted on two tapered roller bearings which may be adjusted to give the required end-float. The adjusting nut is located by a retainer and a split pin (see Figs. 1, 2 and 3). On the 75 to 90 vehicles, ¾ floating rear axles are used and each hub runs on a non-adjustable ball bearing. A single row bearing is specified on the 75, and a double row bearing on the 90 and the 115. On 125 to 175 vehicles, fully floating rear axle shafts are used with the flanges secured to the hubs by studs and nuts. The hubs are each mounted on a pair of adjustable tapered roller bearings with the adjustable nut retained in position by a tab washer and a locknut (see Fig. 8).

Headed wheel studs are fitted, having serrations on the diameters locating in the hub flanges of all models except the rear of the Transit 125, on which they are located in the brake drum. The serrations ensure an interference fit whilst enabling the studs to be driven in or out if required.

The brake drums are located on the parallel sections of the wheel studs except on the Transit 125 where the drum is located before the hub (see Fig. 7). The brake drums are staked to the front wheel studs (75 to 115) and retained by a single countersunk screw (125 to 175). Also, locating cones are used with the twin rear wheels on 130 to 175 vehicles.

MAINTENANCE AND ADJUSTMENTS

At the first service, the wheel nuts should be checked for tightness. Note that the studs and the nuts retaining the left-hand wheels on 125 to 175 vehicles have left-hand threads.

The correct torque for the wheel nuts is 7.6 to 9.7 kg.m. (55 to 70 lb. ft.) on 75 to 115 vehicles (five stud fixing) and 16 to 18 kg.m. (115 to 130 lb. ft.) on 125 to 175 vehicles (six stud fixing).

At 8,400 km. (5,000 mile) services, the wheels should be checked for free rotation and just perceptible end-float. Where applicable, readjust the bearings, (page 5 onwards).

At 25,000 km. (15,000 mile) services, the front hubs and bearings should be dismantled, checked and the bearings repacked with a good quality lithium base grease. See below.

The rear hub bearings are lubricated by oil from the rear axle. Grease should never be added during servicing as this will contaminate the axle oil. Replacement bearings should be packed with a little grease for initial lubrication only.

If any parts of the bearings show signs of wear or damage, renew the cones and rollers and the bearing cups. Never run new cones and rollers with worn cups, even if the cups appear to be sound. Also, it is essential that cones and rollers and bearing cups from the same manufacturer are always run together.

TO LUBRICATE AND ADJUST THE FRONT WHEEL BEARINGS (ALL MODELS)

1. **Remove the hub cap** (where fitted) and the grease cap, jack up the vehicle and fit stands.

2. **Remove the split pin,** the adjusting nut retainer, the nut, the washer and the outer cone and rollers.

3. **Slacken the brake adjusters** and remove the wheel and hub assembly.

4. **Drive out the inner cone and rollers** and the grease retainer. Use a suitable drift or a piece of wood, taking care not to damage the roller cage.

5. **De-grease the hub** and the bearings and check for any signs of wear or damage. If serviceable, work fresh grease well into the rollers and cages but do not repack the hub.

6. **Check the fit** of the bearing cones on the spindle body. The cones should be a push fit but without perceptible clearance. Do not clean up the spindle if a bearing has rotated on it. Always renew the spindle body, see Section 3, and the bearings. If the spindle bodies are damaged due to bearing seizure they should be renewed. Under no circumstances should they be cleaned or re-used as this will result in the cones being a loose fit.

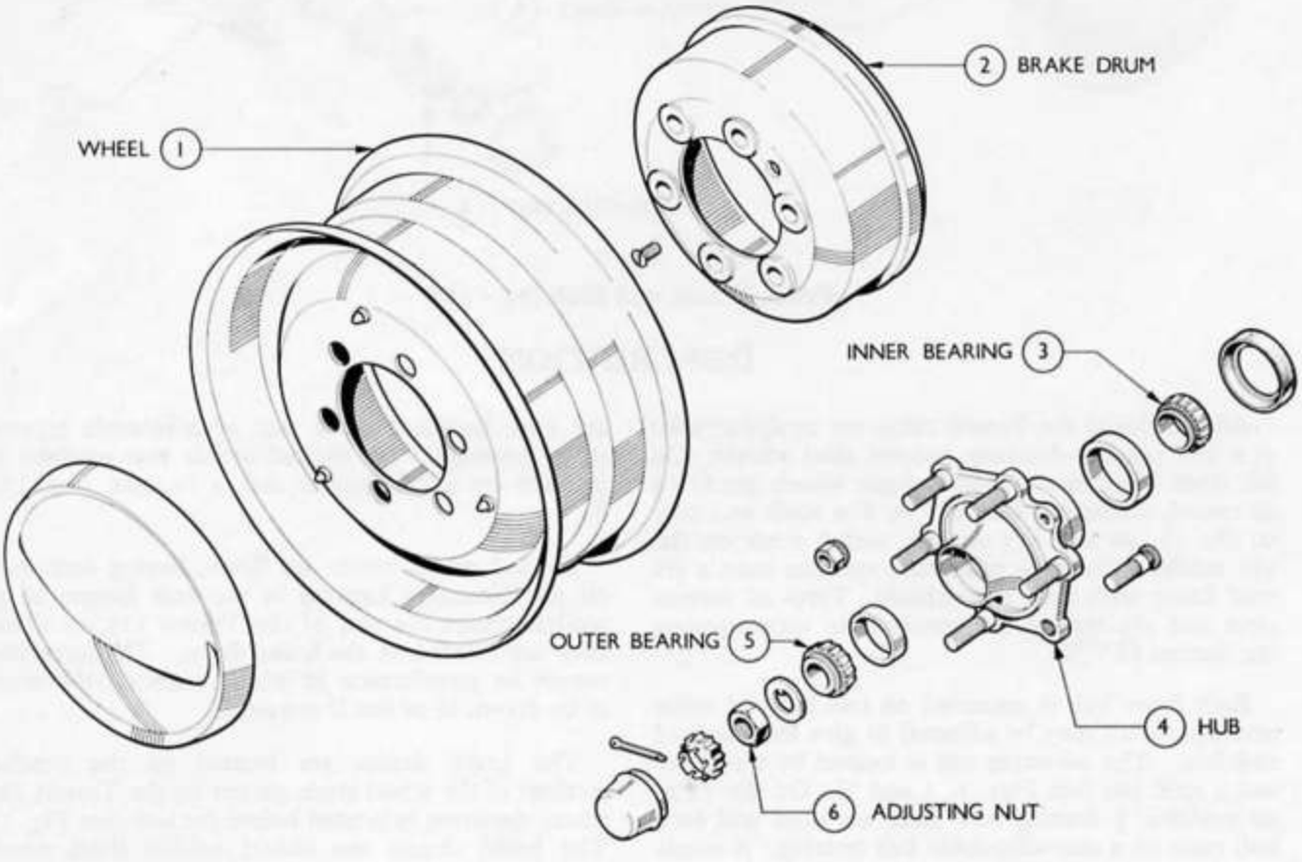


Fig. 2
Front Wheel and Hub (125)

7. Install the inner cone and rollers in the hub and fit the grease retainer, using Tool No. C.1036 and the 550 handle.

8. Mount the wheel and hub assembly on the spindle and fit the outer cone and rollers.

9. Fit the thrust washer and tighten the adjusting nut to a torque of 2.35 to 3.5 kg.m. (17 to 25 lb. ft.), while rotating the wheel. Back off the adjusting nut approximately one flat, to give an end-float of 0.05 to 0.165 mm. (0.002 to 0.0065 in.). Place the retainer on the nut and fit a new split pin.

10. Refit the grease cap and readjust all the brakes.

11. Remove the stands, lower the vehicle to the ground and replace the hub cap, 75 to 125.

OVERHAULING THE FRONT HUB AND DRUM ASSEMBLIES

1. Remove the hub cap where fitted, and slacken the wheel nuts.

2. Jack up the vehicle, fit stands, remove the wheel and slacken the brake adjusters.

3. Prise off the grease cap and remove the split pin and the adjusting nut retainer.

4. Unscrew the adjusting nut and remove the thrust washer and the outer cone and rollers.

5. Remove the hub and drum assembly and wipe out the surplus grease. Drive out the inner cone and rollers and the grease retainer. Use a soft drift or a piece of wood to avoid damaging the roller cage.

6. Remove the brake drum from the studs using a copper mallet.

7. Drive the bearing cups out of the hub, using a suitable drift. Work evenly round the edge, ensuring that the cup remains square with the bore of the hub.

8. Drive the wheel studs out of the hub flange using a copper mallet or press out, using a vice and a suitable socket as a spacer.

9. Mount the hub on the bed of a press and fit the bearing cups, using Tool No. C.1037 and the 550 handle (see Fig. 4). When replacement cups are fitted always use new cones and rollers from the same manufacturer.

10. Drive or press the wheel studs in from the inner face of the hub flange.

11. Check the fit of the bearing cones on the spindle. The cones should be a push fit but without

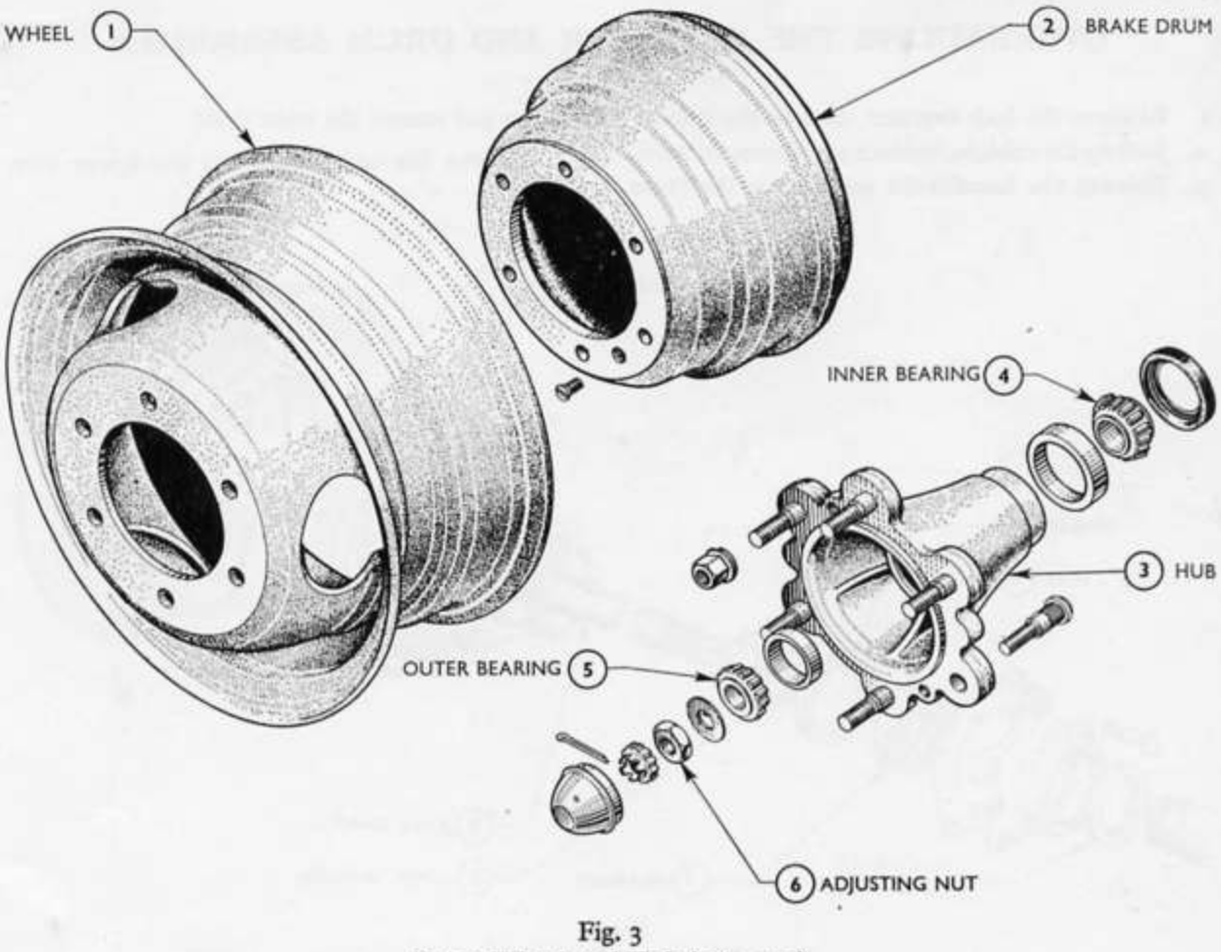


Fig. 3
Front Wheel and Hub (130—175)

perceptible clearance. Do not clean up the spindle if a bearing has seized and rotated on it. Always renew the spindle body, see Section 3, and the bearings.

12. Work fresh grease well into the rollers and cages, but do not repack the hub.

13. Install the inner cone and rollers and fit the grease retainer, using Tool No. C.1036 and the 550 handle.

14. Refit the brake drum to the hub and fit the countersunk screw (125 to 175).

15. Mount the hub assembly on the spindle and fit the outer cone and rollers, the thrust washer and the adjusting nut.

16. Tighten the adjusting nut to a torque of 2.35 to 3.5 kg.m. (17 to 25 lb. ft.), while rotating the hub. Back-off the adjusting nut approximately one flat, to give an end-float of 0.05 to 0.165 mm. (0.002 to 0.0065 in.). Place the retainer on the nut, and fit a new split pin.

17. Re-adjust all the brakes.

18. Fit the wheel and wheel nuts.

19. Remove the stands and lower the vehicle to the ground.

20. Tighten the wheel nuts to a torque of 7.6 to 9.7 kg.m. (55 to 70 lb. ft.) 75 to 115 and to a torque of 16 to 18 kg.m. (115 to 130 lb. ft.) 125 to 175.

21. Replace the grease cap (all models) and the hub cap (75 to 125).

Fig. 4
Replacing the Hub Bearing Cups

OVERHAULING THE REAR HUB AND DRUM ASSEMBLIES

(*a*) 75 TO 115

1. Remove the hub cap and slacken the nuts.

2. Jack up the vehicle, fit stands and remove the wheel.

3. Release the handbrake and slacken the brake adjuster and remove the brake drum.

4. Remove the axle shaft and the spacer from the hub.

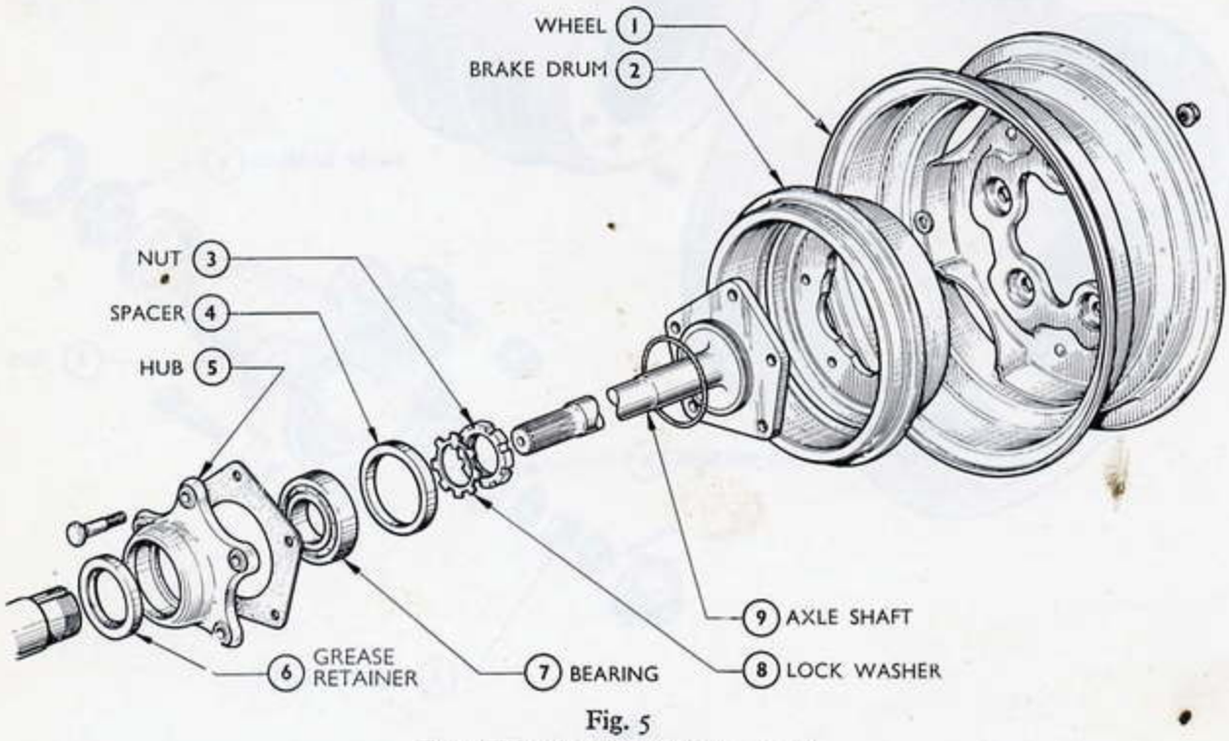


Fig. 5
Rear Wheel and Hub (75 — 115)

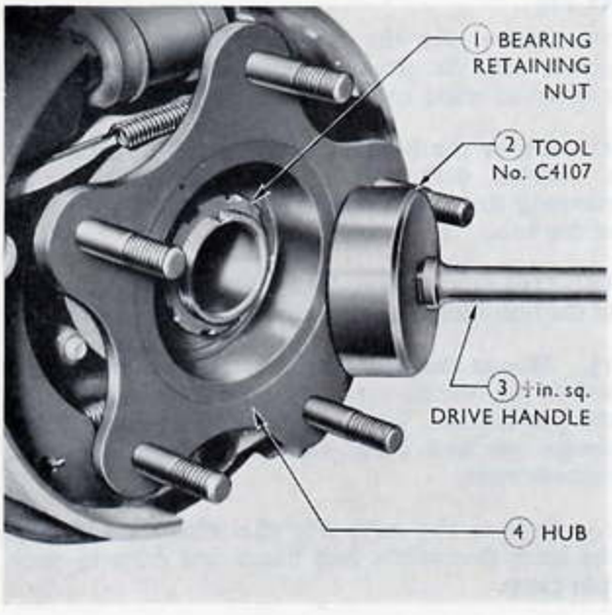


Fig. 6
Use of Tool No. 4107

5. Bend up the tab washer and remove the hub bearing nut, using Tool No. C.4107 and a ½ in. square drive handle (see Fig. 6).

6. Remove the hub assembly, using the slide hammer No. CPT.3072 and adaptor No. CP.3072-4A.

7. Lever the grease retainer out of the hub.

8. Drive the bearing out of the hub from the inside.

9. Drive the wheel studs out of the hub flange, using a copper mallet or a press.

10. Check the fit of the bearing on the axle case. The bearing should be a light drive fit with no perceptible clearance.

11. Clean the bearing and the grease retainer and check for any signs of wear or damage. Renew if any doubt exists. When a new bearing is fitted, work a little grease into the cage to provide initial lubrication.

12. Mount the hub on the bed of a press and install the seal and the bearing, using the 550 handle and adaptor No. CP.1013. Refit the wheel studs.

NOTE.—New rear hub oil seals must be soaked in hypoid 90 gear oil for 15 minutes prior to assembly. The bearing is a semi-sealed type and must be fitted with the seal facing to the outside of the hub.

13. Fit the hub assembly to the axle, using the slide hammer and adaptor No. CP.3072-4A, taking care that the seal is not damaged by the axle housing threads.

14. Engage the inside tab of the lockwasher with the axle case keyway and screw on the retaining nut. Tighten the nut to a torque of 18 to 19.5 kg.m. (130 to 140 lb. ft.) to align the nut with the lockwasher and bend the lockwasher over two flats of the nut, taking care not to damage the bearing seal.

15. Replace the spacer and fit the axle shaft, using a new "O" ring and gasket, and replace brake drum.

NOTE.—Never use more than one gasket for each hub.

16. Replace the wheel and the wheel nuts.

17. Re-adjust all the brakes.

18. Remove the stands and lower the vehicle to the ground.

19. Tighten the wheel nuts to a torque of 7.6 to 9.7 kg.m. (55 to 70 lb. ft.) and replace the hub cover.

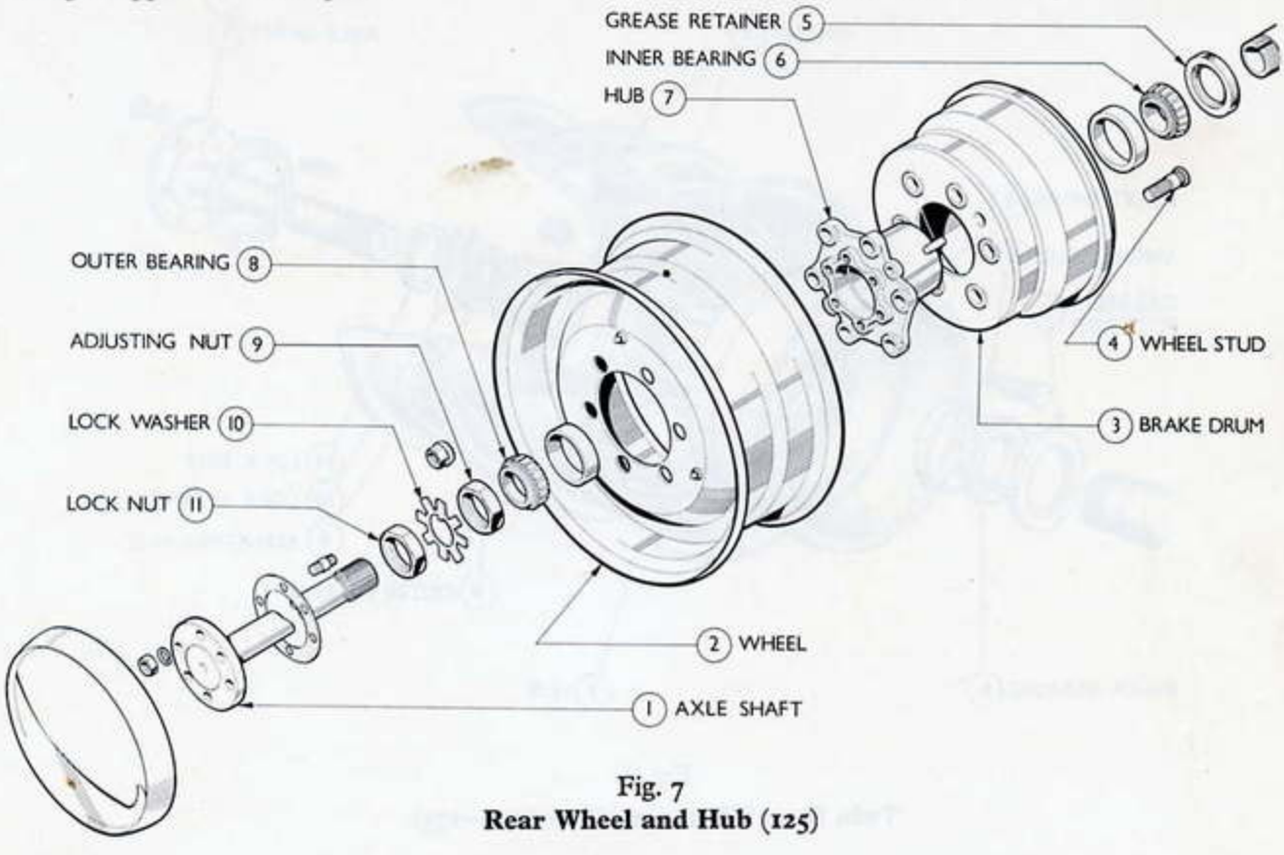


Fig. 7
Rear Wheel and Hub (125)

(*b*) 125 TO 175

1. **Slacken the wheel nuts.**

2. **Jack up the vehicle** and fit stands under the axle.

3. **Remove the wheel nuts** and the wheel(s).

NOTE.—The hub nuts are right-hand threaded for the right-hand wheels, and left-hand threaded for the left-hand wheels.

4. **Release the handbrake** and slacken the brake adjusters.

5. (130 *to* 175 *only*) **Remove the countersunk screw** retaining the brake drum, remove the locating cones from the wheel studs and pull the drum off.

6. **Remove the axle shaft nuts,** the axle shaft and the gasket.

7. **Bend up the tabs** of the lockwasher and unscrew the bearing locknut, using Tool No. C.4109.

8. **Remove the tab washer,** the bearing adjusting nut and the outer cone and rollers.

9. (*a*) (125 *only*) **Remove the hub and drum assembly** and wipe out any surplus grease to avoid contaminating the brake drum. Using a copper mallet and suitable wooden blocks, split the hub and drum.

   (*b*) (130 *to* 175) **Remove the hub** and wipe out any surplus grease.

10. **Drive out the inner cone** and rollers together with the grease retainer. Use a soft drift or a piece of wood to avoid damaging the roller cage.

11. **Drive the bearing cups** out of the hub using a suitable drift. Work evenly round the edge ensuring that the cup remains square with the bore of the hub.

12. (130 *to* 175 *only*) **Drive the wheel studs** out of the hub flange, using a copper mallet.

13. **Mount the hub** on the bed of a suitable press and fit the bearing cups, using Tool No. C.1038 and the 550 handle. When replacement cups are fitted, always use new cones and rollers from the same manufacturer.

14. (130 *to* 175 *only*) **Fit the wheel studs** from the inner face of the hub flange and drive or press into place.

15. **Check the fit** of the bearing cones on the axle case. The cones should be a push fit, but without perceptible clearance. Do not clean up the case if the bearing has seized and rotated on it. Clean the bearings and the grease retainer and check for any signs of wear or damage, renew parts as necessary.

16. **When new bearings** are being fitted work a little grease into the rollers and cages to provide initial lubrication. Do not pack any grease into the hubs as this will contaminate the axle oil.

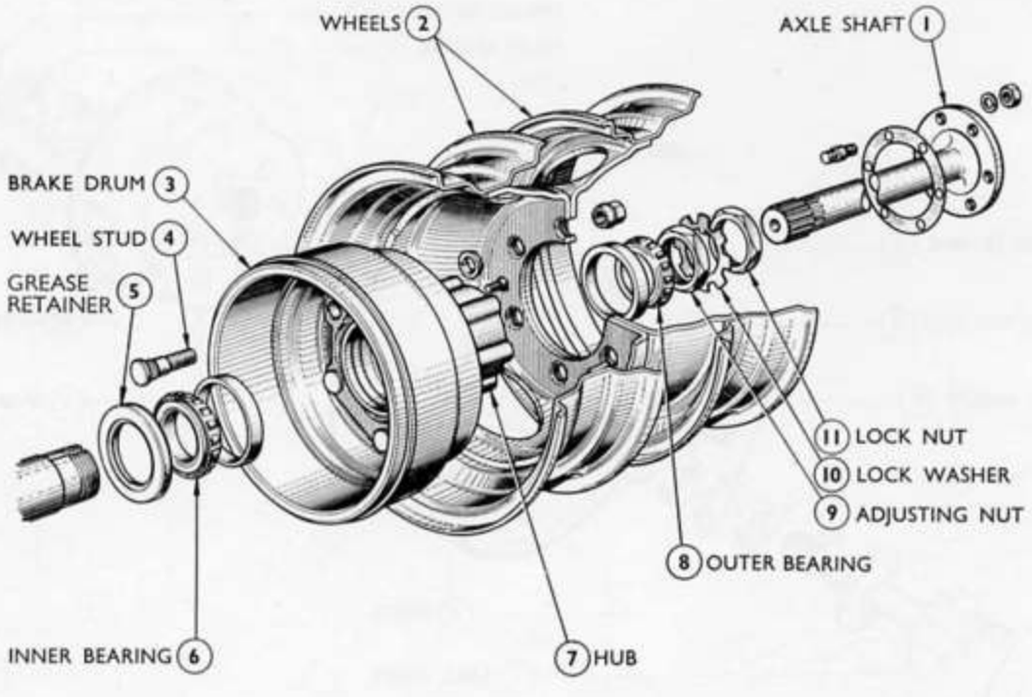


Fig. 8

Twin Rear Wheels and Hub (130—175)

17. Instal the inner cone and rollers and fit the hub seal. Work round the periphery of the seal using a soft drift, ensuring that the seal remains square with the bore of the hub.

NOTE.—New rear hub oil seals must be soaked in Hypoid 90 gear oil for 15 minutes prior to assembly. When fitting take care that the seal is not damaged by the axle housing thread.

18. (125 *only*) **Reassemble the hub assembly** to the brake drum.

19. Reposition the hub (hub and drum on 125 vehicles) on the axle. Fit the outer cone and rollers and the adjusting nut. Tighten the adjusting nut to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.) while rotating the hub. Back off the adjusting nut $\frac{1}{16}$ to $\frac{1}{3}$ of a turn to give end-float of 0.1 to 0.2 mm. (0.004 to 0.008 in.).

20. Engage the inside tab of the lockwasher with the axle case key-way and align one flat of the adjusting nut with the tab of the lockwasher.

21. Fit the locknut and tighten to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.) and check the end-float is 0.1 to 0.2 mm. (0.004 to 0.008 in.). Readjust if necessary and bend the lockwasher over one flat of the adjusting nut and one flat of the locknut.

22. Replace the axle shaft with a new gasket and tighten the nuts to a torque of 7 to 7.6 kg.m. (50 to 55 lb. ft.).

23. (130 *to* 175 *only*) **Replace the brake drum,** secure with the countersunk screw and replace the wheel locating cones on the wheel studs.

24. Readjust all the brakes.

25. Replace the wheel(**s**) and wheel nuts.

26. Remove the stands and lower the vehicle to the ground.

27. Tighten the wheel nuts to a torque of 16 to 18 kg.m. (115 to 130 lb. ft.).

Section 2

BRAKING SYSTEM

CONTENTS

SUBJECT

BRAKING SYSTEM

OVERHAUL PROCEDURES

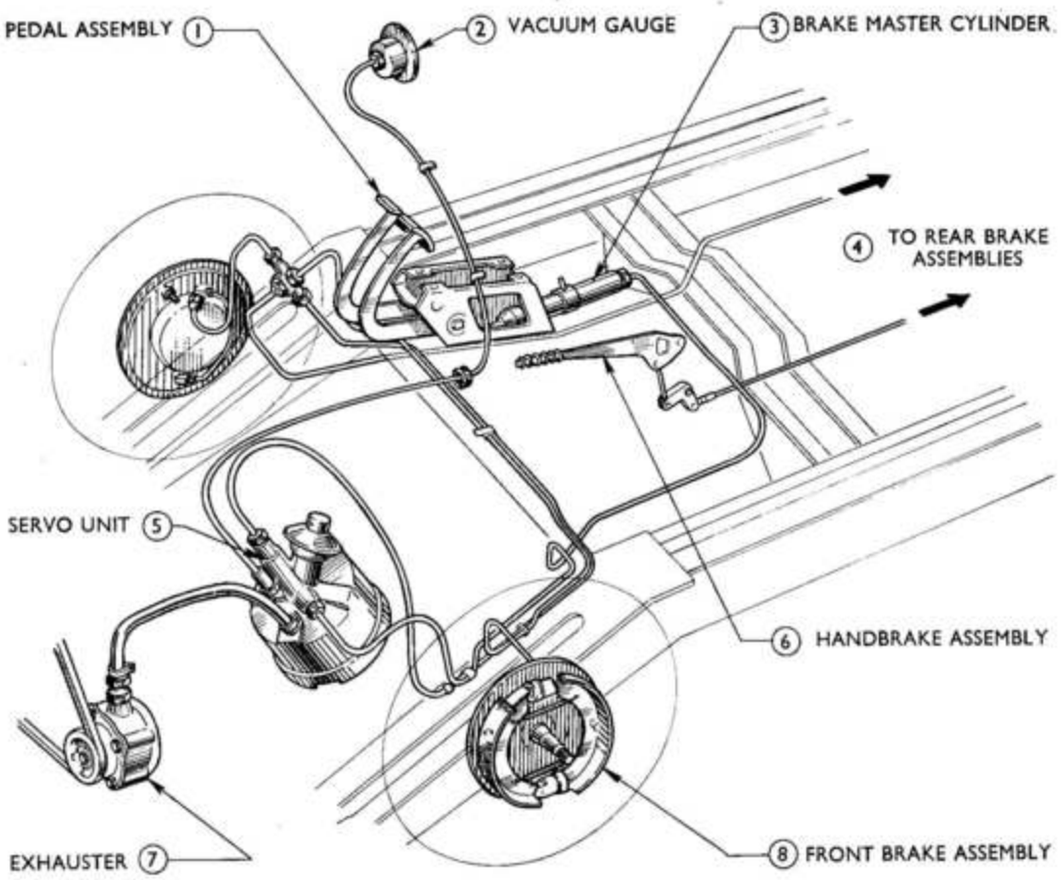


Fig. 1
Braking System—Diesel Engine Vehicle with Servo (Floor mounted pedals — Prior to December 1970)

ROUTINE MAINTENANCE

The braking system is hydraulically operated on all wheels with a vacuum assisted servo unit available as a Regular Production Option. The vacuum is taken off the inlet manifold on petrol engines or an exhauster where a diesel engine is fitted. Prior to December 1970, the master cylinder was mounted beneath the floor of the vehicle and was fed from a remote hydraulic fluid reservoir, located in the engine compartment adjacent to the battery.

From December 1970, a pendant brake pedal was fitted operating a master cylinder and integral reservoir mounted immediately in front of the driver, on the engine compartment side of the bulkhead. The optional servo unit (standard on Custom buses) is of the direct acting type, being located between the master cylinder and the bulkhead.

The handbrake, which operates on the rear wheels only, is mechanical. The stop light switch used on vehicles having floor mounted pedals is connected in the hydraulic circuit and is operated by hydraulic pressure.

On the later pendant pedal vehicles a pedal operated type of stop light switch is used.

A dual line braking system, operated by a tandem master cylinder, is fitted as standard equipment on all export model Transit vehicles.

8,000 Kms. (5,000 Miles)

The brakes must be adjusted at 8,000 kms. (5,000 miles) and the fluid level checked in the fluid reservoir.

Where a vehicle is used on stop/start journeys the brakes may require adjustment at more frequent intervals. Always adjust the brakes if the brake pedal movement becomes excessive.

24,000 Kms. (15,000 Miles)

Remove the brake drums and check the condition of the brake linings. If worn to a minimum thickness of 1.0 mm. (0.04 in.) they must be renewed. At the same time check the wheel cylinders and hydraulic pipes for leaks and replace any defective part.

Check that a clearance of 25.4 mm. (1.00 in.) exists between the front brake hoses and the road wheels when on full lock. Adjust as necessary.

80,000 Kms. (50,000 Miles) or 2 years

Every 80,000 kms. (50,000 miles) or 2 years the braking system should be overhauled and all seals and gaskets replaced. Examine all hoses and connections and replace as necessary. The hydraulic system should be drained and refilled with FoMoCo brake fluid.

Hydraulic seals and dust boots should be lubricated with red rubber grease or clean FoMoCo brake fluid.

BLEEDING THE HYDRAULIC SYSTEM

Preliminary

Before bleeding the hydraulic system the following points should be observed.

1. **Examine the fluid reservoir cap** and ensure that the cap is clean and no dirt can enter the reservoir when the cap is removed.

2. **Check the fluid level** in the reservoir. The fluid level in the remote reservoir should be 5 mm. (0.19 in.) above the mounting strap. The fluid level is clearly marked on the integral reservoirs. If necessary, top up with approved hydraulic brake fluid.

If it is suspected that an incorrect brake fluid has been used, drain the system thoroughly and flush with methylated spirits or commercial alcohol. Do not use petrol. Renew all rubber seals on all wheel cylinders, master cylinder and servo unit slave cylinder

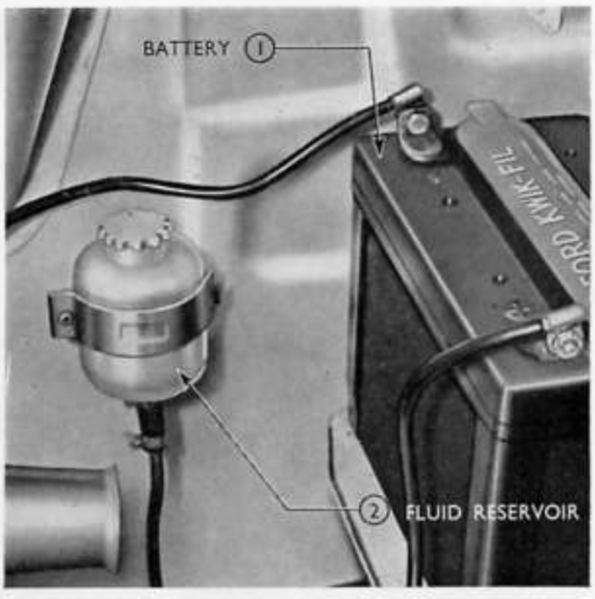


Fig. 3
Fluid Reservoir Location
(Floor mounted pedals)

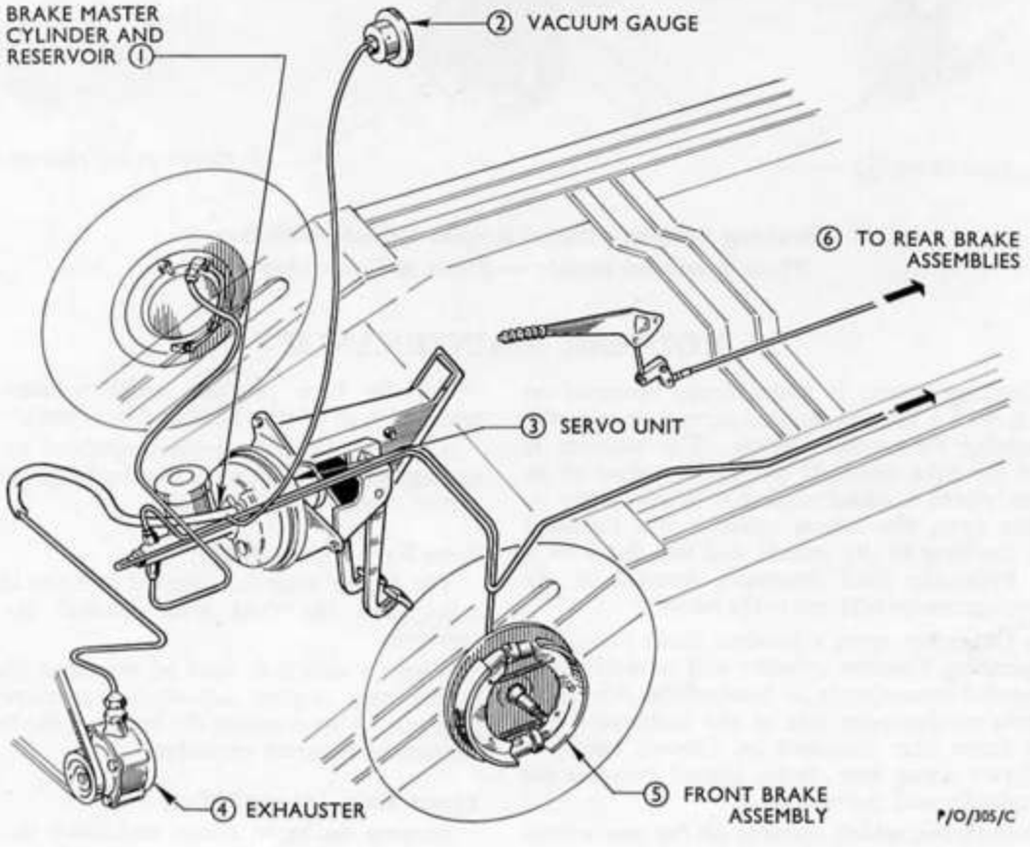


Fig. 2
Single Line Braking System—Diesel Engine Vehicle with Servo.
(Pendant pedals—After December 1970)

Fig 4
Fluid Reservoir Location
(Pendant Pedal Vehicles)

(where fitted). Also, renew all flexible rubber hoses in contaminated systems. Refill the system with new fluid and bleed the brake system.

NOTE.—Use only Ford crimson brake fluid (Part No. ME–3833–E).

3. Check the unions and connections for tightness and freedom from leaks. Also check the condition of the flexible rubber hoses.

4. Check the rubber boots for signs of fluid leakage. If fluid is present on the outside of the cylinders, dismantle and check the rubber seals, replacing them if the sealing lips are damaged.

NOTE.—Slight wetness around the boot lip may be a residue of the boot lubricant and should not be confused with fluid leakage.

Bleeding the System

1. Clean the area round the bleed valve on the wheel cylinders and then slacken brake adjusters. Exhaust all the vacuum from the system by depressing the brake pedal several times (where servo unit is fitted). Use a 4 BA spanner on the rear brake bleed-screws.

NOTE.—On the rear brakes of the Transit 125 model the bleed valve is made more accessible by locating it as shown in Figure 6.

2. Commence to bleed at the bleed valve on the brake assembly having the longest pipe run. Remove the rubber dust cap on the bleed valve and fit a rubber tube on the valve. (A set of bleed tubes is available

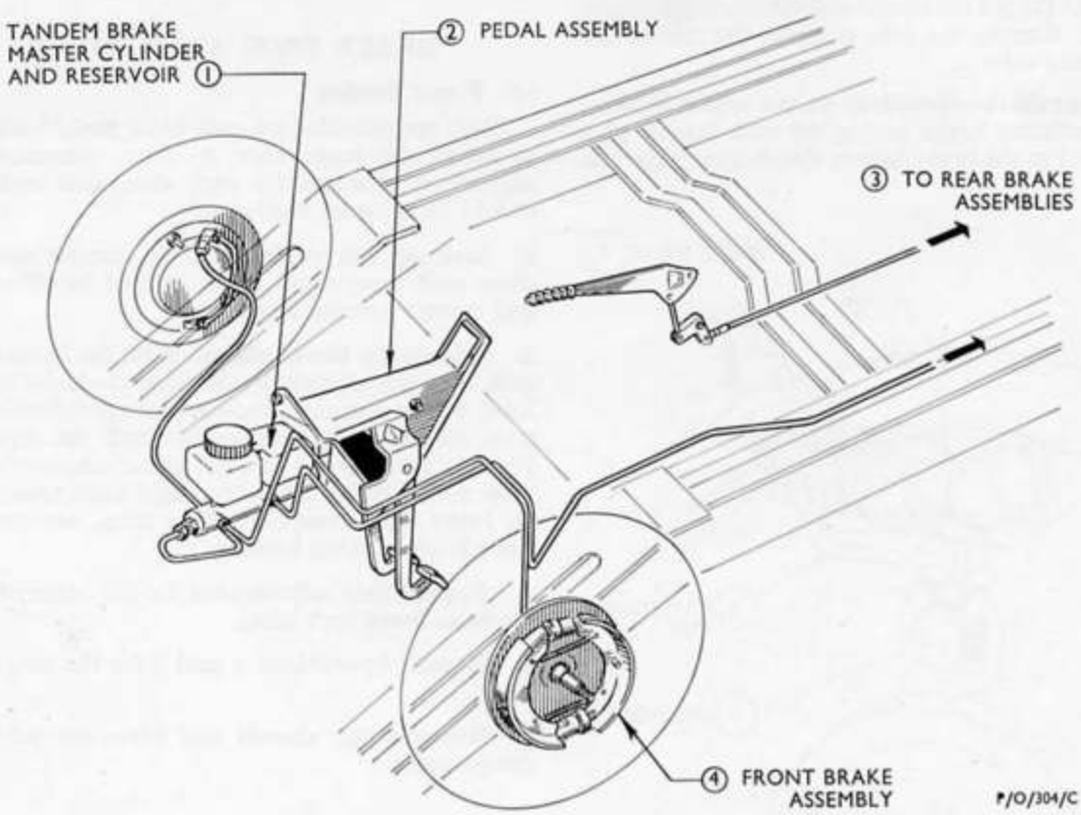


Fig. 5
Dual Line Braking System—Petrol Engine Vehicle
(Pendant pedals—After December 1970)

under Tool No. P.2006.) A 4.76 mm. (0.19 in.) I.D. tube will be required for the rear brake assemblies.

3. Place the end of the bleed tube in a clean jar containing some brake fluid. Keep the end of the tube under the surface of the fluid during the brake bleeding operation.

4. Open the bleed valve and depress the brake pedal several times. Pause for an instant between each depression of the pedal to ensure full recuperation of the master cylinder.

If the master cylinder is sticking, overhaul the master cylinder (see page 15). For each depression of the brake pedal some fluid or air should be emitted from the tube, if neither fluid nor air emerges, the bleed valve has not been opened properly or there is a blockage in the pipe line.

5. Continue depressing the brake pedal, until no more air bubbles emerge from the tube.

NOTE.—It is important that the fluid level in the reservoir is maintained during the brake bleeding operation. Do not replenish the reservoir with fluid drained from the system as it may be contaminated or aerated. If the fluid in the system is dirty it is advisable to drain it completely and refill with fresh fluid.

6. Close the bleed valve. When, with each depression of the brake pedal, fluid alone comes out of the bleed tube, close the valve with the master cylinder fully applied, i.e., with the pedal fully depressed. Do not use excessive force when tightening the valve. Remove the tube and refit the rubber cap on the bleed valve.

7. Repeat these operations on the other brakes, starting with the brake having the next longest pipe line. Bleed at the brake having the shortest pipe line last.

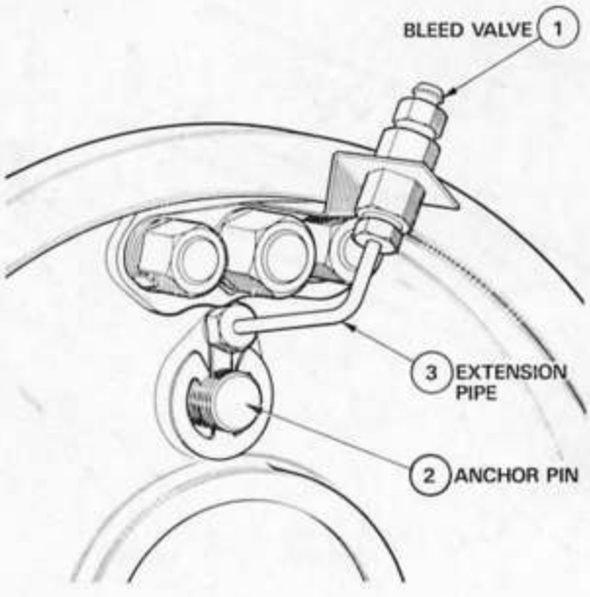


Fig 6
Rear Brake Remote Bleed Pipe (Transit 125 Only)

Fig. 7
Adjusting the Front Brakes

8. Refill the reservoir to the correct level (5 mm. (0.19 in.) above the mounting strap on remote reservoir) and replace the reservoir cap.

BRAKE SHOE ADJUSTMENT

(*a*) Front Brakes

Cams are provided on each front brake back plate to adjust the brake shoe to drum clearance. An adjuster is provided for each shoe, and each shoe should be adjusted individually.

1. Jack up the vehicle and fit suitable stands to allow each front wheel to be checked for "free run" and correct bearing adjustment.

2. Adjust the brake shoes. With the brake drums cold, turn the adjuster for one shoe clockwise for left-hand wheels and anti-clockwise for right-hand wheels until the shoe is in firm contact with the drum (see Fig. 7). Back off the adjuster anti-clockwise for left-hand wheels and clockwise for right-hand wheels until the brake shoe is just clear of the drum, and the drum turns freely without binding.

3. Repeat this adjustment for the other shoe on the same brake back plate.

4. Repeat operations 2 and 3 for the other front wheel.

5. Remove the stands and lower the vehicle to the ground.

(*b*) Rear Brakes

75 — 115

The adjuster, when expanded, adjusts both shoes simultaneously.

Fig. 8
Adjusting Rear Brakes 75 — 115

1. Chock the front wheels, jack up the vehicle and fit suitable stands. Release the handbrake.

2. Adjust the brake shoes. With the brake drums cold, turn the adjuster clockwise until the shoes are in firm contact with the drum. Back off the adjuster anti-clockwise until the brake shoes are just clear of the drum, and the drum turns freely without binding.

3. Repeat this operation for the other rear wheel.

4. Remove the stands and lower the vehicle to the ground.

125 — 175

The adjuster unit is located beneath the rear axle inside the backplate. The adjuster, when expanded, adjusts both shoes simultaneously.

1. Chock the front wheels, jack up the vehicle and fit suitable stands. Remove the blanking plug from the backplate, and release the handbrake.

2. Rotate the adjuster by inserting a screwdriver or adjusting tool through the slot in the backplate and locating in the toothed wheel (Fig. 9).

3. Adjust the brake shoes. With the brake drums cold, rotate the adjuster until the shoes are in firm contact with the drum. Back off the adjuster until the brake shoes are just clear of the drum, and the drum turns freely without binding. Refit plug.

4. Repeat operations 2 and 3 for the other rear wheel.

5. Remove the stands and lower vehicle to the ground. Remove the chocks.

HANDBRAKE ADJUSTMENT PROCEDURE

1. Fully release the parking brake lever and jack up rear of vehicle. Fit stands.

2. Tighten the brake shoes until they bear hard against the drum.

3. Slacken the locknut on the adjusting rod (located adjacent to No. 3 crossmember) and tighten the adjusting nut until the play is eliminated from the parking brake cable. Tighten the locknut.

4. Back off the rear brake adjustment until the wheel and drum are just free to rotate without any binding. Replace the rubber plug (125 to 175).

5. Check that both rear brake assemblies are locked after the handbrake lever has been applied five to seven clicks.

6. Remove stands and lower vehicle to the ground.

FITTING NEW BRAKE SHOES

It is important that the same grade of brake lining is used for each shoe on any one axle assembly and that the shoes are fitted in the same position as prior to removal, otherwise unequal braking may result.

(*a*) **Front Brakes**

1. Remove the brake drum. Apply the handbrake, slacken the wheel nuts, jack up the vehicle and fit suitable stands. Remove the wheel nuts and the wheel.

Fully slacken the brake adjusters, remove the dust cap with a suitable lever, and remove the split pin, retainer and nut. Withdraw the thrust washer, outer bearing cone and hub and drum assembly.

Fig. 9
Adjusting Rear Brakes 125 — 175

2. Remove the brake shoes. Remove the shoe hold down springs and wheel cylinder to shoe clips, and lever the trailing end of one shoe away from its abutment slot in the wheel cylinder. Gradually release the brake shoe so that the retracting springs can be detached and the brake shoes removed.

3. Replace brake shoes. Fit the retracting springs to the brake shoes and slide the leading edge of each shoe into its locating slot in its wheel cylinder piston and replace clip. Carefully lever the trailing edge of each shoe into its abutment at the rear of the wheel cylinder. Replace brake shoe hold down springs.

4. Refit the hub and drum assembly. Clean out the old grease from the hub. Thoroughly clean the bearings, inspecting the rollers for damage; if they are serviceable pack them well with wheel bearing grease. Refit the bearings to the hub and install the inner grease retainer.

Fit the hub and bearing assembly to the axle. Replace the thrust washer and tighten the adjusting nut to a torque of 2.4 to 3.5 kg.m. (17 to 25 lb. ft.) whilst rotating the drum. Back off the nut one or two flats to align a split pin hole in the retainer. The correct end-float should then be 0.5 to 1.6 mm. (0.002 to 0.0065 in.). Fit a new split pin to lock the retainer and refit the dust cap. Replace the wheels and tighten the wheel nuts to a torque of 7.6 to 9.7 kg.m. (55 to 70 lb. ft.).

5. Adjust the brakes as detailed on page 5.

(*b*) **Rear Brakes**

75 — 115

1. Remove the brake drum. Chock the front wheels and partially slacken the rear wheel nuts and fully slacken the adjusters. Jack up the rear axle and remove the wheel nuts and wheels. Knock off the brake drum and the three wheel stud clips, using a rubber or copper-faced mallet.

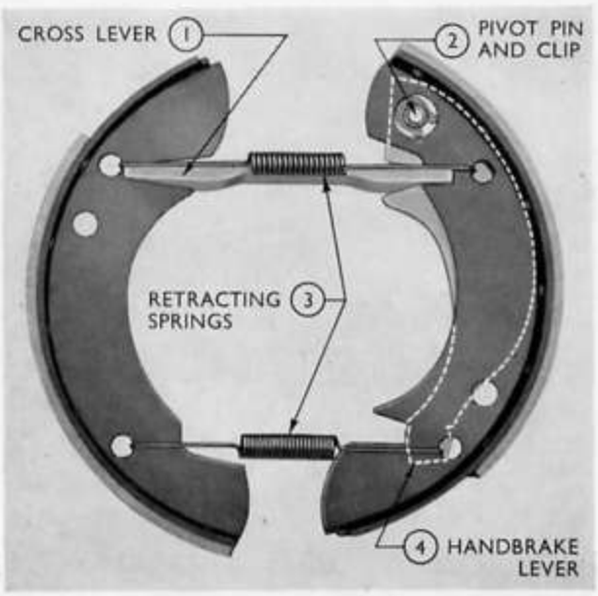


Fig. 10
Rear Brake Shoe Assembly

2. Remove the brake shoes. Remove the brake shoe hold down springs and lever the shoe away from its abutment slot. Remove the handbrake lever pivot pin and the retaining clip and washers and disengage the handbrake cable and remove the levers. Gradually release the brake shoe so that the retracting spring can be detached and the brake shoes removed.

3. Replace the brake shoes. Refit the handbrake lever, pivot pin and retaining clip and washers. Fit the spring washer between the lever and the shoe. Hook the handbrake cable into its location on the lever and fit the upper (black) retracting spring across the shoes. Locate the shoes on the backplate and lever one shoe clear enough to fit the cross-lever. Replace the lower (red) retracting spring and the hold down springs.

4. Refit the brake drum and the three clips. Replace the wheels and tighten the wheel nuts to a torque of 7.6 to 9.7 kg.m. (55 to 70 lb. ft.).

5. Adjust the brake shoes as detailed on page 6.

6. Adjust the handbrake linkage if necessary.

7. Remove chassis stands and lower vehicle to the ground.

125 — 175

1. Remove the brake drum, slacken the wheel nuts, jack up the vehicle and fit stands under the axle. Remove the wheel nuts and the wheels.

NOTE.—The hub nuts are right-hand threaded for the right-hand wheels and left-hand threaded for the left-hand wheels.

Release the handbrake and slacken the brake adjusters.

2. (*a*) (130 — 175 only)

Remove the countersunk screw retaining the brake drum, remove the locating cones from the wheel studs and pull the drum off.

(*b*) (*125 only*)

Remove the axle shaft nuts, the axle shaft and the gasket. Bend up the tabs of the lockwasher and unscrew the bearing locknut, using Tool No. C.4109. Remove the tab washer, the bearing adjusting nut and the outer cone and rollers. Withdraw the hub and drum assembly and wipe out any surplus grease to avoid contaminating the brake drum.

3. Remove the brake shoes. Remove the brake shoe hold down springs and lever the shoe away from its abutment slot. Remove the handbrake lever pivot pin and its retaining clip and washers and disengage the handbrake cable and remove the levers. Release the brake shoes and retracting springs and adjuster.

4. Replace the brake shoes and retracting springs.

NOTE.—That this assembly has a primary and secondary shoe. Care must be taken to ensure that the

shoes are fitted with the primary (thinner) shoe fitted to the front of the vehicle. Fit the lever with the spring washer between the lever and the shoe. Refit the clip and plain washer. Hook the handbrake cable into the lever and fit the upper retracting spring. Locate the shoes onto the backplate and lever one shoe clear to fit the cross-lever and anti-rattle spring. Replace the adjuster unit and the lower retracting spring and the brake shoe hold-down springs.

5. (*a*) (130 — 175 *only*)

Refit the brake drum and cone spacers and replace the set-screw. Ensure that the drum is located correctly against the hub. Refit the wheels and tighten the wheel nuts to a torque of 15.9 to 17.9 kg.m. (115 to 130 lb. ft.).

(*b*) (125 *only*)

Refit the hub and drum assembly. Clean out the old grease from the hub. Thoroughly clean the bearings inspecting the rollers for damage; if they are serviceable pack them well with wheel bearing grease. Refit the bearings to the hub and the hub to the axle as fully detailed in the Wheels and Hub Section. Refit the wheels and tighten to a torque of 15.9 to 17.9 kg.m. (115 to 130 lb. ft.).

6. **Adjust the rear brakes** as detailed on page 7, and check bearing clearance.

7. **Adjust the handbrake linkage** as detailed on page 7 if necessary.

8. **Remove the stands** and lower the vehicle to the ground.

FRONT BRAKE ASSEMBLIES

Each front brake backplate assembly carries two wheel cylinders, one for each brake shoe. The hydraulic supply feeds the upper wheel cylinder, from there it is passed to the lower wheel cylinder by a bridge pipe at the rear of the back plate. A bleed valve is fitted to each lower wheel cylinder.

The leading edge of each brake shoe is mounted and clipped on the piston of its wheel cylinder, whilst the trailing edge abuts the rear of the opposing wheel cylinder. Each shoe is supported by holding down springs enabling it to be held parallel with the braking surface of the drum.

Hydraulic Components

All hydraulic brake parts should be washed in commercial alcohol, methylated spirits or approved brake fluid.

Do not use mineral oils, or cleaning fluid extracted from mineral oil, e.g. petrol, paraffin, carbon tetrachloride, etc., as they will cause the rubber seals to swell and become ineffective. The slightest trace of mineral oil can soon render the brakes inoperative.

Methylated spirits or commercial alcohol must always be used for flushing out the system, washing brake housings, components and any container that comes into contact with brake fluid.

Any foreign matter should be washed from the components with methylated spirit or commercial alcohol. If foreign matter finds its way into the system it may score the pistons or damage the seals and render the brakes either wholly, or partly inoperative.

See that the sealing lips are perfectly formed, concentric with the bore of the seal, free from knife edges, surface blemishes or marks. Any seal that is not perfect, no matter how minute the blemish may appear to be, should be rejected.

Seals should not be turned inside out when inspecting them, since this strains the surface skin and may eventually lead to failure in service.

All pistons and housings must be carefully inspected before assembly. Any imperfections or scores on a piston or cylinder bore may provide a track for fluid leaks under pressure and any damaged parts must be discarded. Parts must be stored and handled very carefully to reduce any possibility of accidental scoring.

Prior to assembly always immerse hydraulic components in clean approved brake fluid or Red Rubber Grease to facilitate fitting and provide initial lubrication for working surfaces. Always fit new seals, gaskets and diaphragms whenever any assembly is dismantled.

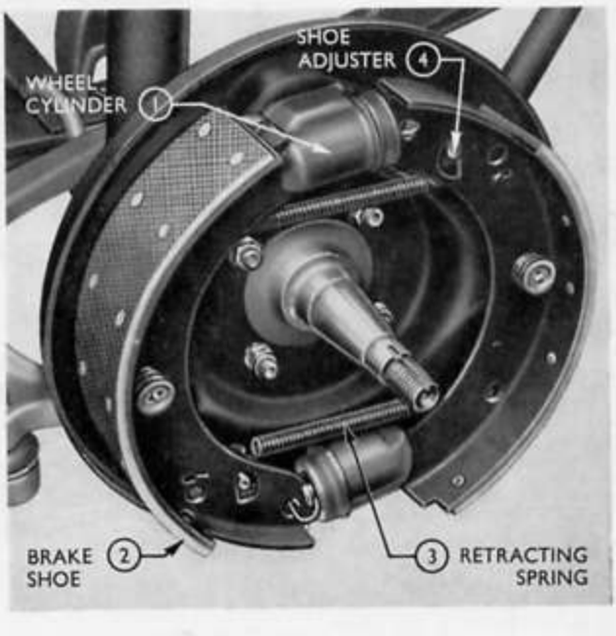


Fig. 11
Front Brake Assembly

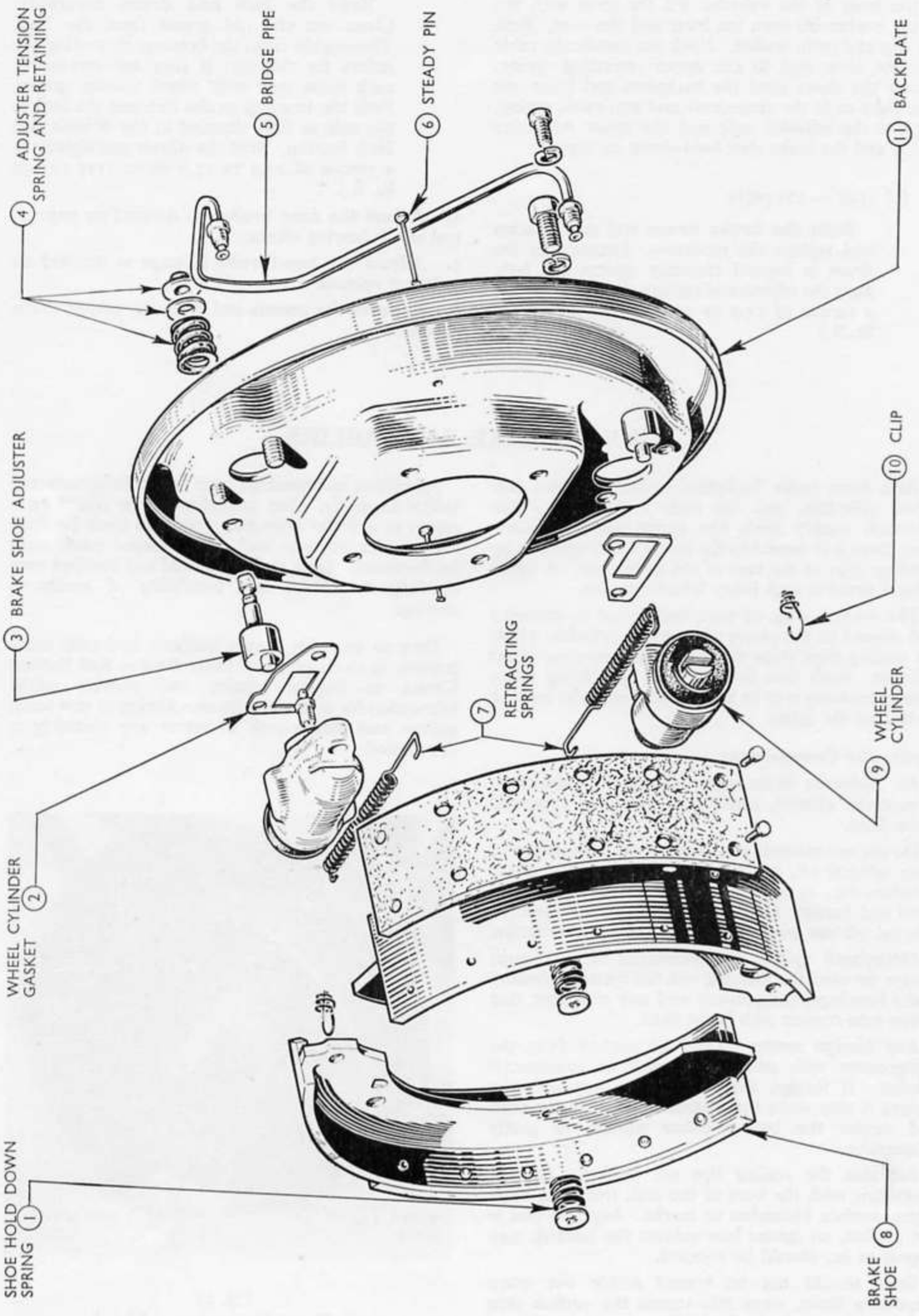


Fig. 12
Front Brake Assembly—Exploded

Pistons and piston seals should be carefully stored away from grease or oil and handled carefully at all times.

The seals should be inspected carefully before fitting, even if they have just been drawn from stock.

To Dismantle

1. **Remove the brake shoes** as described on page 7.

2. **Detach the wheel cylinders** from the brake backplate. Unscrew the hydraulic pipe from the upper wheel cylinder and the bridge pipe connecting the upper and lower wheel cylinders. To prevent loss of fluid fit a blanking plug to the end of the hydraulic pipe (Plugs Tool No. P.2012). Remove the retaining bolts and washers and withdraw the wheel cylinders and gaskets.

3. **Dismantle the wheel cylinder.** Remove the rubber boot and withdraw the piston and remove the seal. Unscrew the bleed valve if required.

To Reassemble

1. **Replace piston assembly.** Fit a new seal on the piston, ensuring that the lips face inwards when fitted.

Lubricate the bore and the piston with clean brake fluid, taking care not to damage the seal. Replace the piston in the wheel cylinder. Replace the wheel cylinder boot. Ensure that the piston is retained in the wheel cylinder.

2. **Refit the upper wheel cylinder.** Enter the wheel cylinder and gasket in its location on the backplate. Refit the retaining bolts and washers and tighten the 9.5 mm. ($\frac{3}{8}$ in.) bolt to a torque of 0.9 to 1.0 kg.m. (6.3 to 7.0 lb. ft.) and the 12.7 mm. ($\frac{1}{2}$ in.) bolt to 1.5 to 1.7 kg.m. (10.5 to 12.5 lb. ft.).

Ensure that the front brake hose is not twisted and is replaced with the wheels in the straight-ahead position. The minimum clearance is 25.4 mm. (1 in.) with the wheels on full lock.

3. **Install the other wheel cylinder** in a similar manner and connect the bridge pipe between the upper and lower cylinders. Replace the bleed valve into its location in the lower wheel cylinder.

4. **Refit the brake shoes** as described on page 8.

5. **Bleed brake system** as described on page 4.

6. **Adjust the brakes** with the cams as described on page 6.

REAR BRAKE ASSEMBLIES

Two types of assembly will be found in service: The Duo-Servo type and the Leading-Trailing Shoe type. Both types utilise a double-acting wheel cylinder, the Duo-Servo working in conjunction with a floating adjuster unit. The Leading-Trailing Shoe type has a fixed adjuster unit.

Leading-Trailing Shoe Type 75 — 115

To Dismantle

1. **Remove the brake shoes** as detailed on page 8.

2. **Remove and dismantle the wheel cylinder.** Remove the hydraulic fluid feed pipe and fit a blanking plug Tool No. P.2012. Remove the wheel cylinder retaining clip and withdraw the wheel cylinder and gasket. Remove the dust boots and pistons from the wheel cylinder. Inspect the seals and remove if unserviceable.

3. **Remove and dismantle the adjuster unit.** Unscrew the two retaining nuts and withdraw the adjuster unit. Remove the tappets and adjusting wedge.

4. **Carefully remove the axle shaft** and gaskets.

5. **Remove the hub nut.** Straighten the tab on the locking washer and using Tool No. C.4107, unscrew the hub nut. Remove the nut and washer.

6. **Withdraw the hub assembly,** using the slide hammer Tool No. CPT.3072 and adaptor Tool No. CP.3072-4A. Locate the adaptor on the wheel studs and secure with the wheel nuts. Screw the slide hammer into the centre of the adaptor and remove the hub assembly.

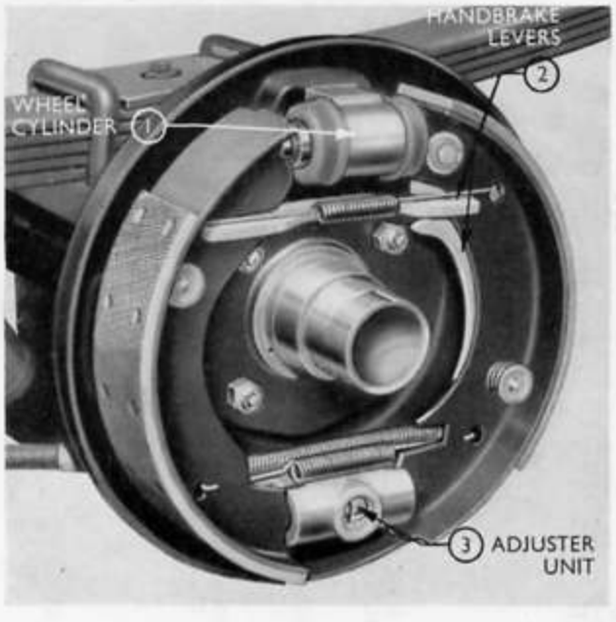


Fig. 13
Rear Brake Assembly 75 — 115

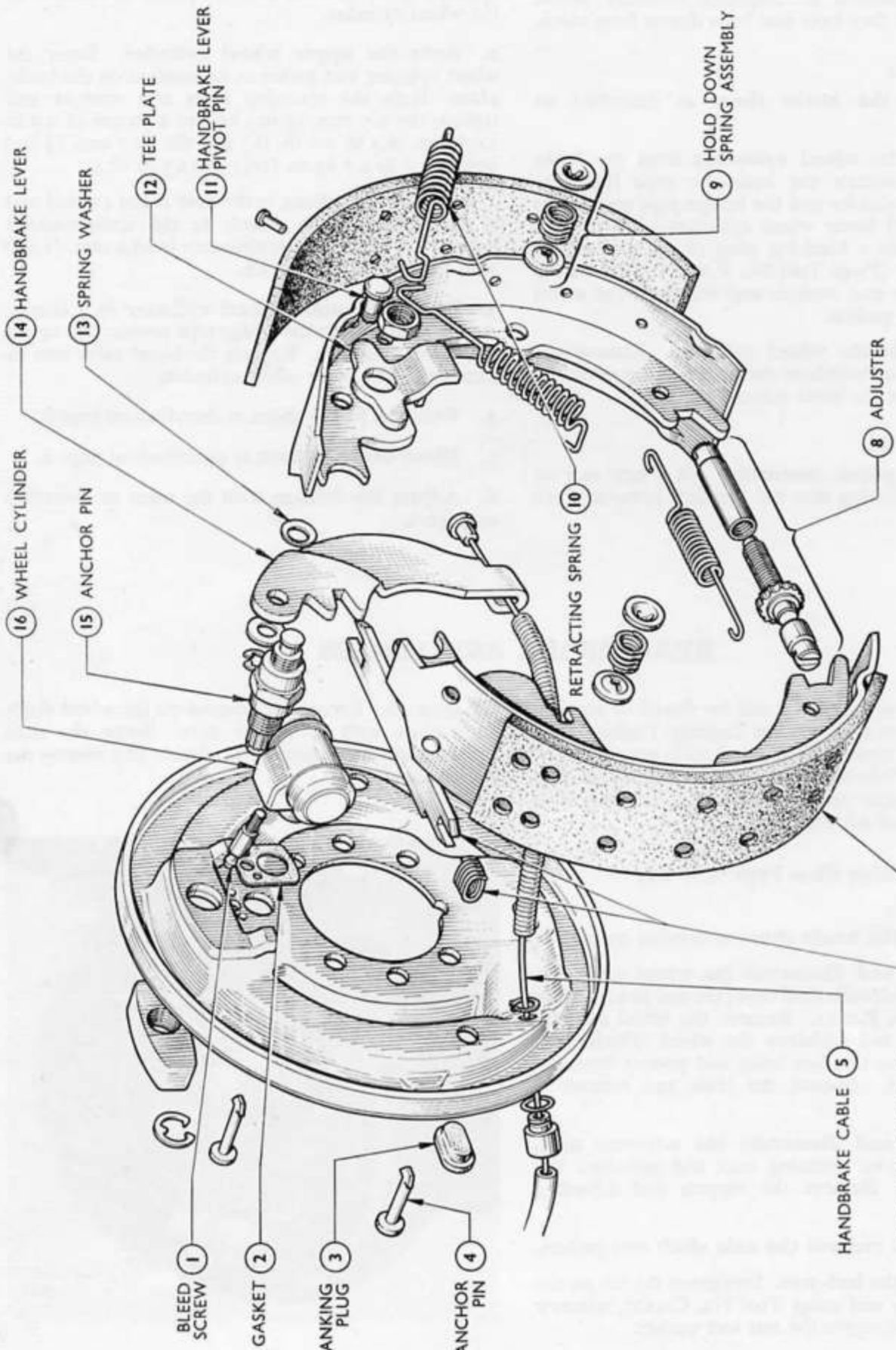


Fig. 14
Rear Brake Assembly—Exploded

7. **Remove the backplate.** Pull off the handbrake cable outer casing retaining clip and withdraw the cable. Unscrew the backplate retaining nuts and remove the backplate.

To Reassemble

1. **Refit the backplate.** A notch is cut in the backplate beneath the axle casing to identify the left-hand brake assembly. Locate the plate on the axle housing and refit the retaining nuts. Tighten to a torque of 4.2 to 4.8 kg.m. (30 to 35 lb. ft.). Insert the handbrake cable through the backplate, ensuring that sealing washer is located correctly, and refit a new retaining clip.

2. **Refit the hub assembly.** Drive the hub into position with the adaptor Tool No. CP.3072–4A until the inner race of the hub bearing contacts the shoulder on the axle housing. Spin the hub to ensure that it is free to rotate. Remove the adaptor.

3. **Fit a new locking washer** and hub nut to the axle housing with the tongue of the washer locating in the axle housing groove. Using Tool No. C.4107 tighten the nut to a torque of 18.0 to 19.4 kg.m. (130 to 140 lb. ft.). Bend tab over to lock the nut when the slot and tab are aligned, taking care not to damage the bearing seal, and refit the spacer if removed.

4. **Refit the axle shaft and gaskets.**

5. **Replace the adjuster unit.** Lubricate all working components with a high melting point grease and refit the wedge and tappets to the adjuster unit. Locate the assembly on the backplate and replace the retaining nuts and washers.

6. **Replace the wheel cylinder.** Lubricate all components with clean brake fluid. Refit the seals to the pistons and insert them into the wheel cylinder body. Replace the dust boots and locate the unit and gasket on the backplate, and fit a new retaining clip. Connect the hydraulic feed pipe.

7. **Replace the brake shoes** as detailed on page 8.

8. **Bleed the braking system** as detailed on page 4.

9. **Adjust the brakes** as detailed on page 6.

The Duo-Servo Assembly 125 — 175

The double-acting wheel cylinder is located on the backplate above the axle with the adjuster beneath the axle. Access to the adjuster for brake shoe adjustment is obtained by removing the blanking plug in the backplate. The handbrake cable which passes through the backplate actuates a lever assembly which expands the brake shoes into the drum.

To Remove

1. **Remove the brake shoes** as detailed on page 8.

2. **Remove and dismantle the wheel cylinder.** Disconnect the hydraulic fluid feed pipe and fit a blanking plug. Remove the tee plate from the anchor pin; unhook the wheel cylinder retaining clip and withdraw the wheel cylinder. Remove the dust boots and withdraw the piston assemblies. Inspect the seals and renew them if unserviceable.

3. **Dismantle the adjuster** if necessary.

4. **Remove the hub assembly,** as detailed on page 8.

NOTE.—On 125 models the hub assembly will have already been removed as a unit with the brake drum.

5. **Remove the backplate.** Pull off the handbrake cable outer casing retaining clip and withdraw the cable. Unscrew the backplate retaining nuts and remove the backplate.

To Reassemble

1. **Refit the backplate assembly.** A notch is cut in the backplate beneath the axle casing to identify the left-hand brake assembly. Locate the backplate and replace the four retaining nuts. Tighten the nuts to a torque of 4.2 to 4.8 kg.m. (30 to 35 lb. ft.). Insert the handbrake cable, ensuring that the sealing washer is fitted and replace the outer casing retaining clip.

2. **Fit the hub and bearing assembly.** Check the fit of the bearing cones, which should be a push fit, but without perceptible clearance. Do not clean up the case if the bearing has seized and rotated on it. Clean the bearings and the grease retainer and check for any signs of wear or damage, renew parts as necessary. When new bearings are being fitted work a little grease into the rollers and cages to provide initial lubrication. Do not pack any grease into the hubs as this will contaminate the axle oil. Install the inner cone and rollers and fit the hub seal. Work round the periphery of the seal using a soft drift, ensuring that the seal remains square with the bore of the hub.

NOTE.—New rear hub oil seals must be soaked in Hypoid 90 gear oil for 15 minutes prior to assembly. When fitting take care that the seal is not damaged by the axle housing thread.

(125 *only*)

Reassemble the hub assembly to the brake drum.

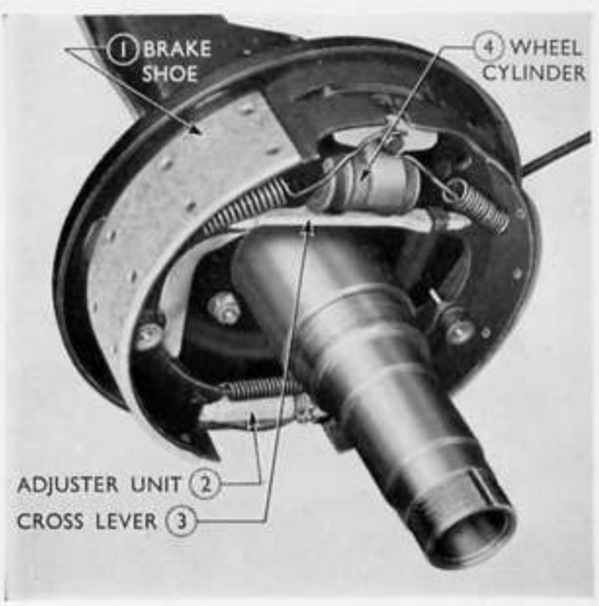


Fig. 15
Rear Brake Assembly (130 — 175 shown)

3. Adjust the hub bearings. Reposition the hub, (hub and drum on 125 vehicles) on the axle. Fit the outer cone and rollers and the adjusting nut. Tighten the adjusting nut to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.) while rotating the hub. Back off the adjusting nut $\frac{1}{16}$ to $\frac{1}{8}$ of a turn to give end-float of 0.1 to 0.2 mm. (0.004 to 0.008 in.). Engage the inside tab of the lockwasher with the axle case key-way and align one flat of the adjusting nut with the tab of the lockwasher. Fit the locknut and tighten to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.) and check the end-float is 0.1 to 0.2 mm. (0.004 to 0.008 in.). Readjust if necessary and bend the lockwasher over one flat of the adjusting nut and one flat of the locknut.

4. Replace the axle shaft with a new gasket and tighten the nuts to a torque of 7 to 7.6 kg.m. (50 to 55 lb. ft.).

(130 — 175 *only*)

Replace the brake drum, secure with the countersunk screw and replace the wheel locating cones on the wheel studs.

5. Assemble the adjuster unit if previously dismantled.

6. Refit the wheel cylinder. Lubricate all working surfaces with clean hydraulic brake fluid and refit the seals to the pistons. Insert the pistons in the wheel cylinder and replace the dust boots. Locate the wheel cylinder and gasket in the backplate and fit the retaining clip. Replace the tee plate in the anchor pin.

7. Replace the brake shoes as detailed on page 8.

8. Bleed the braking system as detailed on page 4.

9. Adjust the brakes as detailed on page 7.

BRAKE MASTER CYLINDER

(Floor mounted pedals — Prior to December 1970)

The master cylinder is bolted to the pedal bracket beneath the cab floor and is fed from a remote reservoir. The reservoir is located adjacent to the battery in the engine compartment.

The master cylinder is push rod actuated by a pedal which passes through the floor of the cab. The pedal moves in a natural arc when the brakes are applied.

To Remove

1. Disconnect the reservoir supply and take-off pipes and fit a blanking plug.

2. Detach the master cylinder assembly. Compress the brake pedal return spring and remove the outer retainer. Remove the split pin and withdraw the clevis pin from the master cylinder push rod. Remove the two master cylinder retaining nuts, washers and bolts and withdraw the master cylinder from the foot pedal assembly, and remove the spring and inner retainer.

To Replace

1. Locate the master cylinder with the fluid inlet port uppermost and fit the two retaining bolts, washers and nuts. Refit the retainers and spring and the clevis pin and check the pedal free play. Adjust the push rod length to obtain 0.76 mm. (0.030 in.) free play between the push rod and the master cylinder piston. Refit the clevis split pin.

2. Refit the master cylinder supply pipe and take-off pipe and bleed the system.

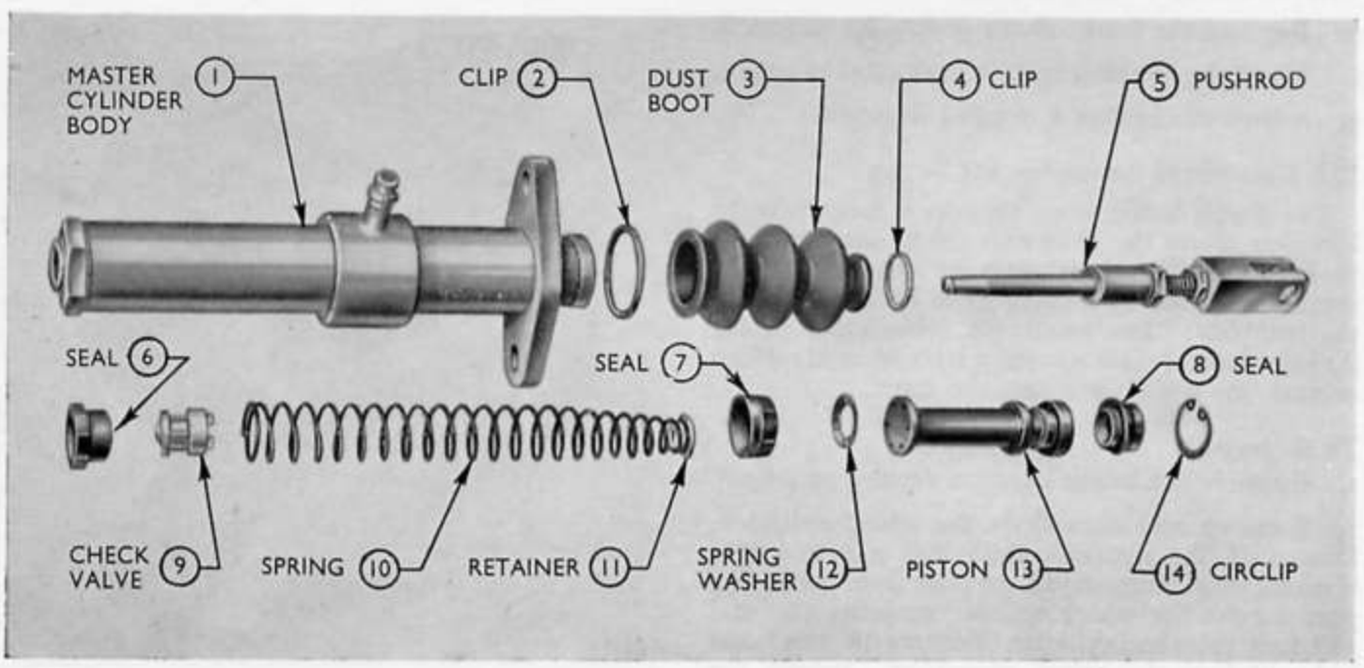


Fig. 16
Brake Master Cylinder (Prior to December 1970)

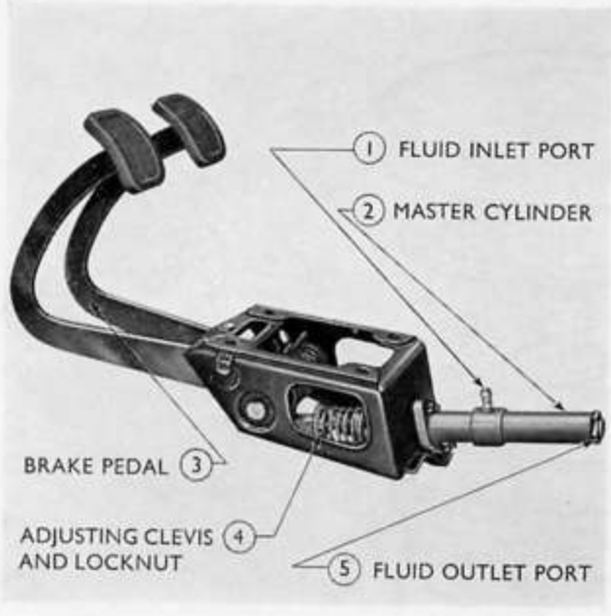


Fig. 17
Pedal Assembly
(Floor mounted pedals)

To Dismantle

1. **Remove the dust boot retaining clips** and withdraw the push rod and the dust boot.

2. **Remove the piston assembly.** Remove the circlip, withdraw the piston assembly, spring washer, cup seal, spring retainer and spring, and remove the piston seal.

3. **Remove the trap valve** by blowing through the outlet port and remove the seal.

Examine the bore of the master cylinder for scratches. If there is any doubt about the condition of the bore, a new cylinder assembly should be fitted. New seals should be fitted whenever the master cylinder is dismantled.

To Assemble

1. **Lubricate the cylinder bore** with Red Rubber Grease. Replace the trap valve seal, fit the valve, ensuring it seats correctly, and insert the spring wider end first.

2. **Lubricate and fit a new seal** to the piston. Insert the spring, retainer and cup seal, locate the spring washer and insert the piston assembly. Depress the piston and fit the circlip.

3. **Insert the push rod** and refit the dust boot with the vent hole downwards and retaining clips.

BRAKE MASTER CYLINDER
(Pendant Pedals — After December 1970)

The master cylinder, which has an integral fluid reservoir, is located on the engine side of the bulkhead immediately in front of the driver. Where a brake servo unit is fitted, it is mounted directly between the master cylinder and the bulkhead (see Figures 4 and 18).

The master cylinder is push rod actuated by a pedal which is pivoted from a steel support bracket located between the bulkhead and the lower edge of the dashboard.

To Remove

1. **Open the bonnet** and fit wing covers.

2. **Remove the three brake pipes** from their unions on the master cylinder and fit blanking plugs, P.2012, to the open ends of the pipes and cylinder unions.

3. (*a*) (*Without Servo*)

From inside the vehicle remove the spring clip and the clevis pin from the brake pedal, remove the two bolts holding the master cylinder to the bulkhead, and withdraw it from the vehicle.

(*b*) (*With Servo*)

Remove the two nuts securing the master cylinder to the servo and detach the cylinder.

To Replace

(*a*) (*Without Servo*)

Replace the master cylinder on the bulkhead and secure with two bolts. From inside the vehicle replace the clevis pin and spring clip to the brake pedal.

(*b*) (*With Servo*)

Replace the master cylinder on the servo unit and secure with the two nuts.

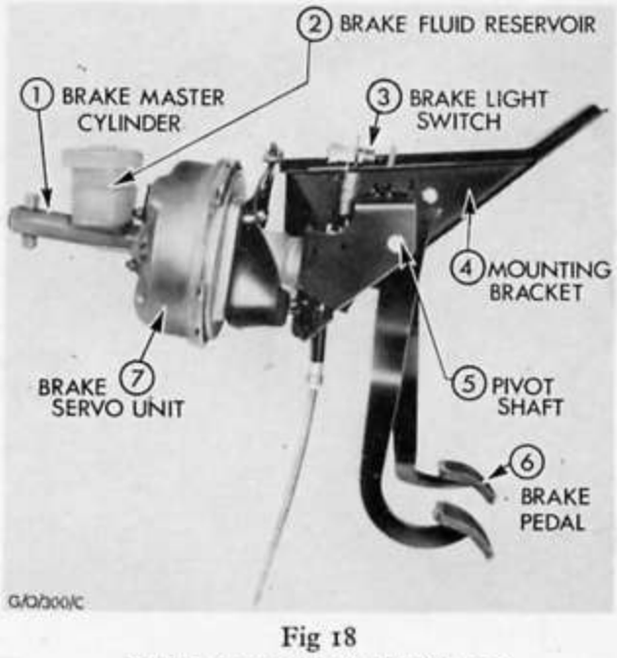


Fig 18
Pedal Assembly (with Servo)
(Pendant pedals)

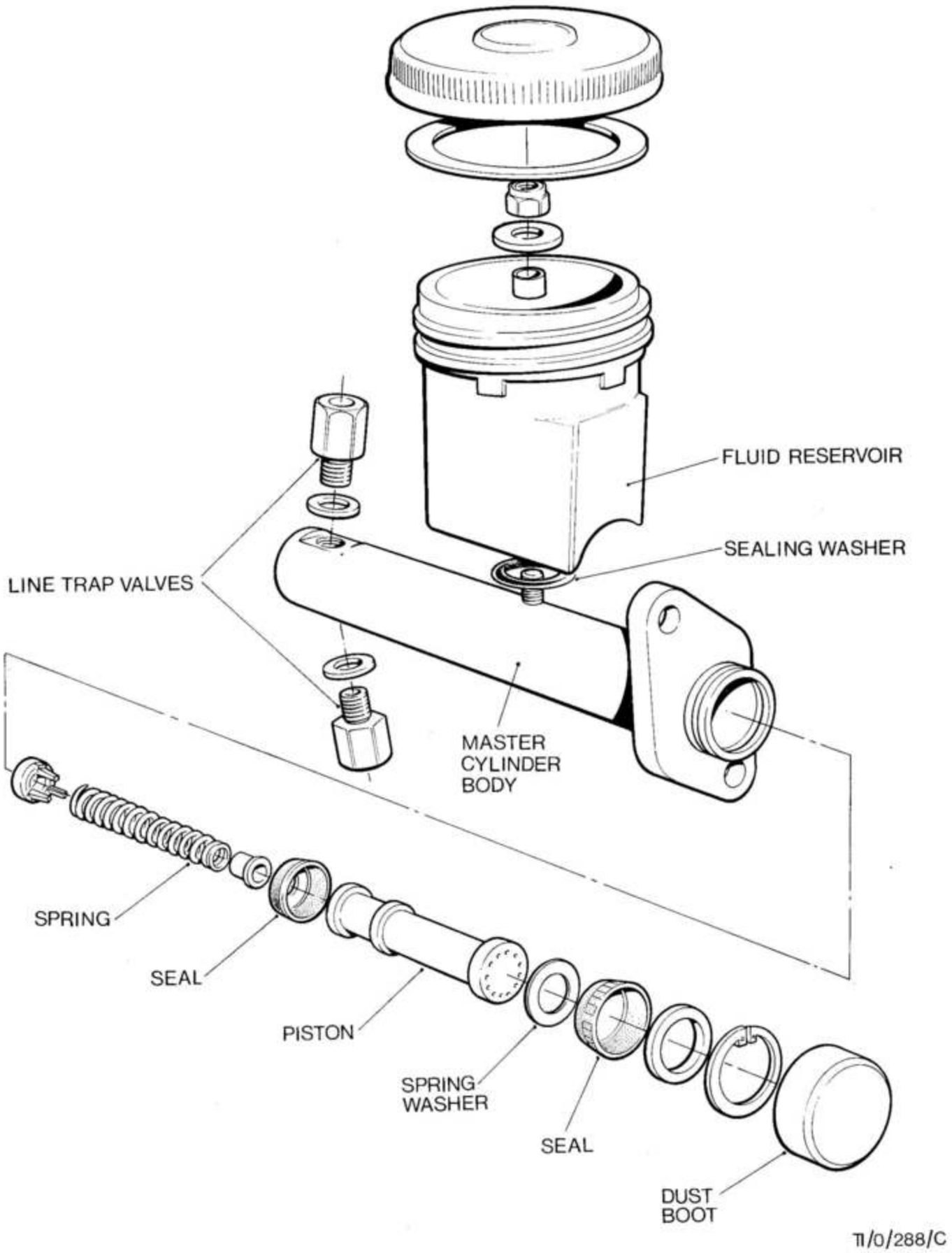


Fig. 19
Single Line Brake Master Cylinder (After December 1970)

2. **Remove the blanking plugs** and refit the brake pipes to the master cylinder.

3. **Bleed the braking system** as detailed earlier.

4. **Remove the wing covers** and close the bonnet.

To Dismantle

1. **Drain the fluid** from the reservoir and remove the retaining nut, spacer and washer holding it to the master cylinder body. Detach the reservoir from the master cylinder body.

2. **Remove the two pipe unions** from the front of master cylinder body.

3. **Remove the rubber boot** from the flanged end of the master cylinder body.

4. **Remove the circlip now exposed** and withdraw the plunger, spring and seals from within the master cylinder.

5. **Replace all seals,** lubricating with brake fluid before and after assembly.

6. **Ensure that the inside of the master cylinder** is scrupulously clean and free from scoring, burrs, etc.

To Reassemble

1. **Replace the plunger,** spring and seal assembly in the master cylinder body and secure with the circlip. Refit the rubber boot.

2. **Refit the pipe unions** to the master cylinder body.

3. **On the base of the reservoir** on its master cylinder jointing face there is an oval shaped rubber seal. Check that this seal is in good condition. If any doubt exists the seal must be replaced.

4. **Replace the reservoir** on the body ensuring that the fluid duct in the base faces to the front of the cylinder. Secure with the nut, spacer and spring washer.

BRAKE PEDAL

(After December 1970)

To Remove

1. **Open the bonnet,** fit wing covers and disconnect the battery.

2. **From inside the vehicle** remove the spring clip and clevis pin connecting the brake pedal to the master cylinder.

3. **Remove the circlip** from the pedal pivot shaft.

4. **Remove the brake pedal return spring** from its location on the pedal and leave attached to the pedal support bracket.

5. **Remove the two bolts** securing the steering column to the underside of the dash panel.

6. **From inside the engine compartment** remove six 13 mm. nuts retaining the pedal shaft mounting bracket to the engine bulkhead.

NOTE.—Three of these nuts retain the servo unit.

7. **Carefully pull the servo unit** off its mounting studs to give access to the remaining two pedal shaft mounting bracket bolts.

NOTE.—Extreme care should be taken when removing the servo unit to avoid damage to the brake fluid lines. Remove the remaining two bolts.

8. **From inside the vehicle** pull the pedal shaft mounting away from the body with the pedals attached.

9. **Remove the air flow ventilation hose** from its location on the heater box and push to one side.

10. **Position the pedal shaft support bracket** so that the pedal pivot shaft is in line with the aperture in the heater box uncovered by the removal of the ventilation hose.

NOTE.—In order to obtain the required position of the bracket relative to the heater box aperture it may be necessary to pull the steering column slightly downwards from its dash panel location.

11. **Push the pedal shaft** from its location in the support bracket towards and, if necessary, into the heater box aperture until the brake pedal can be removed. If spring removal is required the spring should be removed from its bracket mounting at this stage and a new one fitted.

To Replace

1. **Reconnect the spring** to its pedal location.

NOTE.—The spring is connected at this stage as the accessibility is greater.

2. **Align the brake pedal** with the shaft and push the shaft through the pedal into its support bracket location.

3. **Position the bracket** to the body and secure with two bolts.

4. **Reposition the servo unit** and the master cylinder on the mounting bracket studs and secure the assembly with the six nuts.

5. **Refit the circlip** to the brake pedal pivot shaft.

6. **Refit the air ventilation hose** to its heater box location.

7. **Reconnect the brake pedal** to the master cylinder with the clevis pin and spring clip.

8. **Reconect the battery,** remove the wing covers and close the bonnet.

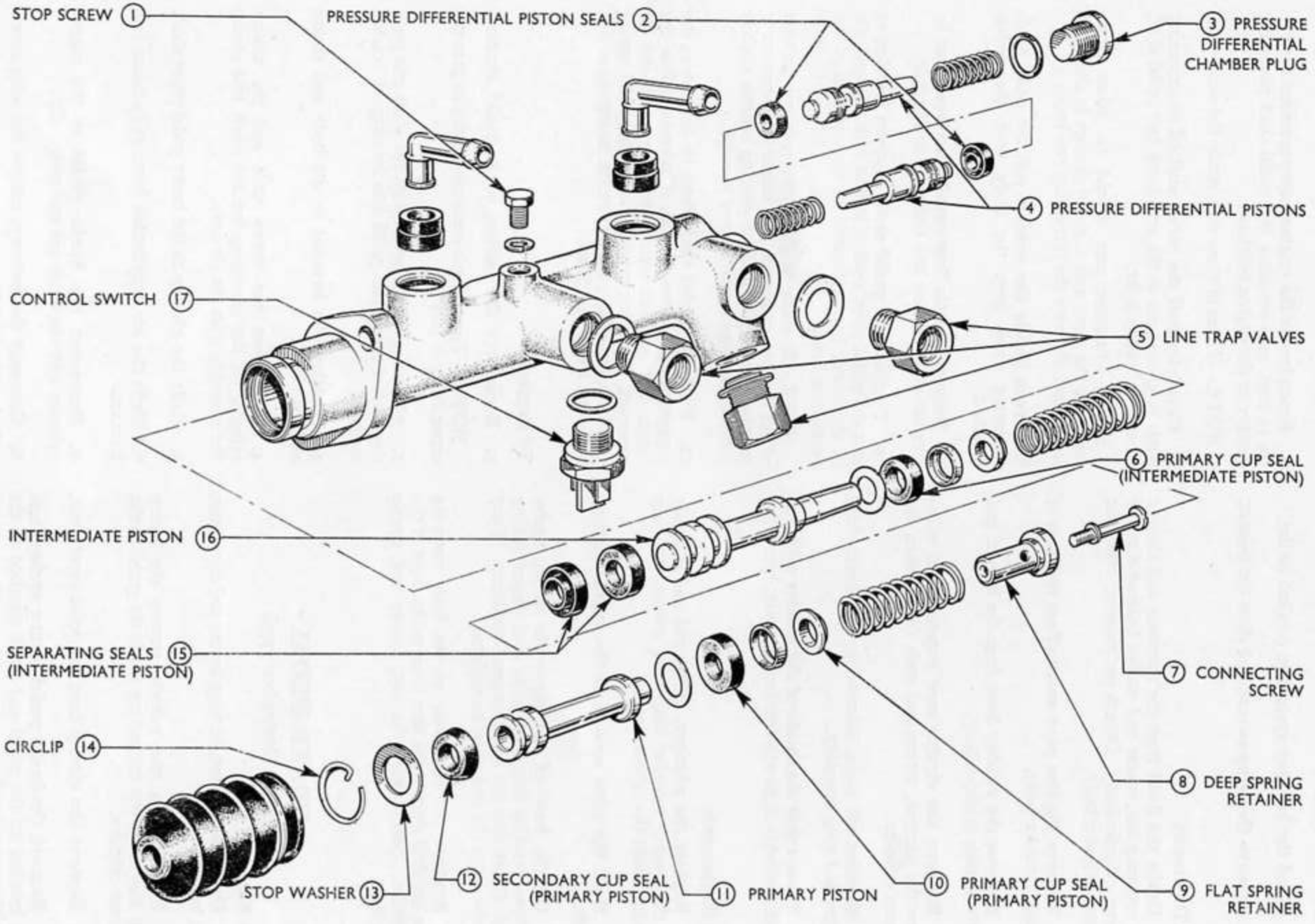


Fig. 20
Tandem Brake Master Cylinder (Prior to December 1970)

TANDEM BRAKE MASTER CYLINDER

With dual line brakes a tandem master cylinder is used to operate two separate hydraulic systems, one for the front brakes and the other for the rear brakes.

Operation

When the brake pedal is depressed, the primary piston is pushed towards the rear of the master cylinder. As the piston moves, the fluid inlet port to the pressurised side of the piston is closed by the primary cup seal. The pressure which is built up pushes the intermediate piston towards the rear of the master cylinder. The fluid inlet port to the pressurised side of the intermediate piston is closed by the piston rear cup seal.

Both front and rear hydraulic systems are pressurised evenly. A balance is achieved by the reaction of the pressures in both systems on the intermediate piston, so that the brakes are applied simultaneously on both axles.

As the brake pedal is released, the brake line pressure is reduced and the pistons in the master cylinder are returned to the released position by the action of the return springs. Recuperation ports in the two pistons aid their return by allowing fluid to by-pass them once the pressure is sufficiently reduced on the high pressure side. A trap valve in each outlet from the master cylinder maintains a line pressure of 0.35 to 1.05 kg./sq. cm. (5 to 15 lb./in.^{2}).

Should one system fail to operate, mechanical contact takes place within the master cylinder and the remaining system is applied.

On some models a brake pressure warning device is fitted. This is operated by two pistons in a chamber parallel to the main master cylinder bore. These pistons face one another and are pushed together by a spring behind each one and by the pressure from the respective parts of the hydraulic system to which they are connected. If one hydraulic system fails, the pressure difference behind the two pistons will cause them to move. This movement activates a switch on the master cylinder which in turn illuminates a warning light on the facia panel.

After December 1970 the tandem master cylinder was located in the engine compartment on the bulkhead. On vehicles fitted with a brake servo, the master cylinder bolted directly to it. The fluid reservoir became an integral part of the cylinder.

To Remove (Prior to December 1970)

1. Disconnect the reservoir supply and brake line pipes and fit blanking plugs.

2. Compress the brake pedal return spring and remove the spring retainer. Remove the split pin and withdraw the clevis pin from the master cylinder push-rod. Remove the two master cylinder retaining nuts, washers and bolts, withdraw the master cylinder from the pedal assembly and remove the spring and spring seat.

To Replace

1. Refit the pedal return spring and seat. Locate the master cylinder with the fluid inlet ports uppermost and fit the two retaining bolts, washers and nuts. Locate the push-rod clevis on the brake pedal, align the holes and fit the clevis pin. Adjust the push-rod length to give a clearance of 0.76 mm. (0.030 in.) between the push-rod and the master cylinder primary piston. Fit a new clevis split pin. Compress the pedal return spring and fit the spring retainer.

2. Refit the master cylinder supply pipes and brake line pipes and bleed the systems.

NOTE.—Use only Ford Crimson Brake Fluid (Part No. ME-3833-E).

To Dismantle

1. Withdraw the push-rod and remove the dust boot.

2. Unscrew the line trap valves and sealing washers and remove the inlet pipes and seals.

3. (Vehicles fitted with a low brake pressure warning light.) Remove the control switch and "O" ring seal. Unscrew and remove the pressure differential chamber plug and seal from the rear end of the master cylinder. Plug the rear brake pipe connection and the control switch thread bore and remove the two pressure differential pistons and springs by blowing through the front reservoir connection. Remove the piston springs and seals.

4. Using a suitable rod, depress the primary piston until it reaches the stop so that the pressure of the intermediate piston is lifted from the stop screw. Remove the stop screw and sealing washer and release the pressure on the piston.

5. Slightly depress the primary piston again so that the circlip, at the flanged end of the cylinder, may be removed. Withdraw the stop washer and the primary piston assembly. Remove the connecting screw and withdraw the deep spring retainer, spring, flat spring retainer, seal retainer, primary seal, seal protector and secondary seal from the piston.

6. Remove the intermediate piston assembly by lightly tapping the master cylinder against a wooden base. Withdraw the spring, spring retainer, seal retainer, primary seal, seal protector and the two separating seals from the piston.

Examine the bores of the master cylinder for scores. If there is any doubt about the condition of the bores, a new assembly should be fitted. New seals should be fitted whenever the master cylinder is dismantled.

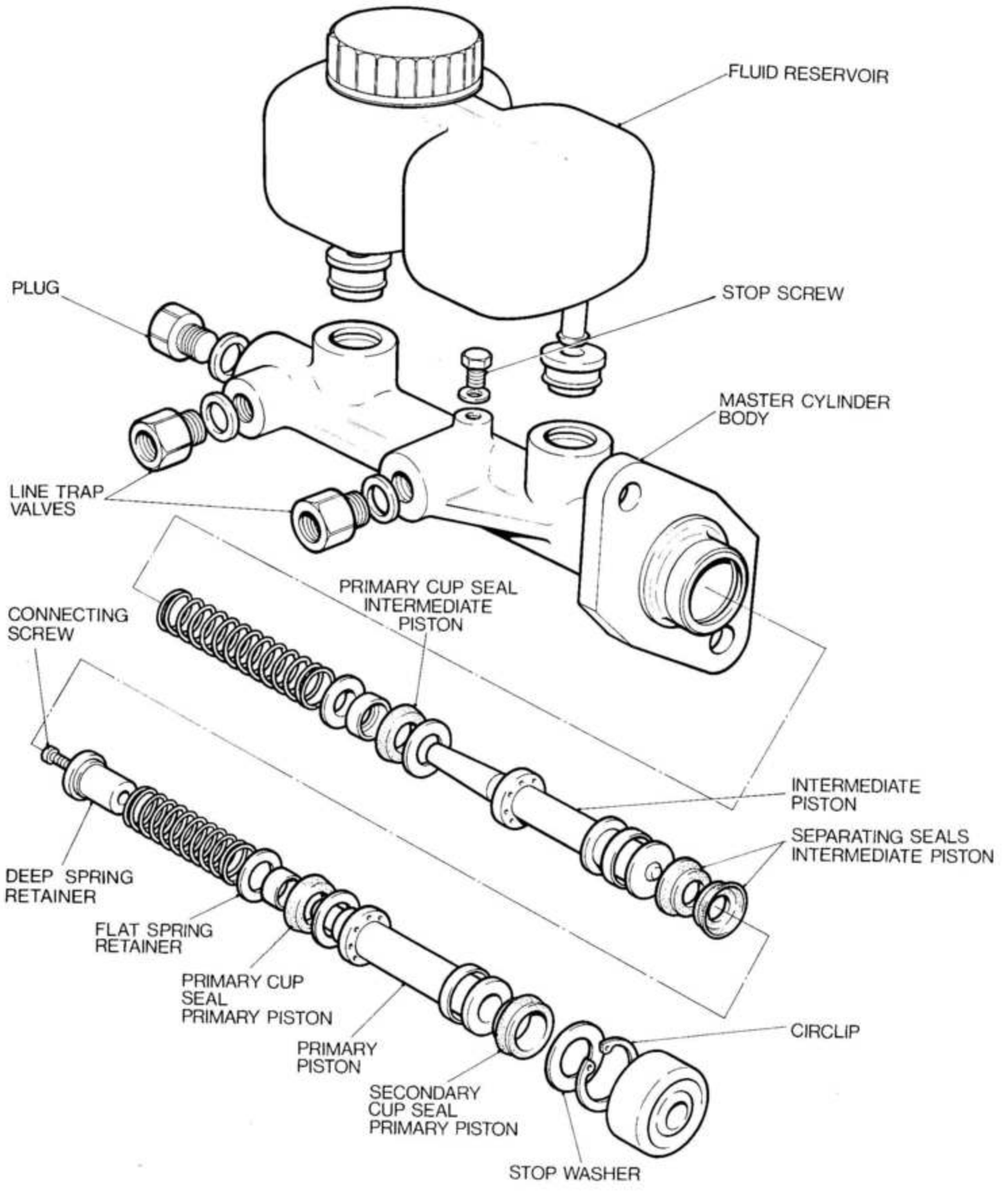


Fig. 21
Tandem Master Cylinder (After December 1970)
(Vehicles not fitted with Servo)

To Reassemble

1. **Lubricate the cylinder bores** with Red Rubber Grease.

2. **Lubricate and fit a new secondary seal** to the primary piston. Locate the primary seal protector, lubricate and fit a new primary seal and refit the seal retainer, flat spring retainer, spring, deep spring retainer and connecting screw.

3. **Lubricate and fit two new separating seals** (colour coded with a silver band) to the intermediate piston. Refit the primary seal protector, lubricate and fit a new primary seal and reassemble the seal retainer, spring retainer and the spring with its narrow end against the retainer.

4. **Clamp the master cylinder housing** so that the main bore is inclined, with the open end downwards, and insert the intermediate piston assembly and the primary piston assembly. To avoid damaging the cup seals a flattened needle should be passed around the lip of each seal to assist entry into the cylinder bore.

5. **Reclamp the master cylinder vertically,** open end upward, place the stop washer in position, depress the primary piston slightly and fit the circlip.

6. **Fully depress the primary piston** and fit the stop screw and a new sealing washer, tightening to a torque of 0.6 to 1.0 kg.m. (4.3 to 7.0 lb. ft.).

7. (Vehicles fitted with a low brake pressure warning light.) Lubricate and fit new seals to the pressure differential pistons and fit the spring, two pistons, second spring and the pressure differential plug and a new sealing washer. Tighten to a torque of 1.5 to 1.9 kg.m. (10.9 to 13.7 lb. ft.). Fit the control switch and tighten to a torque of 1.5 to 1.9 kg.m. (10.9 to 13.7 lb. ft.).

8. **Fit new seals to the inlet pipes** and press them into the master cylinder. Fit new sealing washers to the line trap valves, screw the valves into the cylinder and tighten them securely.

9. **Fit a new dust boot** and insert the push-rod.

EXHAUSTER

To Remove and Dismantle

1. **Disconnect the vacuum and oil pipes** from the exhauster, and fit a plug to the oil pipe.

2. **Slacken the fan belt** and unscrew the mounting bracket retaining bolts. Remove the assembly from the vehicle and scribe alignment marks to facilitate assembly.

3. **Unscrew the pulley retaining bolt** and remove the pulley and driving key.

4. **Remove the rear mounting bracket** after unscrewing the retaining nuts and washers.

5. **Remove the end plate.** Unscrew the three retaining nuts and remove the plate and gasket.

6. **Withdraw the rotor and blades** and inspect the bearing collar on the rotor shaft.

7. **Remove the oil seal** from the exhauster body and check the condition of the bush.

Before reassembling the exhauster, all parts should be thoroughly cleaned and inspected for wear. If the internal bore of the body is excessively worn, which will be indicated by ripples around the bore, the complete pump should be renewed.

To Reassemble and Replace

1. **Fit a new oil seal** to the exhauster body.

2. **Lubricate the blades, rotor and bush** with clean engine oil and refit the blades to the rotor. Insert the rotor into the exhauster body.

3. **Replace the end cover and gasket.** Pass the studs through the front mounting bracket and the exhauster body and locate a new gasket and the end cover, ensuring the alignment marks are in line. Tighten the retaining nuts and washers.

4. **Refit the pulley,** driving key and retaining bolt and washer.

5. **Locate the assembly** on the engine and fit the mounting bracket bolts and nuts.

6. **Adjust the fan belt.**

7. **Reconnect the vacuum and lubrication pipes.**

THE SERVO UNIT

(Prior to December 1970)

Construction

The servo unit is of the suspended vacuum type and is fitted beneath the battery tray in the engine compartment. Vacuum for the unit is created by the exhauster in diesel engined vehicles or by inlet manifold depression on petrol engined vehicles.

The servo unit is connected into the hydraulic pipe line between the brake master cylinder and the wheel cylinders. The booster diaphragm has a rolling action and does not require any lubrication.

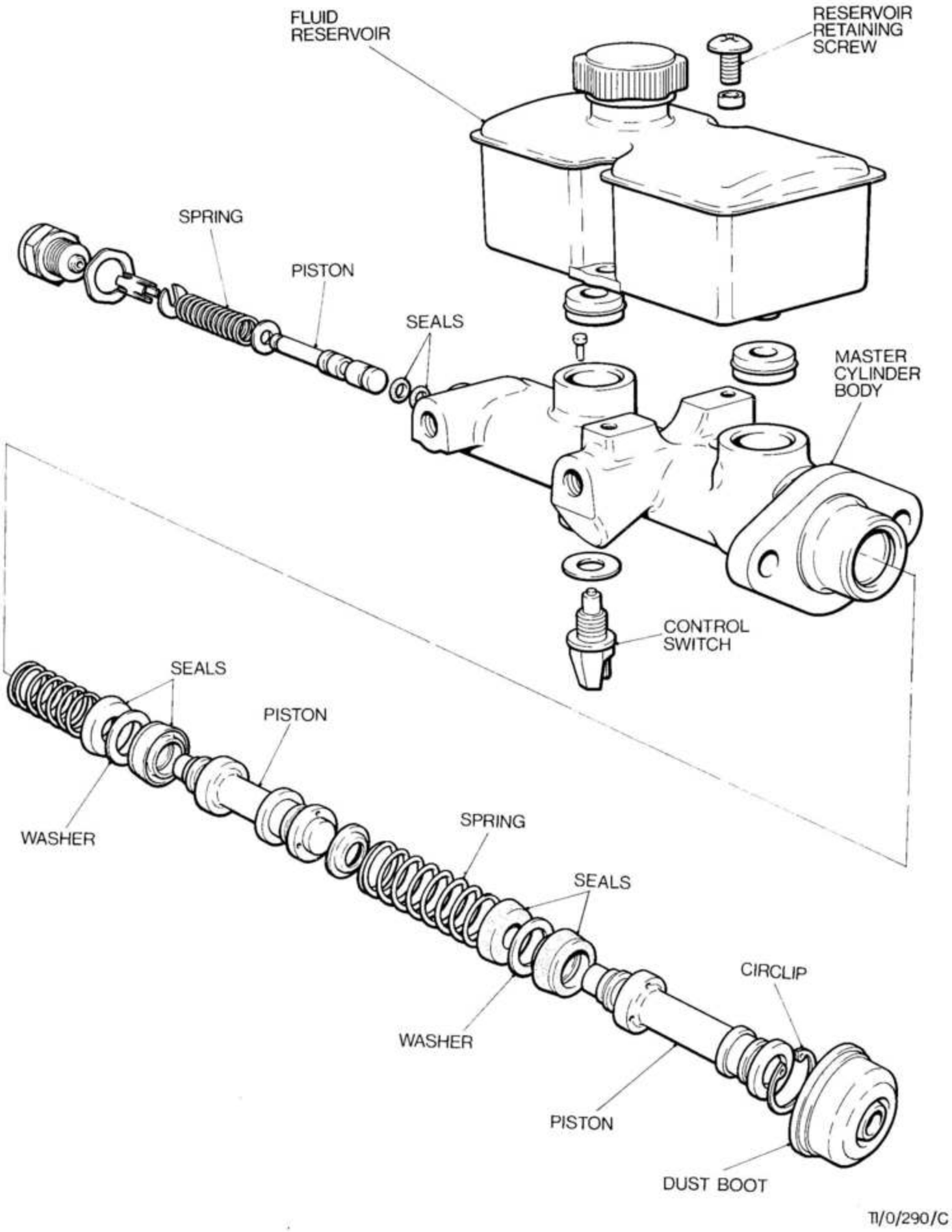


Fig. 22
Tandem Master Cylinder (After December 1970)
(Vehicles fitted with Servo)

The servo unit consists of three basic parts: the reaction valve, the booster/diaphragm assembly and the slave cylinder.

The reaction valve controls the amount of servo action applied to the brakes, the valve itself being governed by the hydraulic pressure coming from the brake master cylinder.

The booster diaphragm consists of a rubber diaphragm, which is clamped between the two halves of the shell and rolls round the booster piston in the released position. A push rod, extending into the slave cylinder is keyed to the power piston. The booster piston and diaphragm is held in the released position by a return spring.

The slave cylinder contains the slave cylinder piston which applies the increased hydraulic pressures to the wheel cylinders when the servo unit is actuated. The slave cylinder piston is pin retained to the push rod and therefore held in the released position by the booster piston return spring. The slave cylinder piston incorporates a safety device should either the vacuum pump or servo unit fail to operate. The hydraulic braking system will then still be operative, but higher pedal pressures will be required.

On vehicles having dual line braking systems, two servo units are fitted.

Principle of Operation

(1) Brakes off—pedal released

With the brake pedal released the servo is at rest and vacuum is present on either side of the booster diaphragm and the reaction valve diaphragm. Vacuum created at the exhauster (diesel) or inlet manifold (petrol) evacuates the booster shell on the slave cylinder side and then passes through a drilling in the body to the lower face of the reaction valve diaphragm. The vacuum is then transferred through the hollow spindle to the opposite face of the reaction valve diaphragm and then to the power side of the booster diaphragm via the transfer pipe. The air inlet valve is held closed by the pressure difference across the valve and the return spring force.

(2) Brakes applied

When the brake pedal is depressed, brake fluid from the master cylinder passes through the slave cylinder to the wheel cylinders. This pressure also acts on the reaction valve piston which displaces the diaphragm spindle until it contacts the air inlet valve, so closing the passage through the hollow spindle and isolating the two sides of the reaction valve and booster diaphragm from each other. Increased effort on the brake pedal results in the spindle lifting the inlet valve off its seat, thus admitting atmospheric pressure to the power side of the booster diaphragm via the transfer pipe. The vacuum within this chamber is partially destroyed resulting in a pressure difference across the diaphragm. The power piston and diaphragm move towards the slave cylinder, the initial movement of the push rod closing the valve in the centre of the slave cylinder piston.

As the booster piston moves towards the slave cylinder, the booster diaphragm unrolls from around the power piston. Continued movement of the booster piston assembly and push rod displaces the slave cylinder piston and increases the fluid pressure to the wheel cylinders.

The pressure difference across the reaction valve diaphragm is the same as the difference across the booster diaphragm. This pressure difference is thus fed back to master cylinder and gives the driver "pedal-feel". When the required degree of braking has been obtained the forces on both sides of the booster diaphragm and reaction valve diaphragm balance, the reaction valve diaphragm is deflected by its bias spring, and the air valve seats to prevent further air entry. The valves are then in a "lap" or holding position. Increase of pedal effort will reopen the air inlet valve and increase the servo-action and braking effect, or a decrease in pedal effort will start to release the brakes.

(3) Pedal released

When the brake pedal is released, brake fluid pressure behind the reaction valve piston is reduced and the diaphragm bias spring returns the diaphragm to its released position. The air inlet valve is closed and connection is again made between sides of the reaction valve diaphragm and booster diaphragm via the hollow spindle of the reaction valve assembly and the transfer pipe.

The slave cylinder piston and booster diaphragm are returned by their respective springs and communication is again made between the master cylinder and the wheel cylinders as the valve in the slave cylinder piston is re-opened. (The rearwards movement of the slave cylinder piston is limited by the spacer, thus

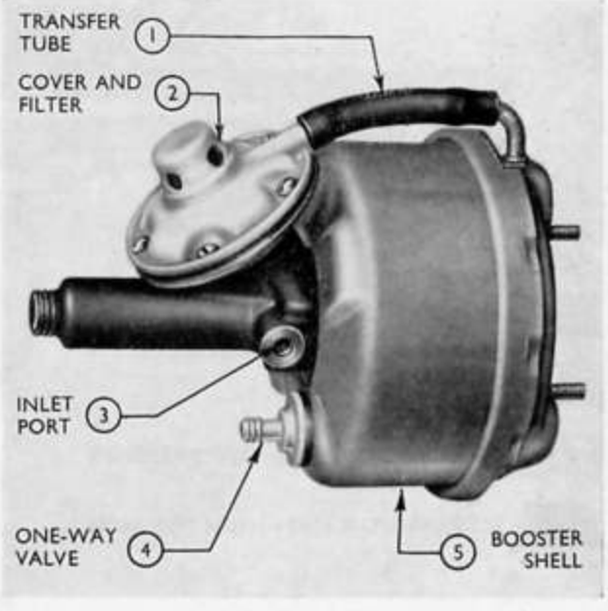


Fig. 23
Servo Unit

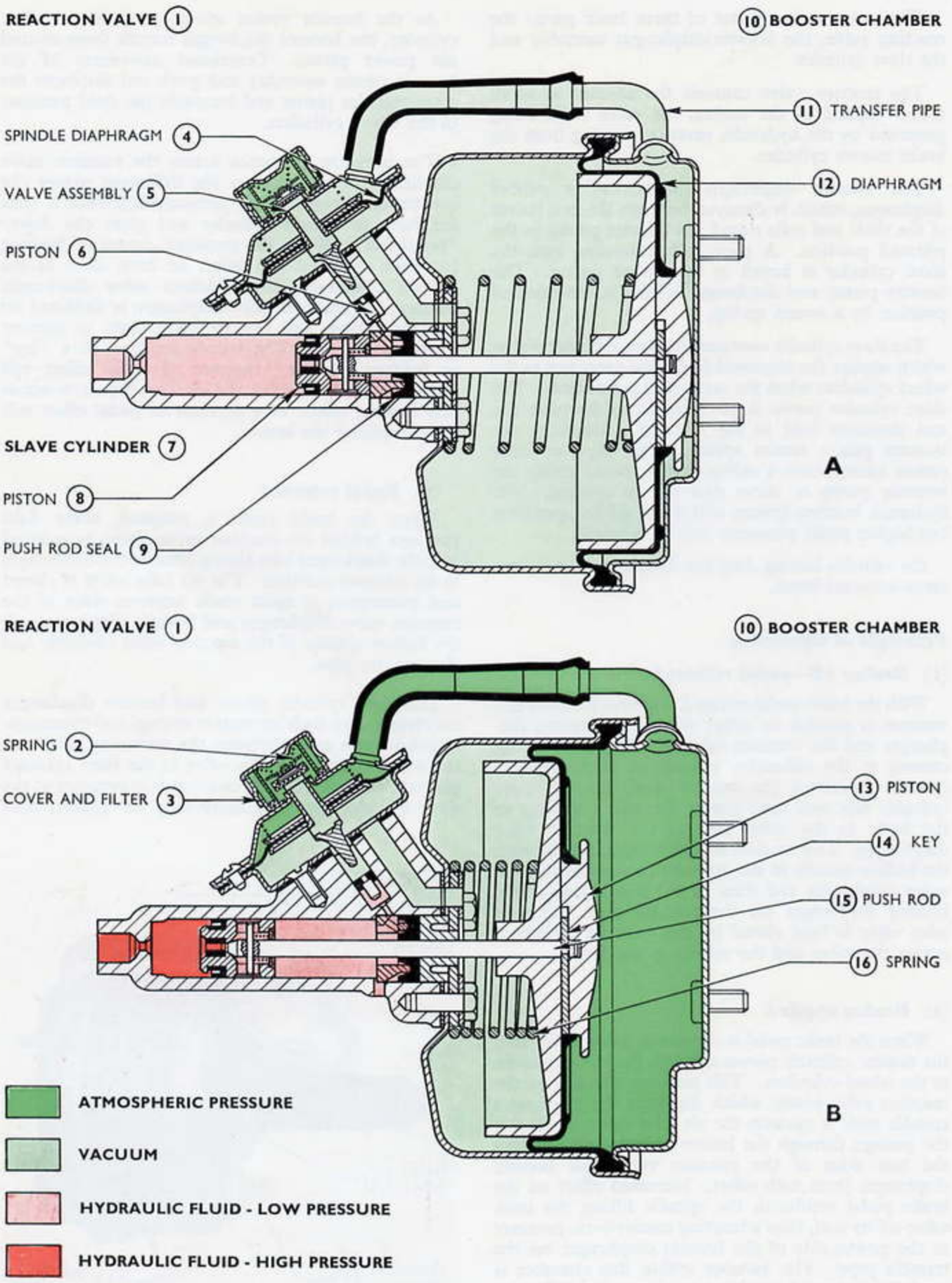


Fig. 24
Servo Unit Operations

A — Brakes Released B — Brakes Applied

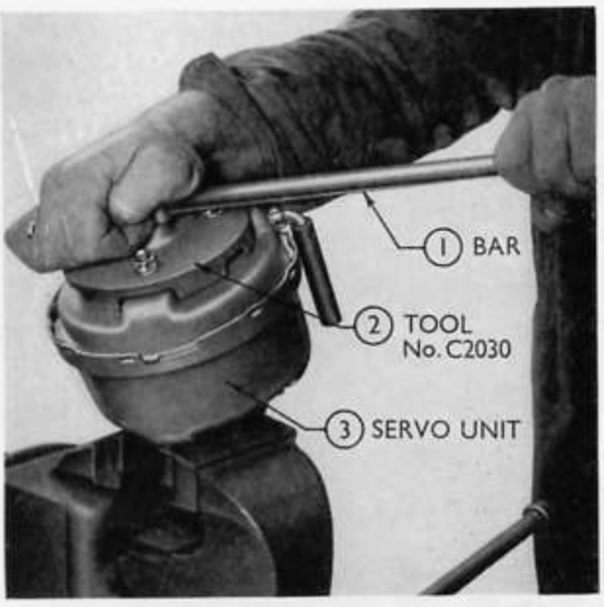


Fig. 25
Separating the Shell

re-opening the valve in the slave cylinder piston. This releases hydraulic pressure and allows fluid to pass back to the master cylinder.)

As the piston returns to its released position the diaphragm rolls around the outside of the piston.

Any air in the unit is then exhausted via the one-way valve by the exhauster (inlet manifold depression on petrol engines).

To Remove the Unit from the Vehicle

1. **Disconnect the hydraulic brake fluid feed pipe,** take-off pipe, vacuum feed pipe and vacuum gauge pipe (diesel models).

2. **Remove the servo unit** and bracket from the vehicle. Unscrew the retaining nuts and remove the unit from the vehicle.

3. **Remove the bracket** from the servo unit. Unscrew the retaining nuts and washers and place bracket to one side.

To Replace

1. **Refit the bracket to the servo unit** and replace the retaining washers and nuts.

2. **Locate the assembly** on the vehicle and refit the retaining nuts and washers.

3. **Reconnect hydraulic input and take-off pipes,** vacuum feed pipe and gauge feed pipe. (Diesel model.)

4. **Bleed the hydraulic system.**

To Dismantle the Reaction Valve

1. **Remove the reaction valve cover and filter.** Unscrew the five retaining screws and remove the cover and transfer pipe, the diaphragm return spring and the diaphragm.

2. **Remove the lower valve housing retaining screws,** housing and gasket. Withdraw the reaction valve piston assembly and inspect the seal. Replace the seal if defective.

3. **Separate the two halves of the booster shell.** Fit Tool No. C.2030 to the mounting studs, using suitable washers and the mounting bracket retaining nuts. Grip the slave cylinder in a vice and separate the two halves of the booster shell (see Fig. 25).

4. **Dismantle the booster piston** and diaphragm assembly. Unroll the diaphragm from the piston and carefully remove the diaphragm. Remove the piston

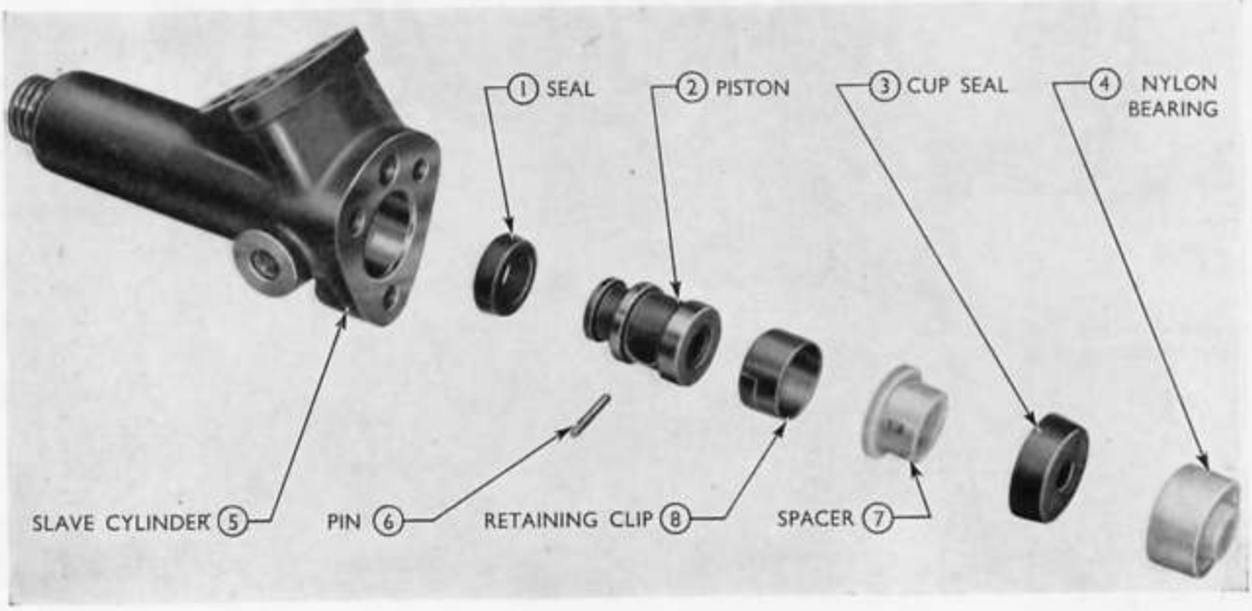


Fig. 26
Slave Cylinder and Seals

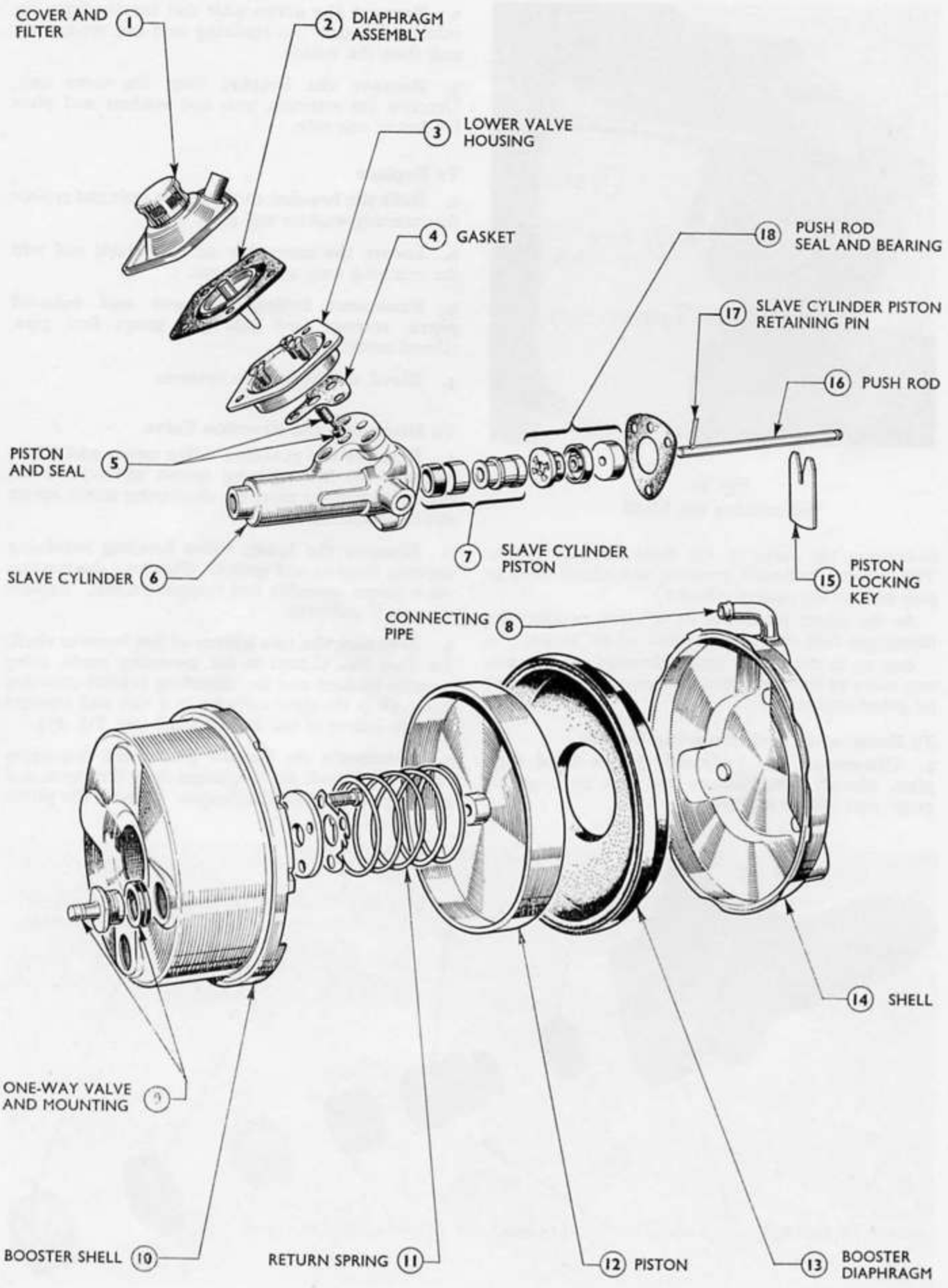


Fig. 27
Servo Unit—Exploded

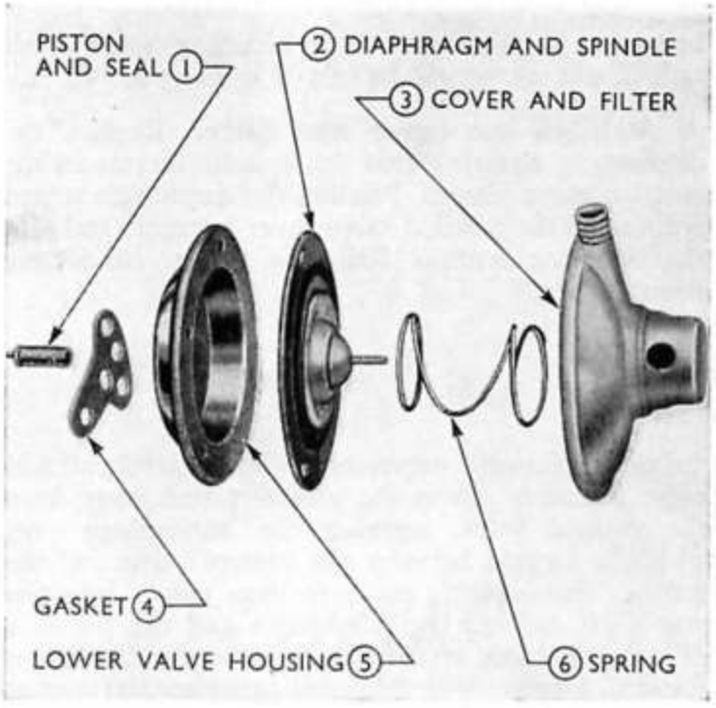


Fig. 28
Air Inlet Valve

retaining key whilst holding down the piston and return spring. Carefully release the piston and spring.

5. Remove the slave cylinder assembly. Knock back the locking tabs and unscrew the abutment plate retaining bolts. Remove the locking plate and abutment plate. Withdraw the slave cylinder assembly and gasket from the shell.

6. Dismantle the slave cylinder. Remove the nylon bearing, cup and spacer from the push rod. Pull back the retaining spring clip from the slave cylinder piston and withdraw the pin. Remove the piston from the push rod. Inspect the piston seal and replace if defective. Do not dismantle the piston any further.

7. Pull off the one-way valve and check its action. Renew if any doubt exists about its condition. Remove the one-way valve rubber mounting.

To Assemble

1. Replace the one-way valve and a new valve mounting with the chamfered face inside the shell.

2. Assemble the slave cylinder. Lubricate all components with clean brake fluid. Fit the slave cylinder piston seal and locate the piston on the push rod. Replace the retaining pin and the spring clip, ensuring that the spring inside the piston is compressed away from the piston seal. Slide the spacer, cup and nylon bearing onto the push rod in the same position as they were removed (see Fig. 26).

3. Refit the slave cylinder to the booster shell. Lubricate the slave cylinder bore with clean brake fluid and insert the push rod assembly into the slave cylinder. Locate the slave cylinder and gasket against the booster shell and refit the abutment plate, locking plate and retaining bolts. Ensure that all the holes in the slave cylinder, gasket, shell and abutment plate are in correct alignment. Tighten the bolts to a torque of 1.73 to 1.93 kg.m. (12.5 to 14 lb. ft.) and bend over the locking tabs.

4. Assemble the booster piston and diaphragm. Locate the piston return spring and carefully fit the piston to the push rod whilst compressing the return spring. Refit the locking key and diaphragm to the piston. Ensure the diaphragm can roll freely around the piston.

5. Assemble the booster shell. Clamp the slave cylinder in a vice and locate the two halves of the booster shell together, ensuring that the diaphragm periphery is located correctly and the transfer pipes

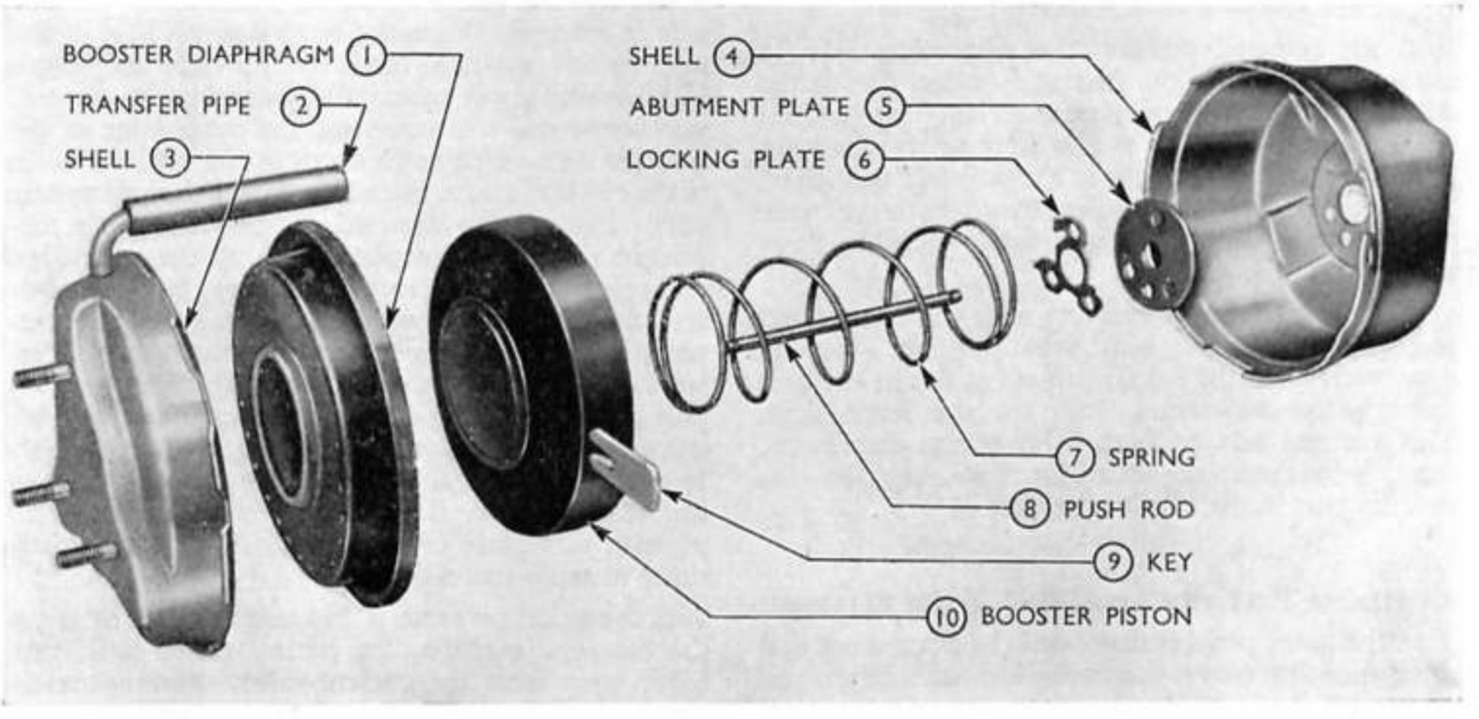


Fig. 29
Booster Piston Assembly and Shell

will align when assembled. With Tool No. C.2030 still clamped to the rear half of the shell, press down on the tool and rotate the assembly until the two halves of the shell are securely locked together (see Fig. 25).

6. Replace the lower half of the reaction valve. Lubricate the reaction valve piston and seal and refit the seal to the piston, if removed. Insert the piston into the bore and refit the gasket and lower valve housing. Replace the three retaining screws and tighten to a torque of 0.69 to 0.97 kg.m. (5 to 7 lb. ft.).

7. Replace the cover and filter. Replace the diaphragm, ensuring that the spindle locates in the reaction valve piston. Position the diaphragm return spring and the reaction valve cover assembly and refit the retaining screws. Refit the rubber connecting transfer pipe.

THE SERVO UNIT

(After December 1970)

The vacuum servo unit is fitted to a bracket attached to the engine compartment rear bulkhead. It is directly connected on one side to the brake pedal and to the brake master cylinder on the other side (see Figures 4 and 18).

Principle and Cycle of Operation

With the engine running, vacuum is supplied to the unit through the non-return valve in the front shell. The diaphragm is thus suspended in vacuum and brake pedal movement admits atmospheric pressure to the rear of the diaphragm, resulting in a pressure difference, which causes the diaphragm and the diaphragm plate to move forward. The brake pedal effort is therefore supplemented by the movement of the diaphragm.

The cycle of operation is best described by following the operation of the unit through four phases:—

1. Brake off — pedal released.
2. Brake partially applied — pedal moving.
3. Brake applied — pedal stationary.
4. Pedal being released.

1. Brake Off — Pedal Released

In the released position the diaphragm is fully retracted away from the master cylinder, due to the action of the diaphragm return spring. The control rod and valve assembly is also fully returned within the diaphragm plate, as far as the stop key will allow. The brake pedal return spring retracts both the brake pedal and the control rod and valve assembly, rearwards.

When the engine is running with the control rod and valve assembly in this position, vacuum depression from the inlet manifold is felt in the unit through the non-return valve in the front shell. This vacuum acts on both sides of the diaphragm, these being inter-connected at this stage by the vacuum port in the diaphragm plate.

2. Brakes Partially Applied — Pedal Moving

As the brake pedal is depressed the control rod and valve assembly moves forward within the diaphragm plate until the control valve abuts the vacuum port. This closes the vacuum port although vacuum is still present on both sides of the diaphragm at this stage.

Further forward movement of the control rod and valve assembly moves the control piston away from the control valve, opening the atmosphere port which is formed between the control valve and the piston. Atmospheric pressure then passes into the rear shell, behind the diaphragm and the pressure differential across the diaphragm moves the diaphragm forward, together with the diaphragm plate and control valve assembly. This action also moves the master cylinder push rod forward, which in turn operates the master cylinder. Providing forward movement of the brake pedal is maintained, the atmosphere port will remain open, and assistance in operating the master cylinder push rod will be provided by the forward movement of the diaphragm.

Should for any reason the vacuum assistance fail, the control rod and valve assembly, together with the diaphragm plate will move forward as a single unit. The master cylinder push rod will then be operated in the normal manner, although the pedal effort will be greater.

3. Brakes Applied — Pedal Stationary

Once the desired degree of braking has been achieved the driver will cease to move the brake pedal forward and a "holding" (balanced) position will be reached. When the brake pedal is held in this intermediate position, the diaphragm and diaphragm plate assembly will momentarily continue its forward movement and will compress the outer edge of the reaction disc which in turn causes the centre portion of the reaction disc to extrude and close the atmosphere port. During this forward movement of the diaphragm and diaphragm plate assembly, the control rod and valve assembly remain stationary, thus momentarily the vacuum port will be opened allowing the diaphragm and diaphragm plate assembly to move rearwards which will result in the closing of the vacuum port and the opening of the atmospheric port. This will allow the diaphragm and diaphragm plate assembly to move forward again compressing the outer edge of the reaction disc. During the holding (balanced) position this cycle of events will be repeated many times in rapid succession.

If the pedal pressure is increased after arriving at the balanced position, the control piston will again move away from the control valve, allowing atmospheric pressure to pass through the atmosphere port. The diaphragm will therefore move forward further, operating the master cylinder push rod until the brake pedal pressure is again held, or the limit of

travel is reached. Alternatively, if the brake pedal pressure is reduced with the unit in the holding position, the control rod is retracted within the diaphragm plate, moving the control valve rearwards. This action opens the vacuum port and vacuum is then felt in the rear shell. The return spring pressure moves the diaphragm and diaphragm plate rearward, allowing the master cylinder to recuperate. This will reduce the line pressure to the brake cylinders until a holding position is again reached.

4. Pedal Being Released

Immediately the brake pedal is released, the vacuum port is opened and the air in the rear chamber is withdrawn into the front chamber. The air is then drawn through the non-return valve to the inlet manifold. At this stage the atmosphere port remains closed and thus a vacuum is very soon created in both the front and rear chambers. The control rod and valve assembly will then be returned to its original position, being assisted by the diaphragm return spring. The master cylinder will then recuperate fully.

To Remove the Unit from the Vehicle

1. **Open the bonnet** and fit wing covers.

2. **Remove the two nuts** retaining the master cylinder to the servo unit and position the master cylinder to one side. Take care when moving the master cylinder that no damage or kinking of the pipes occurs.

3. **Remove the vacuum hoses** to the manifolds and gauge (Diesel) from their location on the servo unit.

4. **From inside the vehicle** remove the spring clip and clevis pin connecting the brake pedal to the master cylinder.

5. **Remove the three 13 mm. nuts** and detach the servo unit, complete with its mounting bracket, from the engine compartment bulkhead.

6. **Remove four nuts** and separate the servo unit from the mounting bracket.

To Replace

1. **Position the servo unit** to the mounting bracket and secure with four nuts.

2. **Position the servo unit assembly** to the engine compartment bulkhead.

NOTE.—Loosely position the assembly in the engine compartment. From inside the vehicle ensure that the servo rod locates with the pedal correctly. When alignment is correct securely tighten the servo mounting nuts.

3. **Reconnect the vacuum hoses** to the servo unit and replace the master cylinder.

4. **Reconnect the pedal** to the master cylinder with the clevis pin and spring clip.

5. **Remove the wing covers** and close the bonnet.

Section 3

FRONT AXLE AND STEERING

CONTENTS

SUBJECT

FRONT AXLE:

MAINTENANCE AND OVERHAUL PROCEDURES

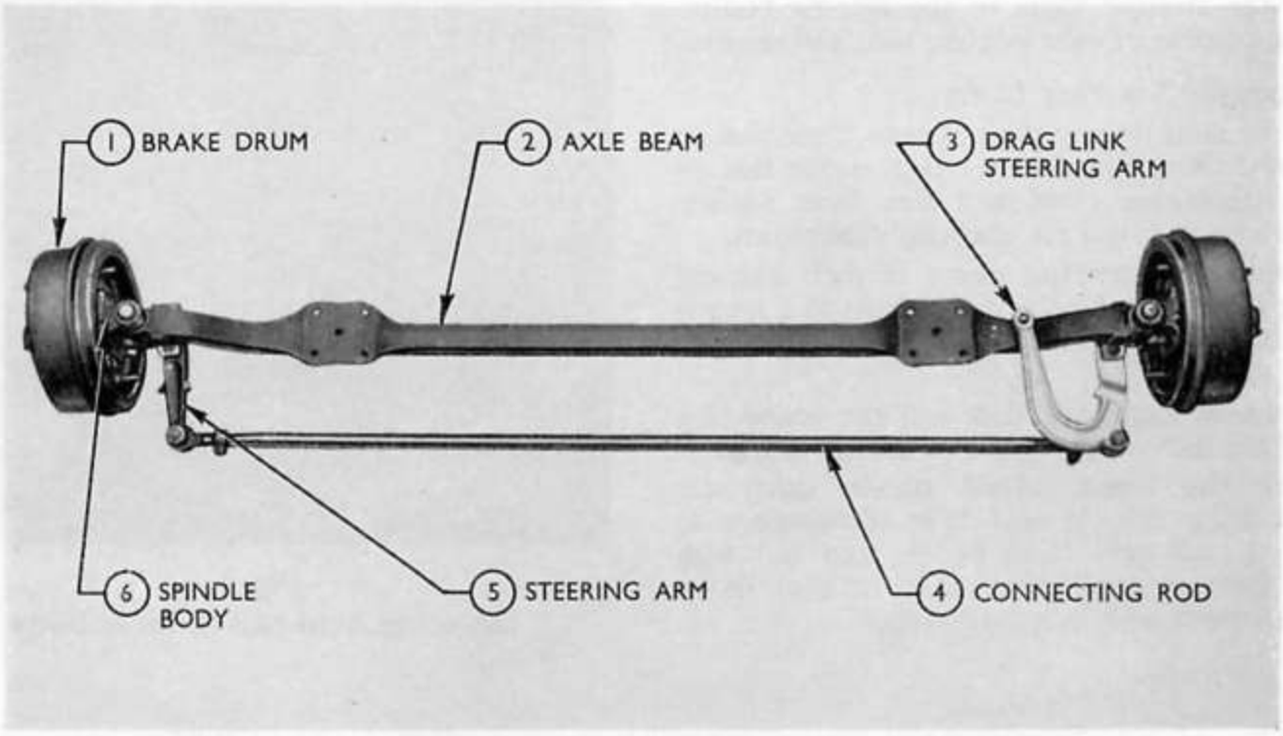


Fig. 1
The Front Axle Assembly

DESCRIPTION

The front axle specified for the "Transit" range of vehicles has a capacity of 1,060 kg. (2,340 lb.). The axle beam is a cranked "I" section forging carried on a pair of semi-elliptic road springs. The spindle bodies are each connected to the axle beam by a spindle bolt, locked to the axle by a parallel grooved pin driven into the axle beam. Bronze bushes are pressed into the spindle bodies to provide the necessary bearing surfaces and thrust washers are located on the spindle bolt between the spindle body and the axle beam.

The steering arms are bolted to the spindle bodies, the combined drag link and connecting rod steering arm (R.H., R.H.D.; L.H., L.H.D.) being cranked to the rear of the axle beam.

The steering lock stops are located in drilled lugs on the underside of the axle beam. The steering movement is limited when the steering arm contacts the head of the bolt forming the stop. The length of bolt protruding governs the steering lock, and this is adjustable by means of the two locknuts.

Telescopic shock absorbers are mounted between a bracket on the underside of the body and a bolt located in the axle beam.

ROUTINE MAINTENANCE

A lubricator is fitted on each of the spindle body bosses (see Fig. 2) and these should be greased at the normal service intervals: 8,000 kms. (5,000 miles). Also, check the steering linkage for wear or damage and renew parts as necessary. The steering joints are packed with grease and sealed during manufacture. The ball joints are serviced as a complete unit and no attempt should be made to dismantle and adjust.

OVERHAUL PROCEDURES
THE SPINDLE ASSEMBLIES

To Remove the Steering Arms

1. **Remove the split pins** and the nuts retaining the connecting rod and the drag link to their respective steering arms and free the ball pins.

2. **Remove the split pins** and the nuts and bolts retaining the steering arms to the spindle bodies. Tap the arms clear of their locating slots and remove.

To Replace the Steering Arms

Check the arms for any signs of wear, distortion or cracks and discard if necessary. Also, ensure that all mating surfaces are clean and free from surface defects. Refer to Fig. 3 for checking dimensions.

1. **Position the steering arms** in their locating slots. Fit the nuts and bolts and tighten to a torque of 5.5 to 6.2 kg.m. (40 to 45 lb. ft.) and fit new split pins.

2. **Reconnect the drag link** and the connecting rod. Tighten the ball pin nuts and fit new split pins.

3. **Check the front wheel toe-in** using the Churchill gauge No. 96 and reset if necessary to 3.2 mm. ± 0.8 mm. (0.13 in. ± 0.03 in.) with cross-ply tyres or parallel 0 mm. to 1.6 mm. (0 in. to 0.06 in.) toe-in with radial-ply tyres.

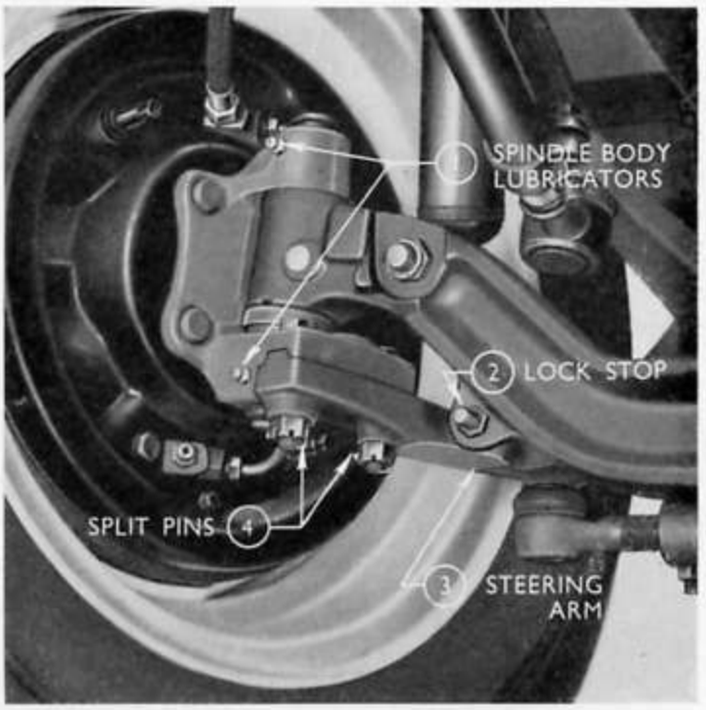


Fig. 2
Steering Arm and Spindle Body

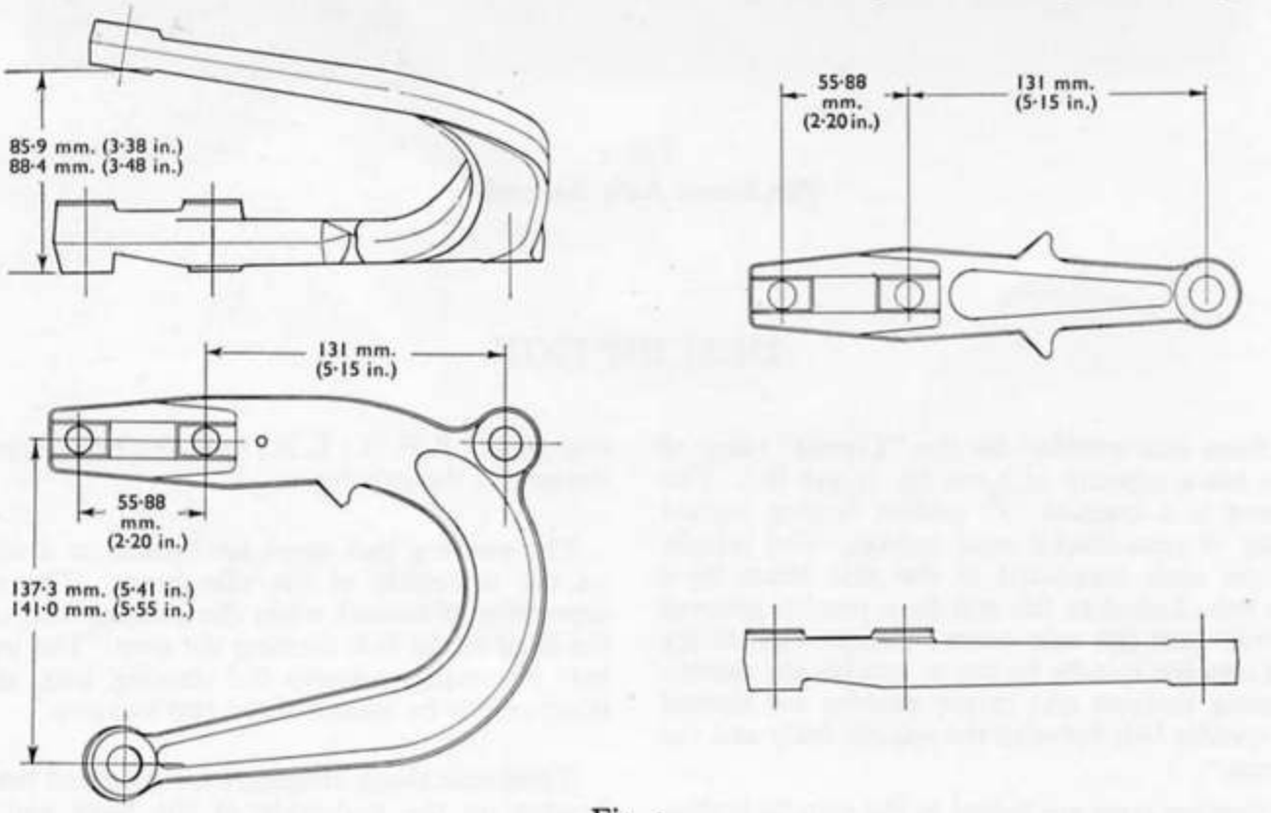


Fig. 3
Steering Arm Checking Dimensions

To Remove a Spindle Body

1. **Jack up the vehicle,** fit chassis stands and remove the hub grease cap.

2. **Remove the split pin** and the adjusting nut retainer. Unscrew the adjusting nut and remove the thrust washer and the outer cone and roller assembly.

3. **Slacken the brake adjusters** and remove the wheel, hub and drum assembly complete.

4. **Remove the split pins,** unscrew the nuts and bolts retaining the steering arm to the spindle body and detach the arm.

5. **Unscrew the four nuts** retaining the brake back plate to the spindle body. Detach the back plate assembly and support it, to avoid tensioning the hydraulic pipe.

6. **Drive out** the parallel groove pin retaining the spindle bolt to the axle.

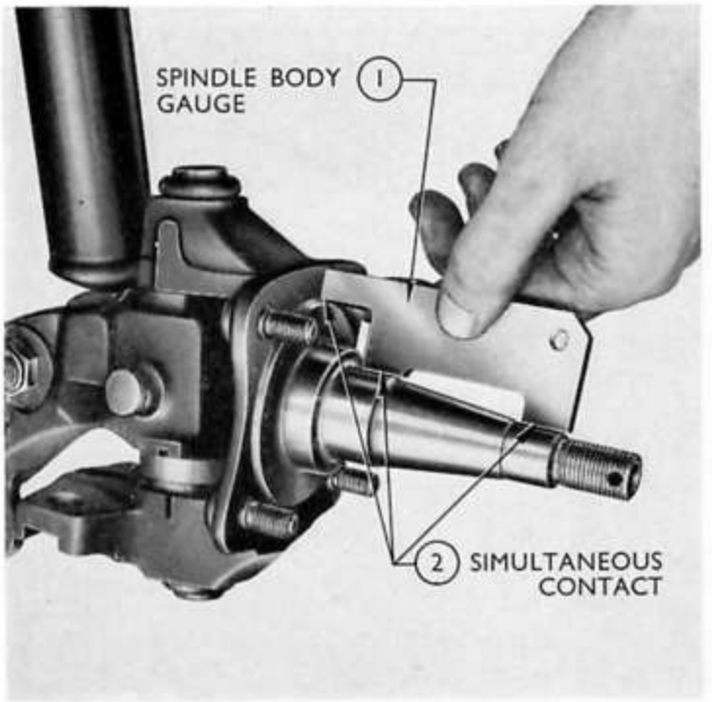


Fig. 4
Use of Tool No. C.3101

7. Remove the sealing rings from each end of the spindle bolt and drive or press out, (preferably using a portable hydraulic ram). Remove the spindle body, the thrust washers and any shims fitted between the spindle body and the axle beam.

To Check the Spindle Body

Clean thoroughly and inspect for wear, damage or cracks. Check the spindle for distortion, using Tool No. C.3101. Note that this check can be carried out with the spindle body in situ (see Fig. 4).

Check the fit of the wheel bearing cones on the spindle. The cones should be a push fit but without perceptible clearance. Under no circumstances should the spindle be cleaned up if a bearing has seized and rotated on the spindle. Always renew the bearings and the spindle body or frequent bearing failure may result with dangerous consequences.

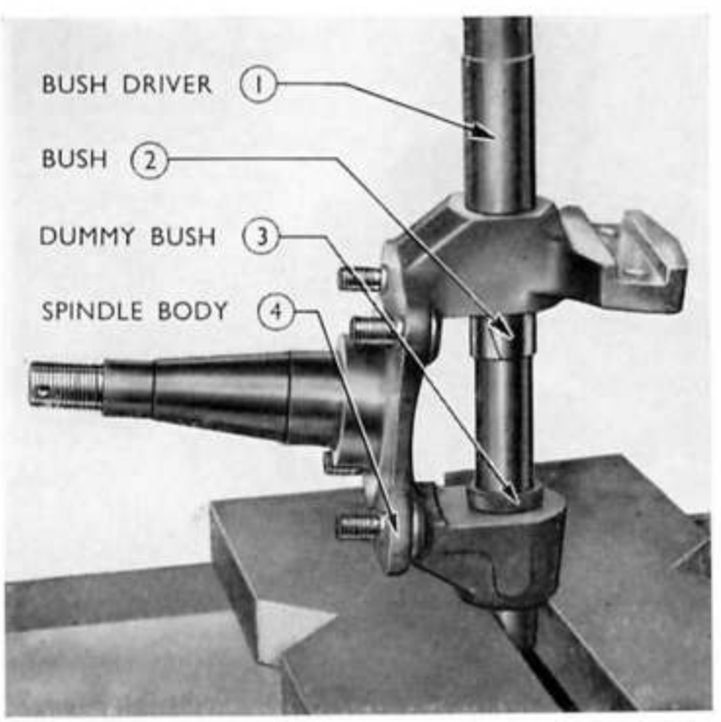


Fig. 5
Removing the Lower Spindle Bush

To Rebush the Spindle Bodies

The spindle bodies can be rebushed after removal from the axle beam. As split bushes are used, they must be expanded in position and broached to size. Reamers must not be used as they do not expand the bushes and the flutes will pick up on the splits in the bushes.

Spindle Bush—Remove and Replace equipment C.3104.

Anvil	Bush Driver	Dummy Bush	Stop Collar
C.3065 A	C.3104/a	C.3104/b	C.3104/d

To Remove the Spindle Bushes

1. Remove the lubricators from each spindle body boss.

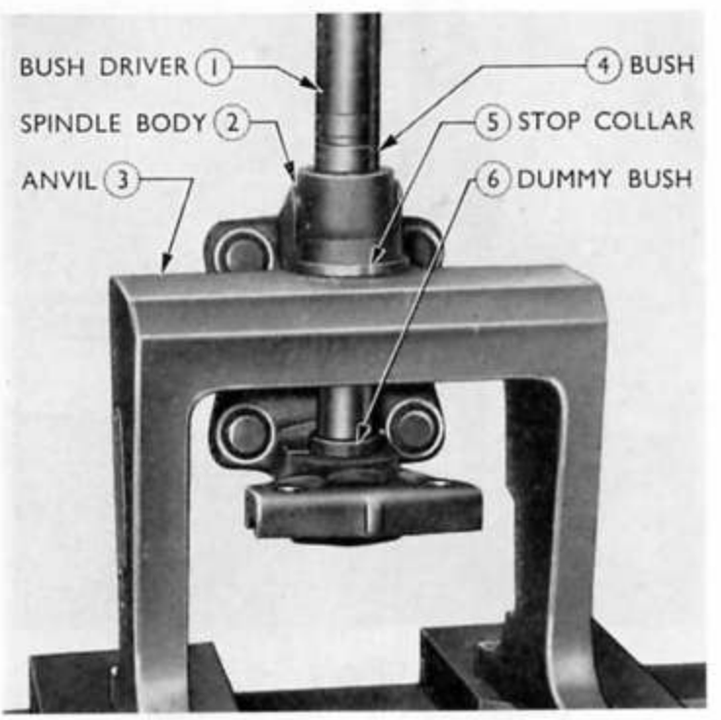


Fig. 6
Replacing the Upper Spindle Bush

2. Place the spindle body on the bed of a suitable press.

3. Enter the bush driver and press the top bush out of the spindle body.

4. Invert the spindle body on the press and install the dummy bush. Enter the driver and press out the remaining bush (see Fig. 5).

To Replace the Spindle Bushes

1. With the dummy bush in the lower boss of the spindle body, position the stop collar and the spindle body on the top face of the anvil. The lip on the stop collar, where present, must be downwards in the anvil, to ensure that the bush is pressed in flush with the inner face of the spindle body boss.

2. Locate a new bush on the driver with the lubrication hole uppermost. Enter the driver and press the bush into place, ensuring that the lubrication holes line up (see Fig. 6).

3. Invert the spindle body and repeat the operation to insert a new lower bush. The stop collar must be used as before, but the guide bush is not required as the top bush will now centralise the driver.

To Broach the Spindle Bushes

Spindle Bush Broaching Equipment C.3103

Broach	Jack	Broaching Support
C.3103/a	C.3103/b	C.3103/e

1. Place the jack between the spindle body bosses, centralise with the bush driver and tighten the screw firmly. This is essential to prevent movement of the bushes while broaching.

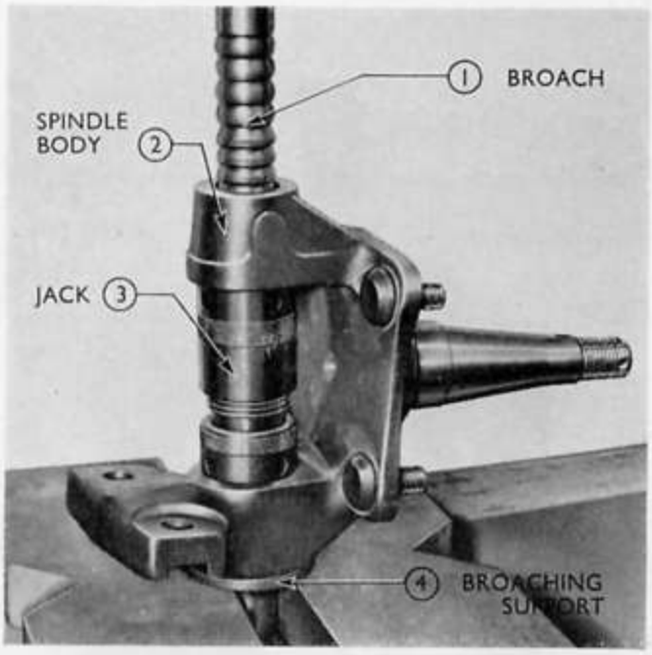


Fig. 7
Broaching the Spindle Bushes

2. Place the broaching support on the press bed with the lip uppermost, and locate the lower machined face of the spindle body on the support.

3. Line up all the components, using the bush driver so that the broach will pass freely through.

4. Press the broach through the spindle assembly, preferably using a hydraulic press. The broach should be lubricated with clean cutting oil and care must be taken to catch the broach, after it has passed through the spindle bushes.

5. Unscrew the jack and thoroughly clean all the cuttings from the spindle and from the bushes, paying particular attention to the lubrication holes.

To Refit the Spindle Body

1. Replace the lubricators in each of the spindle body bosses and drive in the back plate retaining studs.

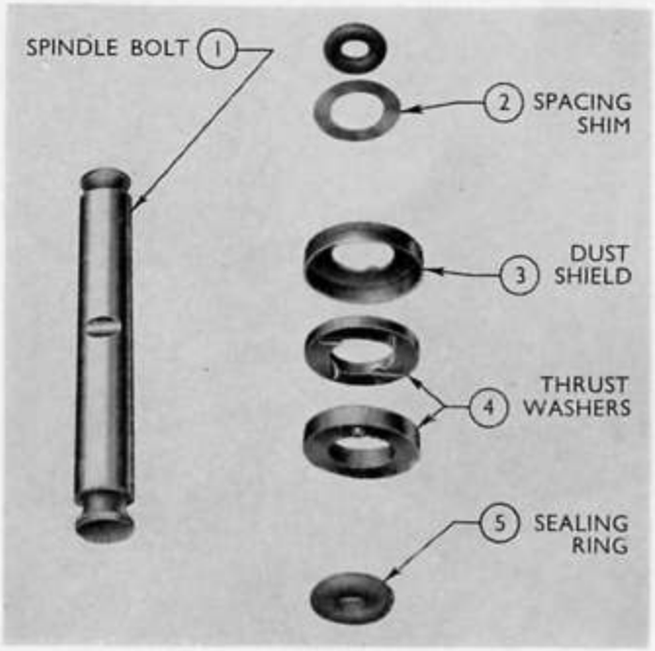


Fig. 8
Spindle, Bolt and Thrust Bearings

2. Position the plastic washer in the thrust bearing shield with the grooves outward. Grease the steel thrust washer and place the flat face on the plastic washer.

3. Place the thrust bearing assembly on the top face of the lower spindle body boss locating the peg on the steel thrust washer in the slot in the spindle body.

4. Align the lugs on the thrust bearing shield with the slot across the lower face of the axle eye and fit the spindle body and thrust bearing assembly to the axle beam (see Fig. 9).

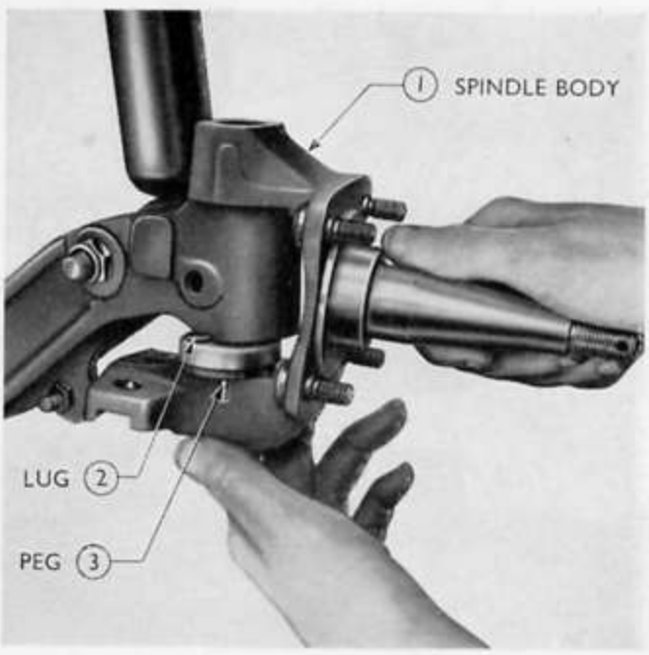


Fig. 9
Fitting the Spindle Body

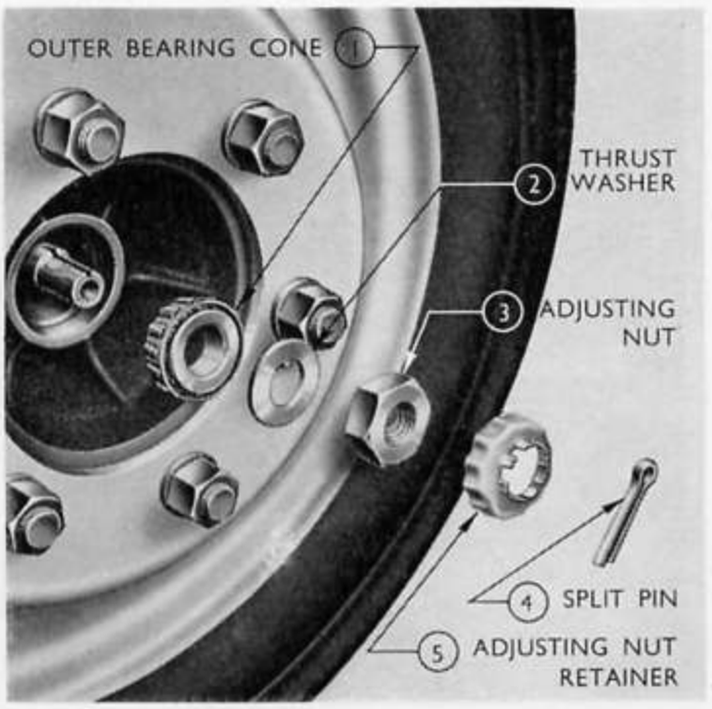


Fig. 10
Wheel Bearing Adjusters

5. **Select and fit shims** between the upper spindle body boss and the axle beam to give a maximum clearance of 0.1 mm. (0.004 in.) and minimum clearance of 0.025 mm. (0.001 in.).

6. **Fit the spindle bolt,** ensuring that the groove in the bolt is in line with the cotter pin hole in the axle beam. Turn the spindle bolt slightly so that when the cotter is driven in, a self-aligning action is obtained. If this instruction is not followed, it will be impossible to drive the cotter in far enough.

7. **Drive in a new grooved pin** from either side. Never use an old pin as the end may have become enlarged and this will prevent the pin entering to the necessary depth. The maximum protrusion of the pin after fitting should be 4.5 mm. (0.2 in.).

8. **Fit new sealing rings** to each end of the spindle bolt.

9. **Lubricate the spindle bolt** using a lithium base grease.

10. **Position the steering arm** in the locating slot. Fit the nuts and bolts, tighten to a torque of 5.5 to 6.2 kg.m. (40 to 45 lb. ft.) and fit new split pins.

11. **Assemble the brake back plate** to the spindle body, fit the four self-locking nuts and tighten to a torque of 4.2 to 4.8 kg.m. (30 to 35 lb. ft.).

12. **Mount the wheel, hub and drum assembly** on the spindle and install the outer cone and roller, grease the spindle before assembly of bearings to shaft after ensuring that the bearings are adequately greased. Fit the thrust washer and the adjusting nut. Tighten the nut to a torque of 2.4 to 3.5 kg.m. (17 to 25 lb. ft.) while rotating the wheel.

13. **Back off the adjusting nut,** $\frac{1}{6}$ to $\frac{1}{3}$ of a turn to give 0.05 to 0.17 mm. (0.002 to 0.0065 in.) end-float. Position the adjusting nut retainer and fit a new split pin.

14. **Fit the hub grease cap** and adjust all the brakes.

15. **Remove the chassis stands** and lower the vehicle to the ground.

THE AXLE BEAM

To Remove

1. **Jack up the front of the vehicle,** fit chassis stands but leave the axle supported.

2. **Remove the wheel and hub assemblies** and if suitable facilities are available, the spindle bodies, see page 4. If more convenient, leave the spindle bodies in place until the axle has been removed from the vehicle, as seized in spindle bolts can then be more readily dealt with.

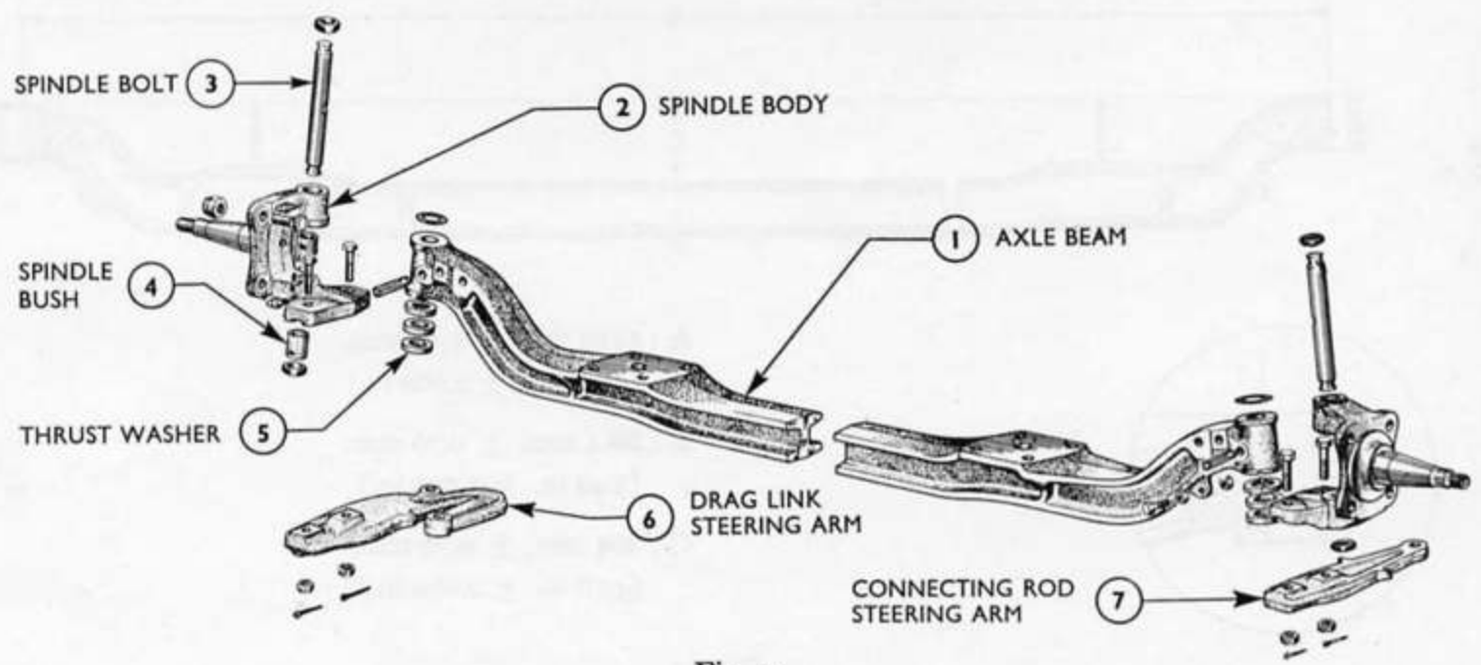


Fig. 11
Front Axle Assembly — Exploded

3. **Remove the nut** retaining the lower shock absorber mounting bolt and drive the bolt out of the axle beam.

4. **Take the weight of the axle** on the jack and remove the eight spring clip nuts retaining the axle beam to the road springs.

5. **Remove the spring clips** and the spring clip spacer, which incorporates the bump stop.

6. **Lower the axle beam** on the jack and remove from the vehicle, retaining the wedge fitted between each spring and the axle beam.

To Check the Axle Beam

Place the aligning rods No. 89A in the spindle bolt holes, securing them by the adjustable cones.

TEST (A)

Measure a fixed distance up the outside of each rod (approximately 30 cm. (12 in.)) and take measurements between these points and the lower end of the opposite rod. The two dimensions should be equal.

TEST (B)

Place a straight edge between the spindle bolt holes and measure the depth to the centre of the beam. Also, measure the depths to the spring seats.

The dimensions should be as tabulated.

TEST (C)

When viewed from the front, the angle of the aligning rods to the vertical should be 4° 50′ to 5° 10′. This angle is the K.P.I.

When viewed from either side, the aligning rods should be in line.

If any of the above checks prove that the axle beam is bent or twisted, it should be renewed.

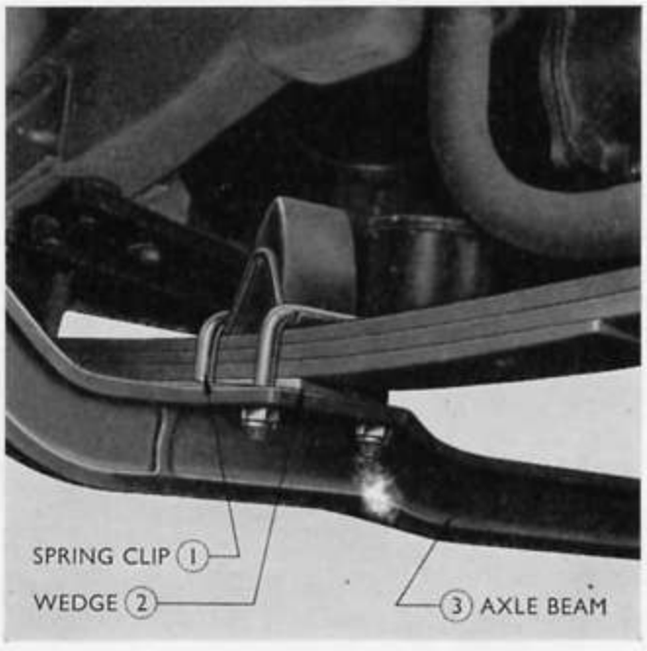


Fig. 13
Spring Clips and Spacer (Early Spring Shown)

To Refit the Axle Beam

1. **Jack the axle into place,** ensuring that the thicker end of the wedge is fitted to the rear (see Fig. 13).

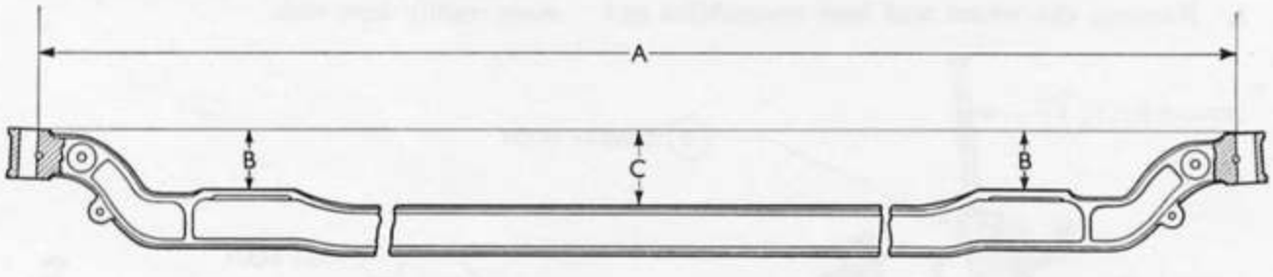
2. **Fit the spring clips** and tighten the nuts to a torque of 7.2 to 8.6 kg.m. (52 to 62 lb. ft.).

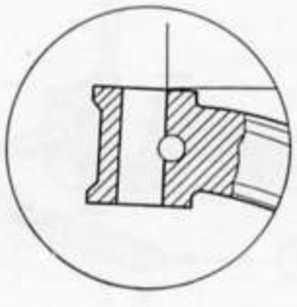
3. **Fit the shock absorber** to the axle and tighten the nut to a torque of 7.6 to 9.0 kg.m. (55 to 65 lb. ft.).

4. **Replace the spindle bodies** and the wheel and hub assemblies, see page 6.

5. **With the vehicle on the ground** and preferably laden, recheck the torque of the spring clip nuts.

6. **Check the axle lock stops** and reset if necessary to give a back lock angle of 42° 40′ (see Fig. 19).





A : 1459 mm. ± 1.52 mm.
(57.44 in. ± 0.060 in.)

B : 86.4 mm. ± 0.76 mm.
(3.40 in. ± 0.030 in.)

C : 104 mm. ± 0.76 mm.
(4.10 in. ± 0.030 in.)

Fig. 12
Axle Beam Checking Dimensions

FRONT WHEEL ALIGNMENT

Correct wheel alignment is essential to give precise steering and minimum tyre wear.

Before attempting to check the front wheel alignment the following points should be checked and rectified if necessary:

1. The tyre pressures.
2. Wheel run-out.
3. Front wheel bearing adjustment and condition, see page 7.
4. Spindle bolts and bushes for wear.
5. Connecting rod and drag link ends for wear.
6. Spindle bodies and steering arms for damage.

Any tests made when these factors have not been corrected will give misleading results.

NOTE.—When checking any wheel alignment figures, allow the vehicle to run straight into the wheel alignment bay, as a sudden turn may result in the wheels being out of the normal running position, which could also give misleading results.

TOE-IN

Toe-in is the inward setting of the front wheels determined at the straight-ahead position when the distance between the two wheels should be less at the front of the wheels than at the rear. Correct setting stabilises the steering in the straight-ahead position without excessive tyre scrub. The correct toe-in is 3.2 mm. ± 0.8 mm. (0.13 in. ± 0.03 in.) for cross-ply tyres and parallel 0 mm. to 1.6 mm. (0 in. to 0.06 in.) toe-in for radial-ply tyres.

CASTOR ANGLE

The castor angle is the inclination of the king pin to the vertical (see Fig. 14). Correct castor provides a self-centring action when the steering is out of the straight-ahead position. The angle is set by the wedge between the axle and the springs and this must be fitted with the thicker end to the rear (see Fig. 13).

CAMBER ANGLE AND KING PIN INCLINATION

The Camber Angle compensates for average road camber and ensures that the tread of the tyre contacts the road surface squarely. The Camber Angle and the King Pin Inclination combine to produce the "scrub radius" (see Fig. 14). This is essential to minimise reaction at the steering wheel when passing over rough ground. The angles are not adjustable and under no circumstances should the axle be bent.

TO CHECK THE TOE-IN

Use the Churchill gauge No. 96 and ensure that the measurements are taken at the same height at the front and rear of the wheels, with the maximum run-out at the top and bottom of the wheels. Alternatively, mark the inside of the tyre and measure at the front then roll the vehicle forward and measure at the rear between the marked points.

To Adjust

1. **Slacken the nut** and the bolt on each connecting rod end.

2. **Adjust the toe-in** as required. Note that the connecting rod ends have left- and right-hand threads, this enables the toe-in to be adjusted by rotating the connecting rod, after the clamp bolts have been slackened.

3. **Tighten the clamp bolts,** re-check the toe-in and remove the tracking gauge.

TO CHECK THE STEERING GEOMETRY

The steering geometry can be accurately and speedily checked, using the gauge No. 121–LA and the turntables. Alternative equipment, such as the Churchill Optoflex may also be used.

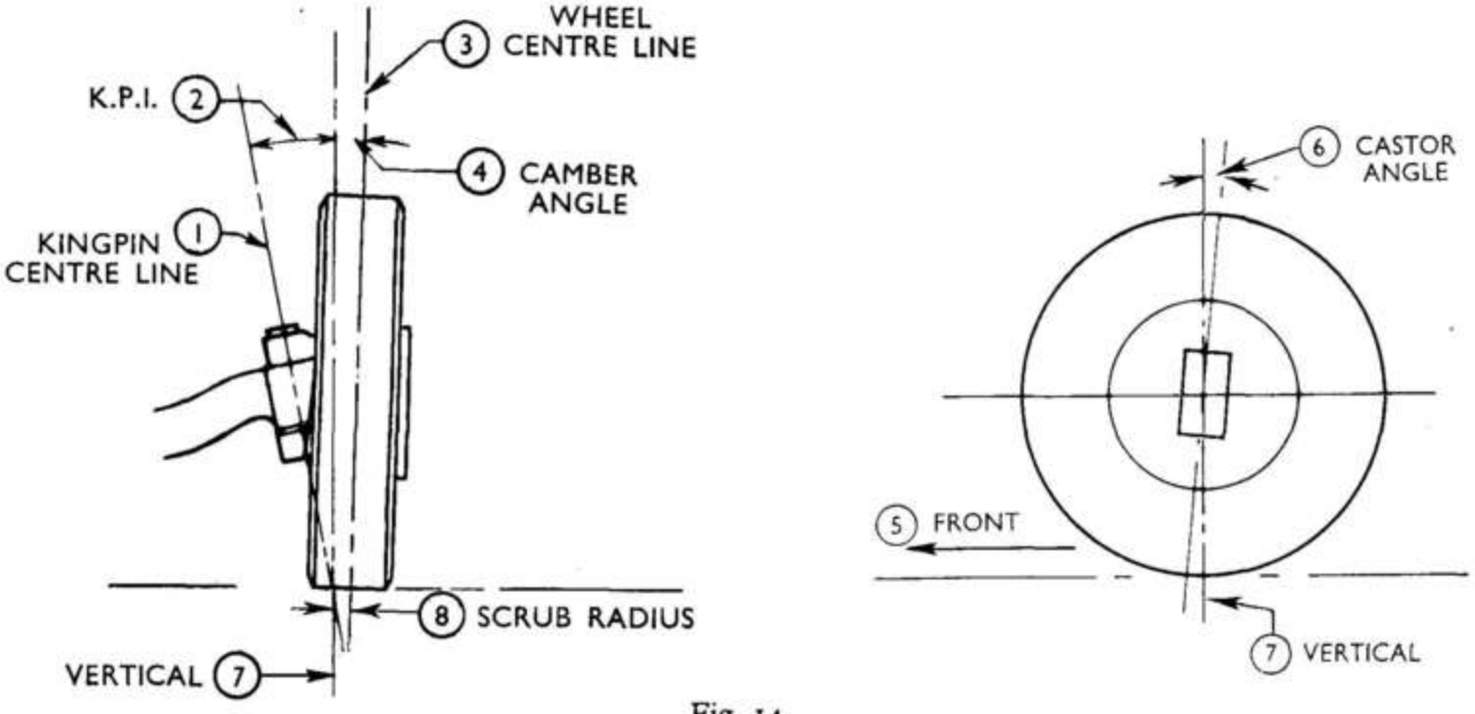


Fig. 14
Wheel Alignment

To Zero the Gauges

1. **The vehicle must be placed** on absolutely level ground with the wheels in the straight-ahead position. Place the turntables in front of the front wheels and "true-up" centrally with the vehicle. Set each pointer to zero with the adjustable scale and plate approximately central, and insert the locking pins to prevent the turntables moving.

2. **Drive the vehicle forward** on to the turntables, using ramps at the front and rear to ensure that the vehicle is perfectly level, apply the handbrake and remove the locking pins. Finally, set the adjustable scale on each turntable to zero and clamp.

3. **Clamp the steering gauge,** Tool No. 121–LA to one of the front wheels, and turn the gauge body so that it is parallel with the wheel. Set the sliding block so that the bubble of the spirit level is central between the marker lines with the gauge line reading zero on the "Camber" scale.

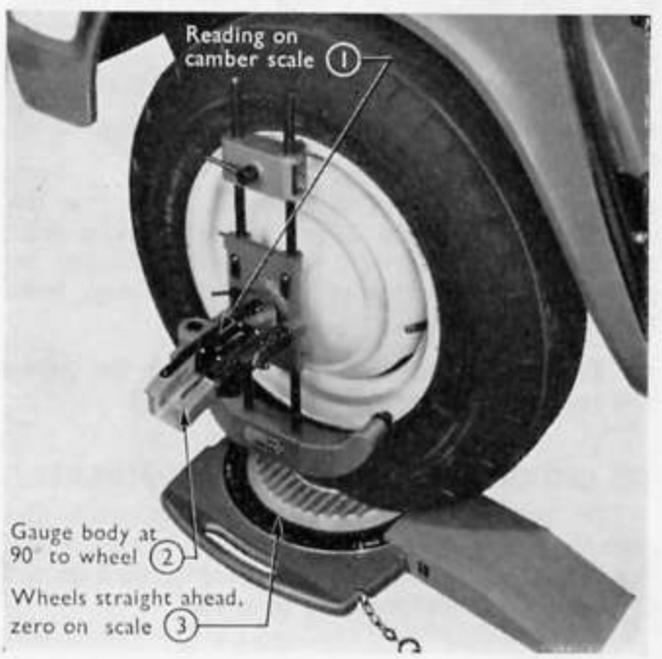


Fig. 15
Camber Angle

To Check the Camber Angle

Turn the gauge body through 90° (see Fig. 15) and set the sliding block, so that the bubble is central between the marker lines. The camber angle should now be read on the "Camber" scale, refer to the Specification for the correct figure.

To Check the Castor Angle

1. **Turn the body of the gauge** so that it is at right-angles to the wheel and to the right of the bar. Turn the front of the wheel towards the operator to read 20° on the turntable scale.

2. **Centralise the spirit level bubble,** set the "Castor and K.P.I." scale to zero, and tighten the screws. Turn the front of the wheel away from the operator to read 20° on the turntable scale.

3. **Centralise the spirit level bubble** and note the reading on the "Castor and K.P.I." scale. This is the castor angle (see Fig. 16).

Fig. 16
Castor Angle

To Check the King Pin Inclination

1. **Lock the wheels** by tightening the front brake adjusters fully.

2. **Turn the gauge body** parallel with the wheel, zero the gauge and turn the wheels until the turntable pointer reads 20°.

3. **Centralise the spirit level bubble,** set the "Castor and K.P.I." scale to zero and tighten the screws.

4. **Turn the front of the wheel** away from the operator to read 20° on the turntable scale.

5. **Centralise the spirit level bubble** and note the reading on the "Castor and K.P.I." scale. This is the king pin inclination (see Fig. 17).

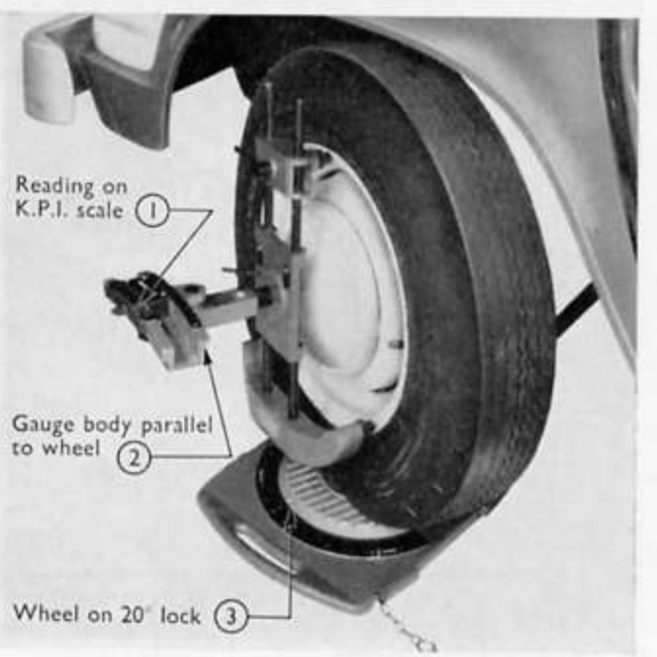


Fig. 17
King Pin Inclination

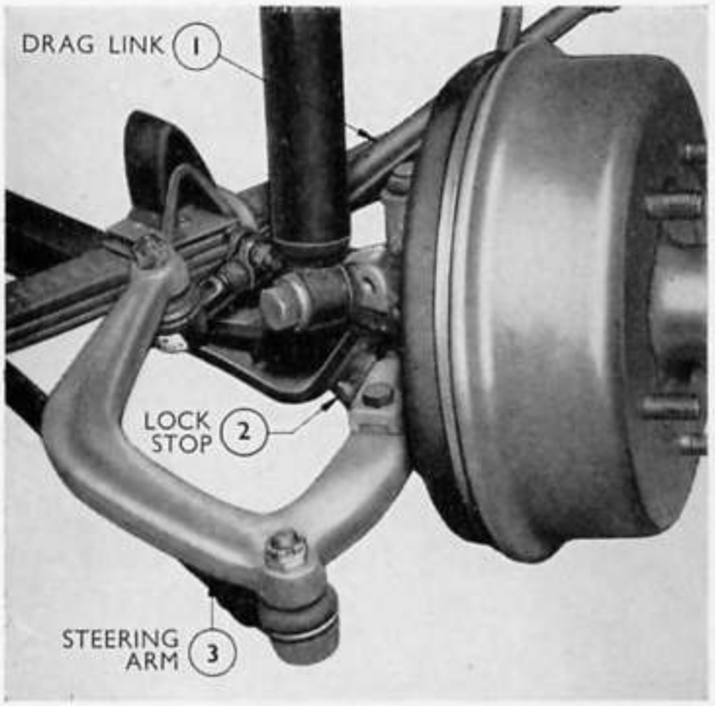


Fig. 18
Lock Stops

To Set the Steering Lock Stops

Adjustable lock stops with locknuts are fitted to the axle (see Fig. 18) and movement of the spindle body is limited when the head of the stop contacts the steering arm. This sets the maximum back lock angle for each wheel.

Refer to the turntables and set the maximum back lock angles to 42° 40′. Also, check the maximum front lock angles (see Fig. 19) as the differing turning angles are essential for correct toe-out on turns. This ensures that the inside wheel always turns more than the outside wheel as required for correct steering geometry.

Support the vehicle on chassis stands, i.e. with the axle "hanging," and ensure that the axle stops limit the steering movement in each direction, without the steering gear reaching its internal limit of travel. If this condition cannot be reached, adjust the length of the drag link. The nominal length is 45.7 cm. (18 in.) between the ball pin centres, but this can be varied to accommodate tolerance build-up in the steering mechanism. The essential condition is that the steering gear is at the centre of its travel with the front wheels in the straight-ahead position.

Note that the drag link ends have left- and right-hand threads and it is therefore possible to adjust the length without detaching either end.

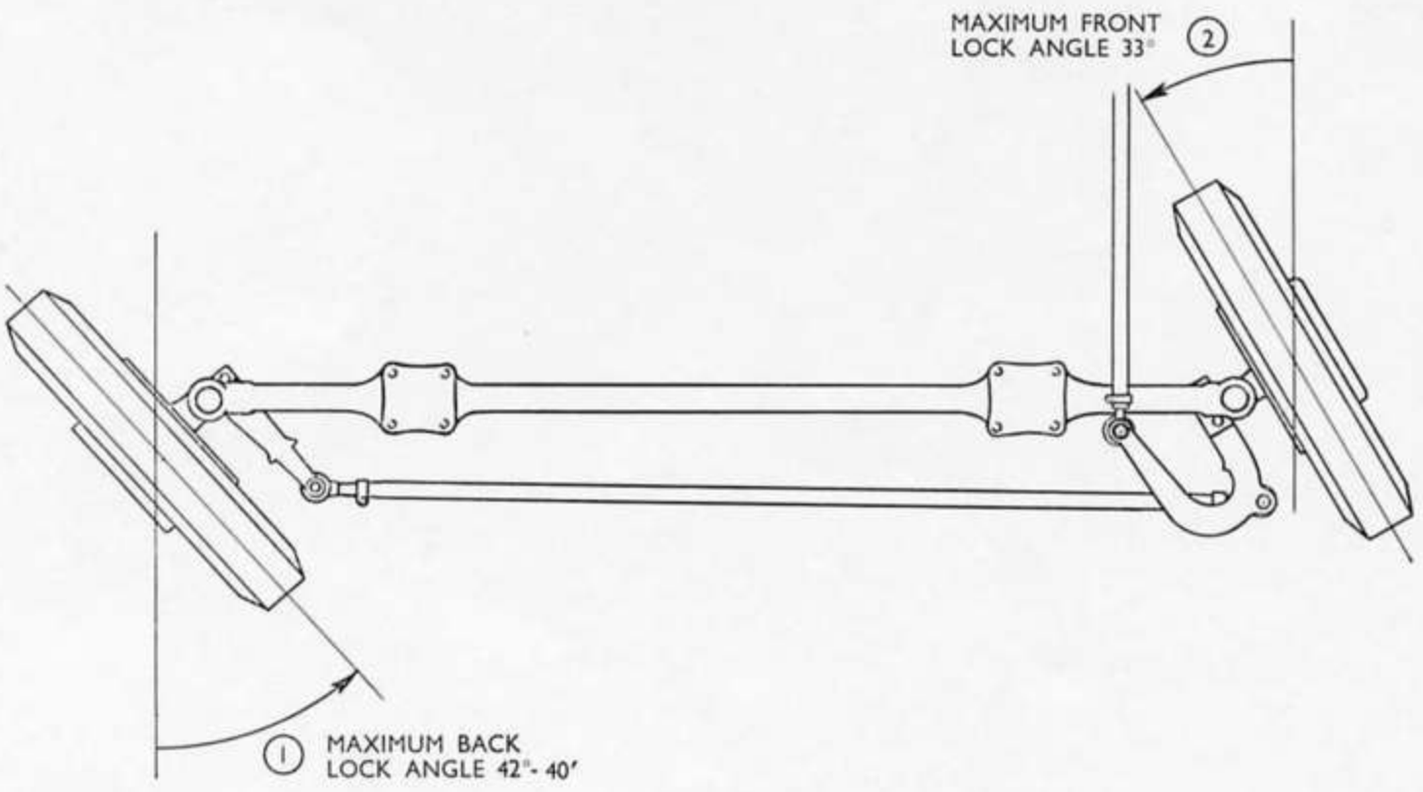


Fig. 19
Turning Angles

STEERING GEAR AND LINKAGE:

MAINTENANCE AND OVERHAUL PROCEDURES

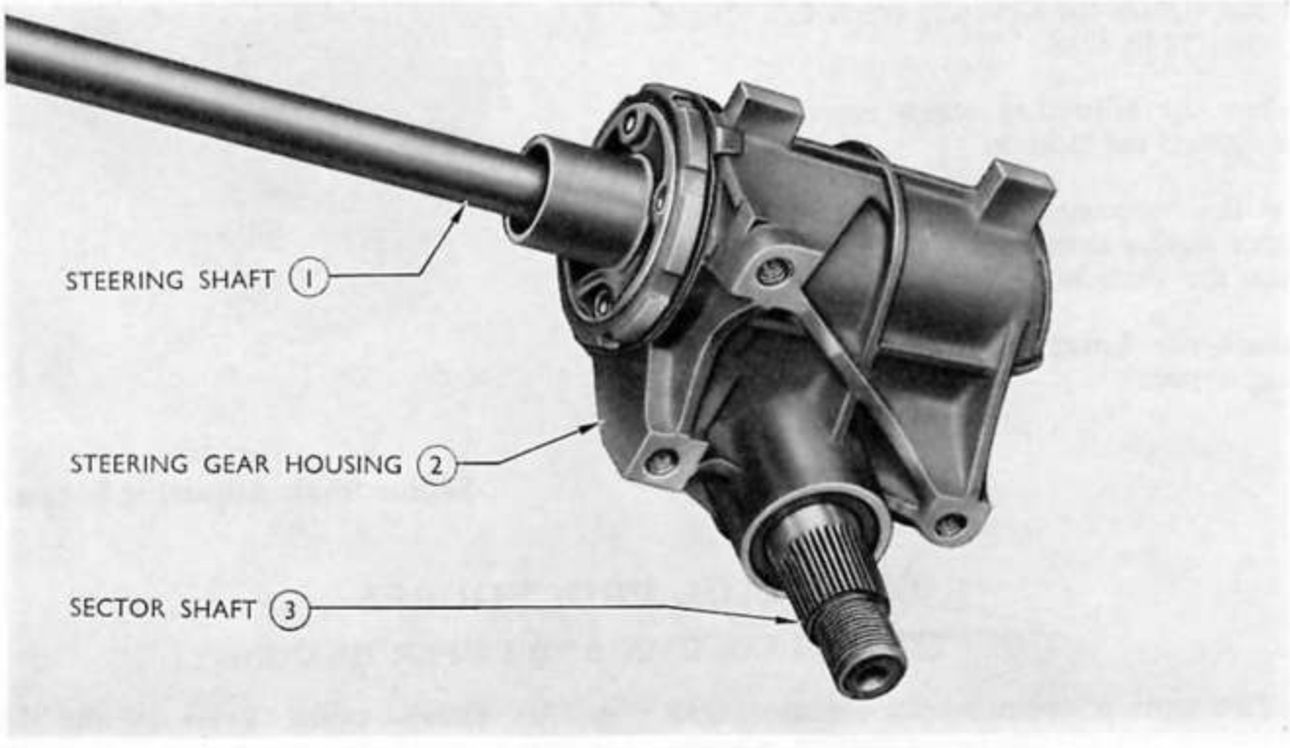


Fig. 20
The Steering Gear

DESCRIPTION

A worm and nut steering gear is used on all Transit vehicles. The nut is driven by a recirculating ball action and the steering movement is transmitted to the drop arm through the toothed sector shaft, except on the 9/12 seat diesel bus (see Fig. 25). On this model, movement is transmitted through a spherical seat on the nut which locates in the rocker shaft.

The steering wheel is splined to the steering shaft and is retained by a nut and a lock-washer. The upper end of the steering shaft runs in a ball bearing housed at the top of the steering column. The lower end of the steering column is clamped to the spigot on the upper worm shaft bearing housing.

A steering lock, operated by the ignition key, is available as optional equipment. Prior to September 1968, the lock was fastened to the lower edge of the dash panel by two "shear head" bolts necessitating their having to be drilled and extracted from the dash panel should the column need removing. After September 1968, a new design of lock was used which clamped to the steering column itself and not to the dash panel. This has the advantage that the steering box may be removed from the vehicle without having to drill out the lock retaining bolts.

When replacing a lock, the special bolts must be used and tightened until their heads shear off.

MAINTENANCE AND ADJUSTMENTS

Lubrication

Except 9/12 Seat Diesel Bus

The steering gear is packed with grease during manufacture and does not require servicing after the initial fill. The correct grease must be used (see specification) and after reassembly, (0.32 kg. (0.7 lb.) of grease should be injected through the filler hole (see Fig. 22).

9/12 Seat Diesel Bus

The steering gear is filled with oil and the level should be checked every 8,000 kgs. (5,000 miles) and should be level with the filler hole (see Fig. 30). See the specification for the correct grade of lubricant.

To Adjust the Steering Gear

1. **Turn the steering wheel** until the wheels are in the straight-ahead position.

2. **Drain the cooling system** and remove the lower radiator hose. Retain coolant if anti-freeze has been added to the cooling system.

3. **Slacken the sector shaft adjusting screw locknut** and tighten the adjusting screw to a torque of 45 kg. cm. (39 in. lbs.).

4. **Slacken the adjusting screw** exactly ¼ turn (90°) and tighten the locknut.

5. **Give the opposite end (drop arm end)** of the sector shaft a sharp blow with a rubber mallet to re-locate the shaft in its correct position.

6. **Replace the lower radiator hose** and refill the cooling system.

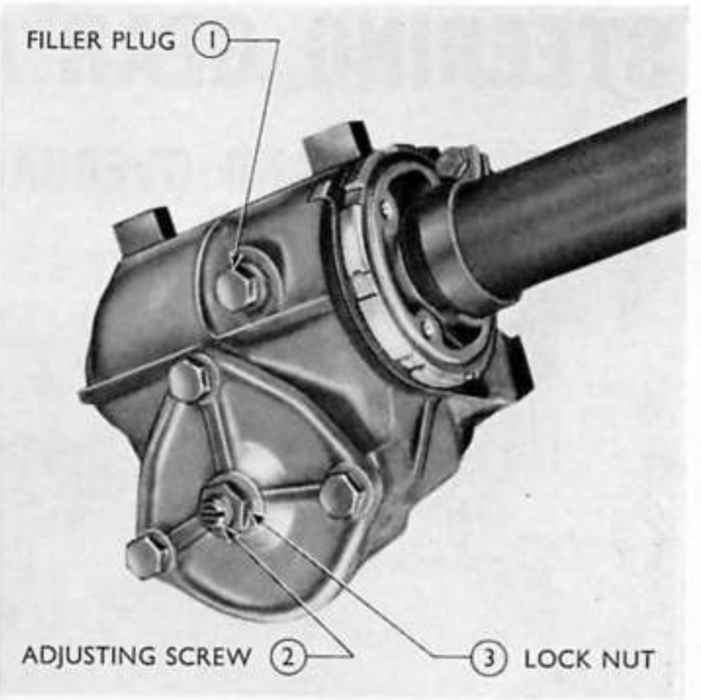


Fig. 21
Sector Shaft Adjusting Screw

OVERHAUL PROCEDURES

THE STEERING COLUMN AND UPPER BEARING

NOTE: Two types of upper bearing are used, both are ball bearings but one can be dismantled, whereas the other is an assembly.

To Remove

1. **Lever out** the steering wheel emblem, using a thin screwdriver.

2. **Bend back** the tabs of the lockwasher, unscrew the retaining nut and remove the steering wheel.

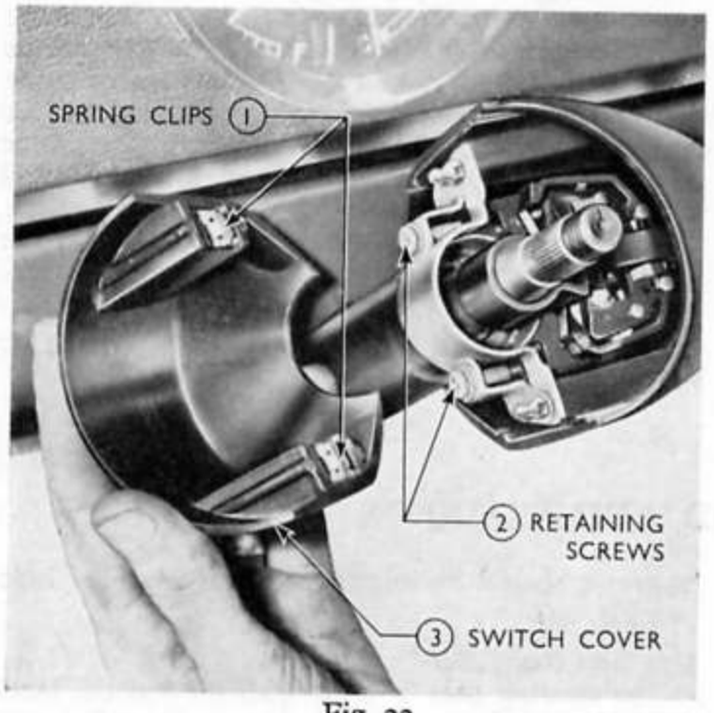


Fig. 22
Indicator and Light Switch (Prior to December 1970)

3. (*a*) (**Early type**) Lever off the side of the indicator and light switch and remove the screws retaining the switch assembly to the steering column (see Fig. 21).

(*b*) (**Late type**) Push up the upper shroud retaining ring, remove the two lower shroud retaining screws and detach the shroud halves from the column.

4. **Remove the turn signal cancelling cam** and the spring.

5. (*a*) (**Pre-September 1968**) Ensure that the steering lock (if fitted) is in the unlocked position, disconnect the wires, drill out the clamp retaining bolts and remove them with a suitable extractor.

(*b*) (**After September 1968**) Ensure that the steering lock (if fitted) is in the unlocked position, disconnect the wires and remove the two bolts retaining the column to the dash panel.

6. **From inside the engine compartment** slacken the tube to box clamp.

7. **Remove the driver's seat** and where fitted, the upper bearing wedge, and ease the column carefully upwards over the steering column shaft. On earlier models fitted with the detachable bearing care should be taken to ensure that the ball bearings do not fall out.

8. (**After September 1968 only**) The lock assembly may be removed from the column at this stage if required by removing the rubber gaiter and drilling out the two retaining bolts. Bend down the tube tabs and tap the combined shroud/indicator switch mounting plate off the top of the tube plate.

9. **The column tube** may be inverted over a suitable container and the bearing assembly driven out.

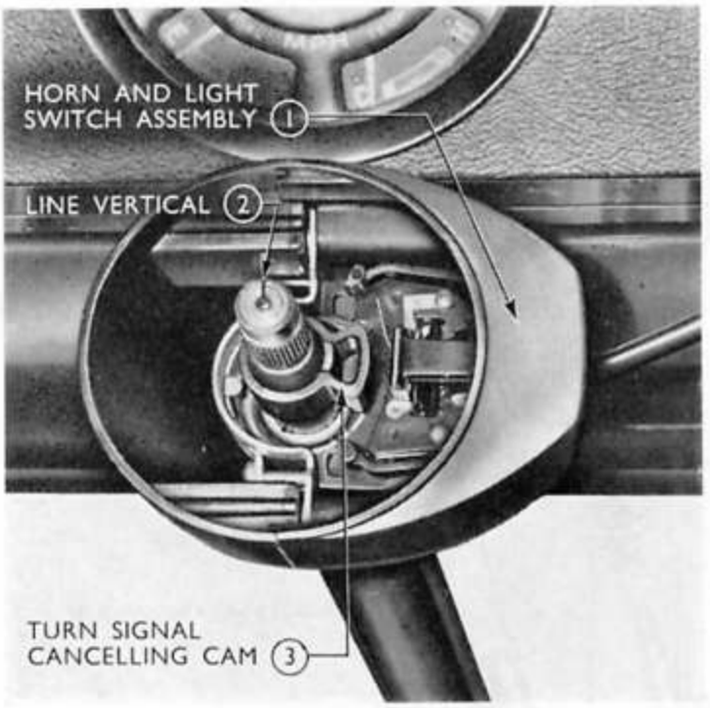


Fig. 23
Installation of the Cancelling Cam (Prior to September 1968)

To Replace

1. Where applicable stick the steel balls in the track of the inner race with suitable grease. 23×3.97 mm. ($\frac{5}{32}$ in.) diameter balls are required.

2. Grease the bearing cup, install the inner race and the balls and fit the circlip above the lower flange of the inner race.

3. Drive the bearing into place, using a piece of tube or a suitable socket locating on the edge of the bearing cup only.

4. (**After September 1968**) Replace the shroud/indicator switch mounting plate and bend down the upper tube plate locking tabs. Replace the ignition switch/steering lock but do not shear the retaining bolts. Replace the rubber gaiter.

5. Slide the tube over the column shaft, refit the wedge and the clamp and tighten the tube clamp to the steering box.

NOTE.—If an early combined clamp and steering lock is fitted the bolts retaining it to the dash panel should now be tightened until the heads shear.

6. Replace the driver's seat.

7. Replace the indicator switch assembly, refit the ignition switch/wires and tighten the bolt heads until they shear.

8. Refit the steering column shrouds and secure with the spring clips on the early models and the two retaining screws and retaining ring on later models.

9. Replace the spring and the indicator cancelling cam. Position the lobe of the cam midway between the operating levers with the steering in the straight-ahead position. Lightly lubricate the rubbing surfaces of the cam and the levers and check the cancelling action.

10. Replace the steering wheel, ensuring that the lug on the cancelling cam engages with the slot in the underside of the steering wheel boss. Note that the line on the end of the steering column should be vertically upward with the steering in the straight-ahead position.

11. Fit the tab washer and the retaining nut. Tighten the nut to a torque of 2.8 to 3.5 kg.m. (20 to 25 lb. ft.).

12. Bend up the tab washer and replace the steering wheel emblem.

THE STEERING GEAR ASSEMBLY

Prior to December 1970, the steering box may be removed from the vehicle as a complete unit with the steering column. After this date however, it is necessary for the column to be removed first as the upper clamp is integral and cannot be passed through the aperture in the bulkhead.

The steering box on the 9/12 seat diesel bus differs from that used on all other Transit vehicles and separate instructions are given to dismantle each box.

9/12 Seat Diesel Bus

The rocker shaft bush is replaceable, but the worm and nut is serviced only as an assembly.

Except 9/12 Seat Diesel Bus

The sector shaft bushes in the steering gear housing and in the side cover are machined in line during manufacture. In the event of wear, the housing and side cover must be renewed as an assembly. Also, the worm and nut is serviced as an assembly but replacement balls are available.

To Remove (Prior to December 1970)

1. Lever out the steering wheel emblem, using a thin screwdriver.

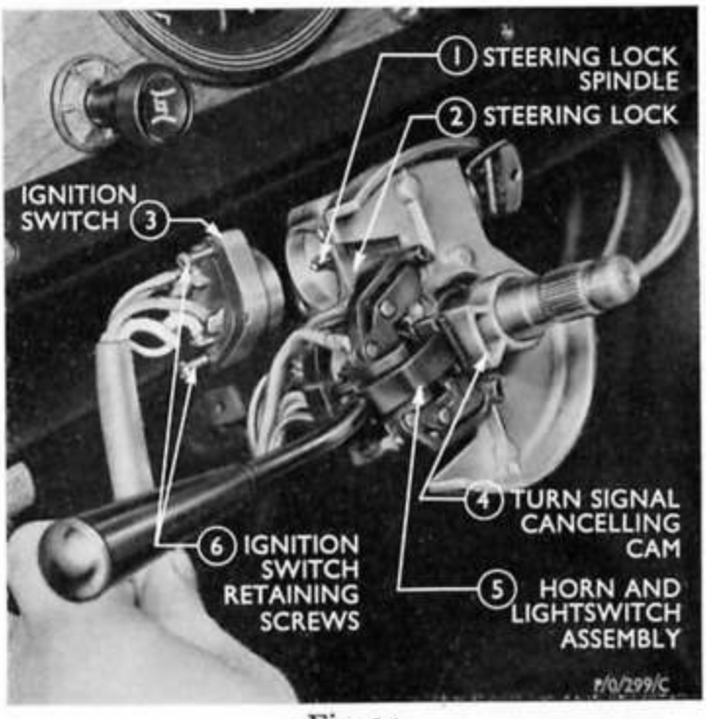


Fig. 24
Ignition Switch and Steering Lock (After September 1968)

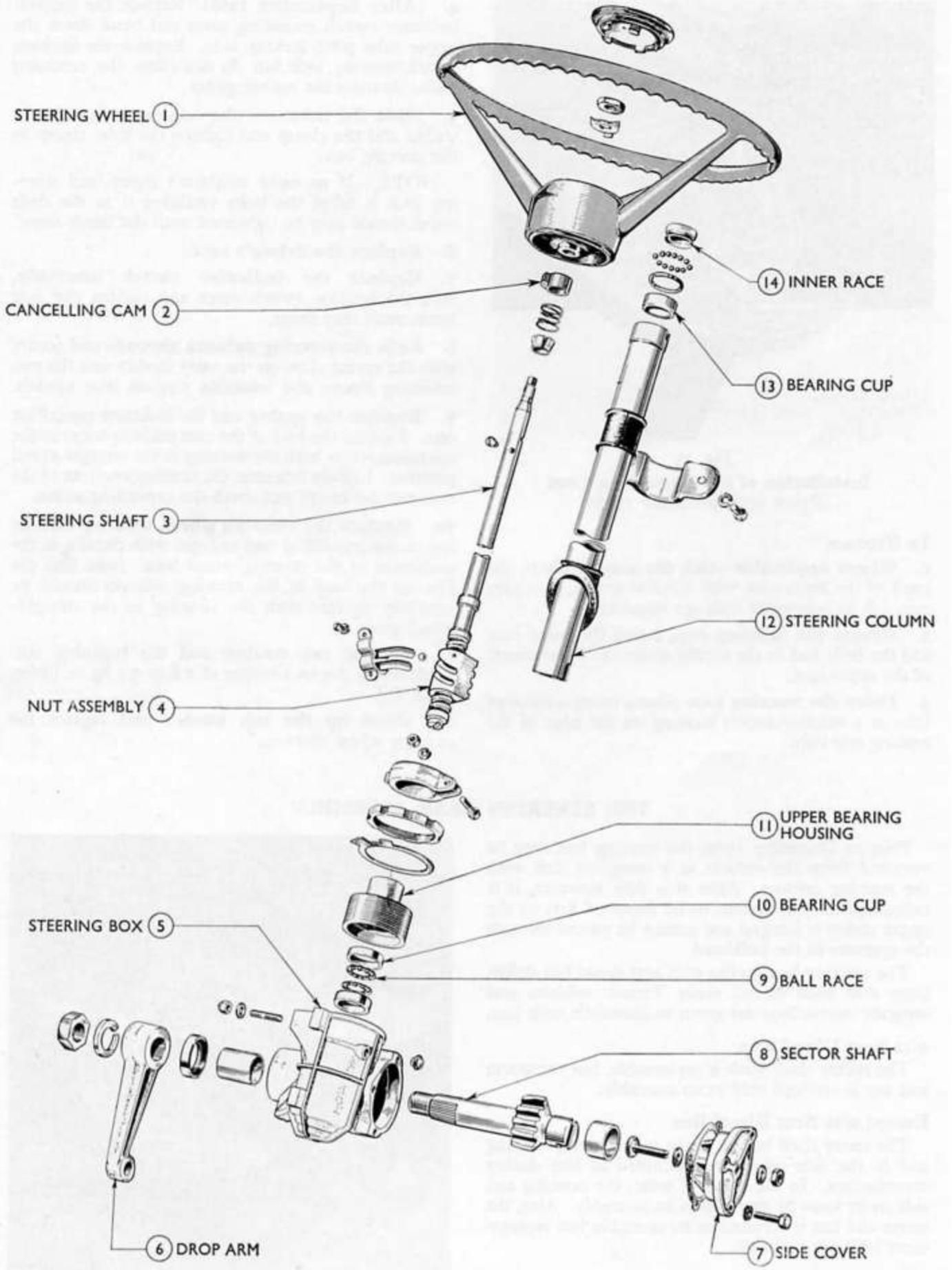


Fig. 25
The Steering Gear — Exploded (Except 9/12 Seat Diesel Bus)
(Prior to December 1970)

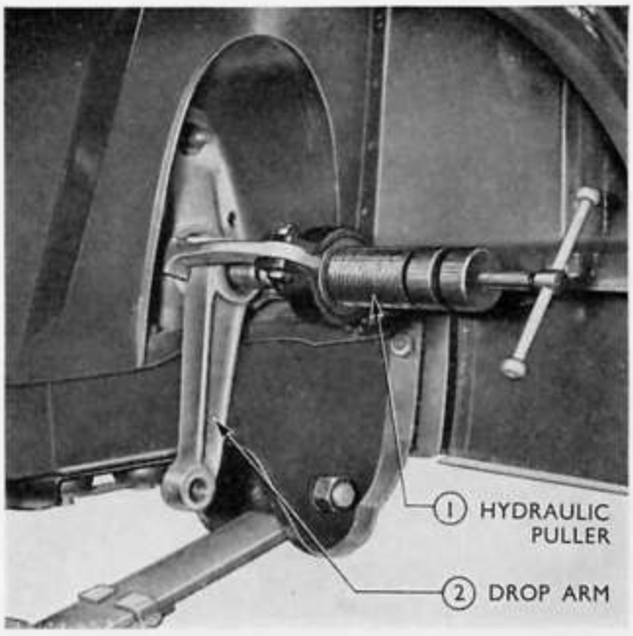


Fig. 26
Removing the Drop Arm

2. **Bend back** the tabs of the lockwasher, unscrew the nut and remove the steering wheel.

3. **Lever off** the side of the indicator and light switch, and remove the screws retaining the switch assembly to the steering column (see Fig. 22).

4. **Remove the turn signal** cancelling cam and the spring.

5. **If a steering lock is fitted,** ensure that it is in the unlocked position and disconnect the wires.

6. **Remove the bolts** retaining the upper steering column clamp or the steering lock.

7. **Remove the driver's seat.**

8. **Remove the nut** and the spring washer retaining the drop arm to the sector shaft and pull the arm off, using the 252 hydraulic puller (see Fig. 26).

9. **Remove the three nuts** securing the steering gear to the chassis frame.

10. **Remove the steering gear** and column assembly, through the engine compartment.

To Replace (Prior to December 1970)

1. **Install the steering gear** and column assembly (see Fig. 28). Fit and tighten the retaining bolts to a torque of 4.2 to 4.9 kg.m. (30 to 35 lb. ft.) and secure the upper clamp or replace the steering lock assembly and reconnect the wires.

2. **Fit the drop arm,** the spring washer and the retaining nut but do not tighten unless the drag link is in place or the steering gear will be damaged.

3. **If necessary connect the drag link,** tighten the nut and fit a new split pin.

4. **Check that the axle stops** limit the steering movement in each direction without the steering gear reaching its internal limit of travel. If necessary, reset the lock stops or adjust the drag link length, see below.

5. **Tighten the drop arm nut** to a torque of 15.2 to 18 kg.m. (110 to 130 lb. ft.).

6. **Replace the indicator and light switch** assembly, see page 14.

7. **Fit the spring** and the cancelling cam, see page 15.

8. **Replace the steering wheel,** ensuring that the lug on the cancelling cam engages with the slot in the underside of the steering wheel boss.

9. **Fit the tab washer** and the retaining nut. Tighten the nut to a torque of 2.8 to 3.5 kg.m. (20 to 25 lb. ft.).

10. **Bend up the tab washer** and replace the steering wheel emblem.

To Remove (After December 1970)

1. **From inside the driving cab** lever out the steering wheel centre emblem and the emblem retaining clip, to expose the wheel retaining nut.

2. **Bend down the locking washer tab,** remove the retaining nut and detach the steering wheel from the column shaft together with the cancelling cam and spring.

3. **Push the upper shroud retaining ring** clear of the shroud and remove two screws, one either side of the column, retaining the shroud to the steering column bracket. Detach the two halves of the shroud from the column.

4. **Disconnect the multi-plug connection** to the ignition and direction indicator switches.

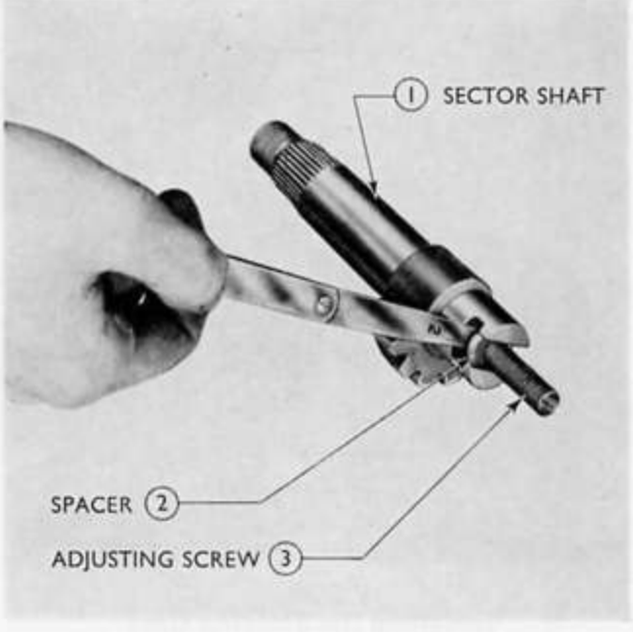


Fig. 27
Sector Shaft Spacer Selection

5. **Remove the driver's seat.**

6. **Remove the two bolts** retaining the steering column clamp to the dash panel.

7. **From under the wheel arch,** remove the nut and spring washer retaining the drop arm to the sector shaft and, using the special tool, No. 252, pull the arm off the shaft (see Fig. 26).

8. **Slacken the clamp** securing the tube to the box and, from inside the driving cab, pull the tube complete with indicator and ignition switch assemblies over the column shaft and position aside.

9. **On vehicles fitted with an automatic transmission oil cooler,** disconnect the fluid inlet and outlet pipe unions to the cooler. Slacken, but do not remove, the two bolts securing the oil cooler and radiator to the body and slide the cooler away from the bolts.

10. **Remove the three bolts** retaining the steering column box to the sidemember.

11. **The steering gear assembly** can now be removed by first pushing the assembly upwards into the driving cab, to gain the required height, and then withdrawing it over the radiator grille and out of the vehicle.

To Replace (After December 1970)

1. **Position the steering gear assembly** in the vehicle.

2. **Loosely retain the box in position** on the sidemember with the three bolts. From inside the wheel arch refit the drop arm and secure with the nut and spring washer. Finally tighten the steering box bolts.

Fig. 28
Installing the Steering Gear

(*Note*: *Outer column would have already been removed at this stage on post December* 1970 *vehicles.*)

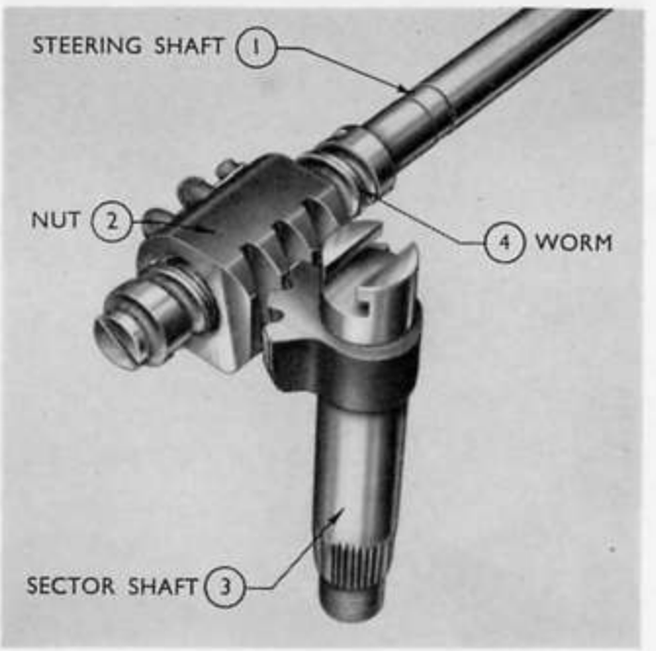


Fig. 29
Worm, Nut and Sector Shaft

3. **Where fitted,** replace the automatic transmission oil cooler and tighten the two bolts retaining the cooler and radiator to the body. Reconnect the transmission fluid inlet and outlet pipes.

4. **From inside the driving compartment** slide the steering column tube assembly down over the column shaft and secure in position with the dash panel and steering box clamps. Ensure that the tube gaiter is correctly positioned in the dash panel aperture.

5. **Reconnect the ignition** and indicator switch multi-plugs.

6. **Refit the steering column shroud.**

7. **Position the cancelling cam** and spring on the column shaft. Ensure that the wheels are in the straight ahead position and then refit the steering wheel, using a new tab washer, and tightening the nut to the specified torque.

8. **Refit the emblem retaining clip** and emblem.

9. **Replace the driver's seat.**

To Dismantle (Except 9/12 Seat Diesel Bus)

1. **(Vehicles Prior to December 1970 only).**
Release the lower steering column clamp and ease the column upwards. Remove the bearing wedge but do not dislodge the inner race or the balls will drop out. Withdraw the steering column and the upper bearing assembly.

2. **(All vehicles.)**
Remove the three bolts retaining the side cover to the steering gear housing and remove the side cover and sector shaft assembly.

3. **Remove the adjusting screw locknut,** separate the sector shaft, and cover and slide the adjusting screw and spacer out of the sector shaft location.

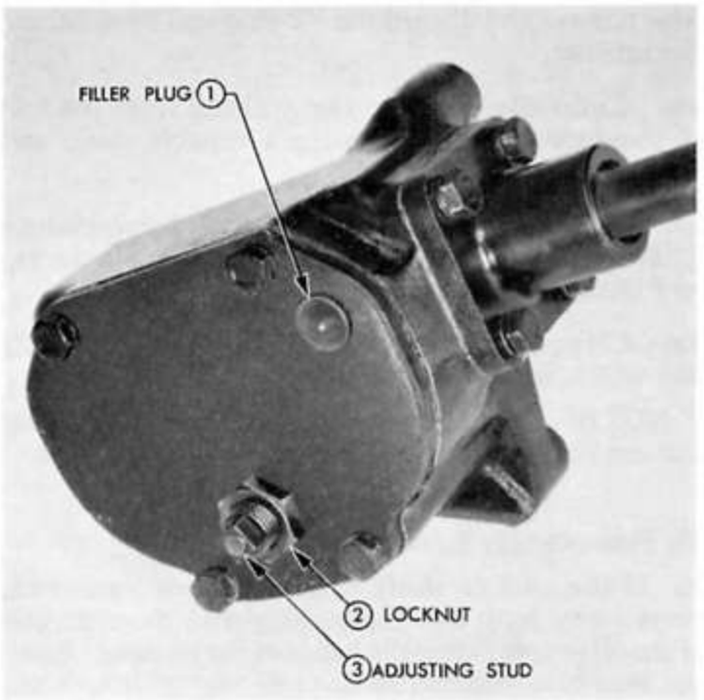


Fig. 30
Rocker Shaft Adjusting Stud

4. **Bend back the tabs** of the locking washer and, using the special tool, unscrew the locking ring from the worm shaft bearing housing.

5. **Unscrew the bearing housing** and withdraw the shaft together with the upper and lower caged rollers.

6. **Remove the bearing cups** from the bearing housing and the steering gear housing.

7. **Clamp the worm shaft** in a soft-jawed vice, then remove the clamp and the transfer tubes from the nut assembly.

8. **Remove the nut body together** with the 62 5.8 mm. dia. steel balls.

9. **Remove the sector shaft grease seal** from the drop arm end of the steering gear housing.

10. **Clean all parts** and inspect for wear.

To Reassemble (Except 9/12 Seat Diesel Bus)

1. **Replace the sector shaft grease seal** in the steering gear housing.

2. **Refit the upper and lower bearing cups** to the bearing and steering gear housings.

3. **Lubricate the worm,** nut and transfer tubes using the specified steering gear grease. Place as many balls as possible in the transfer tubes holding in position with the grease.

4. **Position the nut on the worm** and insert the balls through each of the four holes. Turn the nut as necessary and gently shake the assembly to assist in settling the balls in the grooves. When all the bearings (62) are in position locate the transfer tubes and secure with the clamp.

NOTE.—Ensure that the ball transfer holes are in line before tightening the clamp bolts.

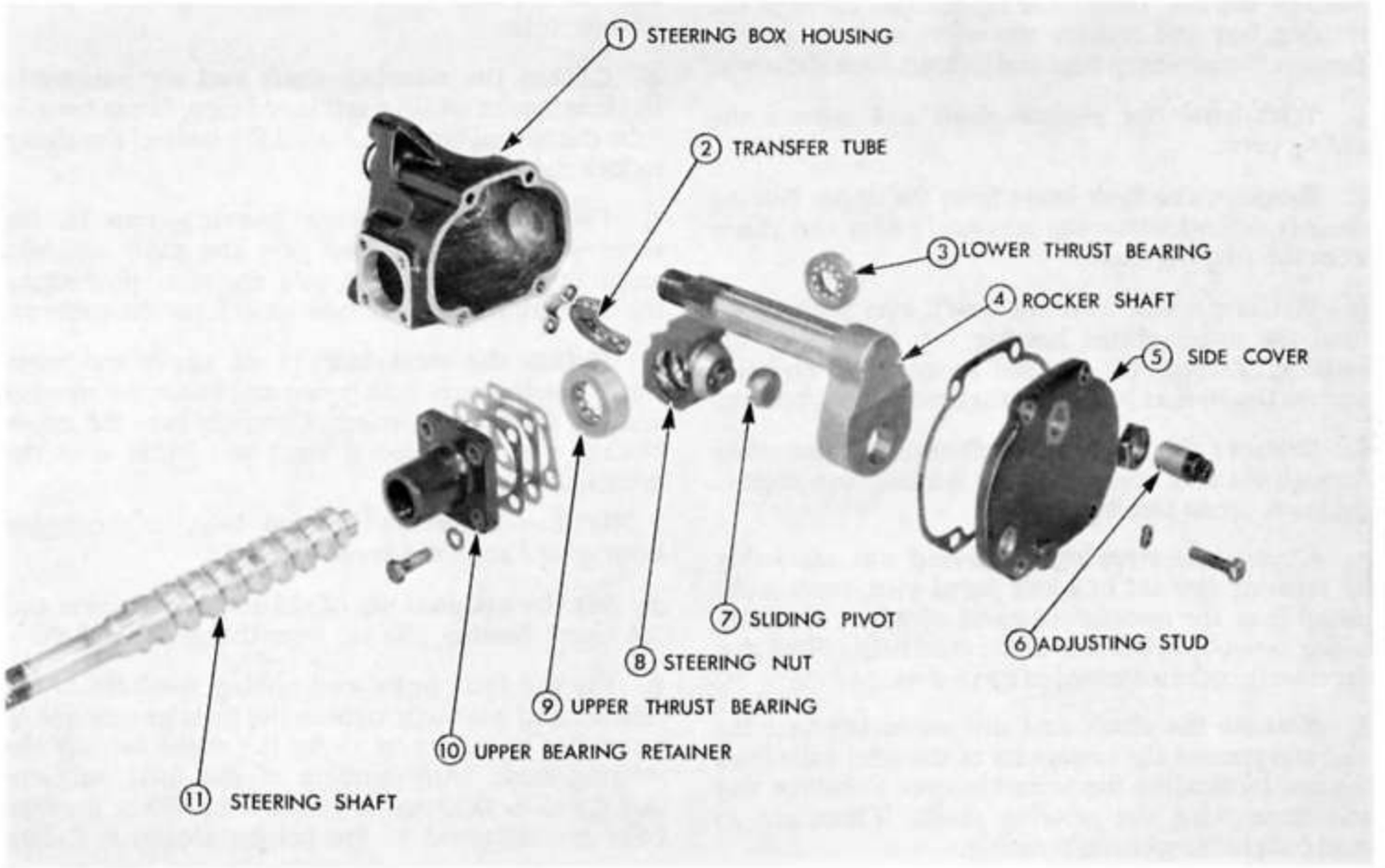


Fig. 31
The Steering Gear — Exploded (9/12 Seat Diesel Bus)

5. **Fit the bearing races** to the ends of the worm and grease thoroughly, fit the worm shaft to the housing and tighten the upper bearing housing to give a pre-load of 4.0 to 7.0 kg. cm. (3.5 to 6.0 lb. in.) on the worm shaft.

6. **Using the special tool** tighten the bearing housing locking ring to 6.1 to 8 kg.m. (44 to 58 lb. ft.) and bend up a suitable tab on the tab washer.

7. **Select an adjusting screw spacer** giving 0.05 mm. (0.002 in.) clearance between the screw and the bottom of the sector shaft locating slot and then thread the adjusting screw fully into the side cover. Loosely fit the adjusting screw locknut.

8. **Fit the sector shaft** and side cover assembly, ensuring that the centre teeth of the nut and sector are engaged, and tighten the three cover bolts.

9. **Adjust the rocker shaft end-float.** See page 14.

10. **Remove filler plug** and inject 0.32 kg. (0.7 lb.) of the specified grease into the box.

To Dismantle (9/12 Seat Diesel Bus)

1. (**Vehicles prior to December 1970 only.**) Release the lower steering column clamp and ease the column upwards. Remove the bearing wedge but do not dislodge the inner race or the balls will drop out. Withdraw the steering column and the upper bearing assembly.

2. (**All vehicles.**)

Drain the steering box oil through the filler hole, unscrew the four bolts securing the side cover to the steering box and remove the cover and the gasket. Remove the adjusting stud and locknut from the cover.

3. **Withdraw the rocker shaft** and remove the sliding pivot.

4. **Remove the four bolts** from the upper bearing retainer and withdraw the retainer, gasket and shims from the steering shaft.

5. **Withdraw the steering shaft,** over a steel tray, until the upper thrust bearing cup is clear of the housing. Remove the cup and 13 steel balls and also remove the 10 steel balls from the lower thrust bearing.

6. **Remove the steering shaft and nut assembly** through the side aperture of the housing and remove the lower thrust bearing cup.

7. **Clamp the steering shaft and nut assembly** by securing the nut in a soft jawed vice, remove the clamp from the transfer tube and withdraw the tube, taking care not to lose any of the steel balls. Note that the transfer tube is formed in two halves.

8. **Release the shaft and nut assembly** from the vice and remove the remainder of the steel balls from the nut by holding the assembly over a shallow tray and unscrewing the steering shaft. There are 27 steel balls in the steering assembly.

9. **Inspect the rocker shaft bush** and if it is unserviceable carry out operations 10 and 11, otherwise remove and discard the 'O' ring seal from behind the retainer.

10. **Carefully remove the staking** from the end of the rocker shaft bore using a suitable chisel and discard the retainer and seal.

11. **Remove the rocker shaft bush** by screwing a $\frac{7}{8}$" B.S.P. tap into the bush and pressing out the tap and bush from the housing.

12. **Clean and inspect all the parts,** replacing any which are unserviceable.

NOTE.—The ball bearings used in the steering nut are larger than those used in the two bearings.

To Reassemble (9/12 Seat Diesel Bus)

1. **If the rocker shaft bush has been removed,** press a new bush into the housing with the open end of the oil groove facing the inside of the housing. Ream the bore to a diameter of 28.55 to 28.575 mm. (1.124 to 1.125 in.) and clean all traces of swarf from the housing.

2. **Fit a new seal and retainer** and stake the outside of the housing in four places to secure the retainer.

3. **Position the nut on the steering shaft** and place as many steel balls as possible in the nut and transfer tube. 27 balls are required at this location. If difficulty is found in accommodating them all, fit the transfer tube and turn the nut on the shaft. Remove the tube again and repeat the above procedure until all the balls have been fitted and finally fit the transfer tube.

4. **Clamp the steering shaft and nut assembly** by securing the nut in a soft jawed vice, fit the transfer tube clamp and bolts, and bend the ends of the clamp to lock the bolts.

5. **Fit the lower thrust bearing cup** in the steering box housing and pass the shaft and nut assembly in through the side aperture, positioning the nut with the transfer tube away from the aperture.

6. **Retain the steel balls** in the upper and lower thrust bearing cups with grease and locate the steering shaft in the lower bearing. Carefully pass the upper bearing over the steering shaft and locate it in the housing.

NOTE.—There are 13 steel balls in the upper bearing and 10 in the lower bearing.

7. **Fit the original set of shims,** a new gasket and the upper bearing retainer over the steering shaft.

8. **Fit the four bolts and spring washers** to the retainer and gradually tighten the bolts to a torque of 2.1 to 2.5 kg.m. (15 to 18 lb. ft.) whilst turning the steering shaft. Any binding of the shaft indicates that the shim thickness is insufficient. When the four bolts are tightened to the correct torque the shim thickness should just eliminate the end float on the steering shaft. Shims should be removed or replaced as necessary, to achieve this adjustment.

9. Remove the bearing retainer and take out a shim 0.051 to 0.076 mm. (0.002 to 0.003 in.) thick. Replace the retainer, apply a suitable sealer to the bolts, and tighten them again to a torque of 2.1 to 2.5 kg.m. (15 to 18 lb. ft.). This will apply the required pre-load to the steering shaft.

10. Turn the steering shaft so that the nut is in the central position, fit the sliding pivot to the nut and locate the rocker shaft in the housing to engage on the nut.

11. Fit a new side cover gasket and replace the cover. Coat the shorter two bolts with a suitable sealer and fit them, with spring washers, into the two holes which break through into the housing. Fit the remaining bolts and spring washers into the other two holes and tighten all four bolts to a torque of 2.1 to 2.5 kg.m. (15 to 18 lb. ft.).

12. Coat the rocker shaft adjusting stud with a suitable sealer and screw it into the side cover until it just contacts the rocker shaft and all end float is eliminated. Fit and tighten the locknut and check that the end float is eliminated.

13. Insert 0.42 litre (0.74 pints) of steering gear oil, Part No. ME–568–C, through the filler hole and fit the filler plug.

14. Replace the steering column, secure the lower clamp and fit the bearing wedge.

THE STEERING LINKAGE

Movement of the drop arm is transmitted directly to the spindle body through the drag link and the drag link to spindle steering arm (see Fig. 32).

The relative movement of the two spindle bodies is controlled by the connecting rod and the spindle to connecting rod steering arms.

To Renew the Drag Link Assembly

1. Remove the nut and the split pin retaining each ball ioint.

2. Free the ball pins, and remove the drag link assembly.

3. If the drag link ends are being renewed, slacken the clamp bolts and unscrew the ends. Note that the drag link ends have left- and right-hand threads.

4. Screw the new drag link ends on to the drag link, ensuring that an equal number of threads are engaged at each end. Set the length between the ball pin centres to 45.7 cm. (18 in.). (Nominal). This length may be varied, to accommodate tolerance build up in the steering mechanism. The essential condition is that the steering gear must be at the centre of its travel with the front wheels in the straight-ahead position.

5. Tighten the clamp bolts and reconnect the drag link ends. Tighten the ball pin nuts and fit new split pins.

6. Check that the axle lock stops are limiting the steering movement in both directions. If not, reset the lock stops to give a back lock angle of 42° 40′ in each direction. If the above condition still cannot be obtained, check the steering arms and the spindle bodies for damage.

To Renew the Connecting Rod Assembly

NOTE.—The connecting rod ends have left- and right-hand threads. Thus, the overall length of the assembly can be adjusted by slackening the clamp bolts and rotating the connecting rod. It is not necessary to detach either end of the rod.

1. Remove the split pins and the nuts from the ball pins at each end of the connecting rod.

2. Free the ball pins and detach the connecting rod assembly.

3. Slacken the clamp bolts and unscrew the ends.

4. Assemble the new ends to the connecting rod, ensuring that an equal length of thread is engaged at each end.

5. Install the connecting rod assembly, tighten the ball pin nuts and fit new split pins.

6. Install the tracking gauge, Tool No. 96 and set the front wheel toe-in between 2.38 and 3.97 mm. (0.094 to 0.156 in.) with textile tyres, or between 0.00 and 1.60 mm. (0.00 and 0.063 in.) with radial tyres.

7. Tighten the clamp bolts and re-check the toe-in. If satisfactory, remove the tracking gauge.

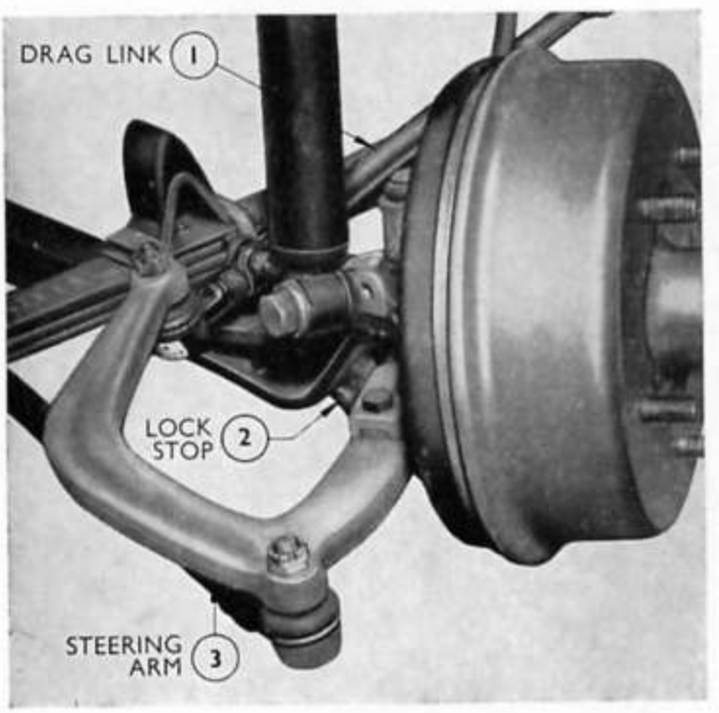


Fig. 32
Lock Stops and Steering Arm

Section 4

REAR AXLE

CONTENTS

SUBJECT

REAR AXLE

OVERHAUL PROCEDURES – *75 TO 115 ONLY*

Description

The rear axle is of the three-quarter floating type, incorporating a hypoid crown wheel and pinion and a four-pinion differential. The crown wheel and pinion are mounted in the differential carrier, which is bolted to the front face of the banjo-type axle housing.

Adjustments are provided for pinion bearing pre-load, crown wheel and pinion backlash and pinion depth of mesh. All repairs can be carried out to the component parts without removing the axle housing from the vehicle.

Lubrication and Maintenance

The rear hub bearings are packed with lubricant when the vehicle is built and should not normally require lubrication except at overhaul periods, when if the bearing is not renewed, it must be repacked with a good quality lithium base grease. The universal joints are the needle roller type, welded to each end of the tubular drive shaft, and are sealed for life.

The combined filler and level plug for the axle is situated at the left-hand side of the differential housing (see Fig. 1,) whilst no drain plug is fitted or required.

After the first 800 kms. (500 miles) interval, check the torque of the differential carrier nuts and check the lubricant level with the vehicle standing on level ground. After this initial check, the lubricant level should thereafter be checked at 8,000 kms. (5,000 miles) intervals. Remove the level plug and the oil should be to the bottom of the hole, add oil if necessary

Fig. 1
Filler and Level Plug

to bring it to this level. Replace the level plug and tighten it securely.

Note that only hypoid and not ordinary gear oil is to be used: refer to the Specification section for the correct grade of oil.

If a new crown wheel and pinion or differential carrier assembly have been fitted, fill the axle to the correct level with the special oil supplied with these parts and run-in the axle as for a new vehicle for 800 kilometres (500 miles).

DRIVE SHAFT AND UNIVERSAL JOINTS

The drive shaft and universal joints can be removed as an assembly and should be treated with care as they are balanced to fine limits.

To Remove

1. **Remove the four self-locking nuts and bolts** from the drive and pinion shaft flanges and push the shaft forward slightly to separate the two flanges.

2. **Lower the rear end of the drive shaft** and ease it to the rear to disengage the gearbox main shaft splines.

NOTE.—When the drive shaft is removed, a small quantity of oil may leak from the gearbox extension housing. The oil level of the gearbox must be checked and topped-up if necessary, after road test.

Overhauling the Universal Joints

The universal joint spider, bearings, oil seals and retainers are serviced as a kit.

1. To dismantle, extract each spider bearing snap ring and remove the bearing cups and rollers by gently tapping the yoke at each bearing.

2. Remove the spider and detach the oil seal and seal retainer from each spider journal.

3. To reassemble, fit new oil seals to the retainers and locate them on the shoulders of the spider journals with the oil seals outwards. Position the spider in the drive shaft yoke, assemble the needle rollers in each bearing cup and refit the bearings, tapping them squarely into place. Take care not to dislodge the needle rollers. Pack the bearing cups with a molybdenum disulphide lithium base grease.

4. Similarly, refit the other half of the joint.

5. Refit the snap rings to each bearing. Lubricate the bearings thoroughly with a molybdenum-disulphide lithium base grease.

To Replace

1. **Slide the front universal joint yoke** onto the gearbox mainshaft splines, taking care not to damage the extension housing rear oil seal or bearing.

2. **Lift the rear end of the drive shaft** and align the mating marks on the drive flanges. Fit the four bolts and self-locking nuts, tightening the nuts securely.

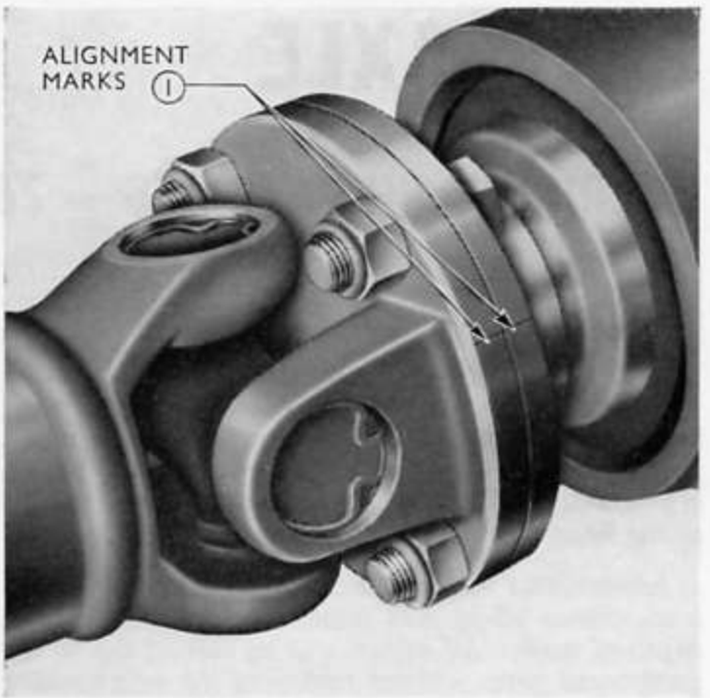


Fig. 2
Universal Joint

3. **Road test the vehicle** and then check the gearbox oil level.

AXLE SHAFT REMOVAL AND HUB OVERHAUL

The axle shafts and hubs may be removed for inspection and overhaul without disturbing the differential assembly, using the procedure detailed below.

To Remove

1. **Jack up the vehicle** and fit stands.

NOTE.—Jacks and stands should only be positioned against the axle housing, and never against body chassis members, unless changing axle or spring assemblies. If it is necessary to support the vehicle on a chassis member, ensure that the vehicle is unladen otherwise the chassis members will be damaged.

2. **Remove the hub cap,** unscrew the wheel nuts and remove the road wheel. Slacken off the brake shoes and remove the brake drum.

3. **Withdraw the axle shaft.**

4. **Remove the hub nut.** Straighten the tab on the locking washer and using Tool No. C.4107, unscrew the hub nut and remove it together with the locking washer.

5. **Withdraw the hub assembly,** using the slide hammer Tool No. CPT.3072 and adaptor CP.3072-4A. Locate the adaptor on the wheel studs and secure with the wheel nuts. Screw the slide hammer into the centre of the adaptor, and remove the hub assembly.

6. **To remove the hub bearing** and bearing spacer, pass the driver, Tool No. P.1021 through the grease retainer, so that it locates on the face of the bearing inner diameter. Support the hub and press out the bearing spacer and bearing.

7. **Lever the old grease retainer** from the hub.

NOTE.—Prior to fitting new grease retainers or oil seals inspect the sealing lips to ensure that they are in a good and serviceable condition.

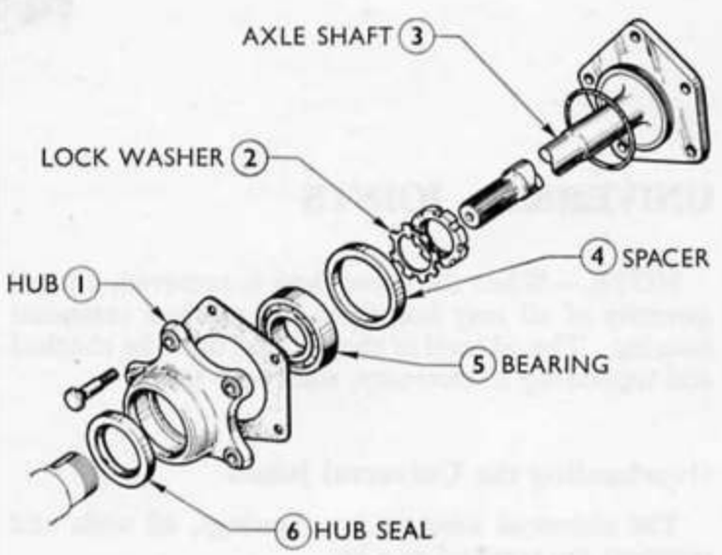


Fig. 3
Rear Hub 75—115

To Replace

1. **Locate a new grease retainer** on the driver Tool No. P.1013 with the sealing lip towards the handle of the tool. Drive the grease retainer into position until it seats against the shoulder in the hub.

2. **Refit the hub bearing.** Pack the bearing with a lithium base grease and locate it squarely in the hub. Press it into position, so that it seats squarely on the shoulder in the hub. Next fit the bearing spacer in a similar manner.

3. **Locate the adaptor** Tool No. CP.3072-4A over the wheels studs and drive the hub into position until the inner race of the hub bearing contacts the shoulder on the axle housing. Spin the hub to ensure that it is free to rotate.

4. **Fit a new locking washer** and the hub nut to the axle housing with the tongue of the washer engaging in the groove in the housing end. Using Tool No. C.4107 tighten the nut to a **minimum** torque of 18 kg.m. (130 lb. ft.). One tab on the locking washer should align with a slot in the nut. If not, **tighten** the nut still further, then bend one tab into a slot in the nut, to lock the nut.

5. **Refit the axle shaft.** Place a new gasket on the hub flange and fit the axle shaft.

6. **Locate the brake drum** on the wheel studs, fit the wheels and wheel nuts. Lower the vehicle to the ground.

7. **Tighten the wheel nuts** to a torque of 7.60 to 9.8 kg.m. (55 to 70 lb. ft.) and refit the hub cap. Readjust the brakes.

Axle Identification

To identify an axle ratio, a tag is fitted to an upper left-hand differential carrier mounting stud (see Fig. 1). This identification tag is stamped with the axle ratio and the axle assembly part number. When overhauling a differential assembly in service always ensure that this identification tag is replaced. Should the axle ratio be altered the original tag must be replaced by a tag corresponding to the new axle ratio.

DIFFERENTIAL CARRIER ASSEMBLY

To Remove

1. **Remove both brake drums** and withdraw the axle shafts as described previously, see page 4.

2. **Place an oil tray** under the centre of the axle housing.

3. **Disconnect the drive shaft** at the rear end, see page 3.

4. **Unscrew the eight self-locking nuts** securing the differential carrier to the axle casing, lift up slightly and allow the oil to drain.

5. **Withdraw the carrier,** complete with crown wheel and differential assembly.

To Replace

1. **Before reassembly, check the mating flanges** of the axle housing and carrier for burrs and place a new gasket on the axle housing studs.

2. **Position the differential carrier** with the pinion to the bottom, and locate it on the studs of the axle housing. Fit the eight self-locking nuts and tighten the nuts to a torque of 3.46 to 4.15 kg.m. (25 to 30 lb. ft.).

3. **Reassemble the drive shaft,** axle shafts, brake drums and road wheels.

4. **Refill the axle** to the level plug with 2.1 litres (4.5 U.S. pints, $3\frac{3}{4}$ Imp. pints) of the correct grade of hypoid gear oil (see Specification section), provided a new crown wheel and pinion have not been fitted (see page 3). After a road test, check the gearbox oil level as some oil may have been lost if the drive shaft was completely removed from the vehicle.

To Dismantle

1. **Remove the differential carrier assembly** and, using the adaptor (Tool No. CP.4046) mount it on the dismantling stand.

2. **Check the mating marks** on the differential bearing caps (see Fig. 17), unscrew the adjusting nut locking plate bolts and detach the locking plates.

3. **Slacken the differential cap bolts** and then using the spanner (Tool No. CP.4007) back off the differential bearing adjusting nuts. Remove the differential bearing cap bolts and lockwashers and carefully detach the bearing caps.

4. **Lift out the crown wheel assembly,** together with the differential bearings and adjusting nuts. Take care to keep the bearings and cups as assemblies.

5. **Withdraw the drive pinion.** This is secured by a retaining nut which presses the coupling flange against the inner face of the front pinion bearing. A tubular spacer is fitted between the pinion bearings and the length of this spacer controls the pinion bearing pre-load. The drive flange retaining nut is staked to the pinion to lock it in position.

   (*a*) Relieve the staking, then holding the pinion flange with the spanner (Tool No. CP.4092), unscrew the drive flange retaining nut.

   (*b*) Pull the drive flange from the pinion splines. The pinion with its tubular spacer and rear bearing cone can now be withdrawn from the carrier.

6. **Remove the pinion bearing cups, front bearing and oil seal.** Drive out the front bearing and oil seal first (see Fig. 5), using the special driver (Tool No. CP.4015A), passing the body of the tool

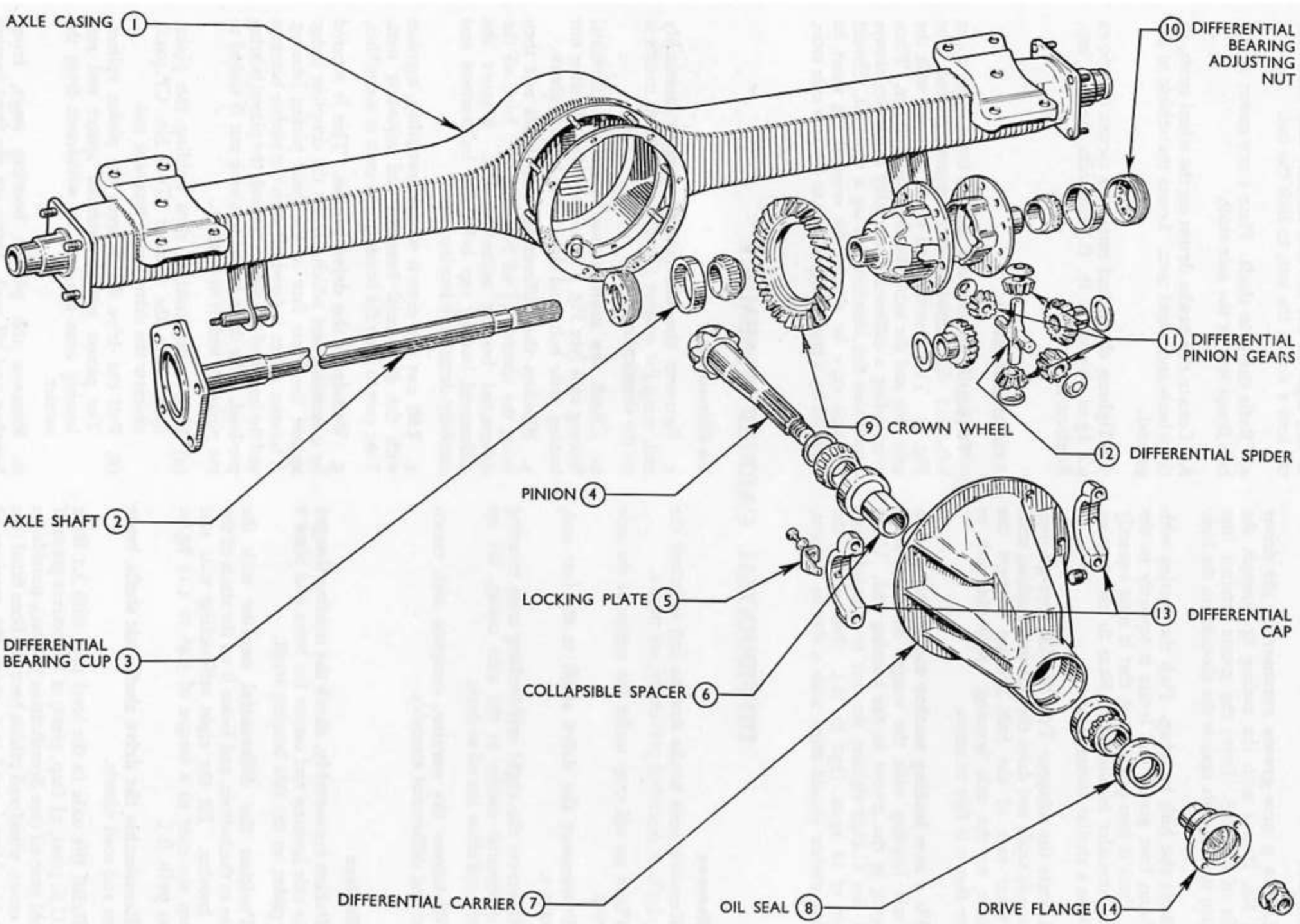


Fig. 4
Rear Axle—Exploded

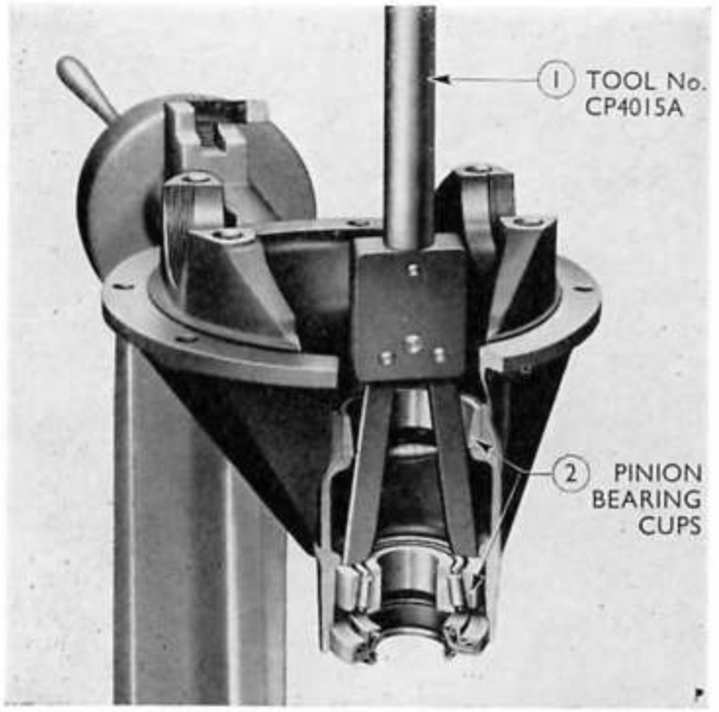


Fig. 5
Removing Front Pinion Bearing and Oil Seal

through the rear bearing cup. Ensure that the spring-loaded legs of the driver are located in the notches provided behind the bearing cup, as shown in Fig. 5. Drive out the rear pinion bearing cup from the front, in the same manner.

7. Dismantle the pinion assembly:

(*a*) Detach and discard the collapsible bearing spacer from the pinion shaft.

(*b*) Locate the pinion assembly in the support ring with the lips of the adaptor segments (Tool No. CP.4000-18) behind the bearing cone. Mount the assembly in the base plate on the bed of a press, or in a hand press (Tool No. CP.4000) as shown in Fig. 6. Check that the bearing cage is free to rotate and press out the pinion. Remove the shim from the pinion shaft.

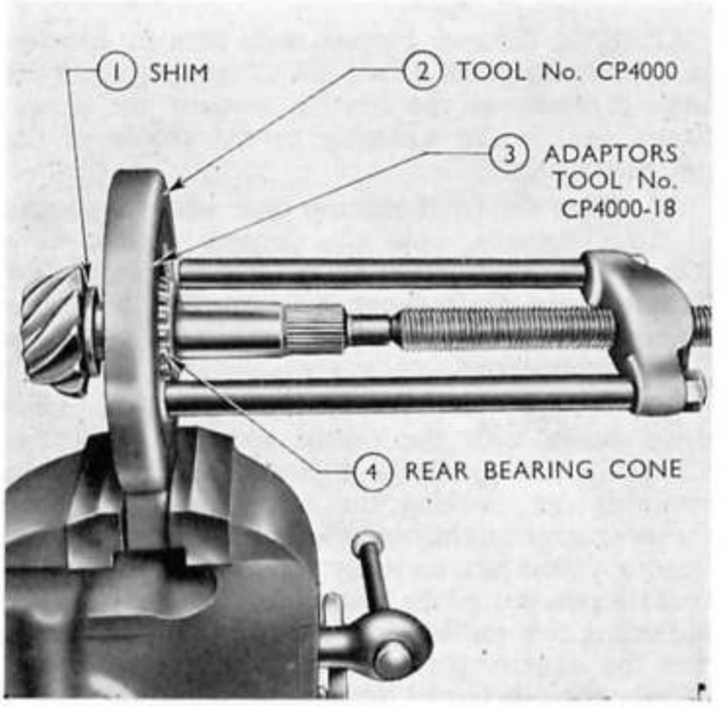


Fig. 6
Removing Rear Bearing Cone

8. Dismantle the crown wheel and differential assembly:

(*a*) Unscrew the eight self-locking bolts securing the crown wheel to the differential case.

(*b*) Suitably support the crown wheel and press the differential case through the crown wheel.

(*c*) Mark the two halves of the differential case to ensure correct reassembly, and then split the differential case and remove the spider, four pinion gears and four spherical thrust washers.

(*d*) Lift out the differential gears and the flat washers located between the gears and the differential case.

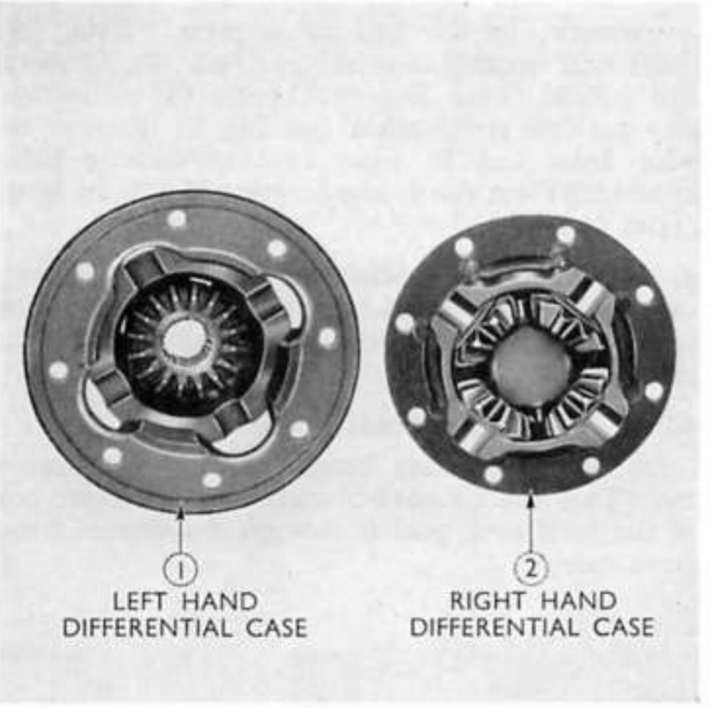


Fig. 7
Differential Case

(*e*) Remove the differential bearing cones. Locate the bearing removing adaptors (Tool No. CP.4000-17) around the differential bearing cones and in the support ring, support the assembly on the bed of a press and, using the driver, press off the bearing cones. Ensure that the adaptors are correctly located under the cone and in the support ring to prevent damage to the roller cage.

(*f*) Clean and examine all parts, renewing where necessary.

To Reassemble

Four adjustments must be carried out when assembling a differential carrier correctly. They are:—

(*a*) Select the correct pinion bearing shim.
(*b*) Adjust the pinion bearing pre-load.
(*c*) Adjust crown wheel and pinion backlash.
(*d*) Adjust differential bearing pre-load.

1. Lubricate the flat thrust washers and position them on the flanges of the axle shaft gears, then locate the gears in the two halves of the differential case.

2. Lubricate each spherical thrust washer and locate one behind each pinion gear on the spider. Position the spider and pinion gears in the left-hand differential case.

3. Assemble the two halves of the differential case, ensuring that the mating marks line up.

4. Refit the crown wheel. Examine the mating faces of the crown wheel and differential case for burrs; any burrs found on these faces should be removed by lightly stoning. Locate the crown wheel on the differential case so that the retaining bolt holes are in line.

Enter two or four suitable bolts through the case flange into the crown wheel to ensure correct alignment and support the crown wheel, teeth downwards, on the bed of a press. Using the differential bearing cone driver (Tool No. CP.4012) and handle (Tool No. 550), press the differential case onto the crown wheel (see Fig. 8). Remove the pilot bolts and fit eight new self-locking bolts, tightening them evenly to a torque of 6.2 to 6.9 kg.m. (45 to 50 lb. ft.).

5. Refit the differential bearing cones. Suitably support the differential assembly and press or drive the bearing cones on to the differential case using the driver (Tool No. CP.4012 and the 550 handle).

6. Fit the pinion bearing cups:

(*a*) Place the inner bearing cup on the adaptor tool (Tool No. CP.4013-2) and, with the centre bolt of the main tool, pass it through the carrier throat from the rear.

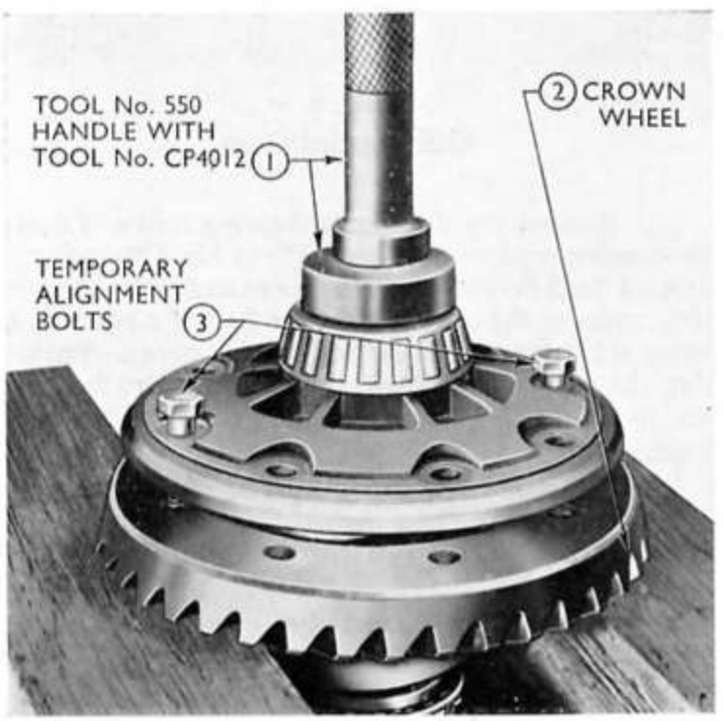


Fig. 8
Fitting the Crown Wheel to the Differential Case

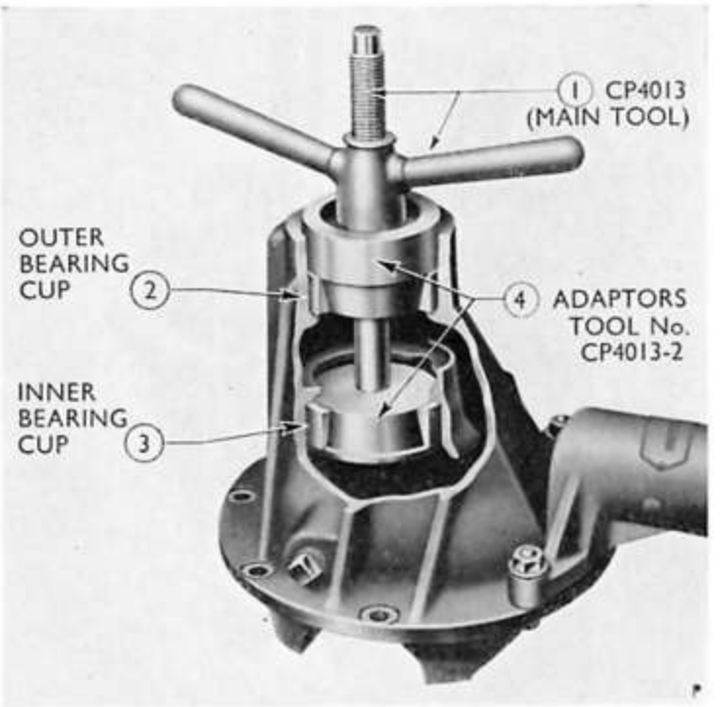


Fig. 9
Replacing Pinion Bearing Cups

(*b*) Holding the inner bearing cup, adaptor and centre bolt, align the front bearing cup, locate the outer bearing adaptor and refit the main tool wing nut to the centre bolt at the front of the housing (see Fig. 9).

(*c*) Tighten the wing nut and press the bearing cups fully home. Unscrew the wing nut and remove the tool and adaptors from the carrier throat.

The axle is now ready for adjustment. Quietness depends on the following adjustments, and every care should be taken to ensure that they are carried out in the proper order, carefully and conscientiously. The correct equipment properly used will ensure satisfactory results.

7. First select the pinion bearing shim to control depth of mesh:

(*a*) Slide the rear bearing cone onto its location on the dummy pinion (Tool No. CP.4075-2), with the large diameter of the bearing towards the pinion flange and fit the assembly to the throat of the differential carrier.

(*b*) Slide the front bearing cone with its smaller diameter inwards, onto the dummy pinion, fit a Mk II drive shaft flange on the dummy pinion (the Transit drive shaft flange will not fit due to the different spline formation) and screw on the drive flange retaining nut.

(*c*) Pre-load the pinion bearings. Hold the pinion drive flange with the special spanner (Tool No. CP.4092) and gradually tighten the drive flange retaining nut, rocking the pinion backwards and forwards whilst tightening the nut to ensure that the bearing rollers are correctly seated and continue to rock the pinion until the bearing drag remains constant, indicating that the bearings are fully seated. Ensure that the dummy pinion flange does not strike and damage the differential bearing cap supports.

Using a suitable socket, fit the pre-load gauge (Tool No. P.4131) and as described previously, set the

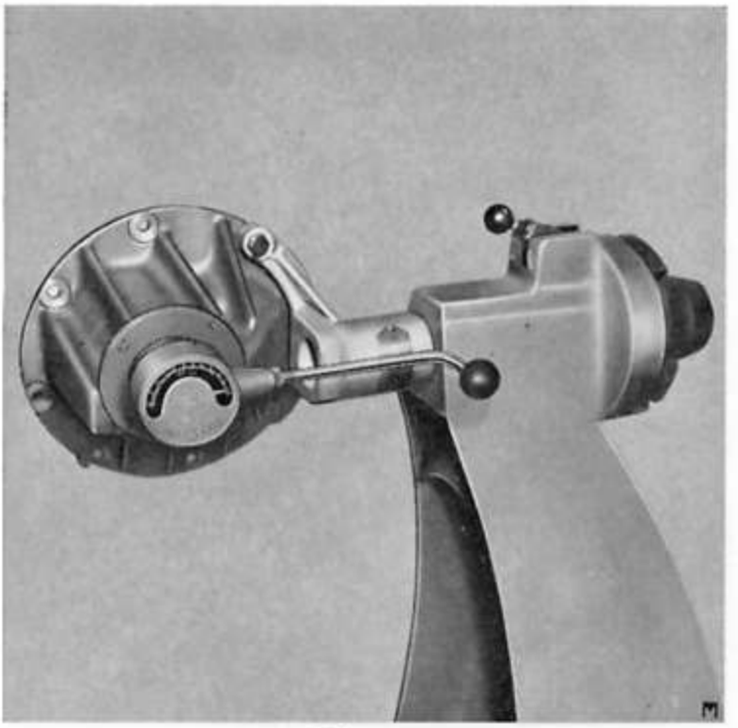


Fig. 10
Checking Pinion Bearing Pre-load (Tool No. P.4131)

pinion bearing pre-load to a running torque of between 0.265 and 0.323 kg.m. (23 and 28 lb. in.). If this pre-load is exceeded, first slacken the drive flange retaining nut to remove all pre-load from the bearings, and then gradually retighten the nut to give the correct pre-load.

(*d*) Check the pinion depth of mesh in the crown wheel. For correct tooth contact the pinion must be moved in or out in relation to the centre line of the crown wheel by fitting a suitable shim between the rear pinion bearing cone and the front face of the pinion. Depth gauge (Tool No. CP.4075 or P.4016) in conjunction with adaptors (Tool No. CP.4075-3) is used to determine the thickness of the shim required to give the correct depth of mesh.

Set the dial gauge to zero by sliding the setting button across the machined under-face of the gauge and adjust the dial as necessary to give a zero reading (see Fig. 11). Ensure that both machined faces are clean and free from grit or burrs, etc.

(*e*) Clean the differential bearing locations then position the gauge so that the dial plunger rests on the upper face of the dummy pinion. Rock the gauge slightly backwards and forwards to ensure that a minimum reading is obtained (see Fig. 12).

(*f*) Add 2.67 mm. (0.105 in.) to the gauge reading to obtain the exact thickness shim to be fitted between the pinion and the rear bearing cone. Referring to Fig. 12, the dial reading is 52 so a shim of 0.157 inches thick is required. Where, however, etched markings exist on the tapered portion of any pinion shaft

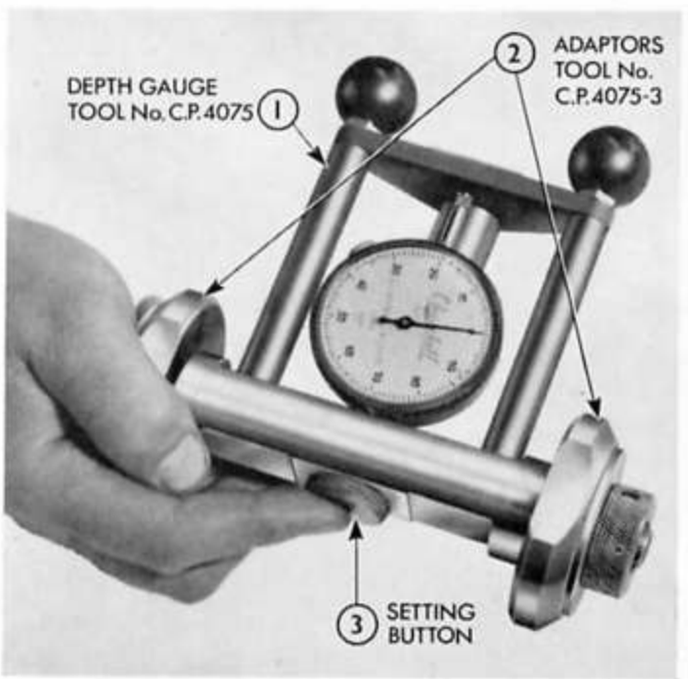


Fig. 11
Zeroing Depth of Mesh Gauge

Fig. 12
Checking Pinion Depth of Mesh

between the two bearing locations, alter the shim thickness accordingly. If the pinion is marked with a plus figure, this figure should be subtracted from the gauge reading, if the marking is a minus figure, this should be added to the gauge reading.

Therefore, if for example the etch marking on the pinion shaft is —2 (see Fig. 13), the pinion bearing shim required is calculated as:—

Gauge reading	0.052
Add	0.105
	0.157
Pinion Marking (—2) ..	+0.002
	0.159

Pinion bearing shims in several thicknesses are identified by the Part Number suffix marked on one of the faces. Full details of these shims are given in the Specification section.

(*g*) Dismantle the dummy pinion from the differential carrier. Unscrew the drive flange retaining nut, pull off the Mk II drive flange and front bearing cone and extract the dummy pinion and rear bearing cone from the housing.

8. Adjust the pinion bearing pre-load:

(*a*) Fit the shim selected in the previous operations to the drive pinion, with the internal chamfer on the shim towards the gear teeth (see Fig. 14). Fit the rear bearing cone to the pinion shaft, support the bearing in the adaptors (Tool No. CP.4000–18), ensure that

Fig. 13
Drive Pinion Components

the bearing cage is free to revolve, then press the bearing right home on the pinion.

(*b*) Refit the front pinion bearing cone to its cup. Locate the oil seal in the axle throat with its lip towards the bearing, pass the centre bolt of Tool No. CP.4013 through the carrier throat and fit the adaptor (Tool No. CP.4013-2) so that its flat face is towards the oil seal. Tighten the wing nut to press the oil seal right home in its seating (see Fig. 15). Unscrew the wing nut and remove the tool.

(*c*) Lightly oil the seal and then assemble the pinion to the differential carrier. Fit a new collapsible spacer to the pinion shaft and fit the pinion into the front pinion bearing. Fit the Transit drive flange and a new drive flange retaining nut, then gradually tighten the nut until only very slight end-float can be felt on the pinion shaft.

Fig. 14
Fitting Pinion Rear Bearing

(*d*) Locate the pre-load gauge and socket on the drive flange retaining nut and check the running torque required to rotate the assembly. This torque is the resistance offered by the oil seal to the drive flange, and when finally setting the pinion bearing pre-load this figure must be added to the pre-load figure of 0.265 to 0.323 kg.m. (23 to 28 lb. in.) for the pinion bearings alone. Therefore, if the torque required to rotate the drive flange within the oil seal is 0.058 kg.m. (5 lb. in.) the drive flange retaining nut must be

Fig. 15
Fitting the Drive Pinion Oil Seal

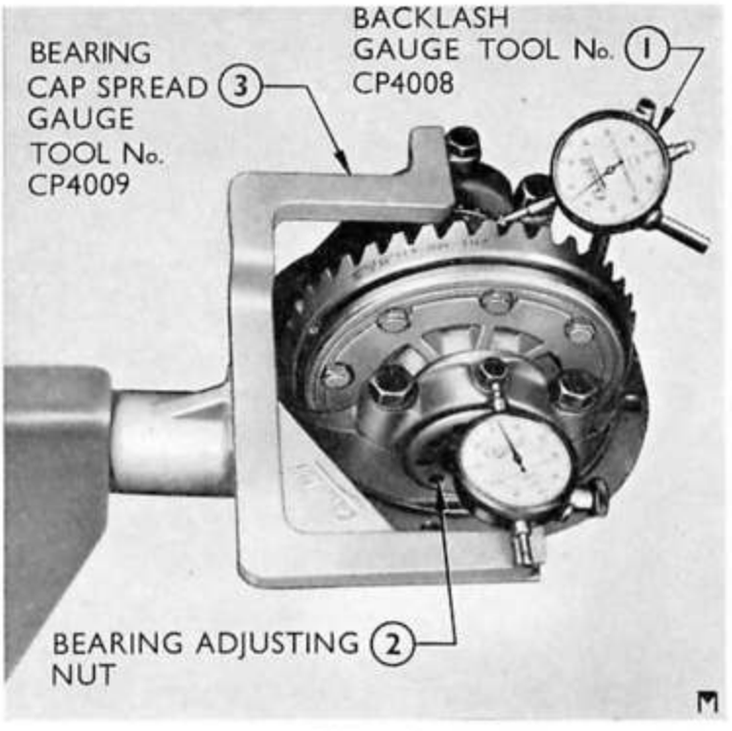


Fig. 16
Cap Spread and Backlash Gauges

tightened so that the assembly turns under a running torque of 0.323 to 0.381 kg.m. (28 to 33 lb. in.) gauged as above.

(*e*) Gradually and carefully tighten the drive flange retaining nut, rotating the pinion throughout the operation to ensure that the bearing rollers are correctly seated until the established pinion bearing pre-load is obtained. Frequent checks on the pre-load must be made whilst tightening the nut, as if the pre-load is exceeded, the assembly must be dismantled, the collapsible spacer removed and discarded and a new spacer fitted to the pinion.

(*f*) Once the correct pinion bearing pre-load has been obtained, stake the drive flange retaining nut securely to the pinion, using a suitable punch.

9. Adjust crown wheel and pinion backlash and differential bearing pre-load.

The adjustment of crown wheel and pinion backlash and differential bearing pre-load is of extreme importance for correct tooth contact.

(*a*) Locate the differential bearing cups on their bearing cones and position the assembly in the carrier housing. Ensure that the bearing cups are positioned squarely on the rollers.

(*b*) Refit the bearing caps, ensuring that the mating marks on the caps and support brackets correspond (see Fig. 17), and replace the bearing cap bolts so that they nip the caps in position. Do not fully tighten the bolts at this stage.

(*c*) Refit the differential bearing adjusting nuts.

(*d*) Install the bearing cap spread gauge (Tool No. CP.4009) by bolting the gauge to the differential cap as shown in Fig. 16. Secure it on the bearing cap so that the plunger of the cap spread gauge locates on the vertical face of the locking plate bolt. Set the dial face of the cap spread gauge to zero and screw in the bearing adjusting nuts, without spreading the caps, so that only slight backlash can be felt between the crown wheel and pinion. Rotate the crown wheel during this operation to ensure that the differential bearing rollers are correctly seated.

(*e*) Mount the backlash gauge (Tool No. CP.4008) on a suitable hole on the differential carrier flange and fit the gauge plunger so that it is resting on the heel of a crown wheel tooth at right angles to it (again see Fig. 16). Zero the gauge and by means of the differential bearing adjusting nuts, adjust the backlash between the crown wheel and pinion until a reading of 0.025 to 0.050 mm. (0.001 to 0.002 in.) backlash is obtained. The adjusting nut on the crown wheel side must be tightened last.

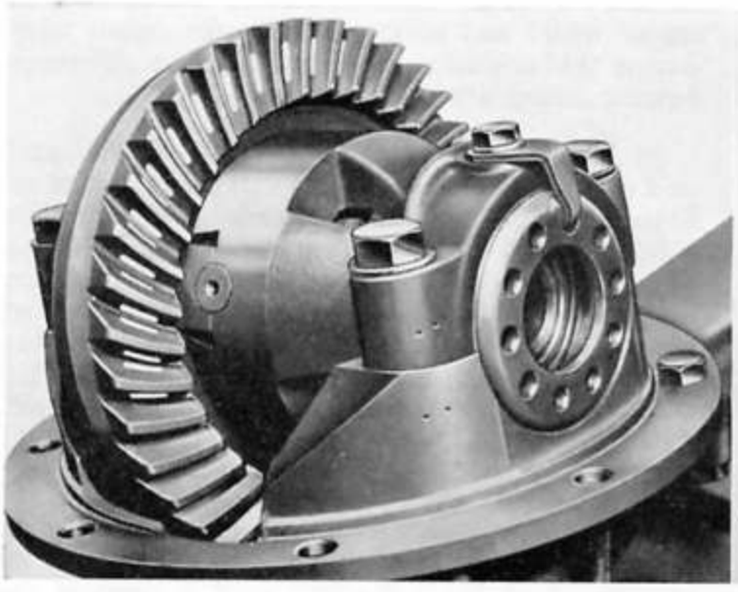
(*f*) Swing the backlash gauge out of position, and rotating the crown wheel all the time, screw in the bearing adjusting nut on the differential side with the spanner (Tool No. CP.4007), until a constant cap spread reading of between 0.127 and 0.178 mm. (0.005 and 0.007 in.) is obtained.

(*g*) Swing the backlash gauge back into position and zero the gauge. Hold the pinion and rock the crown wheel backwards and forwards noting the maximum and minimum readings on the gauge. The correct and final backlash between the crown wheel and pinion should be 0.127 to 0.178 mm. (0.005 to 0.007 in.).

If the backlash is outside these limits, adjust the position of the crown wheel relative to the pinion by slackening the adjusting nut on one side and tightening the nut on the other side by a corresponding amount so that the cap spread is unaffected. (The final tightening must be made from the crown wheel side.)

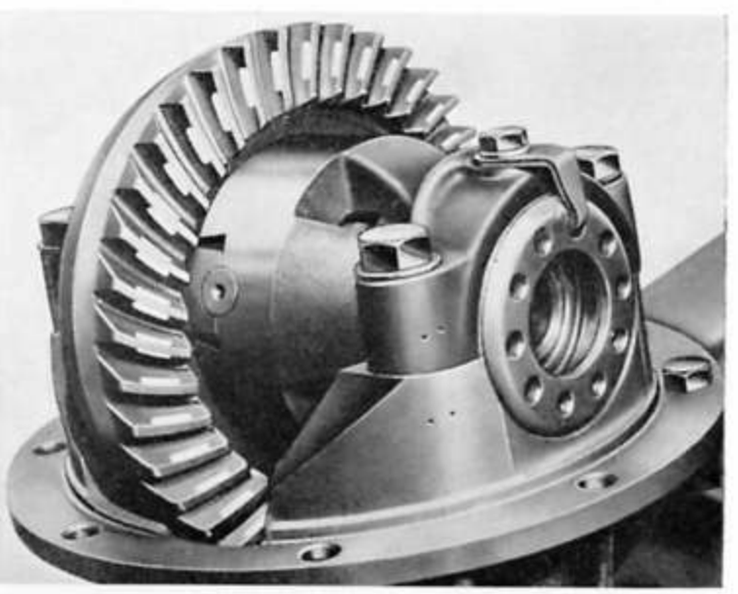
Fig. 17
Correct Tooth Marking

INCORRECT TOOTH MARKINGS



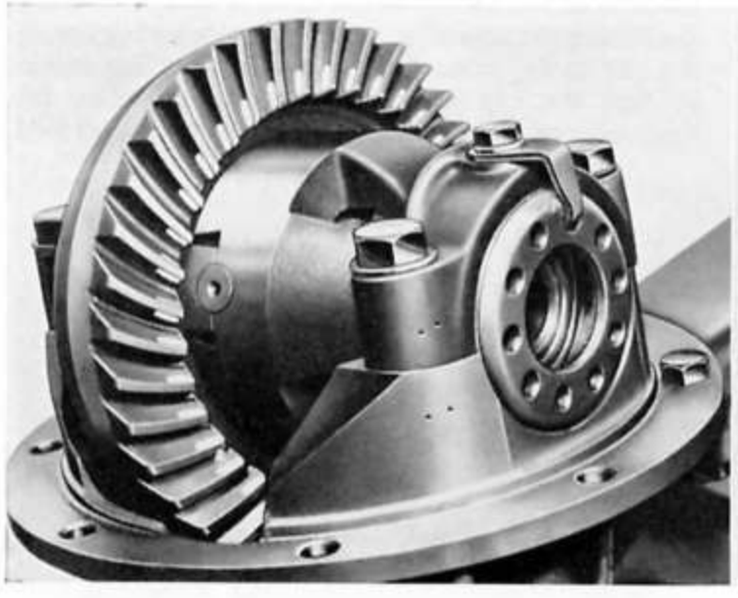
Heavy Flank Contact

In this case the area of contact is below the centre line of the tooth, and the condition should be rectified by moving the pinion away from the crown wheel, using a thinner shim behind the pinion. Reset the backlash and differential bearing pre-load.



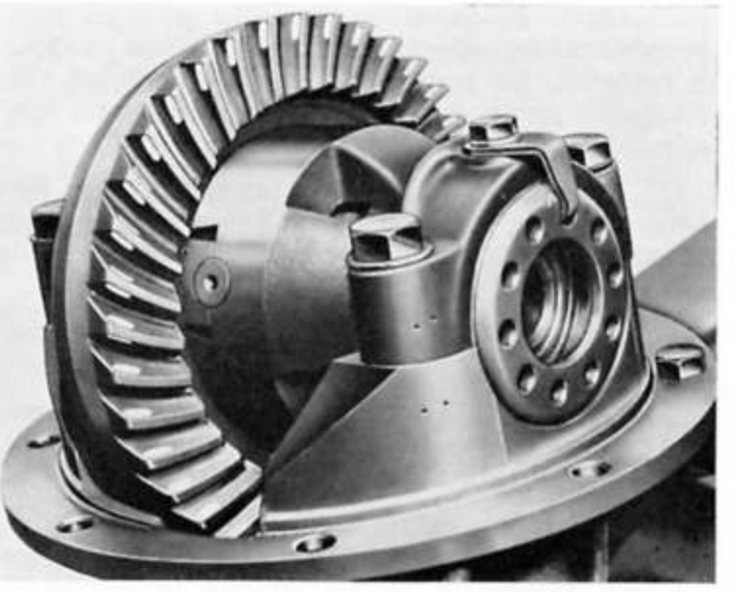
Heavy Face Contact

In this case the area of contact is above the centre line of the tooth, due to the pinion being too far away from the crown wheel. Use a thicker pinion bearing shim to lower the contact area and reset the backlash and differential bearing pre-load.



Contact on Toe

When the area of contact is running off the toe of the pinion, move the crown wheel away from the pinion. Slacken the crown wheel side adjusting nut and screw in the differential side nut an equal amount. It may also be necessary to use a thicker shim behind the pinion in order to keep the backlash within the correct limits.



Contact on Heel

In this case the crown wheel is too far out from the pinion. Slacken the differential side adjusting nut and tighten the crown wheel side nut, re-check the backlash and differential bearing pre-load readings. If the backlash is reduced below the minimum specified, use a thinner shim behind the pinion and using a new collapsible spacer, readjust pinion bearing pre-load.

Fig. 18

(*h*) Refit the adjusting nut locking plate, noting that both left- and right-hand off-set locking plates are available as required. Tighten the locking plate retaining bolts to a torque of 2.07 to 2.76 kg.m. (15 to 20 lb. ft.) and the differential cap retaining bolts to a torque of 9.67 to 11.06 kg.m. (70 to 80 lb. ft.).

(*i*) Check the tooth contact at the crown wheel and pinion. Apply a thin coating of red lead or yellow ochre to the crown wheel teeth. Fit the axle shafts to the differential gears, hold the shafts to apply a load, and rotate the pinion in both directions.

If the pinion pre-load and crown wheel backlash have been correctly set the area of contact should be as shown in Fig. 17. Margins above and below the area of contact should be the same and contact markings should run approximately for three-quarters of the tooth length. Check the patterns on both sides of the gear teeth.

Fig. 18 shows four ways in which the contact pattern may be incorrect and the method of rectification.

10. Reassemble the differential carrier to the axle casing.

To Remove and Replace the Rear Axle

1. Jack up the vehicle, placing supports under the frame sidemembers in front of the rear springs.

NOTE.—Ensure that the vehicle is unloaded before positioning a jack against a chassis member.

2. Remove the wheels and drums and support the axle.

3. Scribe mating marks and disconnect the drive shaft from the pinion drive flange.

4. Disconnect the hydraulic brake pipe at the flexible connection on the body. Fit a blanking plug on the end of the flexible pipe to prevent loss of fluid.

5. Remove the handbrake cable from the rear wheels. Disconnect the cable from the brake shoe and withdraw the cable through the hole in the back plate.

6. Disconnect the shock absorbers from the brackets on the axle casing. These are secured by a bolt, nut and washer.

7. Remove the spring clip self-locking nuts, spring clip plates and spring clips.

8. Withdraw the axle from the vehicle.

To Replace

1. Locate the axle in position with the spring seats welded to the axle casing positioned under the rear spring centre bolts. Slightly raise the axle at one side and fit a spring clip plate and spring clips and nuts. Ensure that the spring centre bolt is correctly positioned. Repeat this procedure for the other side. Tighten to a torque of 7.6 to 9.0 kg.m. (55 to 65 lb. ft.).

2. Locate the shock absorbers on the brackets provided on the axle housing and secure in position with a flat washer and nut. Tighten each nut to a torque of 3.7 to 4.4 kg.m. (27 to 32 lb. ft.).

3. Fit the handbrake cable through the holes in the back plates and attach the inner cable to the brake shoe.

4. Remove the blanking plug from the hydraulic brake hose and connect the hose to the three-way connector on the differential casing.

5. Align the mating marks on the drive shaft and pinion flanges. Fit four retaining bolts and self-locking nuts. Tighten each nut to a torque of 3.04 to 3.73 kg.m. (22 to 27 lb. ft.).

6. Bleed the braking system, and adjust the handbrake linkage.

7. Fit the brake drums and road wheels, re-adjust the brakes, jack up the vehicle and remove stands. Lower jack and then tighten wheel nuts to a torque of 7.60 to 9.7 kg.m. (55 to 70 lb. ft.) and replace hub caps.

8. Check rear axle oil level. Top-up if necessary.

REAR AXLE

OVERHAUL PROCEDURES – *125 to 175 only*

The rear axle is of the fully floating type, incorporating a hypoid crown wheel and pinion and a four-pinion differential. The crown wheel and pinion are mounted in the differential carrier, which is an integral part of the axle housing.

Adjustments are provided for pinion bearing pre-load, crown wheel and pinion backlash and pinion depth of mesh.

Lubrication and Maintenance

The rear hub bearings are packed with lubricant when the vehicle is built and do not require lubrication as they are lubricated by the axle oil. The universal joints are the needle roller type, which are sealed for life and require no servicing.

The two piece drive line is supported by a flexibly mounted centre bearing which is also sealed for life, and requires no lubrication.

The combined filler and level plug for the axle is situated at the left-hand side of the differential housing, whilst no drain plug is fitted or required.

After the first 800 kms. (500 miles) interval ,check the lubricant level with the vehicle standing on level ground. After this initial check, the level should thereafter be checked at 8,000 kms. (5,000 miles) intervals. Remove the level plug and the oil should be to the bottom of the hole, add oil if necessary to bring it to this level. Replace the level plug and tighten it securely.

Note that only hypoid and not ordinary gear oil is to be used; refer to the Specification section for the correct grade of oil.

At the first 800 kms. (500 miles) interval, also check the differential backplate bolts and tighten as necessary to a torque of 1.8 to 2.4 kg.m. (13 to 17 lb. ft.).

If a crown wheel and pinion is fitted in service, the differential should initially be filled with EM-2C-29 Stuart Hypoid lubricant.

DRIVE SHAFT AND CENTRE BEARING

The coupling shaft is supported by a ball type centre bearing which is flexibly mounted. The flexible mounting allows the bearing a certain amount of movement and at the same time prevents slight drive line vibration from being transmitted to the vehicle.

Whenever a coupling shaft is disconnected at the forward end it must be supported. Failure to support the shaft could result in the flexible mounting becoming displaced, with consequent damage to the mounting.

To Remove

1. **Mark the drive pinion flange** and universal joint flange to ensure alignment on reassembly.

2. **Remove the four bolts and nuts,** and remove the drive shaft, sliding it from the coupling shaft at the centre bearing.

3. **Mark the gearbox flange** and universal joint flange to ensure alignment on reassembly.

4. **Remove the bolts** and support the forward end of the shaft.

5. **Detach the coupling shaft and centre bearing** from the vehicle after removing the two nuts.

To Replace

1. **Position the coupling shaft and centre bearing** in the vehicle chassis. Support the shaft and loosely fit the centre bearing clamp securing bolts and nuts.

2. **Align the universal joint and gearbox flange mating marks,** fit the four bolts and self-locking nuts tightening them securely.

3. **Refit the drive shaft to the coupling shaft** at the centre bearing and secure it to the axle pinion flange with the four bolts and nuts, ensuring that the mating marks are lined up.

To Dismantle

1. **Place the coupling shaft in a vice,** and remove the sleeve assembly from the rear of the coupling shaft, using a puller if necessary.

2. **Remove the centre bearing clamp** by straightening the tab at one end of the retainer plate and detaching the plate from the clamp. Pull the flexible rubber mounting from the bearing.

3. **Draw the centre bearing off the coupling shaft** using a suitable puller.

To Assemble

1. **Press the bearing onto the coupling shaft** until it contacts the shaft shoulder.

2. **Fit the flexible rubber mounting** over the bearing assembly.

3. **Press the sleeve assembly** onto the rear end of the coupling shaft.

4. **Position the clamp around the rubber mounting** after first ensuring that the mounting and clamp are clean and free from grease. Fit the retainer plate and bend the tab previously straightened around the end of the clamp.

UNIVERSAL JOINTS

The universal joints fitted to this vehicle are sealed for life and so require no lubrication.

Overhauling the Universal Joints

The universal joint spider, bearings, oil seals and retainers are serviced as a kit.

1. **To dismantle, extract each spider bearing snap ring** and remove the bearing cups and rollers by gently tapping the yoke at each bearing.

2. **Remove the spider and detach the oil seal** and seal retainer from each spider journal.

3. **To reassemble, fit new oil seals** to the retainers and locate them on the shoulders of the spider journals with the oil seals outwards. Position the spider in the drive shaft yoke, assemble the needle rollers in each bearing cup and refit the bearings, tapping them squarely into place. Take care not to dislodge the needle rollers.

4. **Similarly, refit the other half of the joint.**

5. **Refit the snap rings to each bearing.**

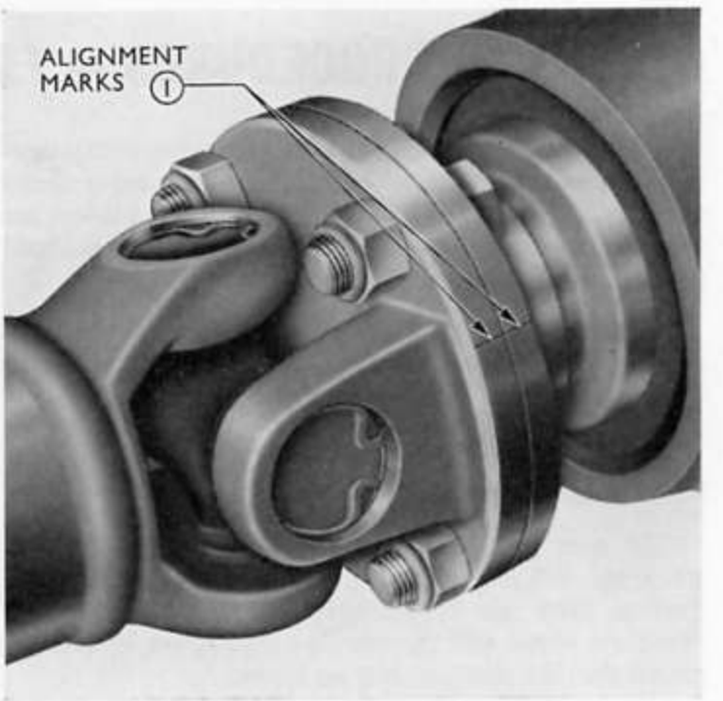


Fig. 19
Universal Joint

AXLE SHAFT REMOVAL AND HUB OVERHAUL

The axle shafts and hubs may be removed for inspection and overhaul without disturbing the differential assembly, using the following procedure:—

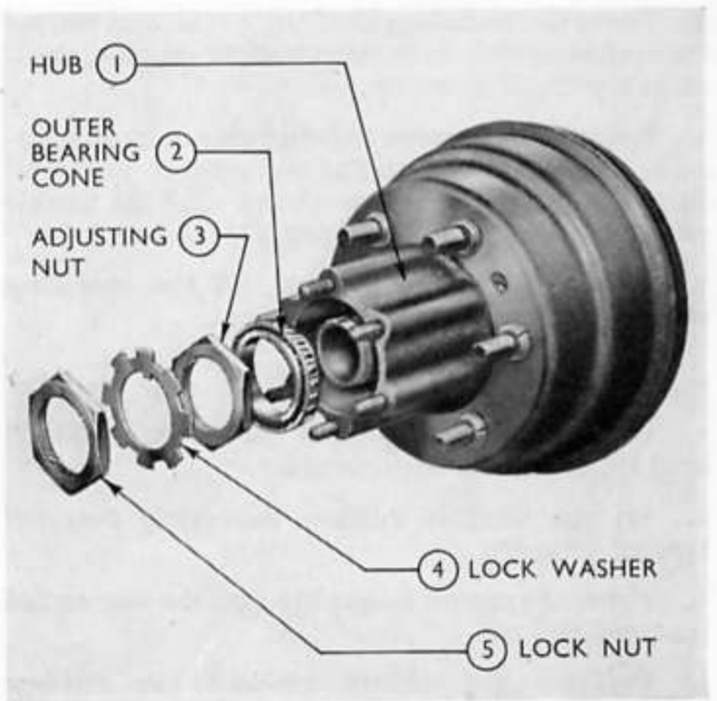


Fig. 20
Rear Hub—130 to 175

To Remove

1. **Slacken rear wheel nuts.**
2. **Jack up the vehicle and fit stands.**

NOTE.—Jacks and stands should only be positioned against the axle housing, and never against body chassis members, unless changing axle or spring assemblies. If it is necessary to support the vehicle on a chassis member, ensure that the vehicle is unladen, otherwise the chassis members will be damaged.

3. **Remove the six nuts securing the axle shaft** to the hub, and remove the axle shaft and gasket.
4. **Remove the wheel nuts** and the double (130 to 175) or single (125 only) rear wheels from each side of the vehicle.
5. **Back off the brakes slightly,** remove the brake drum retaining screw, the locating cones and the brake drum (130 to 175 vehicles only).
6. **Release the locking tab on the hub locknut** and, using Tool No. C.4109, remove the locknut. Remove the lockwasher and using the same tool, remove the adjusting nut.
7. **Remove the hub assembly** from the axle housing (130 to 175 vehicles only).
8. **Back off the brakes slightly** and remove the hub and drum assembly from the axle housing. Split the hub and drum (125 vehicles only).
9. **Remove the outer bearing,** and then remove the inner bearing and oil seal.
10. **Remove the bearing cups.**

To Replace

1. **Replace the bearing cups,** using Tool No. C.1038 and a suitable press.
2. **Replace the inner bearing** and fit a new oil seal.
3. **Reassemble the brake drum** to the hub assembly (125 vehicles only).
4. **Reposition the hub (or hub and drum assembly) on the axle.** Refit the outer bearing. Fit the adjusting nut and tighten to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.) back off $\frac{1}{6}$ to $\frac{1}{3}$ of a turn. Refit a new locking washer and the locking nut. Tighten the locking nut to a torque of 7 to 9 kg.m. (50 to 65 lb. ft.), using the same tool and then lock in position by bending up one of the locking washer tabs.
5. **Refit the brake drum** and secure by replacing the retaining screw and the retaining clips around the wheel studs (130 to 175 vehicles only).
6. **Replace the axle shaft and new gasket** and secure it to the hub using the six nuts.
7. **Replace the rear wheel(s)** and adjust the brakes.
8. **Remove the stands, lower the vehicle** to the ground and tighten the wheel nuts.

DIFFERENTIAL OVERHAUL

On this axle the differential carrier is an integral part of the axle housing, and so the entire axle assembly should be removed to overhaul the differential assembly.

To Remove

1. **Jack up and fit chassis stands.** Leave the jack in position, supporting the differential and taking the weight of the axle.
2. **Remove the rear wheels.**
3. **Disconnect the drive shaft** by removing the four nuts and bolts from the pinion drive flange. Before disconnecting ensure that there are alignment marks on both flanges as this will ensure correct alignment when reassembling.
4. **Disconnect the handbrake linkage.** Remove the return spring and the nut securing the handbrake rod to the handbrake cable. Remove the clips securing the cable to the chassis brackets and remove the cable from these brackets.
5. **Disconnect the exhaust system rear supports,** so that when the axle is withdrawn, the handbrake cable can be removed from around the exhaust system. This is unnecessary on 125 vehicles.
6. **Disconnect the shock absorbers** by removing the nut and bolt securing each shock absorber to its respective bracket on the axle.
7. **Remove the flexible brake pipe connecting the three-way union** on the axle housing to the chassis brake piping. Fit line plugs to minimise loss of brake fluid.
8. **Using a $\frac{7}{8}$ in. A.F. long-socket,** remove the nuts from the spring U bolts. Remove the U bolts and plate.
9. **Remove the axle** by moving it towards the rear of the vehicle, allowing the handbrake cable to be passed over the exhaust pipe as necessary.

To Replace

1. **Position the axle assembly on a mobile hydraulic jack** and move it into position from the rear of the vehicle, passing the loop of the handbrake cable over the exhaust pipe where necessary.
2. **Replace the spring U bolts** and plate, using the $\frac{7}{8}$ in. A.F. long-socket to fit the new locknuts.
3. **Reconnect the shock absorbers** to the brackets on the axle, ensuring that the rubber bushes are in position.
4. **Refit the handbrake linkage.** Replace the handbrake cable in the chassis brackets and secure with the clips. Connect the cable to the rod and fit the return spring.
5. **Reconnect the drive shaft to the pinion flange,** ensuring that the mating marks are in alignment.
6. **Remove the line plugs from the brake pipe** connections and replace the flexible brake pipe.
7. **Reconnect the exhaust pipe mountings** (where they have been disconnected).
8. **Replace the rear wheels.**
9. **Bleed the braking system,** and adjust all brakes including the handbrake.
10. **Remove the stands and lower the vehicle to the ground.**

To Dismantle

1. **Fit the mounting bracket,** Tool No. C.4110, around the axle casing adjacent to the differential casing. Fit the mounting bracket to the stand.

The mounting bracket has been designed so that the axle assembly can be turned end over end whilst mounted in the stand.

2. **Revolve the axle so that the differential backplate is facing the ground.** Position a drain can and remove the bolts retaining the differential backplate. Remove the plate and gasket and allow the oil to drain.
3. **Remove the six nuts and spring washers** securing each axle shaft and withdraw both shafts.
4. **Check the mating marks on the differential bearing caps,** unscrew the adjusting nut locking plate bolts and detach the locking plates.
5. **Slacken the differential cap bolts** and then, using Tool No. C.4123, back off the adjusting nuts. Remove the differential bearing cap bolts and lockwashers and carefully detach the bearing caps and bearing adjusting nuts.
6. **Lift out the crown wheel assembly,** together with the differential bearing cups. Take care to keep the bearings and cups as assemblies.
7. **Withdraw the drive pinion.** This is secured by a retaining nut which presses the coupling flange against the inner face of the front pinion bearing. A spacer is fitted between the pinion bearings, and the length of this spacer controls the pinion bearing preload. The drive flange retaining nut is staked to the pinion to lock it in position.

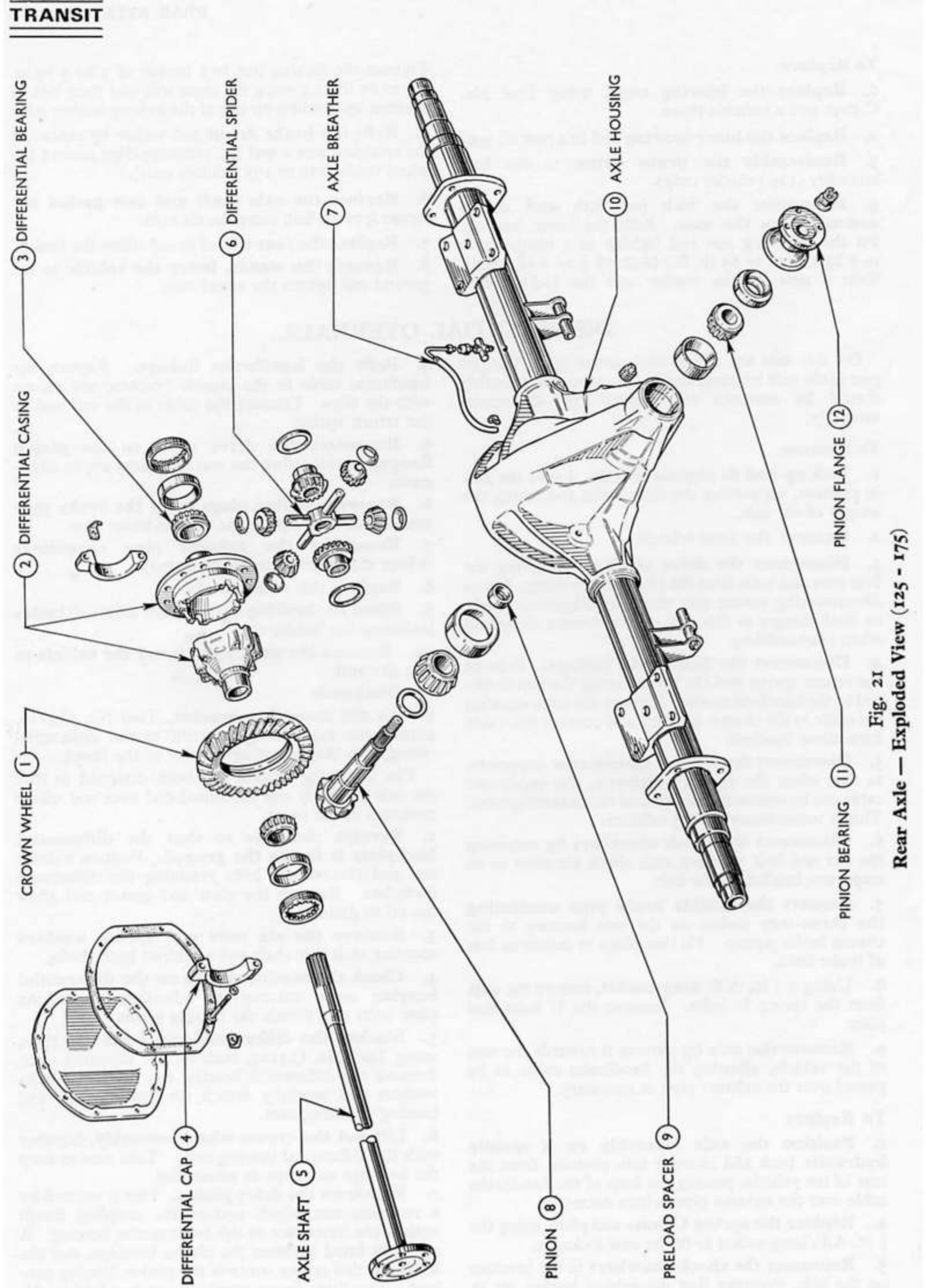


Fig. 21
Rear Axle — Exploded View (125 - 175)

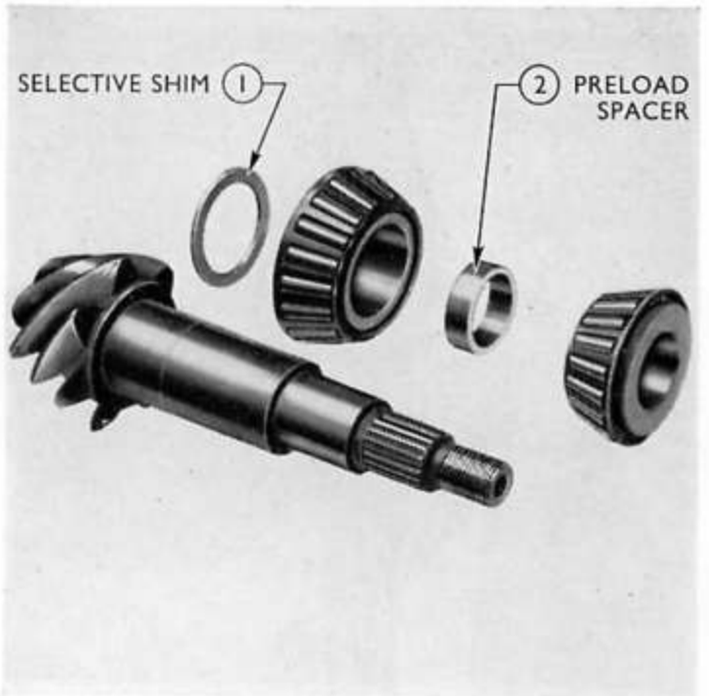


Fig. 22
Pinion Components

(*a*) Relieve the staking, then holding the pinion flange with Tool No. C.4114, unscrew the pinion flange retaining nut.

(*b*) Pull the pinion flange from the splines. The pinion with its spacer and rear bearing cone can now be withdrawn from the housing.

8. Remove the pinion bearing cups, front bearing and oil seal. Drive out the front bearing cup, front bearing and oil seal first, using the special driver, Tool No. CP.4015, passing the body of the tool through the rear bearing cup. Drive out the rear pinion bearing cup in the same way.

9. Dismantle the pinion assembly.

Fig. 23
Pinion Gears and Spider

(*a*) Remove the spacer from the pinion shaft.

(*b*) Locate the pinion assembly in the support ring with the lips of the adaptor segments (Tool No. C.4000–36) behind the bearing cone. Mount the assembly in the base plate on the bed of a press, or in a hand press (Tool No. CP.4000). Check that the bearing cage is free to rotate and press out the pinion. Remove the shim from the pinion shaft.

10. Dismantle the crown wheel and differential assembly :—

(*a*) Unscrew the eight self-locking bolts securing the crown wheel to the differential case.

(*b*) Suitably support the crown wheel and press the differential case through the crown wheel.

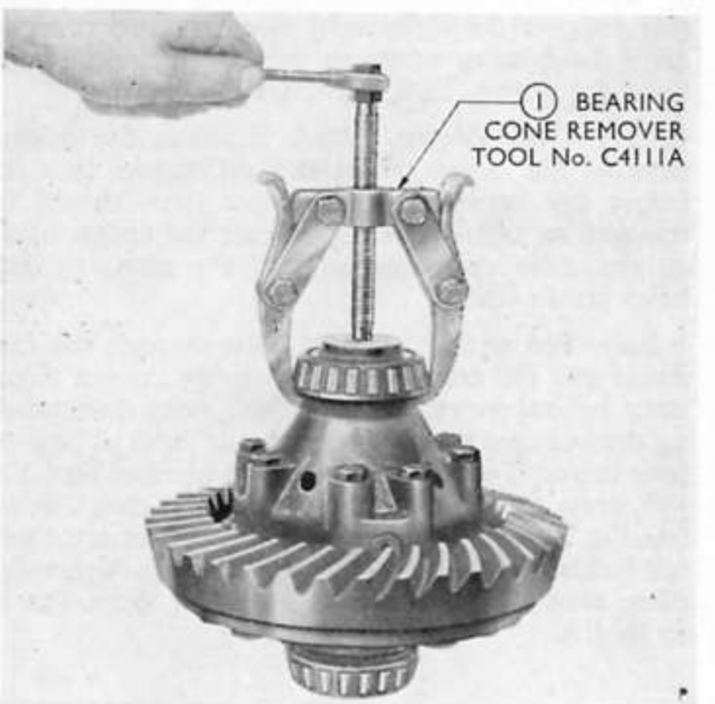


Fig. 24
Removing Differential Bearing Cones

(*c*) Mark the two halves of the differential case to ensure correct reassembly, if not already marked. Remove the eight bolts and split the differential case. Remove the spider, four pinion gears and four spherical thrust washers.

(*d*) Lift out the axle shaft gears and the flat washers located between the gears and the differential case.

(*e*) Remove the differential bearing cones. Locate the legs of the Tool No. C.4111A, in the slots behind the bearing, (see Fig. 24), fit the plate over the axle shaft hole and pull off the bearing. Repeat for the other bearing.

(*f*) Clean and examine all parts, renewing where necessary.

To Reassemble

Three adjustments must be carried out when assembling the differential correctly. They are:

(*a*) Select the correct pinion bearing shim.

(*b*) Select the pinion spacer to give the pinion bearing pre-load.

(*c*) Adjust crown wheel and pinion backlash.

1. Lubricate the flat thrust washers and position them on the flanges of the axle shaft gears, then locate the gears in the two halves of the differential case.

2. Lubricate each spherical thrust washer and locate one behind each pinion gear on the spider. Position the spider and pinion gears in the left-hand differential case.

3. Assemble the two halves of the differential case, ensuring that the mating marks line up.

4. Refit the differential bearing cones. Suitably support the differential assembly and press or drive the bearing cones on to the differential case, using the driver, Tool No. C.4106.

5. Refit the crown wheel. Examine the mating faces of the crown wheel and differential case for burrs; any burrs found on these faces should be removed by lightly stoning. Locate the crown wheel on the differential case so that the retaining bolt holes are in line.

Enter two or four suitable bolts through the case flange into the crown wheel to ensure correct alignment and support the crown wheel, teeth downwards on the bed of a press. Using the differential bearing cone driver, Tool No. C.4106, with handle (Tool No. 550) press the differential case onto the crown wheel (see Fig. 25). Remove the pilot bolts and fit eight new self-locking bolts smeared with Loctite, tightening them evenly to a torque of 10 to 12 kg.m. (72 to 87 lb. ft.).

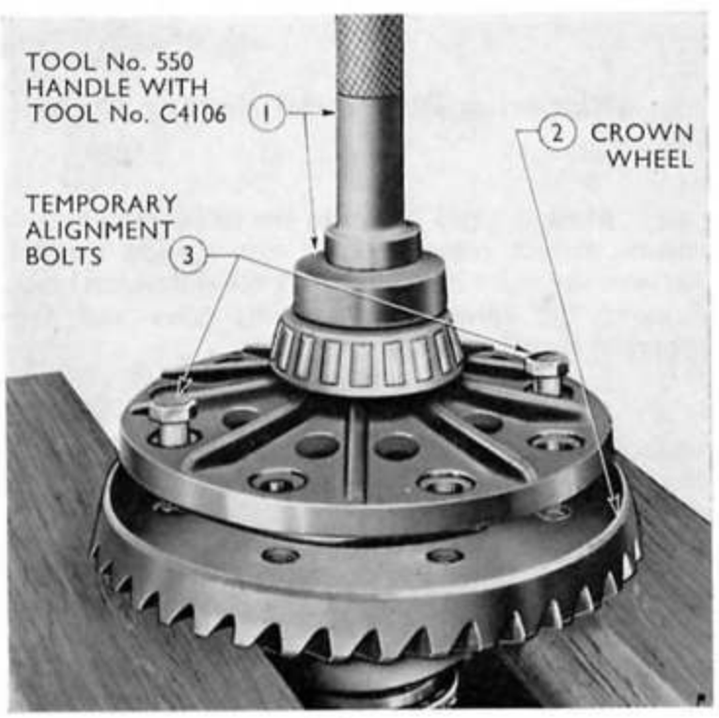


Fig. 25
Fitting the Crown Wheel

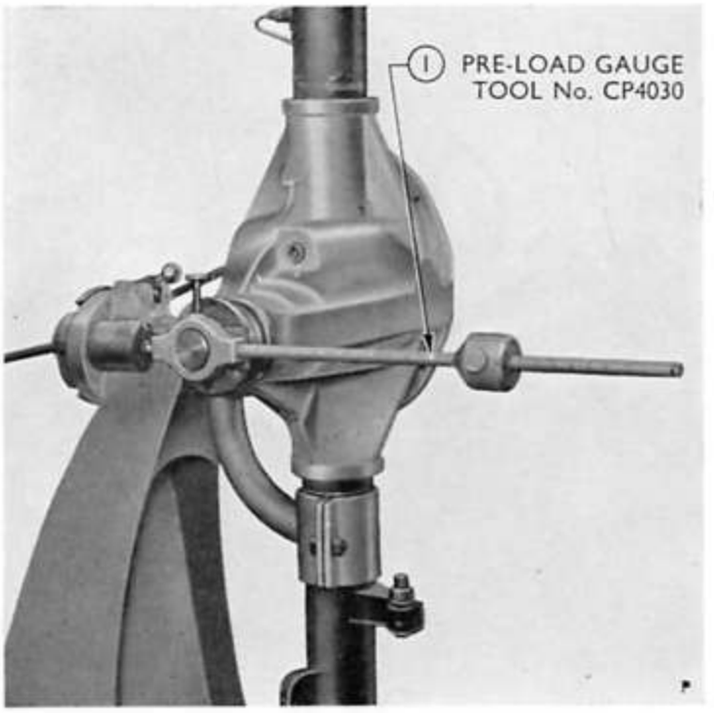


Fig. 26
Checking Pre-Load

6. Fit the pinion bearing cups:

(*a*) Place the rear bearing cup on the body of Tool No. C.4013–4 and pass it through the carrier throat from the rear.

(*b*) Assemble the front bearing cup, loose adaptor and wing nut to the centre bolt of the tool at the front of the housing.

(*c*) Tighten the wing nut and press the bearing cups fully home. Unscrew the wing nut and remove the tool and adaptors from the carrier throat.

The axle is now ready for adjustment. Quietness depends on the following adjustments, and every care should be taken to ensure that they are carried out in the proper order, carefully and conscientiously. The correct equipment properly used will ensure satisfactory results.

7. First select the pinion bearing shim to control depth of mesh:

(*a*) Fit the spacer, Tool No. C4075-5A/e, on the dummy pinion. Slide the rear bearing cone onto its location on the dummy pinion, Tool No. C.4075–5, with the large diameter of the bearing towards the spacer and fit the assembly to the throat of the differential carrier.

(*b*) Slide the front bearing cone with its smaller diameter inwards, onto the dummy pinion. Fit the drive flange and retaining nut.

(*c*) Pre-load the pinion bearings. Hold the pinion drive flange with the special spanner, Tool No. C.4114, and gradually tighten the flange nut, rocking the pinion backwards and forwards whilst tightening the nut to ensure that the bearing rollers are correctly seated and continue to rock the pinion until the bearing drag remains constant, indicating that the bearings are fully seated. Ensure that the dummy pinion flange does not strike and damage the differential bearing cap supports.

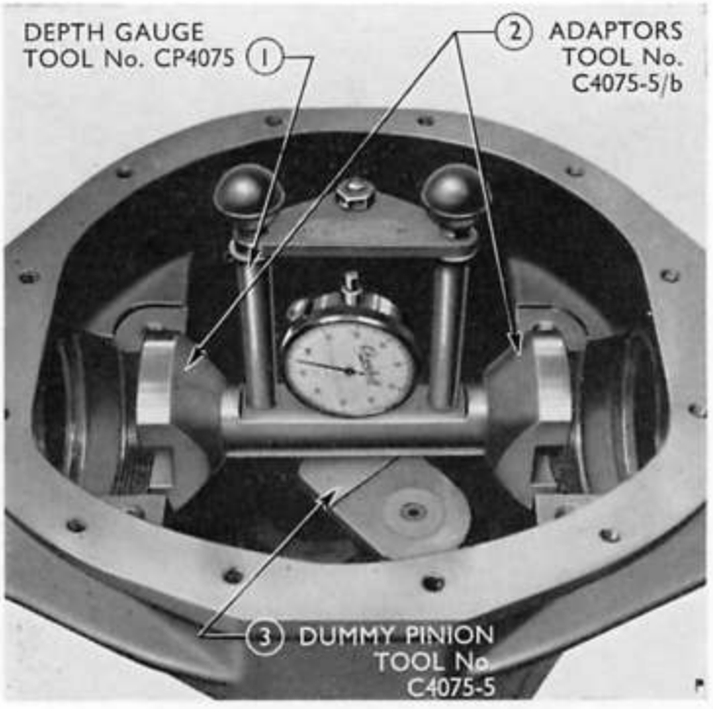


Fig. 27
Depth of Mesh Gauge

Fit the pre-load gauge, Tool No. P.4030, using adaptor, Tool No. C.4030–5 (see Fig. 26) or Tool No. CP.4131, as shown in Fig. 10, using a suitable socket. Set the pinion bearing pre-load to a running torque of between 0.138 to 0.173 kg.m. (12 and 15 lb. in.). If this pre-load is exceeded, first slacken the drive flange adaptor nut to remove all pre-load from the bearings and then gradually re-tighten the nut to give the correct pre-load.

(*d*) Check the pinion depth of mesh in the crown wheel. For correct tooth contact the pinion must be moved in or out in relation to the centre line of the crown wheel by fitting a suitable shim between the rear pinion bearing cone and the front face of the pinion. Depth gauge, Tool No. CP.4075, and adaptors, Tool No. C.4075–5/b, are used to determine the thickness of the shim required to give the correct depth of mesh.

Set the dial gauge to zero by sliding the setting button across the machined under-face of the gauge and adjust the dial as necessary to give a zero reading. Ensure that both machined faces are clean and free from grit or burrs, etc.

(*e*) Clean the differential bearing locations then position the gauge so that the dial plunger rests on the upper face of the dummy pinion. Rock the gauge slightly backwards and forwards to ensure that a minimum reading is obtained (see Fig. 27).

(*f*) The reading obtained from the depth of mesh gauge is the true thickness of the shim to be fitted between the pinion and the rear bearing cone. Where, however, etched markings exist on the tapered portion of any pinion shaft between the two bearing locations, alter the shim thickness accordingly. If the pinion is marked with a plus figure, this figure should be added to the gauge reading, if the marking is a minus figure, this should be subtracted from the gauge reading.

Therefore, if for example the etch marking on the pinion shaft is —2, 0.002 in. (0.051 mm.) should be subtracted from the gauge reading. Pinion bearing shims in several thicknesses are identified by the Part Number suffix marked on one of the faces. Full details of these shims are given in the Specification section.

(*g*) Dismantle the dummy pinion from the differential housing. Unscrew the drive flange nut, pull off the drive flange and front bearing cone and extract the dummy pinion and rear bearing cone from the housing.

8. Adjust the pinion bearing pre-load:

(*a*) Fit the shim selected in the previous operations to the drive pinion, with the internal chamfer on the shim towards the gear teeth (see Fig. 28). Fit the rear bearing cone to the pinion shaft, support the bearing in the adaptors, Tool No. C.4000-36, ensure that the bearing cage is free to revolve, then press the bearing right home on the pinion.

(*b*) Refit the front pinion bearing cone to its cup. Locate the oil seal in the axle throat with its lip towards the bearing, and drive it into position, using Tool No. C.4113.

(*c*) The correct pinion spacer is found by using the dummy spacer, Tool No. C.4112, and soft solder wire. The dummy spacer is fitted to the pinion with a ring of soft wire on its top face, and the pinion carefully fitted into the axle housing, so that the wire is not disturbed. Fit the pinion flange and retaining nut and gradually tighten the nut until only very slight end-float can be felt on the pinion shaft.

The wire supplied with Tool No. C.4112 is 2.67 mm. (0.105 in.) diameter. Wire of this thickness must be used to give the correct spacer thickness.

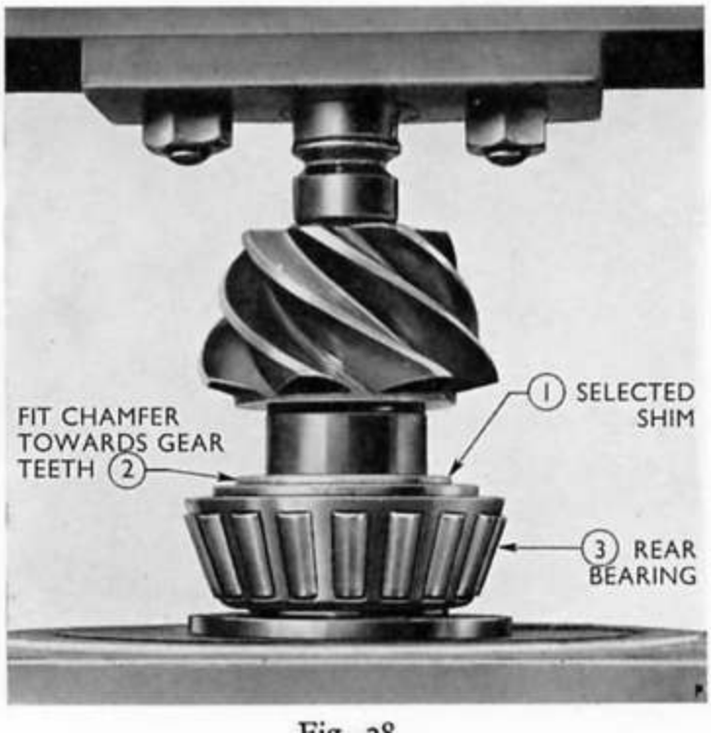


Fig. 28
Fitting Pinion Rear Bearing

(*d*) Locate the pre-load gauge, Tool No. CP.4030 and the adaptor (or Tool No. CP.4131) on the drive flange retaining nut. Check the running torque required to rotate the assembly by turning the pre-load gauge at a steady speed. This torque is the resistance offered by the oil seal to the drive flange, and when finally setting the pinion bearing pre-load this figure must be added to the pre-load figure of 0.138 to 0.173 kg.m. (12 to 15 lb. in.) for the pinion bearings alone. Therefore, if the torque required to rotate the drive flange within the oil seal is 0.058 kg.m. (5 lb. in.) the drive flange retaining nut must be tightened so that the assembly turns under a running torque of 0.196 to 0.231 kg.m. (17 to 20 lb.in.) gauged as above.

(*e*) Gradually and carefully tighten the pinion flange retaining nut, rotating the pinion throughout the operation to ensure that the bearing rollers are correctly seated until the pinion bearing pre-load is obtained. Frequent checks on the pre-load must be made whilst tightening the nut, as if the pre-load is exceeded, the assembly must be dismantled, the flattened wire removed and discarded and new wire positioned on the dummy spacer.

(*f*) Once the correct pinion bearing pre-load has been obtained, dismantle the assembly. Remove the dummy spacer, taking care not to disturb the flattened wire on the spacer. Using a micrometer, measure the thickness of the dummy spacer plus flattened wire. Measure the thickness in three places and take an average reading. This is the thickness of the spacer required.

(*g*) Reassemble the pinion to the axle, with the spacer fitted. Fit the pinion drive flange and tighten the retaining nut to a torque of 16.6 to 20.0 kg.m. (120 to 145 lb. ft.). Stake the retaining nut securely to the pinion.

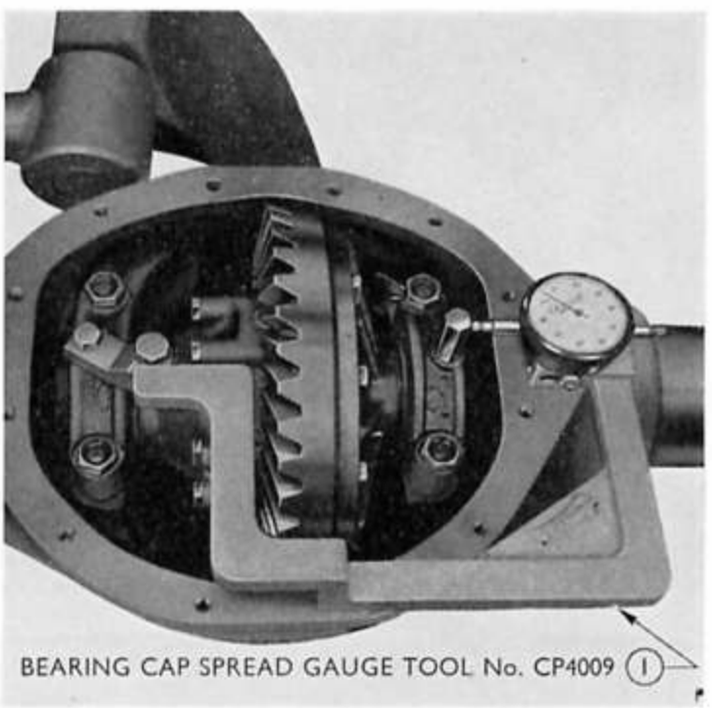


Fig. 29
Cap Spread Gauge

Fig. 30
Backlash Gauge in Position

9. Adjust crown wheel and pinion backlash and differential bearing pre-load.

The adjustment of crown wheel and pinion backlash and differential bearing pre-load is of extreme importance for correct tooth contact.

(*a*) Locate the differential bearing cups on their bearing cones and position the assembly in the carrier housing. Ensure that the bearing cups are positioned squarely on the rollers.

(*b*) Refit the bearing caps, ensuring that the mating marks on the caps and support brackets correspond and replace the bearing cap bolts so that they nip the caps in position. Do not fully tighten the bolts at this stage.

(*c*) Refit the differential bearing adjusting nuts.

(*d*) Install the bearing cap spread gauge (Tool No. CP.4009 and adaptor CP.4009-1) by bolting the gauge to the differential cap as shown in Fig. 29. Secure it on the bearing cap so that the plunger of the cap spread gauge locates on the vertical face of the locking plate adaptor bolt. Set the dial face of the cap spread gauge to zero and screw in the bearing adjusting nuts, without spreading the caps, so that only slight backlash can be felt between the crown wheel and pinion. Rotate the crown wheel during this operation to ensure that the differential bearing rollers are correctly seated.

(*e*) Remove the cap spread gauge and mount the backlash gauge (Tool No. CP.4008) on a suitable hole on the differential carrier flange and fit the gauge plunger so that it is resting on the heel of a crown wheel tooth at right angles to it (see Fig. 30). Zero the gauge and by means of the differential bearing adjusting nuts, adjust the backlash between the crown wheel and pinion until a reading of 0.025 to 0.051 mm. (0.001 to 0.002 in.) backlash is obtained. The adjusting nut on the crown wheel side must be tightened last.

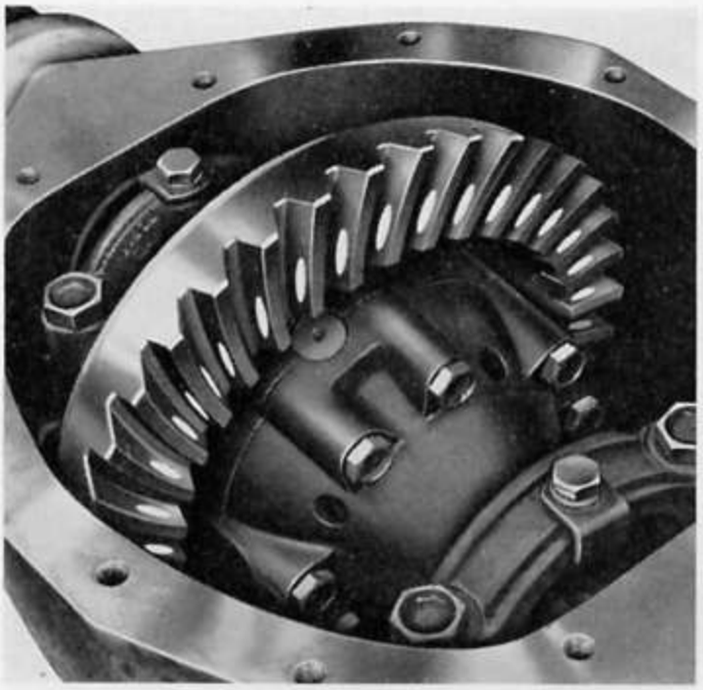


Fig. 31
Correct Tooth Contact

(*f*) Swing the backlash gauge out of position, refit the cap spread gauge and rotating the crown wheel all the time, screw in the bearing adjusting nut on the differential side with the spanner (Tool No. C.4108), until a constant cap spread reading of between 0.12 and 0.16 mm. (0.005 and 0.006 in.) is obtained.

(*g*) Swing the backlash gauge back into position and zero the gauge. Hold the pinion and rock the crown wheel backwards and forwards noting the maximum and minimum readings on the gauge. The correct and final backlash between the crown wheel and pinion should be 0.12 to 0.22 mm. (0.005 to 0.009 in.).

If the backlash is outside these limits, adjust the position of the crown wheel relative to the pinion by slackening the adjusting nut on one side and tightening the nut on the other side by a corresponding amount so that the cap spread is unaffected. (The final tightening must be made from the crown wheel side.)

(*h*) Refit the adjusting nut locking plates, noting that both left- and right-hand off-set locking plates are available as required. Tighten the locking plate retaining bolts to a torque of 2.07 to 2.76 kg.m. (15 to 20 lb. ft.) and the differential cap retaining bolts to a torque of 9.67 to 11.06 kg.m. (70 to 80 lb. ft.).

(*i*) Check the tooth contact at the crown wheel and pinion (see Fig. 31). Apply a thin coating of red lead or yellow ochre to the crown wheel teeth. Fit the axle shafts to the differential gears, hold the shafts to apply a load, and rotate the pinion in each direction.

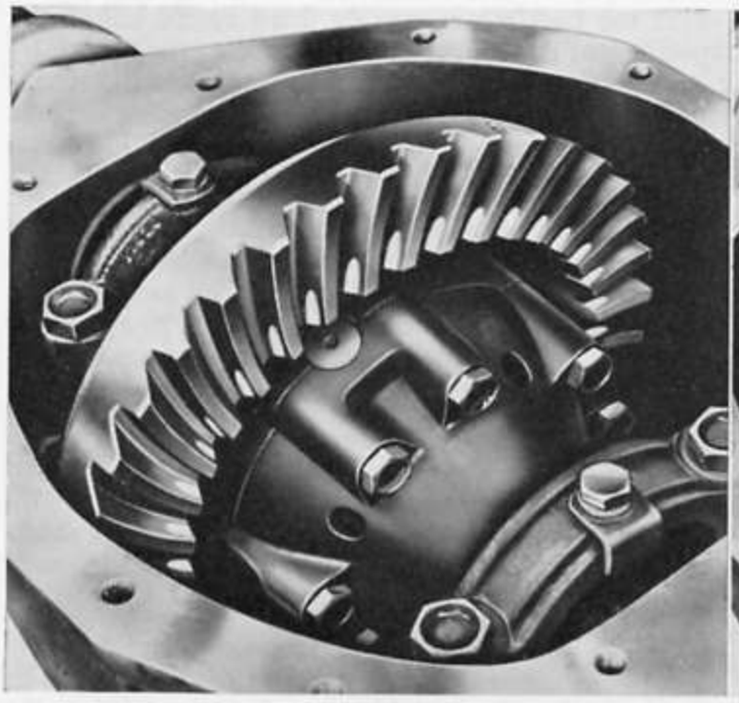
If the pinion pre-load and crown wheel backlash have been correctly set the area of contact should be as shown in Fig. 31. Margins above and below the area of contact should be the same and contact markings should run approximately for three-quarters of the tooth length. Check the patterns on both sides of the gear teeth.

Fig. 32 shows four ways in which the contact pattern may be incorrect and the method of rectification.

10. Refit the differential back plate with a new gasket, and tighten the bolts to a torque of 1.8 to 2.3 kg.m. (13 to 17 lb. ft.).

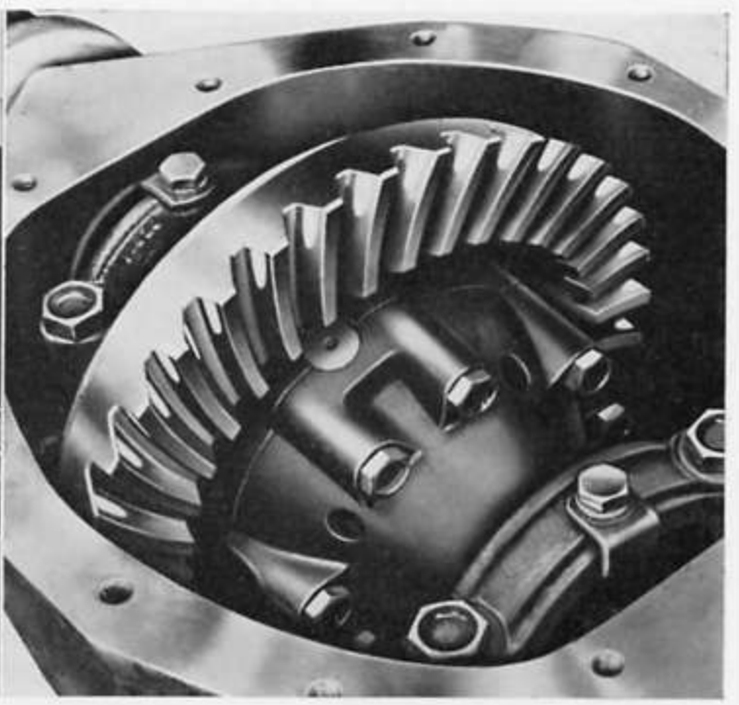
11. Replace the axle shafts with new gaskets and tighten the nuts to a torque of 7.0 to 7.6 kg.m. (50 to 55 lb. ft.).

12. Refill with oil.



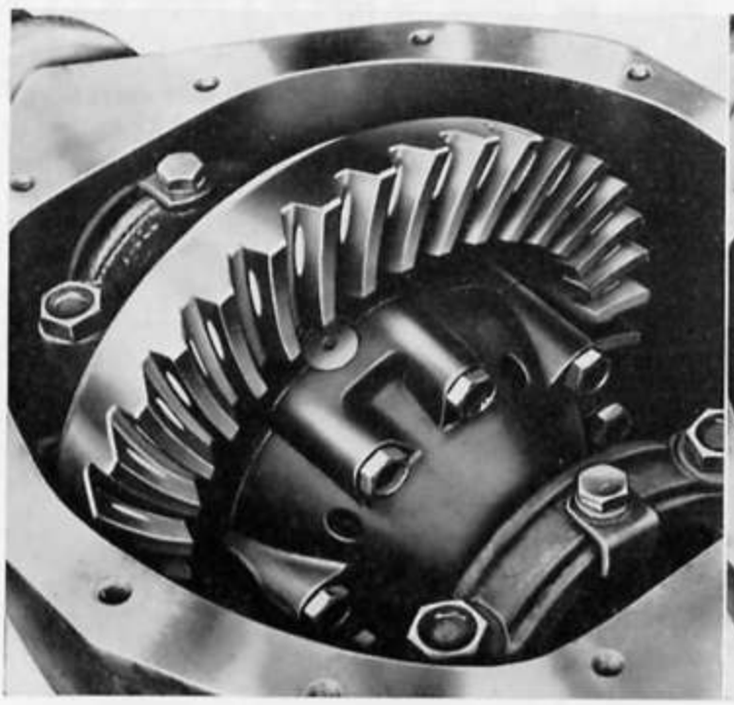
Contact on Heel

In this case the crown wheel is too far out from the pinion. Slacken the differential side adjusting nut and tighten the crown wheel side nut, re-check the backlash and differential bearing pre-load readings. If the backlash is reduced below the minimum specified, use a thinner shim behind the pinion and readjust pinion bearing pre-load.



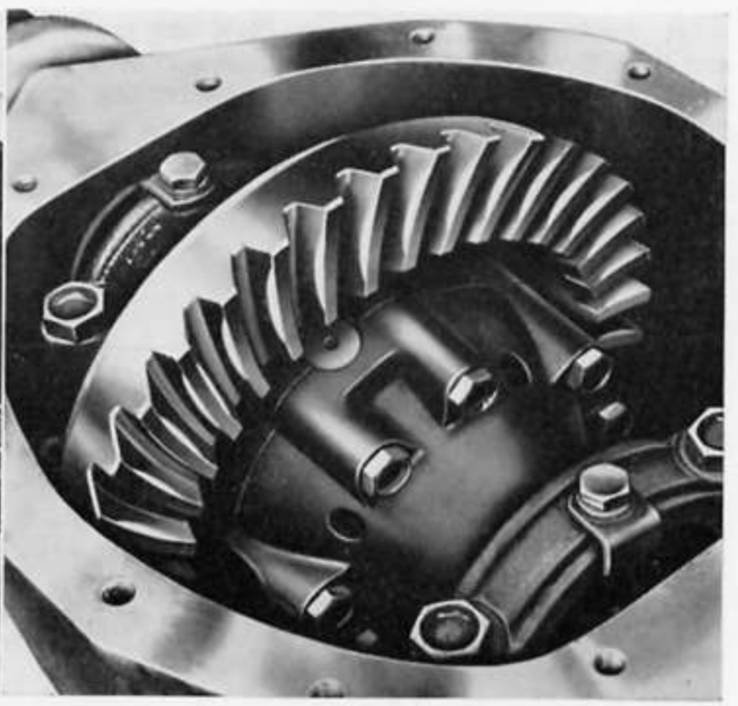
Contact on Toe

When the area of contact is running off the toe of the pinion, move the crown wheel away from the pinion. Slacken the crown wheel side adjusting nut and screw in the differential side nut an equal amount. It may also be necessary to use a thicker shim behind the pinion in order to keep the backlash within the correct limits.



Heavy Flank Contact

In this case the area of contact is below the centre line of the tooth, and the condition should be rectified by moving the pinion away from the crown wheel, using a thinner shim behind the pinion. Reset the backlash and differential bearing pre-load.



Heavy Face Contact

In this case the area of contact is above the centre line of the tooth, due to the pinion being too far away from the crown wheel. Use a thicker pinion bearing shim to lower the contact area and reset the backlash and differential bearing pre-load.

Fig. 32
Incorrect Tooth Marking

Section 5

FRONT AND REAR SUSPENSION

CONTENTS

SUBJECT

FRONT AND REAR SUSPENSION

MAINTENANCE AND OVERHAUL PROCEDURES

DESCRIPTION

Semi-elliptic leaf springs are used throughout the Transit range, with hydraulically damped shock absorbers as standard equipment. Rubber bushes are used at all the spring and shackle pivot points and at the shock absorber mountings. On 130 to 175 vehicles, the back end of each rear spring is carried in a slipper bracket with downward movement controlled by a rebound pin. On 130 to 175 vehicles, a helper leaf is fitted to the rear springs, giving a progressive rate of deflection, (see Fig. 4).

On vehicles built since July 1967, single leaf front springs have been fitted, except parcel vans which use a three leaf spring.

Plastic interleaving has been fitted in the rear spring assemblies on all buses and kombis, since July 1967 on LCX models and since October 1967 on LCY models.

ROUTINE MAINTENANCE

The provision of rubber bushes at all the pivot points in the suspension, eliminates the need for greasing. Also, the shock absorber units are sealed during manufacture and do not require any topping-up.

At 8,000 km. (5,000 mile) services, check the spring clip nuts for tightness. The torques required are 6.2 to 6.9 kg.m. (45 to 50 lb. ft.) on all front spring clips, 7.6 to 9.0 kg.m. (55 to 65 lb. ft.) on the rear of 75 to 125 vehicles and 9.7 to 11.0 kg.m. (70 to 80 lb. ft.) on the rear of 125 to 175 vehicles. Also, check the spring and shock absorber mountings. Tighten to specification or renew parts as necessary and paint the springs with Viscolite AA (Part No. ESEA-M99C-1003A).

OVERHAUL PROCEDURES: FRONT SUSPENSION

To Remove a Front Spring

1. **Jack up the vehicle** and fit chassis stands.
2. **Remove the spring clip nuts,** the spring clips and the spring wedge.
3. **Remove the self-locking nuts** from the spring shackle and detach the side plate.
4. **Drive out** the combined shackle pins and side plate and remove the rubber mounting bushes.
5. **Remove the nut** from the front mounting bolt. Drive out the bolt and remove the spring assembly.

To Dismantle a Front Spring

1. **Remove the rubber bush** from the front eye of the spring, using adaptor No. C.5035/b in a suitable press.

NOTE.—Operations 2, 3 and 4 are not required when single leaf springs are fitted.

2. **Bend up** the spring leaf clamps.
3. **Grip the spring** in a vice, close to the centre bolt.
4. **Remove the nut** from the centre bolt and slowly release the vice.

To Reassemble a Front Spring

NOTE.—Operations 1, 2, 3 and 4 are not required for single leaf front springs.

1. **Assemble the spring leaves** in order of decreasing length on a pilot rod of the same diameter as the centre bolt.
2. **Compress the spring** in a vice and remove the pilot rod.
3. **Fit the spring centre bolt** from the bottom, tighten the nut to a torque of 3.5 to 4.2 kg.m. (25 to 30 lb. ft.), stake the end of the bolt and remove the spring from the vice.
4. **Position the spring clamps** and bend the ends over the top of the spring.

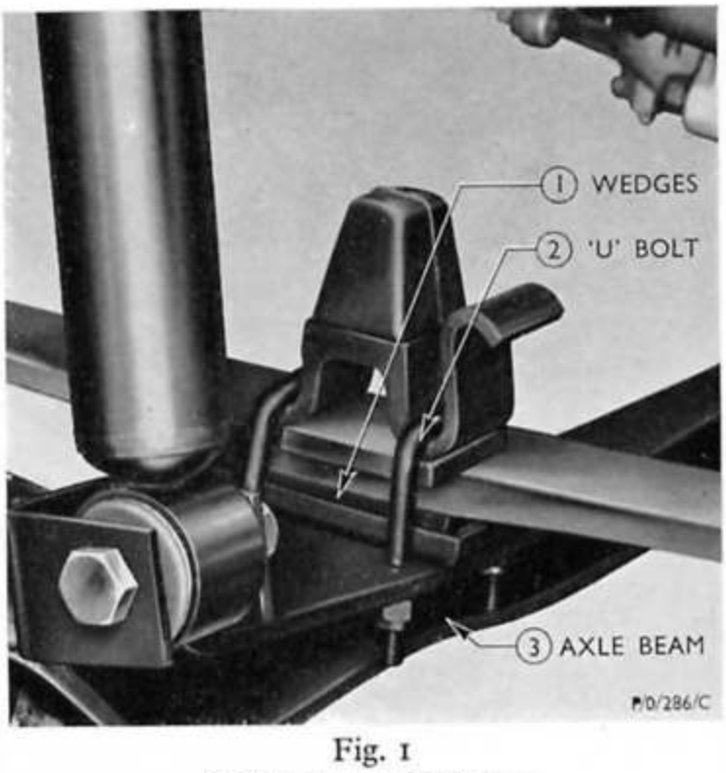


Fig. 1
"U" Bolts and Wedges

5. **Fit a new rubber bush** to the front eye of the spring, using adaptor No. C.5035/b, (see Fig. 2).

To Replace a Front Spring

1. **Position the eye** of the spring in the front bracket, align the holes and fit the front mounting bolt.

2. **Place new rubbers** on the shackle pins and fit the shackle to the rear spring eye and to the rear bracket.

3. **Place new rubbers** on the shackle pins, fit the side plate and the retaining nuts.

4. **Tighten the front mounting bolt** and nut to a torque of 11.06 to 16.58 kg.m. (80 to 120 lb. ft.) and the shackle pin nuts to a torque of 6.2 to 6.9 kg.m. (45 to 50 lb. ft.).

5. **Locate the spring** on the axle, with the thicker end of the wedge to the rear (see Fig. 1).

6. **Assemble the spring clips,** the combined spacer and rubber bump stop and the nuts. Tighten the nuts to a torque of 6.2 to 6.9 kg.m. (45 to 50 lb. ft.).

7. **Remove the chassis stands** and lower the vehicle to the ground.

8. **Check the torque** of the spring clip nuts, preferably with the vehicle laden.

To Remove a Front Shock Absorber

1. **Remove the self-locking nuts** from the mounting bolts at each end of the shock absorber unit.

2. **Drive out the mounting bolts** and detach the shock absorber unit, the mounting rubbers and the flat washers.

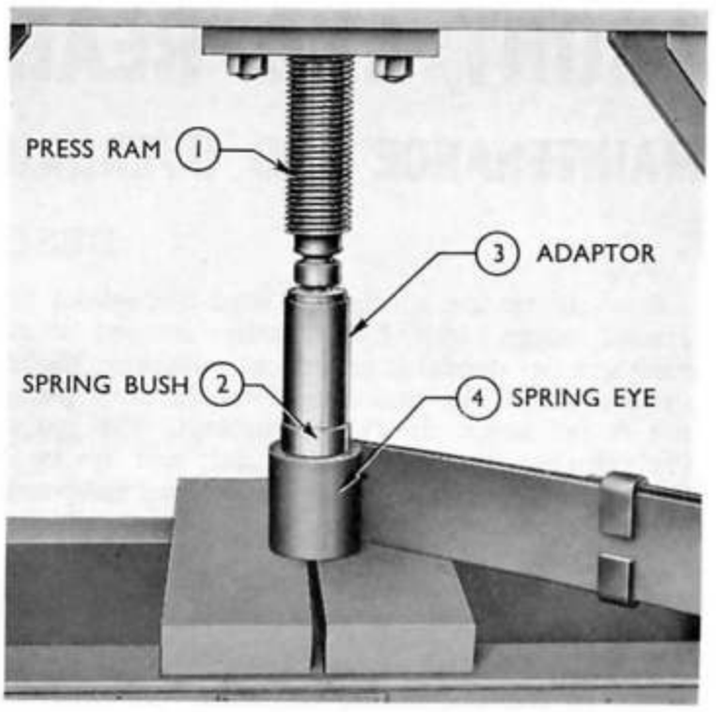


Fig. 2
Replacing the Front Spring Bush

To Replace a Front Shock Absorber

1. **Position the shock absorber** unit with a pair of rubber bushes at each mounting eye.

2. **Fit the mounting bolts** and tighten the retaining nuts to a torque of 6.2 to 8.3 kg.m. (50 to 60 lb. ft.). Note that the mounting rubbers must be compressed between the face of a mounting bracket and a flat washer.

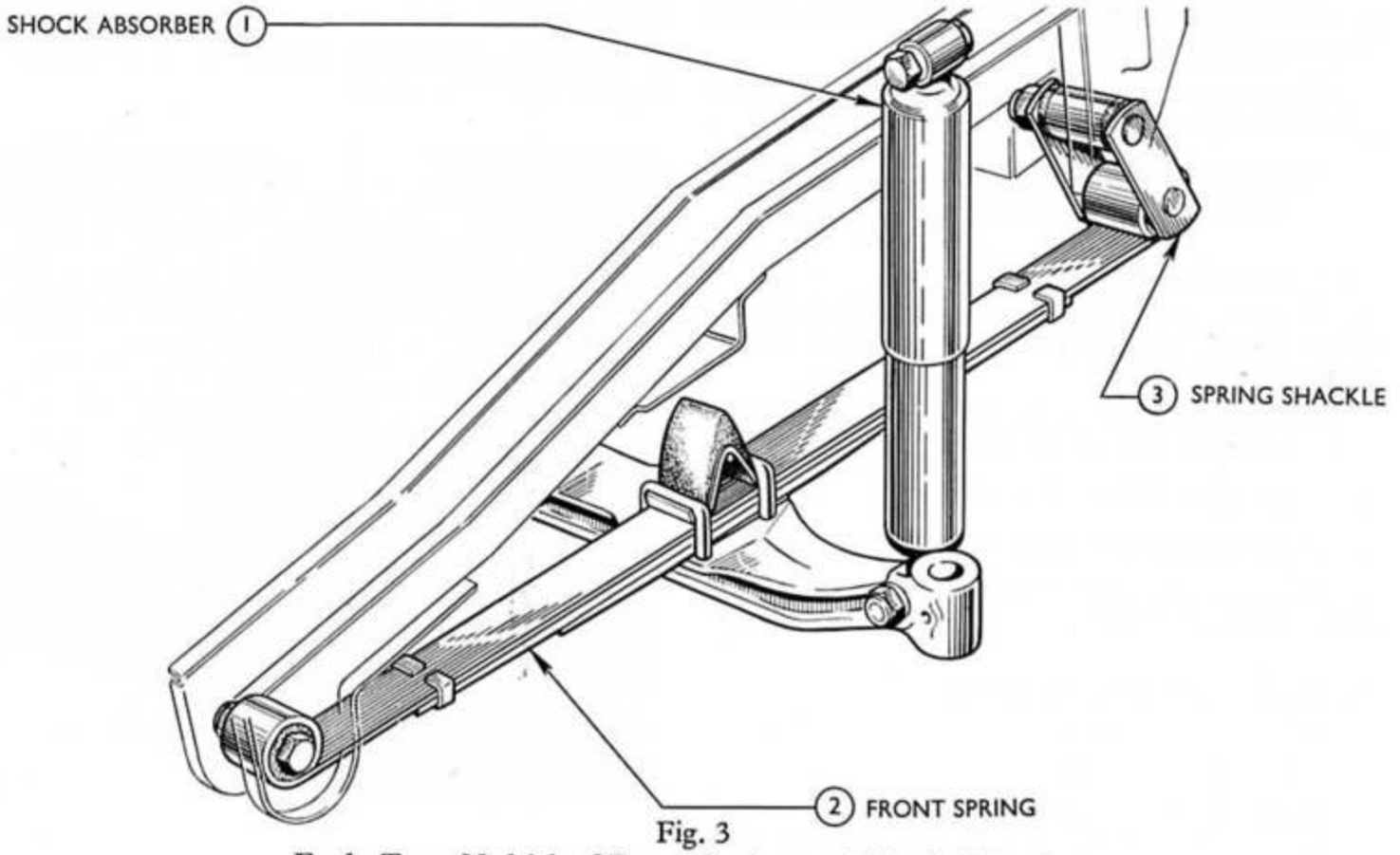


Fig. 3
Early Type Multi-leaf Front Spring and Shock Absorber

REAR SUSPENSION

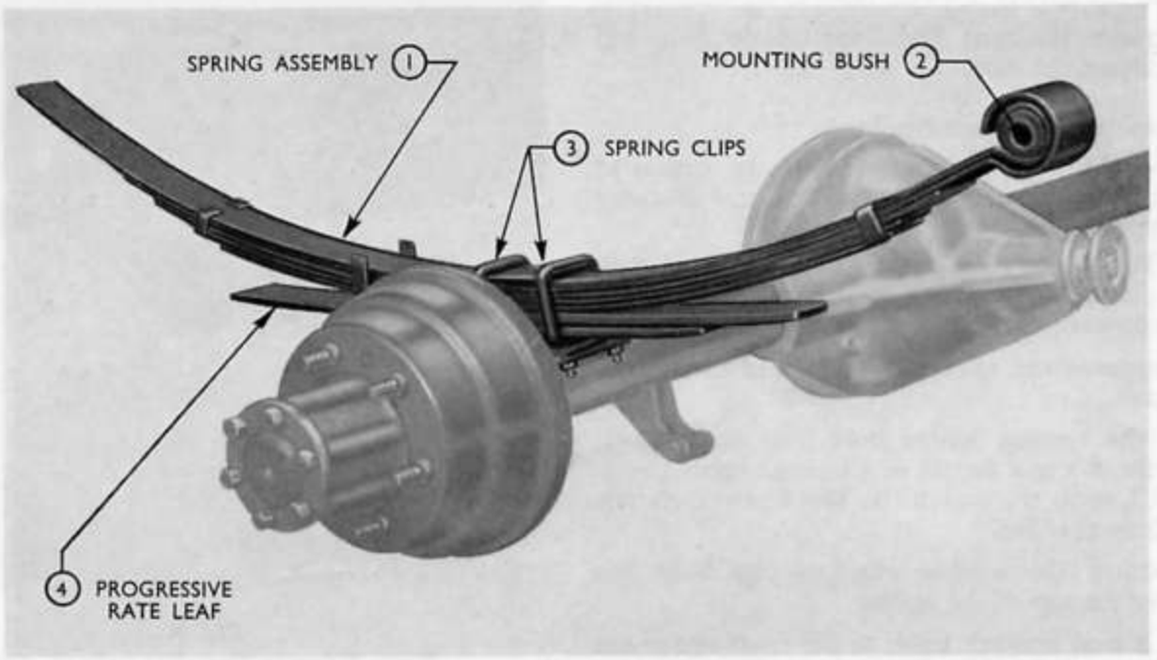


Fig. 4
Early Slipper Type Rear Spring (130 — 175)

To Remove a Rear Spring

1. Jack up the vehicle and fit chassis stands.

2. Remove the spring clip nuts and the spring clips.

3. (*a*) **75 to 125.** Remove the rear shackle retaining nuts, the shackles and the rubber mounting bushes.

(*b*) **130 to 175.** Jack under the axle, to flatten the spring and remove the rebound pin from the rear slipper bracket.

4. Remove the nut from the front mounting bolt, drive out the bolt and remove the spring assembly.

To Dismantle a Rear Spring

1. Remove the rubber bush from the front eye of the spring, using adaptor No. C.5035/b in a suitable press.

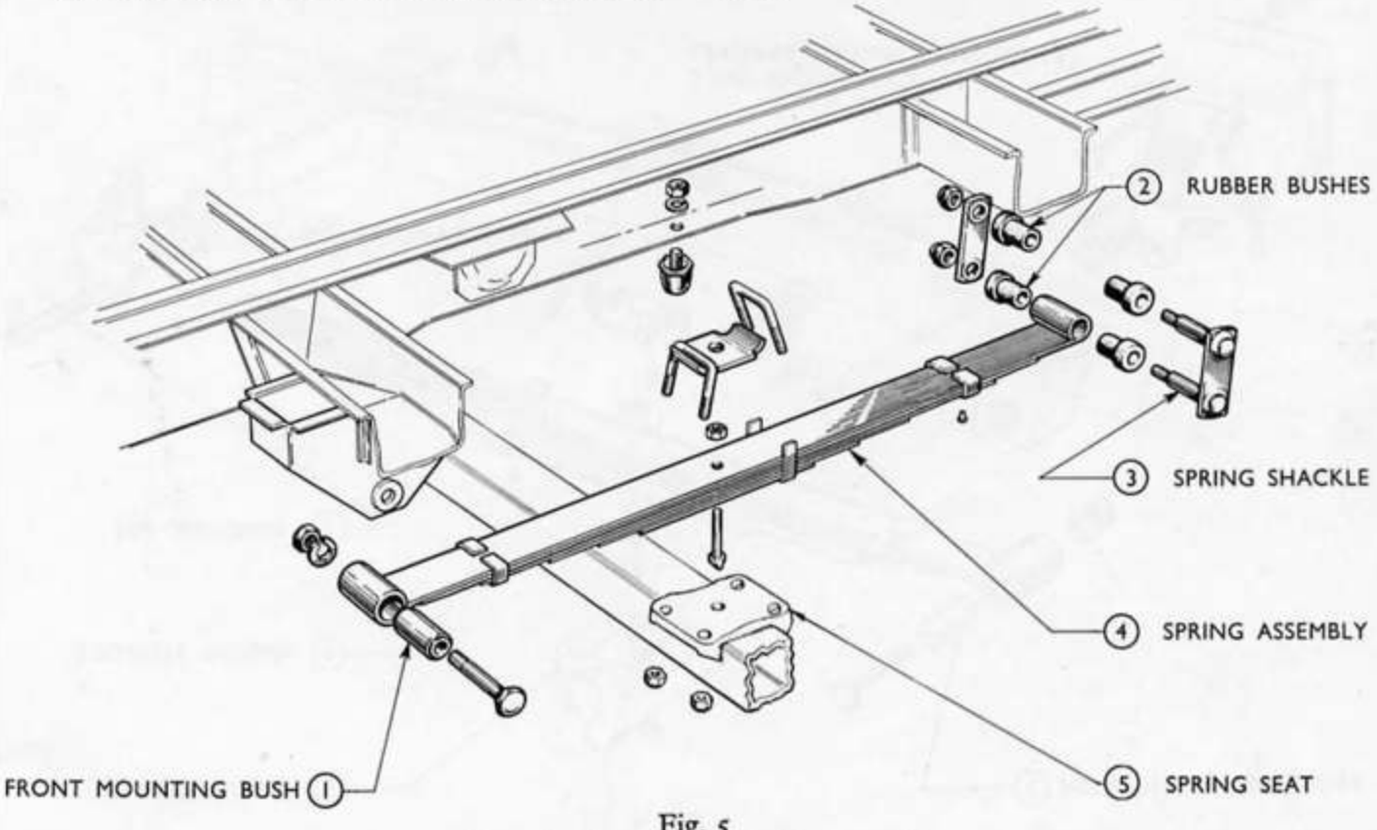


Fig. 5
Rear Spring Assembly (75 — 125)

2. **Bend up** the spring leaf clamps.

3. **Grip the spring** in a vice, close to the centre bolt.

4. **Remove the nut** from the centre bolt and slowly release the vice.

To Reassemble a Rear Spring

1. **Assemble the spring leaves** in order of decreasing length on a pilot rod of the same diameter as the centre bolt.

NOTE.—If the plastic interleaves are fitted they should be positioned between each spring leaf. Worn interleaves should be renewed.

2. **Compress the spring** in a vice and remove the pilot rod.

3. **Fit the spring centre bolt** from the bottom, tighten the nut to a torque of 3.5 to 4.2 kg.m. (25 to 30 lb. ft.), stake the end of the bolt and remove the spring from the vice.

4. **Position the spring clamps** and bend the ends over the top of the spring.

5. **Fit a new rubber bush** to the front eye of the spring, using adaptor No. C.5035/b in a suitable press.

To Replace a Rear Spring

1. **Position the eye** of the spring in the front bracket, align the holes and fit the mounting bolt.

2. (*a*) **75 to 125.** Assemble the shackle, with new rubbers, to the rear spring eye and to the rear bracket.

(*b*) **130 to 175.** Locate the head of the centre bolt in the axle, position the rear end of the spring in the slipper bracket. Jack under the axle to flatten the spring and fit the rebound pin.

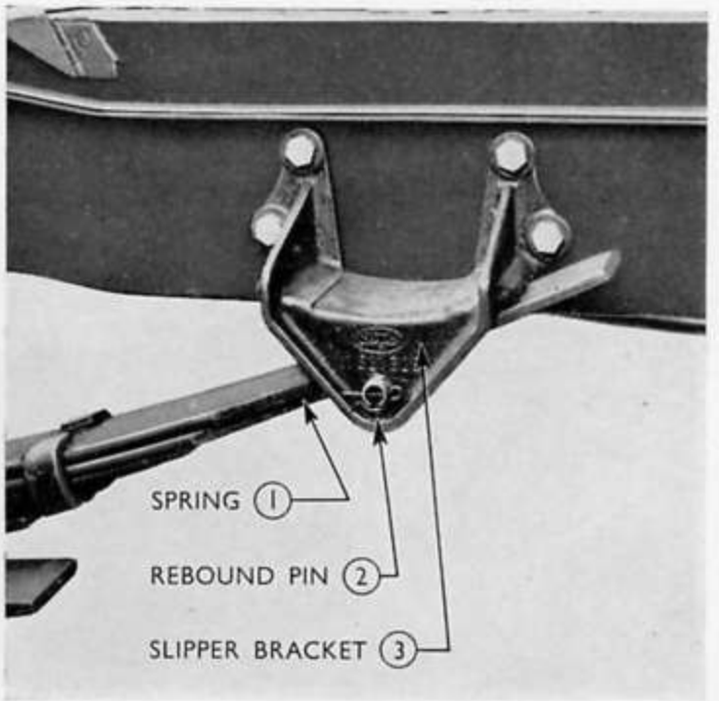


Fig. 6
Rear Slipper Bracket (130 — 175)

NOTE.—Shims are available to take up any side clearance between the spring and the slipper bracket. Up to four shims may be used on each spring.

3. (*a*) **75 to 125.** Tighten the front mounting bolt and nut to a torque of 11.06 to 16.58 kg.m. (80 to 120 lb. ft.) and the shackle pin nuts to a torque of 5.5 to 6.9 kg.m. (40 to 50 lb. ft.).

(*b*) **130 to 175.** Tighten the front mounting bolt and nut to a torque of 16.58 to 22.1 kg.m. (120 to 160 lb. ft.).

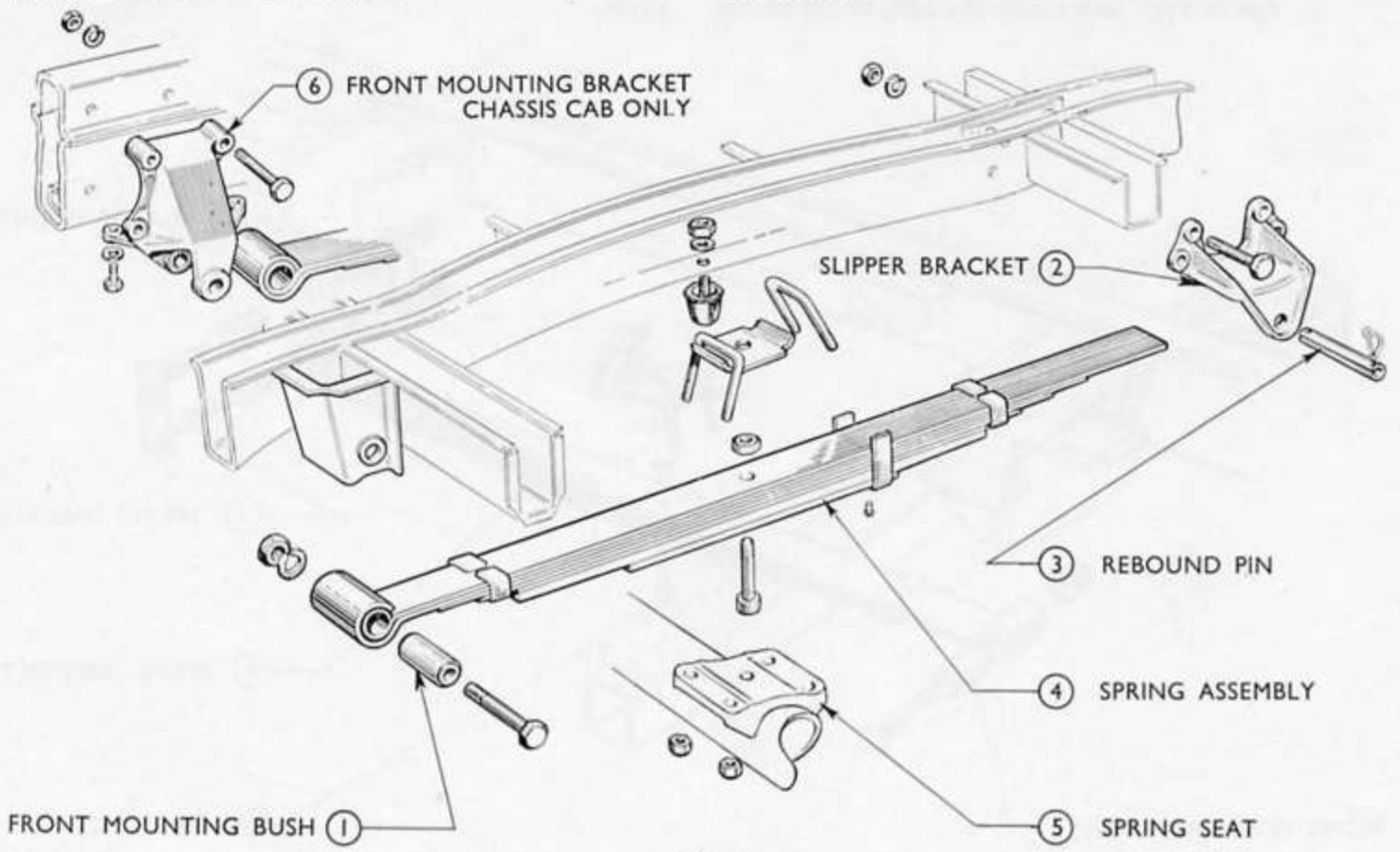


Fig. 7
Rear Spring Assembly (130 — 175)

Fig. 8
Rear Shock Absorber Installation (130 — 175)

Fig. 9
Rear Shock Absorber Installation (125)

4. Locate the spring on the axle, note that there are no spacers fitted. Ensure that the head of the centre bolt registers in the axle. Assemble the spring clips, the spring clip spacer and the nuts. Tighten the nuts to a torque of 7.6 to 9.0 kg.m. (55 to 65 ft. lb.) 75 to 115, and to a torque of 9.7 to 11 kg.m. (70 to 80 lb. ft.) 125 to 175. Use 17.5 mm. ($\frac{11}{16}$ in.) and 22 mm. ($\frac{7}{8}$ in.) A/F long sockets respectively.

5. Remove the chassis stands and lower the vehicle to the ground.

6. Check the torque of the spring clip nuts, preferably with the vehicle laden.

To Remove a Rear Shock Absorber

1. Remove the self-locking nuts from the mounting bolts at each end of the shock absorber unit.

2. Drive out the mounting bolts as necessary and detach the shock absorber unit, the mounting

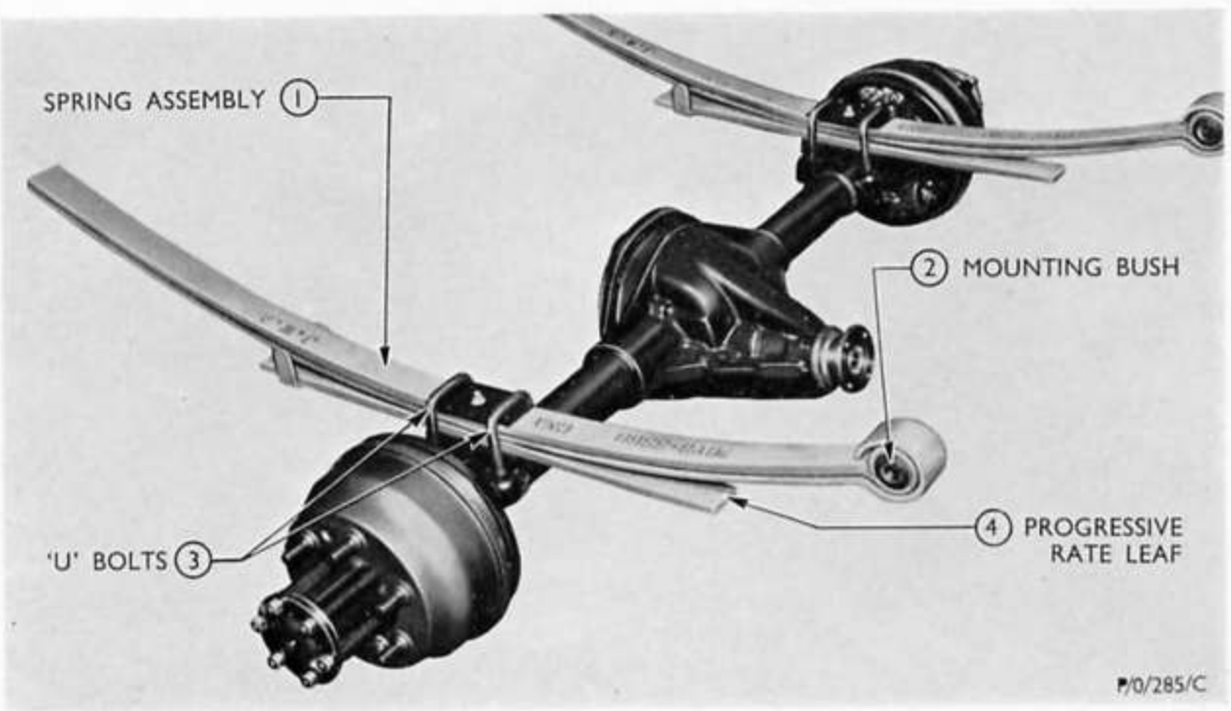


Fig. 10
Later Slipper Type Rear Spring (130 — 175)

rubbers and the flat washers. Note that on some models the handbrake cable bracket is secured by the offside upper mounting bolt.

To Replace a Rear Shock Absorber

1. **Position the shock absorber unit** with a pair of rubber bushes at each mounting eye. Note that the rubber bushes must be compressed between the face of a mounting bracket and a flat washer, or the handbrake cable bracket.

2. **Fit the self-locking nuts** and tighten to a torque of 3.8 to 4.5 kg.m. (27 to 32 lb. ft.) (75 to 115) and upper mounting (125 to 175). Tighten the lower mounting bolt and nut (125 to 175) to a torque of 1.94 to 2.35 kg.m. (14 to 17 lb. ft.).

Section 6

ENGINE

CONTENTS

SUBJECT

ENGINE: PETROL
OVERHAUL PROCEDURES

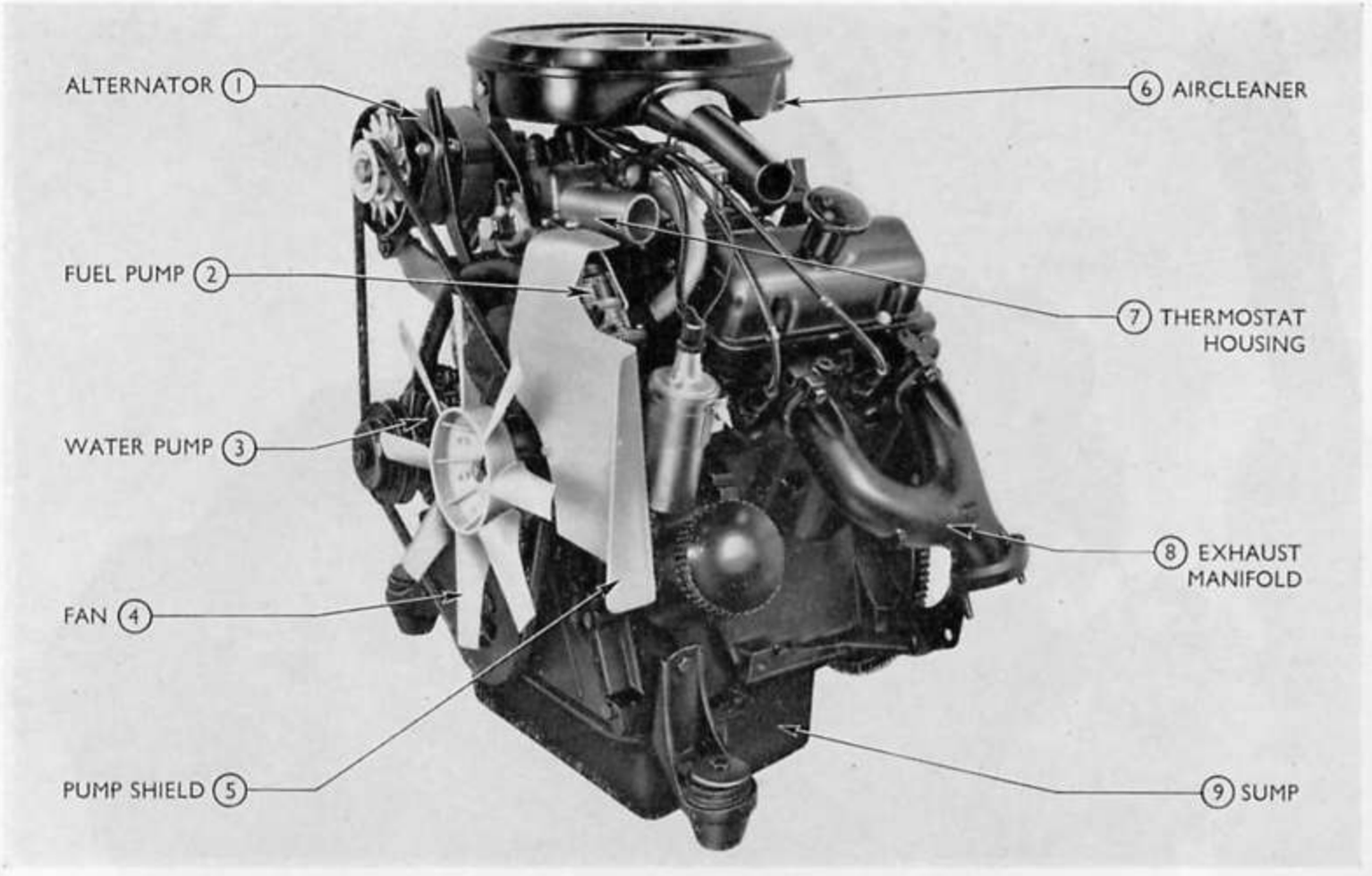


Fig. 1
The Engine Assembly

DESCRIPTION

The engine is a four-cylinder unit, with the cylinders arranged in a 60° Vee formation. Two engines are available of 1.7 litre and 2.0 litre capacities. Both engines have a common bore of 93.66 mm. (3.6875 in.), the stroke being 60.35 mm. (2.376 in.) and 72.42 mm. (2.851 in.) respectively. The compression ratio is 8:1.

The engines are identified by the numbers 1.7 or 2.0 stamped on a pad at the front of the cylinder block on the left-hand side. See Fig. 3.

On vehicles produced after July 1967 optional high compression engines are available. The compression ratio being 9.1 : 1 for the 1.7 litre and 8.9 : 1 for the 2 litre.

The cylinder bores are machined directly in the cast iron cylinder block, which is cast integral with the upper half of the crankcase and are provided with full length water jacketing. The crankcase incorporates three main bearings with caps retained by 11.11 mm. ($\frac{7}{16}$ in.) diameter bolts.

Overhead valves are mounted normal to the cast iron cylinder heads in integral valve guides and are operated by rockers, push rods and tappets from a camshaft located in the valley between the two banks of cylinders. To improve engine breathing the inlet valves are larger than the exhausts and all valves have separate ports. The rocker arms are individually mounted on studs pressed into the cylinder heads and are retained by spherically faced fulcrum seats and self-locking nuts. Valve clearances are adjusted by these self-locking nuts. Valve springs are close coiled at one end and must be fitted with these coils adjacent to the cylinder head.

The camshaft runs in steel-backed white metal bearing bushes and is driven by a fibre gear meshing directly with the crankshaft gear. A skew gear, machined integral with the camshaft immediately behind the front bearing journal drives the distributor and oil pump. An eccentric retained by the camshaft gear securing bolt operates a fuel lift pump mounted on the front cover. Camshaft thrust is taken by a thrust plate located between the camshaft gear hub and the front bearing journal. This thrust plate is of cast iron and is bolted to the cylinder block front face.

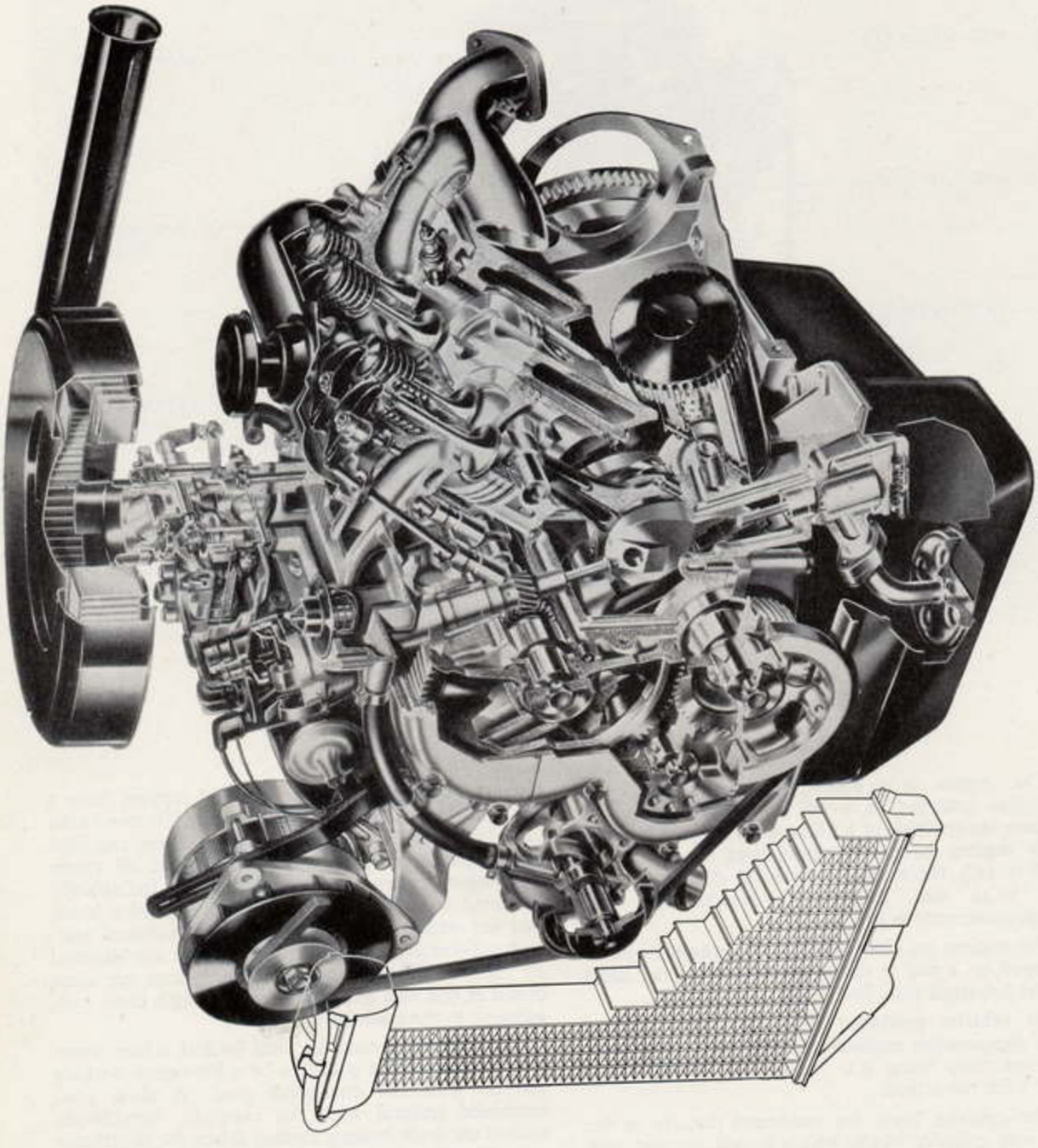


Fig. 2
The Engine Sectioned (Early Type)

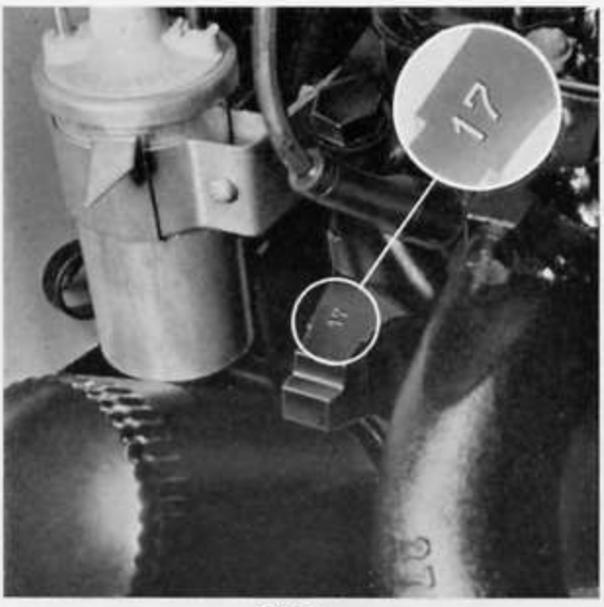


Fig. 3
Engine Identification

The cast iron crankshaft runs in three large diameter main bearings fitted with detachable steel-backed aluminium tin or copper lead bearing liners. Crankshaft end-float is controlled by thrust washers fitted at each side of the centre main bearing.

Seals pressed into the front cover and the rear oil seal carrier prevent oil leaks from the front and rear of the crankshaft. The front seal runs on the pulley hub but the rear seal runs directly on the crankshaft flange.

The connecting rods are H section forgings with the big end caps retained by bolts and located by hollow dowel pins. The bearing liners are steel-backed aluminium tin or copper lead. The small end does not incorporate a bearing and is shrunk onto the piston pin to retain it in the piston.

Aluminium alloy solid skirt autothermic pistons with the combustion chamber machined in the piston crowns are used. Each piston has two compression and one oil control ring above the piston pin. The upper compression ring is chrome plated on the periphery and is also barrel faced. The lower compression ring is externally stepped on the lower face and is impregnated with molybdenum on the periphery together with an overall phosphate coating. The oil control ring is of the slotted channel type scraper with narrow lands.

The cast iron flywheel has a steel ring gear shrunk onto it for the starter motor drive.

As this engine has four cylinders arranged in a 60° Vee formation the rotating and reciprocating masses do not balance themselves out completely and in each case there is an out of balance couple present. These are balanced by weights in the crankshaft pulley, crankshaft and flywheel and, in the case of the reciprocating masses, also by a balance shaft revolving at engine speed in the opposite direction to the crankshaft.

The sump is a steel pressing and has a drain plug located in the right-hand side.

The oil pump may be either of the eccentric bi-rotor or the sliding vane type and is driven by a hexagonal shaft from the distributor drive gear. Each pump incorporates a pressure relief valve. Oil is pressure fed, via a full flow oil filter to the main, big end, camshaft and balance shaft bearings and also to the tappets.

Oil feed to the rockers and valve gear, via hollow push-rods, is controlled by the tappets on engines built before February 1968.

After January 1968, changes to the cylinder block, camshaft, camshaft centre bearing and tappets were incorporated. From this date, oil feed to the valve gear through the hollow push-rods is metered by the camshaft centre journal and bearing. A drilling into the balance shaft front journal oil drilling feeds oil to the thrust plate which directs it in two jets onto the timing gears.

Oil from the rocker arms drains from the cylinder head into the tappet chamber to lubricate the cams and the distributor drive gear as it returns to the sump. The cylinder bores are lubricated by a squirt of oil once every revolution from a small drilling in each connecting rod web. The piston pins are lubricated by oil mist and by oil scraped from the cylinder walls.

The oil filler cap is located on the left-hand rocker cover and also incorporates a filter gauze for the crankcase ventilation system. This system is of the positive type, crankcase fumes being discharged into the inlet manifold, and is controlled by an emission valve in the right-hand rocker cover.

The following pages provide complete instructions for servicing, removal, replacement, dismantling and reassembly operations, which may be necessary on this engine.

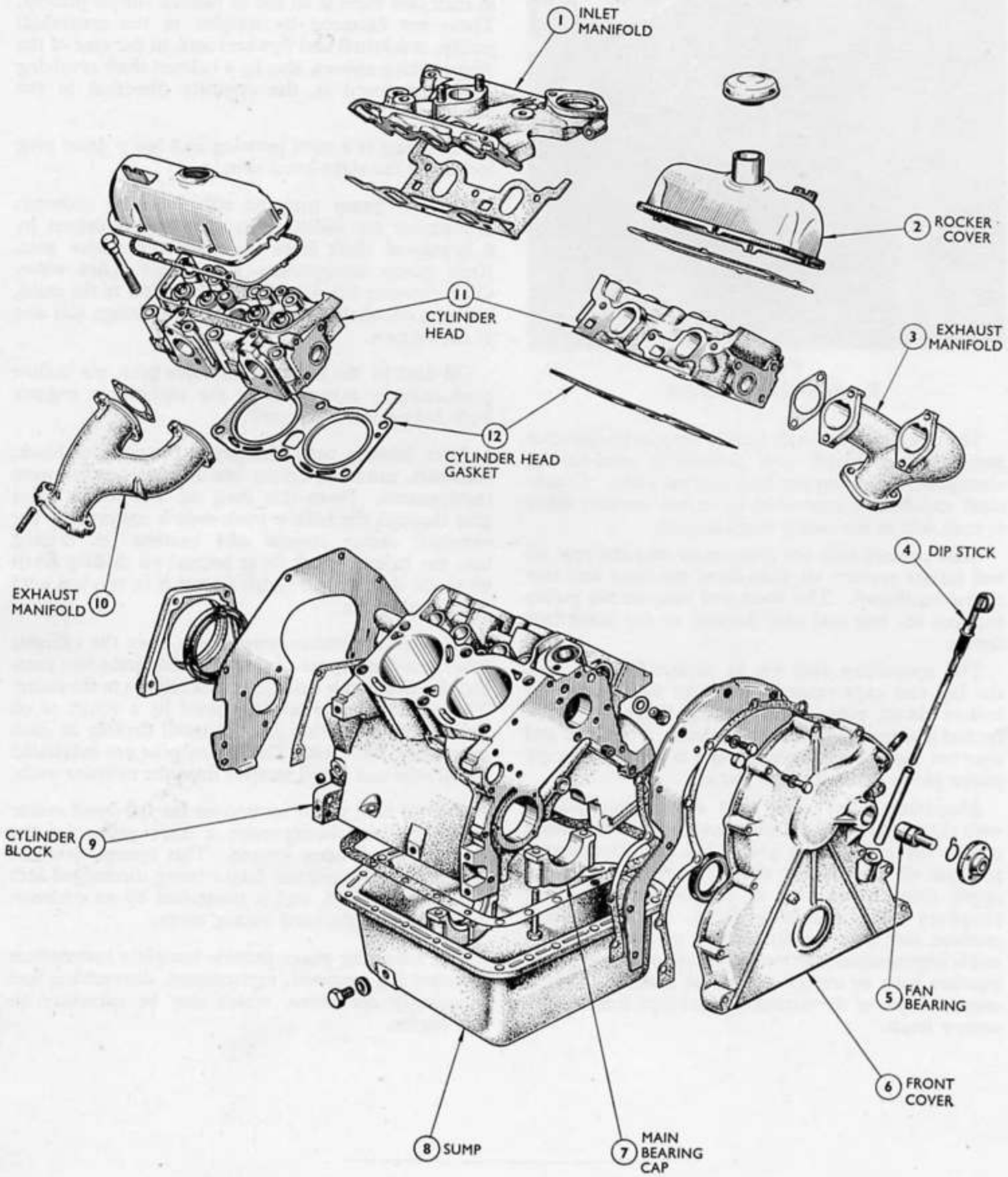


Fig. 4
The Engine — Exterior

ENGINE COMPONENTS

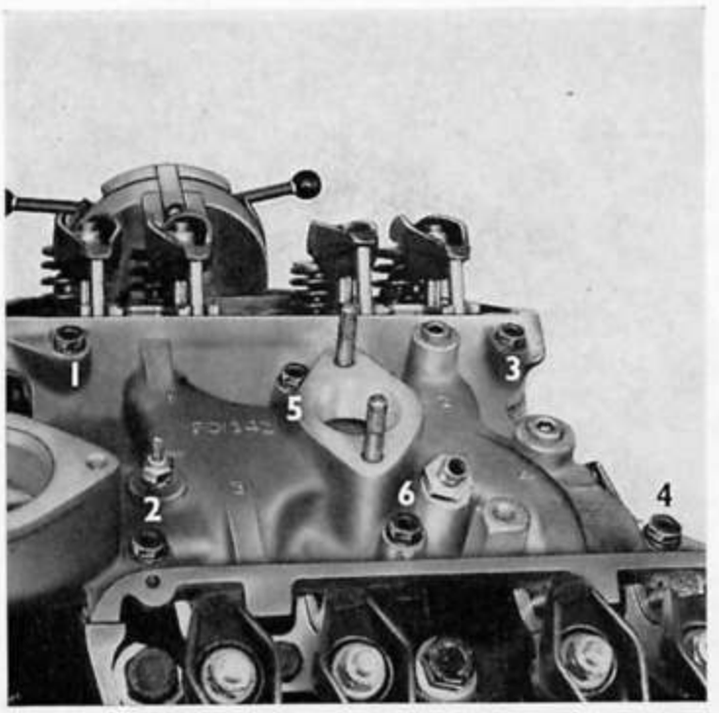


Fig. 5
Inlet Manifold Bolt Tightening Sequence

INLET MANIFOLD

The inlet manifold is an aluminium casting mounted on the cylinder heads between the Vee and thus forms a cover for the tappet chamber. This manifold also incorporates the water outlets from the cylinder heads and the thermostat housing. The induction tracts to each cylinder are separate and are, therefore, heated by the engine coolant, thus ensuring full fuel vaporisation when the engine is at operating temperature, no other "hot-spotting" being provided.

The gasket is of a composition type material with cork inserts at each end to form an oil-tight joint between the manifold and the front and rear walls of the cylinder block tappet chamber.

Prior to replacing the inlet manifold apply sealer EM-49-52 to the areas of the manifold and cylinder heads shown shaded in Fig. 6.

Tighten the bolts progressively in the sequence shown in Fig. 5 as follows:

(1) 0.41 to 0.83 kg.m. (3 to 6 lb. ft.) torque
(2) 0.83 to 1.52 kg.m. (6 to 11 lb. ft.) torque
(3) 1.52 to 2.21 kg.m. (11 to 16 lb. ft.) torque

Trim the gasket ends flush with the rocker cover mating face after fitting the manifold.

Retighten all bolts to 1.80 to 2.21 kg.m. (13 to 16 lb. ft.) torque when the engine is at the normal operating temperature after first retightening the cylinder head bolts.

EXHAUST MANIFOLDS

A cast iron exhaust manifold is used for each bank of cylinders and is bolted to the cylinder head, on the outside of the "Vee". Each manifold has separate ports for each cylinder and incorporates a flange for attaching the exhaust pipe.

The manifolds are fitted with asbestos gaskets, which are reinforced with perforated steel, and are retained by bolts fitted with plain washers.

CYLINDER HEADS

The cast iron cylinder heads are of the cross-flow type with separate ports for each valve and are identical for each bank of cylinders. As the cylinder head height must be constant for accurate alignment and fit of the inlet manifold between the two cylinder heads, the compression ratio is controlled by recesses machined in the head face. These recesses are circular and slightly larger than the cylinder bores. With the valves fitted and the spark plug hole sealed with a solid plug, these vestigial combustion chambers have a volume of 15.65 to 20.58 c.c. low compression, and 6.36 to 10.41 c.c., high compression.

Externally, the type of cylinder head can be identified by the letter H for high, or L for low, stamped on the machining location pads above the exhaust ports.

Identical gaskets are used for each cylinder head and are made of a composition type material reinforced with copper around the cylinder bores. Each cylinder head is retained by six 12.70 mm. ($\frac{1}{2}$ in.) diameter by 93.66 mm. ($3\frac{11}{16}$ in.) long bolts. When fitting the cylinder head tighten the bolts progressively in the sequence shown in Fig. 8 as follows:

(1) 6.22 to 7.60 kg.m. (45 to 55 lb. ft.) torque
(2) 7.60 to 8.98 kg.m. (55 to 65 lb. ft.) torque
(3) 8.98 to 9.67 kg.m. (65 to 70 lb. ft.) torque

Retighten all bolts to 8.98 to 9.67 kg.m. (65 to 70 lb. ft.) torque when the engine is at the normal operating temperature.

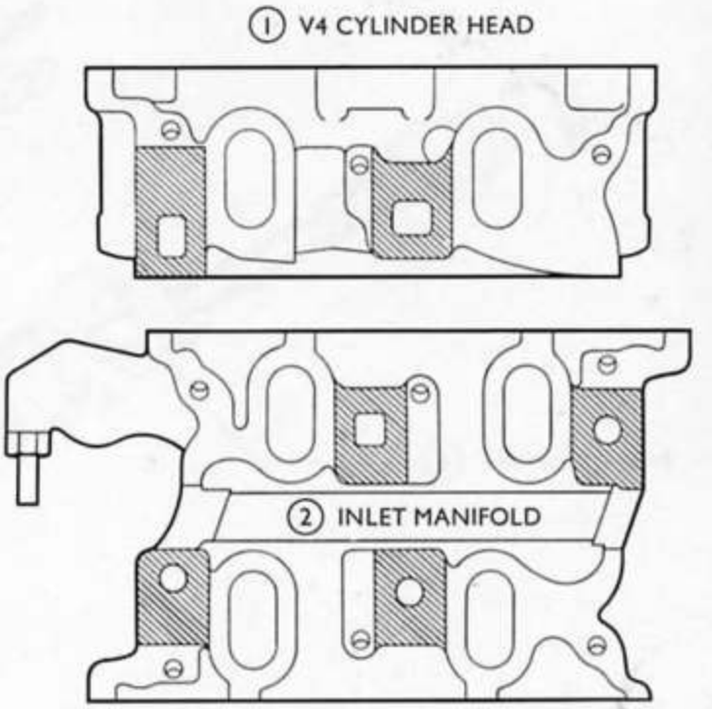


Fig. 6
Apply EM-4G-52 to Shaded Areas Shown

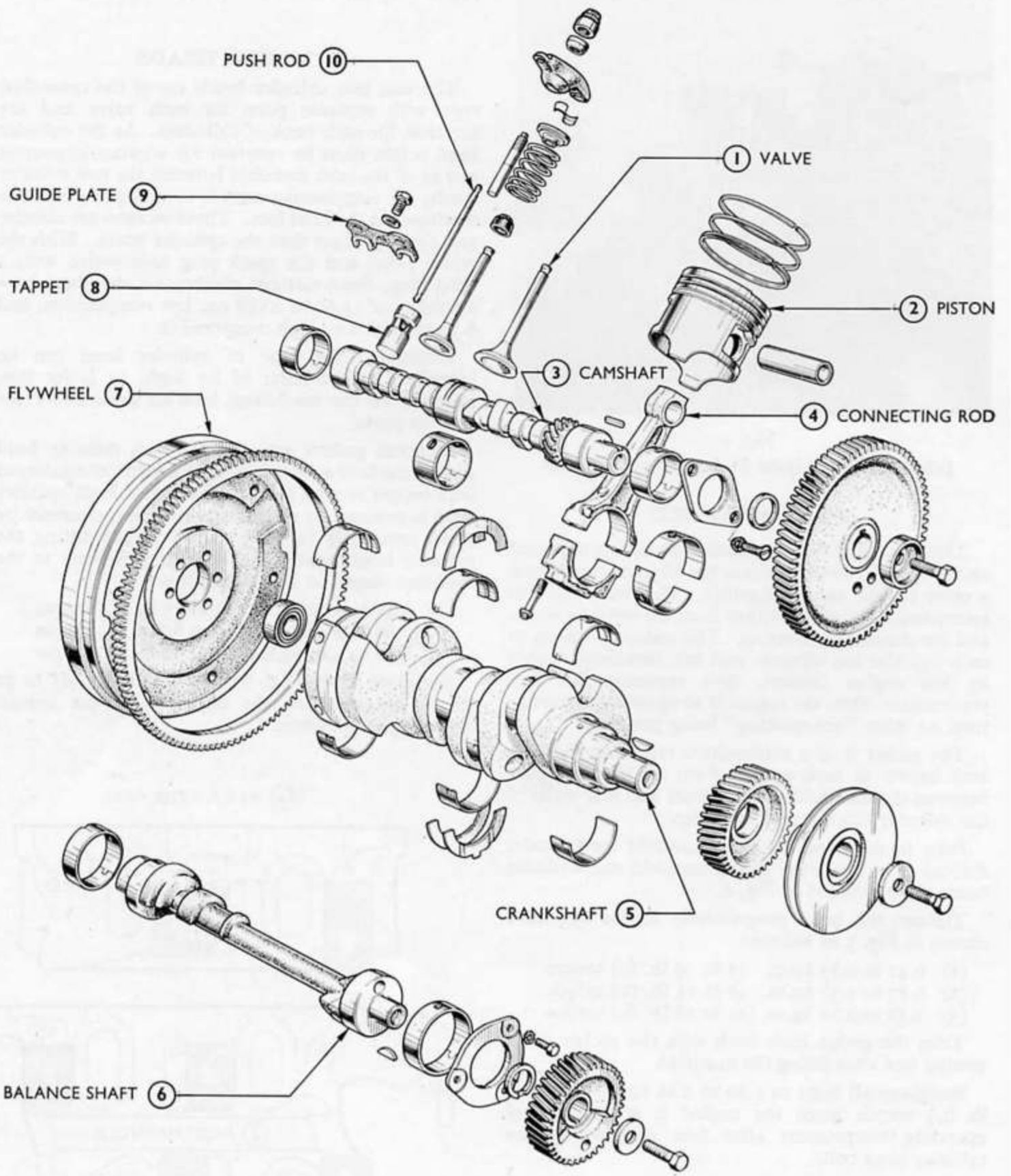


Fig. 7
The Engine — Interior

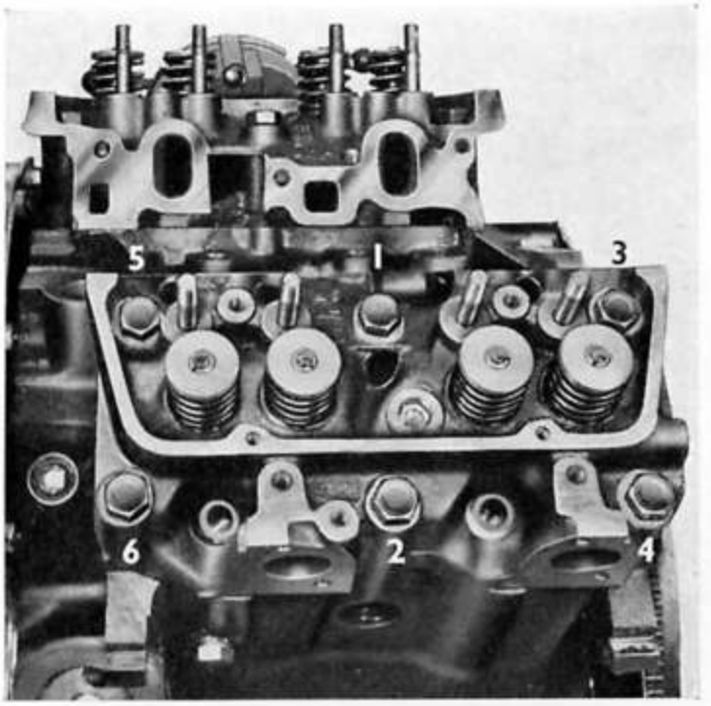


Fig. 8
Cylinder Head Bolt Tightening Sequence

The valves operate in guides machined directly in the cylinder head, although in some instances valve guides may be fitted and are available in service. When fitting valve guides press each new guide into the cylinder head until the plain end is flush with the spot faced boss in the valve port.

Where the guides are machined directly in the cylinder head the bores may be reamed 0.38 mm. (0.015 in.) or 0.76 mm. (0.030 in.) oversize with reamer Tool No. P.6056–015 or P.6056–030 respectively. Valves with 0.38 mm. (0.015 in.) or 0.76 mm. (0.030 in.) oversize stems can then be fitted. This, of course, may also be done where the guides are replaceable. After fitting new valve guides or reaming the valve stem bore the valve seats must be recut to ensure that the seat is concentric with the valve stem bore.

Recut the seats with cutters Tool No. FMC.317–24 (exhaust) and 317–27 (inlet) fitted to pilot Tool No. 316–10 in handle Tool No. 316X. Where necessary, the seats may be narrowed with top face cutters Tool No. 317T–24 (exhaust) and FMC317–27 (inlet). The valve seats should also be recut when they show signs of pitting or burning and when fitting new inlet valves.

Replaceable valve seat inserts are available and should be fitted where necessary. Where inserts have not been fitted previously it will be necessary to machine a recess in the cylinder head for the appropriate valve seat insert. If, for any reason, an existing insert has become loose or damaged, oversize inserts can be fitted.

The sizes for machining the recesses for standard and oversize valve seat inserts are tabulated in the Specification section.

Valve seat inserts may be removed by inserting a suitable chisel under the insert and striking smartly when the insert will be forced out of its location. Care should be taken in this operation to avoid damage to the combustion chamber.

To fit a new insert, select the correct size and enter the insert with the chamfered edge away from the combustion chamber and press into place using insert replacer tools made to the dimensions shown in Fig. 10. After fitting the inserts, the seats must be cut with the appropriate cutter tools to the dimensions in Fig. 9.

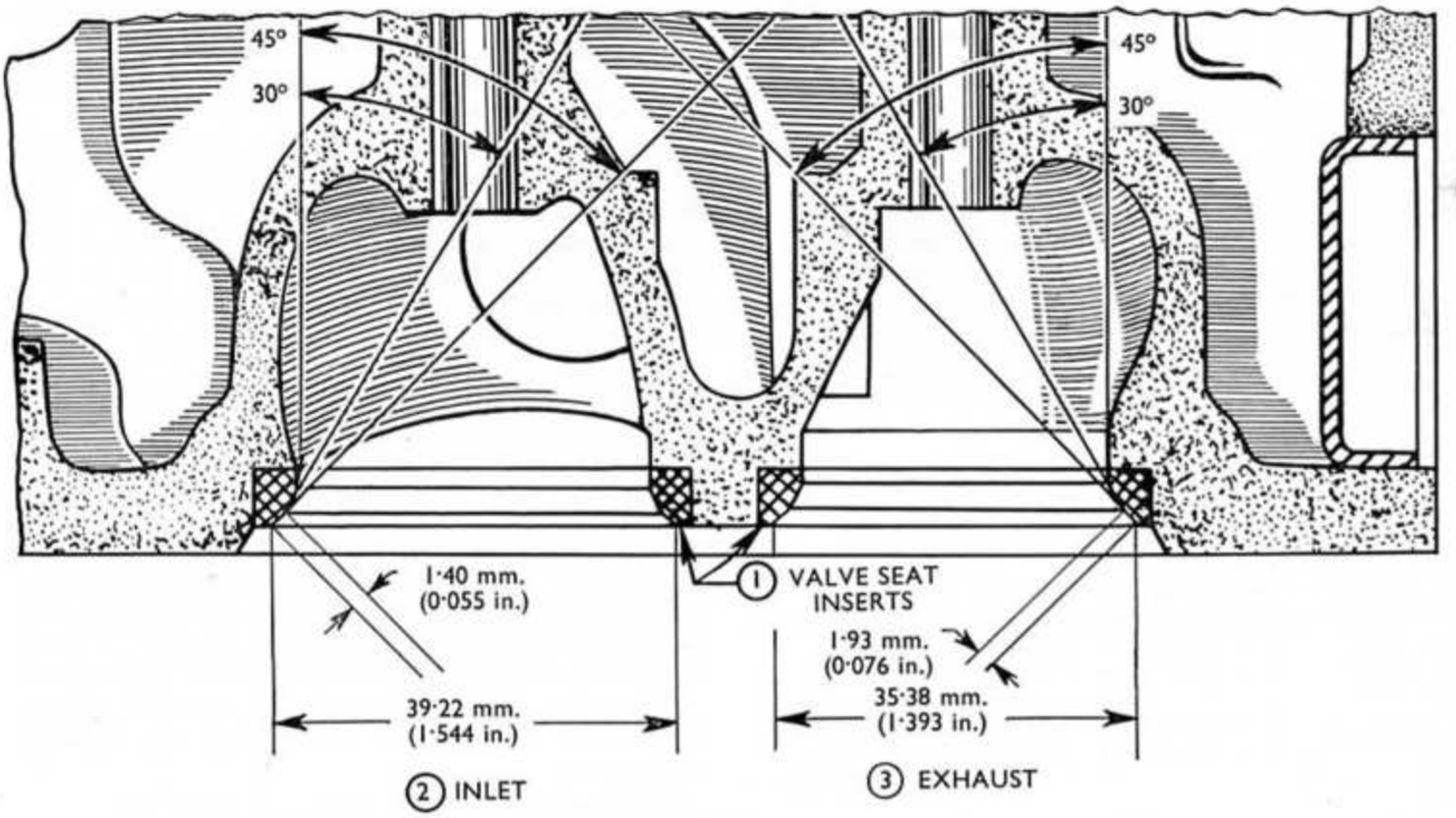


Fig. 9
Valve Seat Insert Machining Dimensions

The rocker studs are pressed into the cylinder head and can be removed, if the threads become worn or damaged, with a nut and a suitable sleeve. Where the stud has broken it will be necessary to carefully drill out the broken portion. Ream out the bore 0.08 mm. (0.003 in.) or 0.38 mm. (0.015 in.) oversize, using reamers Tool No. CP 6148–003 or CP.6148–015. Do not ream out directly to 0.38 mm. (0.015 in.) oversize from standard, but ream the bore out to 0.08 mm. (0.003 in.) oversize first. After reaming remove all swarf from the inlet ports and water jacket.

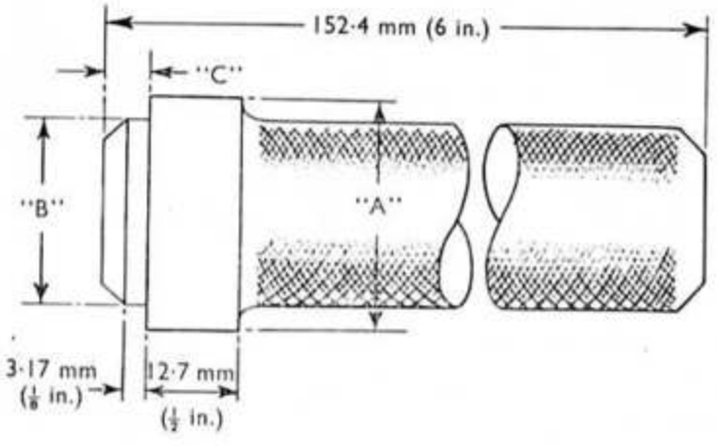
Fit the new studs using replacer Tool No. CP.6142A. Oversize studs can be identified by a single groove round the spigot end for 0.08 mm. (0.003 in.) oversize studs and by a double groove on the 0.38 mm. (0.015 in.) oversize studs. Standard size studs have no identification markings. Screw the stud fully into the replacer and coat the portion which is inserted into the cylinder head with sealer EM–4G–64. Press the stud into the cylinder head until the tool bottoms. The stud is then installed to the correct height of 55.1 mm. (2.17 in.). Unscrew the replacer to remove it from the stud.

NOTE.—Vehicles produced after July 1967 have improved rocker arms, longer studs and thicker adjusting nuts. Previous to this date rocker stud protrusion was 46.74 mm. (1.84 in.) The longer stud replaces the early type.

When replacing the longer studs using Tool No. CP.6172 an 8.4 mm. (0.33 in.) spacer must be used in conjunction with the rocker stud replacer to give the correct stud protrusion which is 55.1 mm. (2.17 in.).

VALVES AND SPRINGS

The valves are mounted vertically in the cylinder head and have concave valve heads, the inlet being larger than the exhaust. Their respective diameters are 40.48 mm. (1 $\frac{18}{32}$ in.) and 36.51 mm. (1 $\frac{7}{16}$ in.) and both have 45° seats. The inlet and exhaust valves are positioned alternately commencing from the front, with an exhaust valve in the right-hand bank of cylinders and an inlet valve in the left-hand bank.



Valve	Dia "A"	Dia "B"	"C"
Inlet	41·66 mm (1·64 in.)	33·78 mm (1·33 in.)	5·33 mm (0·21 in.)
Exhaust	37·85 mm (1·49 in.)	29·97 mm (1·18 in.)	5·33 mm (0·21 in.)

P/0/297/C

Fig. 10
Valve Seat Insert Replacer Tool

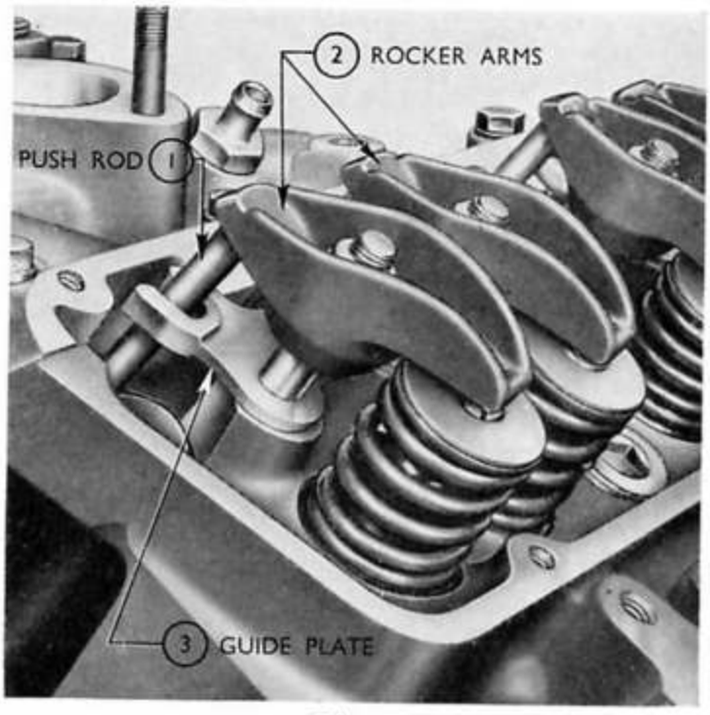


Fig. 11
Stud Mounted Rocker Arms

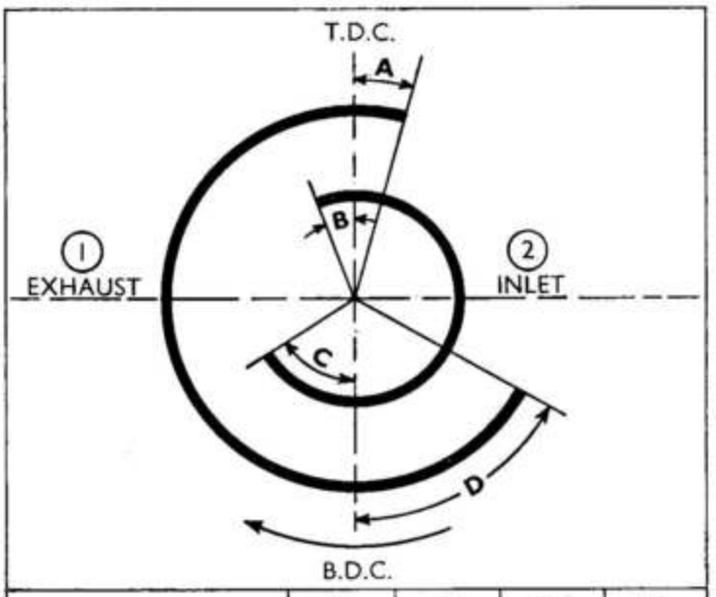
The inlet valve head has a diffused aluminium coating to increase the valves resistance to high temperature oxidisation and to form a hard wear-resistant surface on the seating area. In no circumstances should the faces of "aluminised" inlet valves be ground or the valves lapped in as this will remove the diffused aluminium coating and reduce the valves' wear and heat resistant properties. If the valve faces are worn or pitted it will be necessary to fit new valves and to recut the valve seats or, alternatively, lap the seats using dummy valves.

The exhaust valves may be re-ground if the face is unduly pitted or distorted providing the edge thickness is not reduced to 0.79 mm. ($\frac{1}{32}$ in.) or less. Hand lapping may be used but should be kept to a minimum or the angles may be altered and the seat width become too wide. A seat width of 1.59 mm. ($\frac{1}{16}$ in.) to 2.38 mm. ($\frac{3}{32}$ in.) is acceptable.

Valves with 0.076 mm. (0.003 in.), 0.38 mm. (0.015 in.) and 0.76 mm. (0.030 in.) oversize stems can be obtained, the oversize being marked immediately below the collet groove. The stems on all valves are phosphate coated to improve durability.

Identical springs are used for each valve and are close coiled at one end. When fitting these springs, ensure that the close coiled end is located adjacent to the cylinder head. The valve springs are each retained by a hardened steel retainer and split tapered collets. An umbrella type oil seal is fitted to each valve stem immediately below the valve spring retainer.

NOTE.—On vehicles produced after July 1966, new valves, valve springs, spring retainers, collets, valve guides and valve stem seats have been fitted.



	A	B	C	D
Before Feb. 1968	14°	20°	56°	62°
After Jan. 1968	14°	20°	64°	70°

Fig. 12
Nominal Valve Timing Diagram

These parts are not interchangeable with the parts fitted prior to July 1966. The new valves are easily recognizable as the collet groove is machined nearer to the valve head than on the earlier valve, the valve stem now protrudes approximately 3.2 mm. ($\frac{1}{8}$ in.) above the valve spring retainer.

ROCKER ARMS

The rocker arms are individually mounted on studs pressed into the cylinder head (see Fig. 11). These rocker arms are made of cast iron and pivot on case hardened steel, spherically faced fulcrum seats retained by self-locking nuts. The self-locking nuts providing the adjustment for the valve clearances.

Oversize rocker studs are available should they become loose in service, see the section on "Cylinder Heads" on page 9.

PUSH RODS AND TAPPETS

Early push rods were made of case hardened steel with spherical ends. The later type are of steel tubing with a ball bearing welded to each end. The ball bearings are drilled to provide an oil feed to the rocker arms from the tappets. Sintered iron guide plates are fitted to the cylinder head to hold the push rods in alignment as the rockers on this engine are mounted individually as described previously. When fitting oversize rocker studs a new guide plate with oversize stud holes must also be fitted, as the guide plate is accurately located by these studs. Guides plate with oversize stud holes are marked with a letter "B" for 0.08 mm. (0.003 in.) oversize holes and "C" for 0.38 mm. (0.015 in.) oversize.

Before fitting the push rods to an engine after overhaul, check for wear and straightness. The maximum runout of the rod, with the spherical ends mounted in sockets, should not exceed 0.25 mm. (0.010 in.) T.I.R. at the centre of the rod.

Prior to February 1968

The oil supply to the valves was controlled by the tappets. The earliest tappets incorporated a steel push-rod seat and a metering valve under the seat, both retained by a circlip. These were superseded by a tappet which metered the oil supply via an annular groove on its outside diameter and a drilling through to the tappet centre. The push-rod seat retained by the circlip was still used but the metering valve was deleted.

From February 1968 onwards

The oil supply to the valve gear is intermittent and is controlled by the camshaft centre journal and bearing. The one piece tappets used in this system of oil control have plain bearing surfaces and the unmachined portion has large apertures. Two types of tappet may be encountered. One having a single chamfer 'lead in' to the push rod seat, the other a double chamfer 'lead in'. The former is the current type, the latter was introduced for a short period only. Do not mix these two types of tappet in an engine.

NOTE.—Only two types of tappet are available in service. The latest type with the single chamfer, which must only be used in engines built after January 1968. The early type with the annular groove must only be used in engines built before February 1968.

CAMSHAFT

A single cast alloy iron camshaft is located in the cylinder block "Vee" to operate the valves in both banks of cylinders and runs in three stepped diameter steel-backed white metal faced bearing bushes. The nominal valve timing diagram is shown in Fig. 12.

Bushes available in service are pre-sized and require no machining after fitting. Bushes which are 0.508 mm. (0.020 in.) oversize on the outside diameter are also available. When one bush requires replacement it is advisable to replace all bushes as camshaft alignment may be affected if only one bush is changed. The centre bearing can only be removed after removing the front bearing.

The camshaft bushes can be removed and replaced, through the front of the cylinder block, in the removal sequence, front bush, centre bush, rear bush. Replace the bushes in the reverse order, using remover/replacer Tool No. CP.6160. Assemble the housing, nut, threaded sleeve and tommy bar onto the centre shaft. Align the flats on the threaded sleeve with the flats on the centre shaft nearest the locking pin hole and retain the sleeve with the C washer. Locate the remover, detail "q", at the end of the shaft and retain it with the locking pin. Turn the centre shaft until the remover lies at an angle to it, insert the remover through the front camshaft bush, turn the centre shaft through 180° when the remover will pivot, and be at right angles, to the shaft. Carefully locate the remover in the bush then tighten the nut to withdraw the bush.

The centre and rear bushes are removed in a similar manner from the front of the cylinder block, using remover details "r" and "s" respectively and

locating the threaded sleeve on its next position along the centre shaft for each bush.

Remove the expansion plug from the rear camshaft bore before removing the rear bush.

Replace the bushes in the reverse order to removal.

NOTE.—The rear bush oil feed hole is offset and must be fitted offset to the rear of the block. The centre bush has three oil feed holes two of these are close spaced. When installing the centre bush ensure the close spaced holes, are at the top and the single hole aligns with the bottom oil feed hole in the block. The front bush has one oil feed hole.

Locate the centraliser detail "g" in the expansion plug recess, pass the centre shaft through it until the end of the shaft protrudes from the front of the cylinder block. Fit the new rear bush onto the replacer detail "n", ensure the offset oil feed hole is to the rear of the block, locate the replacer on the end of the shaft and insert the locking pin. Align the oil hole in the bush with the drilling in the cylinder block then carefully draw the centre shaft through the camshaft bore.

When the bush is correctly located in the lead-in of the bush bore, slide the threaded sleeve along the centre shaft and retain it in position with the "c" washer.

Check that the bush and replacer are in alignment with the bush bore then tighten the nut to pull the bush into place.

Install the centre and front bushes in a similar manner using replacers detail "m" and "k" respectively, align the oil holes with their respective drillings. Take care not to damage the bushes previously fitted.

When replacement of the bushes is complete, fit a new expansion plug to the rear camshaft bore.

The cams on the camshaft, which are hardened to improve durability, are offset rearwards from the tappet centre lines and are also tapered. This causes

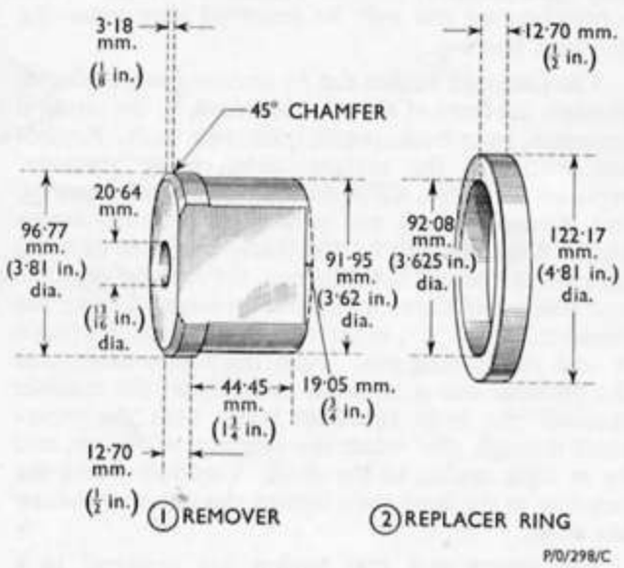


Fig. 13
Cylinder Liner Remover/Replacer Adaptor

the tappets and push rods to rotate, thus further improving durability and eliminating the possibility of uneven wear. The camshaft also incorporates an integral skew gear immediately behind the front bearing journal, for driving the distributor and oil pump. The camshaft is phosphate coated to prevent "scuffing" and "pick-up" of the cams and distributor gear on initial running, the bearing journals however, are burnished to remove this coating as they run in white metal bushes.

The camshaft is retained by a thrust plate screwed to the cylinder block front face. This thrust plate is located between the rear face of the timing gear and the front face of the camshaft front journal. A spacer is fitted to the camshaft behind the gear to give the correct spacing between the gear hub and the camshaft front journal. This spacer must be fitted with the internal chamfer adjacent to the journal.

The timing gear is made of fibre with a cast iron hub and is retained by a centre bolt and the fuel lift pump eccentric, no other washers being used. The fuel lift pump eccentric is, thus, detachable and is made of cast iron with a hardened periphery. When fitting the timing gear the angular position of the eccentric is unimportant on vehicles produced before March 1966. After March 1966 the fuel pump eccentric should be positioned so that its point of maximum eccentricity should be positioned midway between the two cast holes in the camshaft gear. Later engines have the eccentric positively located by a split dowel in the camshaft gear hub and a hole in the eccentric. Tighten the bolt to 3.32 to 3.87 kg.m. (24 to 28 lb. ft.) transmitting this torque through the gear train if necessary. A timing mark is incorporated in the gear to facilitate correct valve timing.

The gears are graded in production to ensure correct backlash with the mating crankshaft gear. Three grades are used, the respective grades being identified by a colour code marked on the gear web. The grades for the camshaft gear are RED top limit, YELLOW mean and BLUE bottom limit. For the crankshaft they are BLUE top limit, YELLOW mean and RED bottom limit. Thus, by selecting gears with a matching colour the correct backlash is obtained.

When fitting a new gear, select a grade that gives the correct backlash. This may have to be a grade larger than that indicated by the colour of the gear being replaced to allow for wear, unless the mating gear is also being replaced.

After January 1968

The camshaft centre bearing and journal were modified to meter the oil feed to the valve gear. A revised cam profile was also introduced. Identification is by the oil groove machined approximately 160° around the centre journal. Also the suffix "F" is stamped on the rear face of No. 3 bearing journal. This camshaft and also the modified centre bush may be fitted to early engines but the tappet type must not be changed, i.e. early engines must have early tappets, later engines must have only latest design tappets.

CYLINDER BLOCK

The cylinder block is cast iron and is cast integral with the upper half of the crankcase. The cylinder bores are arranged in a 60° Vee and a full length water jacket is provided.

Changes affecting the camshaft centre bearing and camshaft resulted in a modified cylinder block, introduced after January 1968, identified by the suffix 'C' to the casting number on the right-hand side of the cylinder block.

A further cylinder block change, increasing the height of the oil pump mounting platform, was effected from October 1968 onwards. This block can be identified by the suffix 'D' to the casting number as above, or by measuring the height of the oil pump mounting platform from the sump joint surface, this, on the modified block, is approximately 63·5 mm. (2·5 in.) compared with 38 mm. (1·5 in.) on blocks produced before October 1968.

When replacing either of the previous cylinder blocks with a 'D' suffix block the later type oil pump must be fitted, see page 6-25.

The crankcase incorporates three main bearings, the main bearing caps being retained by 11·11 mm. ($\frac{7}{16}$ in.) diameter bolts fitted without washers. When dismantling the main bearing caps, ensure that the front and rear cap positions are marked as these caps are identical. Also ensure that the caps are fitted the correct way round on assembly. These caps are marked with an arrow and a letter F, indicating the front.

The crankshaft bearing liner parent bore in the cylinder block may be either standard or 0·38 mm. (0·015 in.) oversize. The standard bore is graded and marked with a RED paint spot on the bearing cap for the smallest grade and BLUE for the largest. Where the bore is 0·38 mm. (0·015 in.) oversize the grades are YELLOW and GREEN respectively. When selecting main bearing liners for use with a new crankshaft, one half must be selected to correspond with the cylinder block grading and the other half with the crankshaft.

The three stepped diameter bores for the camshaft bearing bushes are located in the valley between the two banks of cylinders. These bores may be 0·51 mm. (0·020 in.) oversize but in this case the block is unmarked.

Similarly the stepped diameter bores for the balance shaft bearing bushes may also be 0·51 mm. (0·020 in.) oversize.

The cylinder bores are machined directly into the cylinder block and, in production, are graded for size. Cast iron dry type cylinder liners may be fitted and two sizes of liner are available, a standard and 0·51 mm. (0·020 in.) oversize on the outside diameter.

To remove and replace the cylinder liners, a cylinder liner remover and replacer adaptors should be made to the dimensions shown in Fig. 13. Locate the remover in the bottom of the cylinder liner, with the cylinder liner inverted, and press the liner out on a suitable press. When replacing or fitting a liner, ensure that the cylinder bore is machined to the correct size (see Specification, Servicing and Repair Data). Place the remover adaptor in the replacer ring and locate in the cylinder liner, which should be lubricated on the outside with tallow (no other lubricant should be used). Press the liner into the bore from the top on a suitable press. Cut the connecting rod clearance slots in the base of the liner and machine the bore to give the correct clearance for the piston being fitted.

CRANKSHAFT AND BEARINGS

The cast iron dynamically balanced crankshaft runs in three main bearings fitted with steel-backed aluminium tin or steel-backed copper lead bearing liners. The 2 litre crankshaft has larger throws than the 1.7 litre crankshaft and also incorporates heavier balance-weights. Crankshaft journal diameters and other machined dimensions are identical. The main bearing liners are in two halves, the lower half being plain and the upper incorporating an oil feed hole and groove. The two halves must, at all times, be fitted in their respective positions, in no circumstances should they be interchanged or bearing failure will occur. Each liner has a tongue at one end which locates in a corresponding groove in the cylinder block or bearing cap. These tongues and grooves must always be together on the same side to fully locate the bearing liners.

In new engines the crankshaft may be either standard or 0·25 mm. (0·010 in.) undersize on the main bearing journals and crankpins. The undersize crankshaft, however, is only used in conjunction with cylinder blocks with the 0·38 mm. (0·015 in.) oversize bearing bores. Crankshaft main bearing journals are graded the standard crankshaft webs being marked, adjacent to the journal with a paint spot, BLUE for the smallest grade and RED for the largest. Where the crankshaft is 0·25 mm. (0·010 in.) undersize the grades are GREEN and YELLOW respectively. One-half of the main bearing liner is selected to correspond to the journal grade, the other half

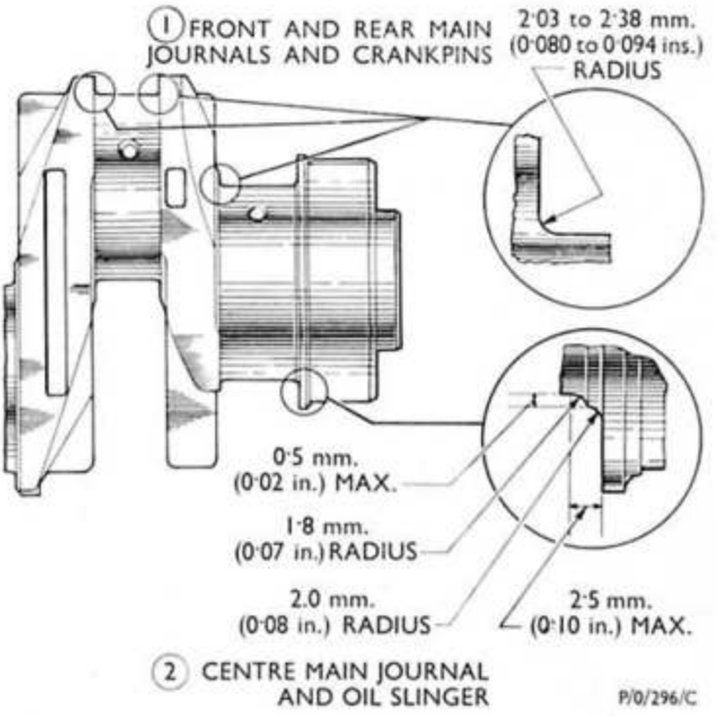


Fig. 14
Crankshaft Fillet Radii

corresponding to the cylinder block grade, as described previously. Where the crankshaft is partly worn select the bearing liners to give the correct clearance.

The crankshaft main bearing journals and crankpins may be ground 0·254 mm. (0·010 in.), 0·508 mm. (0·020 in.), 0·762 mm. (0·030 in.) or 1·016 mm. (0·040 in.) undersize. When grinding crankshafts it is important to maintain the correct fillet radii at all times. The centre main bearing journal and the rear bearing journal at the oil slinger shoulder have a double radius of 1·78 mm. (0·070 in.) and 2·03 mm. (0·080 in.) (see Fig. 14), while the crankpin and the remaining journal fillet radii are 2·03 to 2·38 mm. (0·080 to 0·094 in.). Ensure that the fillet radii are smooth and free from visual chatter marks. The centre main bearing journal length can be increased by up to 1·02 mm. (0·040 in.) providing an equal amount is machined from each face and the corresponding oversize thrust washers fitted. The crankpin length must not exceed 21·64 mm. (0·852 in.), i.e. 0·25 mm. (0·010 in.) oversize.

Main bearing journal and crankpin ovality should not exceed 0·010 mm. (0·0004 in.) T.I.R. with a maximum of 0·005 mm. (0·0002 in.) in any 90° and taper 0·007 mm. (0·0003 in.). The thrust faces should be flat or concave within 0·013 mm. (0·0005 in.) and the runout total indicator reading within 0·03 mm. (0·001 in.). After grinding, crankpins and journals should be polished with a fine lapping paper to produce a good surface finish. Grinding and polishing should both be against the direction of crankshaft rotation.

Crankshaft thrust and end-float are controlled by thrust washers located in recesses on either side of the centre main bearing. These thrust washers are steel faced with aluminium tin or copper lead on the bearing surface and are in two halves, the lower incorporating a tang which locates in a slot in the bearing cap to prevent the washers rotating. In addition to standard size washers the following oversizes are also available: 0·064 mm. (0·0025 in.); 0·13 mm. (0·005 in.); 0·191 mm. (0·0075 in.) and 0·25 mm. (0·010 in.).

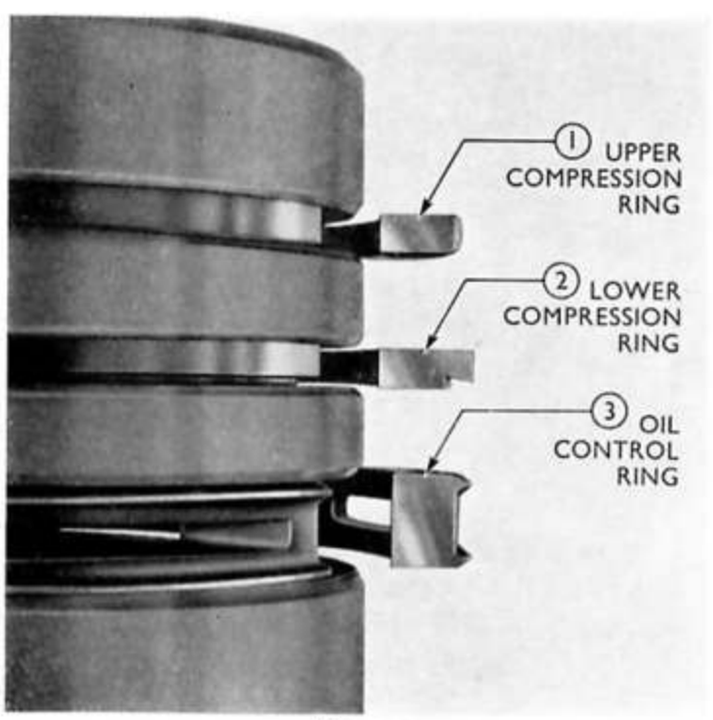


Fig. 15
Piston Ring Assembly

The crankshaft gear, which incorporates a timing mark to facilitate valve timing, is pressed onto the front of the crankshaft and is located by a key. This gear can be removed with remover Tool No. CP.6041 fitted with legs Tool No. STN.6645, if necessary without removing the crankshaft. Fit the gear with replacer Tool No. CP.6032A. This tool is a modification of Tool No. CP.6032 and existing tools should be reworked by increasing the length of the slot to 25·4 mm. (1 in.).

When fitting a new gear, the correct backlash should be obtained by following the colour coding given under the preceding heading "CAMSHAFT".

CONNECTING RODS

The connecting rods are H section steel forgings with detachable big end caps and are common for the 1.7 and 2 litre engines. The caps are located by two hollow dowel pins pressed into the connecting rod and retained by two 9·5 mm. ($\frac{3}{8}$ in.) diameter bolts fitted without any locking device. An oil squirt hole machined in the connecting rod feeds oil from the crankpin to the thrust side of the cylinder bore.

Pads, formed at each end of the connecting rod forgings, are machined down during manufacture, if necessary, to produce finished connecting rods which all fall within a given weight tolerance. The weight is measured simultaneously at the small and big ends and any correction for either end is made to the respective pad. When changing a connecting rod, check the weight of the replacement rod against the original to ensure that the weights of all the connecting rod, piston and pin assemblies in an engine are within 8 grams (see page 15). If necessary fit a complete set of rods to maintain correct engine balance.

The steel-backed big end bearing liners may have either aluminium, tin or copper lead bearing surfaces and incorporate an oil hole to align with the connecting rod squirt hole when fitted to the upper location. Each pair of bearing liners must consist of two liners made of the same material, they should not be mixed. Undersize liners are available in 0·25 mm. (0·010 in.), 0·51 mm. (0·020 in.), 0·76 mm. (0·030 in.) and 1·02 mm. (0·040 in.) sizes, these not being graded.

When dismantling an engine examine the piston markings to check the connecting rods for straightness. A heavy marking on the piston skirt above the pin on one side together with a correspondingly heavy marking below the pin on the other side indicates a bent connecting rod which should be replaced.

The connecting rod small end is shrunk onto the tubular steel piston pin to retain it in position, no circlips being used. Remove the piston pin by pressing it out with a remover Tool No. CP.6149. To assemble the connecting rod to the piston, first locate the piston pin stop, CP.6149/d and support CP.6149/a in the cradle CP.6149/h and place the piston in the cradle. Heat the small end until it reaches between pale straw to dark blue in colour, 232° to

316°C (450° to 600°F). If the tempering colour method is used to determine the temperature the small end must be polished first. After heating, the rod is located in the piston and the pin inserted into the piston. Press the pin home with the driver CP.6149/b until it contacts the stop. Ensure that the connecting rod is fitted the correct way round, the web being embossed "FRONT" to facilitate this.

Connecting Rod Numbering

Connecting rods are numbered when installed in the engine during manufacture, to facilitate correct reassembly should they be dismantled.

The number is stamped on the big end so that a cap and connecting rod of the same number are together and the assembly is fitted in its original position. Never reassemble a bearing cap to another connecting rod. Normally these numbers will be to the right-hand side of the engine, i.e., adjacent to the balance shaft.

It is advisable when removing connecting rods from an engine to check that they have been numbered correctly. Where the connecting rods are unmarked they should be suitably stamped unless they are being scrapped.

PISTONS, PISTON PINS AND RINGS

The pistons are made of aluminium alloy and are of the solid skirt autothermic type with the combustion chamber and valve recesses machined in the crown. Steel struts cast into the piston, around the pin bosses restrain the skirt to control thermal expansion across the thrust faces. Expansion along the piston pin axis and at the top of the skirt, due to heat transference from the combustion chamber, is compensated for by machining the piston oval and tapered. Thus ensuring the correct working clearance at operating temperatures without having excessive clearance when cold.

Three ring grooves are machined in the piston above the piston pin bore, two for compression and a wider one for an oil control ring. The oil control ring groove is slotted to provide a return for oil scraped from the cylinder wall. Some of the oil, however, is returned via radial drillings in this groove to the piston pin bore, to supplement the oil fed to the piston pin through the vertical drillings in the pin bosses.

The piston pin is offset in the piston 1.59 mm. ($\frac{1}{16}$ in.) towards the thrust side of the engine, to minimise piston slap and uneven loading of the skirt thrust face during the power stroke. Therefore, it is important that the piston is fitted the correct way round and to facilitate this a letter "F" is cast on the piston adjacent to the piston pin bore (see Fig. 16). This mark, together with the "FRONT" mark on the connecting rod must face forwards when the piston and connecting rod assembly is fitted to the engine.

The pistons fitted to the 2.0 litre engine differ from those fitted to the 1.7 litre engine. They may be identified by the height of the piston as shown in Fig. 15. It should also be noted that with the larger capacity engine the combustion chamber bowl is deeper and has a proportionally greater volume.

Pistons are weighed during manufacture and, if necessary, pads cast inside the piston under the piston pin bosses are machined down to correct any variation in the weight.

On assembling the piston, pin and connecting rods the assemblies are weighed. The maximum variation of weight between the piston and connecting rod assemblies fitted in an engine is 8 grams. When

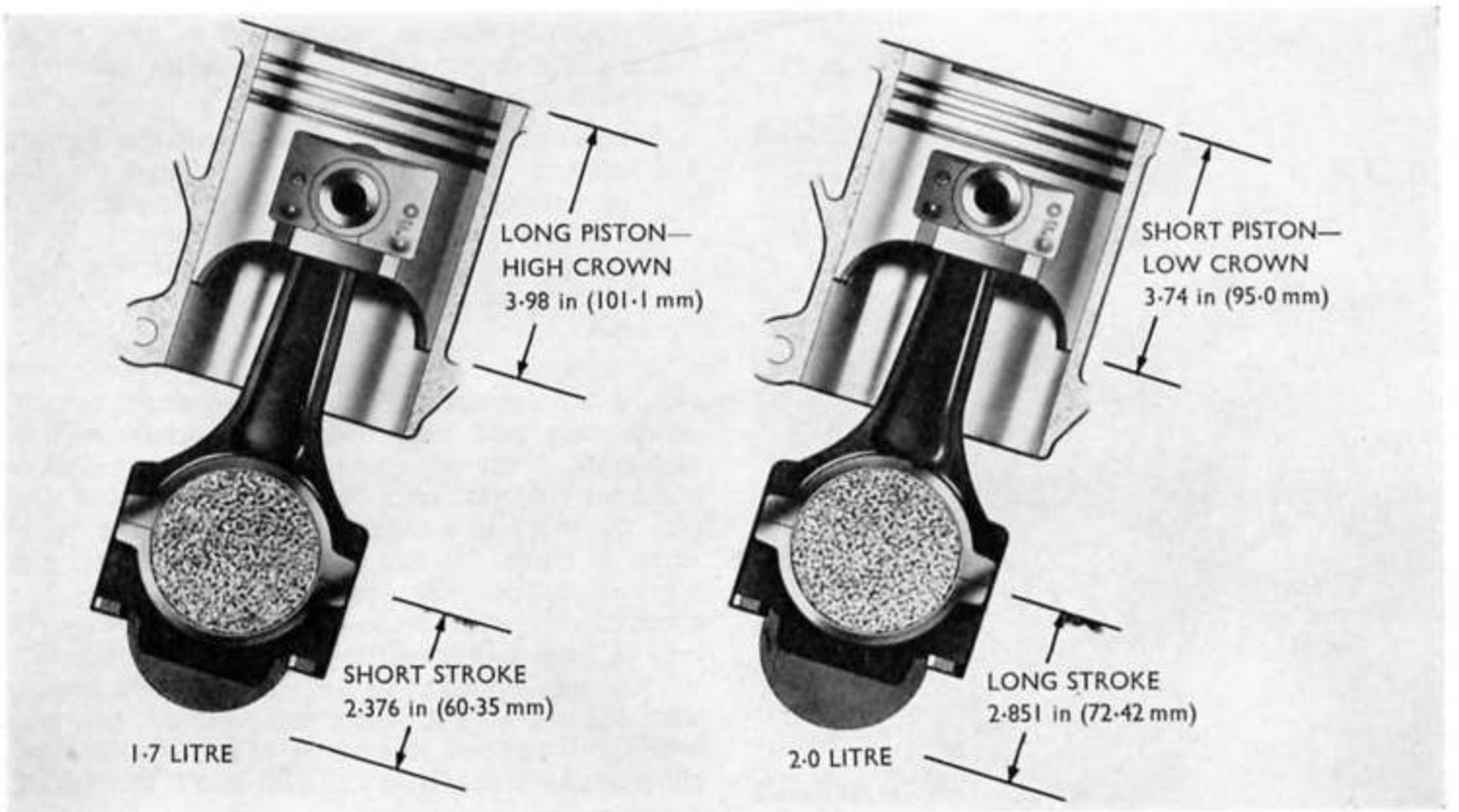


Fig. 16
Piston Identification

changing pistons or connecting rods in service, it is good practice to check the weights of the piston, pin and connecting rod assemblies and, if necessary, select parts to ensure that the weight variation between the respective assemblies does not exceed 8 grams.

Three piston rings are fitted, two compression and one oil control ring. The upper compression ring is chrome plated on the periphery and is lapped to give a barrel-shaped edge. The lower compression ring is bevelled internally on the upper face and has a molybdenum coating on the periphery as well as being phosphate coated. After May 1966 the lower compression ring was changed from a plain ring to a stepped outside diameter ring, the ring being fitted with the step facing downwards (See Fig. 15.) The oil control ring is of the slotted channel "micro-land" type scraper. When fitting the piston rings ensure that they are correctly located in their respective grooves and that the lower compression rings are fitted the correct way up. The upper compression and the oil control ring can be fitted either way up. Stagger the ring gaps when inserting the piston in the cylinder bore.

Oversize pistons and rings are available in 0.064 mm. (0.0025 in.), 0.38 mm. (0.015 in.), 0.76 mm. (0.030 in.), 1.14 mm. (0.045 in.) and 1.52 mm. (0.060 in.) sizes.

Piston Selection

During engine manufacture the cylinder bores and pistons are graded. These gradings ensure that when the piston is fitted there is a clearance of 0.0356 to 0.0508 mm. (0.0014 to 0.0020 in.) between the piston, at a point level with the piston pin and the cylinder bore at a point 47.63 mm. (1⅞ in.) from the cylinder block top face, across the axis of the crankshaft. Two pistons are available in service for a standard bore, a standard and a grade six.

Fig. 17
Checking Piston Fit

When re-boring cylinders in service, to suit oversize pistons or standard size pistons after fitting cylinder liners, it is essential that each cylinder bore is machined to give the correct fit for the individual piston. The piston skirt diameter must be measured accurately at right angles to the piston pin and at a point level with the pin bore axis, the maximum measurement being taken as the piston skirt is oval.

An alternative method of selecting pistons or checking their fit is to use a piston pull scale Tool No. 512 fitted with a 12.7 mm. (½ in.) wide by 0.0508 mm. (0.002 in.) thick steel feeler blade.

Insert the piston pull scale, feeler blade into the cylinder bore for its full length and then slide the corresponding piston, crown first, into the bore after it to trap the feeler blade between the piston skirt at its largest diameter and the cylinder wall. Hold the piston stationary in the cylinder bore without applying any side thrust and withdraw the feeler blade with a steady pull on the piston pull scale, observing the pounds pull required to remove the feeler blade (see Fig. 17).

A pull of 4.08 to 5.89 kg. (9 to 13 lb.) is required to remove the feeler blade from a new piston to give the correct fit in an unused cylinder bore. Where the piston and bore have been used the cylinder walls will be polished and thus friction will be reduced and a lower pull figure can be expected for the same clearance.

FLYWHEEL AND RING GEAR

The cast iron flywheel is located concentrically on the crankshaft flange by a sleeve machined integrally with the crankshaft and retained by six bolts. One of these bolts is unequally spaced to prevent the position of the flywheel being moved relative to the crankshaft This is very important as the flywheel incorporates a balance weight and is thus out of balance, the degree of unbalance being accurately controlled during manufacture.

The flywheel ring gear is shrunk onto the flywheel and locates in a retention groove. Remove the ring gear by cutting between two adjacent teeth with a hack saw and splitting the gear with a chisel. In no circumstances should pressure be applied in an attempt to dismantle the ring gear for repositioning on the flywheel.

When fitting a new ring gear it must be heated evenly to a temperature not exceeding 204°C (400°F) or the ring gear wear resistant properties will be destroyed. If the ring gear is heated by a naked flame place the ring gear on a bed of fire bricks and then play the flame in a circular motion onto the bricks about 38.1 mm. (1½ in.) from the inside of the gear until it reaches the required temperature. The correct temperature can be detected by using a special type of temperature sensitive crayon, or alternatively by polishing a section of the ring gear and heating until it turns a light yellow tint. Fit the ring gear with the chamfered inner edge to the shoulder and allow to cool naturally in air. DO NOT QUENCH.

The clutch is located on the flywheel by three dowels and is retained by six bolts with spring washers.

CRANKSHAFT PULLEY

The cast iron crankshaft pulley is located by a key on the front end of the crankshaft and is retained by a centre bolt and washer. This pulley also incorporates a balance weight which is equivalent to the one in the flywheel. The resulting out of balance being accurately controlled during manufacture. The pulley rear flange is accurately marked to facilitate ignition timing, this mark being aligned with the respective mark on the front cover timing pointer before fitting the distributor or when checking the ignition timing.

BALANCE SHAFT AND GEAR

The balance shaft, which is made of cast iron, is located in the right-hand side of the cylinder block and runs in two, stepped diameter steel-backed white metal bushes. The bushes available in service are pre-sized and require no machining after fitting.

NOTE.—The block bore may be 0.51 mm. (0.020 in.) oversize.

When the bushes require replacement they can be driven out using adaptors Tool No. CP.6152-4 with a 550 handle. Select the larger remover adaptor, to remove the front bush, fit the 550 handle. Insert the adaptor into the bush and carefully drive the bush out of its bore. Repeat the operation using the smaller adaptor, to remove the rear bush.

To replace the bushes use the camshaft bush remover/replacer main tool No. P.6031 in conjunction with adaptor Tool No. CP.6152-4.

Assemble the replacer ring to the larger adaptor, slide the front bush onto the adaptor then locate the bush in its bore in the cylinder block, aligning the oil holes. Insert the shaft of the main tool P.6031 through the adaptor, fit the C washer and tommy bar. Check that the oil hole in the bush is aligned correctly with the one in the cylinder block then tighten the wing nut to fit the bush. Repeat the operation, using the smaller adaptor and replacing ring, to fit the rear bush.

NOTE.—The oil hole in the rear bush is offset. This bush must be fitted with the oil hole to the rear of the cylinder block.

The balance shaft is retained by a sintered iron thrust plate bolted to the cylinder block front face and located between the rear face of the gear and the front face of the front bearing journal. A spacer fitted between the gear hub and the bearing journal maintains the correct working clearance. When fitting this spacer, ensure that the internal chamfer is adjacent to the bearing journal.

The gear, which is made of cast iron is located on the shaft by a woodruff key and retained by a centre bolt and plain washer. Part of the balance shaft balance weight is also incorporated in this gear. The balance shaft must at all times be correctly phased with the crankshaft and to facilitate this a timing mark is incorporated on the gear. This mark is aligned with a corresponding mark on the crankshaft gear during assembly.

FRONT COVER

The front cover is an aluminium pressure die casting bolted to the front face of the cylinder block. Sandwiched between this cover and the cylinder block is a steel plate to completely enclose the camshaft gear. Composition type gaskets on either side of the plate ensure oiltight joints. To prevent oil leaks around the crankshaft pulley boss, an oil seal is pressed into the front cover.

The oil seal can be removed, after first removing the front cover, by supporting the cover around the seal and driving the seal out with remover/replacer Tool No. CP.6176 fitted to a 550 handle. Invert the cover and drive a new seal into the housing, reversing Tool No. CP.6176 on the 550 handle, again supporting the cover around the seal. Ensure that the seal is driven fully home when the two beads on the face of the seal will be compressed against the end wall in the housing bore to prevent any seepage around the outside of the seal. When fitting the cover it is important that the oil seal is aligned concentrically with the crankshaft and pulley boss. To facilitate this a centraliser Tool No. CP.6141 is inserted into the seal while fitting the cover.

The oil level dipstick tube is pressed into the front cover and its upper end must be 184.9 mm. ($7\frac{9}{32}$ in.) vertically above the front cover bottom face if the correct oil level is to be attained.

A bearing and shaft assembly is also pressed into the front cover for the fan. This bearing can be removed, after first removing the front cover, by extracting the circlip and then driving the expansion plug and bearing assembly out through the front cover, using a suitable drift. Press the new bearing into the housing, using a replacer Tool No. CP.8010/b until the circlip grooves are in alignment and then fit the circlip. Remove the fan hub from the old bearing assembly using split ring Tool No. P.8000–4/a with a 370 universal taper base and P.8008 slave ring. Using the same tools press the hub onto the new shaft until the front face of the flange is 85.79 mm. ($3\frac{3}{8}$ in.) from the rear face of the front cover. When measuring from the face of the split ring make an allowance of 3.18 mm. ($\frac{1}{8}$ in.) for the recess depth. Fit a new expansion plug to the bore behind the bearing housing.

A timing pointer is also incorporated on the front cover to facilitate ignition timing and has two marks at 8° and 4° B.T.D.C. The crankshaft pulley timing mark is aligned with the appropriate mark when fitting the distributor or when checking the ignition timing.

REAR OIL SEAL CARRIER

The crankshaft rear oil seal is pressed into the aluminium carrier, bolted to the cylinder block rear face, and runs on the periphery of the flywheel mounting flange.

After removing the carrier the oil seal can be easily removed. Support the carrier, close to the seal, and drive the seal out, using remover/replacer Tool No. CP.6165 fitted to a 550 handle. Invert the carrier and fit a new seal, reversing the Tool No. CP.6165 on the 550 handle.

When fitting the carrier the seal must be aligned concentrically with the crankshaft if oil leaks are to be avoided. Locate a centraliser, Tool No. CP.6147 or CP.6173 in the seal and over the crankshaft while tightening the seal carrier retaining bolts.

SUMP

The pressed steel sump is bolted to the base of the cylinder block and the front cover. The gaskets are made of aluminium foil faced with cork and are in four pieces dovetailed together. When fitting the sump apply EM–4G–47 jointing compound to the gasket dovetails and across the front cover and rear oil seal carrier joints to prevent oil leaks. Tighten the bolts evenly to 0.97 to 1.24 kg.m. (7 to 9 lb. ft.) torque.

The drain plug is located in the right-hand side.

ROCKER COVERS

The rocker covers are steel pressings retained by four screws and plain washers around the flanged edge. A cork and rubber gasket is fitted to each rocker cover and to ensure an oiltight joint, Hermetite Autogel 2, sealing compound is also used where the cylinder head and inlet manifolds join.

The left-hand rocker cover incorporates the oil filler neck while the right-hand cover incorporates a baffle and the crankcase emission valve. Both covers also incorporate brackets for the ignition high tension lead clips.

ENGINE MOUNTINGS

The engine and gearbox assembly has a three-point mounting. The front insulators consist of conical rubber blocks. These insulators are fitted between brackets bolted to the cylinder block, one each side, and supported by the front crossmember the insulators being retained by through bolts and nuts.

The rear insulator consists of a rubber bush mounted in the gearbox extension housing, and two conical rubber bushes which fit into the mounting bracket. A steel bush is bonded to the centre of the rubber bush and a through bolt and nut secures the insulator assembly to the mounting attached to the underside of the vehicle.

REPAIR OPERATIONS

TO REMOVE THE ENGINE

1. Raise the bonnet and disconnect the windscreen washer pipes from the jets.

2. Remove the bonnet. Unscrew and remove the four hinge bolts, two on each side, together with the spring washers.

3. Disconnect the battery.

4. Drain the engine oil and coolant.

5. Disconnect the radiator hoses from the engine.

6. Remove the radiator and hoses. Unscrew the four bolts securing the radiator to the supports and lift the radiator clear of the engine compartment.

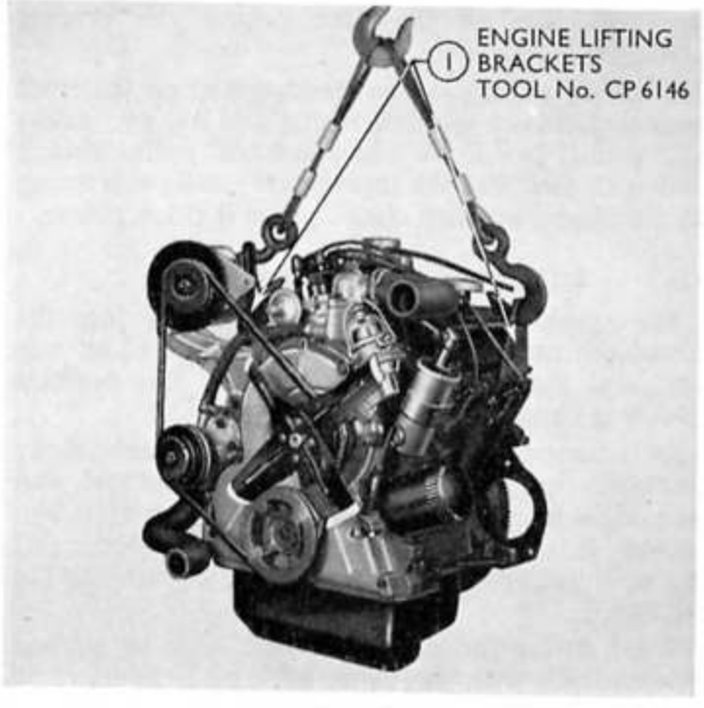


Fig. 18
Removing the Engine

7. Remove the headlamp bezels.

8. Disconnect the bonnet release cable from the release arm.

9. Remove the radiator grille panel. Unscrew and remove the grille panel retaining screws and radiator supports lower bolts.

10. Remove the air cleaner. Slacken the clamp and release the support bracket from the air cleaner.

11. Disconnect the fuel feed pipe from the fuel pump and the return pipe from the carburettor.

12. Disconnect the accelerator linkage and choke control from the carburettor.

13. Detach the oil pressure switch lead and the low tension lead from the coil.

14. Disconnect the temperature gauge sender unit and alternator leads.

15. Slacken the heater hose clips and detach both hoses from the heater unit.

16. Disconnect the vacuum pipe from the engine where servo assisted brakes are fitted.

17. Remove the starter motor. Detach the leads, unscrew the securing bolts and withdraw the starter motor forward.

18. Disconnect the exhaust pipes from the exhaust manifolds.

19. Jack up the front of the vehicle and fit stands beneath the front axle.

20. Release the clutch return spring and remove the clutch housing lower dust cover.

21. Unscrew the clutch housing bolts. Note the position of the bolts which also secure the speedometer cable support clip and engine earth strap.

22. Support the gearbox.

23. Fit the engine lifting brackets Tool No. CP.6146. Using suitable lifting equipment, take the weight of the engine. Should the correct brackets not be available a suitable sling may be used. It may be necessary to remove the alternator and brackets to fit the right hand lifting bracket.

24. Release the front engine mounting, raise and remove the engine from the vehicle.

TO DISMANTLE THE ENGINE

1. Mount the engine on the universal stand. Fit the engine bracket Tool No. CP.6144 to the right-hand side of the cylinder block and mount the engine on the stand and then remove the lifting brackets.

2. Remove the engine ancillaries. Disconnect the high and low tension leads and carburettor vacuum pipe and remove the distributor, spark plugs and coil. Disconnect the fuel pipe and remove the carburettor and fuel lift pump. Disconnect the by-pass tube and remove the water pump. Remove the alternator, thermostat housing, thermostat, fan, fan pulley, fan belt, oil filter and clutch.

NOTE.—When removing the H.T. leads be sure to disconnect them by grasping the covers on the ends of the leads, never pull the lead to detach them. This is because the Rayon conductors do not have the mechanical strength of copper ones and stretching or distortion of the conductors with resultant inferior efficiency will occur if the leads are incorrectly removed.

3. Remove the rocker covers.

4. Remove the inlet manifold. Unscrew the bolts evenly.

5. Remove the rocker arms, keeping them and the fulcrum seats together and in the correct order.

6. Extract the push rods, keeping them in their correct order.

7. Remove the push rod guide plates.

8. Remove the cylinder heads. Unscrew the cylinder head bolts evenly.

9. Dismantle the cylinder heads as follows:—

(*a*) Compress the valve springs, using a valve spring compressor Tool No. 6118B and adaptor Tool No. 6118-1 and extract the split collets.

(*b*) Release the valve spring compressor and remove the spring retainer, valve spring, and oil seal.

(*c*) After removing all the valve springs, turn the cylinder head onto its side and remove all the valves, keeping them in their correct order.

10. Extract the tappets.

11. Invert the engine and remove the sump.

12. Remove the oil pump, note the position of the oil deflector or baffle if fitted.

13. Extract the oil pump drive shaft.

14. Withdraw the piston and connecting rod assemblies. Unscrew the big end bolts a few turns and tap them to release the connecting rods from the caps. Then completely remove the bolts and detach the big end caps. Push the pistons out of the cylinder bores and withdraw the assemblies. It may be necessary to carefully scrape the carbon formation away from the cylinder bore top land, to facilitate removal.

15. Dismantle the piston and connecting rod assemblies. First remove the piston rings and then push the piston pins out of each piston, using a piston pin remover Tool No. CP.6149.

16. Remove the crankshaft pulley, using puller Tool No. CP.6041 if tight.

17. Remove the front cover.

18. Remove the camshaft gear. The fuel lift pump eccentric is also retained by the camshaft gear centre bolt.

19. Remove the sandwich plate.

20. Remove the camshaft thrust plate.

21. Withdraw the camshaft, taking care not to damage the bearings with the cam lobes. If necessary remove the key and spacer from the front of the camshaft.

22. Remove the balance shaft gear. If the gear is tight it can be pulled off, using puller Tool No. CP.6041 fitted with legs Tool No. STN.6645.

23. Remove the balance shaft thrust plate.

24. Withdraw the balance shaft. If necessary remove the key and spacer from the front of the shaft.

25. Remove the flywheel.

26. Remove the backplate and balance shaft cover.

27. Remove the crankshaft rear oil seal carrier.

28. Remove the crankshaft complete with gear. Unscrew the main bearing bolts and remove each bearing cap in turn. Remove the thrust washers located on either side of the centre main bearing. Lift out the crankshaft.

Fig. 19
Checking Crankshaft End-float

TO REASSEMBLE THE ENGINE

Before reassembling the engine, the cylinder block and all components should be thoroughly cleaned, paying particular attention to joint faces and bearing surfaces. Any local high spots or burrs on the joint faces should be removed by stoning lightly.

Ensure that any piece of gasket material or dirt which enters a blind tapped hole, during cleaning, is removed as the bolt may bottom on the resulting plug before the bolt head pressurises the mating part. When tightening a bolt which bottoms, a characteristic springiness will be felt through the spanner or torque wrench. If this occurs, the bolt should be removed and the hole cleaned out using a tap, if necessary, to ensure that the threads are clear.

Inspect all moving parts and bearing surfaces for wear. Check the dimensions of worn parts against the Specification, Servicing and Repair Data, and select new parts where necessary.

If necessary, recondition the engine by overhauling the cylinder head, fitting new valve guides and/or valve seat inserts where required, rebore the cylinders or fit new liners, fit new camshaft bushes and grind the crankshaft undersize as described in the section on "Engine Components" see page 7.

Check all oilways and galleries to ensure that they are clear. When replacing the taper plugs, ensure that they are thoroughly clean and apply a thin line of EM-4G-52 plastic sealer to the screw threads to prevent any possibility of oil leaks or loosening in service.

In the following reassembly sequence it is assumed that all normal instructions regarding cleanliness and lubrication are observed and that all gaskets, oil seals and lockwashers are renewed.

1. Clean and fit the main bearing liners to their appropriate cylinder block and cap locations. Wipe the liner locations clean and fit the liners so that the locating tongues engage in the locating grooves. The liners with oil grooves fit in the cylinder block and those without in the caps.

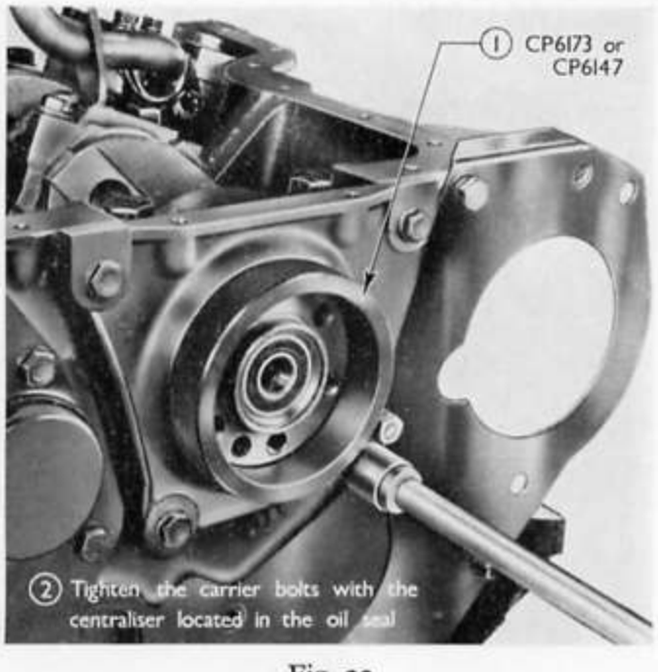


Fig. 20
Fitting Crankshaft Rear Oil Seal Carrier

Fig. 21
Timing Marks

2. Install the crankshaft in the cylinder block after lubricating the main bearing liners. Locate the crankshaft thrust washers on either side of the centre main bearing with the oil grooves facing the crankshaft flange. Fit the main bearing caps in their correct positions in accordance with the mating marks and the arrow mark to the front. Lubricate the threads on the main bearing bolts and insert into the caps. Lever the crankshaft backwards and forwards to centralise the centre main bearing cap and then tighten the bolts evenly to 7.60 to 8.29 kg.m. (55 to 60 lb. ft.) torque. Check the crankshaft rotation after tightening each cap.

3. Check the crankshaft end-float. Move the crankshaft forwards to take up the end-float in one direction and insert feeler blades between the crankshaft and the front thrust washer (see Fig 19). Check that the end-float is between 0.08 and 0.28 mm. (0.003 and 0.011 in.). If necessary, fit oversize thrust washers to rectify excessive end-float.

4. Fit the crankshaft rear oil seal carrier. Using remover/replacer Tool No. CP.6165 together with a 550 handle fit a new seal to the carrier. Locate a centraliser Tool No. CP.6147 or CP.6173 in the seal and fit the carrier to the cylinder block. Do not remove the centraliser until the bolts have been tightened (see Fig. 20).

5. Fit the balance shaft cover and backplate.

6. Refit the flywheel. Ensure that the mounting face and crankshaft flange are clean and free from burrs. Locate the flywheel squarely upon the dowel and flange and press it into place. **Do not hammer** the flywheel into place. Fit the retaining bolts and tighten evenly to 6.22 to 6.91 kg.m. (45 to 50 lb. ft.) torque.

7. Check the flywheel run-out at the clutch periphery, using a gauge Tool No. P.4008. This should not exceed 0.18 mm. (0.007 in.) total indicator reading.

If incorrect, remove the flywheel and re-check the mounting face and crankshaft flange.

8. Slide the balance shaft into position. Fit the spacer and key if they have been removed.

9. Fit the balance shaft thrust plate. Ensure that the timing gear oil feed groove is adjacent to the cylinder block.

10. Fit the balance shaft gear. Align the balance shaft and crankshaft gear timing marks (see Fig. 21) and press the gear home. **Do not hammer** the gear into place. Retain the gear with a plain washer and bolt tightened to 3.32 to 3.87 kg.m. (24 to 28 lb. ft.).

11. Check the balance shaft end-float, using a gauge Tool No. P.4008, by pulling and pushing the balance shaft and gear in and out. End-float should be 0.25 to 0.38 mm. (0.010 to 0.015 in.).

12. Slide the camshaft into position, taking care not to damage the bearings or the edges of the cams and journals. Rotate the camshaft to ensure that it revolves freely in its bearings after fitting. Fit the spacer and key if they have been removed.

13. Fit the camshaft thrust plate.

14. Fit the sandwich plate.

15. Fit the camshaft gear. Align the camshaft and crankshaft gear timing marks (see Fig. 21) and press the gear home. **Do not hammer** the gear into place. Retain the gear with the fuel pump eccentric and bolt tightened to 3.32 to 3.87 kg.m. (24 to 28 lb. ft.).

When fitting the timing gear the angular position of the eccentric is unimportant on engines produced before March 1966. After March 1966 the fuel pump eccentric should be positioned so that its point of maximum eccentricity should be positioned midway between the two cast holes in the camshaft gear. Later engines have the eccentric positively located by a split dowel.

16. Check the camshaft and crankshaft gear backlash at four equally spaced points on the gear. Backlash should be 0.10 to 0.18 mm. (0.004 to 0.007 in.) for a new gear. A gear that has been used will be oil impregnated and the minimum backlash should be 0.05 mm. (0.002 in.).

17. Check the camshaft end-float, using a gauge Tool No. P.4008, by pulling and pushing the camshaft and gear in and out. End-float should be 0.08 to 0.18 mm. (0.003 to 0.007 in.).

18. Fit the front cover. Remove the oil seal, and fit a new seal, using remover/replacer Tool No. CP.6176, ensuring that the seal is fitted with the lip towards the inside of the cover. Fit the cover, centralising the oil seal about the crankshaft with centraliser Tool No. CP.6141 (see Fig. 22).

19. Fit the crankshaft pulley. Align the keyway with the crankshaft key and push the pulley onto the shaft. Draw the pulley fully home with the centre bolt and washer and tighten to 3.32 to 3.87 kg.m. (24 to 28 lb. ft.) torque.

20. Select new pistons, if necessary, see page 16. If the old pistons are being re-used, decarbonise the crowns and ring grooves.

21. Check the piston ring gaps. Locate the piston rings in the unworn portion of the cylinder bore and check the ring gaps, which should be 0.25 to 0.51 mm. (0.010 to 0.020 in.) for compression rings and 0.25 to 0.38 mm. (0.010 to 0.015 in.) for oil control rings.

22. Check the piston ring to groove clearances, which should be as follows:—

Compression Rings
0.05 to 0.10 mm. (0.002 to 0.004 in.)

Oil Control Ring
0.03 to 0.08 mm. (0.001 to 0.003 in.)

23. Assemble the pistons to the corresponding connecting rods, see page 14, ensuring that the FRONT mark on the connecting rod and the F mark on the piston are facing the same way.

24. Fit the piston rings in the correct order. Ensure that the lower compression ring is fitted with the step downwards, see Fig. 15.

25. Clean and fit the connecting rod big end bearing liners to their appropriate connecting rod and cap locations. Wipe the liner locations clean and fit the liners so that the locating tongues engage in the locating grooves.

26. Fit the piston and connecting rod assemblies into the appropriate cylinder bores. Tip the engine on end while completing this operation, as it is necessary to work on the top and bottom of the cylinder block. Stagger the piston ring gaps and compress the rings, using a ring squeezer Tool No. 38U3. Push each piston into its cylinder bore.

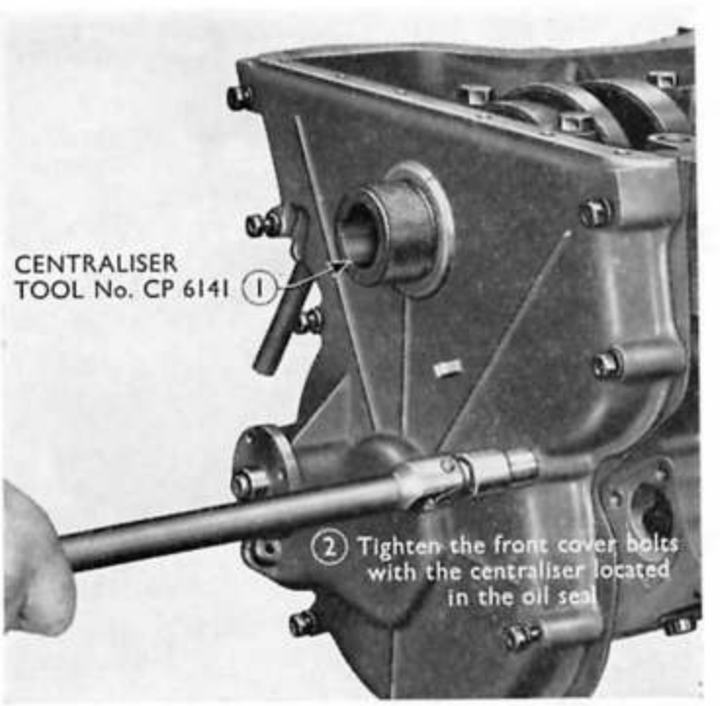


Fig. 22
Fitting the Front Cover

NOTE.—The "F" mark on each piston must face towards the front of the engine.

Turn the crankshaft as necessary to fit the connecting rod big ends to the crank pins. Locate the big end caps on the connecting rod dowels, and enter the bolts into the connecting rod. Tap the big end caps right home and tighten the connecting rod bolts to a torque of 5.26 to 5.95 kg.m. (38 to 43 lb. ft.).

Check the engine rotation after tightening each big end.

27. Install the oil pump drive shaft in the cylinder block with the retaining ring to the top.

28. Fit the oil pump. Check that the pump turns freely before fitting it to the cylinder block. Ensure the oil deflector or baffle, where specified, is positioned correctly.

29. Refit the sump, using EM-4G-47 sealing compound on the dovetail joints in the gaskets.

30. Fit the tappets. Insert the tappets into the bores from which they were removed. The engine should be turned the correct way up when fitting the tappets.

31. Decarbonise the cylinder head. Remove all the carbon from the cylinder head face, valves and ports. Re-cut the valve seats (see page 9) and grind the exhaust valves if necessary and then lightly lap in to produce a continuous narrow seating. Lap the inlet valve seats, using dummy valves. Do not grind or lap the inlet valves. Pitted or worn inlet valves must be renewed. Excessive lapping will result in a seating which is too wide and pocketed valves.

32. Reassemble the valves and springs as follows:—

(*a*) Lubricate each valve stem, insert it into the appropriate valve guide and position the head against the seat. Fit the umbrella type oil seals to the valve stems with the open ends to the head.

(*b*) Turn the cylinder head onto its face and place the valve springs and retainers over the valve stems and oil seals locating the springs in the spring seats (see Fig. 23).

(*c*) Compress the valves springs, using valve spring compressor Tool No. 6118B and adaptor screw Tool No. P.6118-1, located in a push rod guide plate bolt hole. Place the split collets in the valve stem collet grooves and engage the collet and spring retainers by slowly releasing the valve spring compressor.

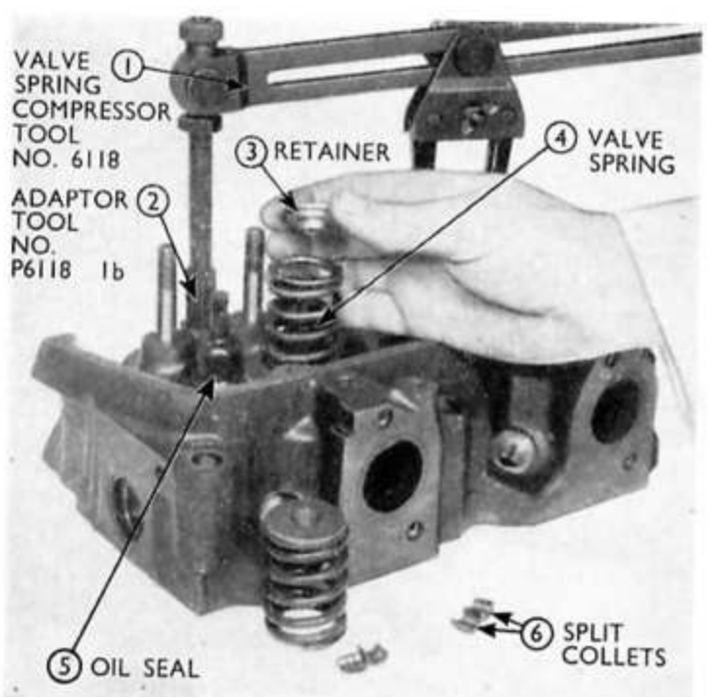


Fig. 23
Assembling the Valves

33. Fit each cylinder head in turn. Position the cylinder head gasket on the locating dowels and studs, Tool No. C.6135A screwed into diagonally opposite cylinder head bolt holes. Fit the cylinder head and install the bolts before removing the two locating studs. Tighten the head bolts down evenly in the sequence given on page 7 and Fig. 8.

NOTE.—Re-tighten the cylinder head bolts when the engine is at operating temperature.

34. Fit the push rod guide plates.

35. Insert the push rods into their respective positions to engage with the tappets.

36. Assemble the rocker arms in their original positions. Ensure that the push rods engage with each rocker arm.

37. Adjust the valve clearances. The specified valve clearances are inlet 0.25 mm. (0.10 in.) and exhaust 0.46 mm. (0.018 in.), set dynamically (with the engine running) at normal engine operating temperature. On initial assembly (when rebuilding the engine) the valve clearances may be set to inlet 0.30 mm. (0.012 in.) and exhaust 0.51 mm. (0.020 in.) to enable the engine to run and reach its normal operating temperature.

To set valve clearances on initial assembly (when rebuilding the engine) turn the crankshaft until the valves given in the first column are fully open, when the valves shown in the second column may be checked and adjusted as required.

Valves Open	*Valves to Adjust*
1 and 4	5 In. and 8 Ex.
2 and 6	3 Ex. and 7 In.
5 and 8	1 Ex. and 4 In.
3 and 7	2 In. and 6 Ex.

To adjust a valve clearance, insert a feeler blade between the rocker pad and the valve end. Turn the rocker arm retaining nut until the correct clearance has been obtained.

NOTE.—The clearance must be checked and readjusted, dynamically, when the engine is at its normal operating temperature.

If new rocker arms, fulcrum seats and studs have been fitted, the valve clearances should be set 0.05 mm. (0.002 in.) under the specified clearance. On subsequent services the valve clearances should be readjusted to the specified clearance.

38. Fit the inlet manifold. Apply sealer EM-4G-52 as shown in Fig. 6. Tighten the bolts progressively in the sequence shown in Fig. 5.

39. Fit the rocker covers. Apply Hermetite Autogel 2 sealing compound to the joint between the inlet manifold and the cylinder heads. Fit the rocker cover with the oil filler cap to the left-hand side and the one with the emission valve to the right.

40. Refit the engine ancillaries. Fit the clutch, align the plate using Tool No. CP.7112A, crankcase ventilation tube, thermostat, thermostat housing, water pump, fuel lift pump, carburettor, spark plugs, coil and distributor. Time the distributor so that when the timing mark on the crankshaft pulley is adjacent to the appropriate timing mark, the distributor points are just opening and the rotor is pointing towards No. 1 high tension pick up in the distributor cap. Screw a new filter on the cylinder block until the gasket just contacts the sealing face and then tighten half a turn. Connect the ignition high and low tension leads, the fuel pipes and the cooling system by-pass tube.

41. Replace the fan pulley and fan. If a plastic fan is fitted tighten the bolts to 0.69 kg.m. (5 lb. ft.) maximum.

42. Remove the engine from the universal stand. Fit lifting eyes Tool No. CP.6146 to the cylinder head to lift the engine from the stand.

TO REPLACE THE ENGINE

1. Fit the engine lifting brackets Tool No. CP.6146. Using suitable lifting equipment, position the engine in the engine compartment.

2. Align the engine with the transmission and engage the gearbox main drive gear with the clutch disc hub and pilot bearing.

3. Secure the clutch housing to the engine with the bolts and spring washers. Ensure that the speedometer cable support clip and engine earth strap are fitted to the appropriate clutch housing bolts.

4. Remove the support from beneath the gearbox.

5. Refit the engine front mounting bolts. Remove the lifting equipment and detach the engine lifting brackets. Refit the alternator and fan belt.

6. Secure the clutch housing lower dust cover in position with the four bolts and spring washers.

7. Adjust the clutch linkage free play and connect the return spring.

8. Refit the starter motor, securing it with two bolts and spring washers. Reconnect the starter motor lead.

9. Jack up the front of the vehicle and remove stands. Lower the vehicle to the ground.

10. Secure the exhaust pipes to the manifolds, two studs in each.

11. Reconnect the servo unit vacuum pipe to the engine on vehicles fitted with servo assisted brakes.

12. Push the heater hoses on to the heater unit and tighten the retaining clips.

13. Reconnect the temperature gauge sender unit and alternator leads.

14. Reconnect the lead to the oil pressure switch and the low tension lead to the coil.

15. Connect the accelerator linkage and choke control to the carburettor.

16. Connect the fuel feed pipe to the fuel pump the return pipe to the carburettor and (if fitted) the carburettor bowl overflow pipe.

17. Position the air cleaner on the carburettor. Secure the support bracket to the air cleaner and tighten the securing clamp.

18. Refit the radiator grille panel and secure the lower ends of the radiator supports.

19. Connect the bonnet release cable to the release arm.

20. Replace the radiator and secure the hoses to the engine.

21. Refill the sump with the correct grade engine oil.

22. Refill the cooling system.

23. Reconnect the battery.

24. Refit the bonnet and connect the windscreen washer hoses to the jets.

LUBRICATION SYSTEM

The engine lubrication system is of the forced feed type, the oil being circulated by an eccentric bi-rotor or a sliding vane type oil pump mounted in the crankcase on the left-hand side of the engine and driven by a hexagonal shaft from the distributor drive gear.

Oil from the engine sump is drawn into the oil pump through a gauze screen and inlet pipe. The oil pressure is controlled by a plunger type relief valve incorporated in the oil pump, which, when open, bleeds oil back to the sump.

From the oil pump, oil flows through drillings in the cylinder block to a full flow cartridge type filter on the left-hand side of the engine. A drilling from the oil filter mounting insert feeds oil, via a diagonal drilling in the cylinder block, to the main oil gallery immediately below the camshaft. The switch for the oil pressure warning light is located at the end of a drilling, which intersects the diagonal drilling, to feed oil to the balance shaft front bearing. Lubrication for the timing gears is provided by a drilling into this oilway and metered holes in the balance shaft thrust plate.

Drillings in the cylinder block feed oil to the camshaft and crankshaft bearing journals. The balance shaft rear bearing is fed with oil through a drilling into the rear main bearing oil drilling. A continuous oil feed to the big end bearings from the oil groove in the upper main bearing liner, is provided by a cross drilling in each main bearing journal and a drilling through each crankshaft web to the crankpins. A small drilling in each connecting rod big end directs a jet of oil onto the thrust side of the cylinder bore once every revolution. Some of the oil scraped from the cylinder wall by the oil control ring returns by a radial drilling in the oil control ring groove to the piston pin bore to lubricate the piston pin. Further lubrication being provided by oil splashes and mist.

Before February 1968

An annular groove around the camshaft centre bearing bush bore feeds oil to a gallery in each cylinder bank. Oil in these galleries lubricates the tappets and flows into the tappet body. The oil supply to the valves via the hollow push-rods was controlled by the tappets. The earliest tappets incorporated a steel push-rod seat and a metering valve under the seat, both retained by a circlip. These were superseded by a tappet which metered the oil supply via an annular groove on its outside diameter and a drilling through to the tappet centre. The push-rod seat retained by the circlip was still used but the metering valve was deleted.

After January 1968

The oil supply to the valve gear is intermittent and is controlled by the camshaft centre journal and bearing. The one piece tappets used in this system of oil control have plain bearing surfaces and the unmachined portion has large apertures.

Oil from the rockers drains into the valley between the banks of cylinders to lubricate the cams and the distributor drive gear.

Lubrication

The oil in the sump should be changed every 8,000 km. (5,000 miles), the exact period depending upon the condition of the oil in the sump. Should the oil get dirty for any reason, it should be renewed and the filter element replaced.

The engine sump capacity is 4.55 litres (9.6 U.S. pints, 8 Imp. pints) but a further 0.85 litres (1.8 U.S. pints, 1½ Imp. pints) must be added for a dry oil filter.

It is preferable to drain the oil when the engine is warm, to ensure that it drains away quickly, carrying away with it any sediment or foreign matter which may be present.

THE OIL FILTER

The oil filter is mounted on the left-hand side of the engine and is retained by a threaded insert into the cylinder block. This filter is of the full-flow cartridge type, which is completely discarded when dirty. Should the normal servicing periods be exceeded and the filter become clogged, a relief valve in the upper end of the element by-passes the filter. The filtering element incorporates an acetate block, in addition to the normal corrugated paper filter, to give supplementary fine filtering. Filter prime is maintained by a non-return diaphragm valve in the filter base, thus reducing the priming time for the lubrication system when re-starting the engine.

Renew the oil filter every 8,000 kms. (5,000 miles) when the engine oil is changed, or more frequently if the lubricant becomes excessively fouled. Unscrew the filter, using a suitable strap tool if necessary, and discard completely. Clean the mounting pad and screw the new filter into the insert until the gasket just contacts the mounting pad, then tighten half a turn.

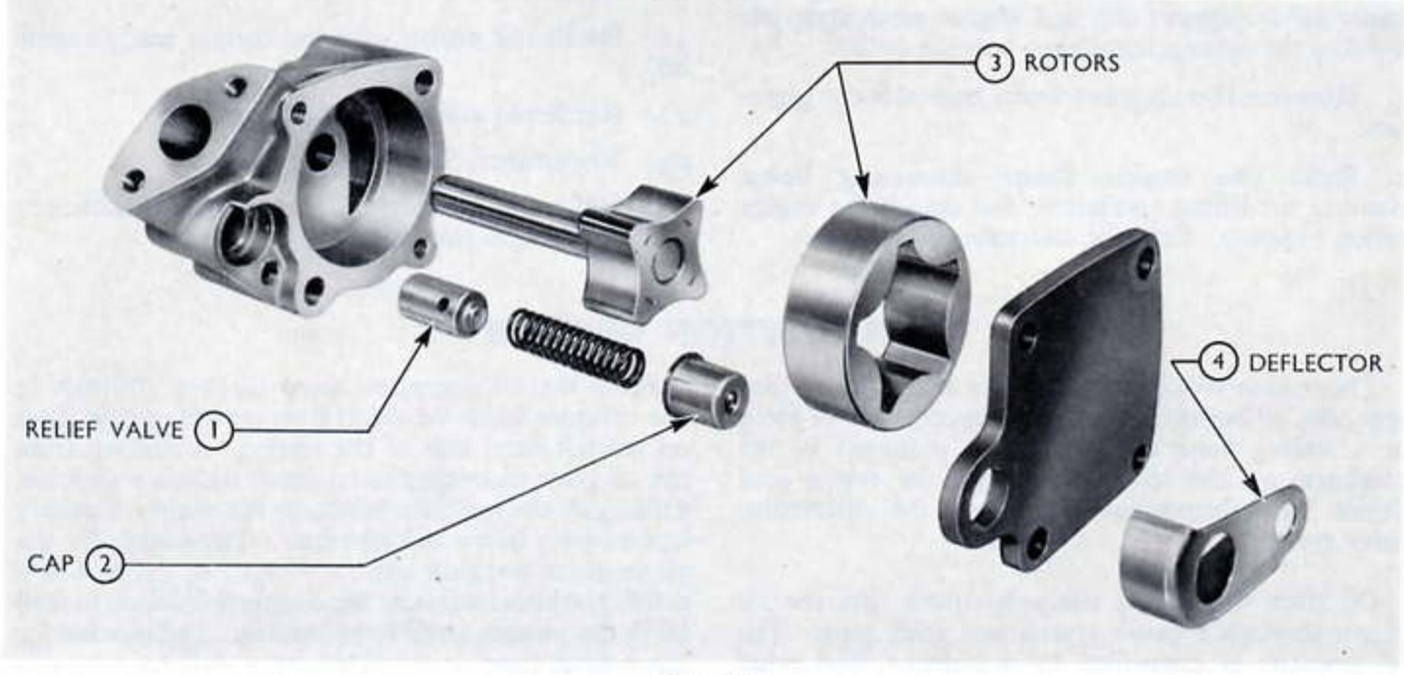


Fig. 24
Bi-Rotor Oil Pump (Oct. 1968 Onwards)

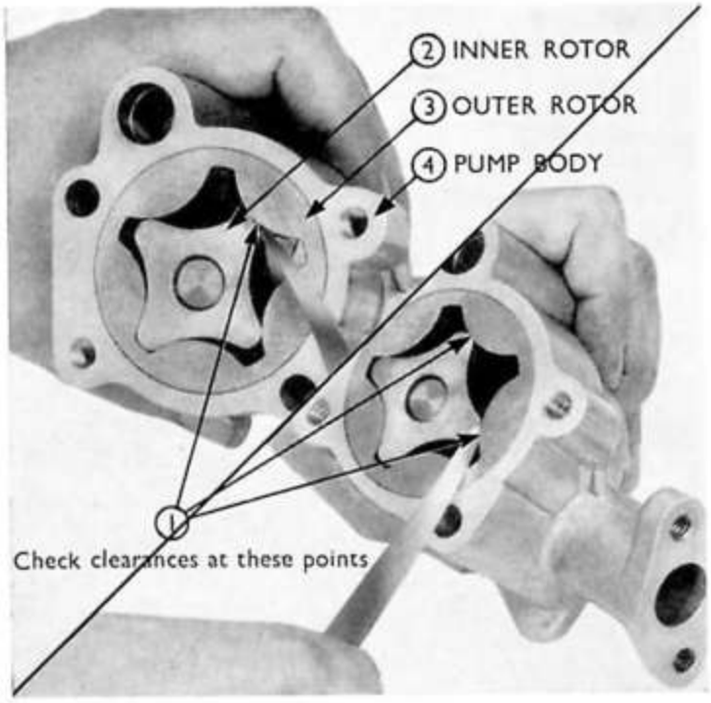


Fig. 25
Checking Rotor Clearance

THE OIL PUMP

The oil pump and inlet pipe assembly is bolted in the crankcase on the left-hand side of the cylinder block and is driven by a hexagonal shaft from the distributor drive skew gear. One of two types of oil pump is fitted in production. The eccentric bi-rotor type or the sliding vane type. These pumps are directly interchangeable, differing only in internal design and may be readily identified by the position of the oil pressure relief valves. On the eccentric bi-rotor type pump the relief valve is incorporated in the pump body but on the sliding vane type it is in the end cover.

A modified cylinder block, together with new oil pumps, was introduced in October 1968. The block can be identified by the height of the oil pump mounting platform above the sump joint surface. The new dimension is approximately 63.5 mm. (2.5 in.) compared with approximately 38 mm. (1.5 in.) on the blocks produced before October 1968.

New oil pumps with shorter drive-shafts, identified by having a mild steel end cover plate, were introduced in October 1968. Although functionally the same, they are not interchangeable with the earlier pumps. A deflector, specified with each of the new pumps, locates over the relief valve spring cap and is retained by one of the pump mounting bolts (See Figs. 24 and 28.) The relief valves are of the non-adjustable plunger type and limit the oil pressure to 3.16 to 3.51 kg.m./sq. cm. (45 to 50 lb./sq. in.).

Both types of pump are self-priming and oil enters them through a common inlet pipe and gauze screen completely immersed in the engine oil.

The oil inlet tube serviced for engines produced prior to October 1968 incorporates a damper fitted over the filter screen. This assembly replaces the previous type. The oil inlet tube, used in conjunction with the new pump, has a support bracket attached to it which is retained by a bolt to the main bearing cap. This assembly has no damper. Internal clearances and wear limits applicable to early type pumps also apply to the new pumps, except where stated otherwise.

ECCENTRIC BI-ROTOR TYPE PUMP

Operation

The pump consists of an inner and outer rotor housed in the pump body, the outer rotor being eccentric to the inner. The inner rotor is pressed onto a short shaft and positively retained by a pin, the upper end of the shaft having a hexagonal recess into which the drive shaft locates. This rotor has four lobes which mesh internally with five segments in the outer rotor. Rotation of the inner rotor thus causes the outer rotor to revolve also, but at a slower speed, in the ratio of the number of lobes to segments.

The inlet port is connected to the sump and the outlet port is connected, via the full flow filter, to the oil galleries in the engine. Oil is drawn, via the inlet port, into the space formed between the inner and outer rotors as they revolve and is then carried round between the lobes to the outlet port. Here the space between the rotors starts to decrease and the oil is forced through the outlet port and filter into the engine oil galleries.

The action of the pump is a continuous repetition of this process. Oil flowing into the space between the rotors from the inlet port is carried around between the rotor lobes and then, as the space decreases, the oil is forced out through the pump outlet port.

NOTE.—On no account install a pump without its specified deflector as the sump oil may become aerated resulting in loss of oil pressure.

To Remove

1. Unscrew the two through bolts securing the oil pump to the cylinder block. Withdraw the pump from the cylinder block together with the drive shaft if the engine is in situ and the oil baffle or deflector.

To Dismantle

1. Remove the inlet pipe and gauze assembly.

2. Unscrew the remaining two bolts and remove the end cover.

3. Extract the relief valve spring seat, spring and plunger.

4. Check the clearance between the lobes of the inner and outer rotors. This should be checked in the positions as shown in Fig. 25, and must not exceed 0.152 mm. (0.006 in.). Check the clearance between the outer rotor and the housing, this should not exceed 0.254 mm. (0.010 in.) pre-October 1968, 0.381 mm. (0.015 in.) after October 1968.

NOTE.—The rotors are supplied as a matched pair, only so that if the clearance is excessive a new rotor assembly must be fitted. Similarly, if the clearance between the outer rotor and pump body is excessive a new rotor assembly and/or pump body should be fitted.

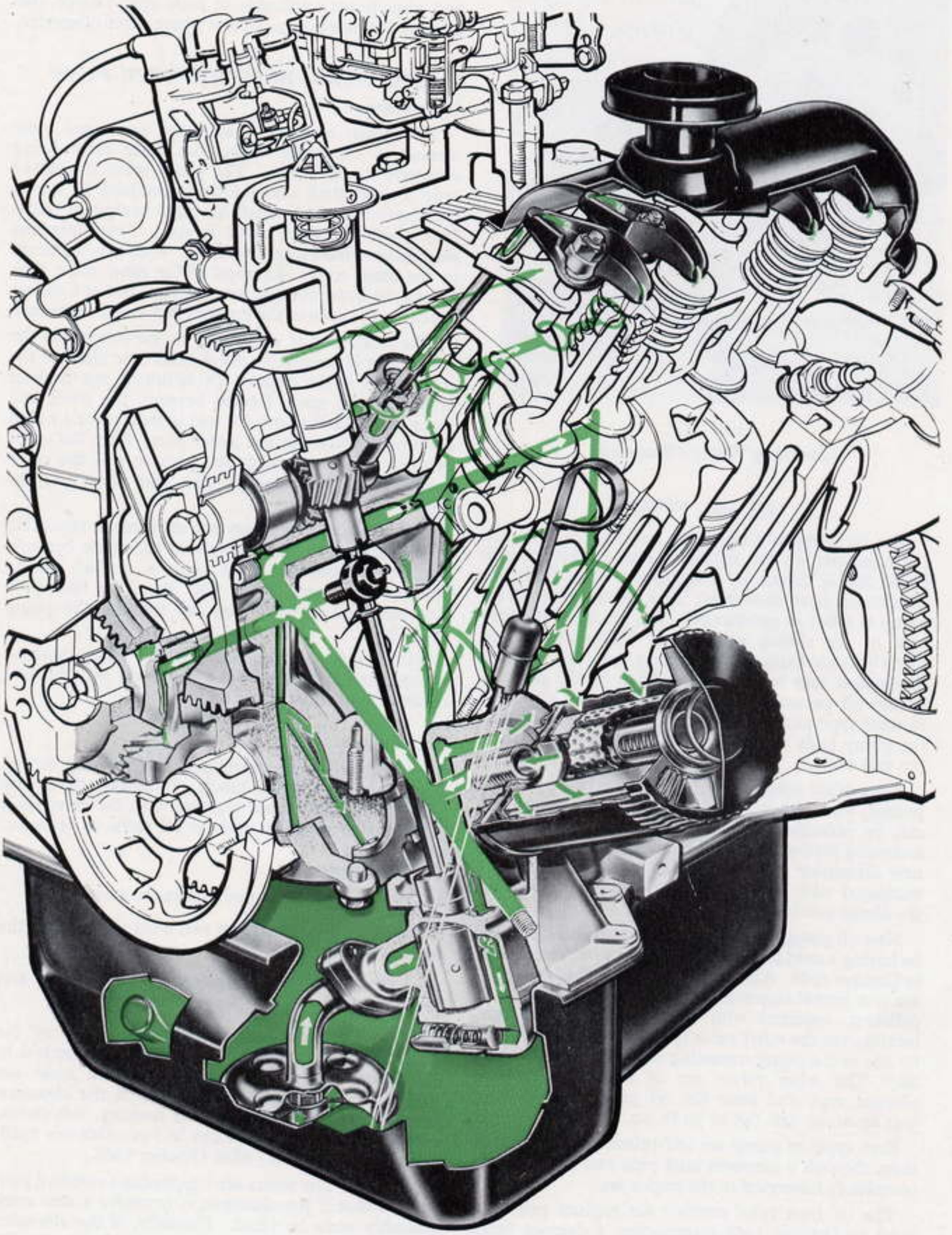


Fig. 26
Lubrication System

5. Place a straight edge across the face of the pump body and check the clearance between the face of the rotors and the straight edge. This should not exceed 0.127 mm. (0.005 in.). If this clearance is excessive, the face of the pump body can be carefully lapped on a flat surface.

6. Withdraw the inner and outer rotors.

To Reassemble

1. Inspect the oil pump component parts for wear and replace as required.

2. Install the inner and outer rotors, ensuring that the chamfered face on the outer rotor is inwards.

3. Insert the relief valve plunger, plain end first, into its bore in the body followed by the spring and spring seat.

4. Fit the end cover with the machined face towards the rotors and secure it in place with two bolts and lockwashers.

5. Fit the inlet pipe and gauze screen assembly.

To Replace

Fit the oil pump and drive shaft to the cylinder block, position the deflector on engines built after October 1968 and secure with the through bolts.

SLIDING VANE TYPE PUMP

Operation

The pump consists of a rotor housed eccentrically in a bore machined in the pump body. Four sliding vanes are located in grooves machined in the periphery of this rotor and are positioned by locating rings on either side of the rotor (see Fig. 28). The vanes being held against the pump body bore by centrifugal force whilst the pump is operating.

The inlet port is connected to the sump and the outlet port is connected to the oil galleries in the engine. As the rotor revolves, the vanes pass over the inlet port and oil is drawn into the space between the rotor and the pump housing. This oil is carried round between the vanes to the outlet port where it is forced out into the engine oil galleries, as the space between the rotor and the pump bore decreases.

The action of the pump is a continuous repetition of this process. Oil flowing into the space between the rotor and the pump bore from the inlet port is carried around between the vanes and then, as the space decreases, the oil is forced out through the pump outlet port.

On this pump a baffle, fitted over the oil pump relief valve aperture, was incorporated from May 1966, to prevent aeration of the sump oil.

To Dismantle

1. Remove the inlet pipe and gauze assembly.

2. Remove the split pin and extract the relief valve spring seat, spring and plunger from the end cover.

3. Unscrew the remaining two bolts and remove the end cover.

4. Place a straight edge across the face of the pump body and check the clearance between the face of the vanes and rotor assembly and the straight edge. This should not exceed 0.127 mm. (0.005 in.). If this clearance is excessive the face of the pump body can be carefully lapped on a flat surface.

Turn the oil pump until one of the vanes is in the centre of the cam form. Check the clearance between the rotor and the oil pump body (see Fig. 27). If this exceeds 0.127 mm. (0.005 in.) a worn body is indicated and a new oil pump assembly should be fitted.

With the rotor in the same position centralise the locating ring and check the clearance between the diametrically opposite vane and the pump body. If the clearance exceeds 0.279 mm. (0.011 in.) the vanes are worn and should be renewed.

Check the vane clearance in the locating groove, if this exceeds 0.127 mm. (0.005 in.), the vanes and/or rotor are worn. Substitute new vanes and recheck the clearance to see if the rotor grooves are worn. If the rotor is worn fit a new rotor and shaft assembly.

5. Extract the vanes, the outer locating ring, the rotor assembly and the inner locating ring.

To Reassemble

1. Inspect the oil pump and replace the worn components.

2. Place the vane locating inner ring in the pump housing and fit the rotor assembly to the pump body.

3. Replace the vane locating outer ring and locate the sliding vanes in the rotor grooves with the curved edges outwards.

October 1968 onwards

Replace the relief valve plunger and spring.

4. Fit the end cover, locating it on the dowels, and secure it in place with two bolts and lockwashers.

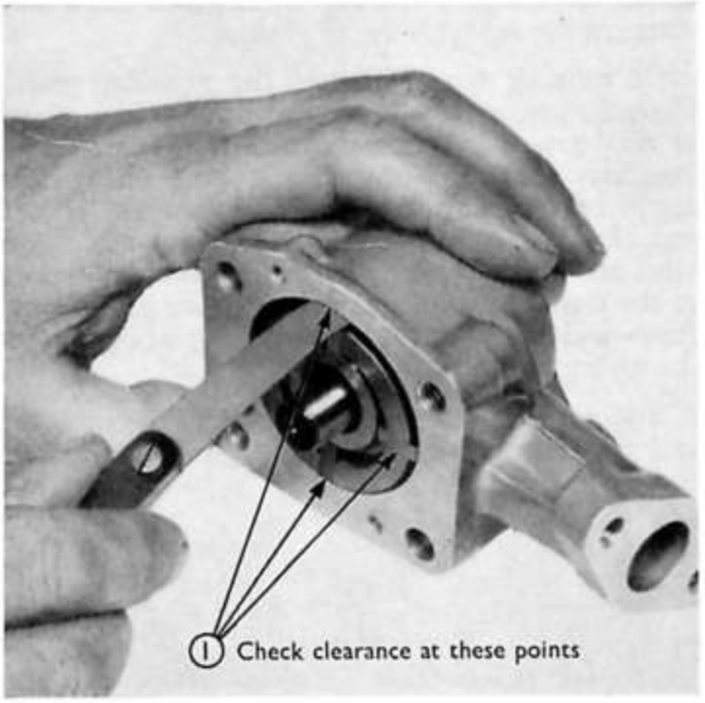


Fig. 27
Checking Vane and Rotor Clearance

Before October 1968

5. Insert the relief valve plunger, spring and spring seal into the end cover and secure with a new split pin.

6. Fit the inlet pipe and gauze screen assembly.

To Replace

Fit the oil pump and drive shaft to the cylinder block, position the baffle or deflector and secure with the through bolts.

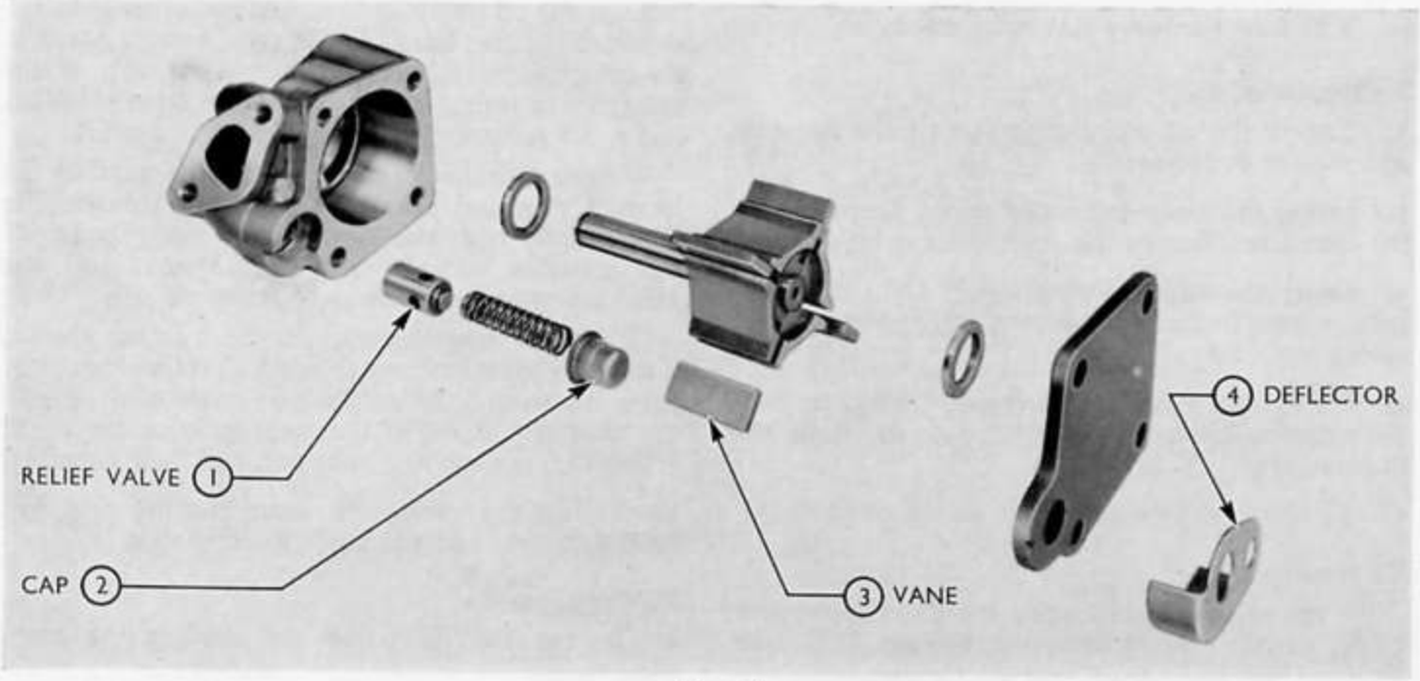


Fig. 28
Sliding Vane Oil Pump (Oct. 1968 onwards)

VENTILATION SYSTEM

A positive ventilation system is used in this engine and may be of either the "open" type, or in some applications, "closed".

In both cases air enters the engine at the oil filler cap on the left-hand rocker cover. In the "open" system the air enters under the rim of the "top hat", but in the closed system the cap is sealed and a hose connects the cap with the air cleaner.

On entering the oil filler cap the air is first passed through a gauze filter to remove any particles of dirt or dust present from the atmosphere. The air then ventilates the left-hand rocker cover, mixing with any fumes present before circulating through the push rod channels and oil drain channels to the tappet chamber. From the tappet chamber access is provided to the crankcase and timing gear housing to remove fumes and gases which have "blown" past the pistons during engine operation.

The now contaminated air passes up the push rod and oil drain channels for the right-hand bank of cylinders to the right-hand rocker cover. A rubber hose connects the right-hand rocker cover to the inlet manifold and thus the contaminated air is drawn off and burnt in the engine.

The flow of contaminated air is controlled by an emission valve in the right-hand rocker cover outlet and has two stages of opening, depending upon manifold depression. During "part load" and idling operation, manifold depression is high and the valve closes limiting flow through a small metered orifice. At full load there is little or no depression and the valve remains open allowing contaminated air to pass through the full area of the valve. The volume of contaminated air being burnt by the engine at any time thus remains fairly constant. Oil droplets that may be present are separated out by a baffle incorporated inside the rocker cover beneath the emission valve.

The emission valve and oil filler cap may be cleaned by washing in petrol. After washing dry, and dip the oil filler cap in clean engine oil. Shake out the surplus oil.

ENGINE: DIESEL

OVERHAUL PROCEDURES

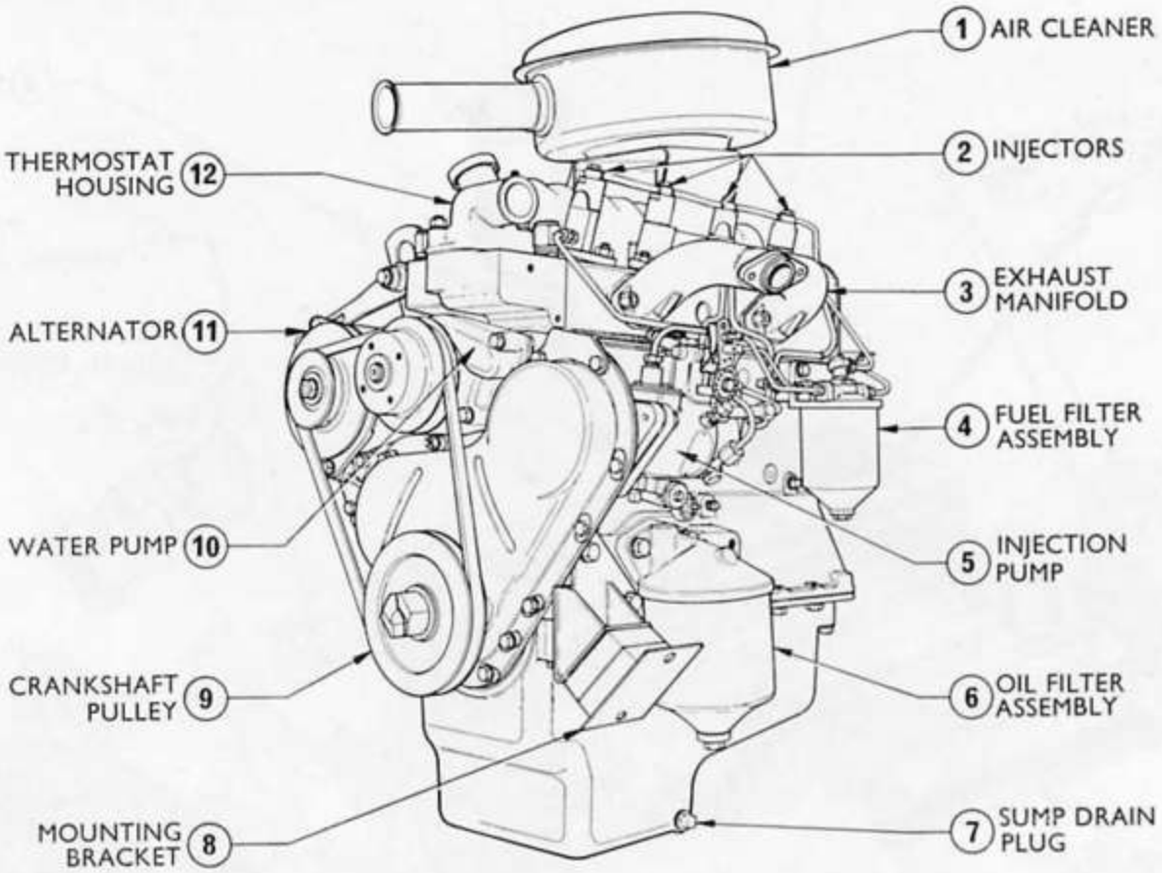


Fig. 30
Engine Assembly (4/108)

Description

Vehicles in the range 75 to 115 produced before May 1966, could be fitted with the Perkins 4/99 Diesel engine as an option to the "vee 4" petrol engine. The 4/99 diesel engine is a four cylinder overhead valve unit with a bore of 76.2 mm. (3 in.) and a stroke of 88.9 mm. (3.5 in.) giving a capacity of 1,621 c.c. (99 cu. in.). Compression ratio is 20 : 1.

Vehicles in the range 75 to 130 produced after May 1966, can be fitted with the Perkins 4/108 diesel engine as an option to the "vee 4" petrol engine. The 4/108 diesel engine is a four cylinder overhead valve unit with a bore of 79.375 mm. (3.125 in.) and a stroke of 88.9 mm. (3.5 in.) giving a capacity of 1,760 c.c. (107.4 cu. ins.). The compression ratio is 22 : 1.

On the 4/99 engine the cylinder block is cast iron with detachable wet cylinder liners flange-mounted at the top and sealed at the bottom by two synthetic rubber rings located in the cylinder block. The cylinder liners are retained in the cylinder block by the cylinder head.

The 4/108 cylinder block is cast iron with detachable dry cylinder liners. These are also retained by the cylinder head.

An indirect injection system is used with pintle type injectors and a distributor type injection pump incorporating a hydraulic governor and automatic advance and retard mechanism.

The valves are mounted vertically in the cylinder head, the inlet valves having a larger diameter head than the exhausts. Two valve springs are used per valve and replaceable valve guides are fitted. The valve springs have damper coils at one end and must be fitted with these coils adjacent to the cylinder head. The inlet valve spring retainer is deeper than the exhaust to allow for a rubber sealing ring fitted in a machined groove in the inlet valve stem. The valves are operated by rockers and push rods from a gear-driven camshaft located in the right-hand side of the cylinder block.

The camshaft, driven by a large idler gear, runs in three bearings which are machined directly in the cylinder block. Camshaft end-float is controlled by thrust washers retained by the engine front plate. The oil pump and fuel lift-pump are driven from the camshaft by a skew gear and an eccentric respectively.

The forged crankshaft runs in three large diameter main bearings. These bearings and the connecting rod big end bearings have detachable aluminium-tin liners.

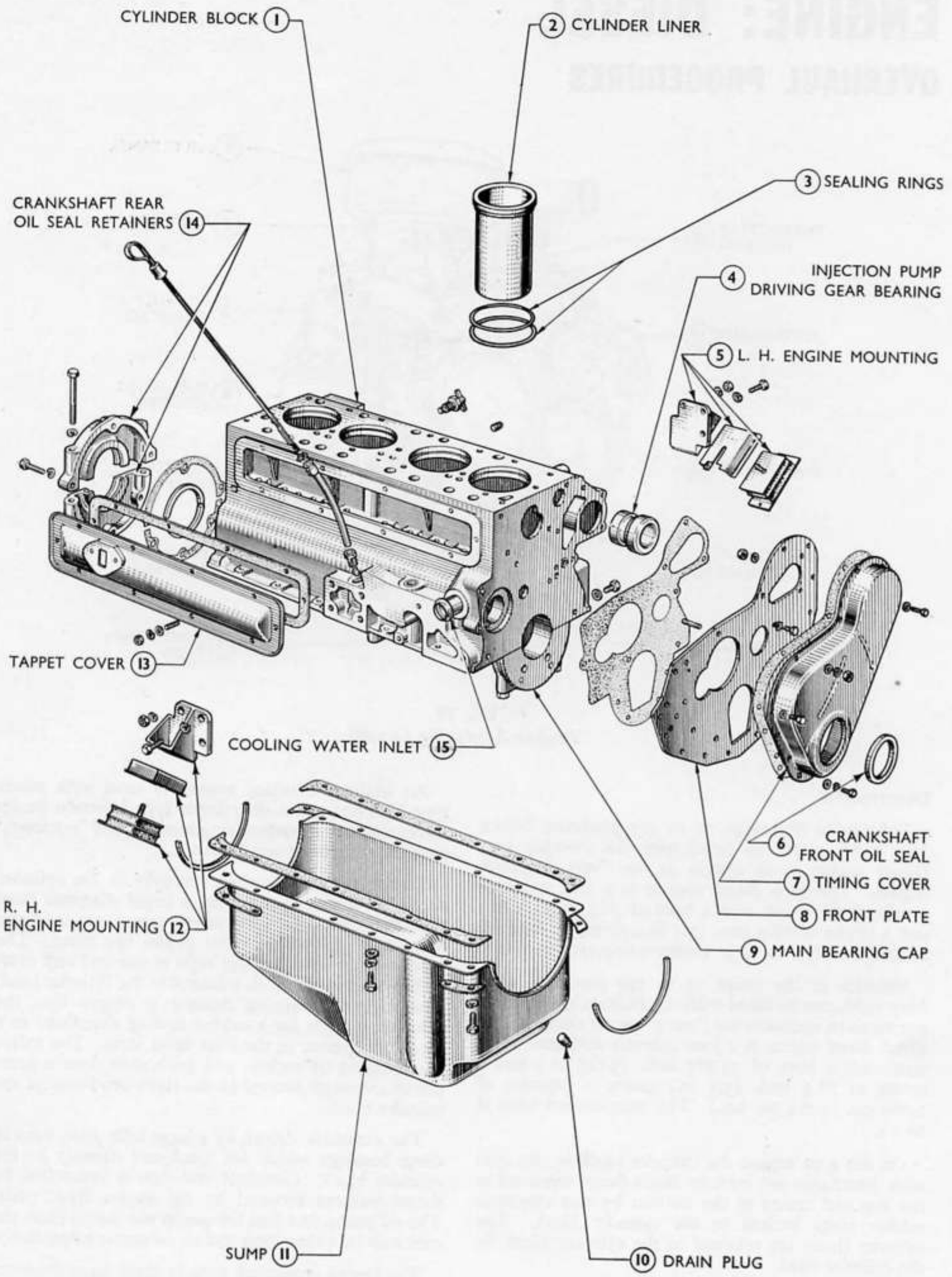


Fig. 31
Cylinder Block and Crankshaft Seals (4/99)

In production, the 4/108 crankshaft is Tufftrided. Should it be necessary to regrind the journals in service, the crankshaft must be re-Tufftrided afterwards in all cases, regardless of the diameter to which it is reground.

Crankshaft end-float is controlled by detachable steel-backed lead-bronze thrust washers fitted at either side of the rear main bearing; a complete washer at the rear and a half-washer, in the cap, at the front.

The connecting rods are 'H' section forgings and the big ends are split at 45 degrees to the connecting rod axis. The connecting rod and cap faces are serrated to ensure positive location, and the cap is secured to the rod by two bolts locked with tab washers on the 4/99 and plain hardened washers on the 4/108.

Aluminium alloy pistons with three compression rings and one oil control ring above the piston pin and one oil control ring below the piston pin, are used. The pistons in 4/108 engines have a steel insert fitted into the top ring groove. No attempt should be made to remove this. The top compression ring is plain cast iron and can be fitted either way up. The two lower compression rings are stepped internally on the upper face with the lower face marked "BTM". The piston pins are fully floating and are retained in position by a circlip installed in a groove at each end of the piston pin bore.

The combustion chambers are in the cylinder head to the left of the valves and are machined in two parts, the upper parts are hemispherical in shape and are machined into the cylinder head. The lower parts are formed by machined plugs which incorporate a throat connecting the combustion chamber to the cylinder bore.

The eccentric rotor type oil pump incorporates a plunger type oil pressure relief valve. Oil is pressure fed, via a full flow oil filter to the main and big end bearings, camshaft bearings, idler gear spigot, injection pump driving hub and timing gears, also there is a controlled oil feed, by a slot in the camshaft centre journal, to the rocker shaft. Push rods, tappets, cams and oil pump drive gears are lubricated by oil returning to the sump from the rocker shaft. Small end bushes and pistons are lubricated by splash and oil mist.

The distributor type injection pump is mounted horizontally on the left-hand side of the engine and is driven at half engine speed by a timing gear in mesh with the idler gear. The injection pump has a timing mark scribed on the mounting flange that aligns with a similar mark on the cylinder block.

The injection pump may be removed regardless of the engine's rotational position, since the injection pump drive shaft has a master spline which locates in a corresponding spline in the timing gear hub. Providing the timing gear position is not changed on its hub, it is possible to replace the injection pump, or fit a new one, and maintain the correct timing by engaging the master splines and aligning the timing marks on the injection pump flange of the cylinder block. The timing gear position on the hub is marked by scribed lines.

ENGINE REMOVAL

To Remove the Engine

1. **Raise the bonnet** and disconnect the windscreen washer pipes from the jets.

2. **Remove the bonnet.** Unscrew and remove the four hinge bolts and spring washers.

3. **Disconnect the battery.**

4. **Drain the engine oil and coolant.**

5. **Disconnect the radiator hoses** from the engine.

6. **Remove the radiator and hoses.** Unscrew the four bolts securing the radiator to the supports and lift the radiator clear of the engine compartment.

7. **Remove the headlamp bezels.**

8. **Disconnect the bonnet release cable** from the release arm.

9. **Remove the radiator grille panel.** Unscrew and remove the grille panel retaining screws and radiator supports lower bolts.

10. **Remove the air cleaner.**

11. **Disconnect the fuel feed pipe** from the fuel lift pump.

12. **Disconnect the "thermostart" connections** at the inlet manifold.

13. **Disconnect the accelerator linkage** and the stop control cable from the fuel injection pump.

14. **Detach the oil pressure switch lead.**

15. **Disconnect the temperature gauge sender unit and alternator leads.**

16. **Slacken the heater hose clips** and detach both hoses from the heater unit.

17. **Disconnect the vacuum pipe from the engine** (where servo assisted brakes are fitted).

18. **Remove the starter motor.** Detach the leads, unscrew the securing bolts and withdraw the starter motor and solenoid as an assembly.

19. **Disconnect the exhaust pipe** from the exhaust manifold.

20. **Jack up the front of the vehicle and fit stands** beneath the front axle.

21. **Release the clutch return spring and remove the clutch housing lower dust cover.**

22. **Unscrew the clutch housing bolts.** Note the position of the bolts which also secure the speedometer cable support clip and engine earth strap.

23. **Support the gearbox.**

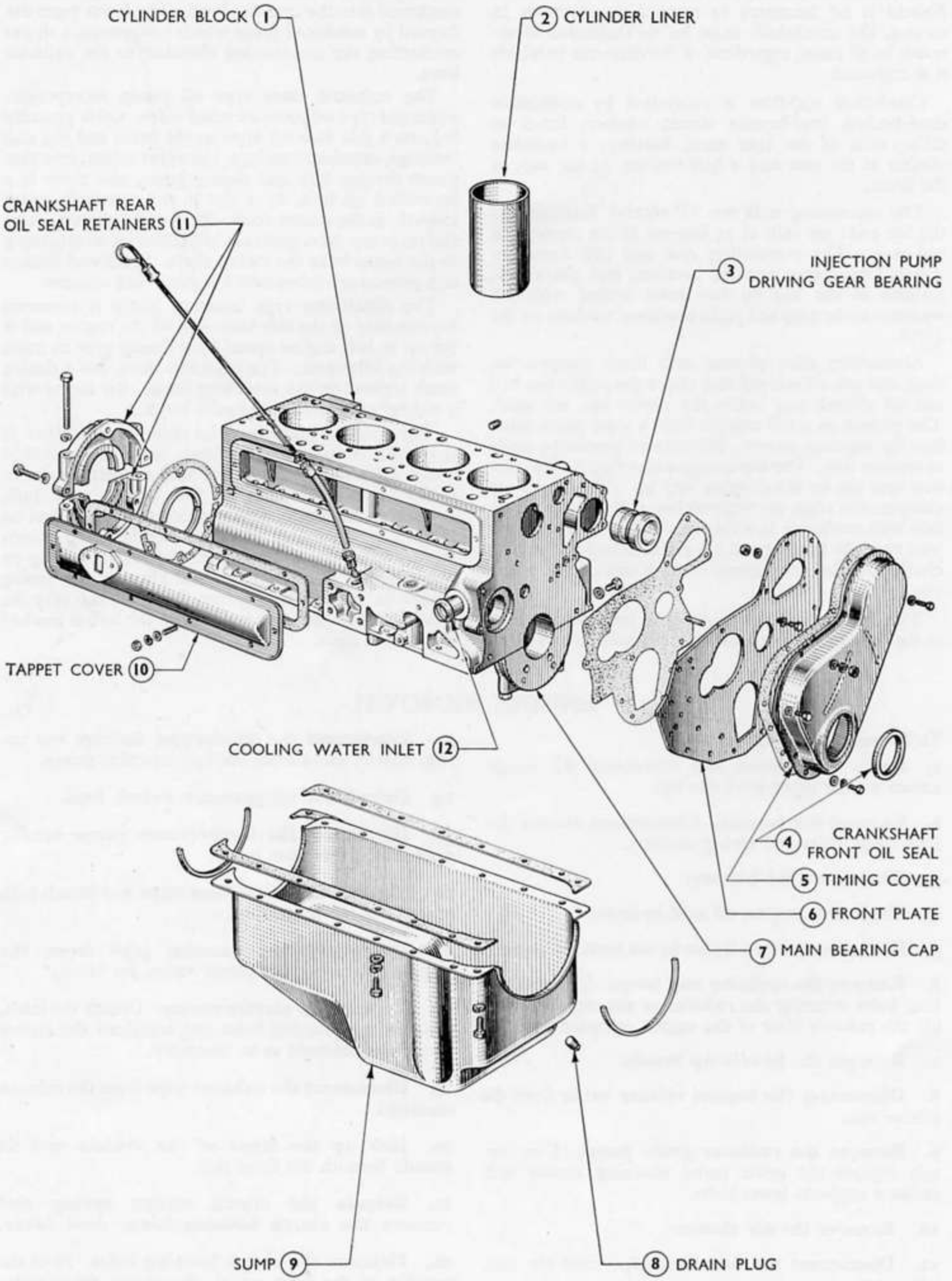


Fig. 32
Cylinder Block, Sump and Front Cover (4/108)

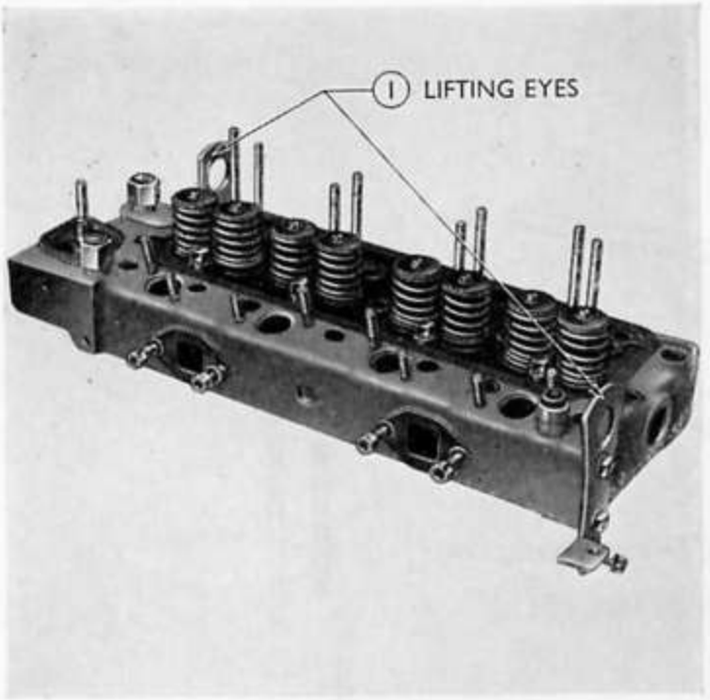


Fig. 33
Engine Lifting Eyes

24. Using suitable lifting equipment and the lifting brackets which are already fitted at the front and rear of the cylinder head, take the weight of the engine.

25. Release the front engine mountings, and remove the engine from the vehicle.

To Replace the Engine

1. Fit suitable lifting equipment to the engine lifting brackets, and position the engine in the engine compartment.

2. Align the engine with the transmission and engage the gearbox main drive gear with the clutch disc hub and pilot bearing.

3. Secure the clutch housing to the engine with the bolts and spring washers. Ensure that the speedometer cable support clip and engine earth strap are fitted to the appropriate clutch housing bolts.

4. Remove the support from beneath the gearbox.

5. Refit the engine front mounting bolts.

6. Remove the lifting equipment.

7. Secure the clutch housing lower dust cover in position with the bolts and spring washers.

8. Adjust the clutch linkage free play and connect the return spring.

9. Refit the starter motor, securing it with two bolts and spring washers. Reconnect the starter motor lead.

10. Jack up the front of the vehicle and remove the stands. Lower the vehicle to the ground.

11. Secure the exhaust pipe to the manifold.

12. Reconnect the servo unit vacuum pipe to the engine.

13. Push the heater hoses on to the heater unit and tighten the retaining clips.

14. Reconnect the temperature gauge sender unit and alternator leads.

15. Reconnect the lead to the oil pressure switch.

16. Connect the accelerator linkage and stop control cable to the fuel injection pump.

17. Reconnect the thermostart connections to the inlet manifold.

18. Connect the fuel feed pipe to the fuel lift pump.

19. Bleed the fuel system. (See Section 9.)

20. Replace the air cleaner and tighten the securing clamp.

21. Refit the radiator grille panel and secure the lower ends of the radiator supports.

22. Connect the bonnet release cable to the release arm.

23. Replace the radiator and secure the hoses to the engine.

24. Refill the sump with the correct grade engine oil.

25. Refill the cooling system, using anti-freeze as required.

26. Reconnect the battery.

27. Refit the bonnet and connect the windscreen washer hoses to the jets.

OVERHAUL PROCEDURES

CYLINDER BLOCK AND CRANKSHAFT SEALS

Cylinder Block and Liners (4/99)

The cylinder block is cast iron with detachable wet cylinder liners (see Fig. 31) which are retained by the cylinder head. The liners are flange mounted at the top and sealed at the bottom by two synthetic rubber sealing rings located in grooves machined in the cylinder block. Small holes in the cylinder block, between each pair of sealing rings, vent the spaces to atmosphere and occasional drops of water from the holes may be ignored.

On removing the cylinder head, secure the cylinder liners in position with suitable spacers and cylinder head nuts on the studs between each pair of cylinders. This will prevent the liners from moving if the engine is turned.

If cylinder liners have to be removed and replaced mark the liners and block so that each liner may be replaced in exactly the same position.

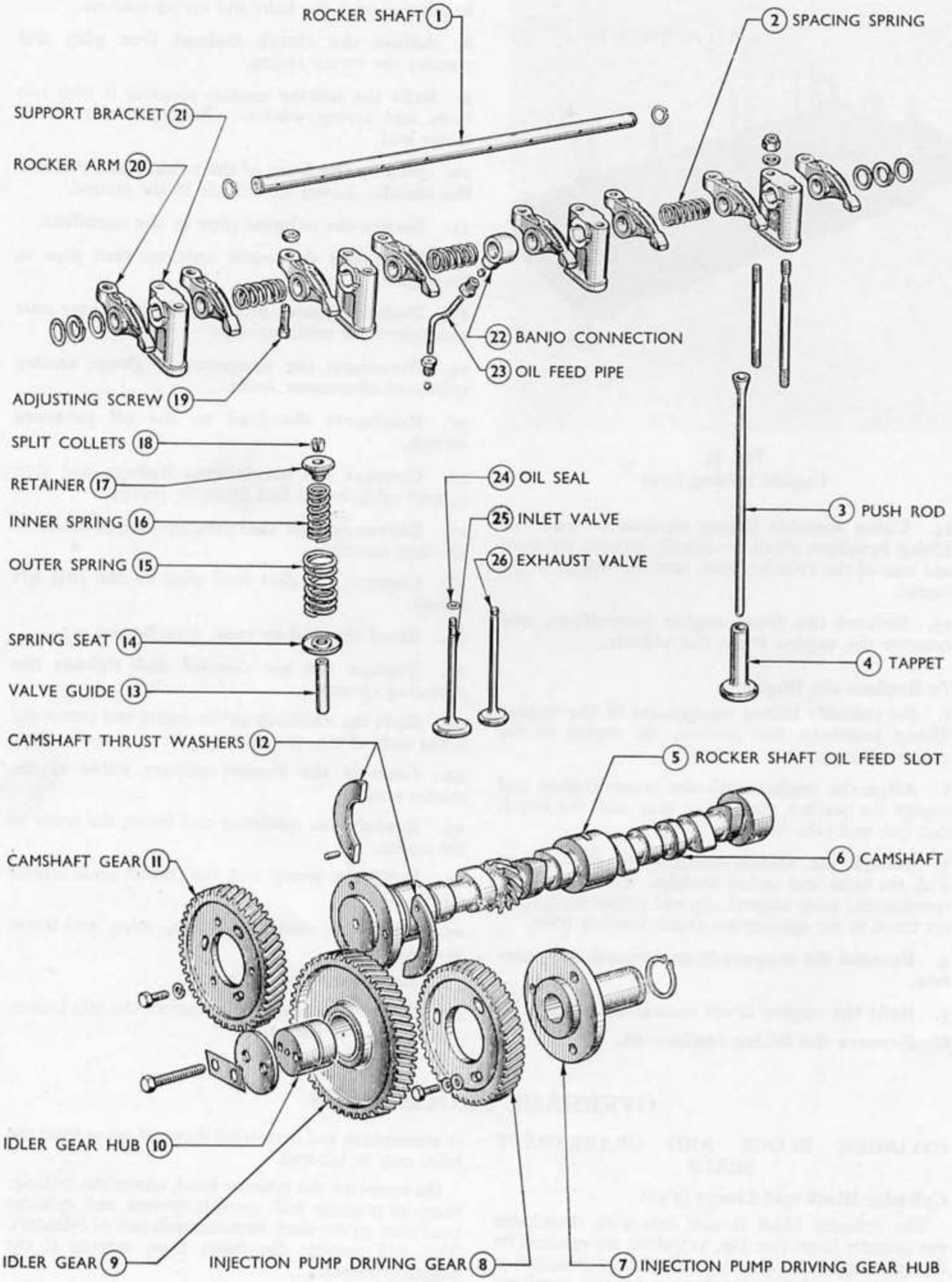


Fig. 34
Valves and Operating Mechanism

Fig. 35
Valve Spring Compressor

NOTE.—Do not centre-pop or score.

Remove cylinder liners, using Tool No. CT.6075 with a 101.6 mm. (4 in.) long piece of steel tubing and adaptor Tool No. PD.50C–2.

When replacing a cylinder liner lubricate the sealing rings with liquid soap and press the liner home by hand.

Cylinder liners should not protrude more than 0.076 mm. (0.003 in.) or be more than 0.0254 mm. (0.001 in.) below the cylinder block face.

Cylinder Block and Liners (4/108)

The cylinder block is cast from high duty cast iron alloy, and contains centrifugally cast "dry" cylinder liners of the thinwall type. The liners are unshouldered, and are an interference fit in the cylinder block parent bores.

It is not possible to rebore these liners. New cylinder liners should be fitted when a rebore would normally be considered necessary.

When checking the bore of the liners, each one should be measured in three positions—at the top, the centre, and the bottom. In each of these three positions, two readings should be taken at right-angles, one along the block and one transversely. These six readings in each bore will check for both "barrelling" and ovality.

It is advisable to allow a period of time to elapse before checking the fitted internal bore of a new thinwall liner, to allow it to settle.

Crankshaft Seals

An oil seal is fitted into the front cover to prevent oil leaks from around the crankshaft pulley boss. Upper and lower oil seal retainers are located on the cylinder block and rear main bearing cap, rubber-cored asbestos packings are located in these to prevent oil leaks from the crankshaft rear journal.

VALVES AND OPERATING MECHANISM

Valves, Guides and Springs

The valves are mounted vertically in the cylinder head and operated from the camshaft by push rods and rocker levers (see Fig. 34). The diameter of each inlet valve head is larger than the exhaust to improve engine breathing. The valve positions are reversed to that normally used. The inlets are numbers 1, 4, 5 and 8 and exhaust numbers 2, 3, 6 and 7.

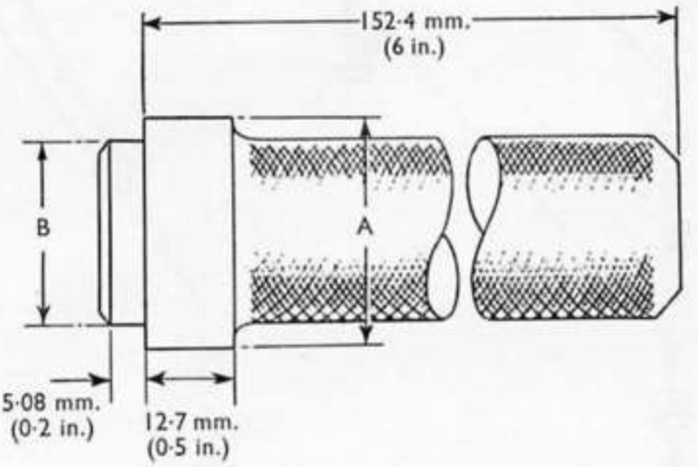
Each valve has two springs which are located on the cylinder head by pressed steel spring seats. The springs are attached to the valves by a spring retainer and split collets. The inlet valve spring retainer is deeper than the exhaust to accommodate a rubber sealing ring fitted in a groove machined in each inlet valve stem. The valve springs have damper coils which are more closely wound at one end. These coils must be nearest to the cylinder head when the spring is fitted.

When removing the valves, compress the valve springs with valve spring compressor Tool No. 6118 and adaptor Tool No. PD.6118–1 located on a convenient rocker shaft support bracket stud.

The valve guides are replaceable and the inlet and exhaust are identical in diameter, but differ in length (see Specifications). When fitting a new guide it must protrude 20.320 to 20.701 mm. (0.800 to 0.815 in.) above the top face of the cylinder head.

Remove and replace the guides with Tool No. PD1C and adaptors PD1C-1 and PD1C-2.

The valve heads are recessed into the cylinder head face to give sufficient clearance for the piston at top dead centre. The clearance between the cylinder



Valve	Dia. "A"	Dia. "B"
Inlet	38·74 mm. (1·525 in.)	31·44 to 31·47 mm. (1·238 to 1·239 in.)
Exhaust	32·77 mm. (1·29 in.)	25·86 to 25·88 mm. (1·018 to 1·019 in.)

Fig. 36
Valve Seat Insert Replacer Tool

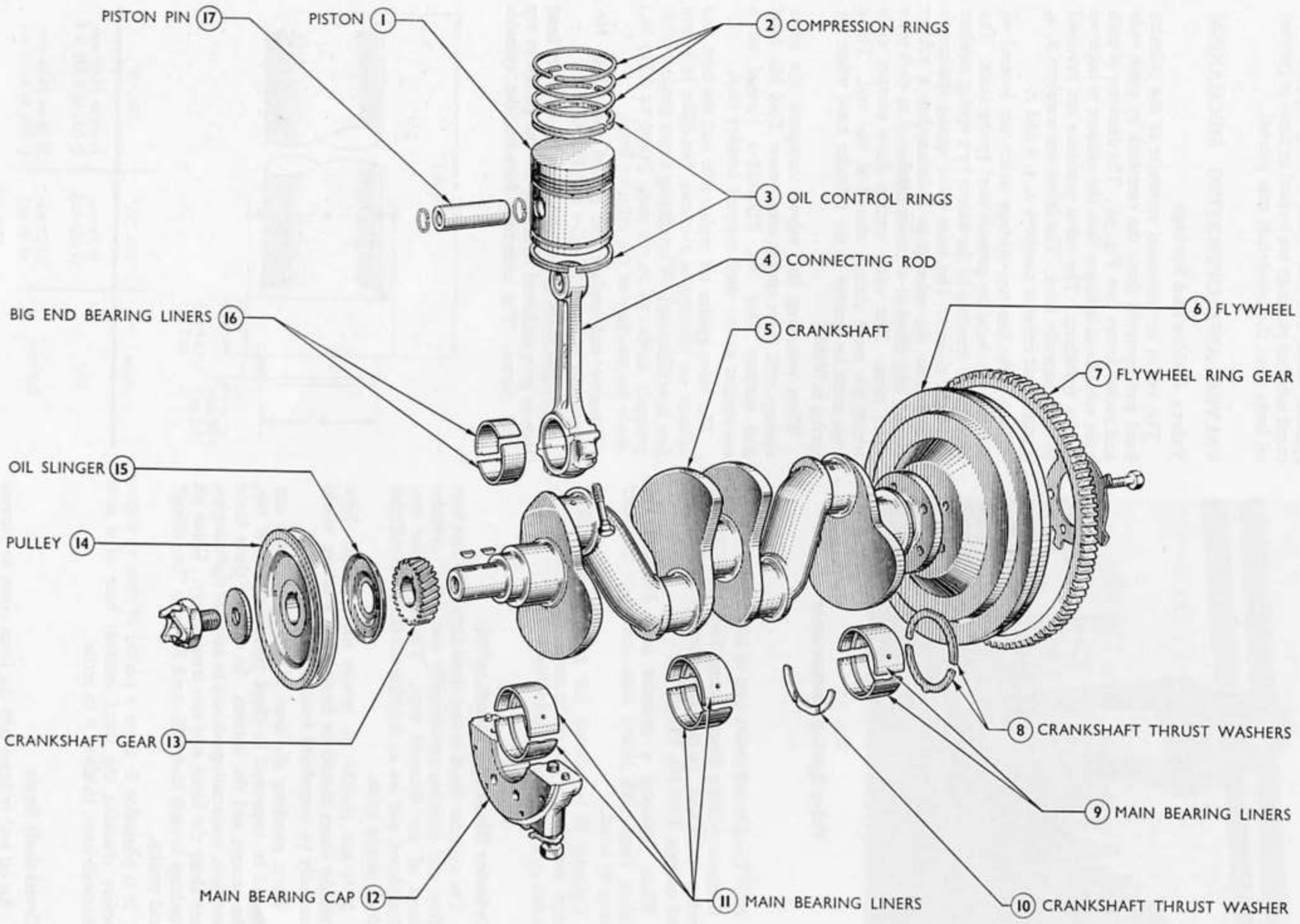


Fig. 37
Crankshaft, Connecting Rod, Piston and Flywheel (4/99)

Fig. 38
Rocker Shaft Assembly

head face and the valve head is 0.711 to 1.219 mm. (0.028 to 0.048 in.) for the inlet and 0.533 to 1.219 mm. (0.021 to 0.048 in.) for the exhaust valves (see Fig. 55).

If a clearance exceeds the above values, or a seat becomes unserviceable, valve seat inserts can be fitted. Cut the recesses to the following dimensions:

Inlet diameter	38.86 to 38.89 mm. (1.530 to 1.531 in.)
Exhaust diameter	32.92 to 32.95 mm. (1.296 to 1.297 in.)
Depth	7.938 to 8.065 mm. (0.3125 to 0.3175 in.)
Corner chamfer	0.381 mm. (0.015 in.) max. at 45°

NOTE.—Before cutting a valve seat, or cutting a recess for an insert, new valve guides must be fitted to the cylinder head to act as a pilot for the cutter.

Press seat inserts squarely into place using drivers made to the dimensions shown in Fig. 36.

Finally, re-cut the valve seat to give the correct cylinder head to valve clearance.

The valve clearances should be set to 0.305 mm. (0.012 in.) cold or 0.254 mm. (0.010 in.) hot. To ensure that each valve is fully closed when being checked, use the following sequence:—

Valves Open	*Valves to Adjust*
1 and 6	3 and 8
5 and 7	2 and 4
3 and 8	1 and 6
2 and 4	5 and 7

Rocker Shaft Assembly

The rocker bores have steel backed white metal bushes which may be replaced when worn. When replacing a bush it is important that the oil hole in the bush is aligned with the hole in the rocker. The bushes are pre-sized and reaming is not required after installation.

The rocker shaft which is hollow is supported by four brackets with the rockers placed on each side. The end rockers are retained on the shaft by circlips and double coil spring washers with plain washers on either side. The other rockers are maintained in their correct position by spacer springs. The rocker shaft is plugged at each end and oil is fed into the shaft by a pipe attached to a banjo connection adjacent to No. 5 rocker. A union at the lower end of this pipe screws into a vertical oil feed hole drilled through the cylinder head and block. Oil is fed to each rocker by oil holes machined in the rocker shaft. An oil hole in the top of each rocker lever feeds oil to the valves and push rods. The oil pipe protrudes into the rocker shaft to locate it in the correct position.

The rocker shaft bores in the support bracket are slotted on the horizontal axis so that the rocker shaft is clamped in position when the rocker shaft securing nuts are tightened, the tightening torque for these nuts is 1.7 to 2.0 kg.m. (12 to 15 lb. ft.), which must not be exceeded.

Push Rods and Tappets

Push rods should be checked for straightness before fitting to the engine. The tappets can only be removed from the crankcase after the camshaft has been withdrawn.

Camshaft and Timing Gears

The gear driven camshaft, which runs in three bearings machined directly in the R.H. side of the cylinder block, incorporates a skew gear for the oil pump drive and an eccentric for the fuel lift pump. The camshaft and injector pump drive gears are driven by a large idler gear in mesh with the crankshaft gear. The camshaft gear has three round and

Fig. 39
Timing Gears

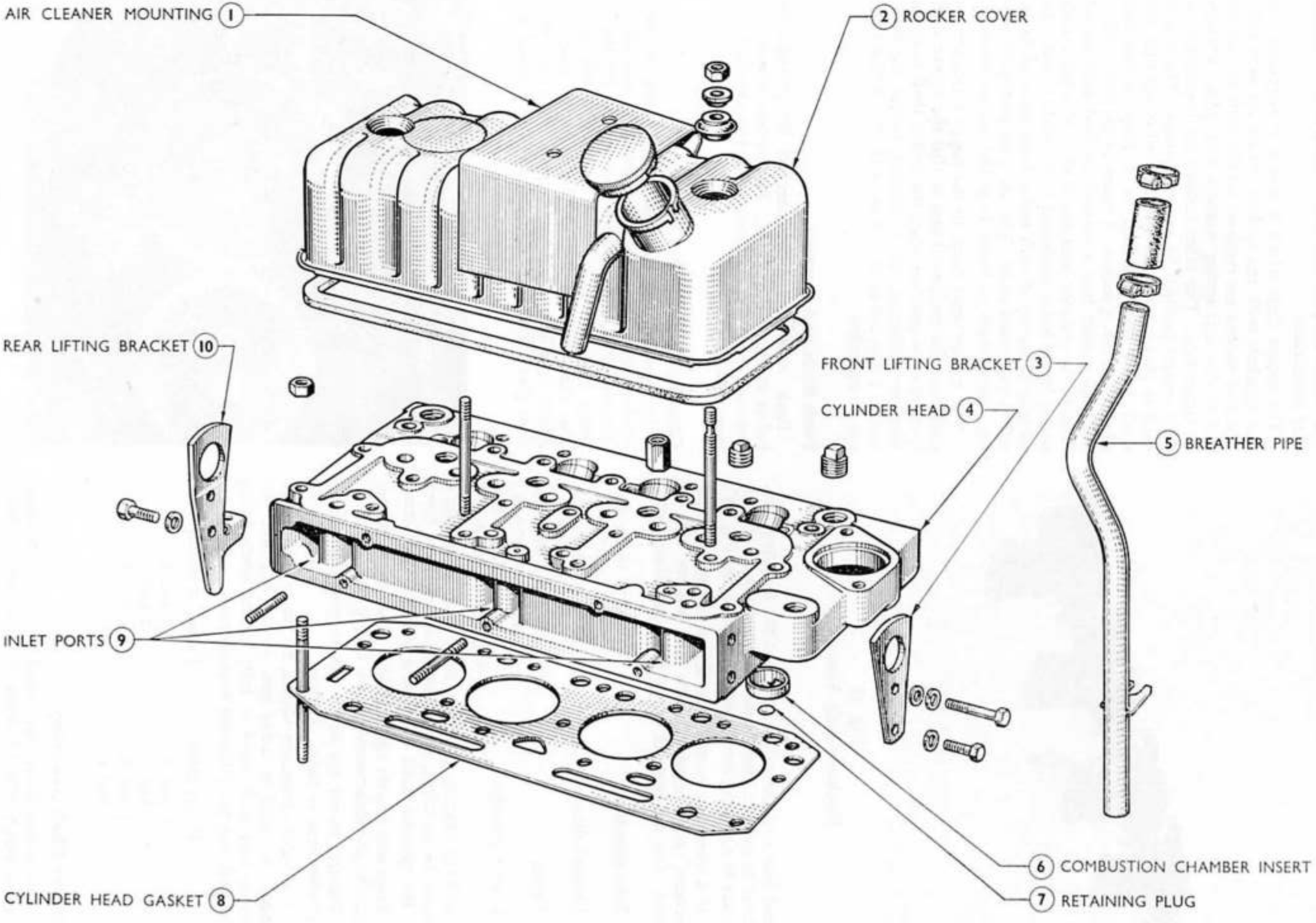


Fig. 40
Cylinder Head and Rocker Cover

three slotted holes and is secured by bolts and spring washers through the round holes. The gear must be assembled with the "D" marks on the gear and on the camshaft aligned (see Fig. 39). The injector pump drive gear is secured by bolts with flat and spring washers, through slotted holes in the gear. The position of the injection pump drive gear on its hub is set and marked during manufacture. This setting must be adhered to at all times.

Timing marks are incorporated on all the gears to facilitate engine timing on assembly. With No. 1 piston at T.D.C. at the end of compression, the timing marks on each gear are in alignment with each other (see Fig. 39). At top dead centre the keyways in the crankshaft are vertically upwards and the T.D.C. mark on the flywheel periphery, also upwards, is in alignment with the "V" notch in the flywheel housing. Note that the idler gear has an odd number of teeth, to ensure even wear. As a result, if the engine is timed after initially aligning the marks, subsequent alignment will not always follow.

Should it be necessary to fit a replacement injection pump drive gear, fit the gear so that the timing marks are in alignment. Do not tighten the bolts. Turn the engine until No. 1 crankpin is positioned, on compression stroke, as follows:—

4/99
26° before T.D.C.

4/108
19° before T.D.C. up to engine No. 108 UD 20214.
20° before T.D.C. from engine No. 108 UD 20215 to engine No. 108 UD 27696.
18° before T.D.C. from engine No. 108 UD 27696.

Timing marks, which must be aligned with a "V" notch in the flywheel housing, are incorporated on the flywheel periphery. Alternatively, position No. 1 piston, on compression stroke, to:—

Fig. 41
Removing Crankshaft Gear

Fig. 42
Timing Gear Backlash

5.74 mm. (0.226 in.) before T.D.C. (4/99).

3.05 mm. (0.12 in.) before T.D.C. (4/108) to engine No. 108 UD 20214.

3.404 mm. (0.134 in.) before T.D.C. (4/108) from engine No. 108 UD 20215 to engine No. 108 UD 27696.

2.75 mm. (0.108 in.) before T.D.C. (4/108) from engine No. 108 UD 27697.

If the cylinder head has not been removed, this can be checked by dropping a valve onto the top of No. 1 piston and, by using a dial gauge to measure the piston movement, turn the engine back to the correct position.

Fit the injection pump and align the timing marks on the mounting flange and cylinder block.

Remove the injection pump inspection cover and turn the drive gear hub, without moving the engine, until the scribed line marked "A" on the injection pump drive plate is in alignment with the squared end of the timing circlip. Injection pump timing procedure is given in full detail in the Fuel System.

Tighten the injection pump drive gear bolts with the engine and injection pump in this position.

Mark the gear, adjacent to the existing timing mark on the hub, to facilitate any subsequent overhaul or repair that may be required at a later date.

The idler gear runs on a spigot and is retained by a plate. The retainer plate and spigot are secured to the cylinder block front face by two bolts. When replacing the idler gear, ensure that the oil feed hole in the spigot is in alignment with the oil drilling in the cylinder block. Backlash between the gears can be varied as there is clearance in the spigot bolt holes. Adjust the position of the spigot so that when the bolts are tightened to 4.56 to 4.98 kg.m. (33 to 36 lb. ft.)

Fig. 43
Piston and Connecting Rod

torque there is 0.038 to 0.076 mm. (0.0015 to 0.003 in.) backlash between the idler, camshaft and crankshaft gears.

Camshaft endfloat is controlled by two half-thrust washers located in a recess machined in the cylinder block front face and retained by the front plate. A dowel pin prevents the washers turning.

CRANKSHAFT, CONNECTING ROD, PISTON AND FLYWHEEL

Crankshaft

The crankshaft is a steel forging supported by three main bearings, with detachable aluminium-tin lined bearings. Three steel backed aluminium-tin or copper-lead half-thrust washers located in recesses, two behind the rear main bearing and one in front of the rear main bearing cap, control crankshaft end-float (see Fig. 47). These thrust washers must be fitted with the oil grooves adjacent to the crankshaft thrust surfaces.

The crankshaft main journals and crank pins may be reground 0.254, 0.508 or 0.762 mm. (0.010, 0.020 or 0.030 in.) undersize.

NOTE.—If the 4/108 crankshaft is reground, it must be re-Tuftrided.

The crankshaft gear may be removed with puller Tool No. 252, fitted with the special flat ended legs.

An oil slinger is fitted to the front of the crankshaft to reduce the possibility of oil leaks.

Connecting Rods

The connecting rods are H section forgings with the big ends split at 45° to the connecting rod axis. To ensure that the connecting rod is assembled the correct way round, the word "FRONT" is embossed on the connecting rod web. Also, the rod and bearing cap faces are serrated to ensure positive location and the cap is secured by two bolts locked by tab washers. The big end bearings are steel backed aluminium-tin liners and the small end bearings are replaceable steel backed lead-bronze bushes.

When fitting small end bushes ensure that the oil holes in the bushes coincide with the holes in the connecting rod. After fitting, ream the bushes in line with the big end bore to a diameter of 23.828 to 23.844 mm. (0.9382 to 0.9388 in.) for the 4/99, or 27.005 to 27.019 mm. (1.0632 to 1.06375 in.) for the 4/108, to suit the respective piston pins and then check the connecting rod alignment on an alignment jig Tool No. 335 and arbor Tool No. 336.

Pistons and Connecting Rods

The connecting rods are numbered on the rod and cap to facilitate correct assembly should they be dismantled in service. The numbers are stamped on the same side as the liner locating slots on the big end. The pistons are also numbered and should they be removed must be re-fitted to their respective connecting rod in the same position from which removed. A new piston may be fitted either way round. When dismantling or assembling the piston and connecting rod heat the piston to 37.8° to 48.9°C. (100° to 120°F.) before removing or inserting the piston pin.

Pistons, Pins and Rings

The pistons are flat topped and at top dead centre must protrude 0.216 to 0.305 mm. (0.0085 to 0.012 in.) on 4/99 engines, or 0.051 to 0.152 mm. (0.002 to 0.006 in.) on 4/108 engines, above the cylinder block face to ensure correct compression characteristics.

In production, pistons are graded by height, to compensate for the normal tolerances on the cylinder block, crankshaft and connecting rod dimensions, and are selected to give the correct protrusion on assembly into the engine. In service, three grades F, L and P are available which should be used as replacements for the corresponding production grades (see table below). When fitting pistons, ensure that they give the correct protrusion, grade P being the lowest and F the highest. *If pistons with unfinished crowns are to be fitted, machine the crowns to give the correct protrusion.*

Measure the piston protrusion as follows:—

(1) If the original piston is to be checked, remove all carbon from the piston crown.

(2) Position gauge Tool No. CT.6120 so that the outer feet **rest on the cylinder block face,** with the centre portion immediately above but not touching the piston.

(3) Locate gauge Tool No. 4008 on a convenient cylinder head stud and zero on top of the gauge Tool No. CT.6120.

(4) Turn the crankshaft until the piston is at top dead centre, when the maximum reading recorded on the dial gauge will be the piston protrusion.

Piston, pin, and ring assemblies available in service are as follows:—

4/99

Height from pin centre line to piston crown	*Service Grade*	*Production Grades*
45.63 to 45.65 mm. (1.7955 to 1.7965 in.)	F	B, D & F
45.55 to 45.57 mm. (1.7925 to 1.7935 in.)	L	H, J & L
45.50 to 45.52 mm. (1.7905 to 1.7915 in.)	P	N & P

4/108

Height from pin centre line to piston crown	*Service Grade*	*Production Grades*
50.30 to 50.23 mm. (1.9803 to 1.9774 in.)	F	B, D & F
50.22 to 50.14 mm. (1.9773 to 1.9744 in.)	L	H, J & L
50.12 to 50.10 mm. (1.9743 to 1.9723 in.)	P	N & P

The piston pins are fully floating and are retained by circlips at each end of the piston pin bore in the piston. The pistons in 4/108 engines have a steel insert fitted into the top ring groove. No attempt should be made to remove this.

Each piston has five rings, three compression and two oil control, one oil control ring being below the piston pin bore. On 4/99 pistons the top compression ring is chrome plated and may be fitted either way up. The two lower compression rings are internally stepped and must be fitted with the stepped face uppermost. The lower face is marked "BTM" for additional identification. Both oil control rings are the slotted channel type.

4/108 pistons have a parallel faced, cast iron top compression ring, two lower compression rings, internally stepped, these must be fitted with the stepped face uppermost, a laminated oil control ring positioned above the piston pin and a slotted channel scraper fitted below the piston pin.

On the 4/99 engine the piston ring gap is 0.305 to 0.432 mm. (0.012 to 0.017 in.) for the top compression ring and 0.229 to 0.356 mm. (0.009 to 0.014 in.) for the remaining rings. On the 4/108 the piston ring gap is 0.229 to 0.356 mm. (0.009 to 0.014 in.) for all rings except the laminated scraper. The above ring gaps apply to bore diameters of 76.20 mm. (3.00 in.) 4/99 and 79.37 mm. (3.125 in.) 4/108. A 0.076 mm. (0.003 in.) increase in ring gap should be allowed for every 0.025 mm. (0.001 in.) increase in these bore diameters. When checking the ring gaps in a worn cylinder bore, the rings should be located at the bottom of the bore.

Flywheel

The flywheel is located on the crankshaft flange by a recess and is retained by five bolts locked with a locking plate. The position of the flywheel relative to the crankshaft is maintained by the bolts which are unevenly spaced, there being no dowel.

Fig. 44
Oil Pump

The ring gear is shrunk onto the flywheel periphery and may be renewed if necessary. Timing marks are also incorporated on the flywheel periphery and are visible through an aperture on top of the flywheel housing.

Flywheel "run-out" should not exceed 0.102 mm. (0.004 in.) total indicator reading at 101.6 mm. (4 in.) radius on the clutch face and 0.305 mm. (0.012 in.) total indicator reading on the flywheel periphery.

CYLINDER HEAD AND ROCKER COVER

The cast iron cylinder head (see Fig. 40) is retained by eighteen studs and nuts, the five nuts adjacent to the injectors being longer than the rest to facilitate cylinder head tightening with the injectors in position. The cast aluminium inlet manifold consists of a vertical air intake pipe integral with a cover. This cover is bolted to the R.H. side of the cylinder head over the inlet tract and ports. The pressed steel rocker cover is retained by two nuts attached to the two rocker studs which are longer than the others. The rocker cover also incorporates the crankcase breather pipe, engine oil filler cap and air cleaner mounting bracket.

If it is necessary, the combustion chamber inserts may be removed after first removing the welch plugs. Clean any carbon deposit from the combustion chamber and fit a new combustion chamber insert with the throat adjacent to the valves. Secure the insert in place with a new welch plug fitted in the recess provided.

When fitting the cylinder head, on the 4/99 engine, tighten the nuts to 5.26 to 5.81 kg.m. (38 to 42 lb. ft.) in the correct sequence (see Fig. 56). On the 4/108 engine, tighten the nuts in three stages to 8.3 kg.m. (60 lb. ft.) in the correct sequence (see Fig. 56). After the engine has run at normal operating temperature remove the rocker shaft and re-tighten the cylinder

head nuts in the correct sequence while still hot. Replace the rocker shaft and set the valve clearances to 0.254 mm. (0.010 in.) hot.

OIL PUMP

The eccentric rotor type oil pump (see Fig. 57) is mounted on the underside of the cylinder block in the sump and is retained by a single bolt which passes through the cylinder block side, below the alternator mounting, into the oil pump housing extension. The oil pump is driven at half engine speed by a skew gear machined on the camshaft. A plunger type pressure relief valve is incorporated in the cover.

The oil pump drive skew gear is an interference fit on the oil pump shaft. When replacing this gear a clearance of 0.787 to 1.194 mm. (0.031 to 0.047 in.) must be established between the body and the gear.

ENGINE OVERHAUL

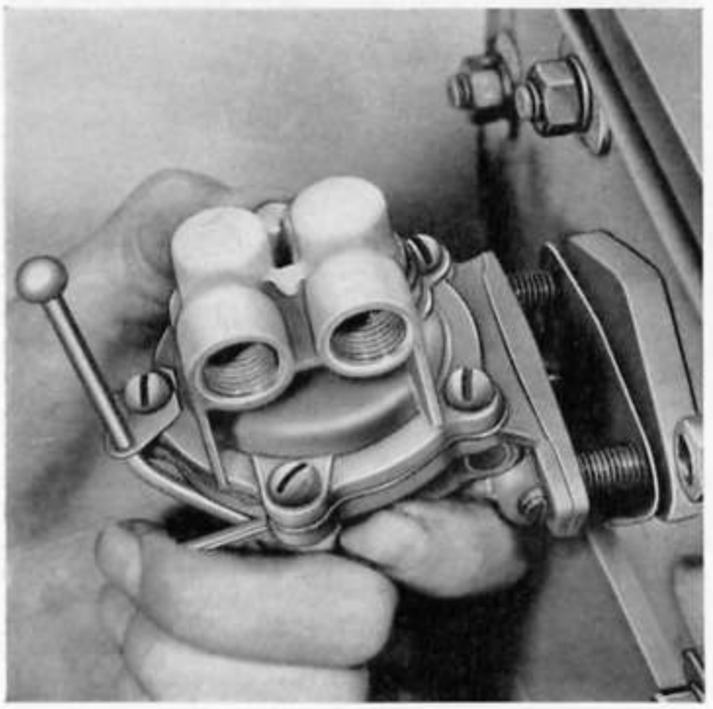


Fig. 45
Fuel Lift Pump

To Dismantle the Engine

1. **Remove the engine** from the vehicle (see page 35).

2. **Slacken off the alternator** and remove the fan belt.

3. **Remove the alternator** and the alternator mounting bracket.

4. **Disconnect the inlet and outlet pipes from the fuel lift pump** and remove the pump.

5. **Remove the dipstick and tube.**

6. **Remove the fuel filter.** Disconnect the inlet and outlet pipes from the filter and remove the filter and bracket.

7. **Slacken the bolt which retains the bottom end of the engine breather tube,** disconnect the tube from the rocker cover and remove the breather tube.

8. **Remove the rocker cover.**

9. **Disconnect the rocker shaft oil supply pipe** from the head, remove the rocker shaft nuts and remove the rocker shaft.

10. **Disconnect the fuel injection pipes** and the fuel return pipe from the injectors and remove the injectors.

11. **Remove the inlet and exhaust manifolds.**

12. **Lift out the eight push rods from the head.**

13. **Remove the alternator adjusting link** from the front of the cylinder head.

14. **Remove the clip securing the low pressure fuel pipe** from the rear of the cylinder head.

15. **Remove the 18 nuts securing the cylinder head** and lift off the head, using the two lifting eyes. Do not insert a screwdriver or other sharp instrument between the head and the block to ease the head off, as this can damage the surfaces of the head and the block. Remove the cylinder head studs.

16. **Remove all the pipes and the throttle return spring from the fuel injection pump** and remove the pump. The pump is secured by two bolts and an Allen screw.

NOTE.—When removing any components from the fuel system, ensure that all connections are plugged to prevent dirt ingress.

Fig. 46
Removing the Camshaft

17. Disconnect the two bolts securing the oil filter assembly to the block and remove the oil filter assembly.

18. Remove the oil pressure sender unit and the cylinder block drain tap.

19. Remove the clutch disc and pressure plate.

20. Straighten the tabwasher securing the five flywheel bolts and carefully remove the flywheel from the crankshaft flange.

21. Disconnect the bolts securing the water pump assembly to the front of the cylinder block, and remove the water pump. Note that two of the bolts are retained in the water pump housing by the pulley.

22. Remove the crankshaft pulley, the front cover and the oil slinger from the crankshaft.

23. Straighten the lock tabs securing the two idler gear retaining bolts and remove the idler gear and hub.

24. Remove the camshaft and fuel injection pump gears. Remove the three bolts securing each gear and ease the two gears from their respective locations.

25. Using a pair of circlip pliers remove the fuel injection pump drive hub locating circlip.

26. Withdraw the fuel injection pump drive hub.

27. Using the puller Tool No. 252 with the special button, remove the crankshaft gear (see Fig. 41).

28. Remove the timing cover back plate, after removing the locating stud.

29. Remove the six bolts securing the crankshaft rear oil seal housing to the rear of the engine and remove the two halves of the housing after removing the two retaining bolts.

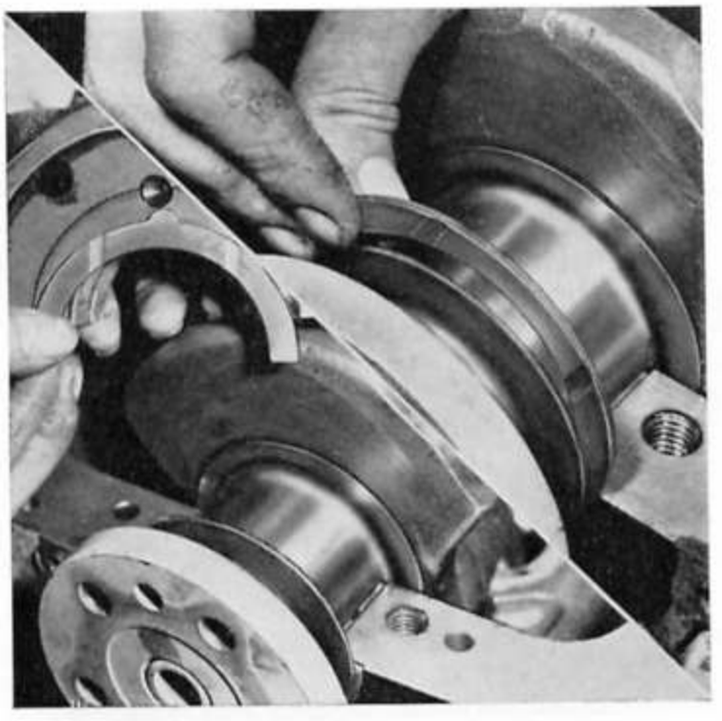


Fig. 47
Fitting the Crankshaft Thrust Washers

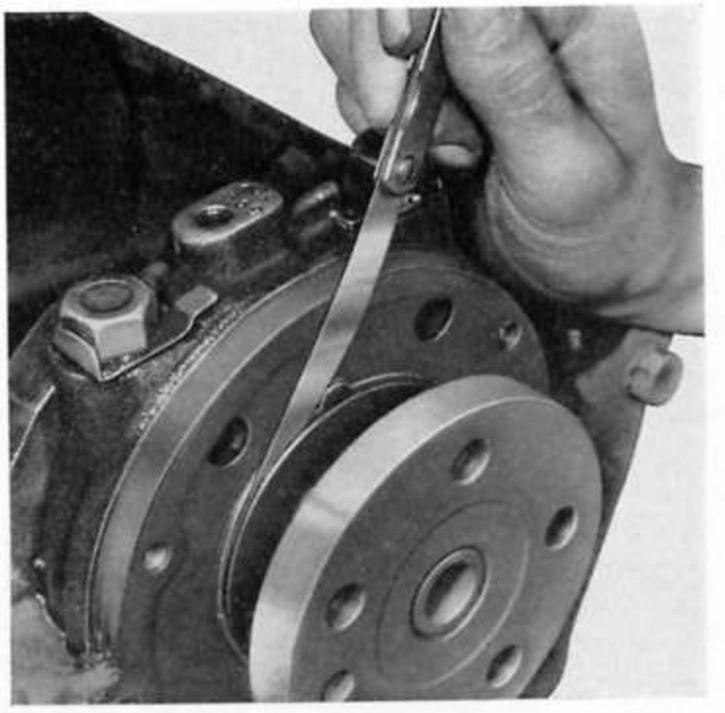


Fig. 48
Checking Crankshaft End-float

30. Remove the sump bolts and carefully remove the sump.

31. Remove the oil pump assembly. Remove the strainer from the end of the oil suction pipe and unscrew the delivery pipe securing nut from the cylinder block. Disconnect the oil pump locating bolt from the cylinder block. Remove the oil pump assembly.

32. Remove the tappet inspection cover and gasket, and the fuel lift pump operating push rod. At this stage either turn the engine upside down so that the tappets are clear of the camshaft, or lift the tappets to the top of their locations and secure with suitable clips.

33. Carefully withdraw the camshaft from the block catching the two thrust plates as they come out of their recess in the front of the cylinder block. Take care not to damage the cams and journals during this operation.

34. Remove the tappets from the engine.

35. Remove the pistons and connecting rods. Rotate the crankshaft until one pair of big ends are at bottom dead centre and remove the connecting rod cap securing bolts, and the connecting rod caps. Carefully push each piston and connecting rod assembly out through the top of the block. Rotate the crankshaft through 180° and repeat the above.

36. Remove the bolts and the main bearing caps. Carefully remove the crankshaft.

37. Press the liners out through the top of the cylinder block, using adaptor Tool No. PD150/5 and a suitable press. Support the block locally in the area of the top of the liner to reduce stress when removing liners. Ensure that the parent bore is not damaged during the removal.

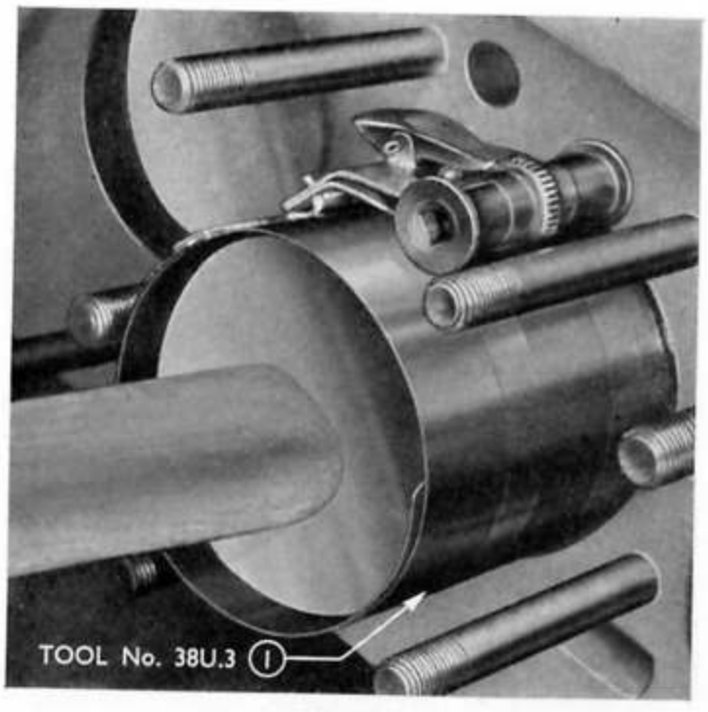


Fig. 49
Piston Replacement

To Reassemble the Engine

1. **Thoroughly clean all components** and inspect for wear and damage.

2. **Fit the cylinder liners.** Lightly lubricate the outside of the liner with clean engine oil, and press it into the bore, ensuring that it enters squarely. Check the protrusion is within the limits given in the Specification. Check the protrusion in four directions to ensure that the top face of the liner is parallel with the top face of the cylinder block. Repeat the above for the other liners.

3. **Bore and finish hone the 4/108 liners** to the dimensions given in the Specifications. 4/99 liners are pre-finished.

4. **Refit the crankshaft.** Clean the main bearing housings in the cylinder block, fit the three top bearing shells and smear with engine oil. Place the crankshaft carefully in position and fit the upper rear thrust washer.

5. **Place the three lower main bearing shells in the bearing caps,** lubricate with engine oil and fit caps, ensuring that the two lower thrust washers are correctly positioned on either side of the rear main bearing cap. Tighten the main bearing cap bolts to a torque of 10.9 to 11.75 kg.m. (79 to 85 lb. ft.).

6. **Check that the crankshaft rotates freely,** and check the crankshaft end-float (see Specifications).

7. **Tighten the main bearings cap bolts** using new shim washers.

8. **Fit new sealing strips to the two crankshaft rear oil seal housings,** and fit the housings to the rear of the engine.

9. **Refit the piston and connecting rod assemblies** from the top of the engine, using Tool No. 38.U.3 to compress the piston rings (see Fig. 49). Ensure that the number on each piston is towards the inlet manifold side of the engine.

10. **Draw the connecting rod towards the crankpin on the crankshaft,** fit the top half of the big end bearing shell, lubricate with clean engine oil, and draw the connecting rod onto the crankpin. Locate the lower half of the bearing shell in the big end bearing cap, lubricate with engine oil and fit into position on the crankpin ensuring the numbers stamped on the rod and cap coincide. Fit the two retaining bolts and tighten to a torque of 5.0 to 5.2 kg.m. (36 to 38 lb. ft.). Repeat for the other connecting rods.

11. **Lubricate the tappets and refit them to the engine block,** clipping them in position if necessary to provide clearance for the camshaft.

12. **Refit the camshaft.** Carefully refit the camshaft into the cylinder block. Before the camshaft is fully home, fit the two thrust washers into the recess in the face of the cylinder block (see Fig. 51). One thrust washer locates on the dowel in the recess. Push the camshaft fully home and release the tappets.

13. **Replace the timing cover back plate,** using a new gasket. Refit the locating stud.

14. **Refit the oil pump assembly.** Place the pump assembly in position and secure with the locating bolt through the cylinder block. Fit the delivery pipe to the block and secure with the nut.

15. **Replace the sump,** using new gaskets.

16. **Refit the injection pump drive hub** in its bearing and locate with the circlip (see Fig. 50). Check the drive hub end-float (see Specifications).

17. **Replace the injection pump drive gear,** ensuring that the timing marks on the gear and the hub are aligned. Fit the three retaining bolts.

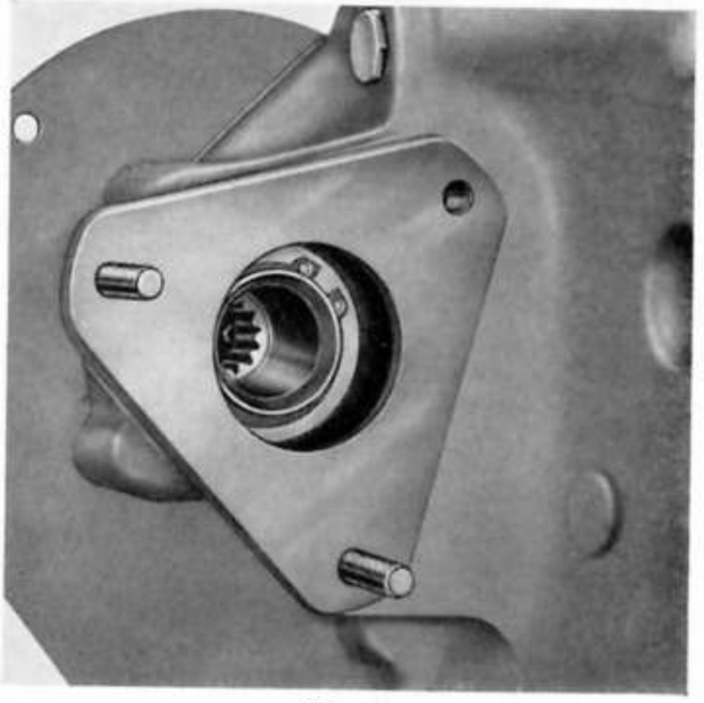


Fig. 50
Injection Pump Drive Hub

18. Refit the crankshaft gear. This gear will only locate on the crankshaft in one position because of the key-way.

19. Refit the camshaft gear, ensuring that the 'D' marks on the gear and hub align.

20. Refit the idler gear and hub, first ensuring that the timing marks on all gears are in alignment. Before finally tightening the idler gear retaining bolts, check the backlash between the timing gears (see Specifications), adjusting as necessary by using the clearance in the idler gear hub bolt holes. Finally tighten the idler gear retaining bolts to a torque of 4.56 to 4.98 kg.m. (33 to 36 lb. ft.). Tighten the camshaft and injection pump gear retaining bolts to a torque of 2.6 to 2.9 kg.m. (19 to 21 lb. ft.). Check the idler gear end-float.

21. Position the flywheel on the crankshaft flange and secure with the five bolts and the tab-washer. Note that the flywheel will only fit in one position as the five bolts are irregularly placed. Tighten the bolts to a torque of 7.6 to 8.3 kg.m. (55 to 60 lb. ft.).

22. Refit the clutch disc and pressure plate.

23. Replace the eighteen cylinder head studs. Before replacing the cylinder head, ensure that the faces of both head and block are clean. A new cylinder head gasket of the "Klinger" type must always be used on a 4/108 engine. Do not use jointing compound of any kind.

On the 4/99 engine a new cylinder head gasket of copper/steel and asbestos must always be used with jointing compound.

24. Insert the fuel lift pump push rod.

25. Place the cylinder head gasket carefully in position on the cylinder block face, with the word "Klinger" showing in the appropriate location (see Fig. 52) 4/108 only.

Fig. 51
Camshaft Thrust Washers

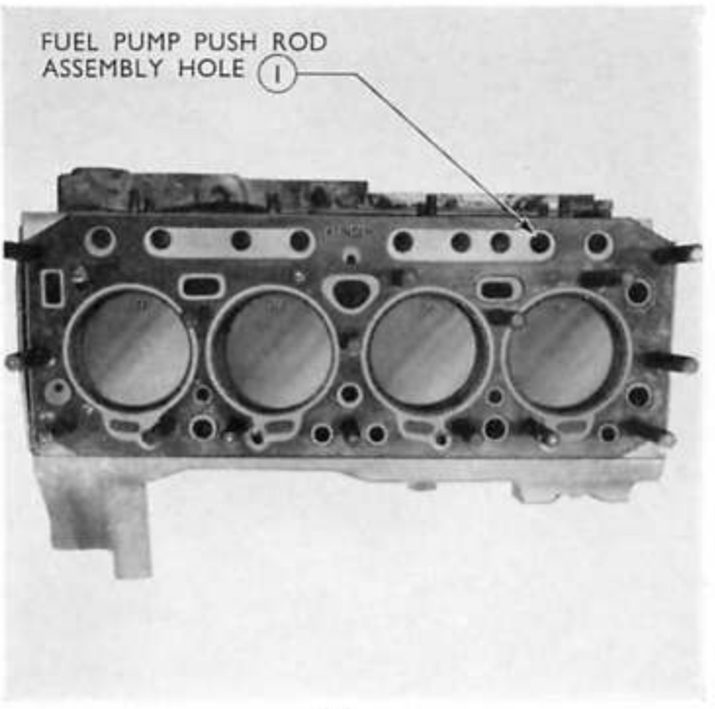


Fig. 52
Cylinder Head Gasket 4/108

26. Lower the cylinder head into position on the gasket.

27. Fit the cylinder head nuts, lubricated with engine oil, and tighten to a torque of 5.26 to 5.81 kg.m. (38 to 42 lb. ft.) on the 4/99, and in three stages to a final torque of 8.3 kg.m. (60 lb. ft.) on the 4/108. See Fig. 56 for the correct tightening sequence.

28. Position the eight push rods, and fit the rocker shaft assembly so that the adjusting screws locate in their respective push rods.

29. Tighten the rocker shaft securing nuts to a torque of 1.7 to 2.0 kg.m. (12 to 15 lb. ft.), fit the oil supply pipe to the head and secure with the retaining nut.

30. Adjust the valve clearances to 0.3 mm. (0.012 in.), using the sequence given on page 37.

31. Refit the fuel injection pump. Because of the master spline the fuel injector pump will only fit into the internal splines of the drive hub in one position. Before tightening the securing bolts and Allen screw, align the marks on the pump flange and the engine.

32. Replace the oil filter assembly.

33. Refit the cylinder block drain tap and the oil pressure sender unit.

34. Replace the front cover, using a new gasket and ensuring that the oil slinger is fitted over the end of the crankshaft.

35. Fit the crankshaft pulley and tighten the retaining bolt to a torque of 19.35 to 20.73 kg.m. (140 to 150 lb. ft.).

36. Replace the injectors, but do not tighten the securing nuts.

37. Refit the tappet inspection cover.

Fig. 53
Idler Gear End-float

38. Replace the fuel lift pump, ensuring that the operating lever is positioned on the operating push rod inside the tappet chamber. Secure with the two retaining nuts.

39. Replace the fuel filter assembly.

40. Reconnect the high pressure fuel pipes to the injectors and the injector pump and the leak-off pipe to the fuel filter.

41. Tighten the injector retaining nuts to a torque of 1.38 to 1.66 kg.m. (10 to 12 lb. ft.).

42. Refit the inlet and exhaust manifolds.

43. Reconnect the low pressure fuel pipes to the injection pump, fuel filter and fuel lift pump. Clip the pipe to the rear lifting eye.

44. Reconnect the alternator adjusting link to the front of the cylinder head.

45. Replace the alternator mounting bracket and the alternator, securing it to the bracket and the adjusting link.

To Dismantle the Cylinder Head

1. Slacken off the alternator and remove the fan belt.

2. Remove the alternator and the alternator mounting bracket.

3. Slacken the bolt which retains the bottom end of the **engine breather tube,** disconnect the tube from the rocker cover and remove the breather tube.

4. Remove the rocker cover.

5. Disconnect the rocker shaft oil supply pipe, from the head remove the rocker shaft nuts, and remove the rocker shaft.

6. Disconnect the fuel injection pipes and the fuel return pipe from the injectors and remove the injectors.

7. Remove the inlet and exhaust manifolds.

8. Lift out the eight push rods from the head.

9. Remove the alternator adjusting link from the front of the cylinder head.

10. Remove the clip securing the low pressure fuel pipe from the rear of the cylinder head.

11. Remove the eighteen nuts securing the cylinder head and lift off the head, using the two lifting eyes. Do not insert a screwdriver or other sharp instrument between the head and the block to ease the head off, as this can damage the surfaces of the head and the block.

12. Using Tool No. 6118 and adaptor PD.6118-1, compress the valve springs and remove the split collets.

13. Remove the spring caps, springs, spring seats, and the sealing rings (inlet valves only).

14. Remove the valves.

15. Remove the combustion chamber inserts. These can be tapped out, using a curved bar through the injector bores.

16. The valve guides can be removed, using Tool No. PD1C and adaptors PD1C–1 and PD1C–2.

To Reassemble the Cylinder Head

1. Clean all carbon from the cylinder head face.

2. Fit new valve guides, ensuring that the protrusion above the top face is correct.

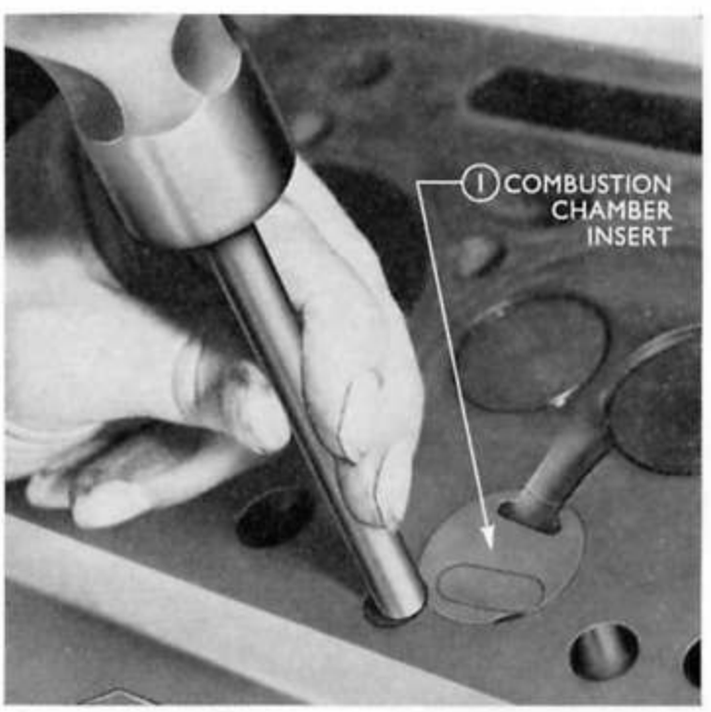


Fig. 54
Fitting the Expansion Washer

3. Replace the combustion chamber inserts. When the inserts are fitted they are located by means of expansion washers fitted into the recesses provided, to prevent the inserts from turning in service. Tap the expansion washers home with a suitable steel bar (see Fig. 54).

4. Inspect the valve seats, and if necessary, fit valve seat inserts (see page 35). Recut the valve seat to give the correct valve head depth.

5. Insert each valve in its respective guide. Each valve is numbered so that it can be replaced in its original location. The cylinder head is marked with corresponding numbers alongside each pair of valve seats.

6. Locate the spring seat washers, valve springs and spring caps in position. Note that the valve springs are close coiled at one end. The springs should be replaced with this end nearest to the cylinder head.

7. Using the spring compressor, refit the collets. On the inlet valves, fit the sealing ring into the groove on valve stem before refitting the collets.

8. Fit the cylinder head gasket.

4/99 engine: apply jointing compound to the gasket and position on the cylinder block.

4/108 engine: Position the gasket, completely dry and with the word "KLINGER" uppermost, on the cylinder block.

9. Lower the cylinder head into position on the gasket.

10. Fit the cylinder head nuts, lubricated with engine oil, and tighten to a torque of 5.26 to 5.81 kg.m. (38 to 42 lb. ft.) on the 4/99, and in three stages to a final torque of 8.3 kg.m. (60 lb. ft.) on the 4/108. See Fig 56 for the correct tightening sequence.

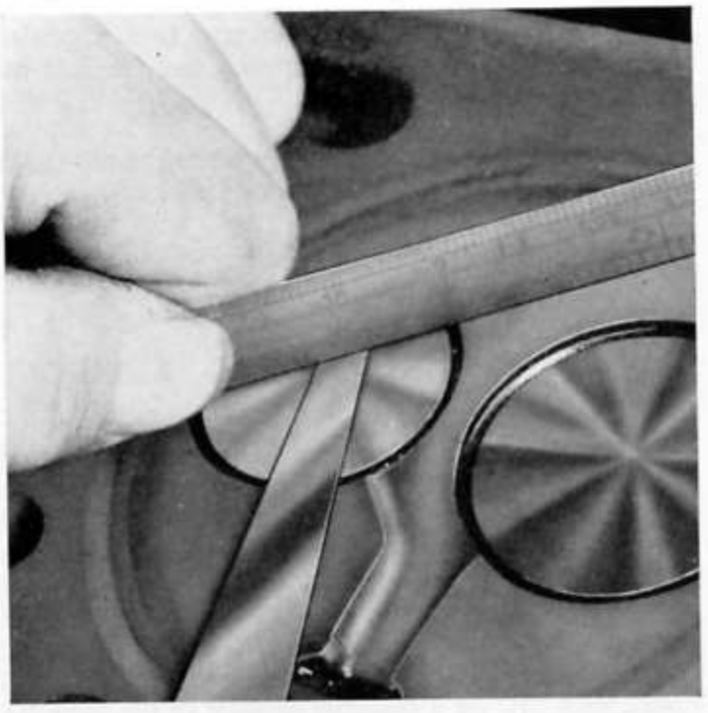


Fig. 55
Checking Valve to Cylinder Head Clearance

11. Position the eight push rods, and fit the rocker shaft assembly so that the adjusting screws locate in their respective push rods.

12. Tighten the rocker shaft securing nuts to a torque of 1.7 to 2.0 kg.m. (12 to 15 lb. ft.), fit the oil supply pipe to the head and secure with the retaining nut.

13. Adjust the valve clearances to 0.3 mm. (0.012 in.), using the sequence given on page 37.

14. Replace the injectors, but do not tighten the securing nuts.

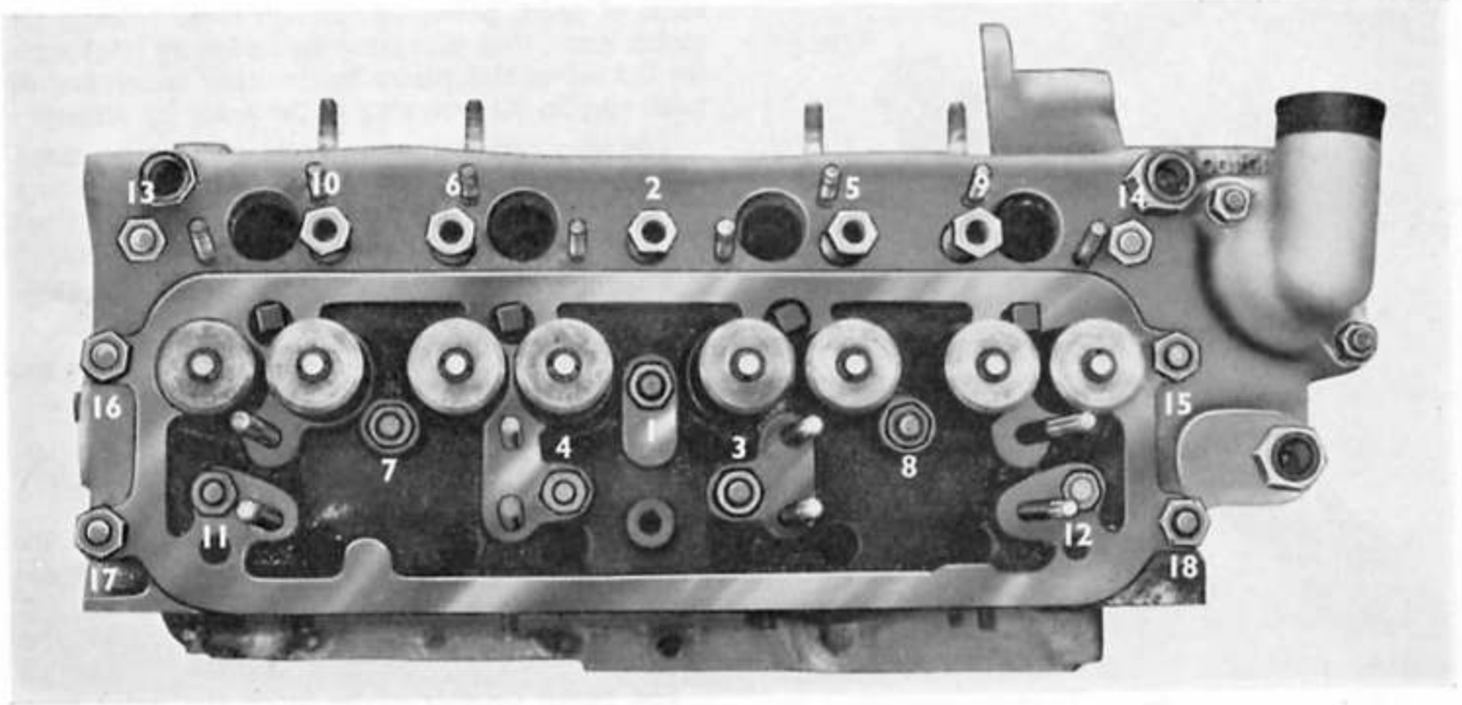


Fig. 56
Cylinder Head Bolt Tightening Sequence

15. Reconnect the high pressure fuel pipes to the injectors and the injector pump and the leak-off pipe to the fuel filter.

16. Tighten the injector retaining nuts to a torque of 1.38 to 1.66 kg.m. (10 to 12 lb. ft.).

17. Refit the inlet and exhaust manifolds.

18. Clip the low pressure fuel pipe to the rear lifting eye.

19. Reconnect the alternator adjusting link to the front of the cylinder head.

20. Replace the alternator mounting bracket and the alternator, securing it to the bracket and the adjusting link.

LUBRICATION SYSTEM

The engine lubrication system is of the forced feed type, the oil being circulated by an eccentric bi-rotor type oil pump mounted in the crankcase and driven by spiral gears from the camshaft. The oil is drawn through a sump strainer before entering the pump itself. Oil is then pumped via a drilling in the cylinder block to a full-flow oil filter mounted externally on the cylinder block. A drilling from the oil filter mounting insert feeds oil, via a diagonal drilling in the cylinder block, to the main oil gallery immediately below the camshaft.

From the main gallery oil is fed through oilways in the crankcase webs to the three main bearings and four big end bearings. An oil seal prevents oil leaking along the crankshaft at the rear and oil thrown from this seal returns to the sump.

The three camshaft bearings are lubricated from oilways connected to the main bearings. The camshaft centre bearing supplies a reduced feed through an oilway in the cylinder block and cylinder head to the rocker shaft assembly. This reduced pressure feed is achieved by allowing oil to reach the rocker shaft assembly via a special groove machined in the centre camshaft journal, this restricts the oil flow and provides a constant reduced pressure feed for the rocker assembly.

Fig. 57
Oil Pump

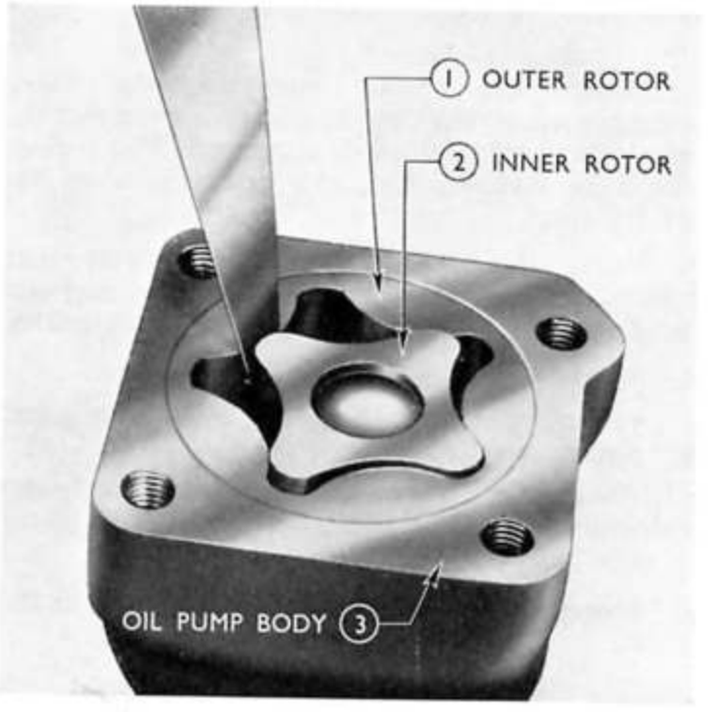


Fig. 58
Checking the Clearance Between the Inner and Outer Rotors

Oil in the rocker shaft escapes through small holes, some of which passes up through bleed holes in the rocker arms, thus providing the necessary lubrication for the valves and guides by means of splash and oil mist, surplus oil returning to the sump by gravity.

The idler and fuel pump gears are pressure lubricated by an oilway connected to the main oil gallery. Surplus oil is returned to the sump by gravity though some oil is retained within the timing case cover.

A rubber-tipped type oil seal prevents oil leakage along the crankshaft at the front end.

The small ends, pistons, cylinder bores, cams and tappets are lubricated by splash and oil mist.

ECCENTRIC ROTOR TYPE OIL PUMP

The oil pump fits into a machined bore in the cylinder block and is located by means of a screw and tabwasher.

Operation

The pump consists of an inner and outer rotor housed in the pump body, the outer rotor being eccentric to the inner. The inner rotor is pressed

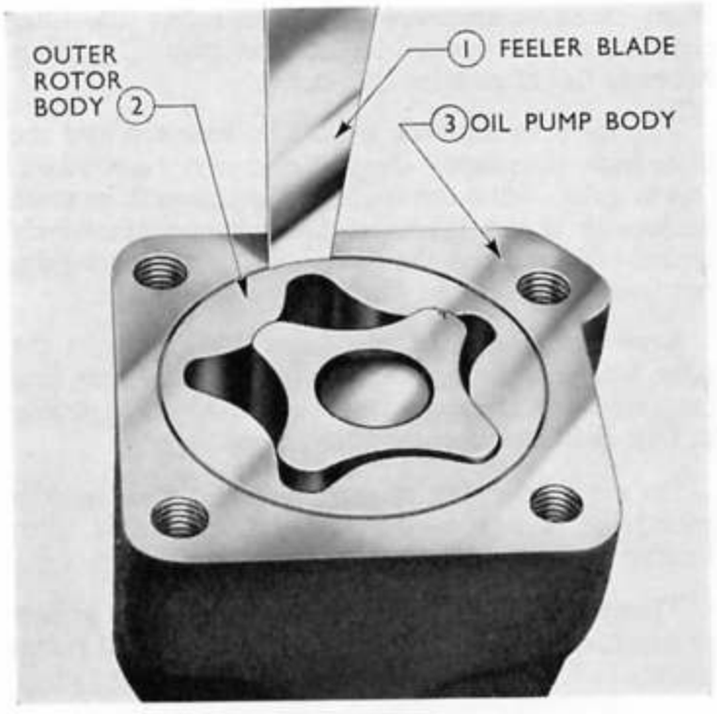


Fig. 59
Checking Outer Rotor to Pump Body Clearance

onto a short shaft and positively retained by a pin, the upper end of the shaft having a skew gear driven by the camshaft.

The inner rotor has four lobes which mesh internally with five segments in the outer rotor. Rotation of the inner rotor thus causes the outer rotor to revolve also, but at a slower speed, in the ratio of the number of lobes to segments.

The inlet port is connected to the sump and the outlet port is connected, via the full flow filter, to the oil galleries in the engine. Oil is drawn, via the inlet port, into the space formed between the inner and outer rotors as they revolve and is then carried round between the lobes to the outlet port. Here the space between the rotors starts to decrease and the oil is forced through the outlet port and filter into the engine oil galleries.

The action of the pump is a continuous repetition of this process. Oil flowing into the space between the rotors from the inlet port is carried around between the rotor lobes and then, as the space decreases, the oil is forced out through the pump outlet port.

To Remove

1. **Unscrew the delivery pipe** securing nut to the cylinder block and remove the strainer from the end of the oil pump.

2. **Unscrew the tabbed location screw** and remove the oil pump assembly from the cylinder block.

To Dismantle

1. **Remove the suction pipe.**

2. **Unscrew the retaining bolts** and remove the end cover. The end cover assembly also incorporates the pressure relief valve housing.

3. **Check the clearance between the lobes of the inner and outer rotors.** This should be checked in the positions as shown in Fig. 58, and must not exceed 0.0635 mm. (0.0025 in.). Check the clearance between the outer rotor and the housing, this should not exceed 0.279 to 0.328 mm. (0.011 to 0.013 in.).

NOTE.—The rotors are supplied as a matched pair only so that if the clearance is excessive a new rotor assembly must be fitted. Similarly, if the clearance between the outer rotor and pump body is excessive a new rotor assembly and/or pump body should be fitted.

4. **Place a straight edge across the face of the pump body** and check the clearance between the face of the rotors and the straight edge. This should not exceed 0.0635 mm. (0.0025 in.). If this clearance is excessive, the face of the pump body can be carefully lapped on a flat surface.

5. **Withdraw the drive gear** by means of a suitable puller and remove the drive shaft complete with inner rotor.

6. **Withdraw the outer rotor.**

To Reassemble

1. **Inspect the oil pump** component parts for wear and replace as required.

2. **Install the inner and outer rotors,** ensuring that the chamfered face on the outer rotor is inwards.

3. **Replace the end cover assembly** and retaining screws.

4. **Press the oil pump drive onto the shaft.**

5. **Rotate the pump by hand** to ensure that it turns quite freely.

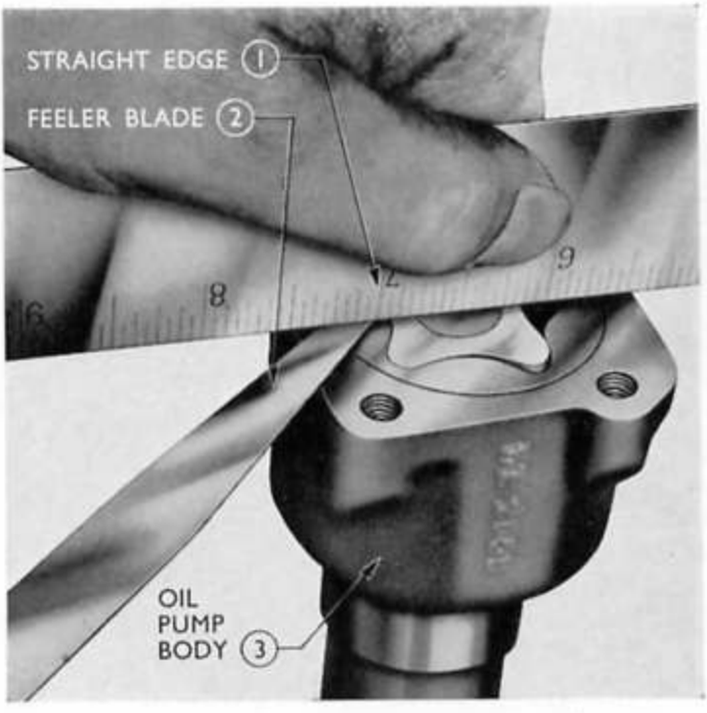


Fig. 60
Checking Rotor End Clearance

To Replace

1. **Refit the suction and delivery pipes** but do not tighten.

2. **Replace the oil pump** and locate with the screw and tab washer.

3. **Locate and tighten the delivery pipe.**

4. **Tighten the suction pipe and refit the strainer.**

NOTE.—The strainer should be thoroughly cleaned in paraffin before being refitted.

THE OIL FILTER

The full flow type oil filter is bolted to the left-hand side of the cylinder block. Oil from the pump enters the filter and passes through the element, from the outside to the inside, before entering the engine lubrication system oil galleries. A filter relief valve, which opens to by-pass the filter when there is an excessive pressure difference across the filter element, is incorporated in the filter mounting flange between the filter inlet and outlet.

The oil filter element should be renewed and the filter body thoroughly cleaned after every 4,000 kms. (2,500 miles) when the engine oil is changed, or more frequently if the lubricant has become excessively fouled. To remove the filter, unscrew the securing bolt and withdraw the filter body and element.

Remove the sealing ring from the groove in the filter body mounting flange, then locate the new ring (supplied with the replacement element) in the groove at four diametrically opposite points.

Do not fit the ring at one point and then work it round the groove as the rubber may stretch, thus leaving a surplus which may cause an oil leak.

Thoroughly clean the filter body, insert a new element, and refit the filter assembly to the oil pump body.

Section 7

GEARBOX—CLUTCH

CONTENTS

SUBJECT

GEARBOX

OVERHAUL PROCEDURES

INTRODUCTION

The gearbox is of the constant mesh type, having four forward gears and one reverse, with synchromesh engagement on first, second, third and top gears. The constant mesh gears are helical to ensure quiet operation.

The main drive gear and mainshaft are mounted on ball bearings, whilst the countershaft and mainshaft spigot are supported on needle rollers. The reverse mainshaft gear, which is the only spur gear on the mainshaft, is also machined to form the first and second gear synchroniser sleeve.

The synchroniser assemblies are splined to the mainshaft, whilst the second and third gears which are in constant mesh with the corresponding gears on the countershaft gear, rotate directly on the mainshaft. On vehicles produced before April 1966 the first gear rotates on a hardened steel bush, which is held in position by a locating ball. On later vehicles, the first gear rotates directly on the mainshaft and is not bushed.

In neutral, with the engine running, the main drive gear and countershaft gear revolve, first, second and third gears revolve on the mainshaft. The mainshaft, reverse gear and first and second gear synchroniser, also third and top gear synchroniser are, of course, stationary.

To engage first gear, the first and second gear synchroniser (which is also the reverse mainshaft gear) is moved rearwards so that the internal teeth engage the dog teeth on the gear, so locking the first gear to the mainshaft. Power is transmitted from the main drive gear to the front countershaft gear, to the first gear, then to the first and second gear synchroniser and mainshaft.

Second gear is engaged by moving the first and second gear synchroniser forward, so locking the second gear to the mainshaft. Power is then transmitted from the main drive gear to the front countershaft gear, to the second gear, then to the first and second gear synchroniser and mainshaft.

Third gear is engaged by sliding the sleeve of the third and top gear synchroniser rearwards to engage the dog teeth on the third gear, so locking it to the mainshaft. The power train is then from the main drive gear to the countershaft gear, to the third gear then to the third and top gear synchroniser and mainshaft.

Top gear is direct drive, as illustrated in Fig. 1, the main drive gear being locked to the mainshaft by the action of the third and top gear synchroniser which has been moved forward so that the internal teeth on the sleeve engage the dog teeth on the main drive gear.

Reverse is engaged by moving the reverse idler gear forward so that the spur teeth engage with a spur gear on the countershaft (located between the first and second gear) and also engage with the spur gear machined on the outer diameter of the first and second gear synchroniser. Power is transmitted from the main drive gear to the front countershaft gear, up the reverse idler gear and then to the reverse gear on the first and second gear synchroniser and mainshaft (see Fig. 1).

The synchroniser assemblies fitted to the forward gears are of the "blocker type". The hub, splined to the mainshaft, has three inserts or blocker bars supported by two light circular springs, one on each side of the hub, whilst the outer sleeve is splined to the hub.

Of the two ends of each circular spring, one is located in a common insert, the other end being free. A bronze blocker ring is interposed between the synchroniser and each forward gear, having a tapered face to mate with the corresponding face on the gear.

The blocker rings have dog teeth forged on their external diameter. It is cut away at three equal points and these locate the blocker bars in the synchroniser. Radial clearance, to give approximately half a pitch of the dog teeth on the blocker ring and gear, exists between the slots and blocker bars. When engaging a forward gear, the frictional drag which exists between the tapered face of the blocker ring and gear (due to the blocker bars being pushed foward by the synchroniser sleeve) will keep one side of the slots against the blocker bars, so that the dog teeth will be out of line with the teeth on the sleeve. This prevents gear engagement as long as there is any difference in the speeds between the mating cones.

As the speeds equalise, however, the blocker ring centralises itself, allowing the sleeve to move fully to engage the dog teeth of the gear.

The main drive gear is supported by a ball type bearing that is retained on the shaft by a circlip. Another circlip fitted in an annular groove on the outer case of the bearing locates the bearing in the gearbox case. The main drive gear is retained in the gearbox by the main drive gear bearing retainer which is secured to the case by three bolts.

An oil seal is also provided in the retainer to prevent the passage of oil towards the clutch assembly.

The mainshaft is supported at its forward end by a spigot that is fitted into the caged needle rollers

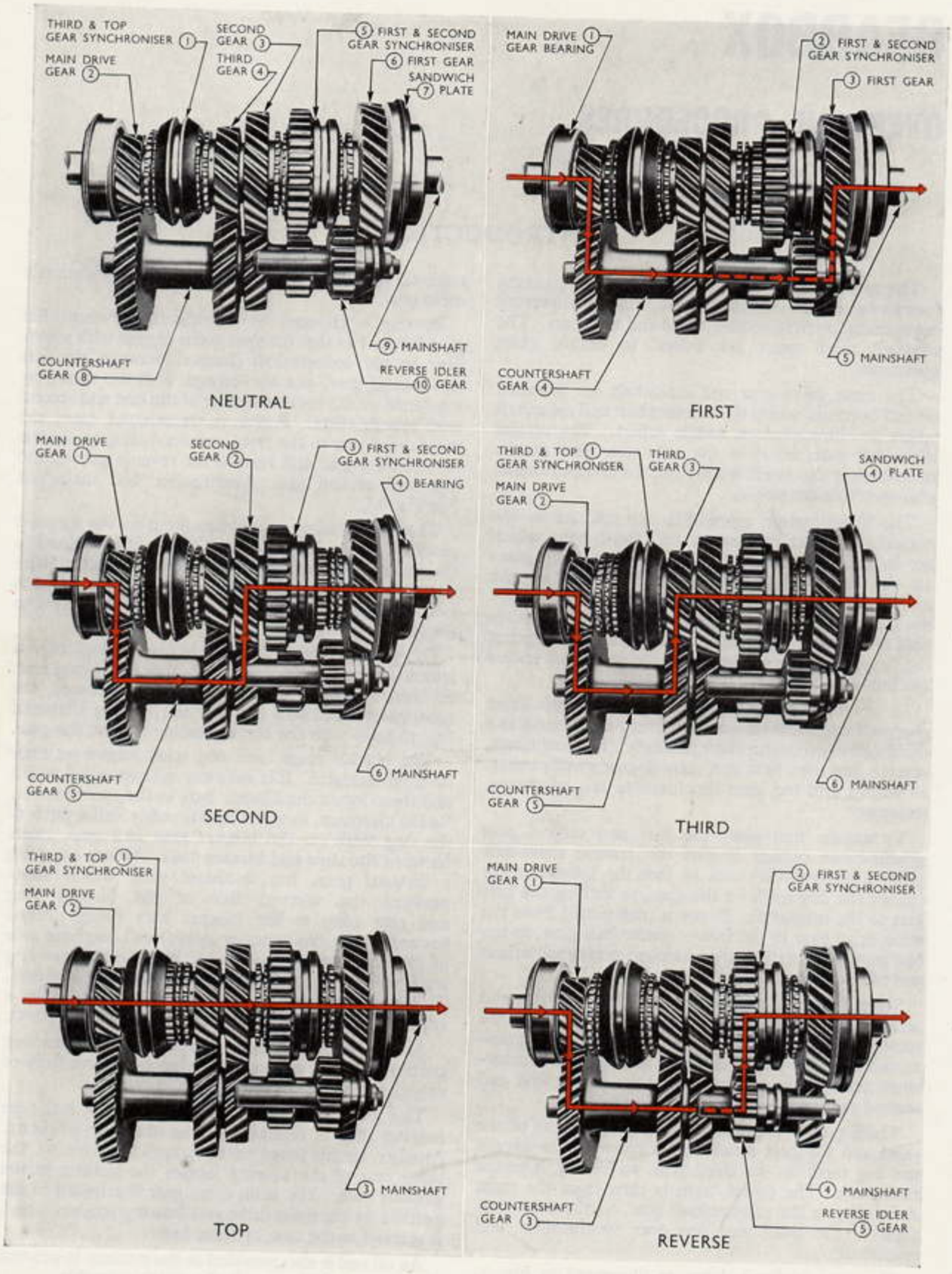


Fig. 1
Power Train Diagrams

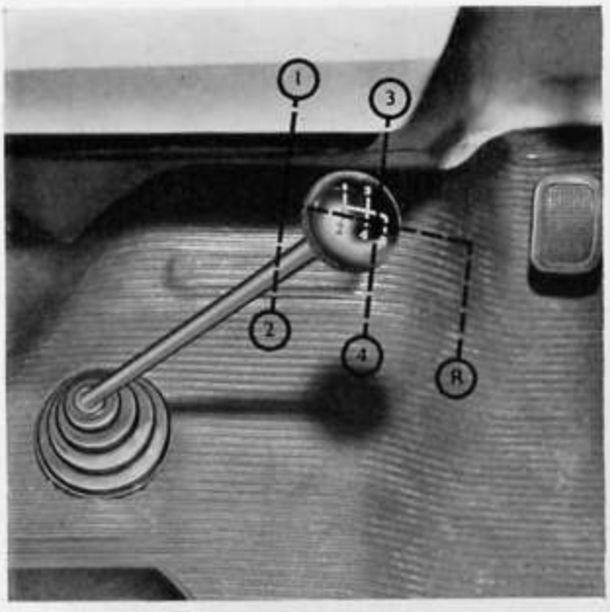


Fig. 2
Gear Lever Positions

housed in the end of the main drive gear. To the rear of the first gear a ball type bearing is fitted on the mainshaft and a sandwich plate fitted over this bearing locates it in the rear of the gearbox case. The extension housing and the mainshaft nut secure the bearing and sandwich plate in place.

Lubrication and Maintenance

At the first 8,000 kms. (5,000 miles) only, the gearbox should be drained by removing the drain plug, preferably after a run to ensure that the oil is warm and will therefore drain freely. Replace the drain plug, inject 4 oz. of gearbox additive through the level plug orifice, and add 2.6 litres (5.4 U.S. pints, 4.5 Imp. pints) of the correct grade extreme pressure oil (see Specification).

Check the level then replace the plug.

Every 8,000 kms. (5,000 miles) thereafter, remove the combined level and filler plug and check the oil level. This should be level with the plug orifice. Add extreme pressure gear oil of the correct grade (see Specification) to correct the level if necessary.

THE GEARBOX

NOTE.—Whilst the gearbox used after April 1966 is basically similar to that used prior to April 1966, the parts used in the two gearboxes are NOT interchangeable.

Except where indicated, the following instructions apply to both gearboxes.

To Remove

1. **Drain the oil from the gearbox.**
2. **Remove the crosshead screws** retaining the gear lever cover plate and remove the plate.
3. **Remove the gear lever.**
4. **Jack up the vehicle** and fit axle stands front and rear.

75 to 115

5. **Mark the drive shaft and pinion coupling flange** to ensure correct reassembly. Unscrew the four self-locking nuts and remove the four securing bolts. Remove the drive shaft.

125 to 175

Mark the drive shaft and gearbox flange to ensure correct reassembly. Unscrew the four self-locking nuts and bolts. Remove the centre bearing retaining bolts and lower both drive shafts.

6. (*a*) (*Petrol engined models prior to December* 1970 *and all Diesel engined models*)
Disconnect the clutch return spring and the clutch rod relay lever from the clutch fork.
(*b*) (*Petrol engined models after December* 1970)
Disconnect the cable from the clutch release arm (see Fig. 23).
7. **Disconnect the speedometer cable** from the gearbox extension housing.
8. **Remove the starter motor from the clutch housing.**
9. **Remove the clutch housing lower dust cover plate** (where applicable).
10. **Disconnect and remove the nearside exhaust manifold to silencer pipe.**
11. (*Petrol engined models prior to December* 1970 *and all Diesel engined models only*)
Disconnect the relay lever support from the extension housing bolts.
12. **Support the engine with a jack.**
13. **Remove the gearbox rear support bolt.**
14. **Release the earth strap** by removing the clutch housing bolt, and then remove the remainder of the clutch housing bolts, and remove the gearbox and clutch housing.

To Replace

1. **Replace gearbox and clutch housing,** and replace the clutch housing bolts, reconnecting the earth strap.
2. **Replace the gearbox rear support bolt.**
3. **Remove the jack** from beneath the engine.
4. **Reposition and secure the starter motor.**
5. (*Petrol engined models prior to December* 1970 *and all Diesel engined models only*)
Replace the clutch relay lever support, and secure it to the gearbox extension housing with the two bolts.
Adjust the support bracket so that the dimension between the inner end of the equaliser bar and the vertical face of the bracket is 17.5 to 19.0 mm. (0.69 to 0.75 in.) with the equaliser bar perpendicular to the centre line of the extension housing.
6. **Refit the clutch rod or cable** and adjust the clutch (see Clutch Section).

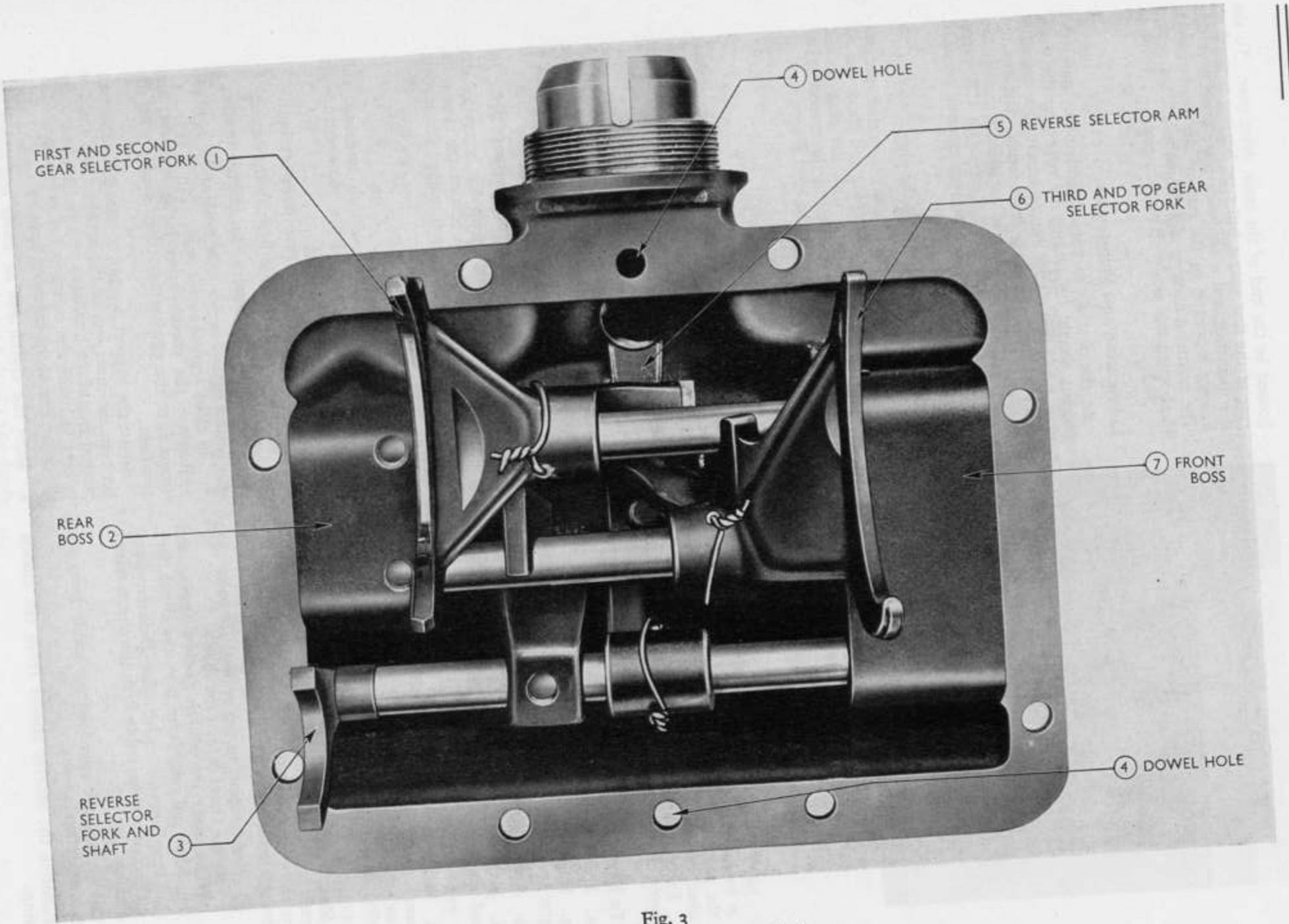


Fig. 3
Selector Housing (early casting)

7. Replace the clutch housing dust cover and refit the clutch return spring (where applicable).

8. Replace and secure the speedometer cable.

9. Replace the nearside exhaust pipe.

10. Refit the drive shaft, lining up the mating marks.

11. Replace the gear lever and refit the cover assembly.

When refitting the lower boot ensure that it will prevent water entry into the gearbox.

12. Remove the stands and lower the vehicle.

13. Fill the gearbox with an approved oil of the correct grade.

TO DISMANTLE THE GEARBOX

1. (*a*) (*Petrol engined models prior to December* 1970 *and all Diesel engined models*)

Dismantle the clutch operating mechanism. Slide the release arm out of the spring clips on the release bearing hub and, lifting the arm off the fulcrum pin, slide the release bearing and hub off the main drive gear bearing retainer. Remove the clutch release arm and gaiter.

(*b*) (*Petrol engined models after December* 1970)

Using a pair of long-nosed pliers release the circlip and slide the release bearing and hub off the main drive gear bearing retainer and remove the clutch release arm and gaiter.

NOTE.—If the gearbox is removed from the clutch housing first, the release arm and the release bearing and hub assembly may be removed as one unit without removing the cirlcip.

2. Remove the clutch housing. Unscrew and remove the five bolts and spring washers securing the clutch housing to the gearbox case.

3. Remove the selector housing. Unscrew the eight bolts and spring washers securing the selector housing to the gearbox case. Remove the paper gasket.

4. Dismantle the selector mechanism.

(*a*) Remove the locking wire from the three shafts and tap out the retaining pins.

(*b*) Remove the first and second selector fork and shaft, taking care not to lose the ball and spring from the rear boss. Tilt the housing to remove the plunger and pin that fits between the two forward gear shafts in the front boss.

(*c*) Remove the third and top selector fork and shaft, and ball and spring from the rear boss. Tilt the housing once again to remove the second plunger from the front boss.

(*d*) Remove the reverse selector fork and shaft, taking care not to lose the ball and spring.

(*e*) If necessary to remove the reverse selector arm, knock out the retaining pin from the outside of the housing and then remove the reverse selector arm and blanking plug.

5. Remove the extension housing and the mainshaft assembly.

(*a*) Remove the speedometer driven gear and the gear bearing from the extension housing.

125 to 175. Remove the gearbox flange retaining nut and flange.

(*b*) Unscrew the four bolts and spring washers securing the extension housing to the gearbox case.

(*c*) Withdraw the extension housing.

(*d*) Mark the sandwich plate and gearbox case to facilitate alignment of the extension housing dowel and the locating hole in the sandwich plate on reassembly.

(*e*) From the front face of the gearbox case, using a brass drift, drive the countershaft towards the rear a limited amount until it is free from the front of the gearbox case. Using a dummy countershaft Tool No. CP.7109, push the countershaft completely out of the gearbox. The countershaft gear will now lie at the bottom of the gearbox case permitting the mainshaft to be withdrawn.

(*f*) Withdraw the complete mainshaft assembly to the rear. Note the top gear blocker ring will be loose on the main drive gear and should be removed. Also remove the caged needle rollers from inside the main drive gear.

6. Remove the main drive gear bearing retainer. Unscrew the three bolts and spring washers securing the retainer to the gearbox case. Withdraw the retainer and the paper gasket. Carefully tap out the main drive gear.

7. Withdraw the reverse idler shaft, using Tool No. CP.7043. Should this tool not be available locate a nut, a flat washer and a sleeve on a $\frac{5}{16}$ in., 24 U.N.F. threaded bolt, screw the bolt into the reverse idler shaft and tighten the nut to withdraw the shaft (see Fig. 4).

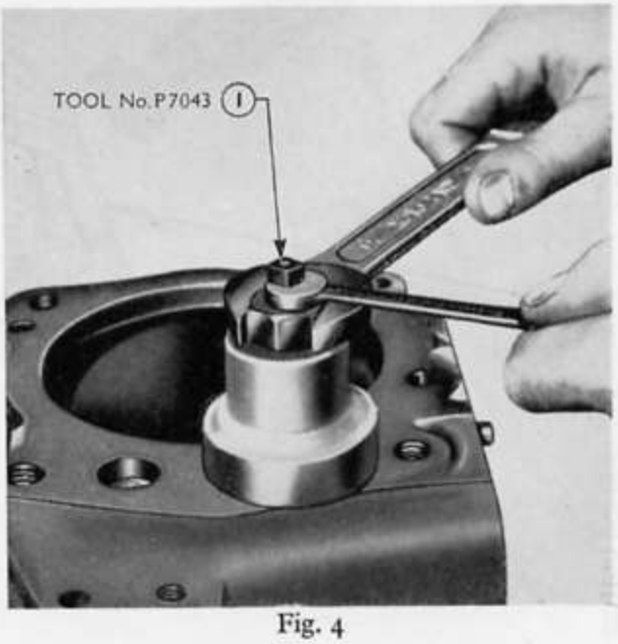


Fig. 4
Removing Reverse Idler Gear Shaft

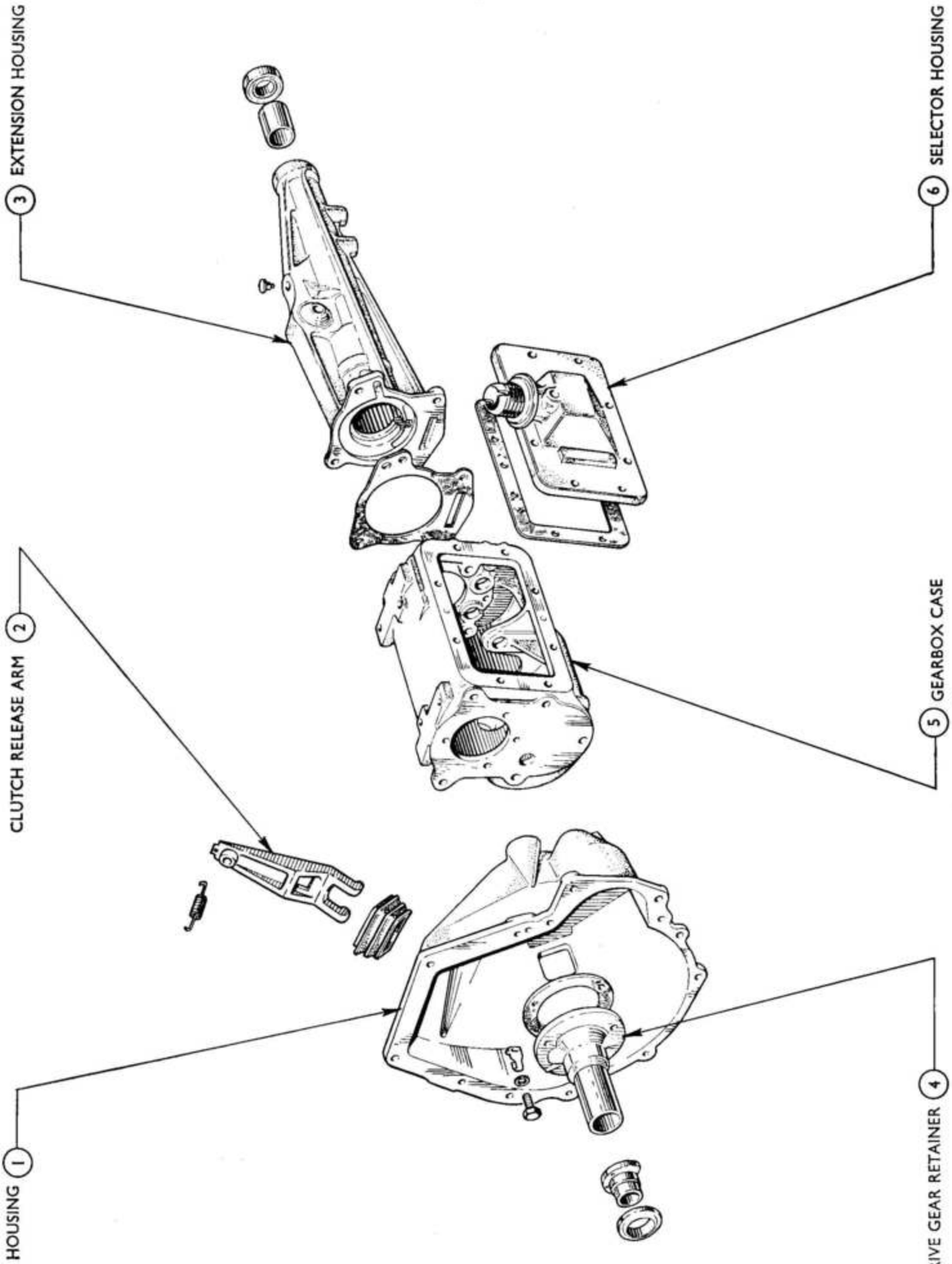


Fig. 5
Exploded View of Gearbox—External (Early type shown)

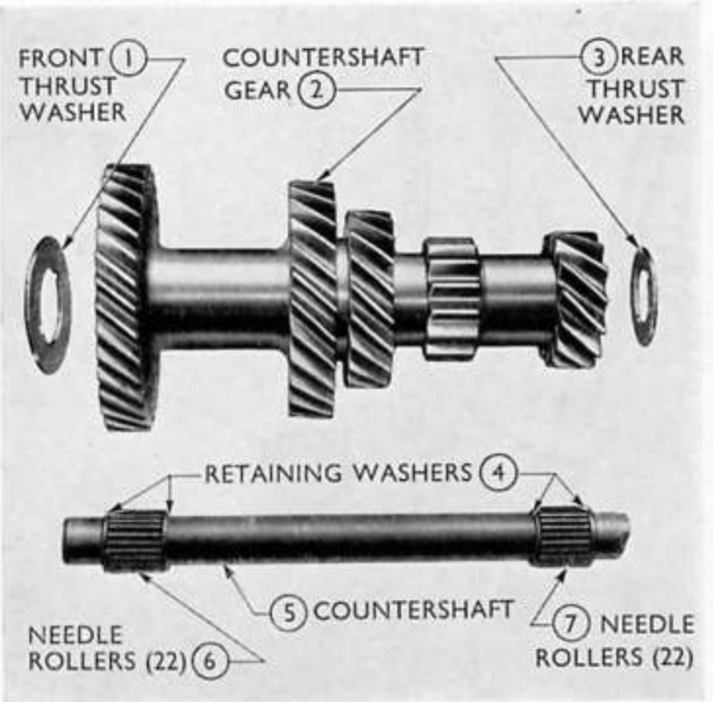


Fig. 6
Countershaft Assembly

8. Withdraw the countershaft gear and the two thrust washers from the gearbox. The countershaft or cluster gear is mounted on forty-four needle rollers (twenty-two at each end). A small washer is located on either side of each set of rollers to retain them in position. Push out the dummy countershaft, remove the retaining washers and needle rollers (if required).

9. Dismantle the mainshaft assembly.

NOTE.—There is a thrust collar machined on the mainshaft that abuts the second gear on one side and the third gear on the other. Provided the appropriate service tools are employed it is possible to remove the gears at one side of this thrust collar without disturbing the gears on the opposite side.

(*a*) Release the tab on the tab washer, and unscrew the nut securing the speedometer drive gear. Remove the nut, tab washer, speedometer gear. Extract the locating ball and remove the spacer.

(*b*) Remove third gear and third and top gear synchroniser assembly. Remove the small diameter circlip at the forward end of the mainshaft. Locate the adaptors (Tool No. CP.4090–7 and adaptor ring) around the rear face of third gear and in the base plate on the base of a press. Press the mainshaft out of the third and top gear synchroniser, and third gear whilst supporting the mainshaft from beneath to prevent it dropping (see Fig. 7).

(*c*) **Prior to April 1966.** Locate the adaptors Tool No. CP.4090-7) around the front face of the first gear and in the base plate of the press. Press the mainshaft bearing, sandwich plate, first gear and first gear bush off the mainshaft. Remove the first gear bush retaining and locating ball from the mainshaft.

After April 1966. Locate the adaptors (Tool No. CP.4090-7) around the front face of the first gear and in the base plate of the press. Press the mainshaft bearing, sandwich plate, first gear and splined spacer off the mainshaft.

(*d*) Carefully remove the circlip located in the mainshaft behind the first and second gear synchroniser hub and discard it.

(*e*) Position the adaptors (Tool No. CP.4090-7) around the front face of the second gear and press the first and second gear synchroniser and second gear off the mainshaft.

NOTE.—The synchroniser hubs and sleeves are mated together and also to the mainshaft. Mating marks are etched on the corresponding splines of the hub and sleeve, and near the hub and mainshaft splines. The synchroniser and hub assembly are serviced as a unit consisting of the synchroniser sleeve, three blocker bars, two light circular springs and the synchroniser hub.

Prior to April 1966. The first gear rotates on a hardened steel bush that is lubricated via two holes in the first gear adjacent to the dog teeth. Always ensure that these holes are kept clear.

10. Dismantle the main drive gear. Remove the circlip securing the main drive gear, support the bearing in the adaptors (Tool No. CP.4000–32) and press the main drive gear out of the bearing.

11. Overhaul the extension housing.

(*a*) Extract the oil seal from the rear of the extension housing if not previously removed.

(*b*) Examine the extension housing rear bearing bush, and remove it if necessary by driving it into the housing, using Tool No. CP.7040.

(*c*) Locate a new bearing over the appropriate diameter of the replacer tool (Tool No. CP.7040) and enter it into the rear of the housing with the split in the bush uppermost, i.e. opposite the groove in the extension housing bore.

Fig. 7
Removing Third Gear

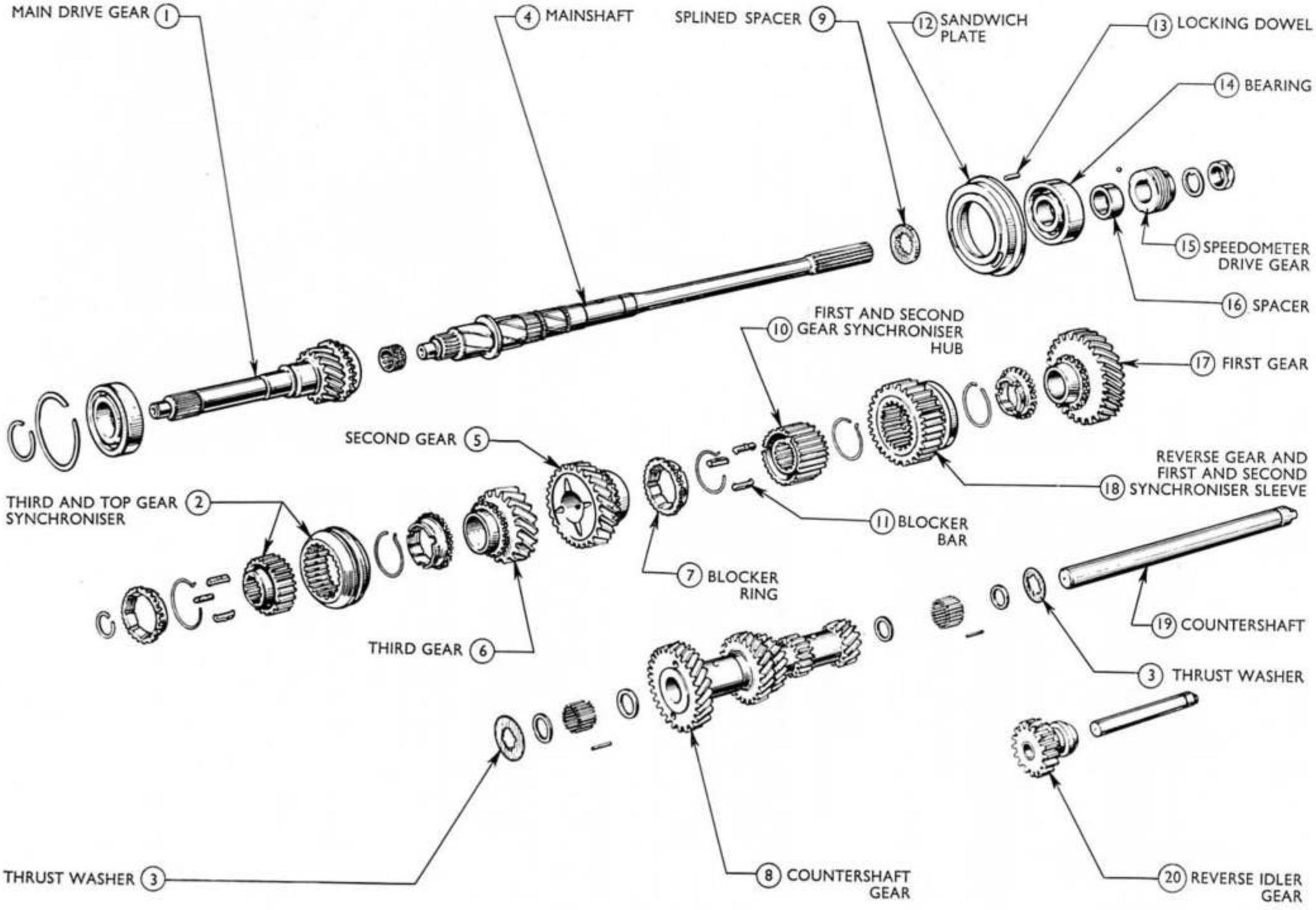


Fig. 8
Exploded View of Gearbox—Interior

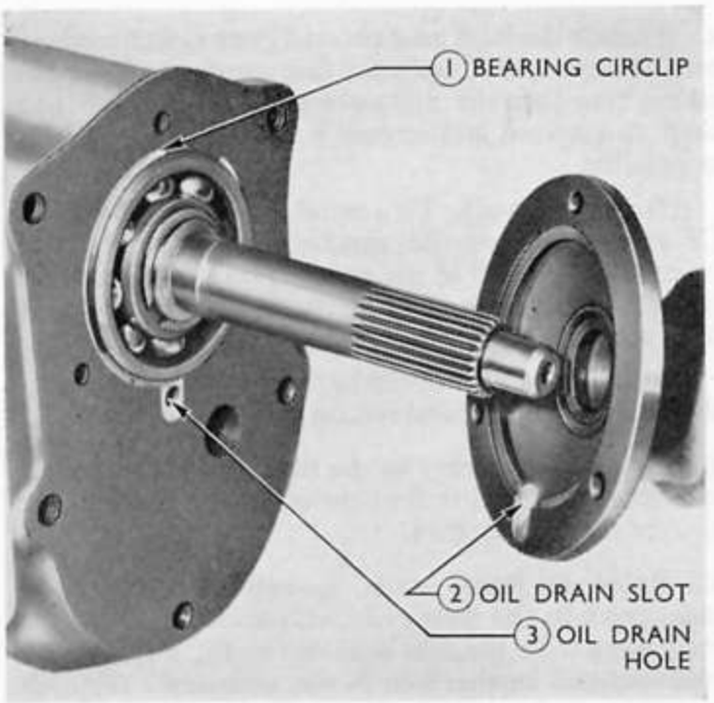


Fig. 9
Fitting the Main Drive Gear Retainer

(*d*) Drive the bearing squarely into position until the rear end of the bearing is flush with the deeper recessed face of the extension housing.

(*e*) Locate the new oil seal on the replacer (Tool No. CP.7064 A) so that the lip on the seal faces into the extension housing and drive the seal into position in the housing.

NOTE.—If preferred the oil seal need not be fitted until the extension housing has been replaced on the gearbox.

(*f*) Examine the gearbox rear support insulator. If necessary, remove using Tool No. C.7124 and adaptor C.7124-a.

(*g*) Fit a new insulator, applying Loctite to the outer casing, using Tool No. C.7124 and adaptor C.7124–b.

12. Overhaul the main drive gear bearing retainer.

(*a*) Remove the oil seal from the bearing retainer.

(*b*) Place a new oil seal on the replacer tool (Tool No. P.7110) so that when fitted, the lips face the gearbox. Drive the seal into position in the housing.

TO REASSEMBLE THE GEARBOX

Preliminary

Inspect all parts for wear. Any that are considered unserviceable should be replaced.

As the threaded holes "break-in" to the gearbox case, to avoid any leakage of lubricant past bolt heads, threads, etc. on reassembly, coat all bolt threads with a suitable sealer before fitting.

1. To Reassemble the Selector Mechanism.

(*a*) Replace the reverse selector arm and fit the retaining pin in the outside of the housing. Fit a new blanking plug in the end of the boss on the outside of the housing.

(*b*) Position the reverse shaft ball and spring through the hole in the boss, and whilst holding the ball down with a screwdriver or similar instrument, insert the reverse selector shaft from the rear of the housing. Fit the reverse selector and before pushing the shaft completely into the front boss, fit the selector retaining pin which will ensure the shaft is correctly aligned to seat on the ball and spring and also to accept the plunger in the front boss. When

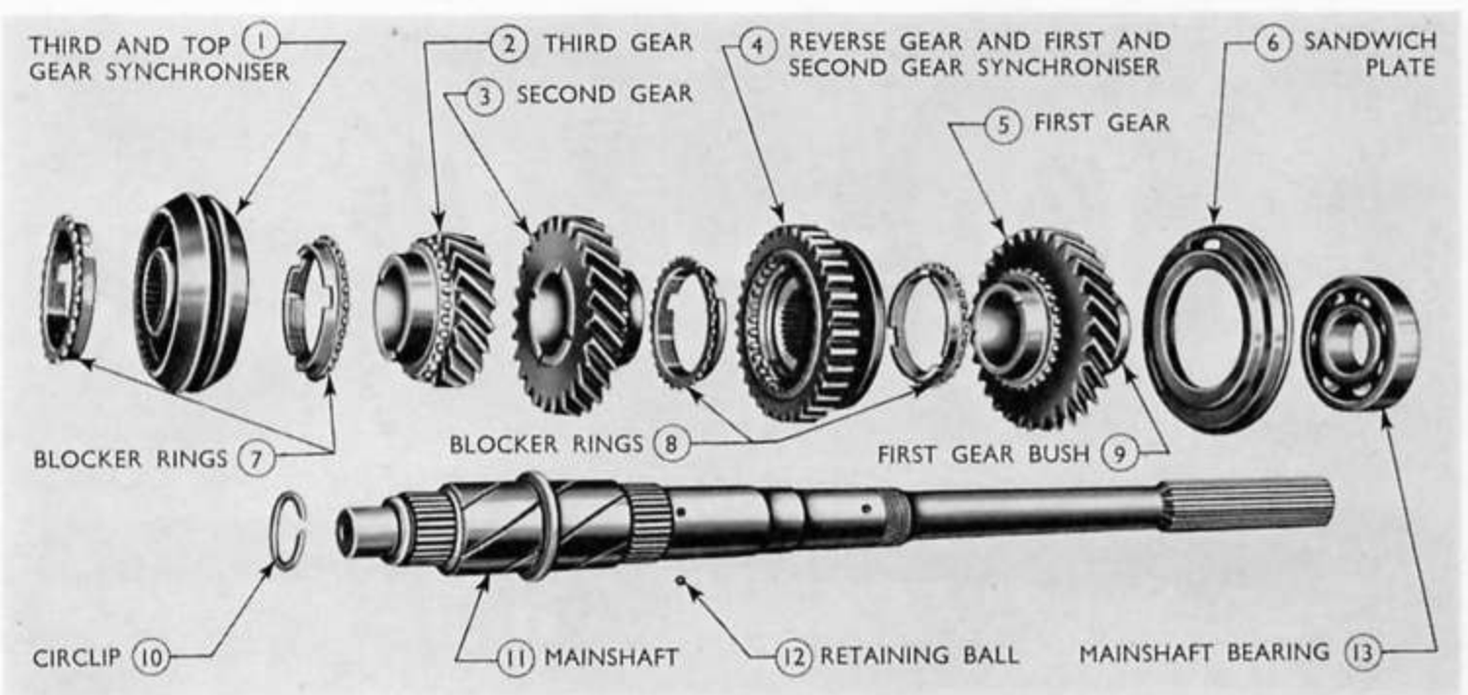


Fig. 10
Exploded View of Mainshaft Assembly (Prior to April 1966)

the shaft is in position insert the plunger through the hole in the top of the front boss.

(*c*) Repeat this operation for the third and top gear selector shaft and fork, fit the interlock pin and second plunger in the front boss, and then replace the first and second gear selector fork and shaft in a similar manner.

(*d*) Thread locking wire through the retaining pin in each shaft and lock each one individually.

To Reassemble the Mainshaft

1. **Assemble the second gear** to the mainshaft so that the dog teeth are towards the rear.

2. **Locate a blocker ring on the cone face** of the second gear.

3. **Assemble the first and second gear synchroniser unit.**

(*a*) If a new unit is to be installed, slide the synchroniser sleeve (reverse mainshaft gear) off its hub. Clean preservative from the hub, sleeve, blocker bars and springs. Lightly oil.

(*b*) Fit the synchroniser sleeve over the hub with the mating marks aligned (see Fig. 12 for similar mating marks on the third and top gear synchroniser unit). Locate a blocker bar in each of the three slots cut in the hub.

(*c*) Install a blocker bar spring in one blocker bar (the tag to locate in the "U" section of the blocker bar). Note the direction of rotation of the spring. Fit the other spring to the opposite face of the synchroniser unit, ensuring that the spring tag locates in the same blocker bar as the spring just previously fitted but with this second spring running in the opposite direction. Leave the other end of each spring free.

4. **Locate the first and second gear synchroniser on the mainshaft** (selector fork groove to the rear) taking care that the mating splines on the hub and shaft correspond and engage it on the splines as far as possible.

After April 1966. Fit a suitable adaptor (Tool No. CP.4090-7) behind the synchroniser assembly and locate it in the bed of the press. Press the mainshaft into the synchroniser assembly, taking care that it does not tilt as it moves over the circlip groove.

Carefully fit a new circlip to the groove in the mainshaft behind the first and second gear synchroniser.

5. **Fit a blocker ring in the first and second gear synchroniser** so that the cut-outs in the blocker ring fit over the blocker bars.

6. **Prior to April 1966. Locate the hardened steel bush in the first gear** with the shoulder on the bush away from the first gear dog teeth. Position the retaining ball in the hole in the mainshaft. Fit this assembly on the mainshaft ensuring that the key-way in the bush locates over the retaining ball. The first gear dog teeth are located adjacent to the blocker ring and first and second gear synchroniser.

After April 1966. Slide the first gear onto the mainshaft so that the dog teeth are located adjacent to the blocker ring and first and second gear synchroniser.

Fit the splined spacer behind the first gear.

7. **Position the sandwich plate on the mainshaft** with dowel hole to the rear. Fit the mainshaft bearing. Slightly withdraw the sandwich plate to the rear to fit over the bearing.

8. **Prior to April 1966. Hold the steel bush in place** and locate the adaptor (Tool No. CP.4090-7) over the bearing, insert the assembly and fit in the slave ring (Tool No. 370) on the bed of a press.

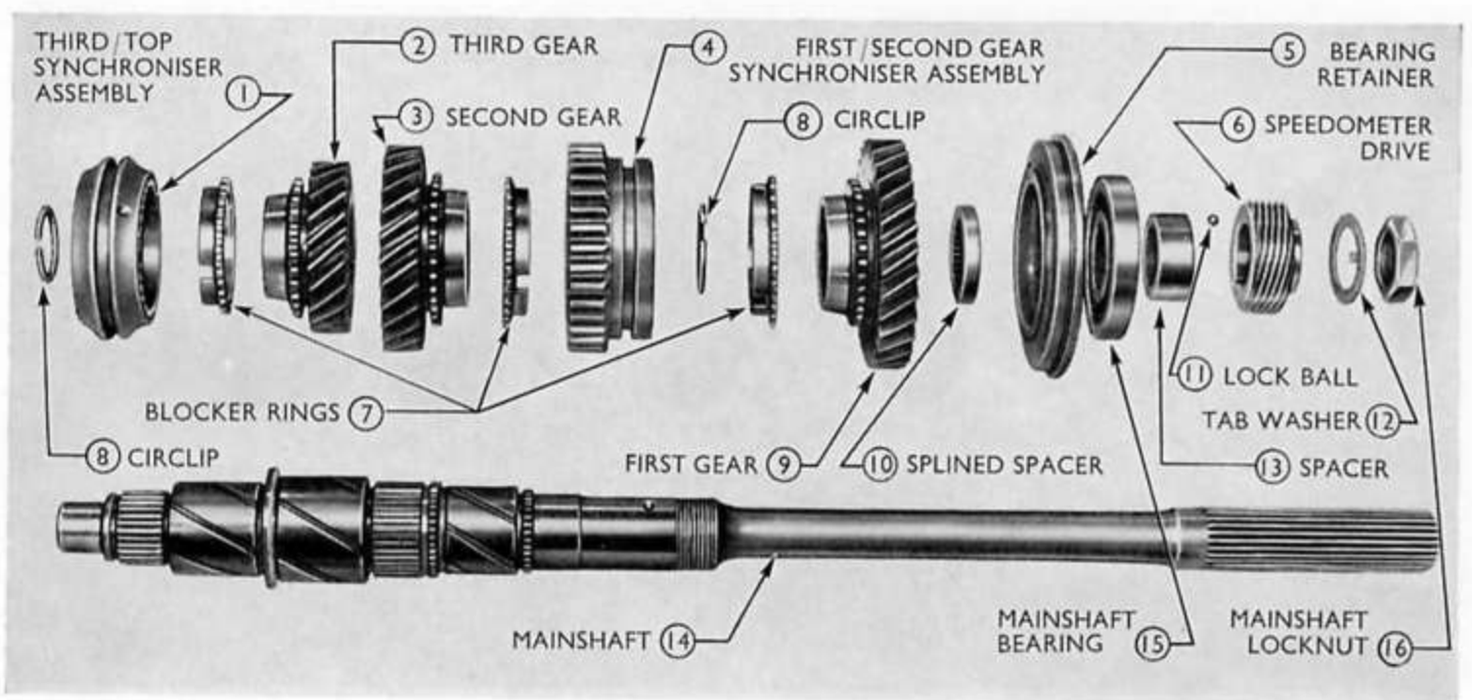


Fig. 11
Exploded View of Mainshaft Assembly (After April 1966)

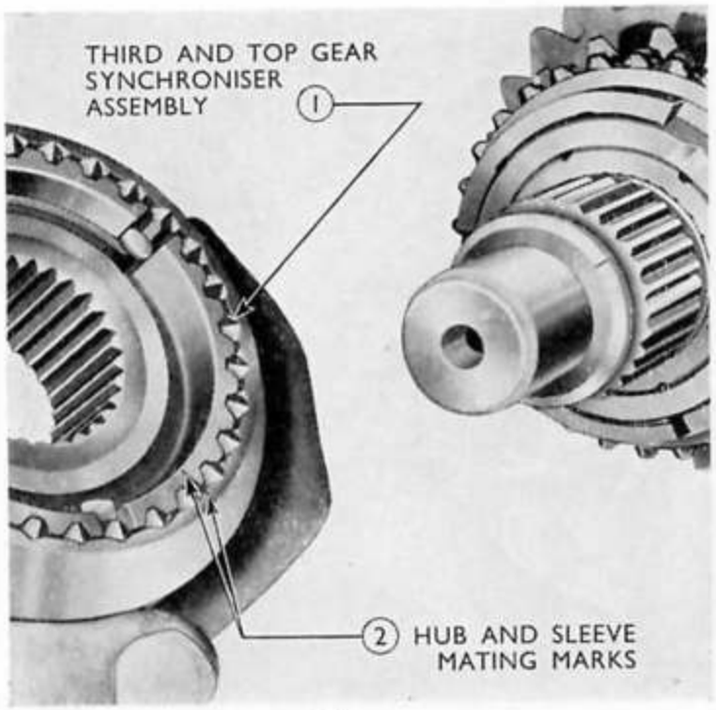


Fig. 12
Third and Top Gear Hub and Sleeve Mating Marks

After April 1966. Locate the adaptor (Tool No. CP.4090-7) over the bearing, insert the assembly and fit in the slave ring (Tool No. 370) on the bed of a press.

9. Ensure that the cut-outs in the first and second gear blocker rings are aligned with the blocker bars in the first and second gear synchroniser, and also that the mainshaft and hub mating marks are still aligned, and press the bearing onto the shaft.

10. Slide the third gear onto the shaft with the dog teeth away from the thrust collar on the shaft and locate the blocker ring on the taper face of the gear (see Fig. 11).

11. Locate the third and top gear synchroniser hub on the mainshaft with its long boss towards the front of the shaft. Ensure that the mating marks on the hub and shaft correspond (see Fig. 12).

12. Support the third and top gear synchroniser hub on the adaptor (Tool No. CP.4090–7). Locate the shaft so that the mating marks on the hub and the shaft are in line. Press the synchroniser hub right home on the shaft. Fit the circlip in its locating groove to retain the assembly in position.

13. Fit the synchroniser sleeve on its hub with the mating marks in line (see Fig. 12). Locate a blocker bar in each of the three slots cut in the hub. Install a blocker bar spring (at the rear of the hub) so that the tag end locates in a blocker bar the other end being left free. Note the direction of rotation of this spring. Fit the other spring at the front face of the synchroniser ensuring that the tag on this spring locates in the same blocker bar as the spring previously fitted but with this spring running in the opposite direction. Leave the other end of this spring free.

14. Slide the spacer onto the mainshaft, install the locating ball for the speedometer drive gear in its seating and fit the gear with the shoulder to the rear. Fit the tab washer over the shaft and locate the tab on the inner diameter into the groove on the inside of

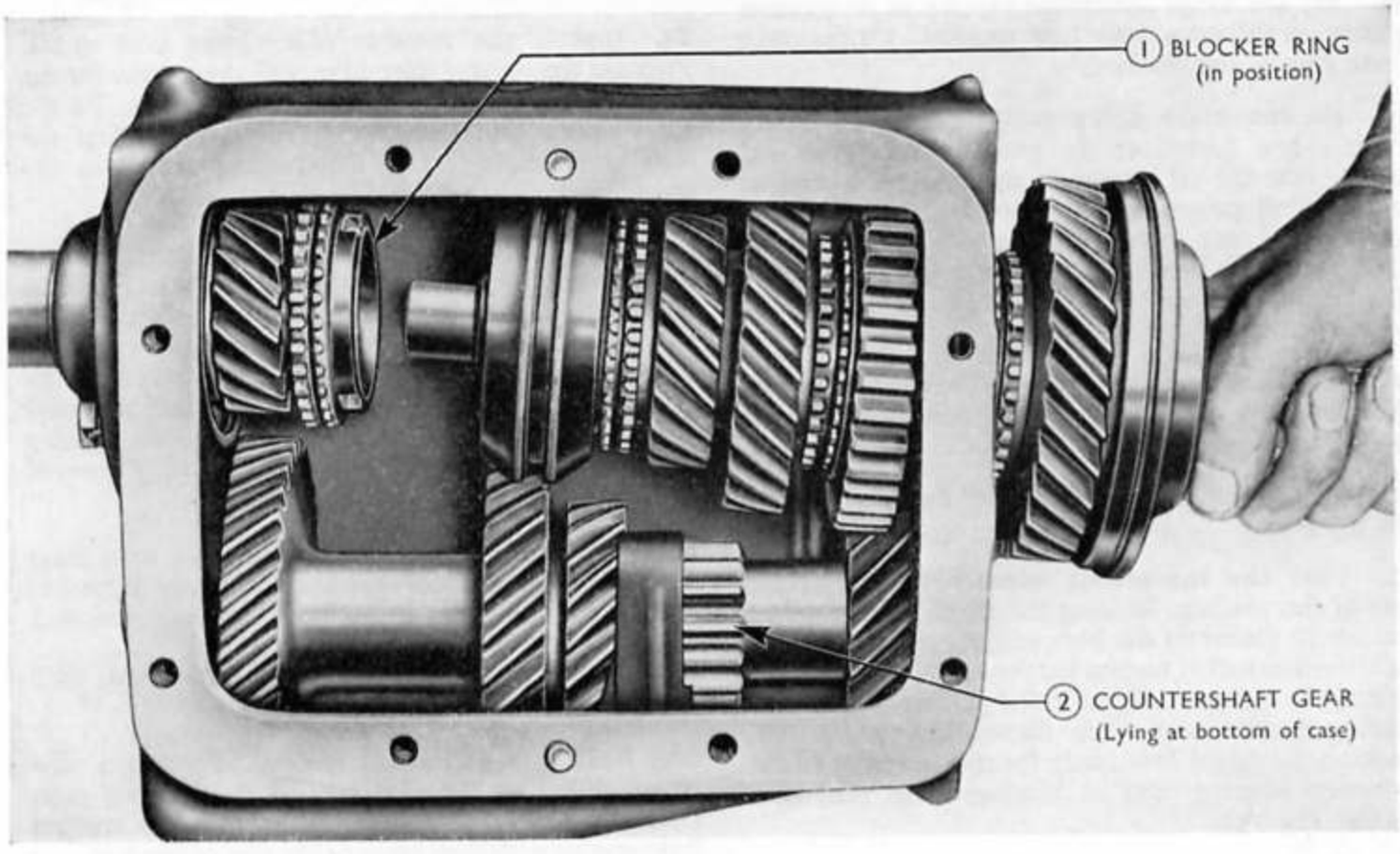


Fig. 13
Fitting the Mainshaft Assembly

the speedometer drive gear. Screw on the nut and tighten to a torque of 2.76 to 3.45 kg.m. (20 to 25 lb. ft.). When using a torque wrench in conjunction with the mainshaft nut wrench, Tool No. CP.7098, the torque wrench should be set at 2.35 to 2.90 kg.m. (17 to 21 lb. ft.) to allow for the increased leverage given by Tool No. CP.7098. This will result in the final torque being to the correct figure. Bend over a section of the outer edge of the tab washer so that it securely locks the nut.

15. Assemble the main drive gear. Position the main drive gear bearing on the gear, with the external circlip groove on the bearing away from the gear, support the assembly with the adaptor (Tool No. CP.4090–7) and press the bearing right home on the gear, using the press adaptor STN.7245, located in the spigot recess of the main drive gear. Fit the smaller diameter circlip in the groove provided in the shaft of the main drive gear.

16. Reassemble the countershaft (Fig. 6). Fit a retaining washer to abut the machined shoulder inside the gear, one at either end. Grease the needle rollers and locate twenty-two in the recess in the countershaft gear. Fit a retaining washer then insert the dummy countershaft to retain the rollers in position. Repeat this procedure at the other end of the countershaft gear. Locate the thrust washers in position in the gearbox. Ensure that the tongues on the thrust washers are located in the machined recesses in the gearbox.

17. Position the countershaft gear in the bottom of the gearbox casing, taking care not to displace the thrust washers.

18. Fit the large diameter circlip in its locating groove on the main drive gear bearing. Fit the main drive gear to the gearbox.

19. Fit the main drive gear bearing retainer. Place a new gasket on the gearbox front face and ensure that the oil groove in the retainer is in line with the oil passage in the gearbox casing and the gasket does not cover this passage (see Fig. 9). Coat the three retaining bolts with suitable sealer, fit a spring washer on each bolt, then tighten the bolts securely.

20. Install the caged needle rollers in the bore of the main drive gear, and fit a new gasket over the rear face of the gearbox.

21. Position a blocker ring over the taper face of the top gear.

22. Pass the mainshaft assembly through the rear of the gearbox, locating the mainshaft spigot on the needle rollers in the bore of the main drive gear. As the mainshaft is tapped in, the sandwich plate will fit into the recess provided in the gearbox. Align the mating marks made when dismantling which will position the dowel hole ready for the assembly of the extension housing (and its locating dowel pin) later on (see Fig. 13).

23. Complete the assembly of the countershaft gear. Carefully lift the gear into mesh with the mainshaft and main drive gear and, taking care that the thrust washers are not displaced, carefully refit the countershaft from the rear, keeping it in contact with the dummy shaft. Tap the countershaft in, so that the front face is flush with the front face of the gearbox case, ensure that the locking face at the rear of the countershaft is positioned so that it will mate with the locking recess in the extension housing.

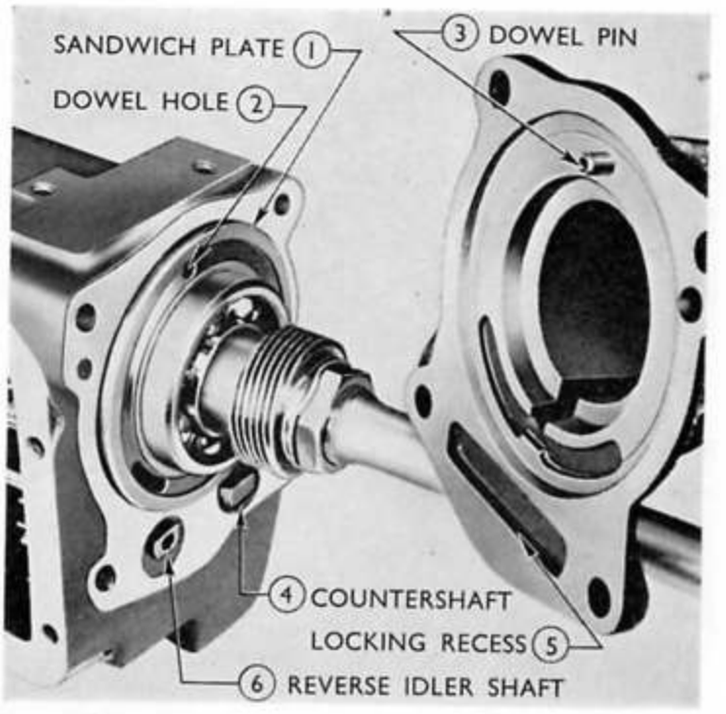


Fig. 14
Fitting the Extension Housing

24. Install the reverse idler gear and shaft. Position the reverse idler gear with the groove for the selector fork towards the rear of the gearbox. Fit the shaft in the case and through the gear so that the flats will line up with the locking recess in the extension housing. (See Fig. 14.)

25. Fit the extension housing. See there is a new gasket on the rear face of the gearbox, fitted in operation 20, ensuring that the oil-way in the extension housing will not be obstructed. Pass the extension housing over the mainshaft whilst ensuring that the dowel in the housing locates in the drilling provided in the sandwich plate. Secure the extension housing to the gearbox case with four bolts (suitably covered with sealer) and four spring washers.

26. Refit the clutch housing. Secure it in place with five bolts and lockwashers, previously dipped in sealer. Fit the fulcrum clip if it has been removed.

27. Check that all gears can be obtained, then place all gears in the neutral position.

28. Refit the selector housing. Position a new paper gasket on the side face of the gearbox case. Offer up the selector housing, so that the selector forks engage with their appropriate gear or synchroniser sleeve. Secure the housing to the gearbox with eight bolts and spring washers.

29. Reassemble the clutch release mechanism.

(*a*) (*Petrol engined models prior to December* 1970 *and all Diesel engined models*)

(i) **Pass the release fork through the clutch housing** aperture from inside the housing.

(ii) **Locate the release bearing assembly on the main drive gear shaft** bearing retainer, after first inspecting the sleeve for burrs, and smearing it lightly with high melting point grease.

(iii) **Engage the release fork in the spring clip** on the rear of the release bearing assembly and in the fulcrum spring.

(iv) **Fit the rubber gaiter** over the clutch release arm, ensuring that the arm is correctly located in the clutch housing.

(*b*) (*Petrol engined models after December* 1970)

(i) **Place the circlip** and the release arm over the input shaft.

(ii) **Slide the release bearing** and hub assembly over the input shaft and through the bore in the release arm. Relocate the circlip in its location in the hub assembly.

(iii) **Replace the rubber gaiter** in the clutch housing.

30. Refit the speedometer driven gear in the aperture provided in the extension housing.

GEARBOX AND CLUTCH FAULT DIAGNOSIS

Below is a list of sections into which clutch and gearbox faults will fall.

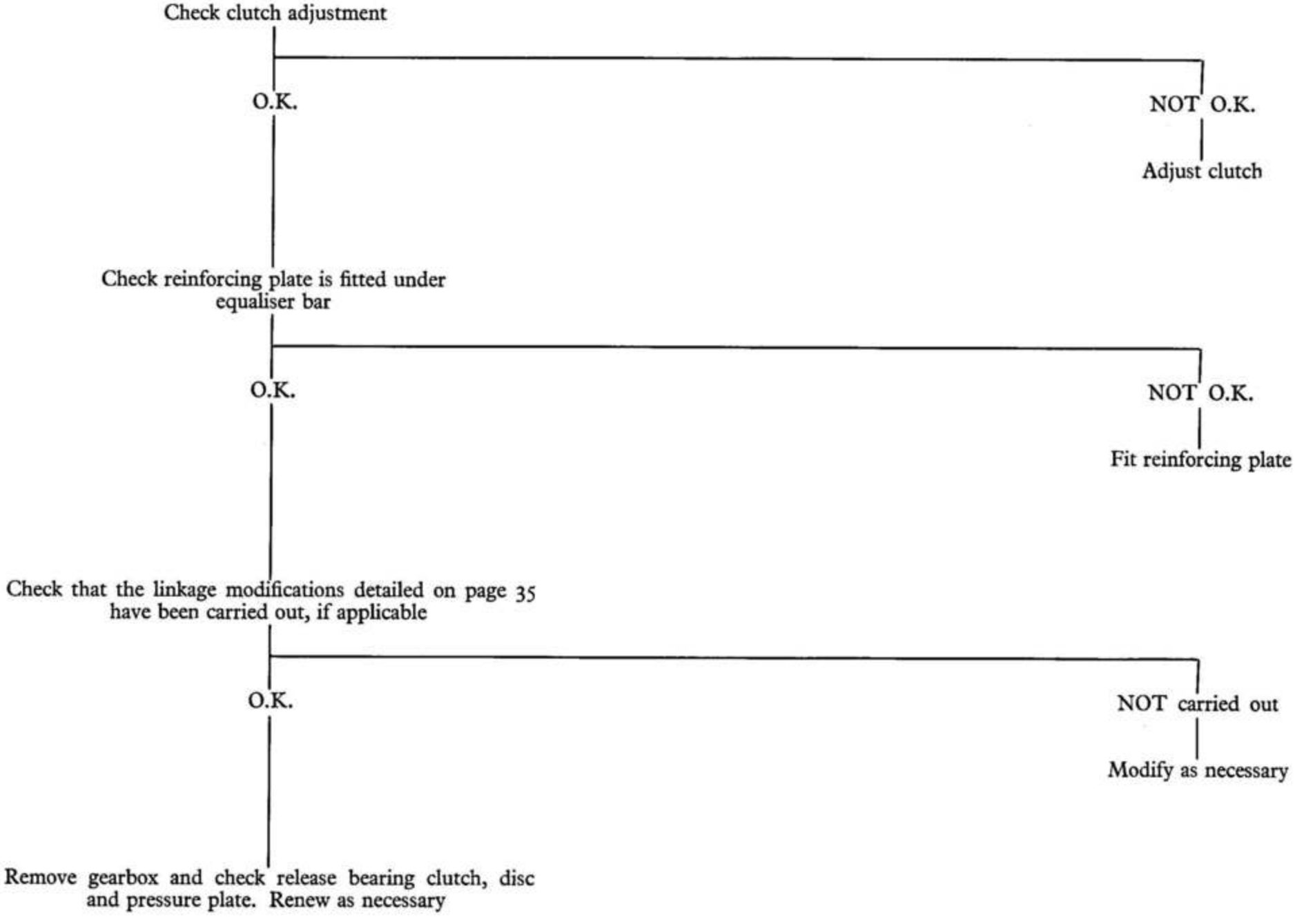
1. Clutch 'slip', 'judder' or loss of adjustment.
2. Difficult gear engagement.
3. Gear 'crashing'.
4. Jumping out of gear.
5. Jamming in gear.
6. Noises.

Before attempting to rectify any defects, road test the vehicle to ascertain in which section the complaint falls. Note which gear or gears are affected or whether the fault is due to the clutch operation.

In all cases, the following preliminary checks should be performed prior to commencing any dismantling.

1. Check gearbox oil level.
2. Check that the clutch is correctly adjusted.
3. Check that the clutch pedal can be fully depressed and is not restricted by mats, etc. The driver of the vehicle should be able to do this with the driver's seat in its normal position.
4. Ascertain the effective disengagement of the clutch as follows:
   (*a*) Apply the handbrake securely.
   (*b*) With the engine idling and the clutch engaged, very gently move the gear lever toward reverse gear until the teeth can just be felt to clash.
   (*c*) Depress the clutch pedal slowly – the gears should cease to clash, i.e. the clutch should fully disengage within 25.4 mm. (1 in.) of the pedal to floor condition. Hold the pedal at the point of disengagement and increase the engine speed. Check that the clutch remains disengaged with the increase in engine speed.

1. CLUTCH SLIP, JUDDER, LOSS OF ADJUSTMENT

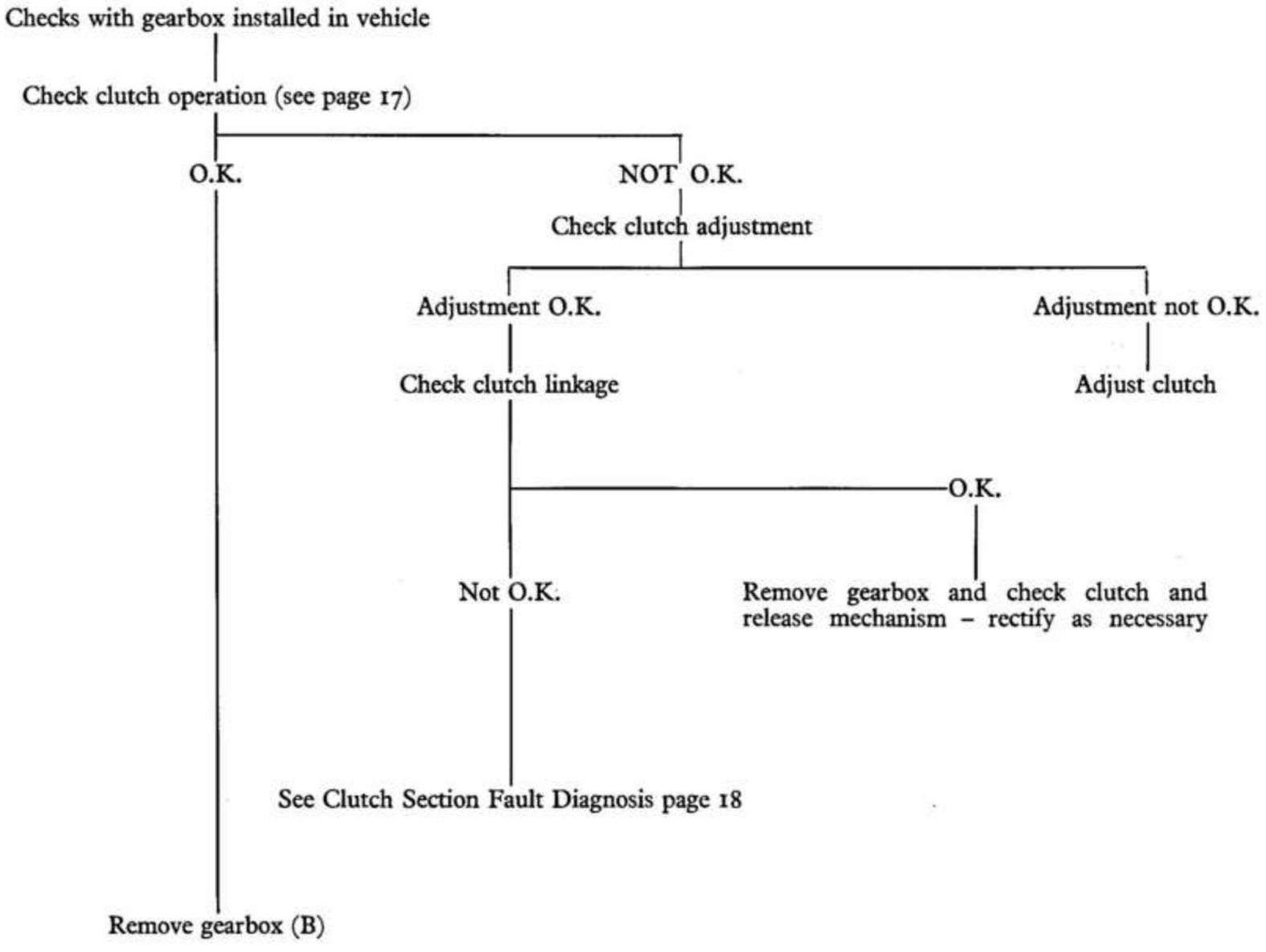


2. DIFFICULT - GEAR ENGAGEMENT

Problem Definition

Gear lever positions not positive
Excessive lost motion
High effort to cross gate
Gearshift excessively stiff ('gritty' feel)
High effort to engage gears after selecting gear position

A



B Checks with Gearbox removed from vehicle.
To locate the area of complaint – remove the selector housing. Rotate the input shaft and attempt to engage all gears by hand, i.e. by moving the synchroniser sleeves into the gear positions. Repeat two or three times.

SELECTOR MECHANISM

If the gears engage satisfactorily the problem is probably in the selector mechanism.

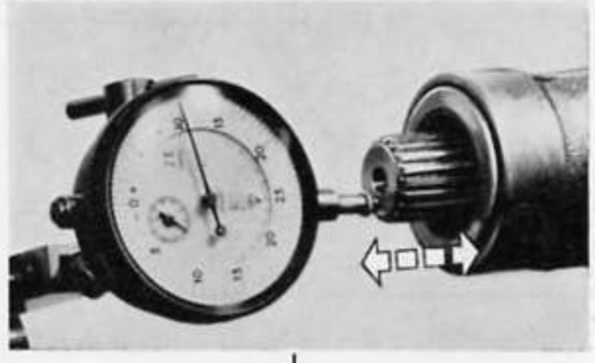
NOTE – This is not a 100% indication because the gearbox is not subject to normal operating conditions. Therefore, if after carrying out the following checks, no defects can be found the mainshaft checks should be performed.

see page 22.

MAINSHAFT

If the gears do not engage satisfactorily the problem will be connected with the mainshaft and its components.

Check the mainshaft end-float. It should not exceed 0.015 in.

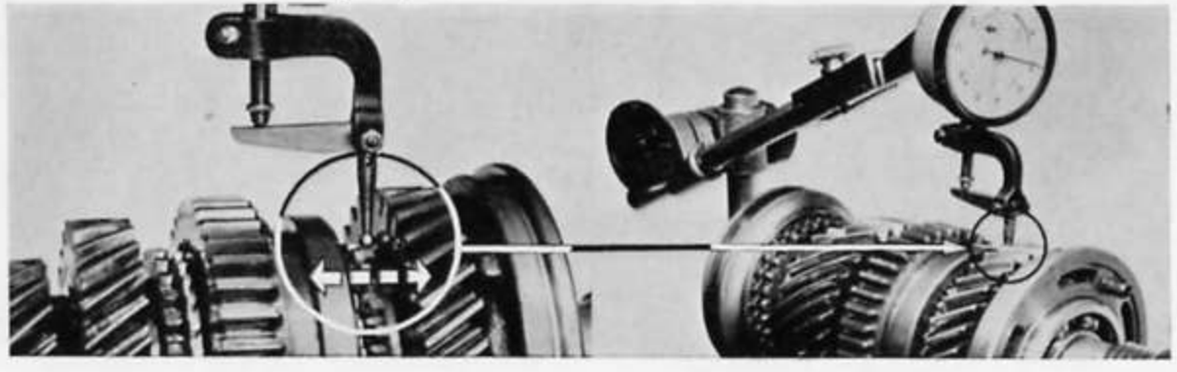


IF NOT O.K.

Check that the tab washer retaining the mainshaft nut is intact. It may be possible to "rock" the nut but the tab washer should prevent it rotating. Check that the mainshaft bearing or its abutment faces are not worn. Also, ensure that the extension housing to case gasket is not damaged or excessively compressed.

IF O.K.

Remove the mainshaft and measure the end-float of the gears (see Specification Section for end-float figures).

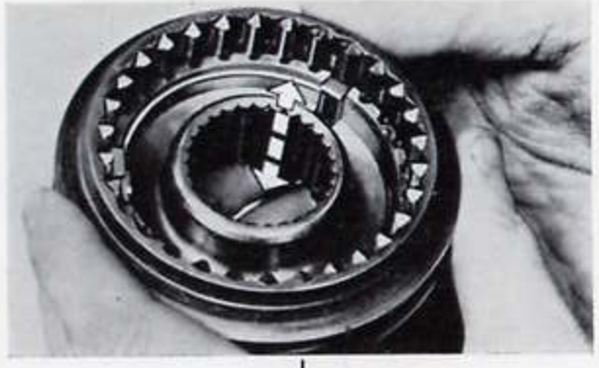


IF NOT O.K.

Dismantle the mainshaft and re-build using new components as required to give correct end-floats.

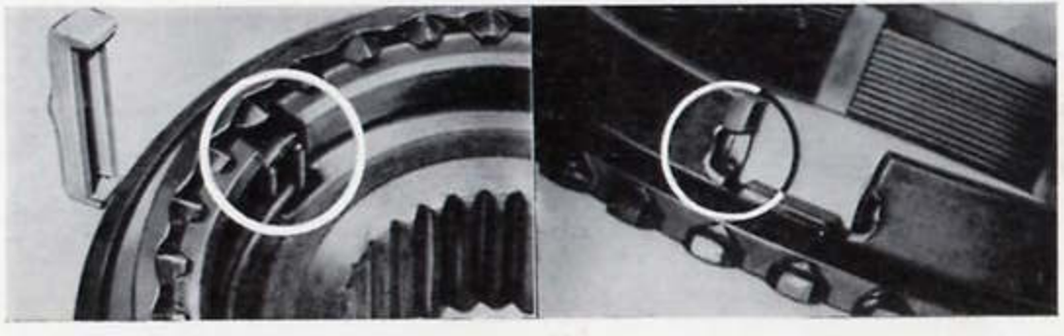
IF O.K.

Remove the 3rd/4th or 1st/2nd synchroniser assembly (which one to remove obviously depends on which gear was difficult to engage). Check that the sleeve is a good sliding fit on the hub. There must be no perceptible "rock".



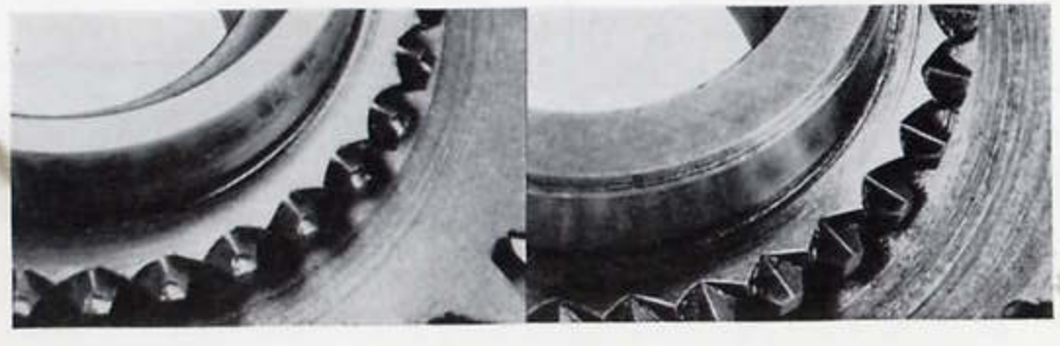
IF NOT O.K.

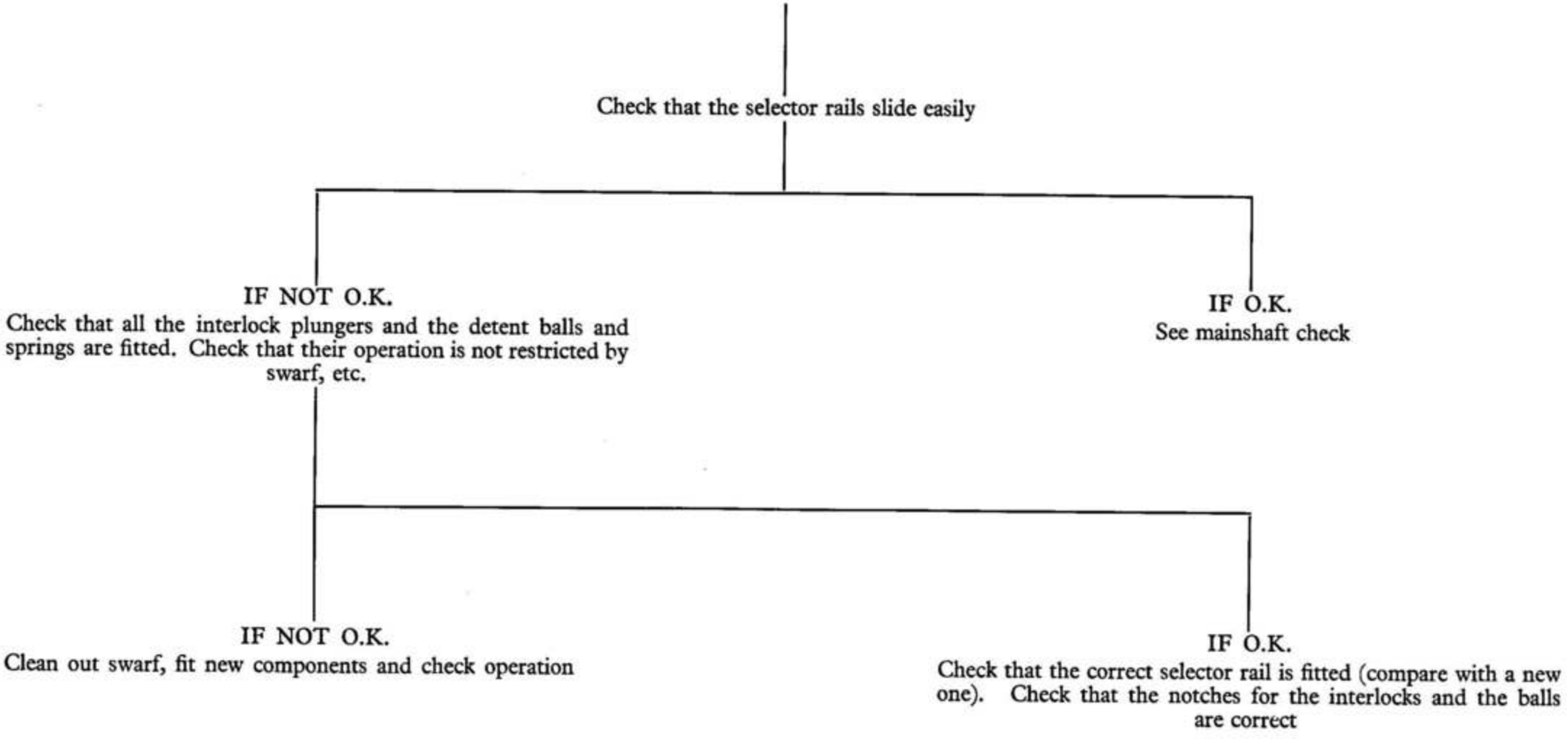
Check that the insert springs are correctly assembled and that the inserts are not damaged. Examine the synchroniser ring insert slots for signs of damage. If the springs, inserts or the synchroniser ring is damaged, then renew only the components that are damaged. Do not renew the complete synchroniser assembly.



IF O.K.

Inspect the dog teeth on the gear, sleeve and synchroniser ring. If the synchroniser ring only is damaged then renew only the synchroniser ring. If either the gear or sleeve is damaged, all three components should be changed.




Check that the selector rails slide easily
IF NOT O.K.
Check that all the interlock plungers and the detent balls and springs are fitted. Check that their operation is not restricted by swarf, etc.
IF O.K.
See mainshaft check
IF NOT O.K.
Clean out swarf, fit new components and check operation
IF O.K.
Check that the correct selector rail is fitted (compare with a new one). Check that the notches for the interlocks and the balls are correct

3. GEAR "CRASHING"

Problem Description – This is characteristic grating or crashing noise which occurs when engaging a gear. It is caused by failure of the synchromesh to operate. This may be due to a defective synchromesh or an outside factor such as the clutch failing to disengage.

A

Checks with Gearbox installed in the vehicle

Check Clutch Operation (see Clutch Section Fault Diagnosis page 18)

- O.K. (see page 24)
- NOT O.K.
  - Check Clutch Adjustment
    - Adjustment O.K.
      - Check clutch linkage
        - O.K.* → Remove gearbox and check clutch and release mechanism. Rectify as necessary.
    - Adjustment NOT O.K.
      - Adjust Clutch*
        - NOT O.K. → Rectify as necessary* (See Clutch Section)

*NOTE If it is found that the crashing is caused by defective clutch operation, consideration should be given to removing the gearbox to rectify the damage caused by crashing. This decision should be based on the severity of the crashing and the length of time it has been evident.

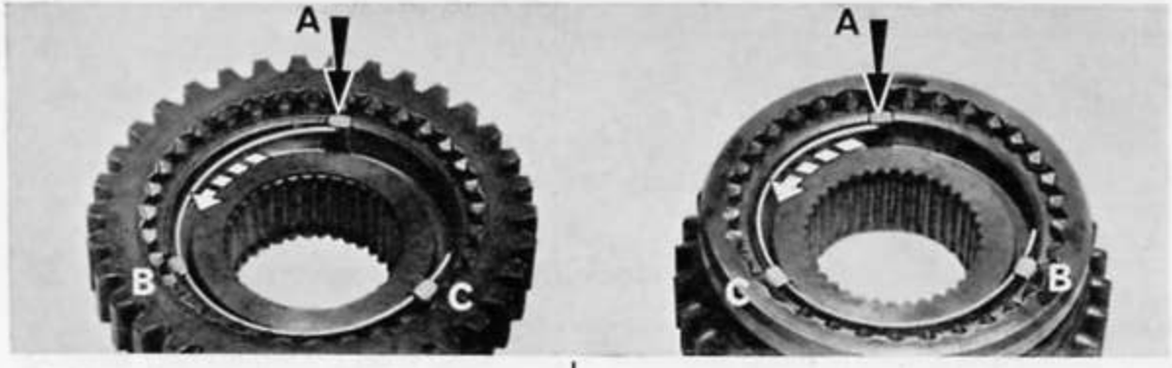
B Checks with the Gearbox removed from the vehicle.

Remove the selector housing.

Check that all the synchroniser rings are fitted.

IF O.K.

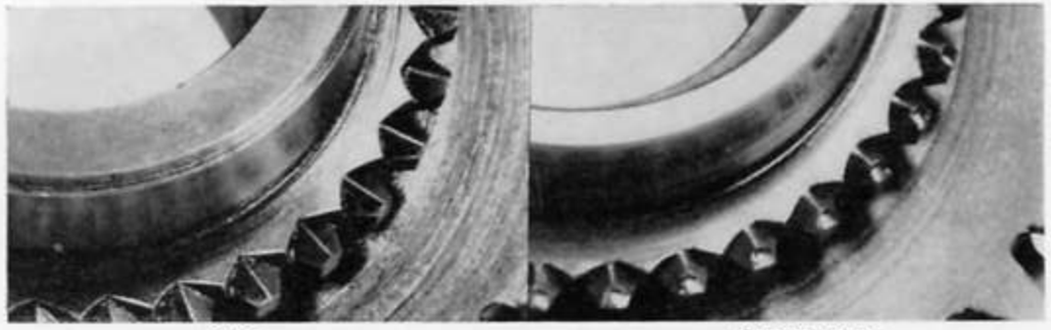
Remove the mainshaft assembly and dismantle the area required (i.e. if it crashes in first gear it is only necessary to dismantle the components associated with first gear). With the synchroniser still assembled check that the insert springs are correctly fitted. They should run anti-clockwise (starting from the tang) when viewed from either side, also the spring tangs should be located in the same insert.
Check that the inserts themselves are undamaged.



IF NOT O.K.

Dismantle the mainshaft and examine the dog teeth on the gear and sleeve, renew damaged components and re-build the mainshaft with synchroniser rings.

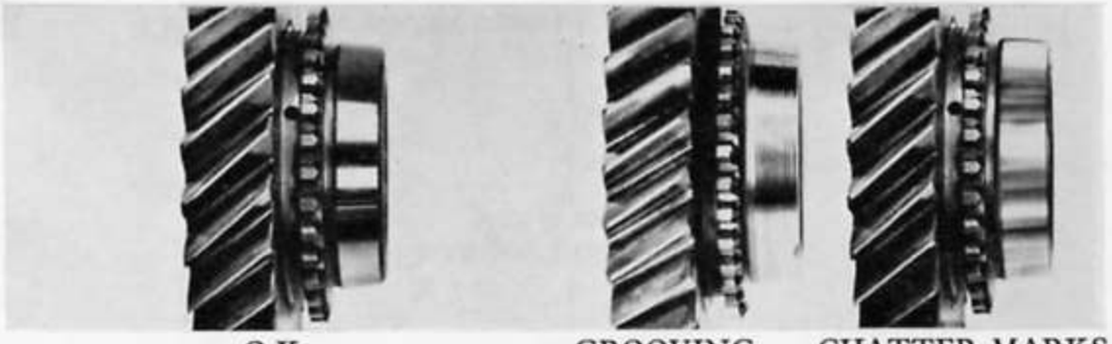
Inspect the dog teeth on the synchroniser ring, sleeve and the gear.



O.K. NOT O.K.

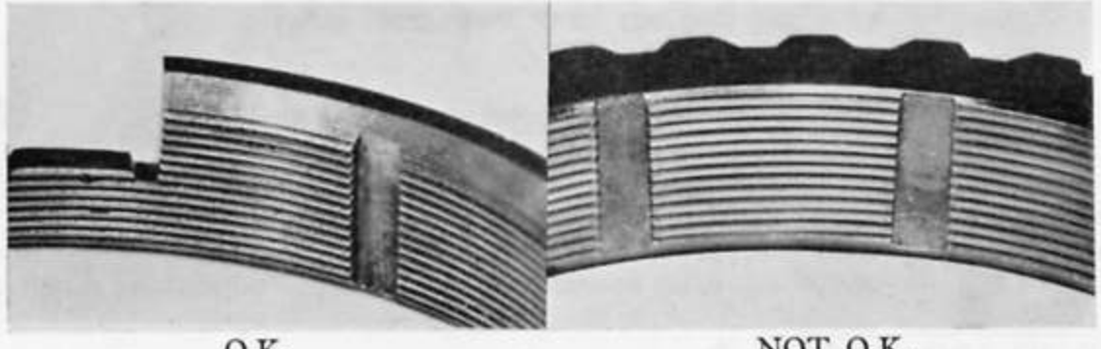
IF O.K.

Examine the gear cone finish for signs of grooving, burnishing or chatter-marks. The cone should have a smooth matt or lightly polished surface.



O.K. GROOVING CHATTER-MARKS

Inspect the synchroniser ring for wear of the internal thread.



O.K. NOT O.K.

IF NOT O.K.

If either the sleeve or the gear is damaged then both these should be renewed and so should the synchroniser ring.

4. JUMPING OUT OF GEAR

Problem Description – Disengagement of gear on drive or over-run.
This can be attributed to one of three items. Failure of the shift mechanism to engage the gear fully, failure of the selector mechanism to engage the gear fully and hold it in engagement, or damaged or incorrectly machined components on the mainshaft.

A Checks with Gearbox installed in the vehicle.

Check gear lever does not foul bodywork and is free to move in the body aperture.

- O.K.
- NOT O.K. – Rectify as necessary.

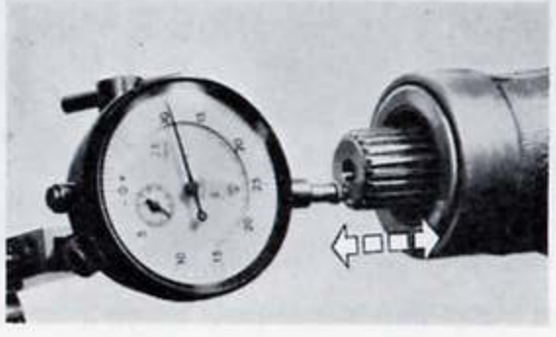
Check gear lever retaining plate is secure.

- O.K.
- NOT O.K. → Secure plate.

B Checks with the gearbox removed.

(i) Forward Gears only.

Check the mainshaft end-float. It should not exceed 0.015 in.



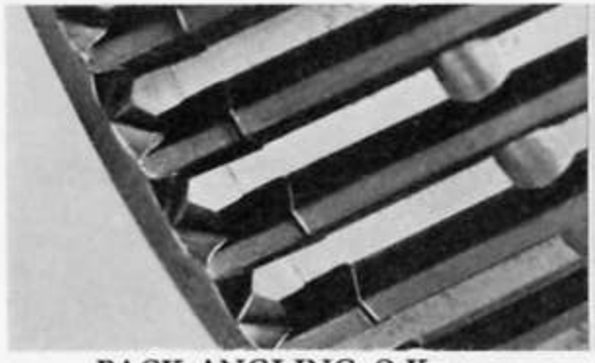
O.K.

Remove the mainshaft assembly and dismantle the area required (i.e. if it jumps out of first gear it is only necessary to remove components associated with first gear).

NOT O.K.

Check that the tab washer retaining the mainshaft nut is intact. It may be possible to "rock" the nut but the tab washer should prevent it rotating. Check that the mainshaft bearing or its abutment faces are not worn. Also, ensure that the extension housing to case gasket is not damaged or excessively compressed.

Examine the gear and sleeve dog teeth for back-angling (first and third gears only), it must be evenly disposed. Check all dog teeth for damage (chipped teeth, etc.).



BACK-ANGLING O.K.

BACK-ANGLING NOT O.K.

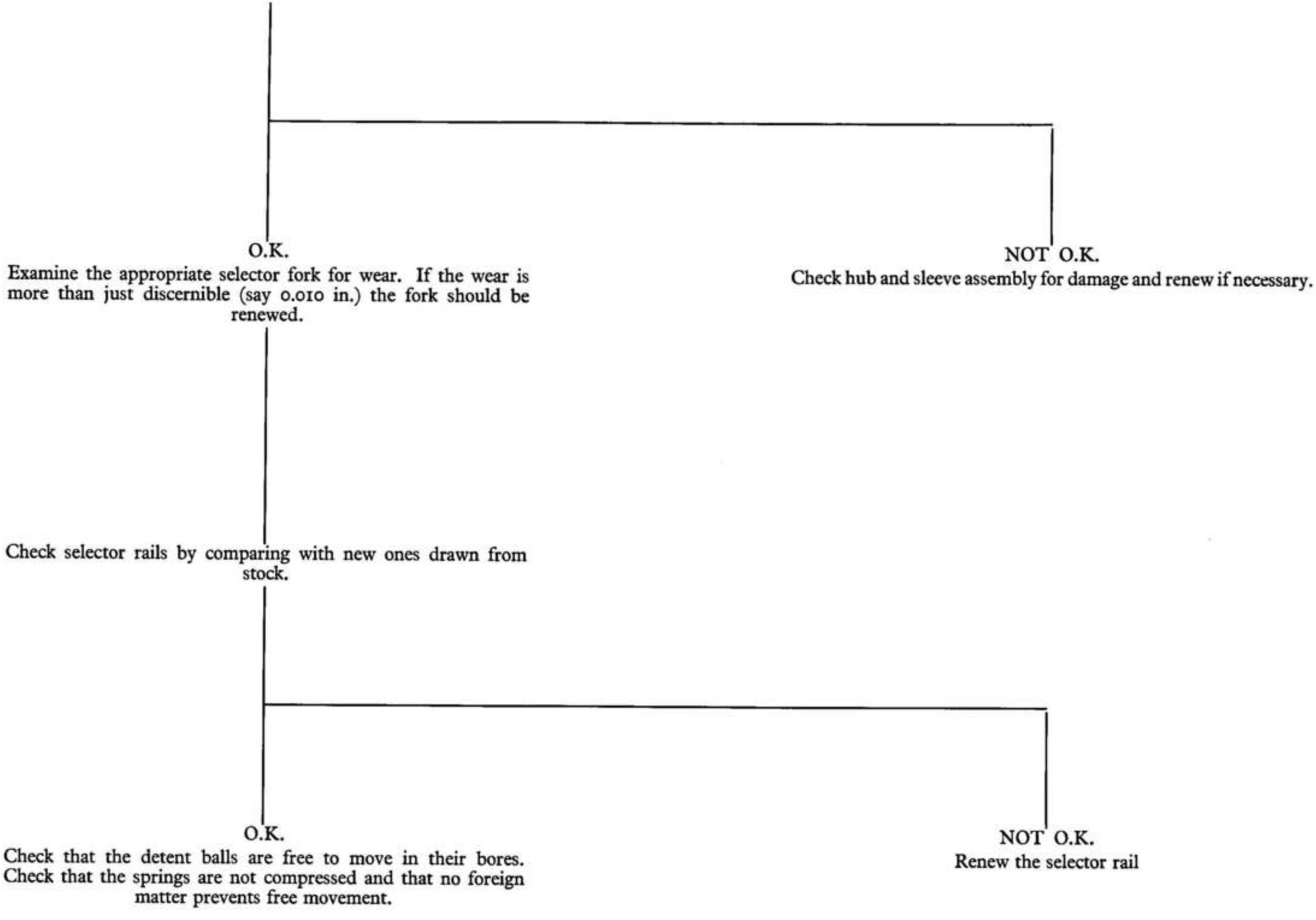
O.K.

Check that the sleeve is a good sliding fit on hub. There must be no perceptible "rock".

See next page

NOT O.K.

If either the gear or the sleeve is damaged then both these components and the synchro ring should be renewed.


O.K.
Examine the appropriate selector fork for wear. If the wear is more than just discernible (say 0.010 in.) the fork should be renewed.
NOT O.K.
Check hub and sleeve assembly for damage and renew if necessary.
Check selector rails by comparing with new ones drawn from stock.
O.K.
Check that the detent balls are free to move in their bores. Check that the springs are not compressed and that no foreign matter prevents free movement.
NOT O.K.
Renew the selector rail

(ii) Reverse Gear

Check the reverse idler gear for damage to the teeth.

O.K.

Ensure that the idler gear bush is correctly positioned in the bore of the gear and not misplaced.

NOT O.K.

If the idler gear is damaged it should be renewed. Also, check associated components (cluster gear, first/second hub and sleeve assembly, etc.) which may have been damaged.

O.K.

Check that the first/second gear sleeve is a sliding fit on its hub. There must be no perceptible "rock".

NOT O.K.

Replace gear and bush assembly.

5. JAMMING IN GEAR

Problem Description – Impossible to disengage gear. It may or may not be possible to move the gear lever. This will be associated with the selector mechanism in the top of the gearbox.

Check gear lever retaining plate is secure.

- NOT O.K. — Secure plate.
- O.K. — Remove selector housing and try to disengage the gear by moving the synchroniser sleeve.

- NOT O.K. — Remove gearbox and check mainshaft.
- O.K. — Check that the selector forks are securely attached to the selector rails.

- NOT O.K. — Secure the fork to the rail.

  NOTE – If a selector fork pin is missing or loose the fork will stay where it is and the rail will move so operating the interlock plungers.
- O.K. — Check that all the interlock plungers are fitted.

- NOT O.K. — Dismantle and rebuild with interlock plungers. (Check that the interlock plungers that should have been fitted are not loose in the box.)
- O.K. — Examine the selector rails. Ensure that they are free to move. Check that they are not distorted or jammed by foreign matter between the selector rails and the gearbox case.

6. GEARBOX NOISES

(a) Gear Rattle or Clutch Thrash -

This is a muffled metallic ringing or rattling noise which is most evident when accelerating from low speeds in top gear.

As the engine has two power impulses for each revolution of the engine, the crankshaft tends to accelerate and slow down twice per revolution. This unevenness is reduced by the flywheel and its effect is then almost eliminated by the torsional damper, "built-in" to the clutch disc. If the clutch disc is damaged, distorted or contaminated with oil, the effectiveness of the damper may be reduced and a very small torsional resonance could then be transmitted to the gearbox. This results in the cluster gear rotating at an uneven speed. This, in turn, results in the undriven mainshaft gears repeatedly taking up their running clearances. The noise that occurs when this happens is Gear Rattle or Clutch Thrash.

Normally, the only effective corrective action is to renew the clutch disc.

(b) Knocking or Tapping -

This is usually caused by a gear tooth imperfection (burr, high spot, chipped, etc.). This will be evident in one particular gear, not in all gears. This requires a very careful examination of the gear teeth to locate the fault.

(c) Bearing Noise -

This is a "growling" noise. It is indicative of a bearing breaking up.

If the noise is evident in the intermediate gears only, then the spigot bearing is suspect.

If the noise is evident in all gears, including neutral, then the main drive gear (probably) or the countershaft rollers (possibly) are suspect.

If the noise is evident in all gears but not in neutral then the mainshaft bearing is suspect.

(d) Gear Noise -

Some gear noise is inevitable, especially with a new gearbox or if new gears are fitted. In these cases the noise should decrease considerably as the gears wear in. Do not dismantle a new gearbox to attempt any rectification until the gearbox has been in use for at least 1,000 miles. If the noise is still excessive it will be necessary to dismantle the gearbox and examine the individual gears. The teeth should be smooth and burnished. The wear pattern should be evenly disposed on each tooth, there should not be any evidence of "scuffing" or "feathering".

NOTES:

(i) If, with the vehicle stationary and the engine running, a noise is evident when the clutch pedal is depressed, DO NOT suspect the gearbox. It should be obvious that, under these conditions, no part of the gearbox is moving and thus cannot cause a noise.

(ii) Literal descriptions of audible noises are always open to mis-interpretation and dispute. While the foregoing descriptions will be helpful it is advisable that fault diagnosis be carried out by someone with sufficient experience to be able to diagnose noises quickly and accurately.

CLUTCH AND RELEASE MECHANISM

OVERHAUL PROCEDURES

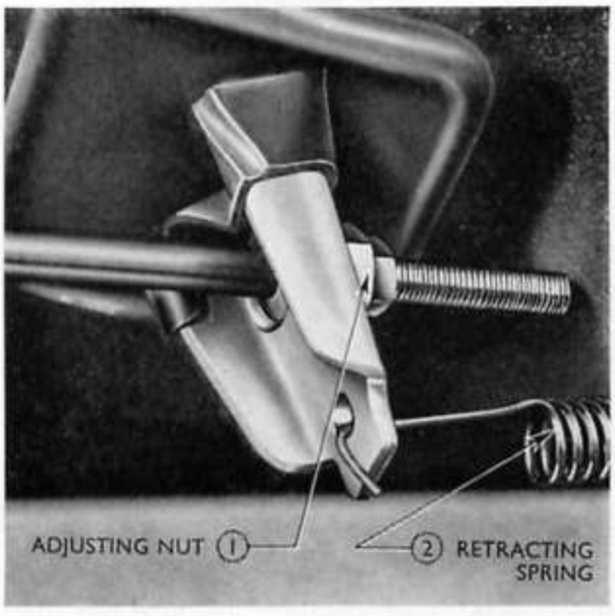


Fig. 15
Clutch Release Arm Adjustment (Prior to December 1970)

DESCRIPTION

The clutch assembly comprises a diaphragm spring type pressure plate with a single 216 mm. (8.5 in.) diameter, dry plate clutch disc. To ensure a smooth take-up of the drive the linings of the clutch disc are flexibly mounted and the hub is spring cushioned.

The clutch disc hub is free to slide along the splines of the main drive gear shaft, the forward end of which forms a spigot, to fit into the clutch pilot bearing in the centre of the crankshaft.

Prior to December 1970, the clutch release mechanism is mechanically actuated by two connecting rods and an equaliser bar. The equaliser bar is situated between the gearbox extension housing and the chassis sidemember, and is free to rotate. A rod is connected from the clutch pedal to a lever on the equaliser bar, and from a second lever on the equaliser bar, another rod is connected to the end of the clutch release arm.

When the clutch pedal is depressed the clutch pedal to equaliser bar connecting rod moves towards the rear, causing the equaliser bar to revolve which in turn, moves the second connecting rod rearwards and actuates the clutch release arm.

As the diaphragm's centre is moved towards the flywheel by the release bearing, the diaphragm's outer edge deflects towards the clutch housing, causing the clutch to disengage.

The release bearing is retained to the clutch release arm fork by means of a two-pronged spring prior to December 1970, and a circlip after this date.

The connecting rod system was replaced in December 1970 on petrol engined Transits by a cable directly connecting the pendant pedal to the clutch release arm. On diesel engined versions a similar cable connects the pendant pedal to a simplified rod linkage which runs directly to the clutch release arm.

CLUTCH ADJUSTMENT

Prior to December 1970 (Fig. 15)

The clutch should be adjusted until the clearance between the clutch release arm to equaliser bar connecting rod adjusting nut and the release arm is 1.02 mm. (0.04 in.).

To effect this adjustment, disconnect the release fork retracting spring, release the locknut and turn the adjusting nut until there is no free play, then back off one complete turn (1 turn equals 1.02 mm.).

Tighten the locknut securely, re-check the adjustment and reconnect the retracting spring.

After December 1970

Petrol Engines (Fig. 16)

The cable adjuster, located inside the vehicle, should be adjusted until the clearance between the clutch pedal and its stop is 3.5 to 4.5 mm. (0.13 to 0.18 in.) (see Fig. 26).

Slacken the cable adjuster locknut (see Fig. 16) and adjust the cable as necessary, until this figure is achieved. Retighten the locknut.

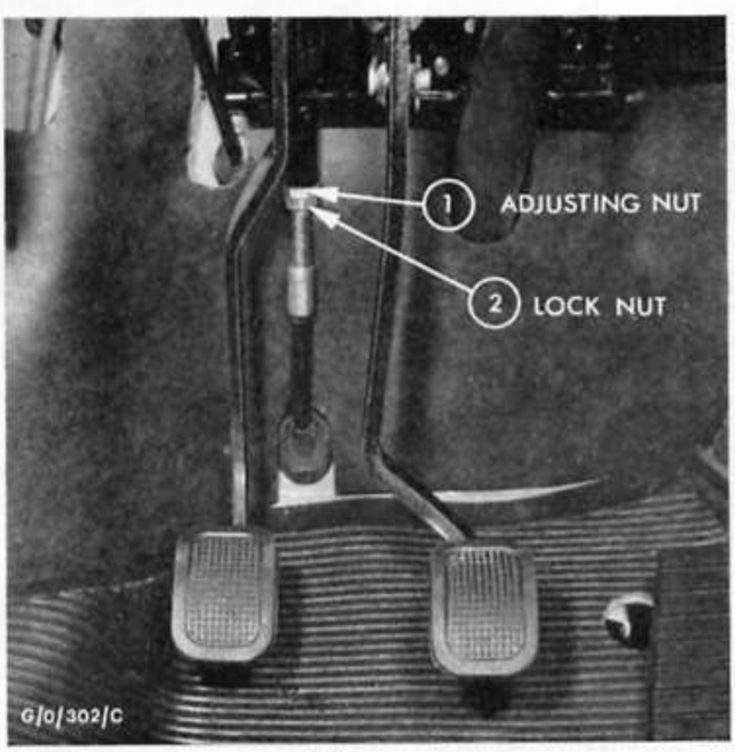


Fig. 16
Clutch Cable Adjustment (Petrol Engined Models after December 1970)

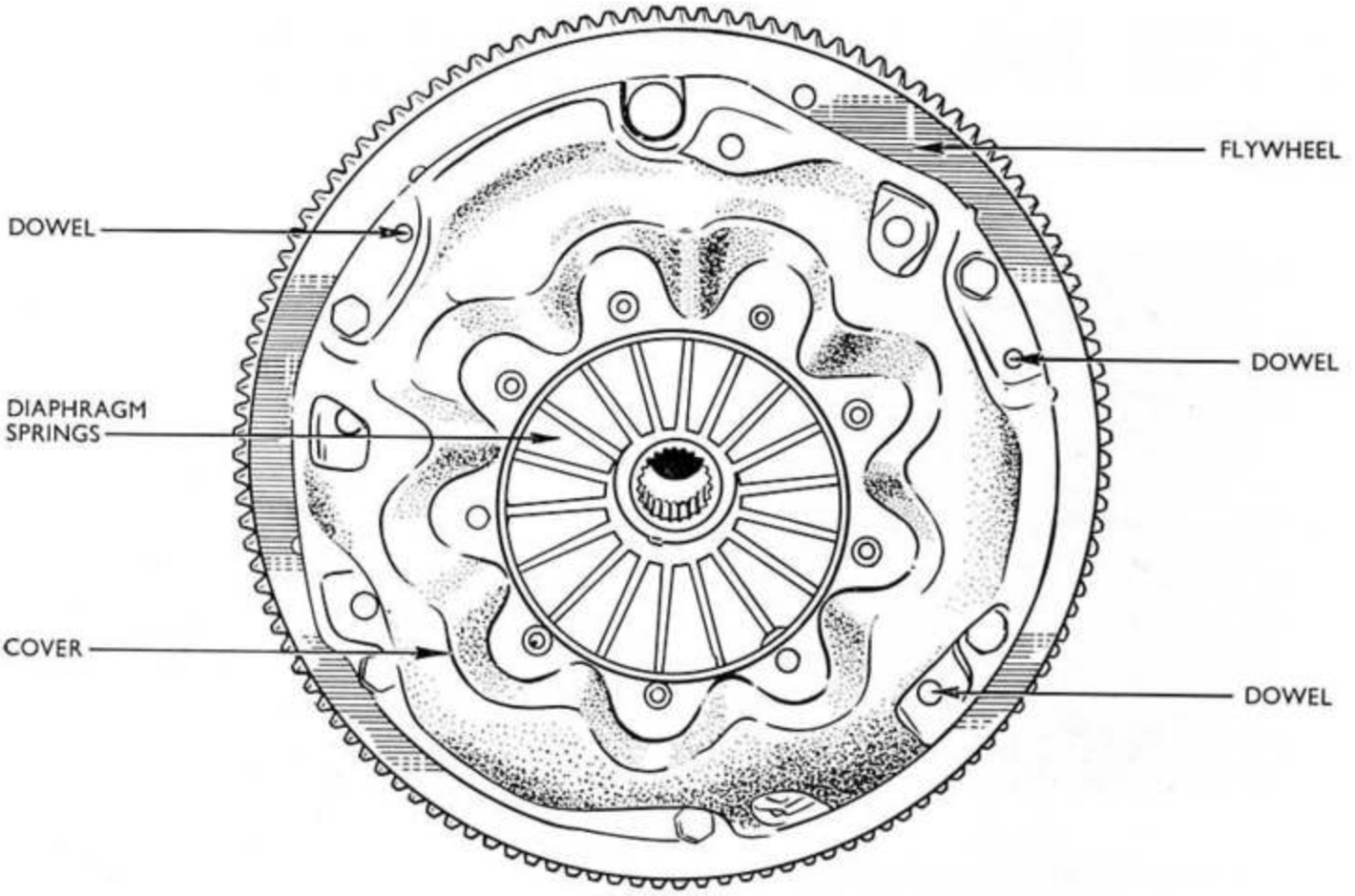


Fig. 17
Clutch Assembly (prior to March 1968)

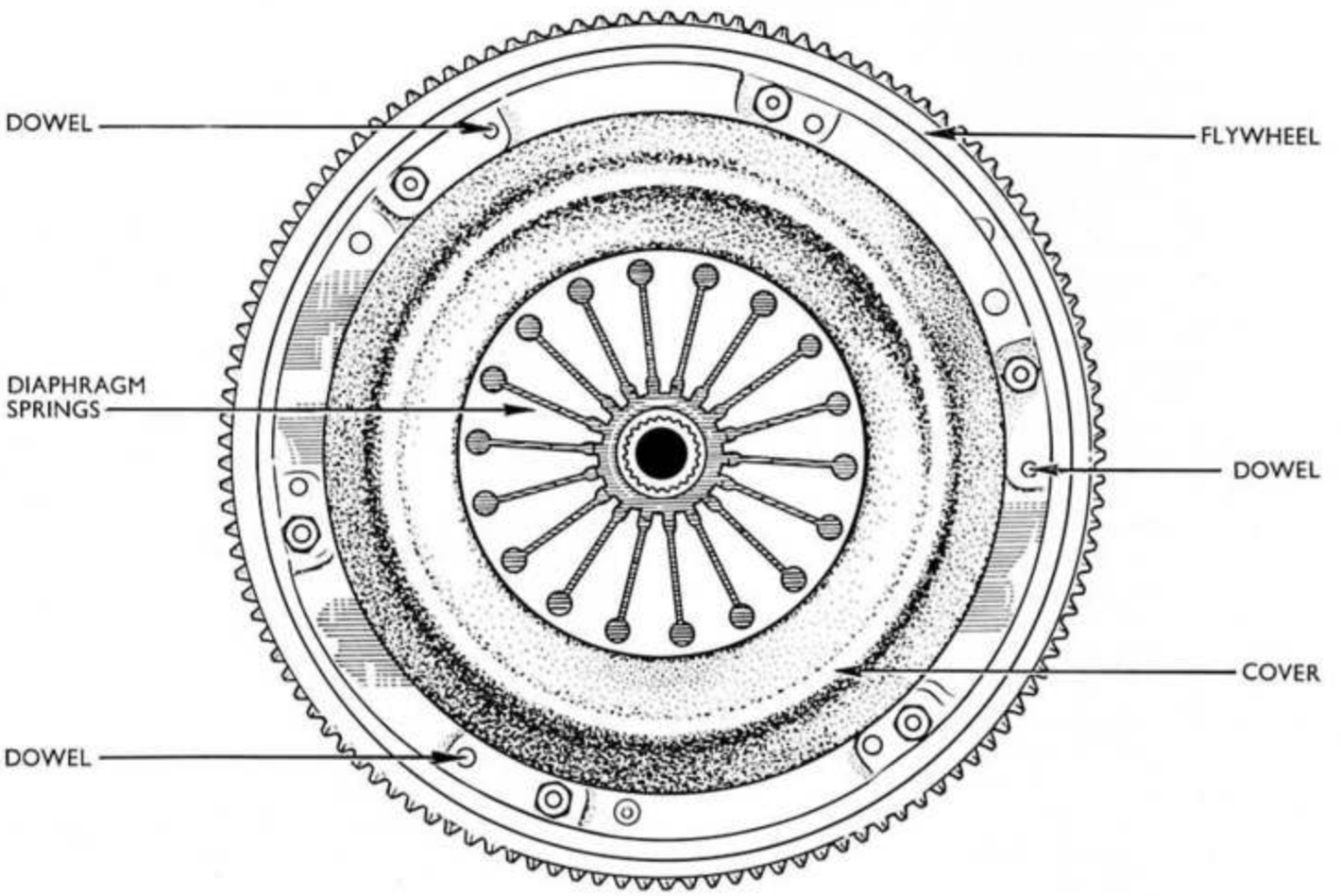


Fig. 18
Clutch Assembly (from July 1968)

Diesel Engines (Fig. 19)

The clutch should be adjusted until the clearance between the clutch pedal and its stop is 3.5 to 4.5 mm. (0.13 to 0.18 in.) see Fig 26.

From underneath the vehicle, slacken the adjusting rod locknut (see Fig 19) and adjust the rod until this figure is achieved. Retighten the locknut.

NOTE.—Add a smear of grease, ESEA–M1C–1001–A to the nut and the release arm contact areas after setting.

THE CLUTCH, PILOT BEARING AND RELEASE BEARING

Fig. 19
Clutch Release Arm Adjustment
(Diesel Engined Models after December 1970)

NOTE: The release arm retracting spring fitted previously must NOT be used on pendant pedal vehicles.

THE CLUTCH

The clutch is located on the flywheel by three dowels and is retained by six bolts and spring washers.

To Remove

1. Remove the gearbox and clutch housing assembly, see the Gearbox Section.

2. Remove the clutch disc and pressure plate assembly by slackening each of the six retaining bolts approximately one turn at a time, working diagonally across the clutch, until all tension has been removed from the diaphragm spring.

3. Inspect the clutch disc and pressure plate. Check that the linings are secure and free from oil. The disc should also be checked for excessive wear and signs of overheating. If the linings are worn down near to the rivet heads, or, if any of the above conditions are apparent, the disc should be renewed.

Check the condition of the pressure plate and the release plate surface. Should any sign of scoring, overheating or distortion be present, change the assembly.

Clutch Assemblies (Pre-December 1970)

NOTE.—Changes in the clutch assembly have taken place and these could affect the fitting of a new pressure plate and disc.

The clutch fitted until the end of February 1968 may be identified by its riveted cover plate. From 15th July 1968 the cover plate may be identified by its smooth continuous cover. These two clutches are interchangeable.

A half-inch wide yellow paint band on the cover identifies the clutch fitted between the above dates. This clutch is not available for service and a small modification will be necessary so that a new assembly may be fitted.

The flywheel dowels should be renewed and the clutch fork pull rod disconnected from the equaliser bar and reconnected to the inner of the two holes in the lever (Hole B in Fig. 20).

If the second hole is not drilled in the lever, the equaliser bar must be removed and a hole drilled in the shorter of the two levers to the dimension given in Fig. 20.

To Refit

1. Place the clutch disc in position on the flywheel with the hub away from the flywheel.

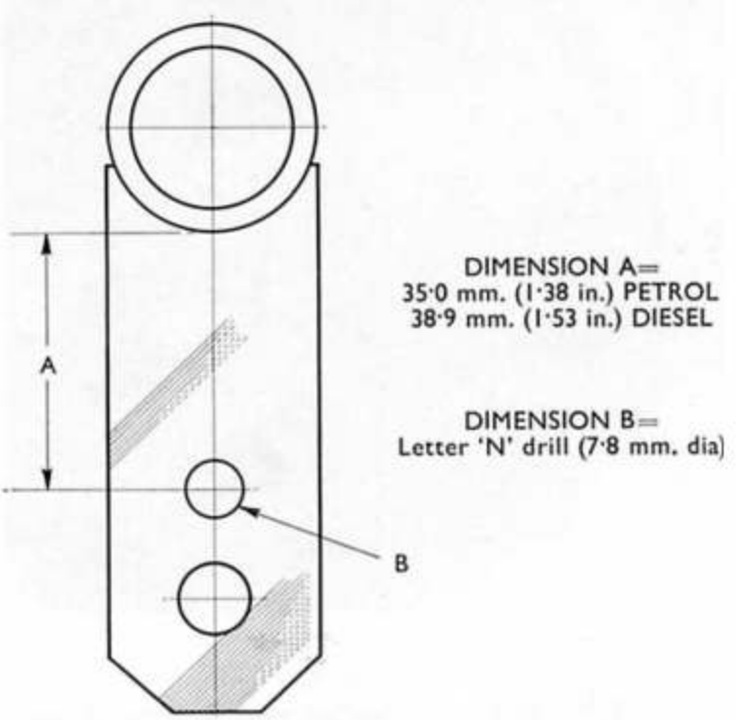


Fig. 20
Modified Clutch Equaliser Bar

(The disc is stamped "Flywheel Side"). Align the disc with the pilot bearing, using the locator Tool No. CP.7112A.

2. Refit the pressure plate assembly, locating it on the three dowels. Replace the six securing bolts and spring washers, tightening them evenly to a torque of 1.6 to 2.0 kg.m. (12 to 15 lb. ft.). Remove the clutch disc locator.

3. Refit the gearbox and clutch housing assembly as described in the Gearbox Section.

THE PILOT BEARING

The clutch pilot bearing located in the centre of the crankshaft flange is an enclosed ball race. The bearing is lubricated and sealed in manufacture and does not require attention in service.

To Remove

1. Remove the gearbox and clutch housing assembly, see the Gearbox Section.

2. Detach the clutch disc and pressure plate, see page 35.

3. Withdraw the pilot bearing by engaging the legs of the puller, Tool No. CP.7600–6, behind the bearing and screwing the centre screw of the main tool, Tool No. 7600B onto the puller. Tighten the wing nut on the centre screw to extract the bearing.

To Refit

1. Position the bearing in the crankshaft flange, and using the replacer, Tool No. CP.7123, with the driver handle, Tool No. 550, tap the bearing gently into position, ensuring that it fits squarely into the bore.

Fig. 21
Clutch Release Bearing and Release Arm (Petrol Engined Models prior to December 1970 and all Diesel Engined Models)

2. Fit the clutch, see above.

3. Refit the gearbox and clutch housing assembly as described in the Gearbox Section.

THE RELEASE BEARING

(Petrol engined models prior to December 1970 and all diesel engined models)

To Remove

1. Remove the gearbox and clutch housing assembly, see the Gearbox Section.

2. Remove the rubber gaiter from the clutch housing.

3. Withdraw the release arm away from the release bearing sufficiently to disengage the fulcrum spring and the spring clip on the rear of the release bearing assembly.

4. Withdraw the release bearing assembly from the main drive gear shaft bearing retainer.

5. Remove the release arm from the clutch housing.

NOTE.—It should not be necessary to dismantle the clutch release bearing and hub assembly since the parts are not serviced separately.

To Refit

1. Pass the release fork through the clutch housing aperture from inside the housing.

2. Locate the release bearing assembly on the main drive gear shaft bearing retainer, after first inspecting the sleeve for burrs, and smearing it lightly with high melting point grease.

3. Engage the release fork in the spring clip on the rear of the release bearing assembly and in the fulcrum spring.

4. Fit the rubber gaiter over the clutch release arm, ensuring that the arm is correctly located in the clutch housing.

5. Refit the gearbox and clutch housing assembly as described in the Gearbox Section.

THE RELEASE BEARING

(Petrol engined models after December 1970)

To Remove

1. Remove the gearbox and clutch housing assembly, see the Gearbox Section.

2. Remove the rubber gaiter from the clutch housing.

3. Slide the release bearing and hub assembly forward away from the release arm until prevented from doing so by the circlip, located behind the release arm, on the release bearing hub.

4. Locate the "eyes" of the circlip with a pair of long-nosed circlip pliers through one of the two elongations in the bore of the release arm and release

the circlip. It may be necessary to "work" the circlip round until the eyes can be seen.

NOTE.—The release arm and the release bearing and hub assembly may be removed as one unit without releasing the circlip, if the gearbox is separated from the clutch housing.

5. Withdraw the release bearing and hub assembly from the release arm and remove from the housing.

NOTE.—It should not be necessary to dismantle the clutch release bearing and hub assembly as the parts are not serviced separately.

6. Slide the release arm from the locating dowel and remove from the housing. The circlip may now also be removed from the main shaft.

To Replace

1. Place the circlip and the release arm over the input shaft.

2. Slide the release bearing and hub assembly over the input shaft and through the bore in the release arm. Relocate the circlip in its location in the hub assembly.

3. Replace the rubber gaiter in the clutch housing.

4. Replace the gearbox and clutch housing assembly as described in the Gearbox Section.

THE CLUTCH LINKAGE

(All models prior to December 1970)

To Remove

1. Remove the clutch pedal to equaliser bar connecting rod by releasing the retaining clip at each end of the connecting rod.

2. Release the clutch arm retracting spring, slacken the locknut, and remove the locknut and adjusting nut from the end of the clutch release arm to equaliser bar connecting rod.

3. Remove the clutch release arm to equaliser bar connecting rod from the equaliser bar by removing the split pin and clevis pin.

4. Remove the equaliser bar. Remove the two bolts securing the equaliser bar support to the gearbox extension housing. Pull the support from the end of the equaliser bar, taking care not to lose the split retaining ring from around the end of the support ball.

In a similar manner remove the equaliser bar from the outer support ball attached to the side-member.

If necessary to remove the outer support ball, unscrew the retaining nut, and remove.

To Refit

1. Reposition the equaliser bar outer support ball and fit the retaining nut.

2. Fit a new rubber seal over the support ball, position the split retaining ring around the ball and fit the equaliser bar, pulling the rubber seal over the end of the equaliser bar.

3. Fit the inner support ball to the end of the equaliser bar in a similar manner.

4. Replace the two bolts which secure the equaliser bar inner support to the gearbox extension housing.

Adjust the support bracket so that the dimension between the inner end of the equaliser bar and the vertical face of the bracket is 17.5 to 19.0 mm. (0.69 to 0.75 in.) with the equaliser bar perpendicular to the centre line of the extension housing.

5. Refit the clutch pedal to equaliser bar connecting rod, retaining it with a clip at each end.

6. Refit the equaliser bar to clutch release arm connecting rod. Replace the clevis pin and split pin securing the connecting rod to the equaliser bar, and pass the threaded end through the hole in the release arm.

7. Replace the adjusting nut and locknut and adjust the clutch movement as described on page 33. Refit the retracting spring.

THE CLUTCH CABLE

(Petrol engined models)

To Remove

1. Loosen the locknut at the cable adjuster and slacken the cable by means of the adjusting nut.

2. Disconnect the lower end of the cable from the clutch release arm underneath the vehicle by withdrawing it through the larger of the two holes in the arm (see Fig. 24).

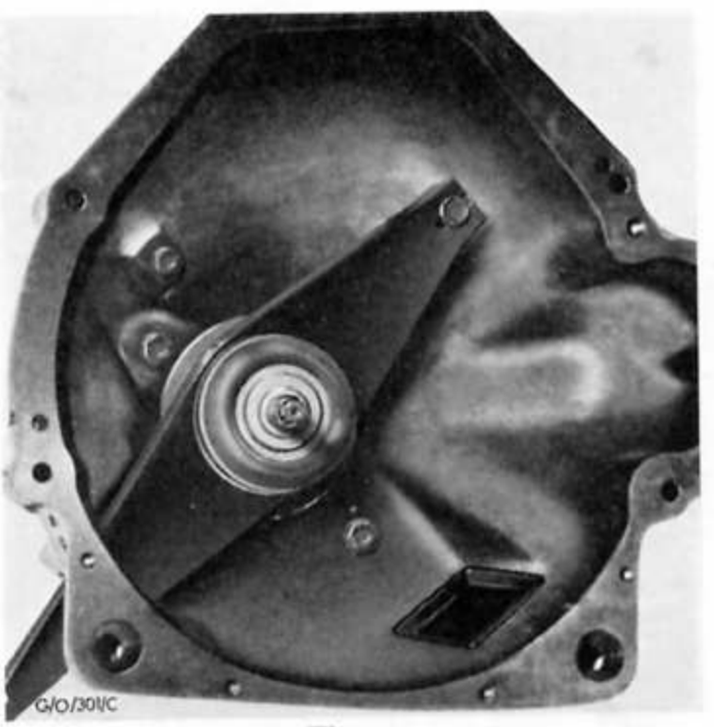


Fig. 22

Clutch Release Bearing and Release Arm (Petrol Engined Models after December 1970)

3. Remove the retaining pin from the nylon seat (see Fig 23) and withdraw it from the eyelet.

4. Withdraw the cable from the pedal support bracket and remove the cable from the vehicle.

To Replace

1. Feed the upper end of the cable up through the pedal support bracket and through the nylon seat in the pedal. Slide the retaining pin through the hole in the cable eyelet and press the pin and eyelet into the groove in the nylon seat (see Fig. 23).

2. Pass the cable through the bulkhead and connect the lower end to the clutch release arm. Refit the grommet to the bulkhead.

3. Using the adjusting nut, adjust the clutch pedal as covered earlier under "Clutch Adjustment".

THE CLUTCH CABLE

(Diesel engined models)

To Remove

1. From underneath the vehicle disconnect the clevis pin and clip securing the cable to the clutch release mechanism actuating lever mounted on the rear of the gearbox extension housing and detach the clutch cable.

2. From inside the cab remove the retaining pin from the nylon seat (see Fig. 23) and withdraw it from the eyelet.

3. Withdraw the cable from the pedal support bracket and remove the cable from the vehicle.

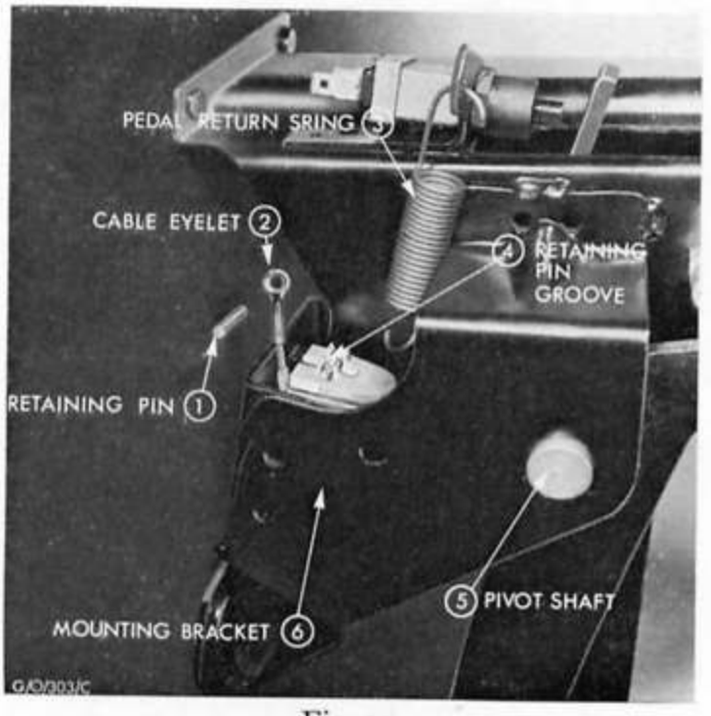


Fig. 23
Clutch Cable Location in Pedal
(All Models after December 1970)

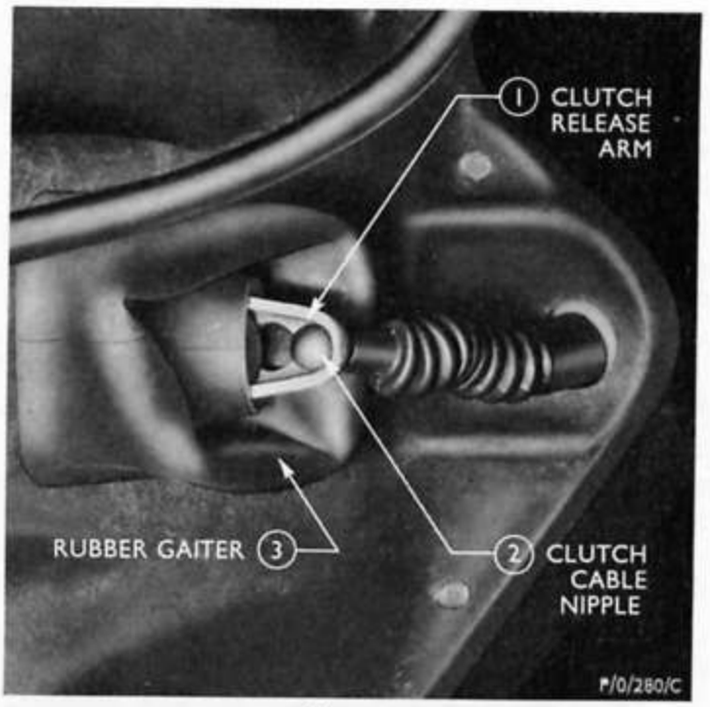


Fig. 24
Clutch Cable Location in Release Arm
(Petrol Engined Models after December 1970)

To Replace

1. Feed the upper end of the cable up through the pedal support bracket and through the nylon seat in the pedal. Slide the retaining pin through the hole in the cable eyelet and press the pin and eyelet into the groove in the nylon seat (see Fig. 23).

2. Pass the cable through the bulkhead and connect the lower end to the release mechanism actuating lever, using the clevis pin and spring clip.

3. Adjust the clutch as detailed under "Clutch Adjustment".

NOTE.—If the mechanical linkage requires servicing it can be removed from the vehicle at this stage by removing the two bolts securing the actuating lever to the extension housing.

THE PEDAL ASSEMBLY
(Prior to December 1970)

The clutch pedal is pivoted below the floor of the vehicle in a common bracket with the brake pedal. No clutch pedal adjustment is provided, the only adjustment required for the clutch linkage being provided at the end of the release arm, as described previously.

To Remove

1. Disconnect the clutch pedal to equaliser bar connecting rod from the clutch pedal.

2. Disconnect the fluid pipes from the brake master cylinder and fit a blanking plug to the reservoir supply pipe.

3. Remove the retracting springs from the brake and clutch pedals.

4. Remove the screws securing the retaining plate around the clutch and brake pedal shafts in the floor pan, and remove the retaining plate.

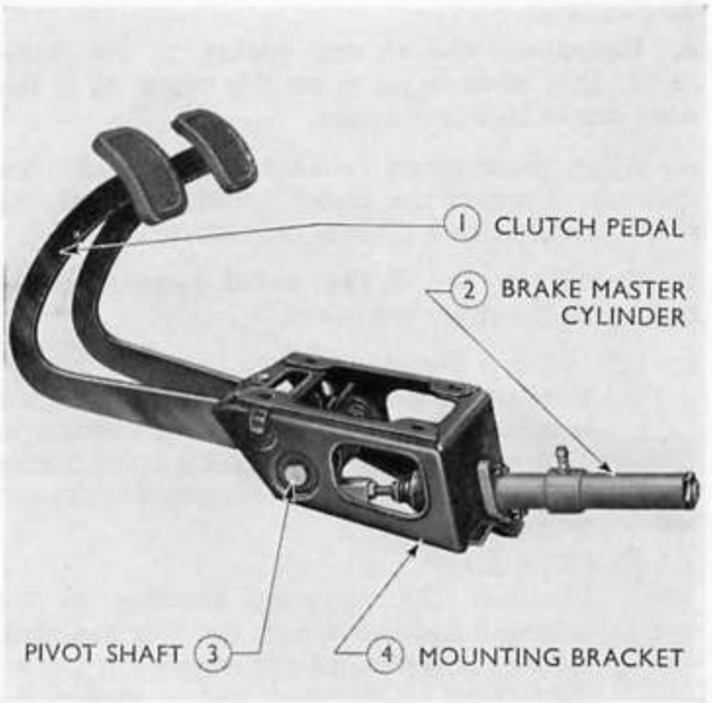


Fig. 25
Clutch Pedal Assembly
(Prior to December 1970)

5. Remove the four bolts securing the pedal assembly bracket to the floor of the vehicle, and remove the assembly.

6. Remove the circlip from the end of the clutch and brake pedal pivot shaft. Suitably support the brake pedal and tap out the pivot shaft, taking care not to lose the two bushes from each pedal. Remove the clutch pedal.

7. Check the pedal bosses, bushes and pivot shaft for wear.

To Replace

1. Position the bushes in the pedal bosses. Insert the grooved end of the pivot shaft into the circular hole in the bracket, fitting the pedal bosses over the shaft as it is inserted. Rotate the shaft as necessary so that the flat on the shaft mates with the flat on the hole in the support bracket. Fit the retaining circlip.

2. Replace the pedal assembly and secure to the floor of the cab with the four bolts.

3. Position the clutch and brake pedals and fit the retaining plate in the floor pan around the pedal shafts.

4. Refit the retracting springs.

5. Reconnect the clutch pedal to equaliser bar connecting rod to the clutch pedal and fit the retaining clip.

6. Reconnect the fluid pipes to the brake master cylinder and bleed the system.

THE PEDAL ASSEMBLY
(After December 1970)

The clutch pedal is of the pendant type, being pivoted with the brake pedal from a common support bracket, located between the lower edge of the dashboard and the bulkhead (see Fig. 26).

The pedal operates a direct cable to the clutch release arm, adjustment having been covered previously.

To Remove

1. Open the bonnet, fit wing covers, and disconnect the battery.

2. From inside the cab remove the spring clip and clevis pin connecting the brake pedal to the master cylinder, and remove the two wires from the brake light switch.

3. Remove the circlip holding the pedal pivot shaft in position in the support bracket.

4. Detach the lower ends of the brake and clutch pedal return springs and leave attached to the support bracket.

5. Remove the two bolts securing the steering column to the underside of the dashboard.

6. Disconnect the clutch cable from its pedal location (see Fig. 23).

NOTE.—Slacken off the cable adjustment in order to provide sufficient cable slack.

7. From inside the engine compartment remove six 13 mm. nuts retaining the pedal support bracket to the engine bulkhead. Note that three of these nuts secure the brake servo unit where fitted.

8. (*a*) (*Without Servo Unit*)
Remove the bolt and stud securing the master cylinder to the bulkhead and care-

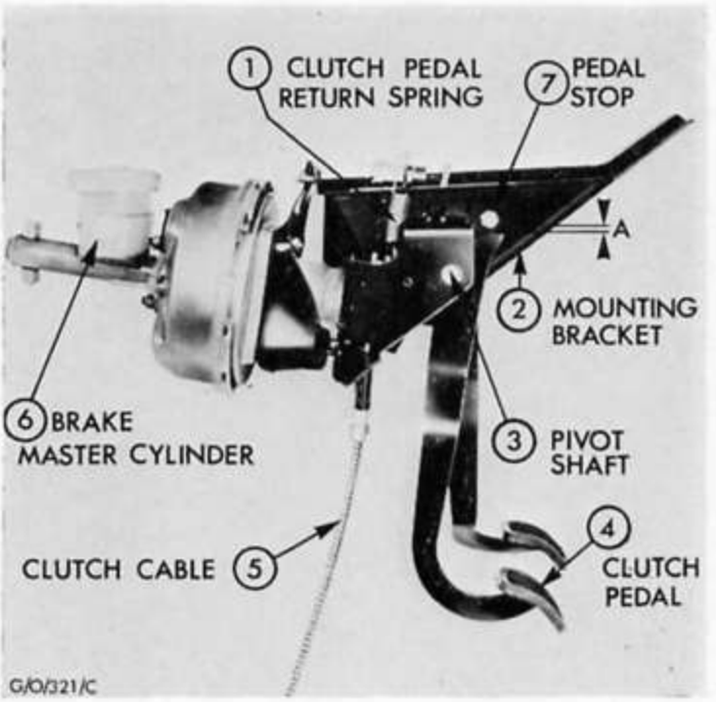


Fig. 26
Clutch Pedal Assembly (After December 1970)
NOTE: Dimension A = 3.5 to 4.5 mm. (0.13 to 0.18 in.)

fully support the master cylinder avoiding any damage to the brake lines.

(*b*) (*With Servo Unit*)
Carefully pull the servo unit off its mounting studs to give access to the remaining two pedal shaft support bracket bolts.

NOTE.—Extreme care should be taken when removing the servo to avoid damaging the brake lines. Support the servo and remove the remaining bolt and stud.

9. Pull the pedal support bracket away from the body with the pedals attached.

10. Remove the air flow ventilation hose from its location on the heater and push it to one side.

11. Position the pedal support bracket so that the pivot shaft is in line with the aperture in the heater box uncovered by the removal of the ventilation hose.

NOTE.—In order to obtain the required position of the bracket relative to the heater box aperture it may be necessary to pull the steering column slightly downwards from its dash panel mounting.

12. Slide the pivot shaft from its location in the support bracket towards and into the heater box aperture until the shaft is clear of the pedals. They can then be removed.

13. Inspect the pedal bushes for any sign of wear.

To Replace

1. Reconnect the return spring to the clutch pedal. It is easier to carry out this operation at this stage due to improved access.

2. Align the support bracket with the heater box aperture. Position the clutch pedal and push the shaft until the clutch pedal is fully located.

3. Reconnect the brake pedal return spring and repeat the above procedure.

4. (*a*) (*Without Servo*)
Reposition the support bracket to the bulkhead and position the master cylinder to it by means of the two securing bolts. Secure the assembly with the six nuts, washers and spring washers.

(*b*) (*With Servo*)
Position the support bracket to the bulkhead and secure with the bolt and stud. Locate the servo unit and master cylinder on the support bracket studs and secure with the six nuts, washers and spring washers.

5. Retain the brake pedal shaft in position by refitting the circlip, and refit the two wires to the brake light switch.

6. Refit the air ventilation hose to the heater box.

7. Relocate the clevis to the brake pedal and secure with the pin and clip.

8. Reconnect the battery, remove the wing covers and close the bonnet.

AUTOMATIC TRANSMISSION

OVERHAUL PROCEDURES

INTRODUCTION

The automatic transmission consists of a torque converter and a hydraulically controlled automatic epicyclic gearbox with three forward gears and one reverse. In all gears the drive is through the torque converter which results in maximum flexibility, especially in top gear. The gears are selected automatically by engaging clutches and/or applying brake bands in various combinations by a hydraulic control system. The hydraulic control system and the torque converter are supplied with oil under pressure by two gear type oil pumps.

A manually controlled mechanical parking pawl lock is incorporated so that the transmission output shaft can be locked when the vehicle is stationary.

The transmission selector lever is mounted in the instrument panel, convenient to the driver's left hand (R.H.D. vehicles). As a crash safety precaution the lever may be fully depressed into the dash, and easily drawn out again for normal operation. Five selector positions are given, namely "L" lock-up, "D" drive, "N" neutral, "R" reverse, and "P" park. The engine starting cycle is routed through an inhibitor switch, which makes it impossible to start the engine unless the selector is in "N" or "P" position. On later models the selector position indicator illuminates when the side lights are switched on.

Driving Technique

Cold Starting Procedure (Petrol Engines only— see page 73).

For normal driving, move the selector lever to the "D" position. Release the handbrake and depress the accelerator. The vehicle will move off in first gear, and automatically change to second and third gears as the road speed increases. The actual road speeds at which the upward gear changes occur will depend on the accelerator pedal position. Under light throttle conditions, the upward changes will occur at lower speeds, thereby assisting fuel economy. Under heavy throttle conditions, the upward gear changes will occur at higher road speeds, thereby making the best use of the lower gears to obtain maximum acceleration. To slow up or stop the vehicle, release the accelerator and apply the brakes.

NOTE.—With the selector lever in the "D" position, there is no engine braking effect.

If the selector lever is moved to the "L" position when the vehicle is stationary, the transmission will automatically select first gear, and will remain locked in that gear as the vehicle is driven off, irrespective of road speed or accelerator position. Maximum engine braking is obtained under these conditions.

If the vehicle is being driven in "D", and the transmission is in third gear, an immediate downchange to second gear will be experienced if the selector is moved to "L", and moderate engine braking will be felt.

NOTE.—"L" should not be selected at road speeds in excess of 25 m.p.h. (Diesel), or 45 m.p.h. (Petrol). The transmission will then remain locked in second gear until either (*a*) the selector is returned to the "D" position whereupon the transmission will change up into third gear, or (*b*) the road speed decreases sufficiently for the transmission to change down to first gear. In the case of (*b*), the transmission will remain locked in first gear, until the selector is moved to the "D" position, thus making upward changes possible.

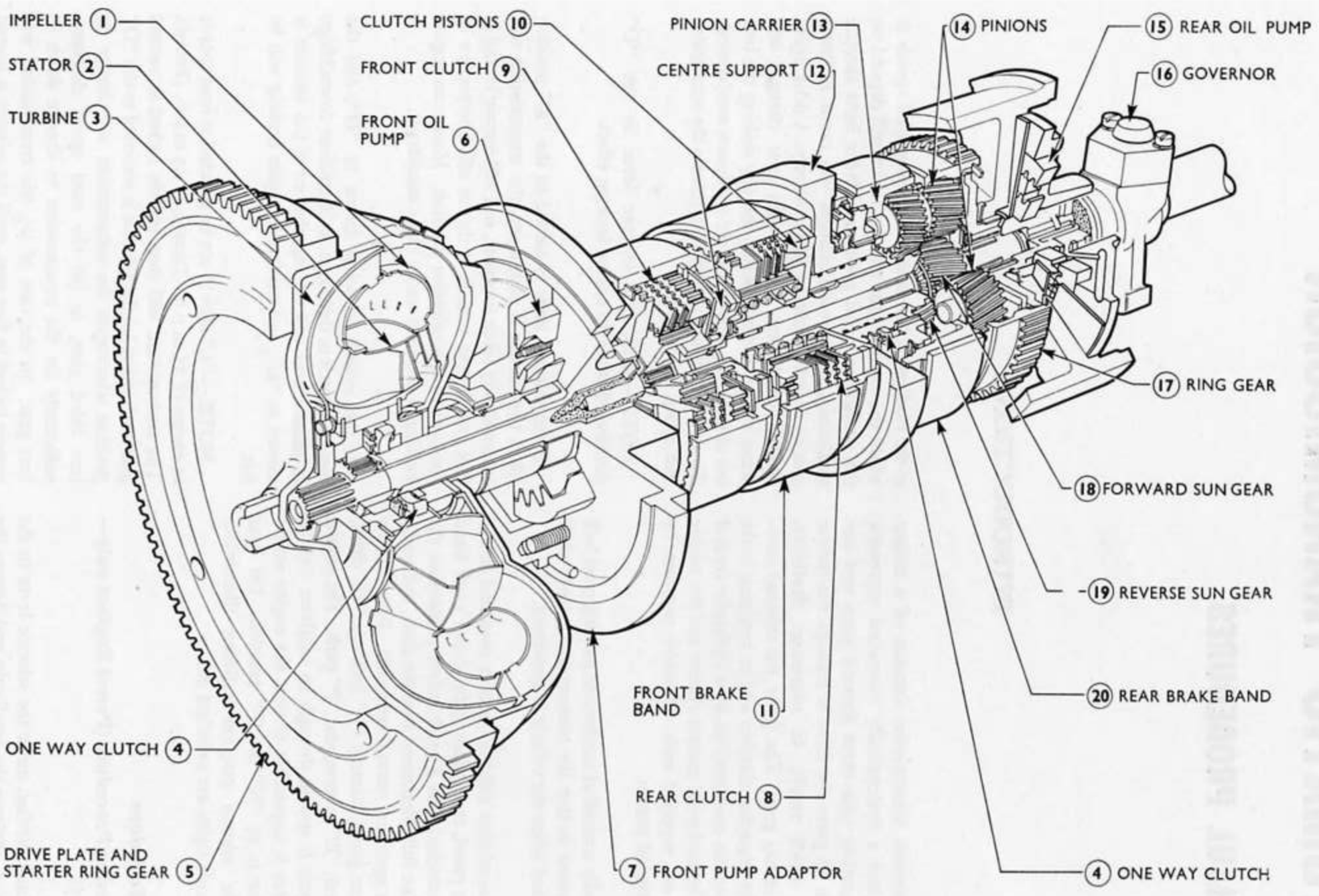


Fig. 27
Sectioned View of Transmission

Fig. 28
Selector Lever

If the accelerator is fully depressed, the "kickdown" position will be obtained. Under these conditions, upward gear changes will be delayed until the road speed in each gear has reached a pre-determined maximum. Downward gear changes will be made if the road speed is less than the pre-determined maximum for the lower gears.

To reverse the vehicle move the selector lever to "R", and depress the accelerator pedal. (IMPORTANT.—Never select "R" whilst travelling forward. The transmission will change into reverse gear, causing extensive damage, apart from being extremely dangerous.) The only exception to this rule is when "rocking" the vehicle out of snow or mud, when "D" and "R" are selected alternately.

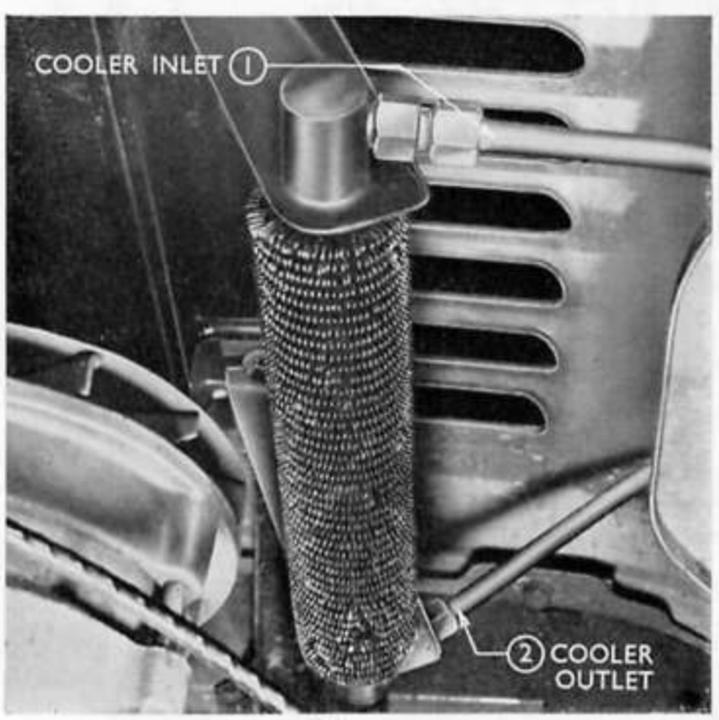


Fig. 29
Oil Cooler

If it is required to tow the vehicle, the selector lever should be moved to the "N" (neutral) position.

In the event of the transmission being seized, the propshaft should be disconnected and tied up before the vehicle is towed, or extensive damage may result.

When the vehicle is to be parked, the selector should be moved to the "P" position. This automatically locks the transmission, thereby immobilising the vehicle. Under no circumstances should "P" be selected whilst the vehicle is moving.

Tow Starting

(*a*) *Petrol-Engined Vehicles.* Select 'N' and tow the vehicle at approximately 40 k.p.h. (25 m.p.h.). Select 'D' for two or three seconds, and then select 'L'.

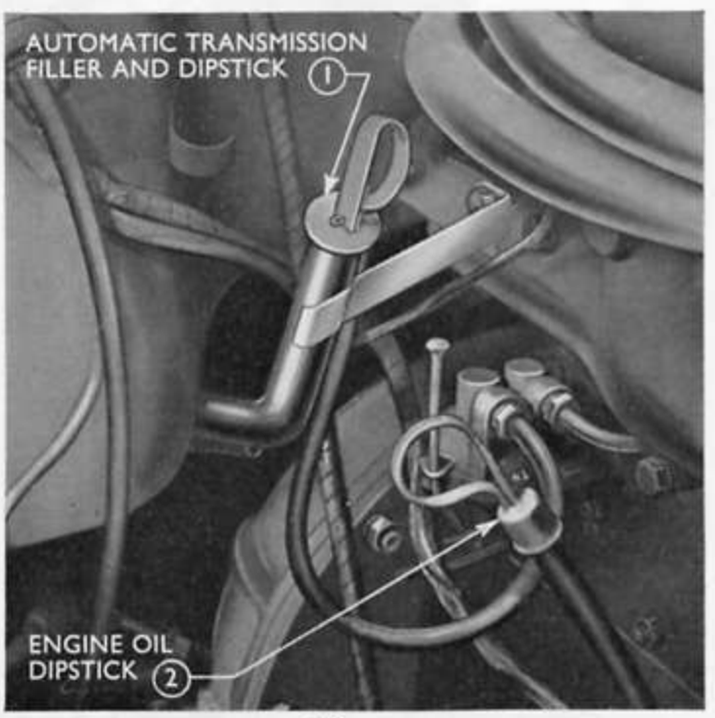


Fig. 30
Dipstick and Filler Tube (Diesel shown)

(*b*) *Diesel-Engined Vehicles.* Select 'N'. With high axle ratio vehicles, it may be necessary to tow at speeds up to 56 k.p.h. (35 m.p.h.). Select 'D' for two or three seconds, and then select 'L'.

Routine Maintenance

Every 8,000 km. (5,000 miles) the transmission fluid level should be checked with the vehicle on level ground and with the transmission at normal operating temperature. Select "P" and allow the engine to idle for two minutes. With the engine still idling in "P", withdraw the dipstick, wipe it with a piece of clean non-fluffy rag, and check the fluid level. If necessary add fluid through the dipstick tube to bring the level up to the full mark.

The transmission incorporates a cooler, mounted at the right hand side of the radiator. Ensure that the cooler is kept clean and free of mud, etc. as it may otherwise lose its efficiency and overheating may result.

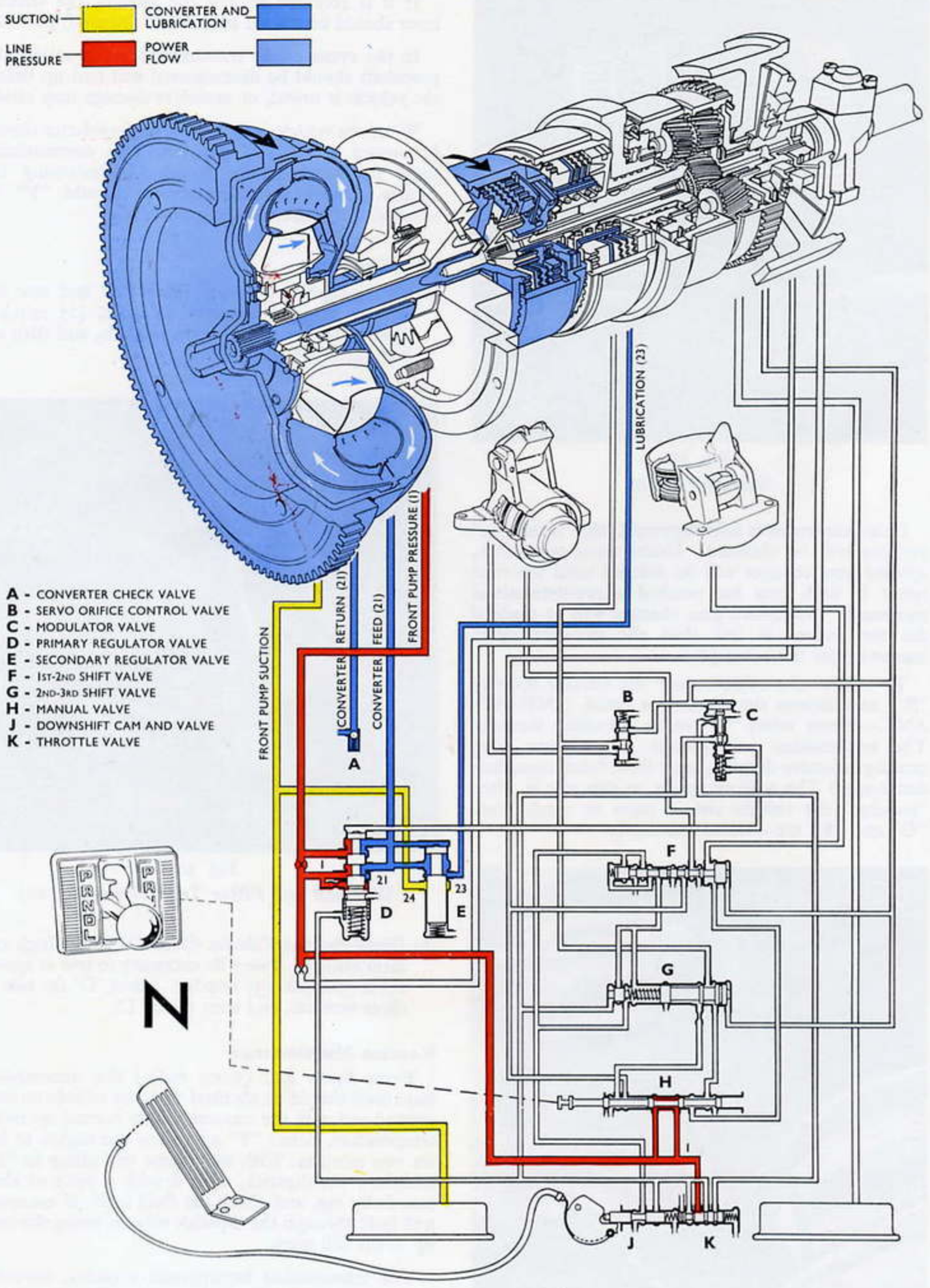


Fig. 31
Hydraulic Circuits and Power Flow "N"
(For details of hydraulic circuit numbers, see page 51)

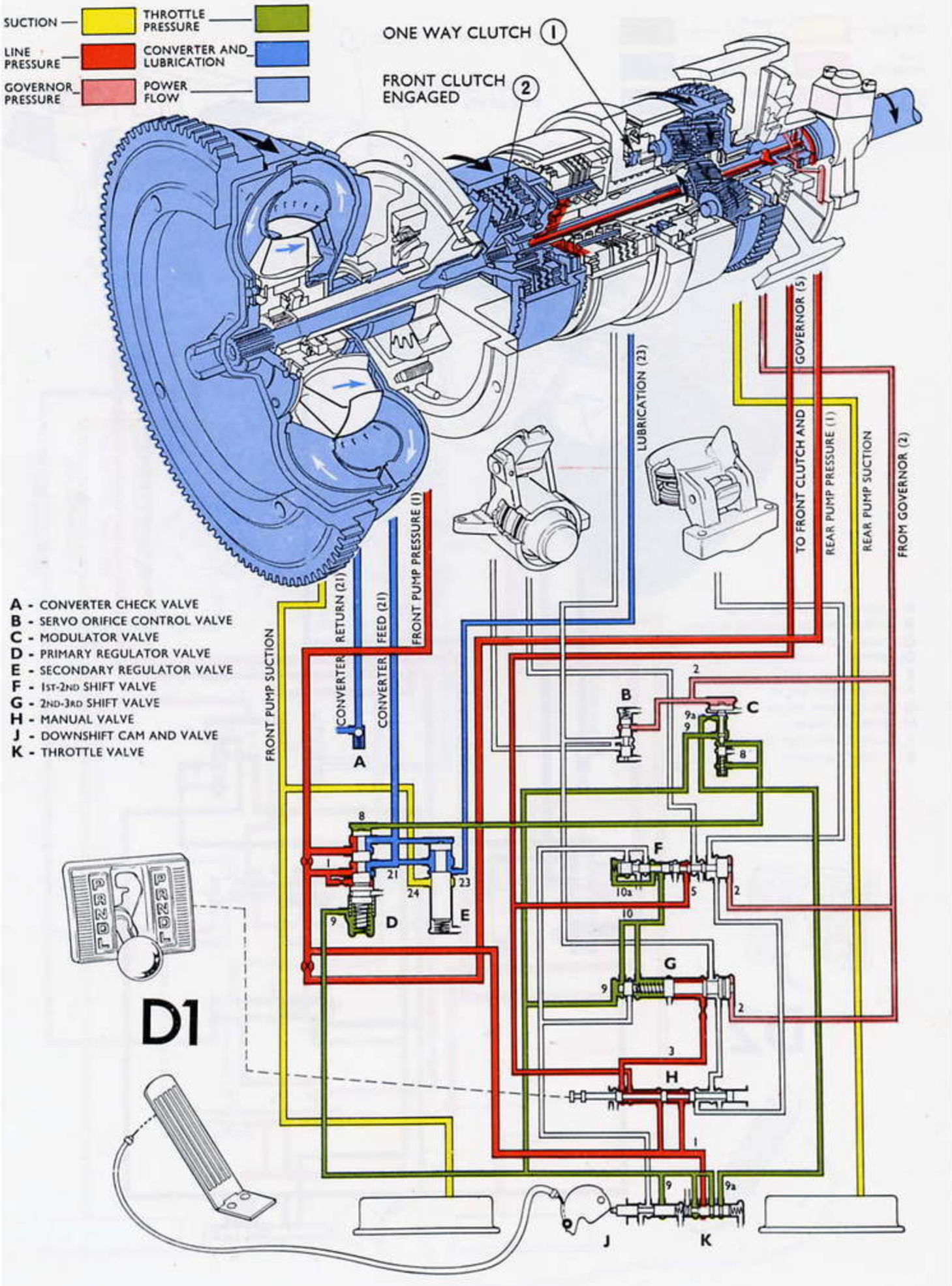


Fig. 32
Hydraulic Circuits and Power Flow "D1"
(For details of hydraulic circuit numbers, see page 51)

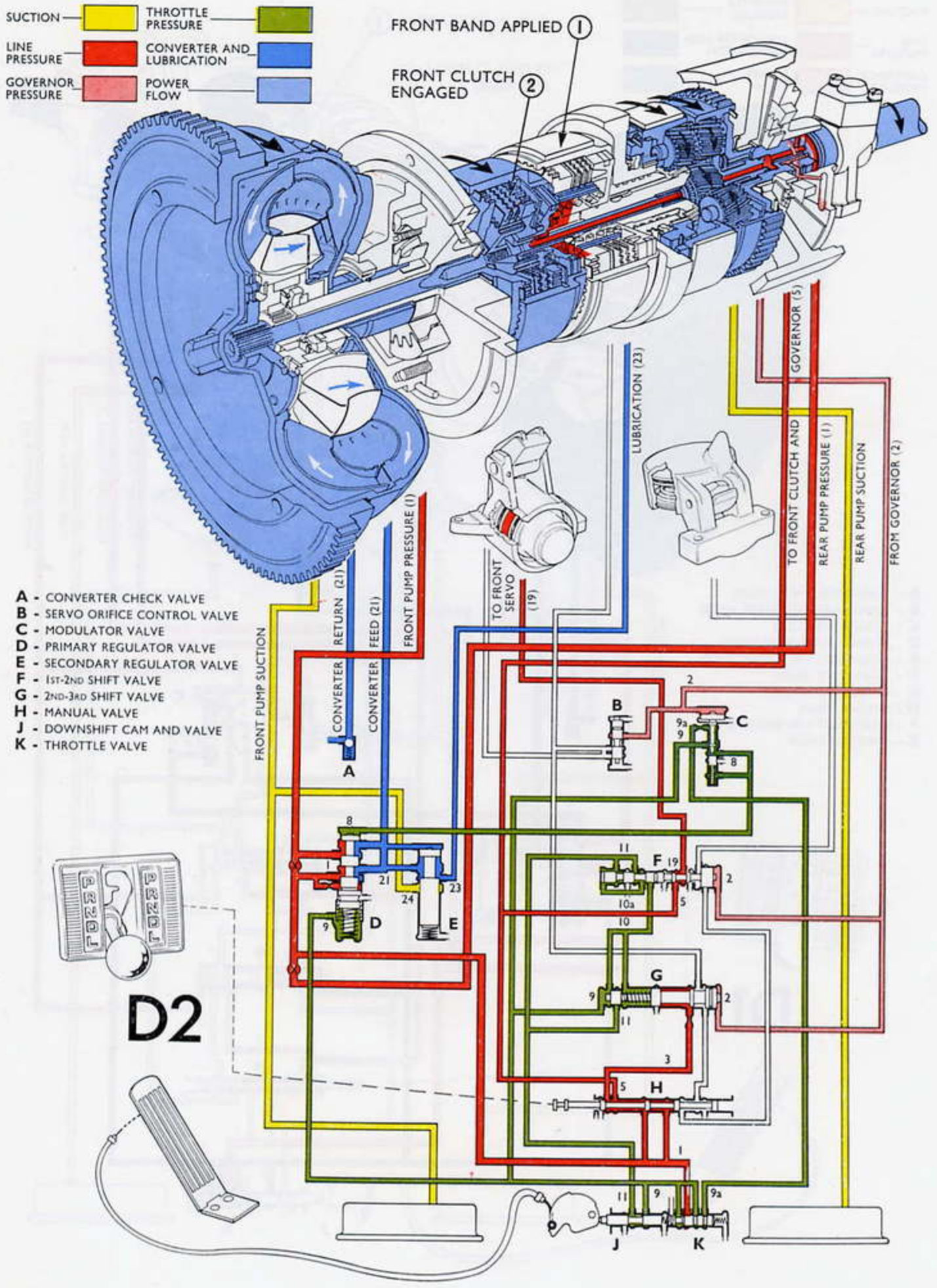


Fig. 33
Hydraulic Circuits and Power Flow "D2"
(For details of hydraulic circuit numbers, see page 51)

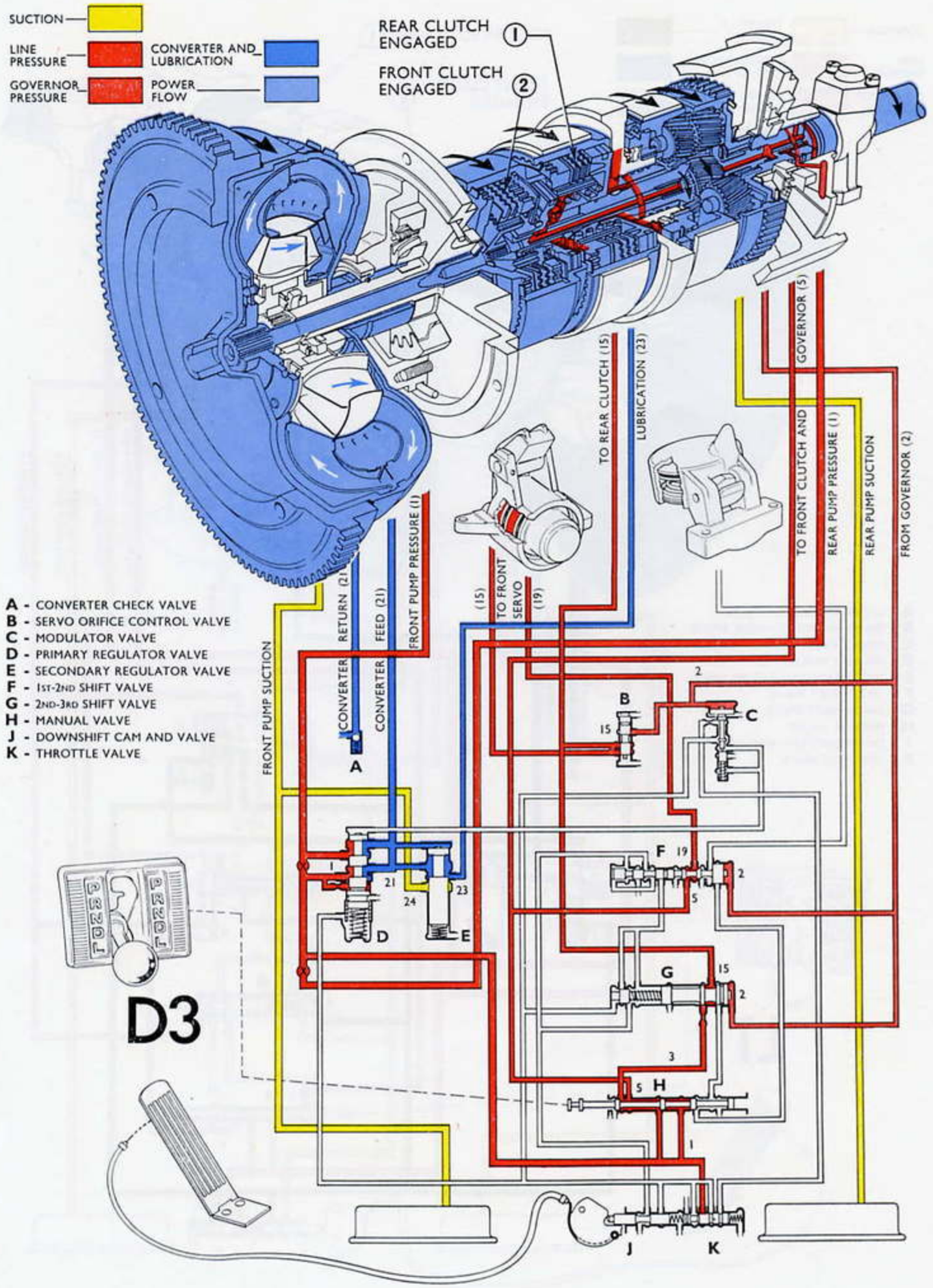


Fig. 34
Hydraulic Circuits and Power Flow "D3"
(For details of hydraulic circuit numbers, see page 51)

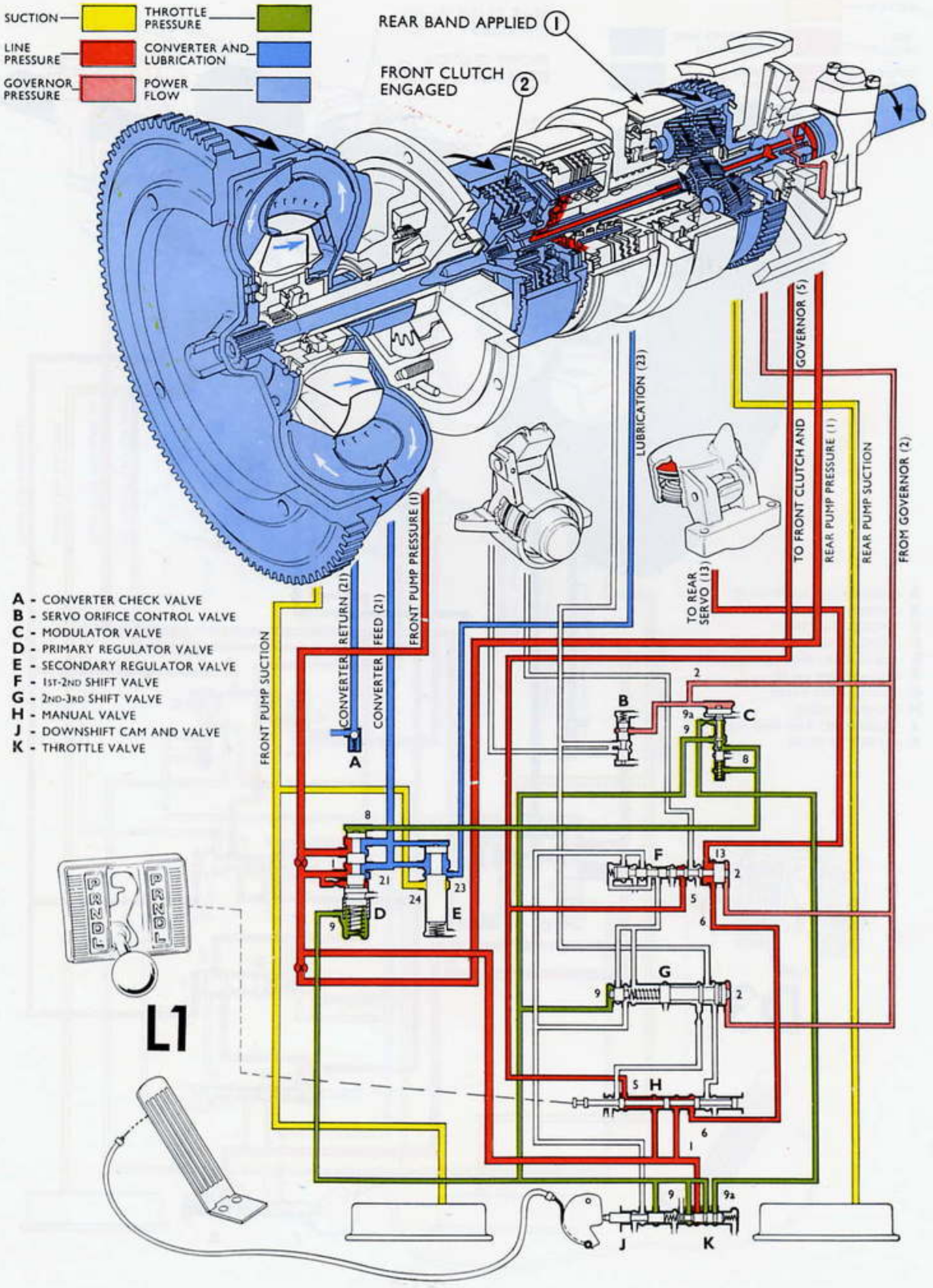


Fig. 35
Hydraulic Circuits and Power Flow "L1"
(For details of hydraulic circuit numbers, see page 51)

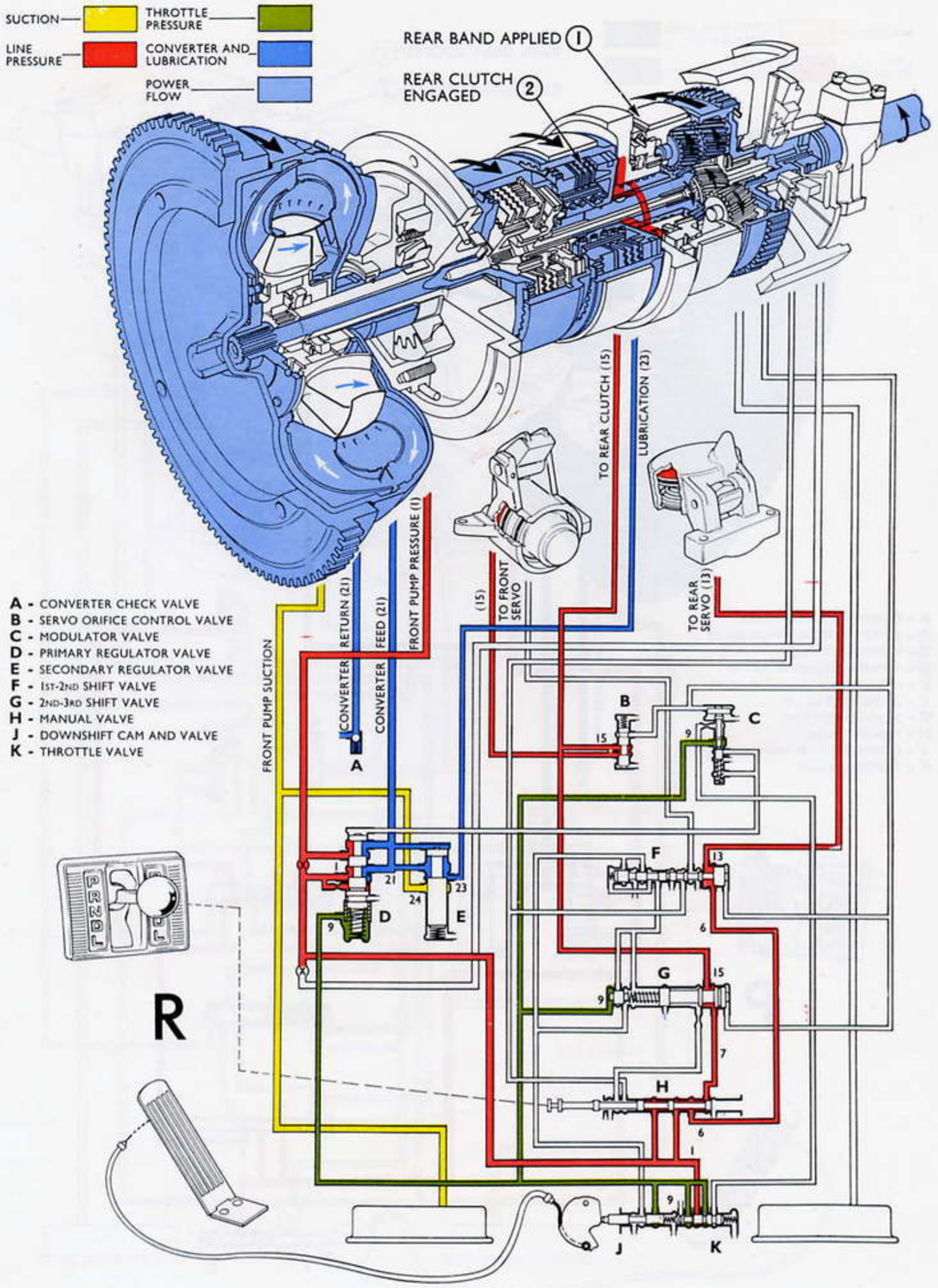


Fig. 36
Hydraulic Circuits and Power Flow "R"
(For details of hydraulic circuit numbers, see page 51)

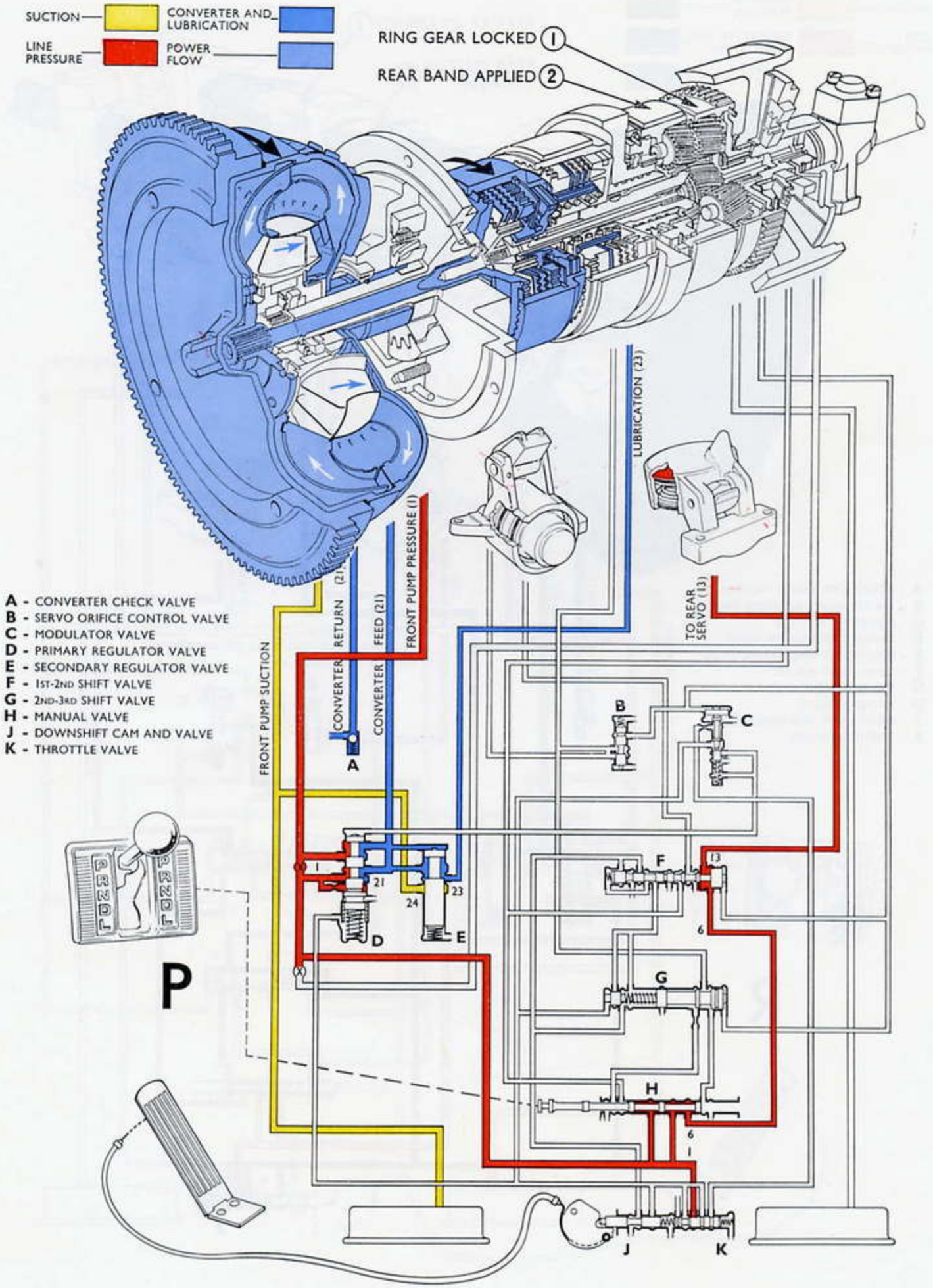


Fig. 37
Hydraulic Circuits and Power Flow "P"
(For details of hydraulic circuit numbers, see page 51)

TABLE 1—HYDRAULIC CIRCUITS

(*Used in conjunction with Figs.* 31 *to* 37)

Circuit No.	*Pressure Name*	*From*	*To*
1	Line pressure	Front and rear pump ..	Primary regulator valve. Manual valve. Throttle valve.
2	Governor pressure.. ..	Governor	Modulator valve. 1–2 shift valve. 2–3 shift valve. Servo orifice control valve.
3	Directed line pressure ..	Manual control valve ..	2–3 shift valve.
5	Directed line pressure ..	Manual control valve ..	Front clutch and governor feed. 1–2 shift valve.
6	Directed line pressure ..	Manual control valve ..	1–2 shift valve.
7	Directed line pressure ..	Manual control valve ..	2–3 shift valve.
8	Modulated throttle pressure	Modulator valve ..	Primary regulator valve (piston end).
9	Throttle pressure	Throttle valve	Modulator valve. Primary regulator valve (spring end). 2–3 shift valve. Shift valve plunger.
9a	Throttle pressure controlled by modulator valve ..	Modulator valve ..	Throttle valve.
10	Shift valve plunger pressure	Shift valve plunger ..	2–3 shift valve. 1–2 shift valve.
10a	Shift valve plunger pressure	Shift valve plunger ..	1–2 shift valve.
11	Forced throttle pressure ..	Downshift valve.. ..	1–2 shift valve. 2–3 shift valve.
13	Line pressure	1–2 shift valve	Rear servo apply.
15	Line pressure	2–3 shift valve	Rear clutch and front servo release.
19	Line pressure	1–2 shift valve	Front servo apply.
21	Converter pressure ..	Primary regulator valve	Secondary regulator valve and converter.
23	Lubrication pressure ..	Secondary regulator valve	
24	Exhaust	Secondary regulator valve	Front pump suction.

TRANSMISSION OVERHAUL PROCEDURE

To remove

1. Disconnect the battery.

2. Jack up the vehicle and fit four stands.

3. Remove the drain plug and drain the gearbox.

4. (*a*) 130 Diesel.

Disconnect the driveshaft from the gearbox and tie to one side.

(*b*) 75, 90 and 115 Diesel; 75, 90 and 115 Petrol.

Mark the driveshaft coupling flange and the pinion flange to facilitate correct reassembly. Disconnect the driveshaft from the pinion. Lower the rear end of the shaft and slide it back so that the front end is drawn off the transmission output shaft splines. Remove the driveshaft.

5. Disconnect and remove the exhaust pipe from the manifold and the silencer.

6. Disconnect the speedometer cable.

7. Disconnect the selector cable at the gearbox end, and remove the support bracket.

8. Remove the dipstick; disconnect and remove the dipstick tube assembly.

9. Disconnect the wires from the two spade terminals on the inhibitor switch.

10. Disconnect the downshift cable from the throttle link and bracket.

11. Disconnect the starter motor leads and remove the starter motor.

12. (*a*) *Diesel Engines.* Remove the small access panel from the forward face of the bell housing mounting plate. (Retained by two cross-head screws.)

(*b*) *Petrol Engines.* Remove the two engine stays and the bell housing inspection cover.

13. (*a*) *Diesel Engines.* Working through the access hole, bend back the lock tabs and remove the four bolts securing the drive plate to the torque converter.

(*b*) *Petrol Engines.* Working through the bell housing inspection aperture, remove the four bolts securing the drive plate to the torque converter. (NOTE: There are no lock tabs on these bolts.)

14. Release the oil cooler inlet and outlet pipes from the gearbox.

15. Disconnect the track rod from one end and swing the rod to one side to obtain sufficient working clearance.

16. Support the transmission with a transmission jack and a suitable block of wood beneath the gearbox sump. Secure the transmission to the jack by means of the jack retaining chains.

17. Remove the extension housing support bolt and bushes, and slightly lower the transmission jack.

18. Support the engine with a jack and suitable block of wood under the engine sump.

19. Remove the remaining bell housing bolts.

20. Draw the transmission jack rearwards to disconnect the torque converter spigot from its location in the crankshaft adaptor.

21. Lower the transmission and withdraw from beneath the vehicle.

22. Place the transmission on the special overhaul cradle (Tool No. BW 35B).

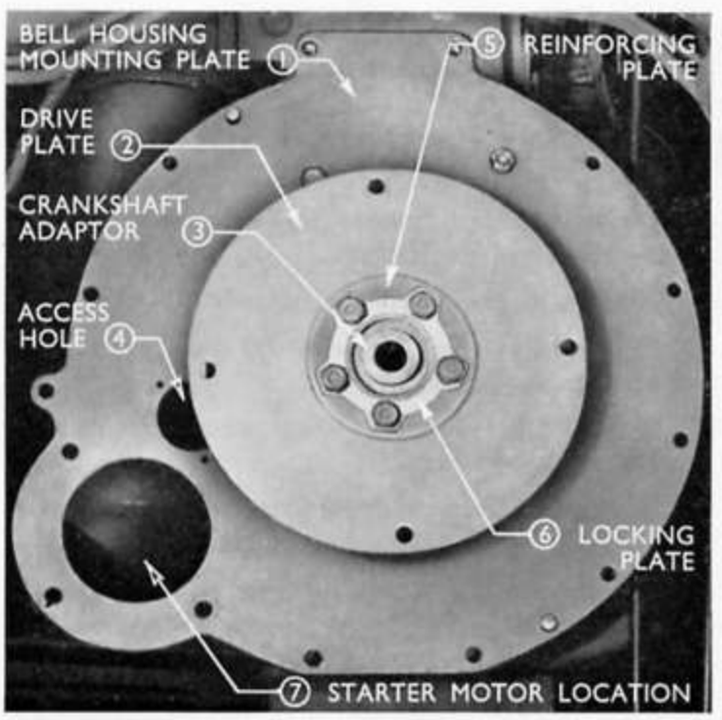


Fig. 38
Drive Plate Assembly
(Diesel shown)

Fig. 39
Torque Converter and Ring Gear Assembly

23. Draw out the torque converter and starter ring gear assembly.

24. Remove the six bolts securing the bell housing to the gearbox, and remove the housing.

25. 130 Diesel.

Remove the retaining nut from the transmission output shaft drive flange, and draw the flange off the shaft.

26. Remove the four bolts securing the extension housing to the gearbox case, and remove the housing.

To Replace

1. Reassemble the bell housing to the gearbox and tighten the six retaining bolts.

2. Locate the torque converter correctly in the bell housing, and push firmly into position on the input shaft splines whilst rotating the converter.

3. Reassemble the extension housing to the gearbox case, and tighten the four retaining bolts.

4. 130 Diesel.

Slide the drive flange onto the output shaft, and fit the retaining nut.

5. Position the transmission assembly on a transmission jack beneath the vehicle. Slide the assembly forward so that the torque converter spigot locates in the crankshaft adaptor.

6. Insert and tighten the bell housing bolts.

NOTE.—The wiring loom and speedo cable support clips, the selector control cable support bracket and, in the case of petrol engines, the filler tube support bracket, are all located on bell housing bolts, and must be assembled at this stage.

7. Position the extension housing as necessary and insert the single support bolt, two rubber bushes, and tighten the nut.

8. Remove the transmission and engine jacks.

9. Replace the track rod.

10. Replace the oil cooler inlet and outlet pipes.

11. Replace the speedometer cable.

12. Replace the inhibitor switch wires.

13. Replace the driveshaft.

14. Locate the selector control cable in the support bracket. Select the "D" position on the selector lever in the cab. Push the manual valve operating lever fully rearwards, and then move the lever forward by two "clicks". This puts the gearbox in "D". Adjust the length of the cable so that the clevis can be connected freely to the operating lever in this position. Tighten the cable adjuster locknut and again check that the clevis pin can be freely inserted. Lock the clevis pin with a spring clip.

15. Replace the four bolts securing the torque converter to the drive plate, and bend back the lock tabs.

16. (*a*) *Diesel.* Replace the access plate and secure with the two crosshead screws.
(*b*) *Petrol.* Replace the two engine stays and the bell housing inspection cover.

17. Replace the starter motor and reconnect the motor leads.

18. (Diesel only) Replace the dipstick tube, and reconnect the support bracket to the inlet manifold.

19. Reconnect the exhaust system.

20. Remove the stands and lower the vehicle.

21. Select "P" with the selector lever in the cab.

22. Reconnect the battery.

23. Refill the system with transmission fluid, type M-2C-33F and check the level (see page 43).

24. Reconnect the downshift cable to the throttle linkage, and adjust the cable length. (See page 69, Adjustments).

25. Check for correct operation of the starter inhibitor switch. (Engine should only start in "P" or "N"). If necessary, adjust the switch as described on page 69, Adjustments.

TO OVERHAUL THE TRANSMISSION

FRONT PUMP

To Remove

1. Check the input shaft end-float.

2. Withdraw the front pump assembly, gasket and thrust washer after removing the six bolts and spring washers.

3. Remove five bolts, one cheese-head screw and spring washers to separate the pump housing from the pump adaptor.

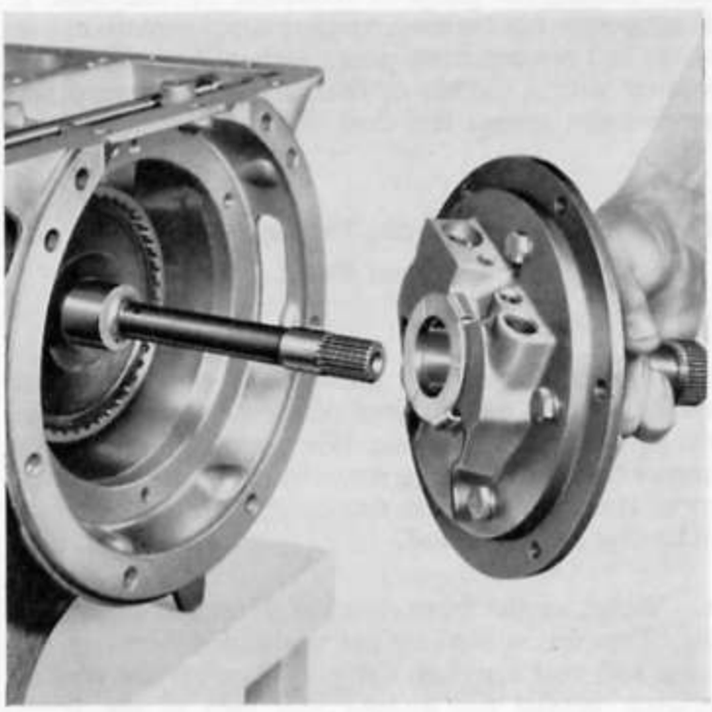


Fig. 40
Removing Front Pump

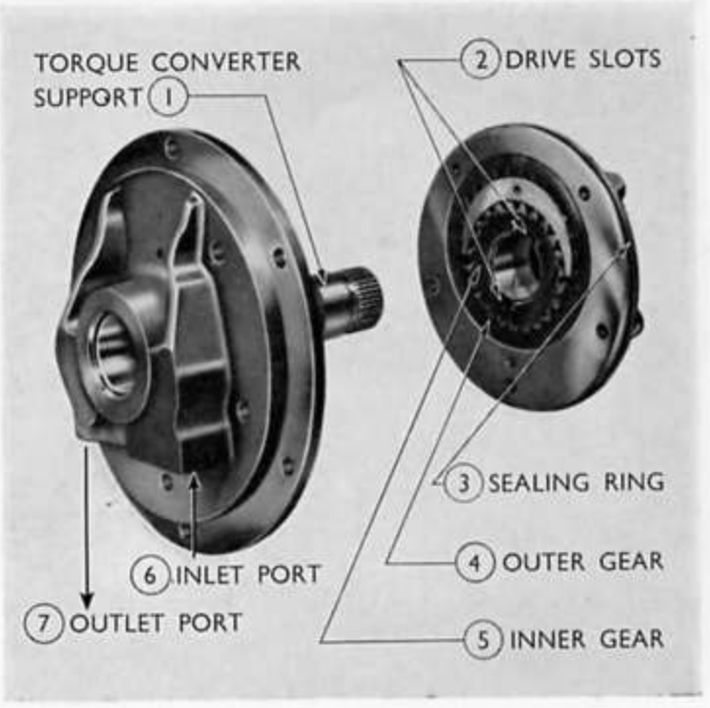


Fig. 41
Front Pump - Exploded

4. Mark both the inner and outer gear faces to ensure that when reassembled the gears are replaced the same way round as removed. Remove both gears.

5. Remove the sealing ring from around the periphery of the pump housing. Carefully clean and inspect each part for signs of wear, paying particular attention to the white metal bearings in the pump housing, the adaptor and the driving gear. If necessary, remove the seal from the pump housing.

To Replace

1. Replace the seal in the pump housing. This seal has a bright metal outer diameter.

2. Replace the inner and outer gears in the pump housing, noting the marks made when dismantling, and lightly lubricate them with transmission fluid.

3. Fit a new sealing ring around the periphery of the pump housing.

4. Position the pump housing on the pump adaptor, lining up the hole in pump housing segment with the corresponding hole in the pump adaptor. Secure the pump adaptor with five bolts and lockwashers, and one cheese-headed screw and lockwasher. Torque the five bolts to 2.4 to 3.1 kg.m. (17 to 22 lb. ft.) and the cheese-head screw to 0.3 to 0.4 kg.m. (24 to 36 lb. in.).

5. Position the thrust washer on the rear face of the front pump and, using a new gasket, replace the front pump and secure with six bolts and lockwashers.

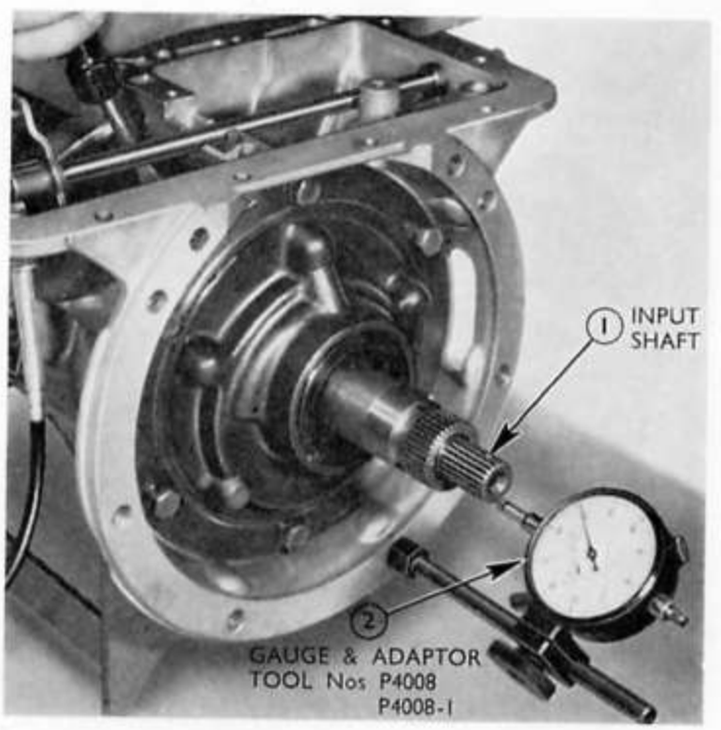


Fig. 42
Checking End-float of Input Shaft

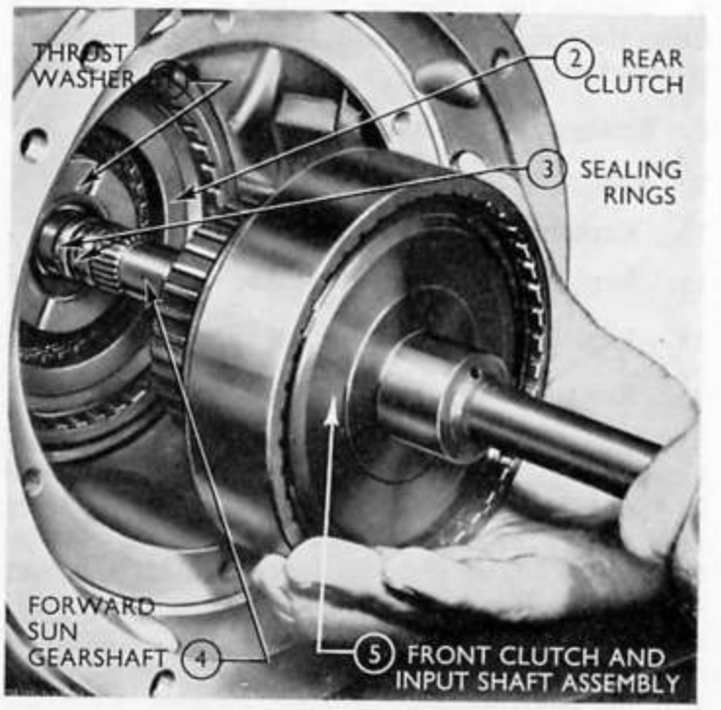


Fig. 43
Removing Front Clutch and Input Shaft

6. Check the gear train end-float. Using a screwdriver between the case and the front of the front clutch, push the gear train as far rearwards as possible to take up any end-float. Set up a dial indicator gauge, Tool Nos. P.4008 and P.4008-1, on the front face of the gearbox with the dial indicator set on the end of the input shaft, and set the gauge to zero. Lever the gear train assembly forward, inserting the screwdriver between the ring gear and rear wall of the transmission case, reading the gauge to determine the end-float. If this figure is not between 0.254 to 0.762 mm. (0.010 to 0.030 in.) remove front pump and replace the thrust washer with a thicker or thinner one as appropriate to give the correct end-float. Re-check end-float.

Front or Rear Clutch, Primary Sun Gear or Front Band

To Remove

1. The front servo is secured by two bolts and spring washers and removal of these bolts will enable the servo to be withdrawn. When removing the servo ensure that the operating strut, which transmits movement from the servo to the band, does not fall out, otherwise it may be lost.

2. Withdraw the front clutch and input shaft assembly. Two thrust washers are positioned between the front and rear clutches, the phosphor bronze washer bearing against the ground rear face of the front clutch and the steel washer, which has two flats on its internal diameter, locating on the rear clutch projection.

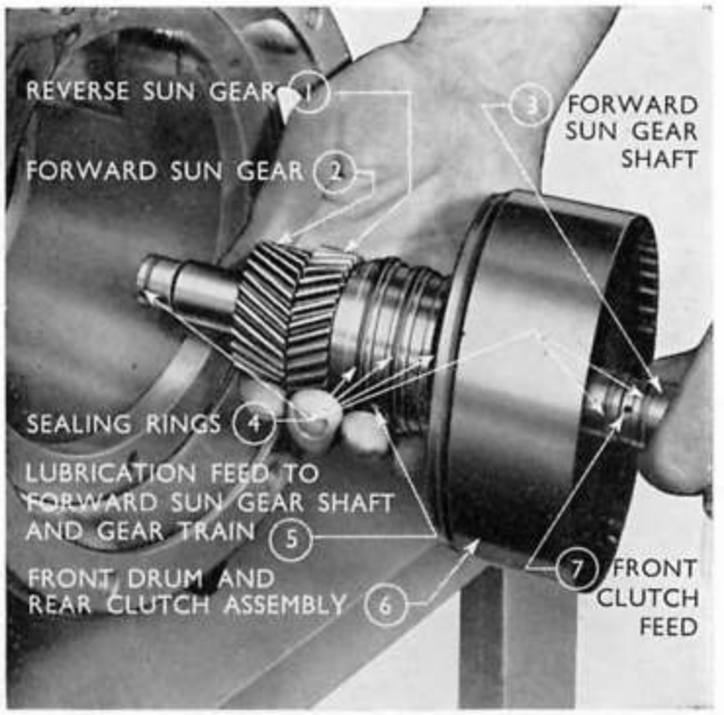


Fig. 44
Removing Rear Clutch and Sun Gears

3. Withdraw the rear clutch and sun gears. The needle thrust race and washer are positioned on the rear of the front sun gear shaft and should be removed. Disengage the front band from the stop in the transmission case, tilt slightly and remove.

4. Carefully remove two sealing rings from the front end of the forward sun gear shaft. Withdraw the forward sun gear shaft from the rear clutch assembly. The clutches may now be serviced as follows:—

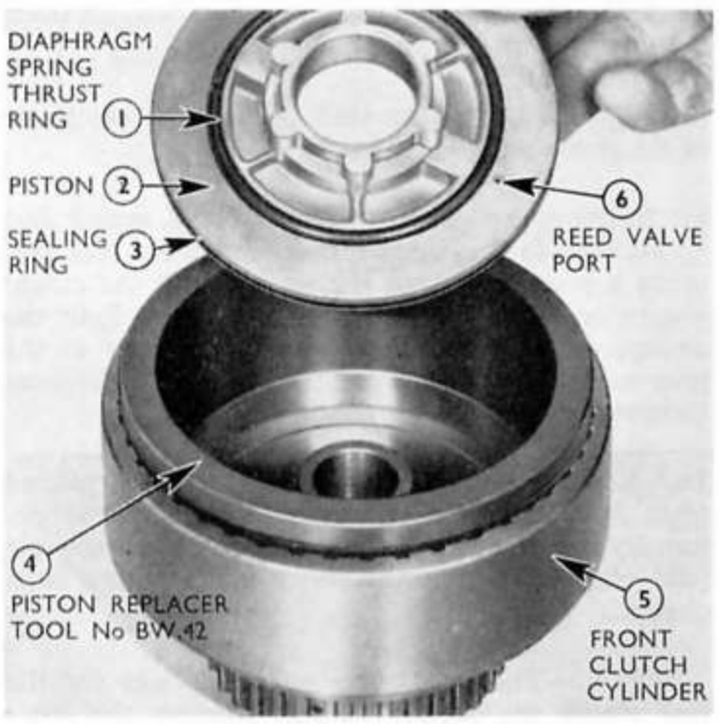


Fig. 45
Replacing Front Clutch Piston

(a) **Front Clutch**

To Dismantle

1. With the aid of a screwdriver remove the circlip retaining the input shaft to the clutch cylinder. Then withdraw the input shaft and thrust washer.

2. Remove the clutch plates, noting their positions. An internally toothed plate should be the first plate viewed when the input shaft is removed and the thick externally splined pressure plate the last, the plates alternating.

3. Remove the clutch inner hub which will reveal a further large circlip retaining a diaphragm spring and piston. Remove this circlip and spring.

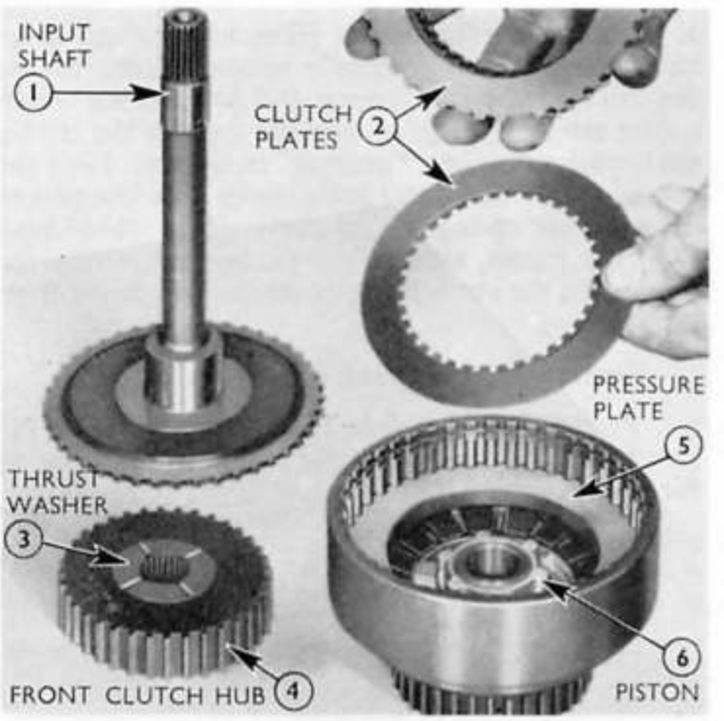


Fig. 46
Refitting Front Clutch Plates

4. To remove the piston, it is necessary to blank off one end of the clutch cylinder piston guide and apply air pressure, via a suitable adaptor, at the other end of the guide. The outer face of the piston has a steel pressure ring pressed into it. Remove the rubber sealing ring from the outer periphery of the piston and also the seal from the piston guide in the clutch cylinder.

To Reassemble

5. Thoroughly clean and inspect all parts and lubricate them with transmission fluid prior to assembly. Replace the rubber seals around the periphery of the piston and piston guide. Refit the piston, using Tool No. BW.42, ensuring that the steel pressure ring on

the outer face of the piston is correctly seated. Reposition the spring with the fingers resting on the steel pressure ring of the piston and secure with a large circlip.

6. Refit the thick externally splined pressure plate, with the plain face outwards, and alternating internally and externally splined clutch plates ending with an internally splined plate. The front clutch externally toothed plates are flat, whereas those for the rear clutch are slightly dished.

7. Replace the central hub and thrust washer.

8. Reposition the input shaft and secure with a large circlip.

(*b*) Rear Clutch

To Dismantle

1. Remove the large circlip retaining the clutch plates, with the aid of a screwdriver.

2. Remove the thin spacer plate, adaptor and alternate internally and externally splined plates. Locate the clutch spring compressor, BW.37A, on the clutch spring retaining plate so that the ends of the circlip are opposite the large "window" in the tool. Place the assembly in a press and press down onto the tool to compress the spring. Using circlip pliers, 7066J with "J" type points, remove the circlip and release the press until the spring is fully released. Remove from the press.

3. Remove the spring and spring seat.

4. To remove the piston, apply air pressure to the hole in the groove next to the sealing ring closest to the front drum.

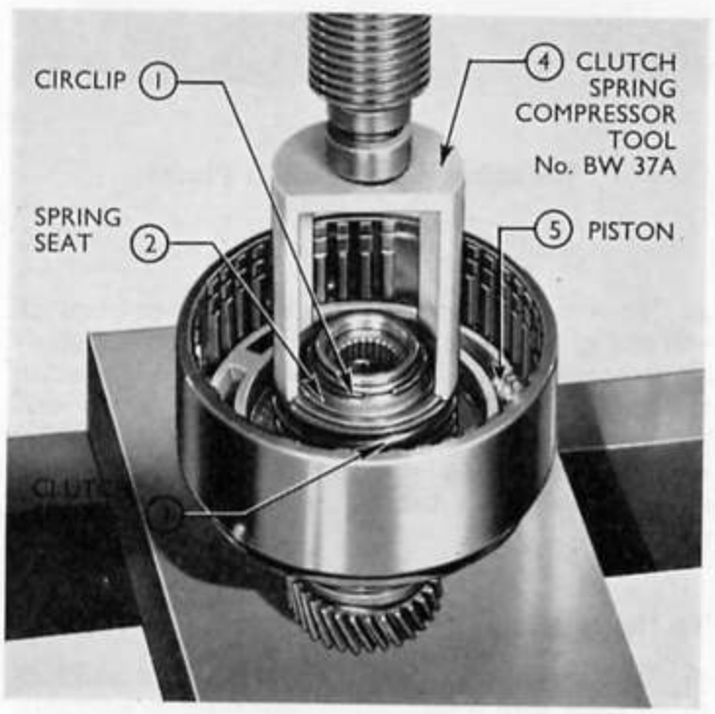


Fig. 47
Dismantling Rear Clutch

Fig. 48
Fitting Rear Clutch Piston

5. Remove the rubber sealing rings from around the periphery of the piston and piston guide.

6. Carefully remove three sealing rings from the reverse sun gear shaft.

To Reassemble

7. Thoroughly clean and inspect all parts, paying particular attention to the needle race which supports the forward sun gear shaft.

8. Replace the rubber seals around the periphery of the piston and piston guide.

9. Position the piston (using BW.41), spring and spring seat; fit the clutch spring compressor tool and, using a press, compress the spring until the circlip groove on the piston guide is uncovered. Refit the circlip, ensuring that it is seating correctly in the groove. Release the press and remove the clutch spring compressor.

10. Replace the clutch plates, externally splined plate first, and then alternating internally and externally splined plates, ending with a thin spacer plate (and adaptor). Secure the clutch plates with a large circlip.

NOTE.—That the outer splined plates for the rear clutch are slightly dished, whereas the front clutch plates are flat. These dished plates can be fitted so that the dishing is either towards or away from the piston, but they must all face the same way.

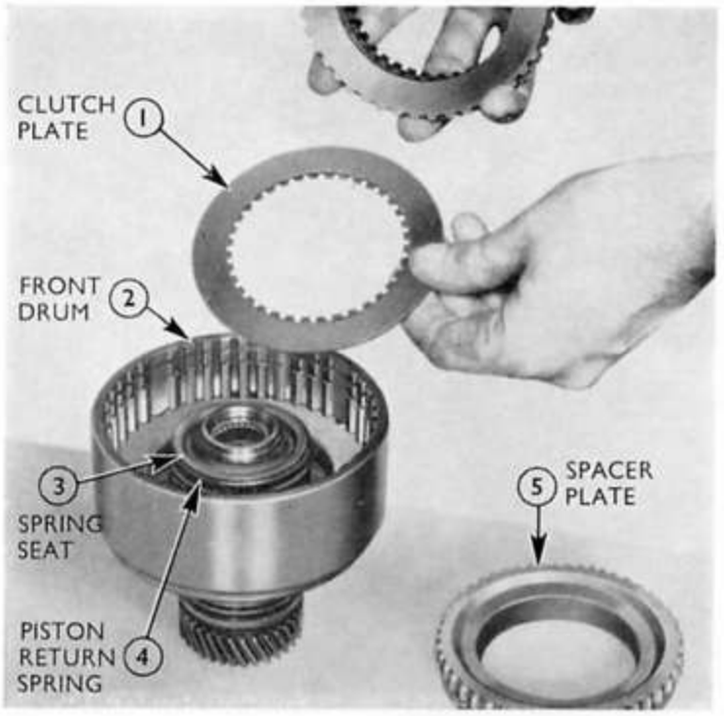


Fig. 49
Fitting Rear Clutch Plates

To Replace

1. Slide one needle thrust race onto the forward end of the forward sun gear shaft and seat it on the front face of the forward sun gear. Pass the forward sun gear shaft through the centre of the rear clutch assembly, so sandwiching the thrust race between the rear face of the reverse sun gear and the front face of the forward sun gear.

2. Replace two sealing rings on the shaft in the appropriate grooves. Fit a steel thrust washer to the front of the rear clutch, engaging the internal flats on the washer with the corresponding flats on the rear clutch. Fit a phosphor bronze thrust washer alongside the steel thrust washer. Centralise the sealing rings on the shaft and centralise the thrust washer in the centre of the front clutch.

3. Carefully assemble the front clutch to the rear clutch in a vertical position.

Replace the needle thrust race on the rear of the forward sun gear shaft. Fit a steel washer to the shaft, after the thrust race, with the lip towards the rear.

Offer up the front and rear clutch assemblies passing through the front band. When correctly positioned rotate the output shaft to ensure that the assembly will turn freely.

4. Reposition the forward band in the case, engaging the end of the band with the fixed stop on the centre web of the case.

5. Refit the front servo. Retain the operating strut to the servo operating arm by means of petroleum jelly and offer the servo assembly into position, engaging the strut with the brake band.

6. Adjust the front brake band as follows:—Slacken the adjusting screw locknut, move the servo lever outwards and place a 6.35 mm. (0.25 in.) gauge BW 34 between the servo piston pin and the adjusting screw. Tighten the adjusting screw to 0.14 kg.m. (10 lb. in.), using torque screwdriver BW548 and the adaptor BW 548-2 to tighten the locknut to 2.1 to 2.8 kg.m. (15 to 20 lb. ft.) and then remove gauge.

REAR BRAKE BAND, OUTPUT SHAFT, FREE WHEEL AND/OR PINION CARRIER ASSEMBLY

To Remove

1. Remove the extension housing.

2. Remove the speedometer driving gear.

3. Before removing the governor it should be noted that the small rectangular plate secured by two countersunk screws should face rearwards. Remove the circlip and draw the governor rearwards, care should be taken not to lose the driving ball.

4. Remove the rear pump housing, and remove the three cast-iron sealing rings from the output shaft. Mark the inner gear and driving peg to ensure correct reassembly, then remove. Withdraw the pump plate.

5. The rear servo is secured by two bolts and spring washers and removal of these bolts will enable the servo to be withdrawn. When removing the servo ensure that the operating strut which transmits movement from the servo to the band, does not fall out, otherwise it may be lost.

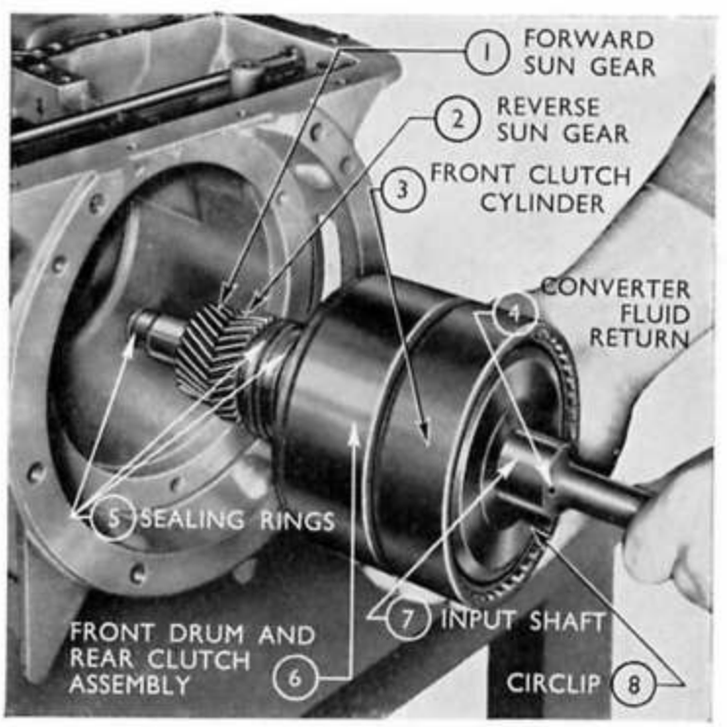


Fig. 50
Fitting Front and Rear Clutches

6. Mark where the screws are located and unscrew the two centre support securing screws and lockwashers. These screws are around the outside of the case in line with the centre support and positioned 120° either side of the rear servo front securing screw. Mark the centre support in relation to the case and if necessary tap the end of the output shaft with a hide mallet. This will drive the centre support forward so that it can be removed.

7. Withdraw the planet gear assembly. A steel washer and needle thrust washer are positioned between the planet gear assembly and the output shaft.

8. Disengage the rear band from the stop and remove.

9. Extract the one-way clutch from the outer race and then remove the outer race which is secured by a circlip in the planet gear assembly.

To Replace

10. Fit the one-way clutch outer race to the planet gear carrier, engaging the lugs on the outer race with the driving lugs on the carrier. Secure with a large circlip. Fit the one-way clutch to the outer race with the lips to the outside. Turning the cage whilst pressing inwards will assist in fitting the one-way clutch. Then, fit the centre support to the assembly, so that the centre boss is inside the one-way clutch. Place the steel washer onto the rear of the planet gear assembly with the lip rearwards, and then fit the large needle thrust race after the steel washer.

11. Position the rear band in the case, engaging the end of the band with the adjuster.

12. Offer up the planet gear assembly and centre support, engaging the planet gears with the ring gear. Align the marks, made when dismantling, on the centre support with the marks on the case and gently tap the centre support into position. Ensure that the holes in the centre support are in line with the case holes and fit the two external securing bolts and lockwashers. These lockwashers are also oil seals, and must, therefore, be fitted with the rim facing the gearbox case.

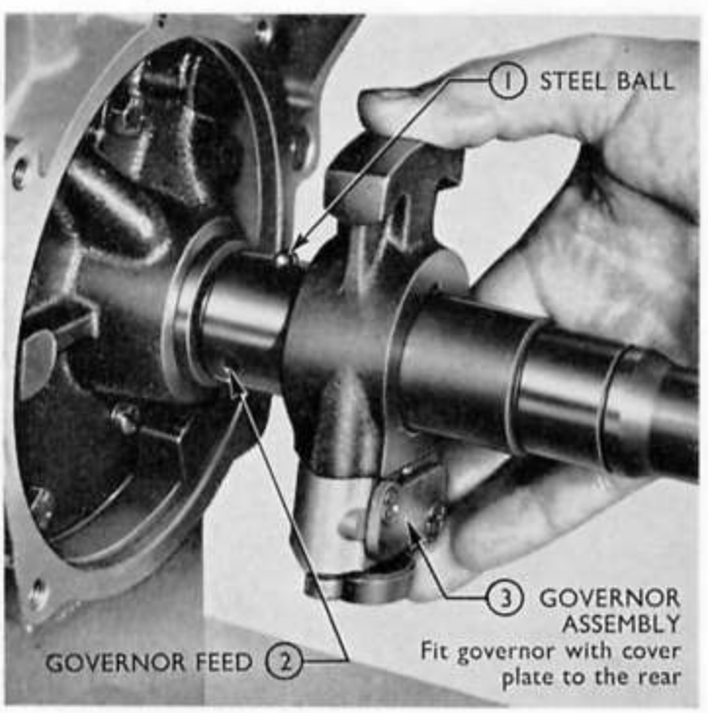


Fig. 51
Fitting the Governor

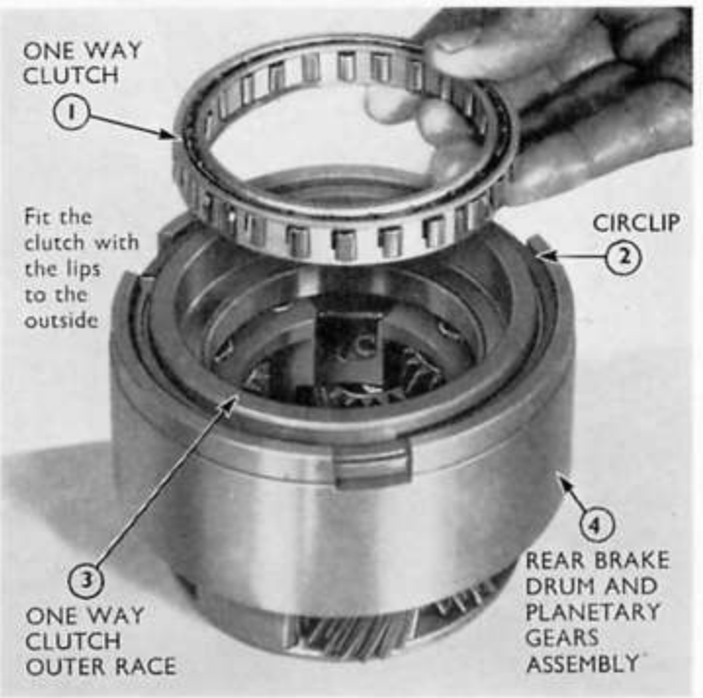


Fig. 52
Fitting One-way Clutch

13. Refit the rear pump plate, driving peg, inner gear, and the three cast-iron sealing rings. Align the pump plate by means of the hole provided for the small cheese head screw. Replace the pump housing, complete with the outer gear, taking care not to damage the sealing rings. Align the housing, using the small cheese head screw as a register, and replace the five large screws to a torque of 0.55 to 0.70 kg.m. (4 to 5 lb. ft) and the small screw to 0.24 to 0.35 kg.m. (20 to 30 lb. in.).

14. Refit the servo. Retain the operating strut to the servo operating arm by means of petroleum jelly and offer the servo assembly into position, engaging the strut with the brake band. The forward bolt for the rear servo is longer and has a reduced diameter at one end to locate the centre support.

15. Refit the governor. Turn the output shaft until the governor driving ball hole is uppermost and position the ball. Then, slide on the governor assembly ensuring that the governor plate, secured by two screws is facing rearwards. Fit the governor retaining circlip using circlip pliers.

16. Replace the speedometer driving gear, and secure with the retaining circlip (75 to 115) or the spacer tube (130 Diesel).

17. Clean the rear face of the gearbox and place a new gasket in position. Refit the extension housing and secure with four bolts and lockwashers.

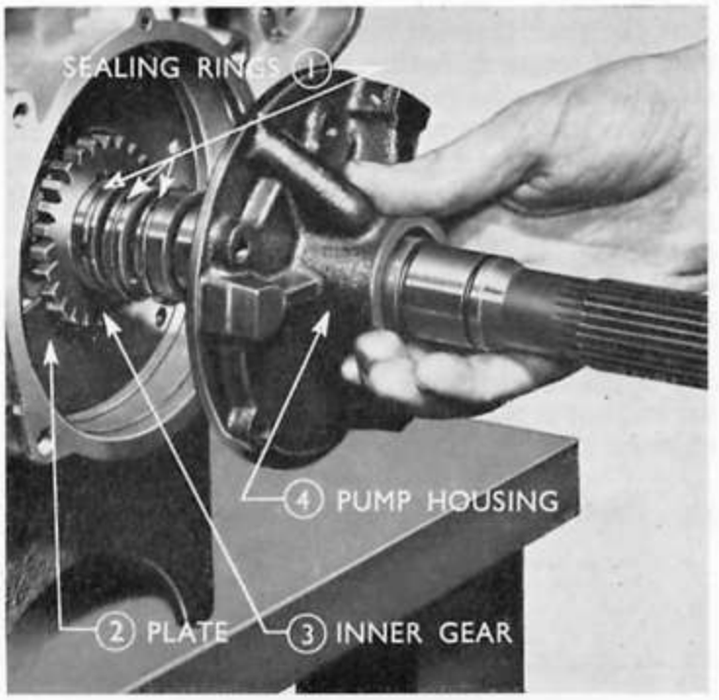


Fig. 53
Fitting the Rear Pump

18. To adjust the rear brake band, slacken the adjusting screw locknut on the right-hand side of the gearbox case and then tighten the adjusting screw 1.382 kg.m. (10 lb. ft.). Slacken the adjusting screw one turn and tighten the locknut using BW 547A-50 and BW 547A-50-2 adaptor.

Parking Gear

1. Withdraw the output shaft and thrust washer. If necessary, separate the output shaft from the ring gear by removing the circlip which retains them together.

Replace the circlip which retains the shaft to the ring gear, it should be noted that the retaining circlip is a selective fit. Three circlips are available, see below, and the one used should be selected to give a minimum end-float.

1.397 mm. (0.055 in.) 1.448 mm. (0.057 in.)
1.499 mm. (0.059 in.)

2. Before fitting the output shaft, position the rear thrust washer on the inside rear face of the transmission case, retaining it in position, if necessary, with petroleum jelly. The three lugs on this thrust washer will contact protrusions in the transmission case casting to prevent the thrust washer from turning.

Gearbox Case and/or Selector and Parking Pawl Levers

To Remove

1. Slacken the inhibitor switch locknut and remove the switch. Unscrew the downshift valve cable retainer and remove the cable. Drive out the tension pin securing the manual valve operating lever to the cross-shaft and draw to one side. Care should be taken when removing this lever as the detent ball is under spring pressure.

2. Drive out the tension pin securing the cross-shaft locating collar. The cross-shaft may now be withdrawn by tapping the end to which the manual linkage was previously attached. This will enable the spring, inhibitor switch cam, parking pawl linkage and collar to be removed.

3. Withdraw the parking pawl actuating mechanism after removing the spring clip. A careful note should be made of the manner in which the spring is fitted before removal.

4. From outside the case drive out the tension pin retaining one parking pawl pivot pin and drive out the pivot from inside the case. The second pivot pin is not secured but is retained by a lug on the extension housing. If the case is up-ended and gently tapped this pin will fall out and the parking pawl can be removed.

5. Remove the locknut from the rear band adjuster and screw the adjuster screw into the case to remove it.

6. Remove the dipstick tube adaptor.

To Replace

7. Refit the rear band adjuster by screwing it into the case from inside and fit the locknut to thread onto it outside of the case. Reposition the parking pawl

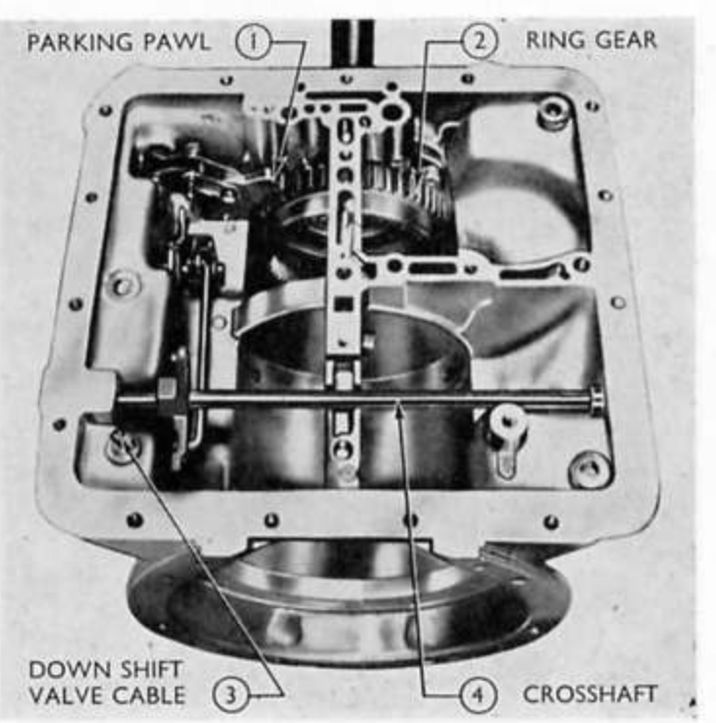


Fig. 54
Parking Pawl and Selector Levers

mechanism in the box and replace two pivot pins. The stepped pivot should be tapped right home and a new tension pin fitted to the case to prevent this pivot coming out.

8. The parking pawl actuating mechanism should be repositioned, in the manner removed, on the pivot in the transmission case. Before continuing with the assembly check the working of the parking pawl by manual operation.

9. Replace the seals in the cross-shaft bosses in the transmission case. Carefully slide the cross-shaft into the case from the side opposite to the inhibitor switch and position on the shaft, the collar, parking pawl actuating mechanism and bias spring, in that order. Pass the shaft through into the opposite boss in the case and locate it in the correct position with the collar and tension pin. Position the spring and ball and compress these with a piece of tube, at same time sliding the manual valve detent arc over the ball. When in position line up the hole in the cross-shaft with the hole in the cam boss and secure it with a tension pin. Connect the parking pawl operating link to the actuating mechanism and secure it with a washer and spring clip.

10. Refit the inhibitor switch, but do not tighten the locknut at this stage, as the switch will need to be adjusted after the transmission has been re-built.

11. Replace the dipstick tube adaptor.

THE FOLLOWING OPERATIONS CAN BE CARRIED OUT WITH THE TRANSMISSION IN SITU, AND WITH THE GEARBOX SUMP REMOVED

To Replace Downshift Cable

To Remove

1. Disconnect the downshift valve cable from the accelerator linkage. Slacken the locknut securing the downshift valve outer cable to the bracket. Remove the split pin locking the downshift cable clevis pin and remove the pin.

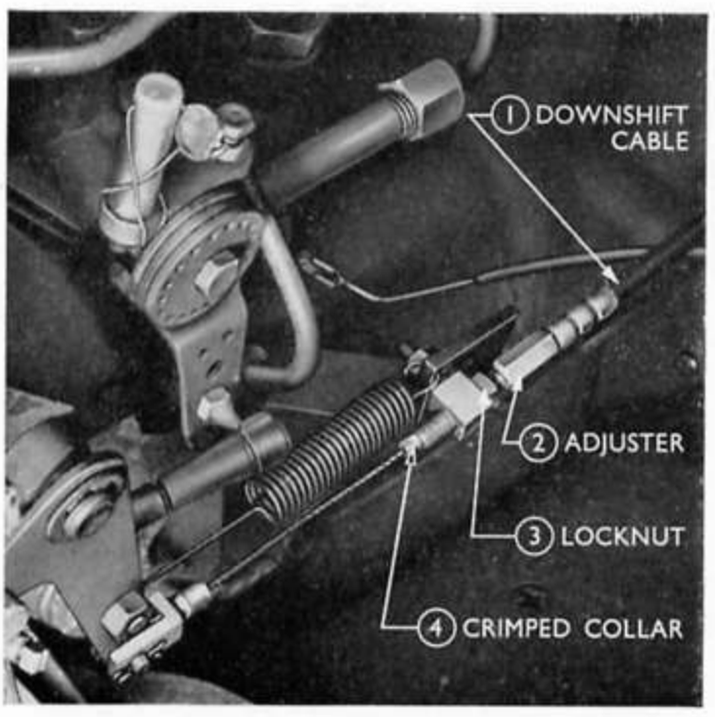


Fig. 55
Downshift Cable (Diesel shown)

2. Disconnect the downshift valve cable from the cam. Unscrew the downshift valve cable retainer and remove the cable.

To Replace

3. Screw the downshift valve cable retainer into the gearbox case and connect the inner cable to the cam.

4. Locate the outer cable adjuster in the bracket on the engine. Connect the inner cable to the accelerator linkage and adjust as described on page 69, Adjustments.

NOTE.—On Diesel engines, the downshift cable clevis pin must be reconnected to the same hole in the bell crank relay lever from which it was removed.

To Overhaul Front Servo

To Remove

1. Remove the four fluid transfer pipes by prising them out with a protected screwdriver blade.

2. The servo is secured by two bolts and spring washers and removal of these bolts will enable the servo to be withdrawn. When removing the servo ensure that the operating strut, which transmits movement from the servo to the band, does not fall out and become lost.

To Dismantle

1. Depress the servo piston and piston guide assembly, to overcome spring pressure, and remove the circlip. The piston spring will then push the piston and its guide from the servo housing.

2. Withdraw the piston from its guide and extract the spring.

3. Remove the square section sealing ring from the guide and the two circular section sealing rings from the piston.

4. To remove the operating lever from the housing it is necessary to withdraw the lever's pivot which is retained by a pin in the servo housing. This pin can be tapped out with the aid of a 3.18 mm. ($\frac{1}{8}$ in.) diameter drift.

To Reassemble

1. The operating lever should be fitted so that the adjusting screw will pass through the hole in the end of the housing. Fit the pivot through the housing and operating lever, ensuring that the retaining pin holes in the housing and pivot are in line. Fit the retaining pin.

2. Fit two circular section sealing rings to the piston and the square section sealing ring to the piston guide.

3. Insert the piston into the guide so that the flanges of the piston and guide abut.

4. Place the piston retracting spring in the piston and insert the assembly, piston first, into the housing. Retain with a circlip after depressing the piston guide to overcome spring pressure.

To Replace

1. Refit the front servo. Stick the operating strut to the servo operating arm by means of petroleum jelly and offer the servo assembly into position, engaging the strut with the brake band.

2. Adjust the front band, see page 69 Adjustments.

3. Fit the fluid transfer pipes. These pipes are a push fit and are held in position by the sump. Each tube is different in length and shape.

To Overhaul Rear Servo

To Remove

1. Remove the four fluid transfer pipes by prising them out with a protected screwdriver blade.

2. The servo is secured by two bolts and spring washers and removal of these bolts will enable the servo to be withdrawn. When removing the servo ensure that the operating strut, which transmits movement from the servo to the band, does not fall out, otherwise it may be lost.

To Dismantle

1. Withdraw the servo piston by removing the operating spring and lever, the pivot of which will have to be drifted out of the housing.

2. Pull out the piston. Remove the sealing ring from the piston.

To Reassemble

1. Fit the sealing ring to the piston and fit the piston into the housing.

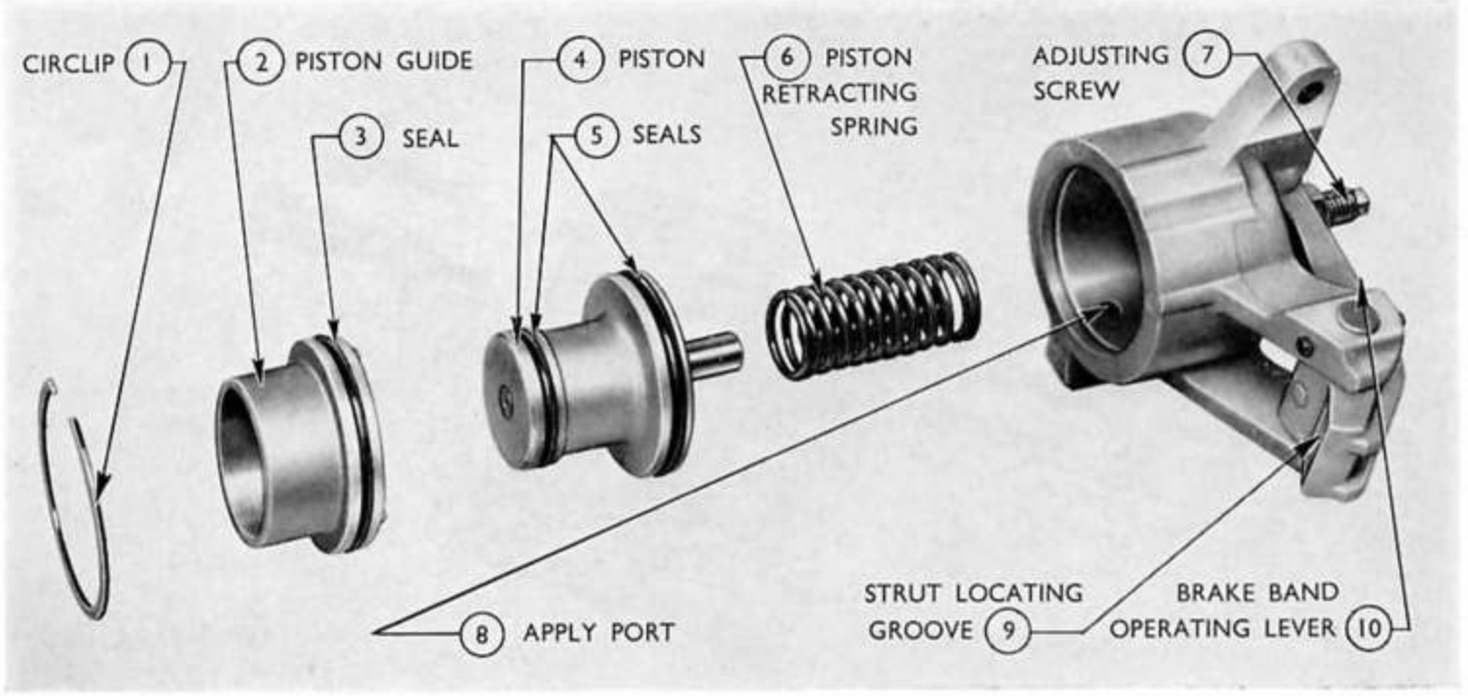


Fig. 56
Front Servo - Exploded View

2. Fit the operating lever and shaft. Replace the spring in tension.

To Replace

1. Refit the rear servo. Stick the operating strut to the servo operating arm by means of petroleum jelly and offer the servo assembly into position, engaging the strut with the brake band. The forward bolt is longer and has a reduced diameter at one end to locate the centre support.

2. Adjust the rear brake band. (See page 69 Adjustments).

3. Fit the fluid transfer pipes. These pipes are a push fit and are held in position by the sump, when fitted. Each pipe is different in length and shape and cannot be fitted incorrectly.

To Overhaul Valve Bodies Assembly and Oil Pick-Up Tubes

To Remove

1. Remove the four fluid transfer pipes by prising them out with a protected screwdriver blade.

2. Withdraw the valve bodies assembly. Disconnect the downshift valve cable from the cam. Remove the two rear bolts passing through the strainer and the bolt just to the rear of the front pump strainer. Take care to draw off the valve bodies assembly evenly to avoid damage to the front pump tubes.

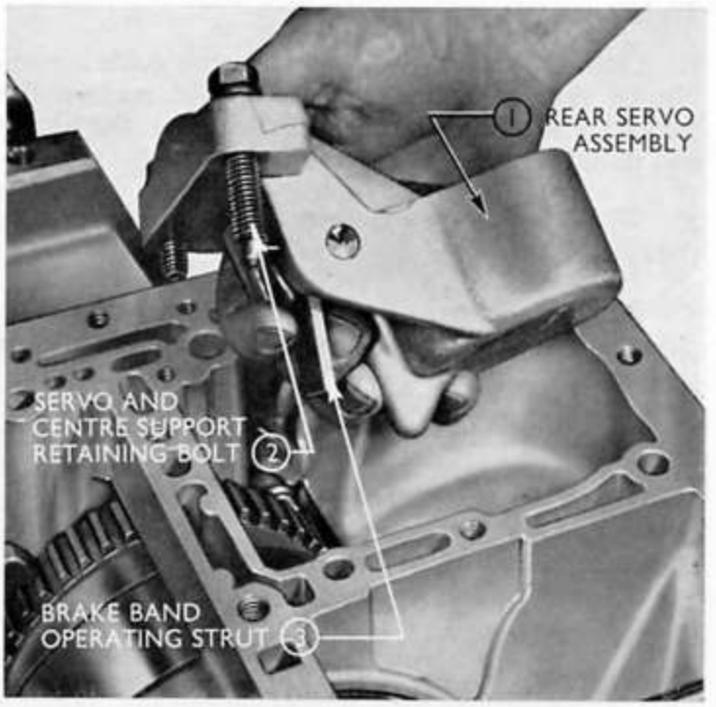


Fig. 58
Replacing Rear Servo

3. Withdraw the four oil tubes from the front pump adaptor. It will be seen that the outside pair are of unequal diameter and, therefore, cannot be refitted incorrectly. The inner pair comprises one straight tube connecting the pump to the control assembly, and a shaped tube connecting the pump to the cooler inlet.

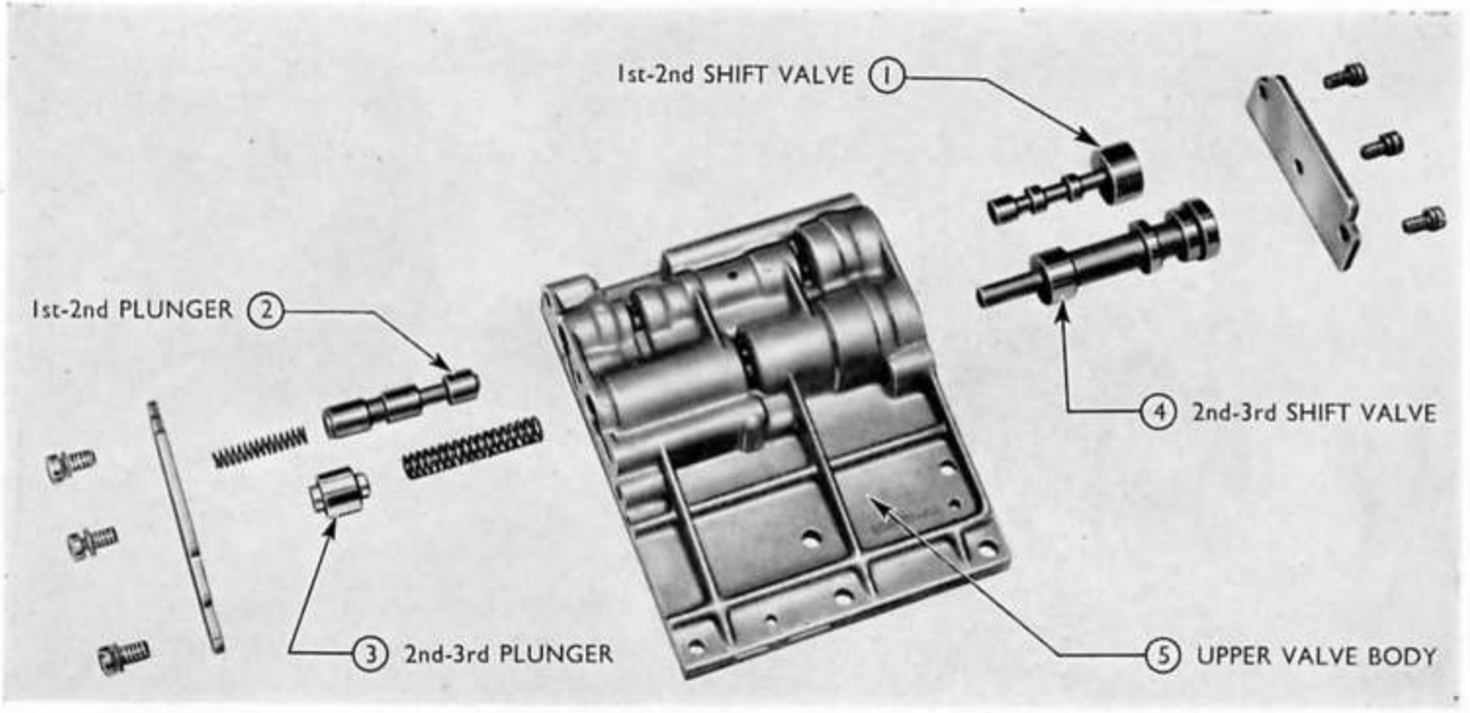


Fig. 57
Upper Valve Body and Valves

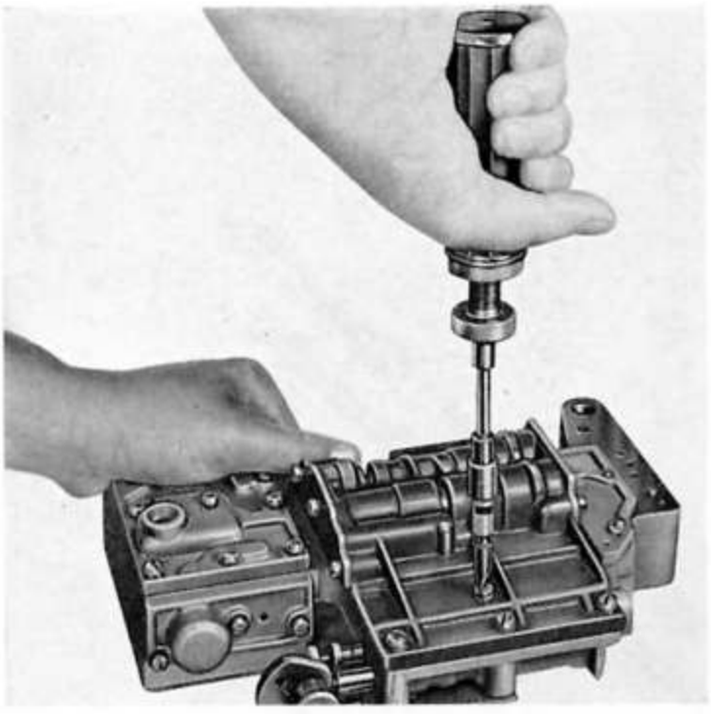


Fig. 59
Tightening Valve Body Screws

To Dismantle

To facilitate fitting the valves, etc. it is advisable to dismantle the assembly on a clean steel bench covered with clean white paper.

To avoid confusion each component of the valve bodies assembly should be washed separately in clean petrol, paraffin or industrial solvent, carefully inspected and replaced in the order in which they were removed. Before installing the parts they should be lubricated with automatic transmission fluid.

1. Withdraw the manual control valve. Unscrew the two bolts securing the downshift valve cam bracket to the valve body and remove the bracket and cam assembly. When the cam has been removed, the downshift valve, with its spring, may be withdrawn.

2. Remove the strainer, which is secured by four short screws with spring washers.

3. Separate the upper and lower valve bodies by removing the six cheese-head screws (one long and five short) from the lower valve body and the two cheese-head screws from the upper valve body.

4. Remove the governor line plate. Unscrew the two screws located inside the rear pump strainer body and remove the governor line plate.

5. The upper valve body has two end plates, each secured by three cheese-headed screws. Remove these retainer plates followed by the second to third shift valve, spring, plunger and the first to second shift valve from the rear of the body. From the front of the body withdraw the first to second shift valve spring and plunger (see Fig. 57).

6. Remove the oil tube collector by unscrewing eight cheese-head screws. Keeping the separator plate uppermost, remove the two screws situated in the rear filter body. The separator plate can now be removed carefully, revealing the converter check valve, rear check valve, the throttle valve keep plate, and throttle stop plate and spring in the lower valve body (see Fig. 61).

7. The servo orifice control valve is retained by a keep plate and the modulator valve by a keep plate and the modulator valve by a small dowel pin. Remove the keep plate and dowel pin and remove both valves and springs.

8. Remove the three screws securing the primary and secondary regulator valves retainer plate and remove the retainer plate. Care should be taken when removing these screws since two regulator valve springs are retained by the plate. With the plate removed, withdraw the primary regulator valve spring, sleeve and valve. Remove the secondary regulator valve spring and valve.

To Reassemble

1. Fit the regulator valves. Fit the primary regulator valve, sleeve and spring in the lower valve body. Then, replace the secondary regulator valve, followed by its spring. Fit the retainer plate with the three screws to 0.24 to 0.35 kg.m. (20 to 30 lbs. in.).

2. Refit the modulator valve spring, valve plunger, valve and plug. Secure the plug with the dowel. Refit the servo orifice control valve and spring, locating the spring inside the counterbore in the end valve and retain it with a keep plate.

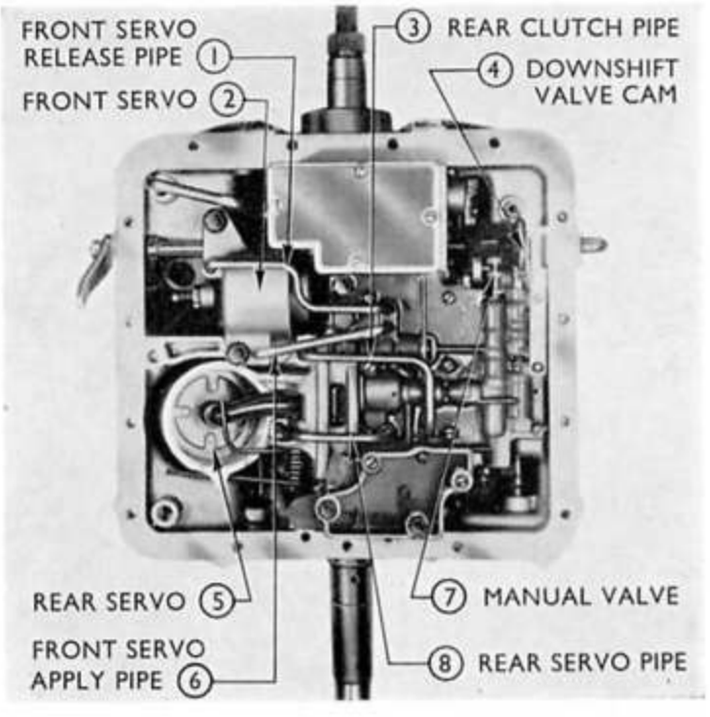


Fig. 60
Fluid Transfer Pipes

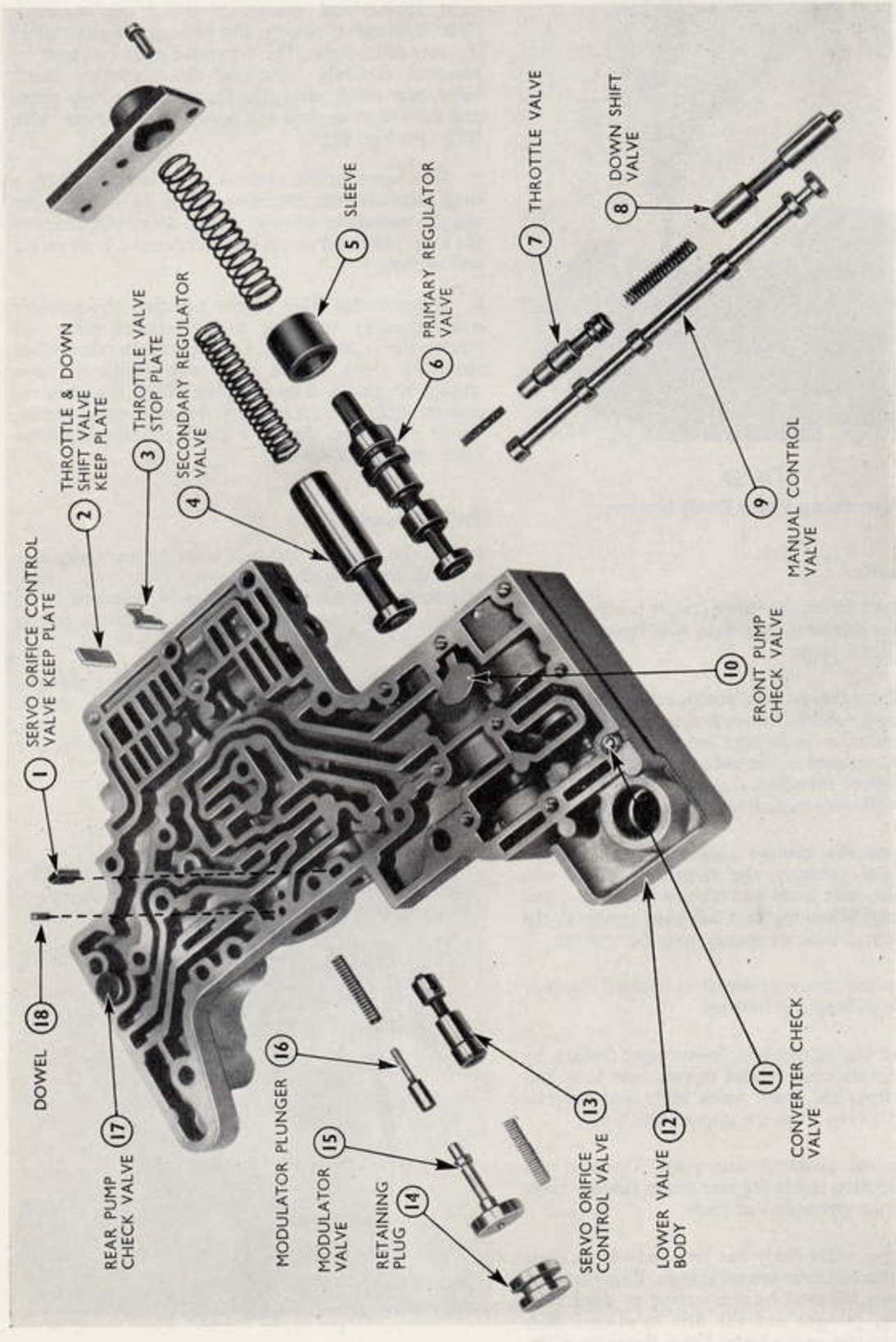


Fig. 61
Lower Valve Body and Valves

3. Reposition the throttle valve keep plate, throttle valve return spring, throttle valve and stop plate. Fit the converter check valve spring, the ball and rear check valve spring and the disc type valve.

4. Carefully position the separator plate on top of the lower valve body, making sure that the check valves are not displaced.

5. Locate the governor line plate and retain it with two screws and spring washers from underneath the rear pump strainer body. Finger tighten screws.

6. Reposition the first to second spring, plunger and shift valve and fit the second to third plunger, spring and shift valve in the upper valve body. These valves, springs and plungers are of different diameters and cannot be confused. Refit the retainer plates, using three screws and spring washers for each. Tighten the screws to 0.24 to 0.35 kg.m. (20 to 30 lbs. in.). The retainer plates are dissimilar and cannot be confused.

7. Reposition the upper valve body on the separator plate and retain with eight screws and spring washers. Finger tighten screws.

8. Replace the manual control valve and downshift valve. The throttle valve spring is interposed between two valves, locating in a counterbore in the end of the downshift valve.

9. Refit the oil tube collector with eight screws and spring washers. Finger tighten screws.

10. Reposition the downshift cam and bracket with the cam in contact with the downshift valve, having first wound up the spring. Retain with two bolts and lockwashers. Tighten the bolts to a torque of 0.24 to 0.35 kg.m. (20 to 30 lbs. in.).

11. Refit the front strainer, ensuring that it is flat to 0.794 mm. ($\frac{1}{32}$ in.) concave and is free from kinks. Secure it with four screws and spring washers. Tighten all the screws to 0.24 to 0.35 kg.m. (20 to 30 lbs. in.).

To Replace

1. Replace the oil pick-up tubes in the front pump housing, fitting a new seal to the front pump inlet.

2. Position the valve bodies assembly, engaging the oil tubes in the oil tube collector and making sure that the manual control valve is engaged with the peg on the operating lever. Secure the assembly with three bolts, flat and spring washers. The two longer bolts pass through the rear housing and the shorter bolt is positioned centrally just to the rear of the front pump strainer.

3. Reconnect the downshift valve cable to the cam and check its adjustment. (See page 69 Adjustments.)

4. Fit the fluid transfer pipes. These pipes are a push fit and are held in position by the sump, when fitted. Each tube is different in length and shape.

To Replace the Extension Housing

To Remove

1. Jack up the vehicle and fit stands.

2. Disconnect the driveshaft (see item 4, page 51), and remove the drive flange, where fitted, from the gearbox output shaft.

3. Support the transmission with a jack and a block of wood beneath the gearbox sump.

4. Disconnect the speedometer cable from the gearbox, and remove the speedometer driven gear.

5. Remove the extension housing rear support bolt, and slightly lower the jack.

6. Remove the four bolts securing the extension housing to the gearbox case, and carefully remove the housing.

To Replace

1. Clean the rear face of the gearbox and place a new gasket in position. Refit the extension housing and secure with the four bolts and spring washers. Replace the drive flange (where fitted), and tighten the retaining nut.

2. Replace the extension housing rear support bolt.

3. Replace the speedometer driven gear, connect the speedometer cable and tighten the bolt which retains the holding clip.

4. Reconnect the driveshaft.

5. Remove the transmission jack.

6. Remove the stands and lower the vehicle to the ground.

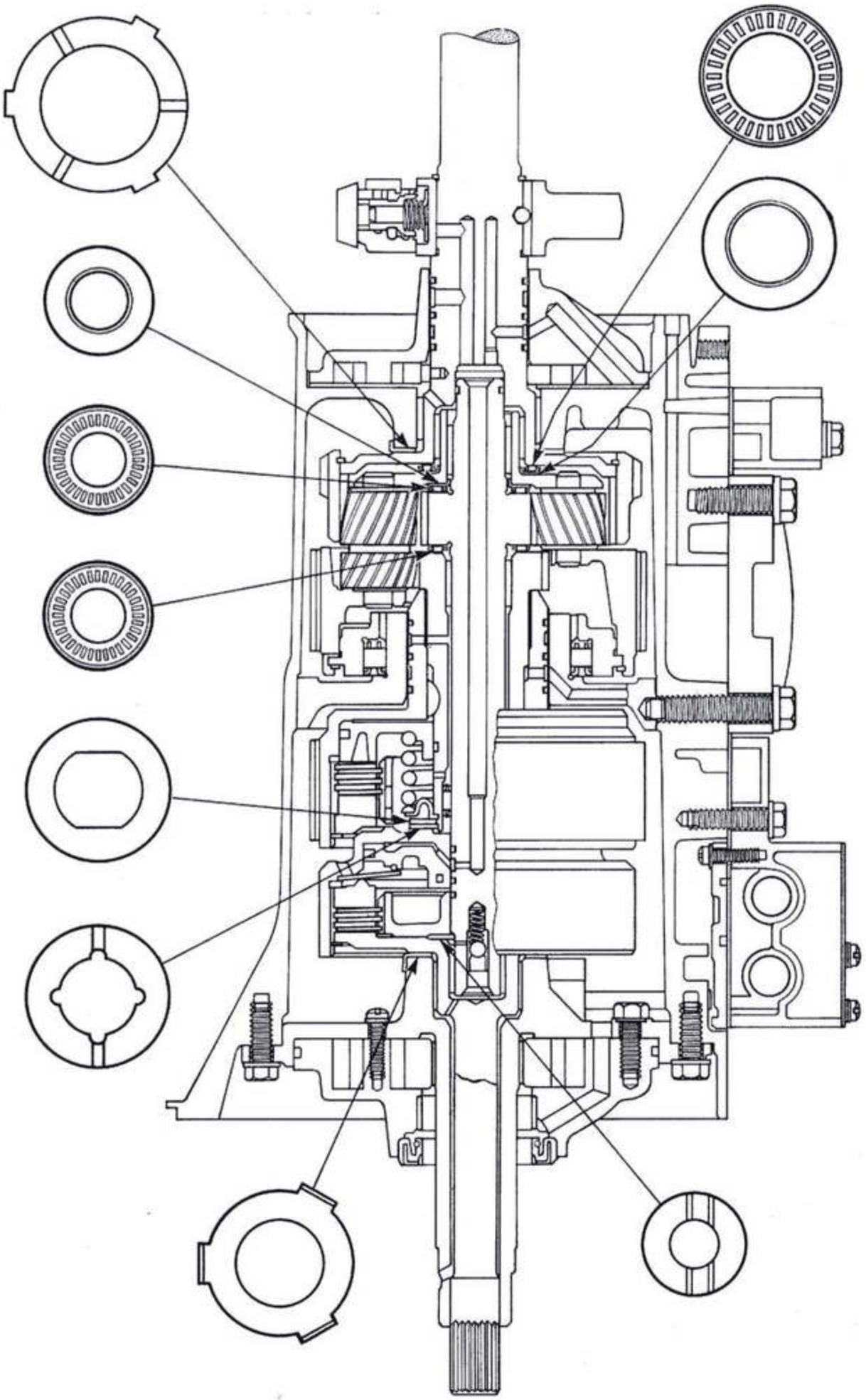


Fig. 62
Location of Thrust Washers

To Replace the Speedometer Drive Gear

To Remove

1. Remove the extension housing (see previous page).

2. Withdraw the spacer tube (130 Diesel), or circlip (75–115).

3. Withdraw the speedometer drive gear, taking care not to lose the locking ball.

To Replace

1. Place the locking ball in the hole in the output shaft.

2. Slide on the speedometer drive gear, and locate the keyway over the ball.

3. Replace the spacer tube (130 Diesel), or circlip (75–115).

4. Replace the extension housing and the drive flange (where fitted).

To Overhaul the Governor Assembly

To Remove

1. Remove the extension housing.

2. Remove the speedometer drive gear, thrust washer, and retaining circlip.

3. Remove the governor retaining circlip and withdraw the governor, taking care not to lose the locking ball.

To Dismantle

1. Separate the two parts of the governor body by removing the two cheese-headed screws, together with their spring washers (see Fig. 64). The governor valve and spring can be removed from the governor weight by removing the governor spring retainer, which partially encircles the governor weight stem. If necessary, remove the cover plate which is retained by two screws to the governor body.

To Reassemble

1. If the cover plate has been removed, refit and retain with two screws. Pass the stem of the governor weight through the body from the top; slide the valve, smaller diameter first, over the governor weight stem, followed by the spring and secure with a retainer, dished side to the spring. Secure the two parts of the governor body together, after cleaning the mating faces, with two cheese-headed screws and spring washers.

To Replace

1. Turn the output shaft until the governor driving ball hole is uppermost and position the ball. Slide on the governor assembly ensuring that the governor cover plate, secured by two screws, is facing rearwards. Fit the governor retaining circlip.

2. Refit the speedometer drive gear circlip, and thrust washer.

3. Refit the speedometer drive gear and locking ball.

4. Refit the spacer tube (130 Diesel), or the circlip (75–115) and replace the extension housing.

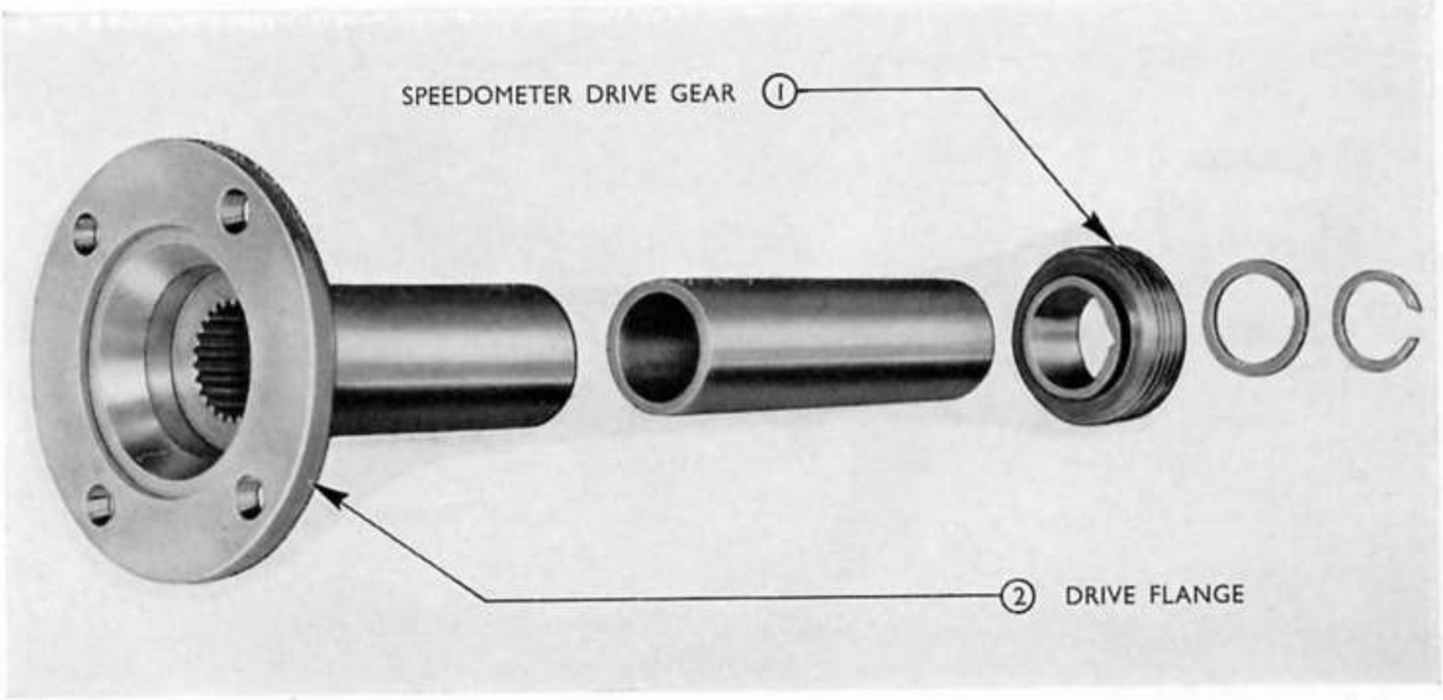


Fig. 63
Speedometer Drive Gear (130 Diesel)

To Replace the Inhibitor Switch

To Remove

1. Disconnect the two leads from the switch, noting their respective positions.

2. Slacken the locknut and unscrew the switch.

To Replace

1. Screw the switch into the gearbox case.

2. Adjust the switch (see page 69 Adjustments).

3. Tighten the locknut, and replace the electrical leads.

4. Test the switch for correct operation. The engine should only start when either "N" or "P" is selected.

To Replace the Transmission Selector Assembly and/or the Selector Cable

To Remove

1. Unscrew and remove the selector lever knob.

2. Remove the selector facia plate, by drawing the plate forward off two clips.

3. Disconnect the demister hose, and move the hose to one side.

4. Remove six screws and withdraw the selector assembly from behind the instrument panel.

5. Disconnect the selector cable from the control assembly.

6. To change the selector cable, disconnect the other end of the cable from the manual valve operating lever on the gearbox, and also from the support bracket. Withdraw the cable through the bulkhead.

To Replace

1. If a new selector cable is to be fitted, connect the cable to the selector assembly, then pass the cable through the hole in the bulkhead, from inside the cab, taking care not to damage the sealing grommet.

2. Replace the selector assembly behind the instrument panel, and secure with the six screws.

3. Replace the rubber gate on the facia plate and press the plate home onto its retaining clips.

4. Screw on the selector lever knob.

5. Reconnect the demister hose.

6. Connect the selector cable to the support bracket adjacent to the gearbox.

7. Adjust the length of the selector cable (see page 69) and connect the clevis to the manual valve operating lever. Insert the clevis pin and secure the pin with a spring clip.

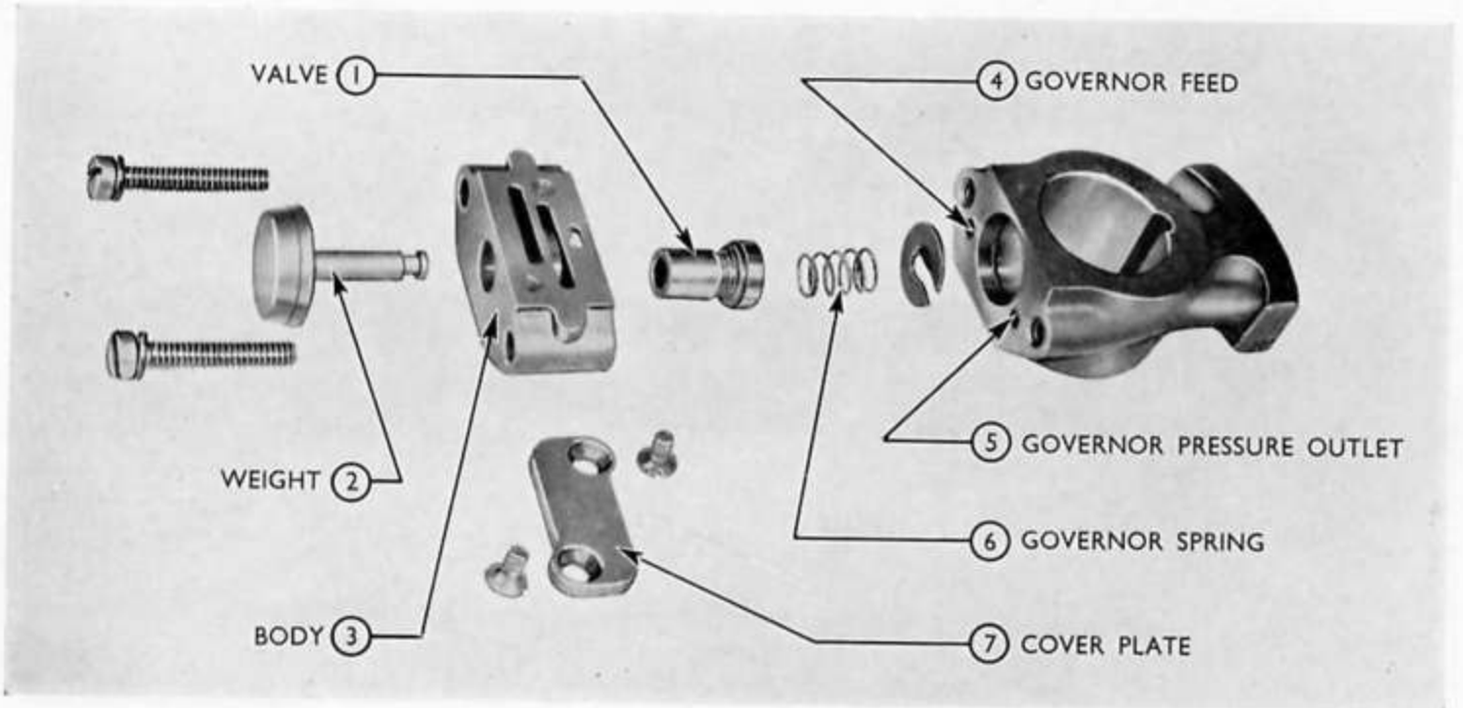


Fig. 64
Governor Assembly - Exploded

ADJUSTMENTS

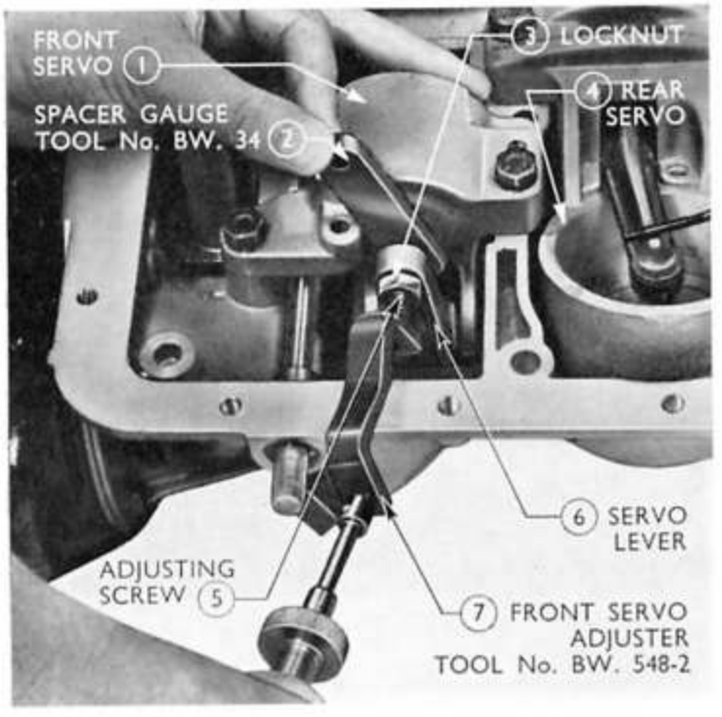


Fig. 65
Front Band Adjustments

Front Band

1. Drain and remove the gearbox sump.

2. Slacken the adjusting screw locknut, move the servo lever outwards and place a 6.35 mm. (0.25 in.) thick gauge (Tool No. BW 34) between the piston pin and the adjusting screw.

3. Tighten the adjusting screw to 0.14 kg.m (10 lb. in.) with the Tool No. BW 548 and then tighten the locknut to 2.1 to 2.8 kg.m. (15 to 20 lb. ft.). Remove the gauge block.

4. Ensure that the mating faces are clean and refit the sump with a new gasket. Tighten the fifteen bolts, with lockwashers, to 1.1 to 1.4 kg.m. (8 to 10 lb. ft.).

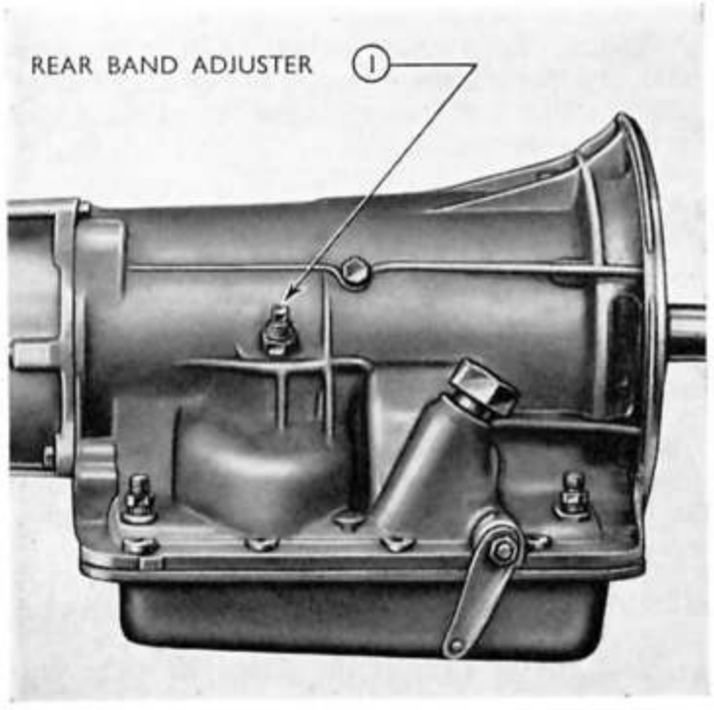


Fig. 66
Rear Band Adjustment

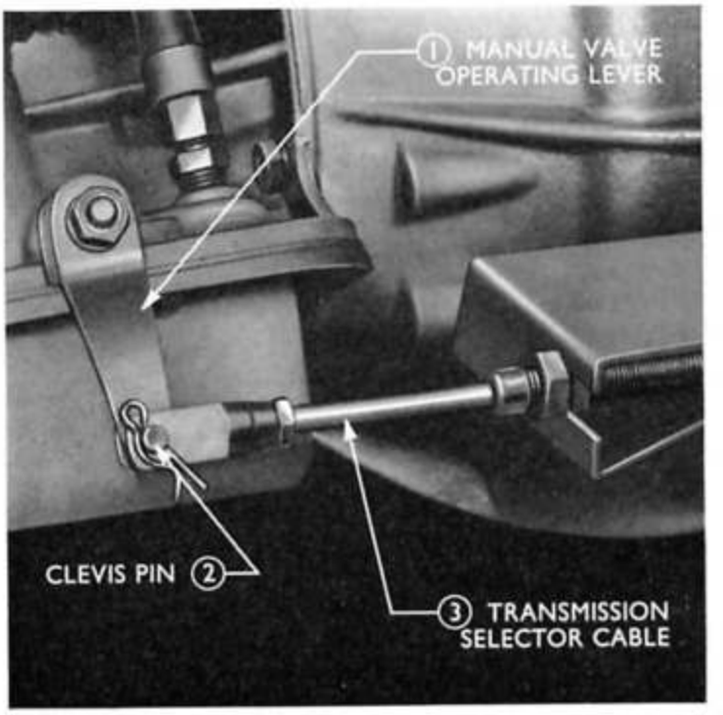


Fig. 67
Selector Cable Adjustment

Rear Band

1. Slacken the adjusting screw locknut on the right-hand side of the gearbox case.

2. Tighten the adjusting screw to 1.4 kg.m (10 lb. ft.) with Tool No. BW 547A-50 and adaptor BW 547A-50-2.

3. Slacken the adjusting screw one full turn and then tighten the locknut.

Transmission Selector Cable

1. Disconnect the cable from the manual valve operating lever, and push the lever fully rearwards.

2. Move the lever forward by two "clicks". This puts the gearbox in "D".

3. Select the "D" position on the selector lever in the cab.

4. If necessary, slacken the adjuster locknut, and adjust the length of the cable so that the clevis pin can be freely inserted in the clevis when in position on the operating lever. Tighten the adjuster locknut and again check that the clevis pin is free to move easily in the clevis and operating lever.

5. Lock the clevis pin with a spring clip.

6. Check the five positions on the selector lever in the cab, ensuring that engagement of each position can be felt.

Inhibitor Switch

1. Disconnect the two leads from the inhibitor switch.

2. Connect a lamp and battery across the two terminals.

3. Move the selector lever in the cab to the "P" position.

4. Slacken the inhibitor switch locknut and then screw the switch in until the lamp lights. Note the position of the switch, and then screw in for a further quarter of a turn.

5. Tighten the locknut, remove the battery and lamp, and reconnect the switch leads.

6. Check that the engine will only start with the selector in the "P" or "N" position.

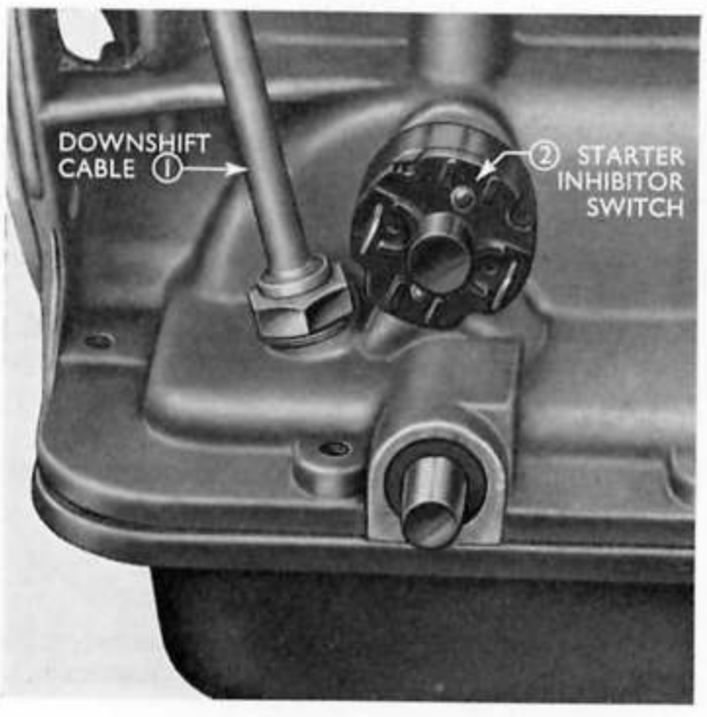


Fig. 68
Inhibitor Switch

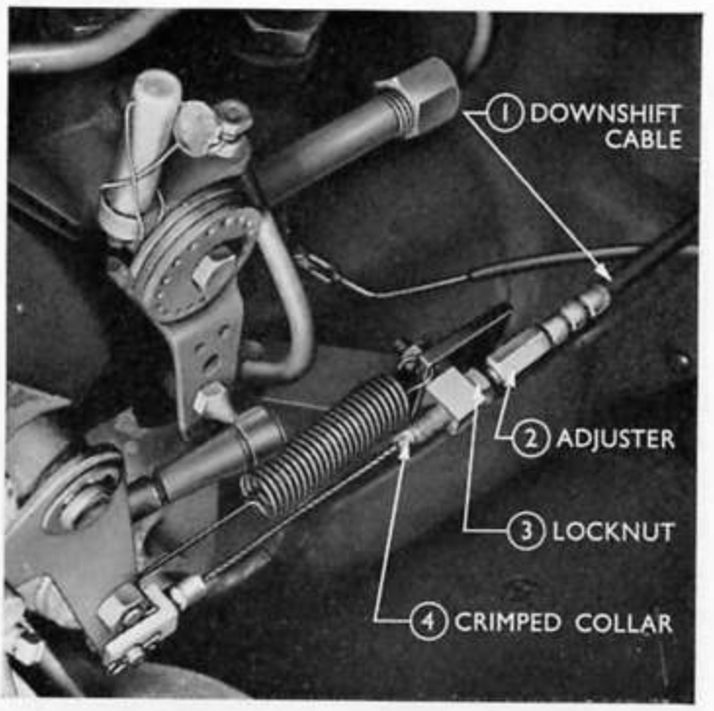


Fig. 69
Downshift Cable Adjuster

Downshift Cable

There are three methods of adjusting the downshift cable, as follows:—

Method 1

(Only possible with cables which are the original vehicle equipment, and which still have the original crimped collar on the cable at the adjuster end.)

1. Ensure that the accelerator linkage is set correctly and that there is no free play in the linkage.

2. Slacken the adjuster locknut. Adjust the outer cable length until the crimped collar on the inner cable is within 3.18 mm. ($\frac{1}{8}$ in.) of the adjuster, with the inner cable taut.

3. Tighten the adjuster locknut.

Method 2

(This method is very accurate and may be used when fitting a new cable. NOTE.—New cables do not incorporate crimped collars.)

With the downshift valve cable connected to the cam, the cable adjustment may be checked by determining the position of the downshift valve cam in relation to the accelerator pedal.

1. Remove all free play from the accelerator linkage.

2. Note the position of the downshift valve cam when the accelerator pedal is released. The heel of the downshift valve cam should lay against the large diameter of the downshift valve, see "idling position", (Fig. 71) with all slack in the inner cable taken up.

Fig. 70
Checking Line Pressure

3. With the accelerator pedal pressed down fully in the kickdown position, the constant radius lobe of the cam should be in contact with the downshift valve, as seen in "kick-down position". The position of the cam can be altered by adjusting the downshift valve cable length.

Method 3

Special tools required.

1. Tachometer drive adaptor C.6170 (Diesel only).
2. Tachometer drive cable. Inner cable 100E-17262-A, Outer cable 100E-17261-A. (Diesel only).
3. Tachometer (Smith's type ATH 10) (Diesel only).
4. Line pressure gauge BW.1A
5. Adaptor BW.38.
6. Electronic tachometer (Petrol only).

Procedure

1. Ensure that the engine and transmission are at normal operating temperature.
2. Check that the transmission fluid level is correct.
3. Check that the accelerator linkage is correctly adjusted and that there is no free play in the linkage.
4. (*a*) Petrol engined vehicles.

Connect an electronic tachometer to the engine.

(*b*) Diesel engined vehicles.

(i) Carefully remove the welch plug from the right hand side of the cylinder block.

NOTE.—The oil pump drive shaft is situated immediately below the welch plug and great care should be taken to avoid damaging the end of the shaft when removing the plug.

(ii) Connect the tachometer adaptor and drive cable to the cylinder block, ensuring that the adaptor drive is located firmly in the slot in the top of the oil pump drive shaft. Connect the Smith's ATH 10 tachometer.

5. Attach a line pressure gauge, BW.1A to the pressure take-off point in the rear face of the gearbox, with an adaptor, BW.38.

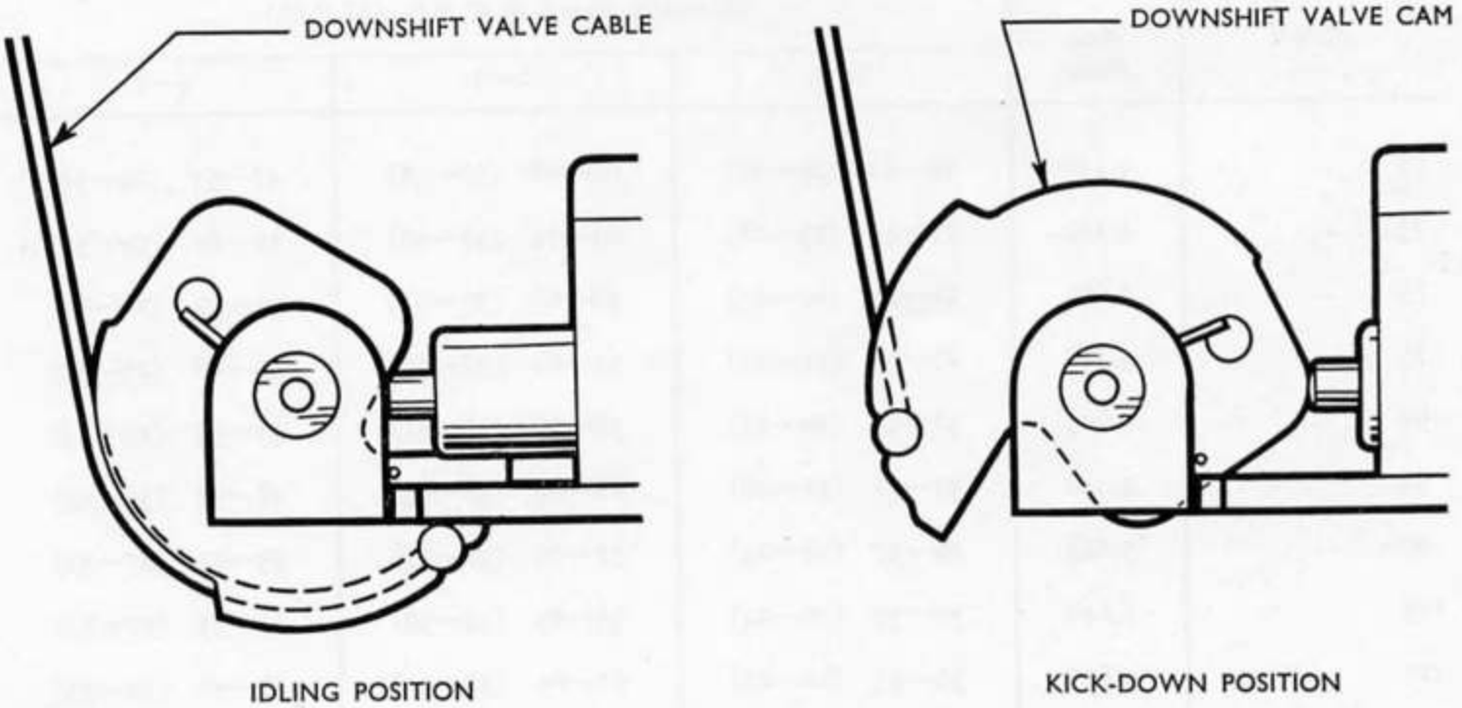


Fig. 71
Downshift Valve Cam and Cable

6. By means of the tachometer, adjust the engine idling speed to 580 r.p.m.

7. Apply the foot and handbrake, and select "D".

8. Note the reading on the line pressure gauge. This should be between 3.52 and 4.62 kg/sq. cm. (50 and 65 lb./sq. in.).

9. With the foot and handbrakes firmly applied, increase the engine speed to 1000 rpm and note the pressure rise. This should be 1.1 to 1.4 kg/sq. cm. (15 to 20 lb./sq. in.) above the pressure noted in (8).

NOTE.—Do not hold the engine speed at 1000 rpm for longer than 20 seconds. If the engine speed exceeds 1000 rpm during the test, the results will not be valid, and the test must be repeated.

10. The downshift cable should be adjusted until tests (8) and (9) yield the correct pressure figures.

11. Remove the test equipment and road test the vehicle, checking the quality of change and the shift speeds (see table 2).

TEST PROCEDURE AND FAULT DIAGNOSIS

Test Procedure and Fault Diagnosis

Test 1. Check that the starter only operates in 'P' and 'N'.

Test 2. Apply the brakes, and with the engine idling, move the selector lever from 'N' to 'D', 'N' to 'L', and 'N' to 'R'. Check that transmission engagement can be felt in each position selected.

Test 3. Allow the engine and transmission to reach normal operating temperature, then check the converter stall speed as follows:—

1. Connect a tachometer and a pressure gauge as described on page 71.

2. Apply the hand and foot brakes firmly, select 'L', and momentarily depress the accelerator to the kick-down position. Note the readings on the line pressure gauge and the tachometer and release the accelerator pedal. Important—do not stall for longer than 10 seconds, or the transmission will overheat.

3. Repeat the test with the transmission in 'D', and and again in 'R', making sure that the hand and foot brakes are firmly applied during each test.

4. The correct figures for the pressure and engine speed during the stall tests are as follows:—

Engine Type	*Speed (Revs./Min)*	*Pressure kg/sq. cm. (lb/sq. in.)*
Diesel	1400–1600	11.2–14.0 (160–200)
Petrol (1.7 litre)	1700–2000	10.2–11.6 (145–165)

TABLE 2

CORRECT SHIFT SPEEDS AT "KICKDOWN" CONDITION (Diesel Engines)

Model	*Axle Ratio*	*Gearshift Speeds in K.P.H. (M.P.H.)*		
		1—2	2—3	3—2
75	4.440	33—42 (21—26)	60—68 (37—42)	47—55 (29—34)
75	4.110	37—45 (23—28)	65—74 (41—46)	51—60 (32—37)
75	4.625	32—40 (20—25)	58—66 (36—41)	45—53 (28—33)
75	5.143	27—35 (17—22)	51—60 (32—37)	40—48 (25—30)
90	4.625	32—40 (20—25)	58—66 (36—41)	47—55 (29—34)
90	4.440	33—42 (21—26)	61—69 (38—43)	48—56 (30—35)
90	5.143	29—37 (18—23)	51—60 (32—37)	43—51 (27—32)
115	5.140	30—39 (19—24)	55—63 (34—39)	43—51 (27—32)
115	4.625	35—43 (22—27)	61—69 (38—43)	48—56 (30—35)
130	6.167	22—30 (14—19)	42—50 (26—31)	32—40 (20—25)
130	5.830	24—32 (15—20)	45—53 (28—33)	35—43 (22—27)

TABLE 2 *(continued)*

CORRECT SHIFT SPEEDS AT "KICKDOWN" CONDITION (Petrol Engines)

Model	*Axle Ratio*	*Gearshift Speeds in K.P.H. (M.P.H.)*		
		1—2 shift	*2—3 shift*	*3—2 shift*
75	4.625	43—51 (27—32)	74—82 (46—51)	61—69 (38—43)
75	4.440	45—53 (28—33)	77—85 (48—53)	63—71 (39—44)
75	5.143	39—47 (24—29)	66—74 (41—46)	53—61 (33—38)
90	5.143	40—48 (25—30)	69—77 (43—48)	56—64 (35—40)
90	4.625	45—53 (28—33)	77—85 (48—53)	63—71 (39—44)
115	5.143	42—50 (26—31)	74—82 (46—51)	60—68 (37—42)
115	4.625	47—55 (29—34)	82—90 (51—56)	66—74 (41—46)

Important

At no time should any Borg Warner automatic transmission be operated with the downshift cable broken or disconnected. If the cable is broken, the transmission will tend to remain in top gear, but there will be insufficient hydraulic pressure to prevent the brake bands and clutches from slipping, with consequent severe overheating and damage to the transmission.

Should a downshift cable fail on the road, an emergency fix can be effected by pulling the inner cable forward to its full extent, and fixing the cable securely in this position. The downshift valve cam will thus be locked in the "kick-down" position, and although upward gear shifts will consequently be delayed, until the road speeds in Table (2) have been reached, it will be safe to drive the vehicle to the nearest service area.

Cold Starting Procedure (Petrol Engines only)

1. Depress the accelerator pedal, once only, to its full extent of travel and allow it to return. This will release the fast idle cam allowing it to return to the starting position, at the same time closing the choke plate.

2. Switch on the ignition and engage the starter until the engine starts. (This should not normally exceed 15 secs.)

NOTE.—The accelerator pedal must not be actuated during this period.

3. When the engine has started and stabilised its speed (normally not more than 10 secs.) **depress the accelerator pedal lightly and release it once more.** This will permit the fast idle cam on the carburettor to take up a position designed to give the optimum engine fast idle speed during the initial warm up period, and on automatic transmission vehicles will give a reduced engine speed suitable for the engagement of drive.

It should be noted that the engine fast idle speed will gradually fall back to normal as the engine warms up providing that the accelerator pedal is depressed from time to time (as in normal driving). If the accelerator pedal is not depressed the engine speed will gradually rise and will produce speeds too high for the engagement of drive on vehicles fitted with automatic transmissions.

TABLE 3—QUICK REFERENCE DIAGNOSIS CHART

	A	B	C	D	E	F	a	b	c	d	e	f	g	h	j	k	l	m	n	p	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Selecting "R", "D" or "L" from Rest																																	
Harsh engagement	.	2	.	1	.	.	.	.	5	3	.	4	.	.	.	.	.	.	.	.	.	6	.	7	.	.	.	.	.	.	.	.	.
Delayed engagement	1	.	2	3	.	.	4	7	6	5	.	.	.	.	.	.	.	.	13	8	9	.	10	.	.	11	.	.	.	.	12	.	.
No engagement	1	.	2	.	.	.	3	4	5	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	8	9	10	.
Starting from Rest:																																	
No drive forward	.	.	1	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	5	.	.	.	.	.	.
No drive in reverse	.	.	1	.	.	2	7	6	5	.	.	.	.	.	.	3	4	.	.	.	.	.	9	.	.	8	.	.	.	.	.	.	.
Box seizes in reverse	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Forward movement in neutral	.	.	1	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
Upward Changes:																																	
No first to second change	.	.	1	.	2	.	8	9	10	.	.	6	7	3	.	4	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.
No second to third change	.	.	1	.	.	.	8	9	10	.	.	6	7	2	.	.	3	4	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.
Above normal change speeds	.	1	.	.	.	.	.	8	9	10	.	2	7	3	.	4	5	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Below normal change speeds	.	1	.	.	.	.	.	5	6	.	.	2	.	3	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Upward Change Quality:																																	
Slip on first to second change	1	2	3	.	4	.	8	9	10	6	.	7	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.
Slip on second to third change	1	2	3	.	4	.	9	10	11	7	.	8	.	.	.	.	.	.	.	.	.	.	5	.	6	.	.	.	.	.	.	.	.
Harsh first to second change	.	1	.	.	2	.	.	.	10	3	.	4	5	6	.	.	.	.	.	.	9	.	.	.	.	7	8	.	.	.	.	.	.
Harsh second to third change	.	1	.	.	2	.	.	.	6	3	.	4	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.
Box seizes on first to second change	.	.	.	.	.	1	.	5	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	3	4	.	.	.	.	.
Box seizes on second to third change	.	.	.	.	1	.	2	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downward Changes:																																	
No second to first change	.	1	.	.	.	.	.	.	.	.	.	.	.	3	.	2	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.
No third to second change	.	1	.	.	.	.	.	.	.	.	.	.	.	3	.	2	.	.	.	.	.	.	.	4	5	.	.	.	.	.	.	.	.
Involuntary high speed third to second change	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
Above normal change speeds	.	1	.	.	.	.	.	5	6	.	.	4	.	2	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Below normal change speeds	.	1	.	.	.	.	.	5	6	.	.	4	.	2	.	7	8	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Downward Change Quality:																																	
Slip on second to first change	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Slip on third to second change	.	.	.	.	1	.	6	7	8	4	.	5	.	.	3	.	.	.	.	.	.	.	9	.	2	.	.	.	.	.	.	.	.
Harsh second to first change	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.
Harsh third to second change	.	.	.	.	1	.	.	.	5	3	.	4	.	.	2	.	.	.	.	.	.	.	6	7	8	.	.	.	.	.	.	.	.	.

TABLE 3—QUICK REFERENCE DIAGNOSIS CHART (*continued*)

	A	B	C	D	E	F	a	b	c	d	e	f	g	h	j	k	l	m	n	p	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Line Pressure:																																	
Low on idling (below approx. 3.515 kg./sq. cm. (50 p.s.i.) in "D") ..	1	.	2	3	.	.	6	8	5	4	.	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	9	.	.	.
High on idling (above approx. 4.570 kg./sq. cm. (65 p.s.i.) in "D") ..	.	1	.	2	.	.	.	.	.	3	5	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Low at stall (Diesel—Below 11.2 kg./sq. cm.) (160 p.s.i.) (Petrol—Below 10.2 kg./sq. cm.) (145 p.s.i.)	1	2	.	.	.	.	6	8	7	3	.	5	4	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	.
High at stall (Diesel—Above 14.1 kg./sq. cm.) (200 p.s.i.) (Petrol—Above 11.6 kg./sq. cm.) (165 p.s.i.)	.	.	.	.	.	.	.	.	4	1	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stall Speed:																																	
Low } See page 72, item 4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
High } See page 72, item 4	1	.	2	.	.	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	8	.	9	.	.	10	11	.	12	.	.	13	.
Overheating	1	.	.	.	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Will not tow start	1	.	2	.	6	5	8	9	10	11	.	.	.	.	.	.	.	.	.	3	7	.	.	.	.	.	.	.	12	.	.	.	4

NOTE.—Numbers indicate the sequence for fault investigation.

FAULT INVESTIGATION KEY

Preliminary Adjustment Faults

- **A** Fluid level incorrect.
- **B** Downshift valve cable incorrectly assembled or adjusted.
- **C** Manual linkage incorrectly assembled or adjusted.
- **D** Incorrect engine idling speed.
- **E** Incorrect front band adjustment.
- **F** Incorrect rear band adjustment.

Hydraulic Control Faults

- **a** Oil tubes missing or not installed correctly.
- **b** Sealing rings missing or broken.
- **c** Valve body assembly screws missing or not correctly tightened.
- **d** Primary regulator valve sticking.
- **e** Secondary regulator valve sticking.
- **f** Throttle valve sticking.
- **g** Modulator valve sticking.
- **h** Governor valve sticking, leaking or incorrectly assembled.
- **j** Orifice control valve sticking.
- **k** First to second shift valve sticking.
- **l** Second to third shift valve sticking.
- **m** Second to third shift valve plunger sticking.
- **n** Converter "out" check valve missing or sticking.
- **p** Pump check valve missing or sticking.

Mechanical Faults

- **N** Front clutch slipping due to worn plates or faulty parts.
- **O** Front clutch seized or plates distorted.
- **P** Rear clutch slipping due to worn plates or faulty check valve in piston.
- **Q** Rear clutch seized or plates distorted.
- **R** Front band slipping due to faulty servo, broken or worn band.
- **S** Rear band slipping due to faulty servo, broken or worn band.
- **T** One-way clutch slipping or incorrectly installed.
- **U** One-way clutch seized.
- **V** Input shaft broken.
- **W** Front pump drive tangs on converter hub broken.
- **X** Front pump worn.
- **Y** Converter blading and/or one-way clutch failed. Rear pump worn or drive key broken.

Section 8

COOLING SYSTEM

CONTENTS

SUBJECT

COOLING SYSTEM:

OVERHAUL PROCEDURES, PETROL AND DIESEL

DESCRIPTION

The pressurised cooling system is of the forced circulation type. The water pump of the petrol engine is bolted to the off-side of the engine below the alternator. The fan is mounted in the centre of the front cover, immediately behind the radiator.

The water pump fitted to the diesel engine is mounted above the timing case and the fan is bolted to the pump pulley.

Water circulates from the base of the radiator, through the pump and into the cylinder block up through the thermostat at the front of the engine and so to the radiator header tank. The water then flows down the radiator tubes and is cooled by air induced by the fan situated behind the radiator.

A wax-type thermostat in conjunction with a by-pass assists rapid warming up, and control of engine cooling.

When the coolant is cold, the thermostat is in the closed position and the water flow from the cylinder head(s) to the water pump is by means of the by-pass only. When the thermostat is fully open, full circulation through the block, cylinder head(s) and radiator takes place.

ROUTINE ADJUSTMENTS AND MAINTENANCE

The only maintenance required is to check the coolant level daily and check the fan belt tension every 8,000 kms. (5,000 miles).

To check the coolant level, remove the radiator filler cap and top-up as necessary to within 25 mm. (1 in.) below the bottom of the filler neck. If an anti-freeze solution is in use, top-up with the correct mixture to avoid weakening the coolant and raising the freezing point. The pressure cap should not be removed when the coolant is near boiling point.

The fan belt adjustment is correct when, as it is pushed and pulled at a point midway between the alternator and fan pulleys, the total belt movement does not exceed 13 mm. ($\frac{1}{2}$ in.). Details for adjusting the belt tension will be found on page 10.

To Drain the Cooling System

Two drain taps are fitted, one in the base of the radiator and the other on the cylinder block, behind the oil filter, of the petrol engine. The 4/99 diesel engine block tap is above the starter motor. The 4/108 diesel engine block tap is located at the rear of the water jacket on the right-hand side.

The vehicle should be standing on level ground with the filler cap removed when draining. If anti-freeze mixture has been used, the coolant should be drained into a clean container and retained.

1. **Open the drain taps** and release the radiator pressure cap slowly. Do not remove the pressure cap when the water is near boiling point, as this may cause water and steam to be blown out of the filler neck, possibly causing personal injury.

2. **Probe the tap orifices,** when the water has finished running, to make sure that no sediment, scale, etc., has prevented the entire contents draining away.

NOTE.—It is advisable to leave an indication on the vehicle that the cooling system has been drained should the vehicle be left standing.

To Fill

1. **Close the radiator and cylinder block taps.**

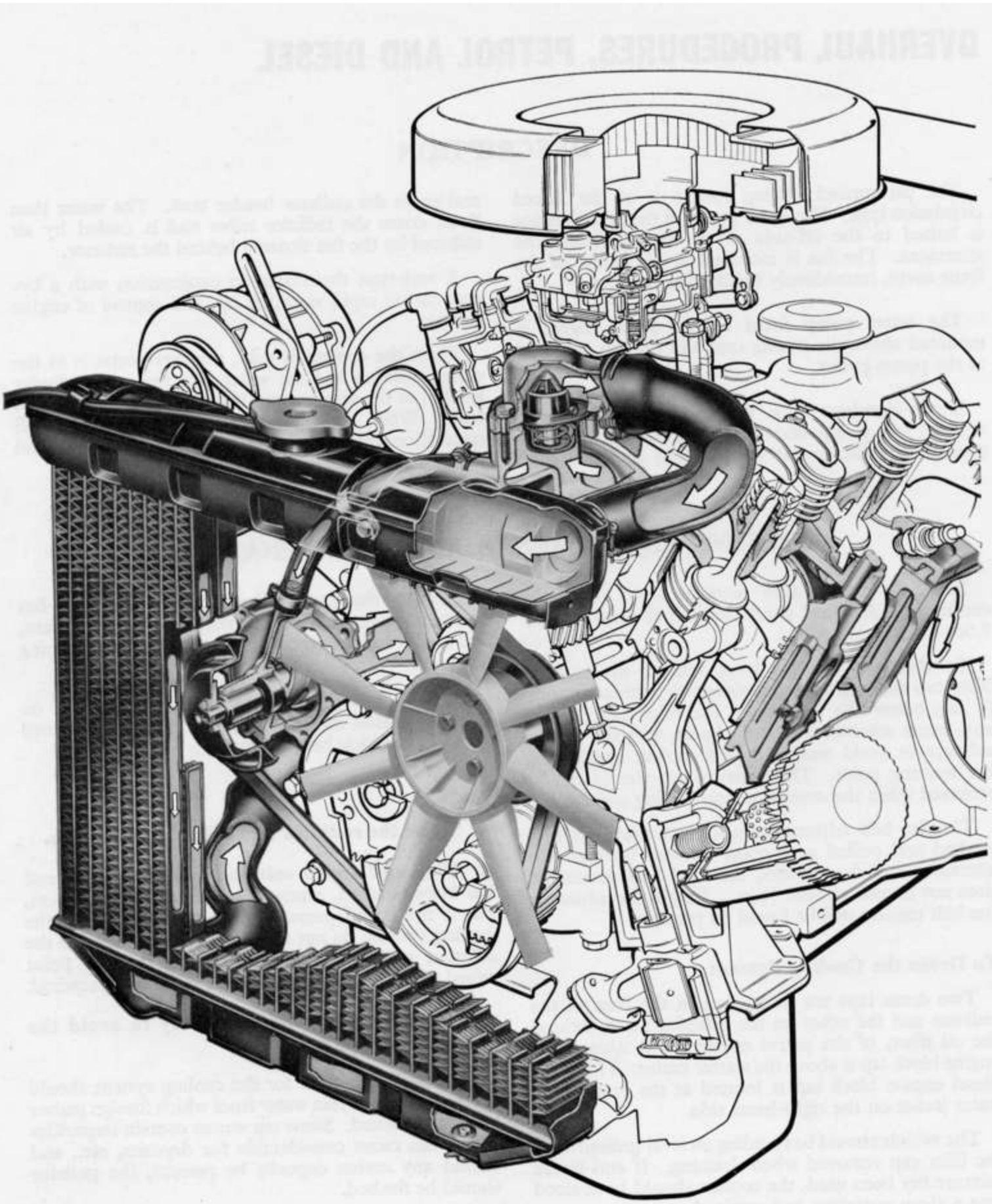
2. **If an anti-freeze solution has been in use** and has been retained, return this to the cooling system, but if the liquid present is not sufficient to fill the cooling system, do not add plain water, otherwise the solution may be weakened and the freezing point raised. Add additional anti-freeze solution as required.

3. **Fill the cooling system slowly to avoid the possibility of air locks.**

NOTE.—Water used for the cooling system should preferably be soft rain water from which foreign matter has been strained. Some tap waters contain impurities which can cause considerable fur deposits, etc., and should any undue deposits be present, the radiator should be flushed.

4. **Replace the radiator filler cap** securely, and check for any signs of water leakage.

5. **Run engine,** when just warm accelerate to moderate speed for a few seconds to clear any air pockets in the system. Stop and recheck coolant level.



Anti-freeze Mixture

In the winter months an anti-freeze solution should be used to prevent damage to the engine, which could result from the cooling water freezing.

An approved anti-freeze solution, ESE–M97B18C, is available which contains a suitable inhibitor which will reduce rust formation and corrosion in the cooling system to a minimum.

The percentage of anti-freeze solution in the cooling system will determine the degree of protection, and it is advisable to allow a margin of safety in cases where lower temperatures than normal may be encountered.

The cooling system should be flushed out thoroughly before adding anti-freeze solution. Check the condition of all hoses and connections in the cooling system and heater, if fitted. Inspect the cylinder head to block joints and other similar joints for leaks.

It is advisable to mix the anti-freeze solution in a separate container before filling the cooling system.

The quantities of anti-freeze for various degrees of protection are given in the table in the Specification at the end of this Section. The precentage of anti-freeze in the cooling system can be checked by measuring the specific gravity of the coolant. A hydrometer is required having a range of S.G. 1.000 to 1.050 calibrated at 15.6°C (60°F). When checking the specific gravity, the temperature of the coolant should be between 14.4 and 16.6°C, (58 and 62°F), but if this is inconvenient see that the reading taken is corrected to 15.6°C (60°F). Instructions for this are normally available for the particular hydrometer in use. Compare this corrected hydrometer reading with the figures given in the Specification at the end of this Section.

THE WATER PUMP

The water pump of the petrol engine is mounted on the front face of the cylinder block below the alternator. Both the 4/99 and the 4/108 diesel engines have the pump mounted above the timing case.

All three pumps are of the centrifugal type and are driven via a "Vee" belt from the crankshaft pulley.

The pump shafts and bearings utilised on the petrol and the 4/99 diesel engines are serviced as an assembly only.

The shaft of the 4/108 engine water pump is carried within two replaceable ball bearings.

Water is contained in the impeller chamber by a seal which, on the petrol engine water pump, registers against the impeller. On both of the diesel engine water pumps, the seal abuts a removable, ceramic faced, insert located in the pump body.

To Remove the Water Pump—Petrol engine

1. **Drain the cooling system** as described on page 3.

2. **Remove the fan belt** after removing the alternator adjusting arm clamp bolt and slackening the alternator mounting bolt. The alternator must be pivoted towards the engine.

3. **Slacken the hose clamps** and disconnect the lower radiator hose from the water pump, and the water pump to thermostat hose.

4. **Detach the pump and gasket,** after removing three bolts and spring washers securing the pump to the block, together with the alternator adjusting arm. One bolt is 'trapped' by the pump pulley.

To Remove the Water Pump—Diesel engines

1. **Drain the cooling system,** release the upper and lower radiator hoses and remove the radiator.

2. **Remove the fan** by unscrewing the four retaining bolts.

3. **Remove the fan belt,** slacken the alternator mounting bolts, remove the adjusting link bolt and pivot the alternator towards the engine, lift the fan belt from the pulley.

4. **Unscrew the bolts** securing the water pump to engine, three bolts are 'trapped' by the pulley, and detach the pump and back plate.

To Dismantle the Water Pump—Petrol engine

Throughout the following operations, a suitable press with the 370 Universal taper base should be used, together with the water pump tool kit C.8010.

1. **Remove the water pump** as described above.

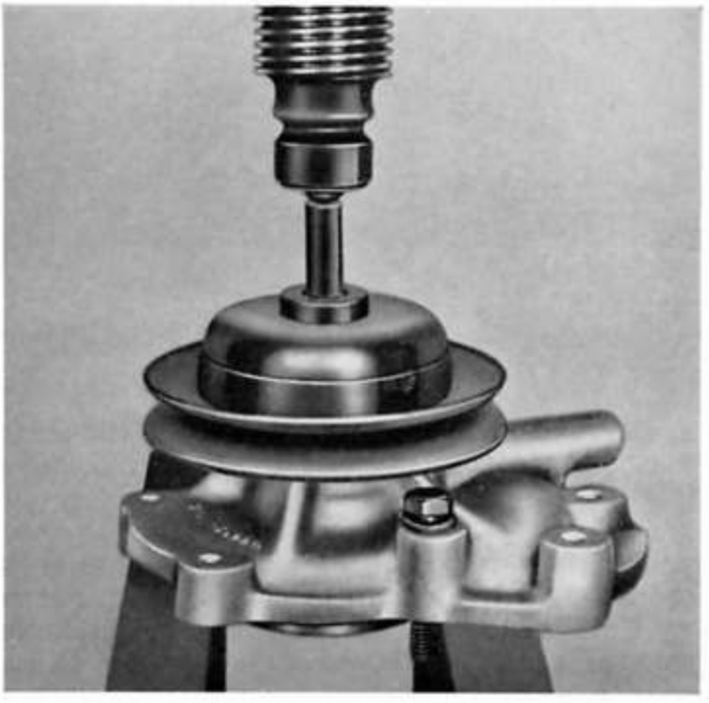


Fig. 2
Removing the Pump Pulley

2. Remove the cover from the pump housing.

3. Remove the pump pulley and shaft and bearing assembly by supporting the pump housing as shown in Fig. 2 and, using a suitable diameter rod, press out the shaft assembly.

NOTE.—A water pump repair kit is available should extensive replacement of parts be necessary to overhaul the pump. The kit consists of the shaft and bearing assembly, a slinger bush, pump seal, impeller and gasket.

To Reassemble

1. Press the slinger bush onto the shaft and bearing assembly.

2. Fit the shaft assembly into the housing, using adaptors C.8010–b and C.8010–g as shown in Fig. 3.

3. Press the pump seal into the housing, using adaptor C.8010–e, with the carbon face away from the bearing (Fig. 4).

Fig. 3
Fitting Shaft Assembly to Housing

4. Press the impeller onto the rear of the shaft, using the 370 Universal base and adaptor C.8010–a (Fig. 5).

5. Fit the bolt and spring washer which is 'trapped' by the pulley into the pump housing. Using the 370 Universal base and adaptor C.8010–a again, fit the pump pulley to the front end of the shaft (Fig. 6), and press on to give a dimension of 5.66 to 5.74 cm. (2.20 to 2.26 in.) between the centre line of the pulley groove and the rear face of the housing. Do not press the pulley past this distance.

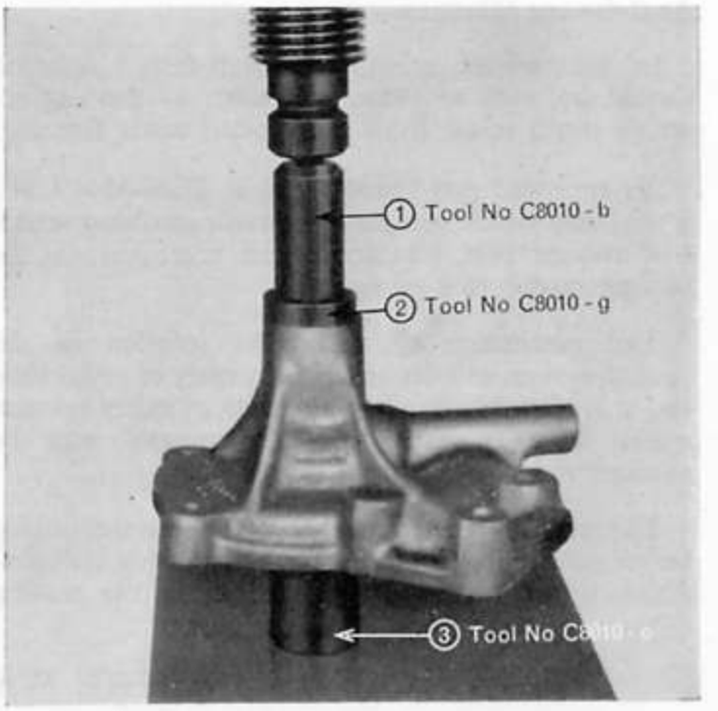


Fig. 4
Fitting Seal to Housing

6. Clean off the housing faces, fit a new gasket and refit the rear water pump cover.

To Replace the Water Pump—Petrol engine

1. Clean the front face of the cylinder block and the part of the rear face of the water pump that abuts it.

2. Fit the water pump and tighten all retaining bolts.

3. Locate the fan belt around the pulleys, and adjust as described on page 10.

4. Refill the cooling system and check for coolant leaks.

Fig. 5
Fitting Impeller to Shaft

Fig. 6
Fitting the Pump Pulley

To Dismantle the Water Pump–4/99 Diesel engine

1. **Remove the drive pulley,** using puller Tool C6156 in the tapped holes of the pulley face.

2. **Extract the circlip,** locating the shaft assembly, through the slot in the pump body.

3. **Support the pump body** and press the shaft out complete with impeller, seal, insert, and water slinger.

4. **Remove the impeller** from the shaft using the puller tool or a press, remove the seal, insert, and slinger.

Examine all parts for damage, wear or corrosion, pay particular attention to the seal and insert mating faces and the fit of the impeller and pulley on the pump shaft. Replace where necessary.

NOTE.—A ceramic faced insert and a larger diameter carbon faced seal, introduced in September 1968, replace the original insert and seal.

To Reassemble the Water Pump

1. **Ensure that the insert recess** and the drain hole in the pump body are clean. Lightly coat the inner diameter of the recess and the outer diameter of the insert with Loctite "AVV" and press the insert fully home, remove all trace of surplus Loctite.

NOTE.—Extreme care must be exercised during this operation as the face upon which the seal registers must not be marked.

2. **Fit the water slinger** onto the longer end of the shaft, large diameter towards the bearing (Fig. 8).

3. **Press the shaft assembly** into the front of the pump body, longer end of the shaft towards the water chamber, taking care not to dislodge the insert.

4. **Enter the shaft assembly retaining clip** through the slot in the pump body and push fully into its location.

5. **Insert the three pump mounting bolts,** with spring washers, which are obstructed by the pulley.

6. **Support the impeller end of the shaft** on a press and fit the drive pulley until the face of the pulley is flush with the end of the shaft.

NOTE.—The pressure required to fit the pulley should be approximately 2,540 kgs. (5,600 lbs.), if the pressure to fit the pulley is substantially less than this figure a new pulley and/or shaft must be fitted.

7. **Invert the pump on the press,** support the pulley end of the shaft. Fit the seal, carbon face towards the insert and then press the impeller onto the shaft until a clearance of 0.125 to 0.635 mm. (0.005 to 0.025 ins.) is obtained between the front face of the impeller and the pump body see (Fig. 9).

To Dismantle the Water Pump—4/108 Diesel engine

1. **Remove the pulley from the shaft** by means of a suitable puller, the threaded holes in the pulley face may be utilised for this purpose.

2. **Support the pump body** and press the shaft out complete with the impeller, seal, insert and thrower.

3. **Press the impeller from the shaft** and remove the seal, insert and thrower.

Fig. 7
Removing Water Pump Pulley—Diesel

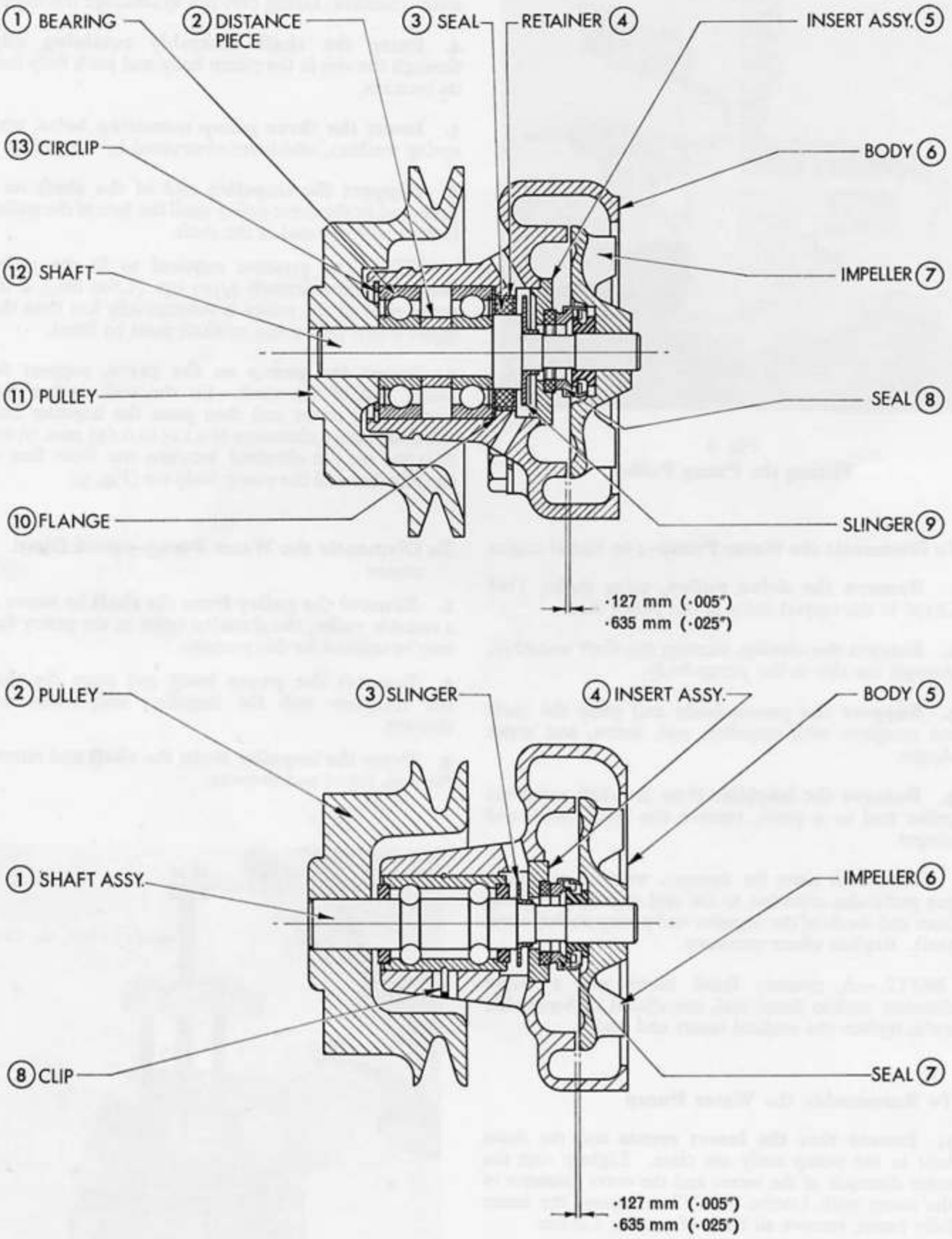


Fig. 8
Sectional Views of Diesel Engine Water Pumps
UPPER - 4/108 LOWER - 4/99

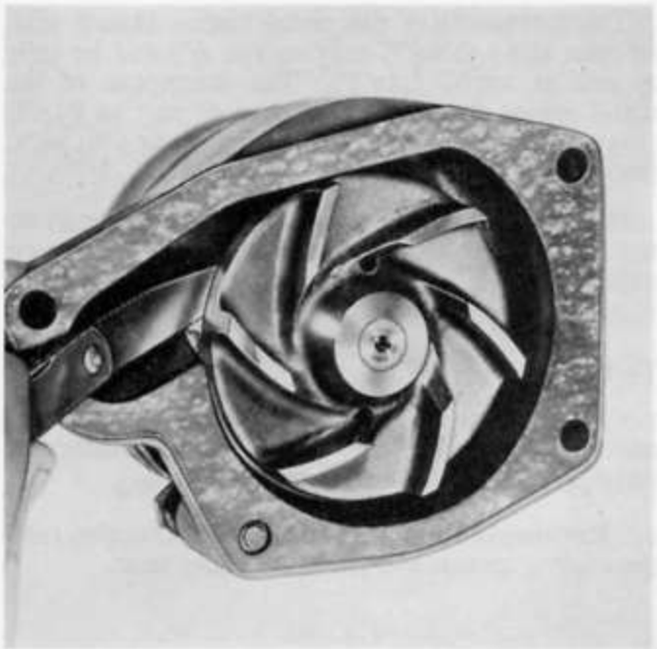


Fig. 9
Checking Impeller Clearance—Diesel

4. Remove the circlip retaining the bearings and press the bearings and distance piece out through the front of the pump body. Remove the felt seal, retainer and plate.

Examine all parts for damage, wear or corrosion, pay particular attention to the seal and insert and the fit of the impeller and pulley on the pump shaft. Replace where necessary.

NOTE.—A ceramic faced insert and a larger diameter carbon faced seal, introduced in September 1968, replace the original insert and seal.

To Reassemble

1. Insert the oil seal retainer into the pump body, replace the felt oil seal followed by the retaining plate.

NOTE.—The felt seal should be soaked in engine oil and the excess oil squeezed out before fitting.

2. Fit the two bearings, with the distance piece between them, onto the shaft. Pack the bearings, and pack the space between the bearings approximately ¾ full of high melting point grease.

3. Press the bearings and shaft assembly into the pump body, impeller end first, and fit the retaining circlip.

4. Press the water thrower into position on the shaft, larger diameter towards the shaft collar (Fig. 8).

5. Ensure the insert recess and drain hole in the pump body are clean. Lightly coat the inner diamer of the recess and the outer diameter of the insert with Loctite 'AVV' and press the insert fully home. Remove all trace of surplus Loctite.

NOTE.—Extreme care must be exercised during this operation as the face upon which the seal registers must not be marked.

6. Place the seal on the drive shaft so that the carbon face mates with the insert face.

7. Support the pulley end of the shaft and press the impeller onto the shaft until a clearance of 0.127 to 0.635 mm. (0.005 to 0.025 ins.) is obtained between the impeller and the pump body (Fig. 9).

8. Invert the pump assembly and support the impeller end of the shaft, insert the three mounting bolts, with spring washers, into the pump body, press the pulley onto the shaft until the face of the pulley is flush with the shaft.

NOTE.—The pressure required to fit the pulley should be approximately 2,540 kgs. (5,600 lbs.), if the pressure to fit the pulley is substantially less than this figure a new pulley and/or shaft must be fitted.

To Replace the Water Pump—Diesel engine

1. Clean all traces of gasket and jointing compound from the cylinder block mating face and the water pump back plate. Using new joints lightly coated with a suitable jointing compound secure the water pump and plate to the engine.

2. Refit the fan belt, replace the alternator adjusting link bolt, adjust the belt tension and tighten the alternator mounting bolts.

3. Refit the fan using new spring washers.

4. Refit the radiator, reconnect the upper and lower hoses. Refill the cooling system.

THERMOSTAT

A wax-type thermostat is located beneath the water outlet on the front of the inlet manifold casting of the petrol engine. The thermostat fitted to the diesel engines is located at the front of the cylinder head.

When the coolant is cold, the thermostat is in the closed position and the by-pass restricts the circulation in the block and cylinder head(s). When the thermostat is fully open, full circulation through the block, cylinder head(s) and radiator takes place.

Use of a wax-type thermostat ensures that its operation, although fully sensitive to temperature changes, remains unaffected by pressure developed within the cooling system.

To Remove

1. **Drain the cooling system** as previously described and disconnect the hose from the water outlet.

2. **Remove the water outlet connection** after removing the two bolts securing the water outlet to the inlet manifold or cylinder head, lift off the gasket and extract the thermostat from its recess.

Testing the Thermostat

If it is suspected that the thermostat is not operating correctly, it may be tested in the following manner:

Suspend the thermostat in water in a suitable container and gradually heat the water, frequently checking the temperature with an accurate thermometer. Neither the thermostat nor the thermometer must touch the container.

The thermostat of the petrol engine should start to open at 85 to 88°C (185 to 190 F°) and be fully opened at 100°C (212°F). The thermostat of the diesel engine should start to open at 79.5 to 83.5°C (175 to 182°F) and be fully open at 93.5 to 96°C (200 to 205°F).

If the thermostat does not function properly, do not attempt any adjustment, but replace with a new unit.

To Replace

1. **Locate the thermostat** in its recess, fit a new gasket and replace the water outlet connection, securing with two bolts and spring washers.

2. **Reconnect the top hose** to the water outlet, refill the cooling system and check for water leaks.

FAN

Petrol

The petrol engine has an eight bladed plastic fan which is secured to the hub on the front cover by four bolts and spring washers. The bolts should be tightened to 0.7 kg.m. (5 lb. ft.) maximum.

Some pre-August 1967 vehicles may have the original four blade steel fan fitted. Should this fan require changing, discard the spacer used between the steel fan and the shaft flange, then fit a plastic fan. As the dished boss of the plastic fan faces the radiator it will be found advantageous to use a $\frac{3}{8}$ in. drive socket and swivel bar to replace the securing bolts.

Diesel

Prior to January 1970 a four bladed steel fan 292 mm. (11.5 in.) diameter was used, secured to the water pump pulley by four bolts and lockwashers.

An eight bladed fan, of 317 mm. (12.5 in.) diameter, was available where extra cooling was required.

In January 1970, an eight bladed plastic fan of 292 mm. (11.5 in.) diameter became standard, with a 305 mm. (12.0 in.) diameter being available for extra cooling.

NOTE.—Do not attempt to turn the engine over by means of a plastic fan as this will distort the blades and cause them to run out of true.

FAN BELT

A single V-type belt is used to drive the alternator and water pump from the crankshaft pulley.

Correct fan belt tension is important otherwise the belt itself may be damaged or undue strain placed on the alternator or water pump bearings.

There is provision for fan belt adjustment by moving the alternator on its mounting and it is important that this adjustment is released when a new fan belt is to be fitted, otherwise any attempt to strain a new belt over the sides of the pulley, using a lever, can easily cause damage to the belt or pulleys.

To Adjust the Fan Belt Tension

The correct tension of the fan belt is such that when the belt is pushed and pulled at a point midway between the alternator and fan pulleys, the total movement is 12.5 mm. ($\frac{1}{2}$ in.)

1. **Slacken the alternator** adjustment locking bolt and the mounting bolt(s).

2. **Move the alternator** towards or away from the engine as necessary until the correct belt tension is obtained, testing the tension midway between the alternator and fan pulleys.

3. **Lock the alternator** adjustment locking bolt and tighten the mounting bolt(s).

RADIATOR

The radiator consists of an upper and lower tank connected by a matrix. This in turn consists of vertical cooling tubes passing through copper fins. The fins increase the total surface area available to the cooling air passing through the radiator.

When the thermostat is open, hot coolant passes into the top tank of the radiator and is cooled as it flows down through the tubes by air flow through the matrix. The coolant is then recirculated from the lower tank through the engine by the water pump.

To Remove the Radiator

1. **Drain the cooling system** as described on page 3.

2. **Disconnect the top and bottom hoses** from the radiator.

3. **Remove the bolts** attaching the radiator to the two radiator support bars, which are connected to the front panel. Remove the radiator.

To Replace

1. **Reposition the radiator** in the vehicle and secure it in position, with the four support bolts.

2. **Refit the top and bottom hoses.** Tighten the hose clamps.

3. **Refill the cooling system** with clean water or anti-freeze solution as required.

4. **Run the engine** and check for water leaks.