Ford

TRANSIT

WORKSHOP MANUAL

FORD OF BRITAIN

FORD

TRANSIT

Shop Manual

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

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

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

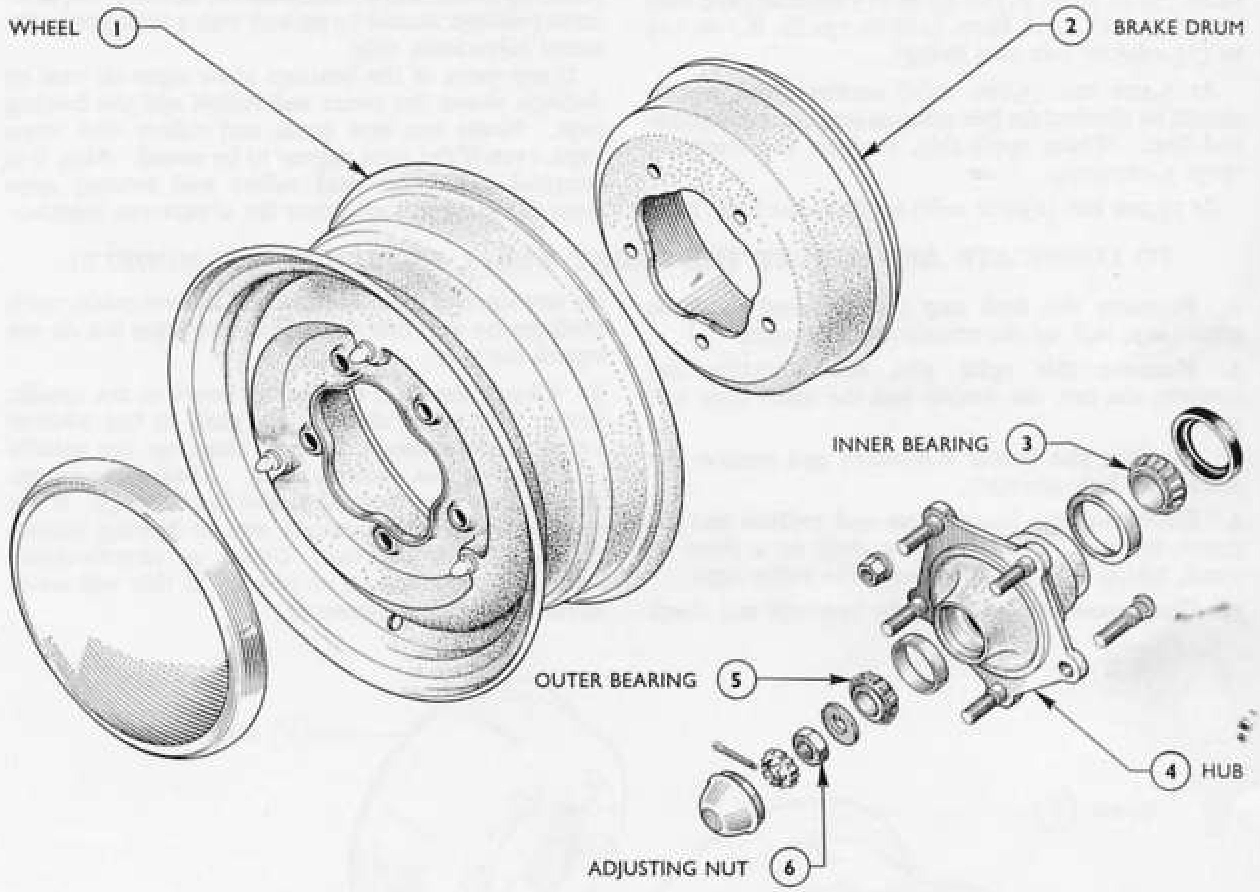


Fig. 1
Front Wheel and Hub (75 - 115)

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, $\frac{3}{4}$ 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 counter-sunk 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.

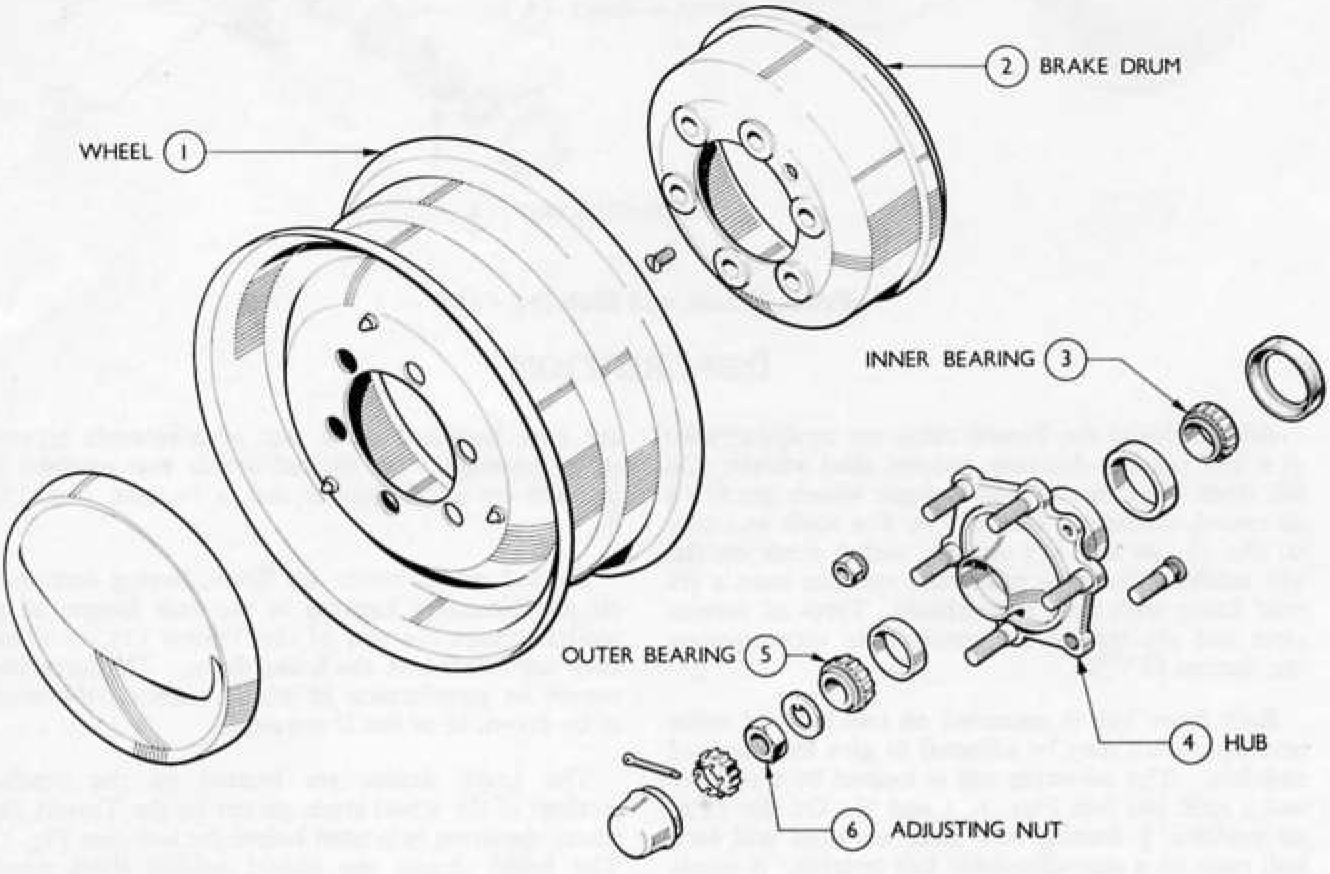


Fig. 2
Front Wheel and Hub (125)

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

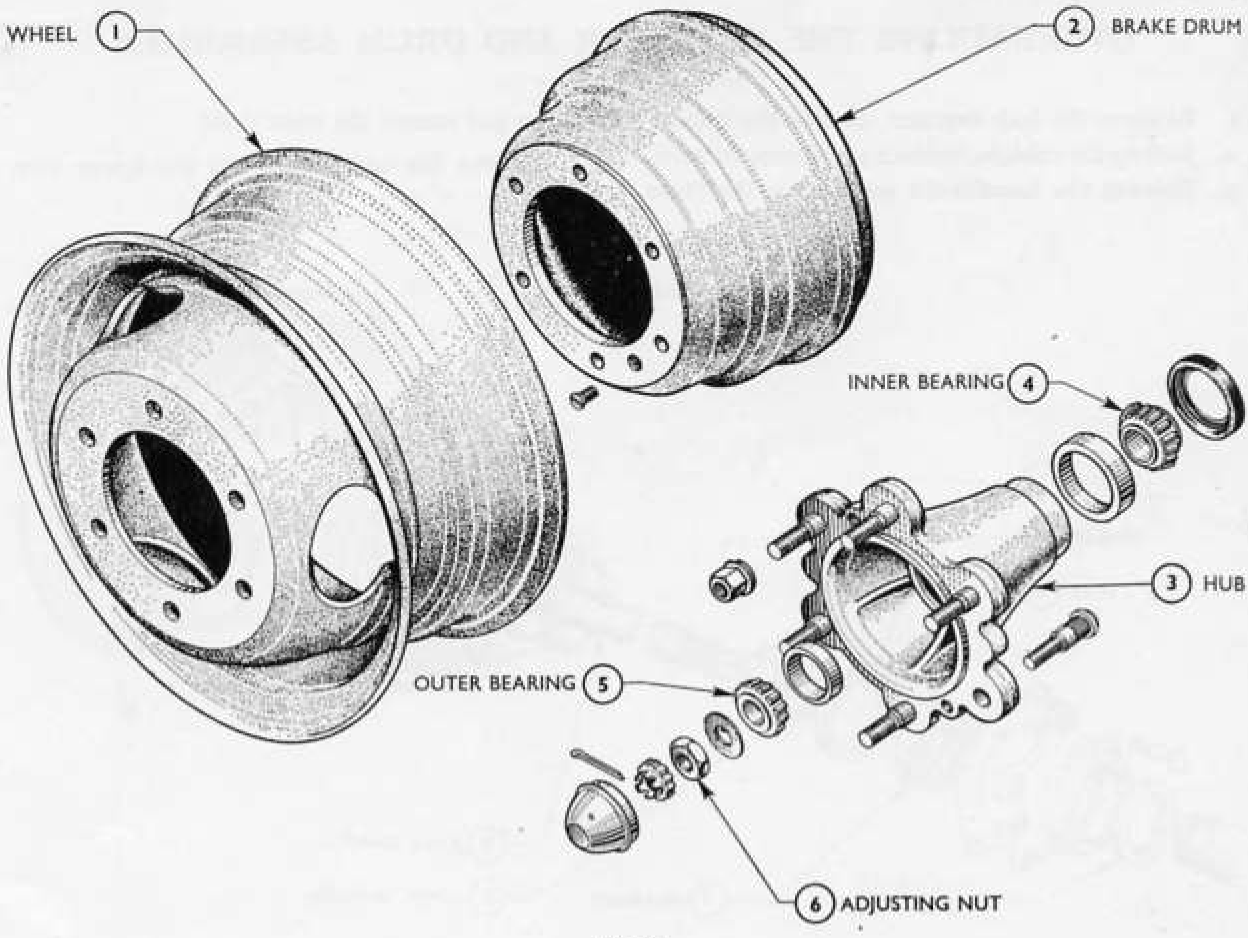


Fig. 3
Front Wheel and Hub (130—175)

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.

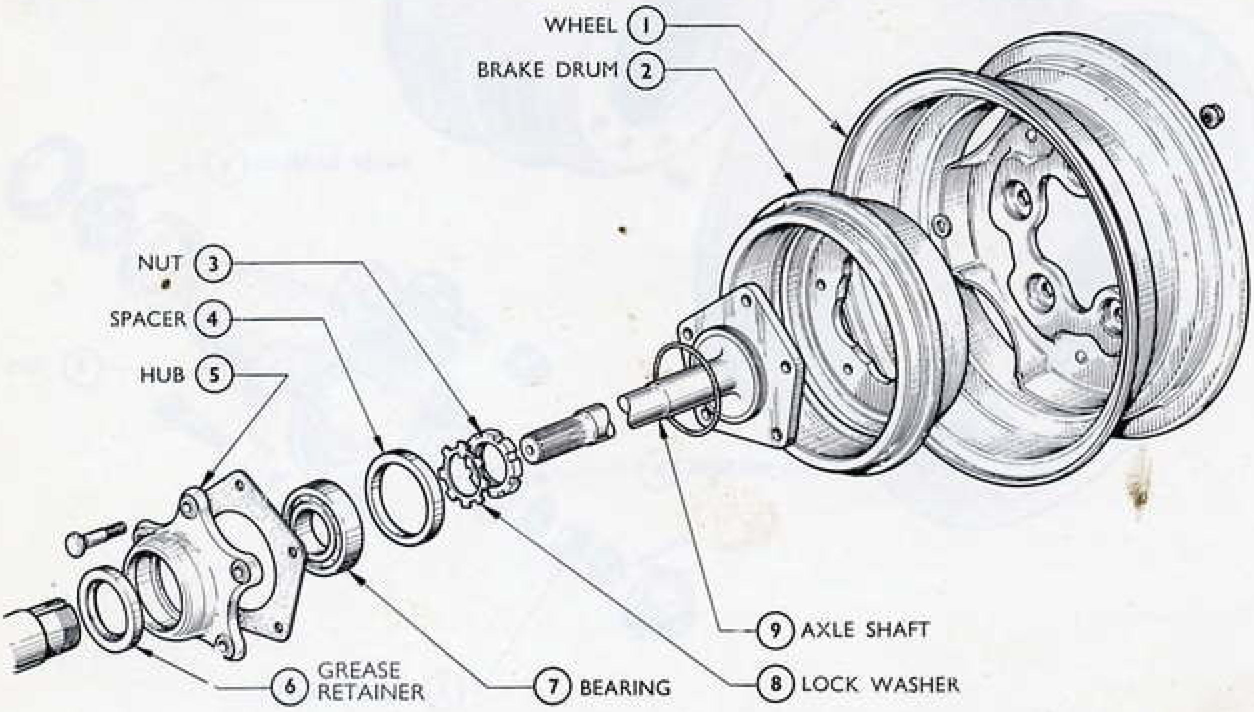


Fig. 5
Rear Wheel and Hub (75 — 115)

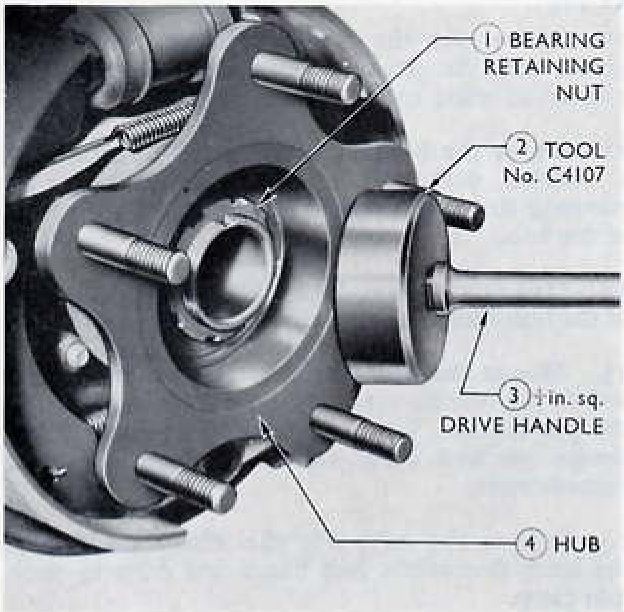


Fig. 6
Use of Tool No. 4107

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.

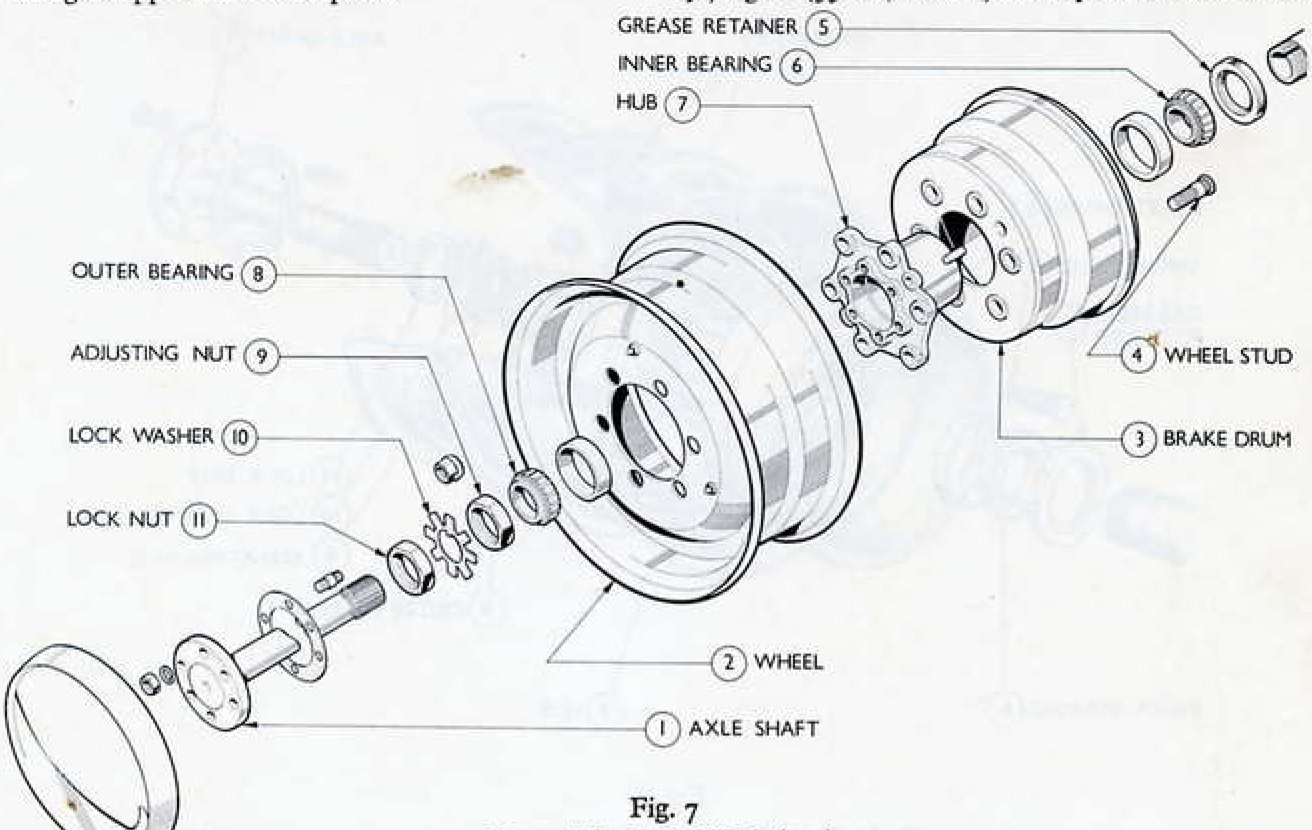


Fig. 7
Rear Wheel and Hub (125)

(*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.

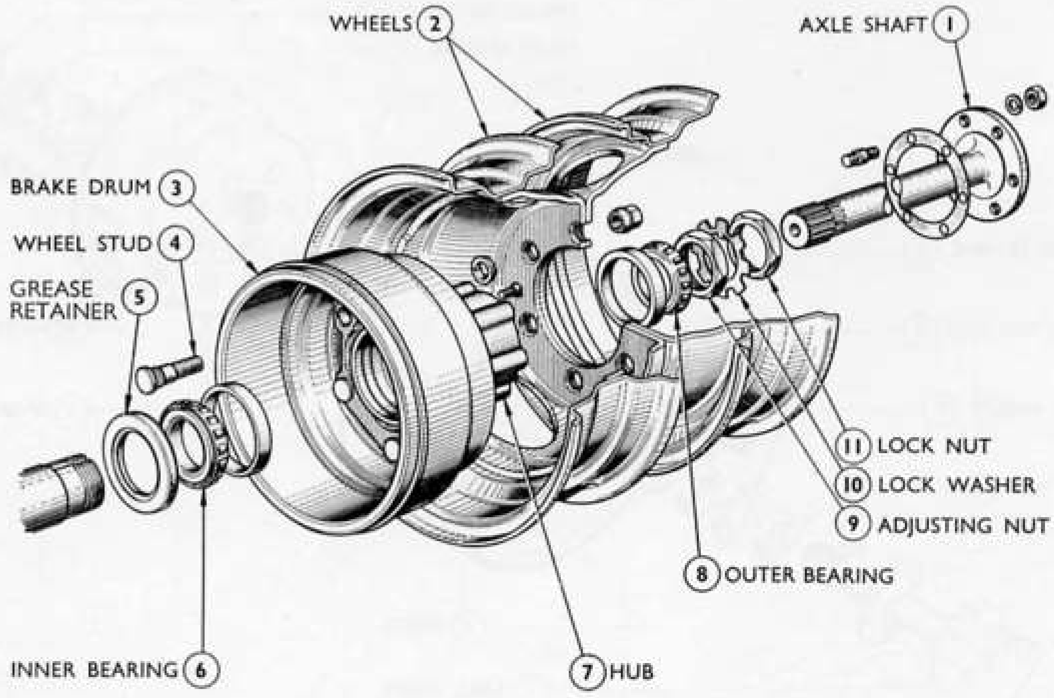


Fig. 8
Twin Rear Wheels and Hub (130—175)

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

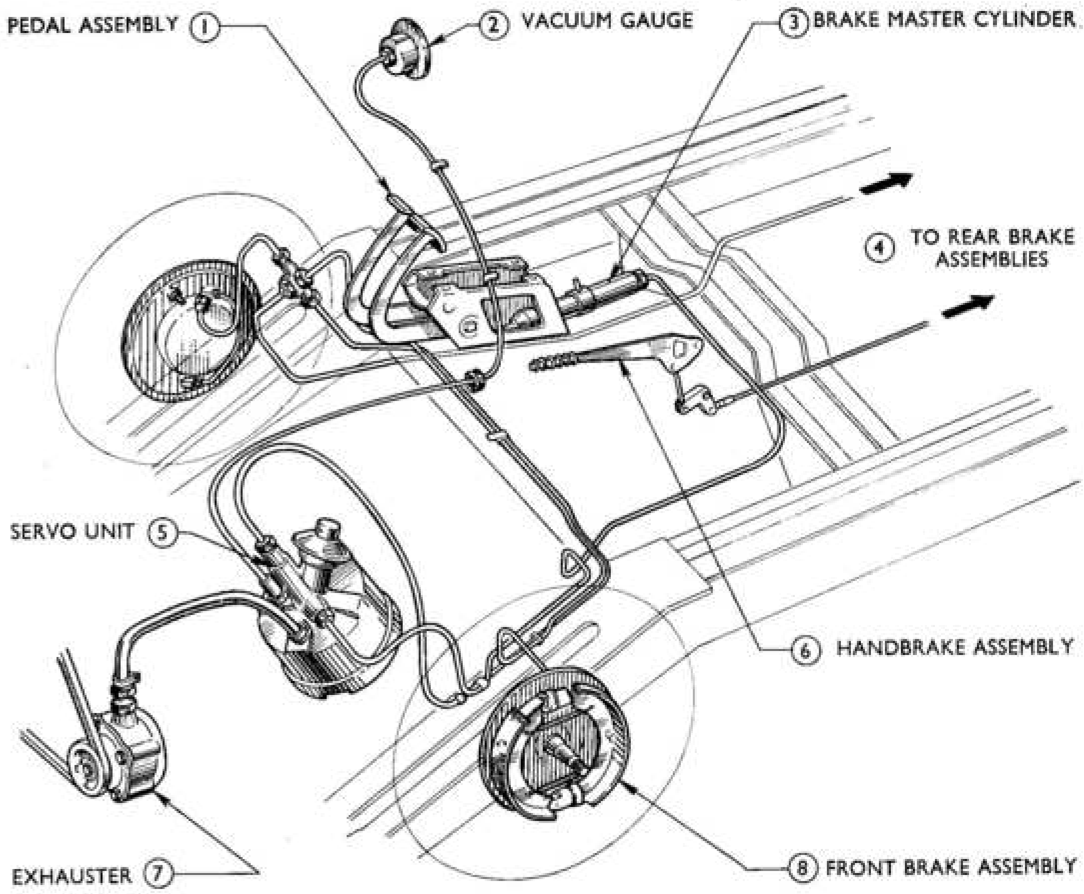


Fig. 1
Braking System—Diesel Engine Vehicle with Servo
(Floor mounted pedals — Prior to December 1970)

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

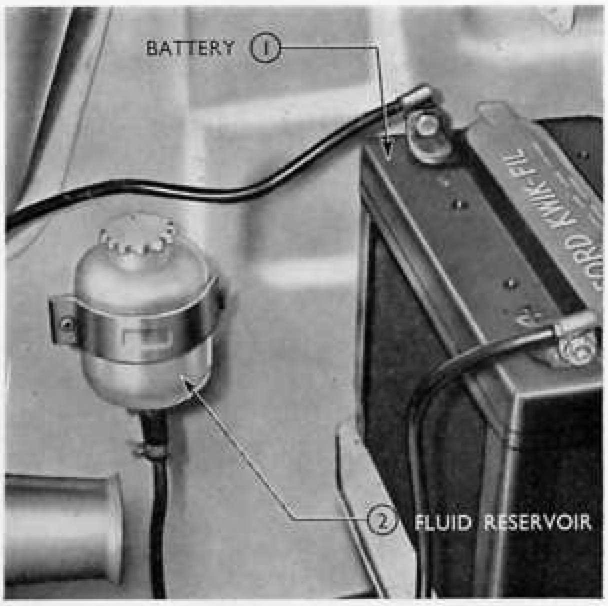


Fig. 3
Fluid Reservoir Location
(Floor mounted pedals)

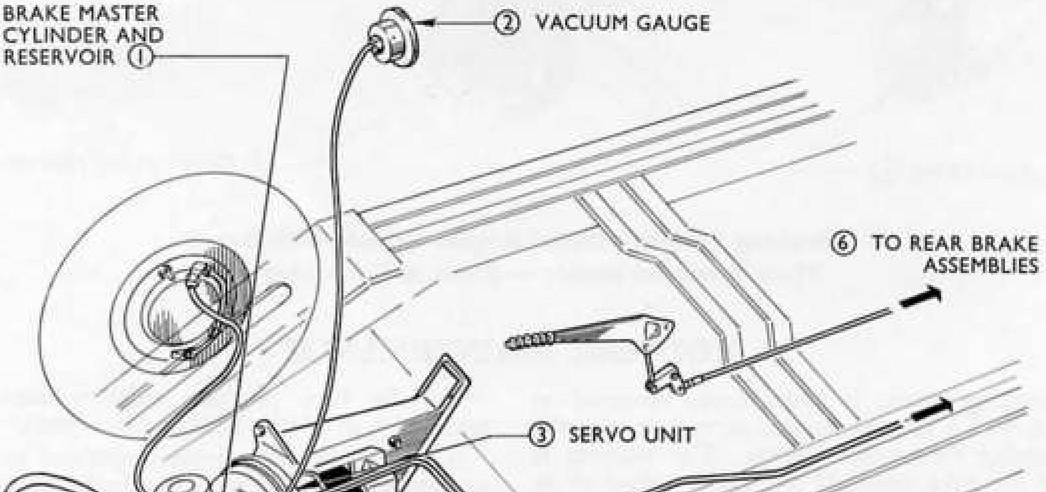


Fig. 2
Single Line Braking System—Diesel Engine Vehicle with Servo.
(Pendant pedals—After December 1970)

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

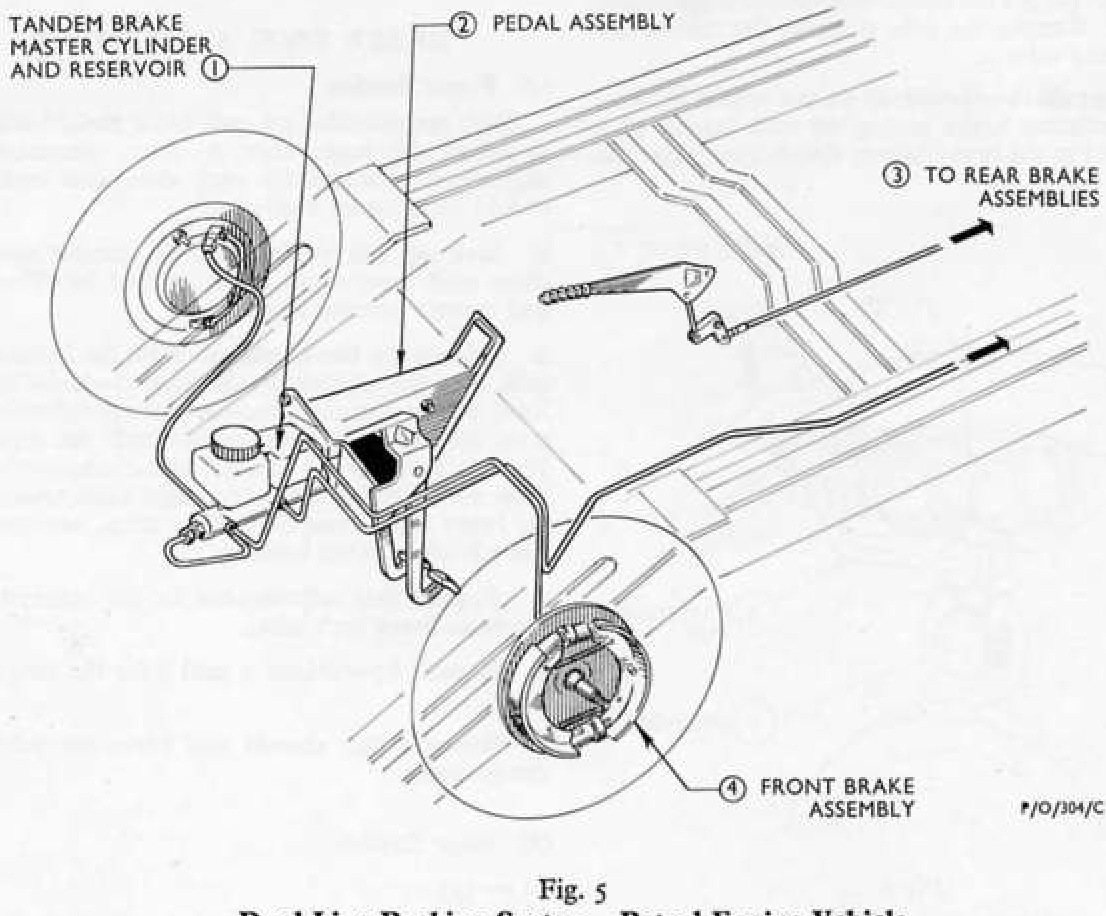


Fig. 5
Dual Line Braking System—Petrol Engine Vehicle
(Pendant pedals—After December 1970)

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.

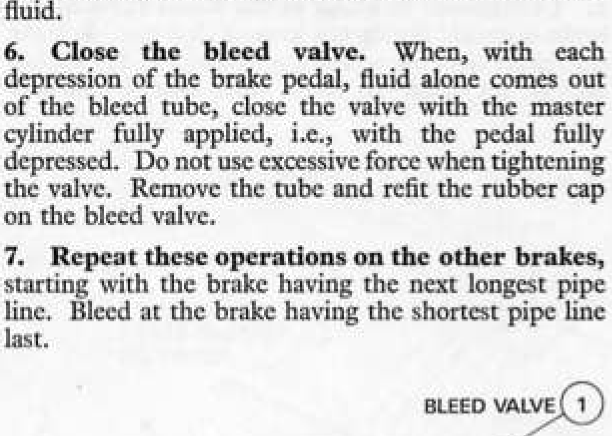


Fig 6
Rear Brake Remote Bleed Pipe (Transit 125 Only)

Fig. 7
Adjusting the Front Brakes

8. **Refill the reservoir** to the correct level (5 mm. (0.19in.) 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.

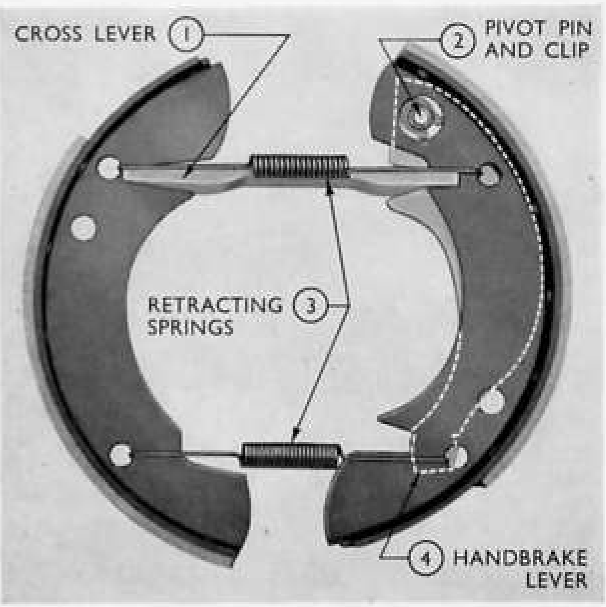


Fig. 10
Rear Brake Shoe Assembly

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.

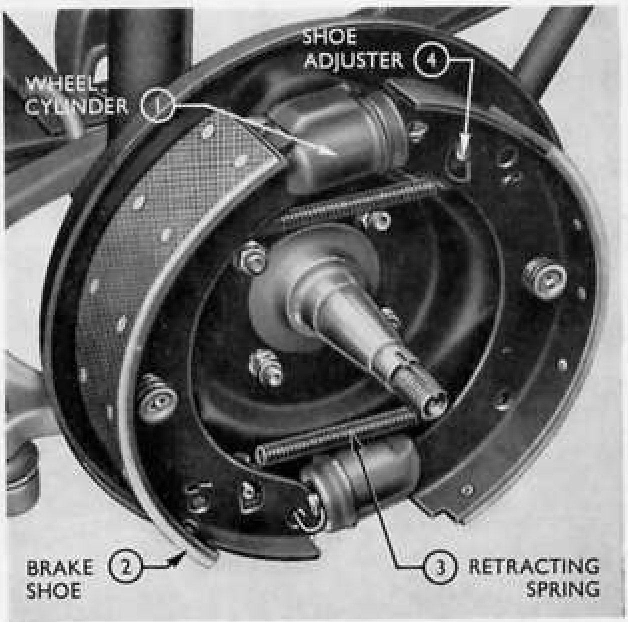


Fig. 11
Front Brake Assembly

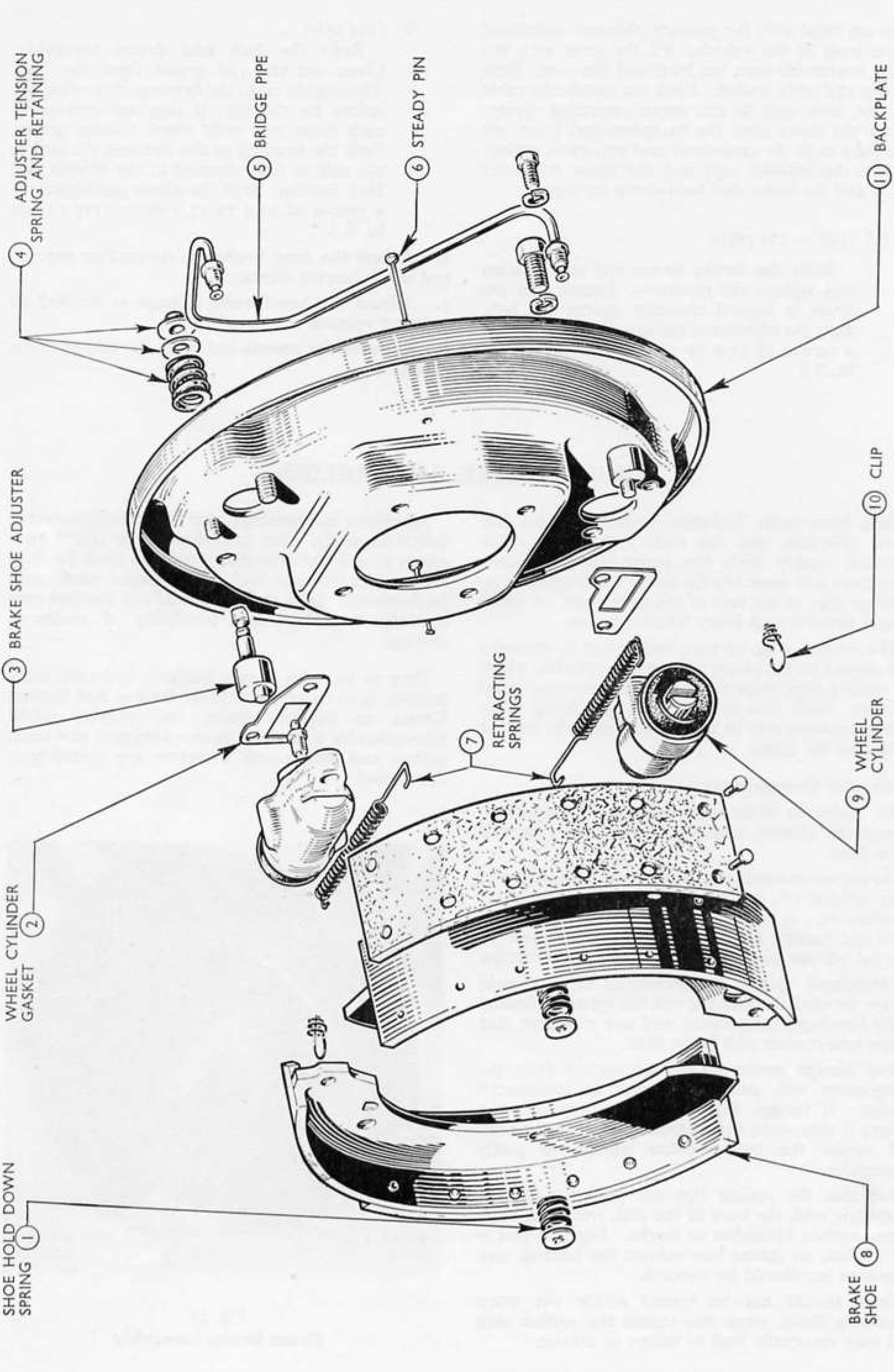


Fig. 12
Front Brake Assembly—Exploded

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.

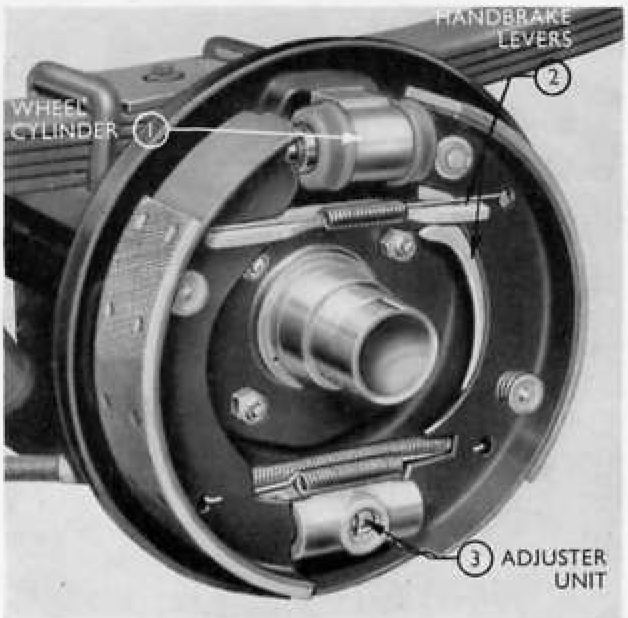


Fig. 13
Rear Brake Assembly 75 — 115

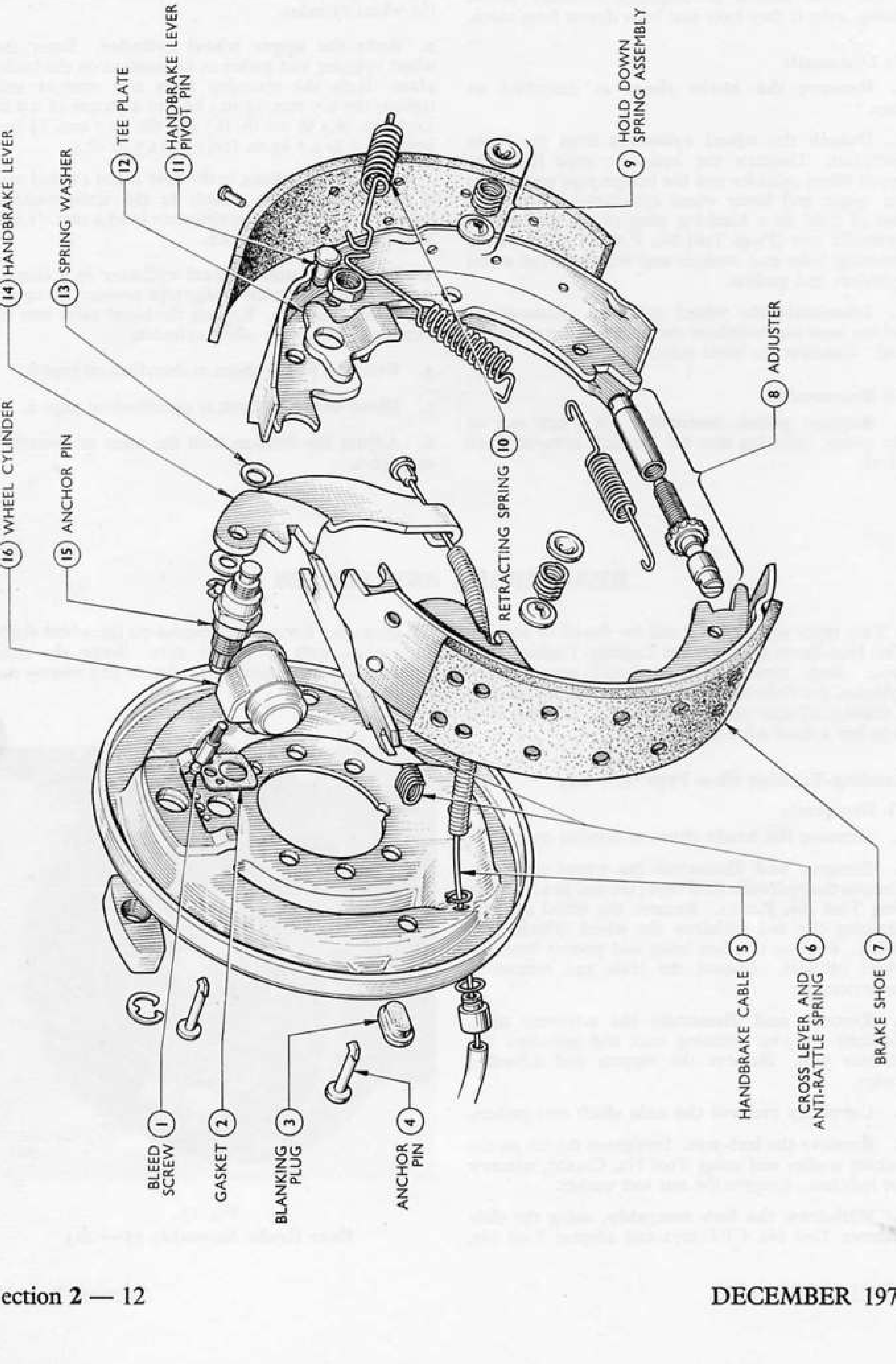


Fig. 14
Rear Brake Assembly—Exploded

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.

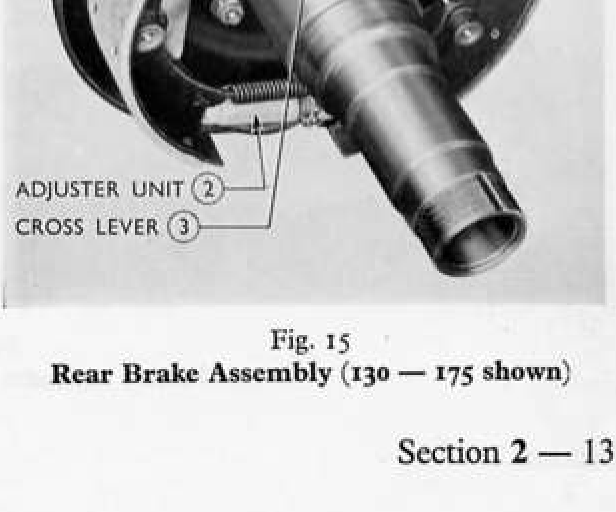


Fig. 15
Rear Brake Assembly (130 — 175 shown)

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 lock-washer 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 counter-sunk 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.

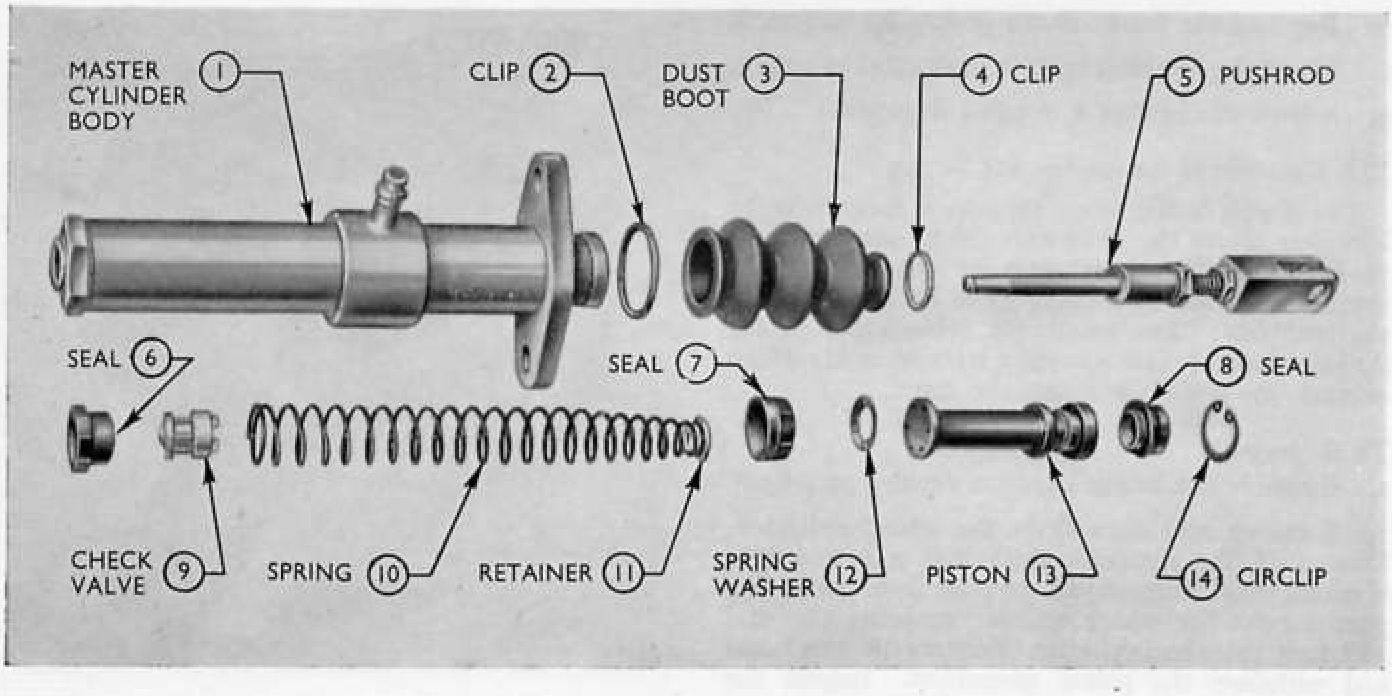


Fig. 16
Brake Master Cylinder (Prior to December 1970)

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.

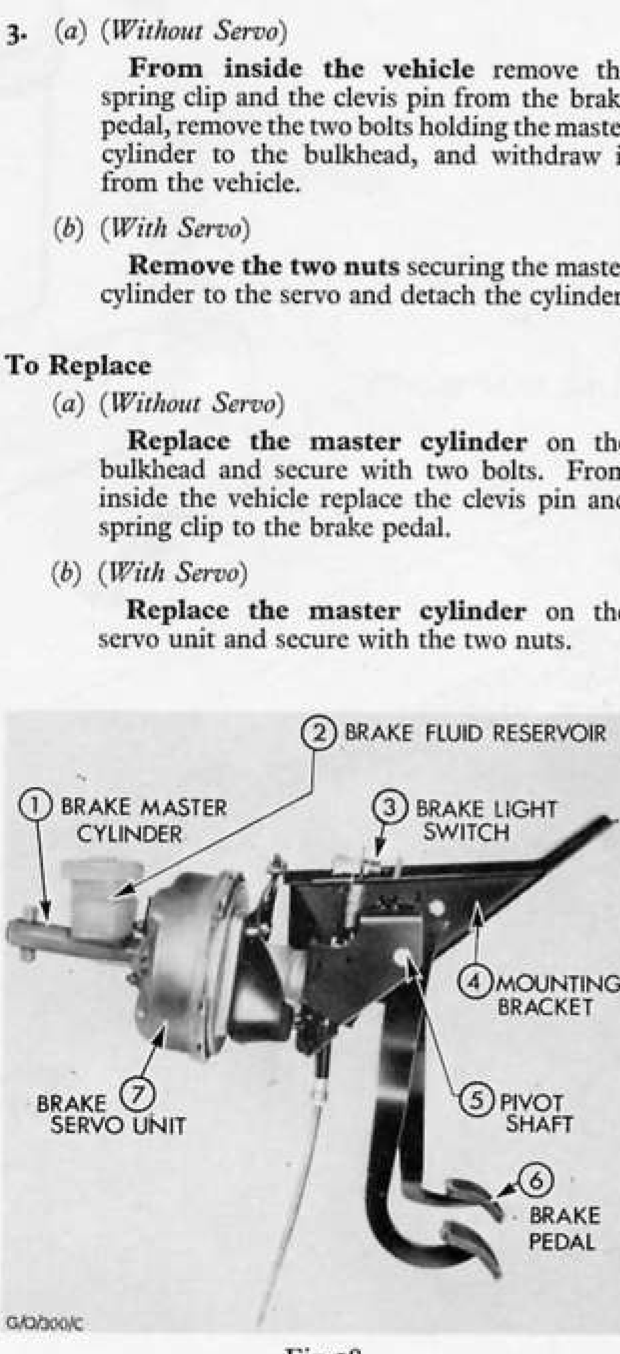


Fig 18
Pedal Assembly (with Servo)
(Pendant pedals)

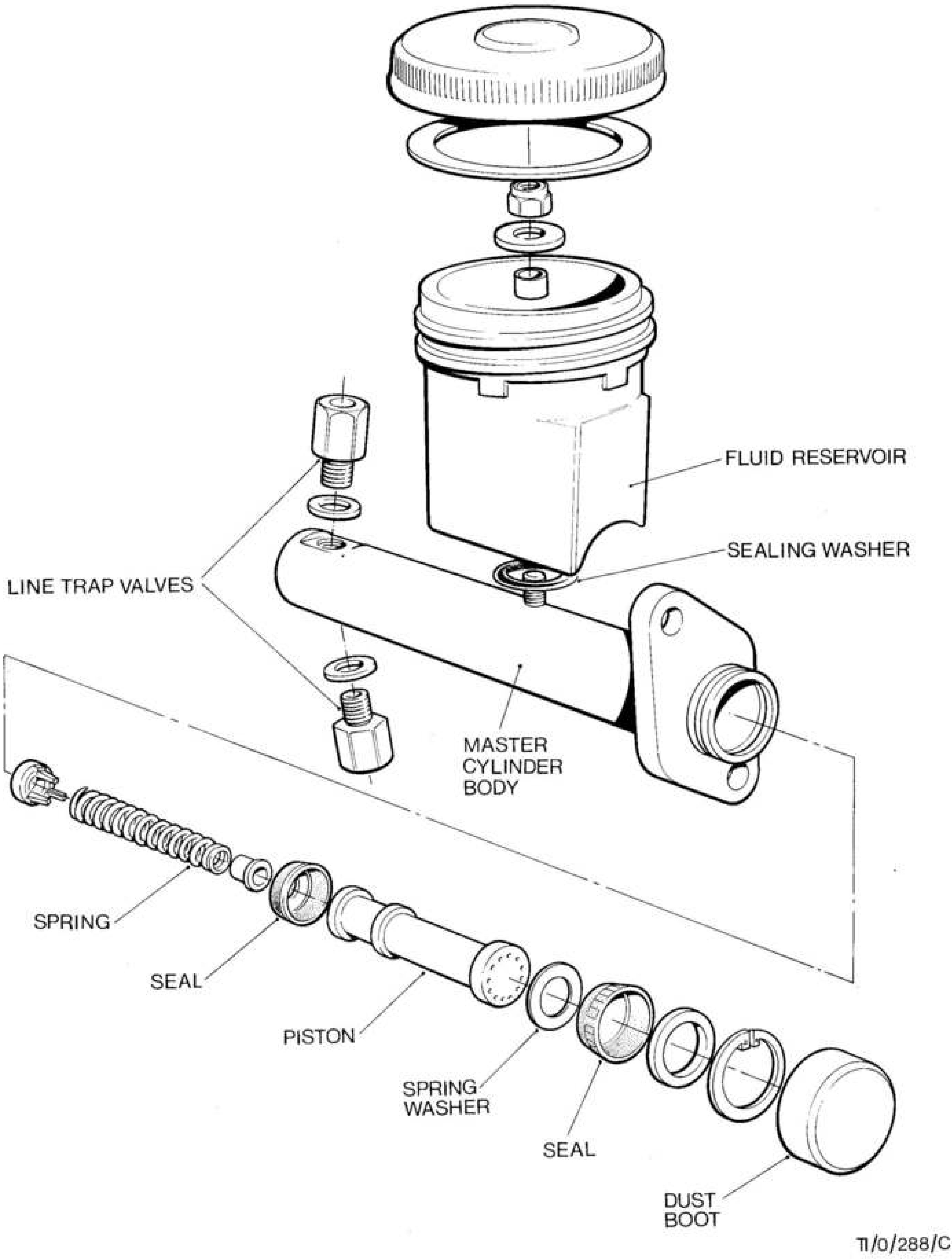


Fig. 19
Single Line Brake Master Cylinder (After December 1970)

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.

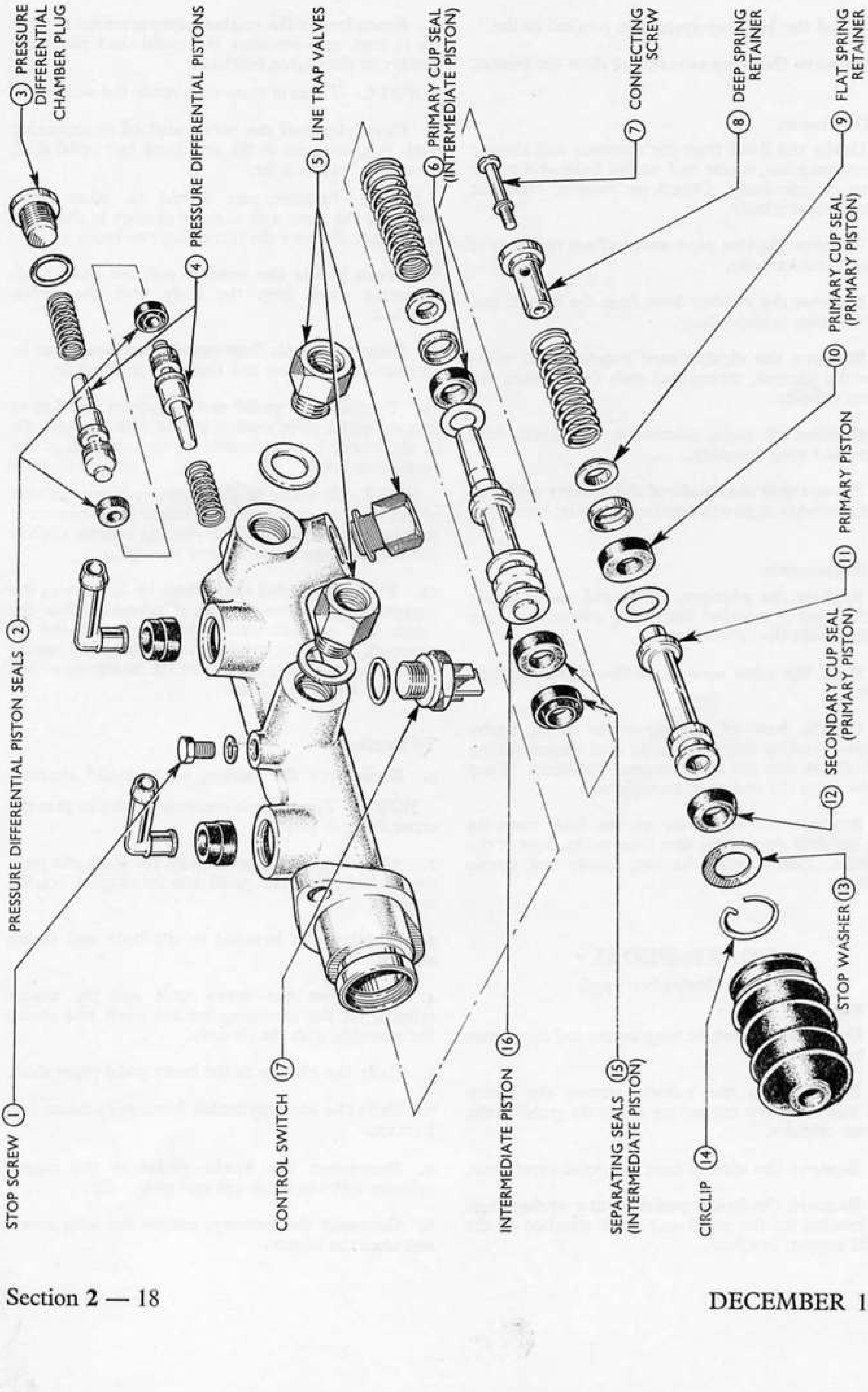


Fig. 20
Tandem Brake Master Cylinder (Prior to December 1970)

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.

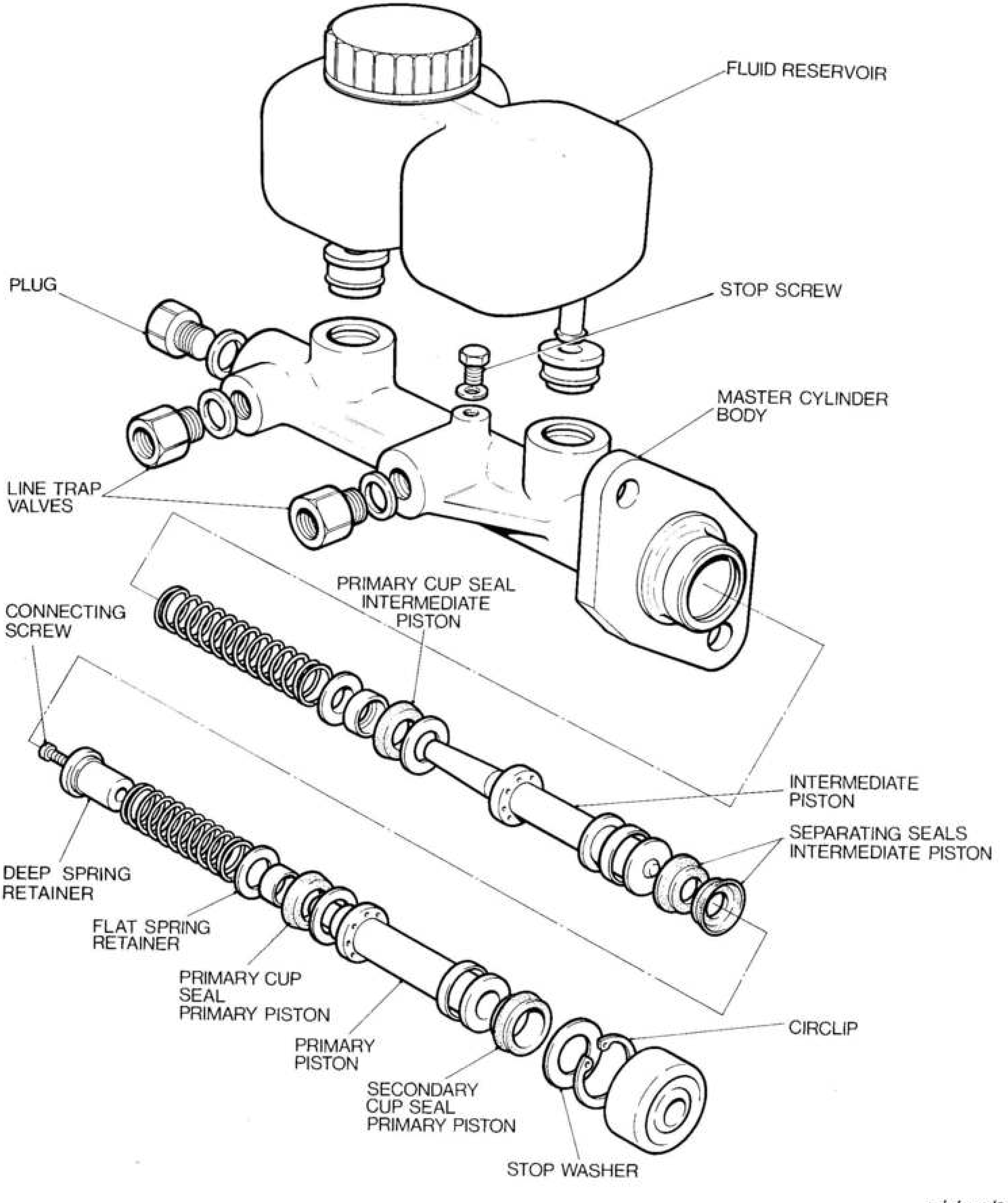


Fig. 21

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.

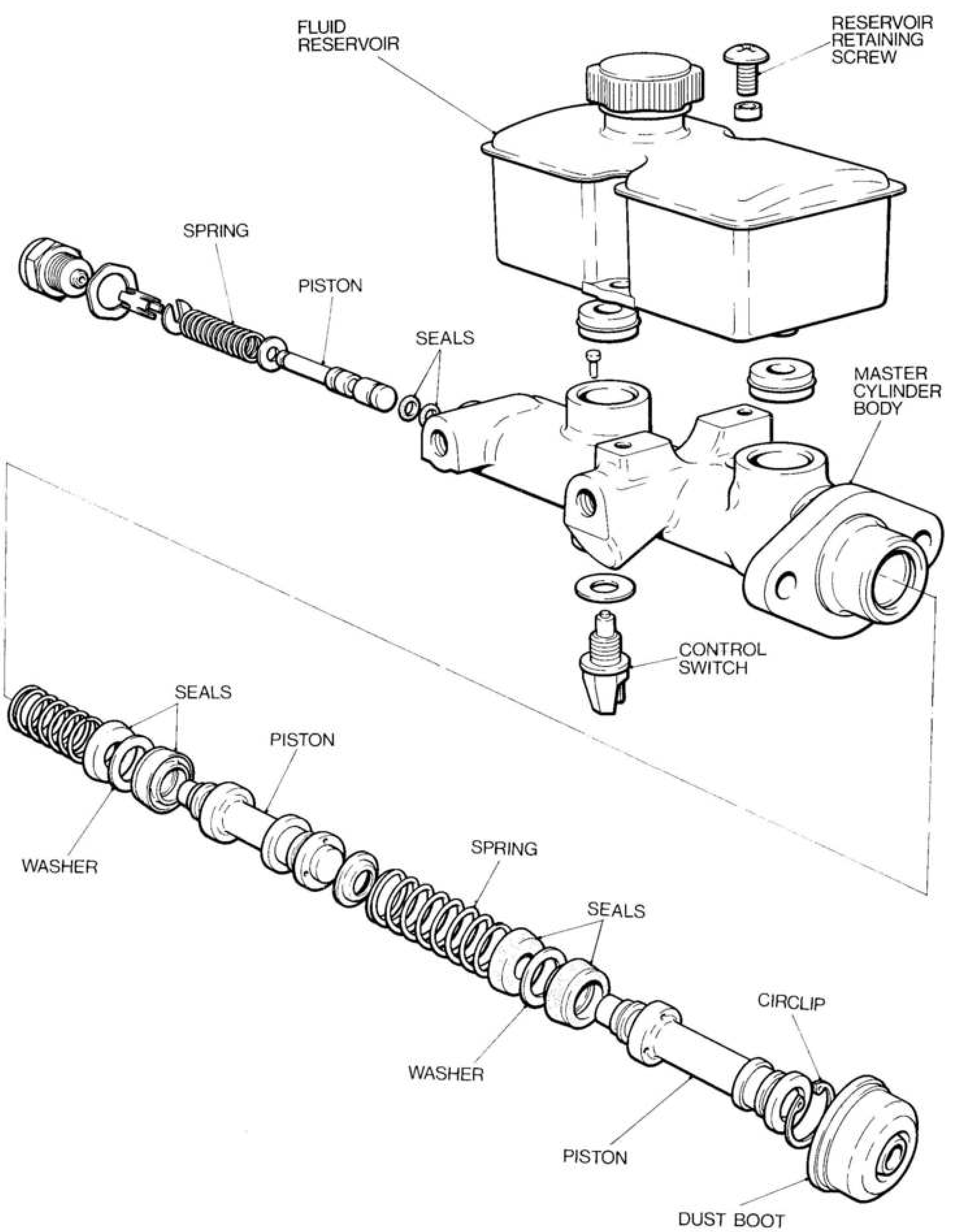


Fig. 22
Tandem Master Cylinder (After December 1970)
(Vehicles fitted with Servo)

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

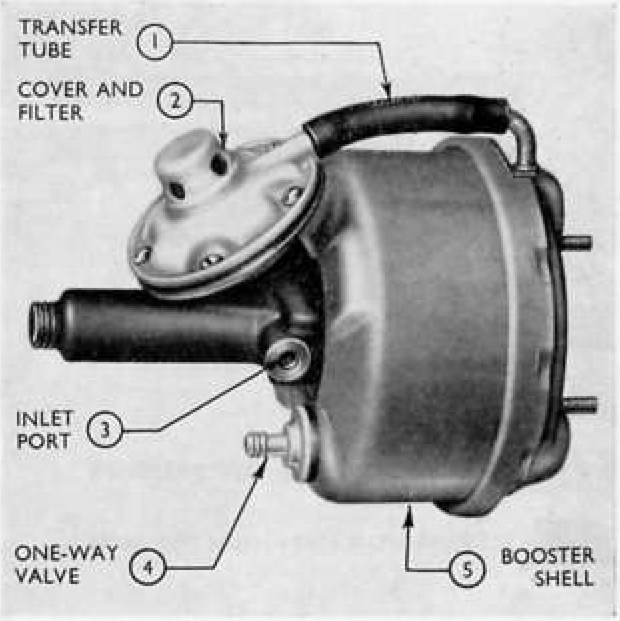


Fig. 23
Servo Unit

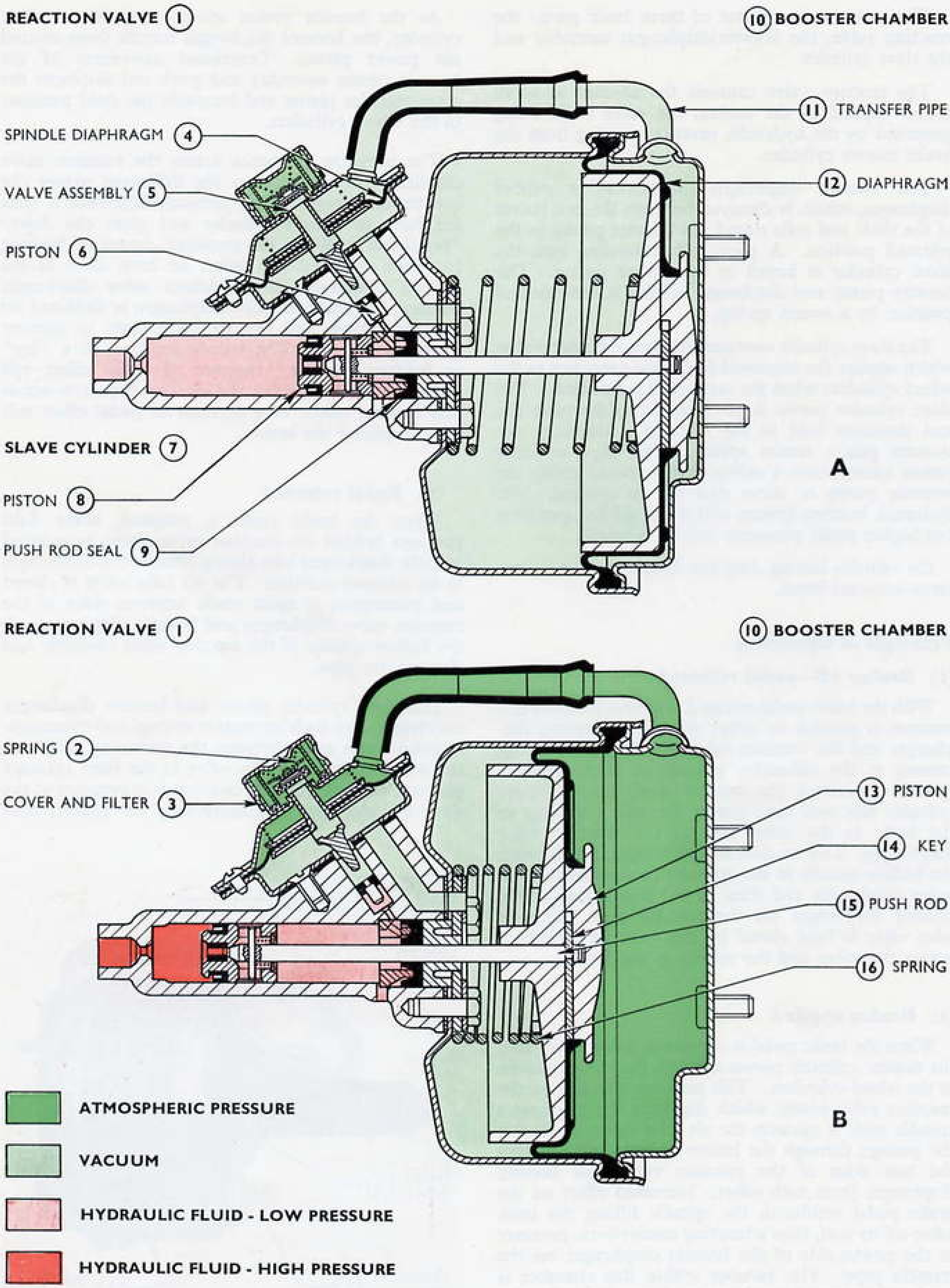


Fig. 24
Servo Unit Operations

A — Brakes Released B — Brakes Applied

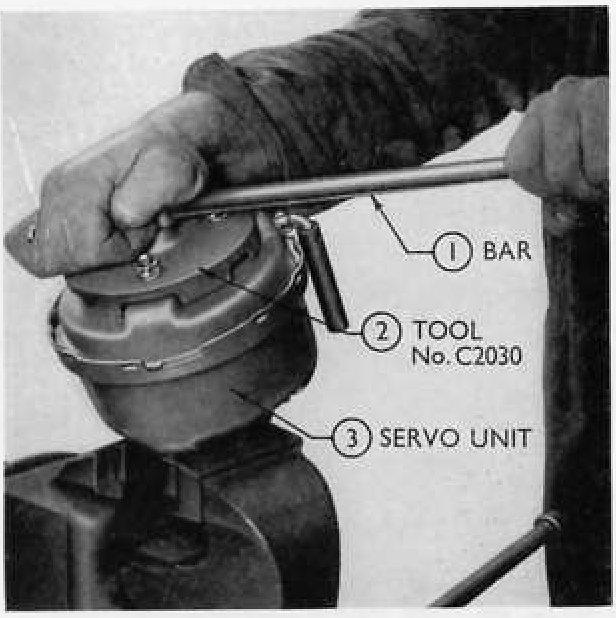


Fig. 25
Separating the Shell

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

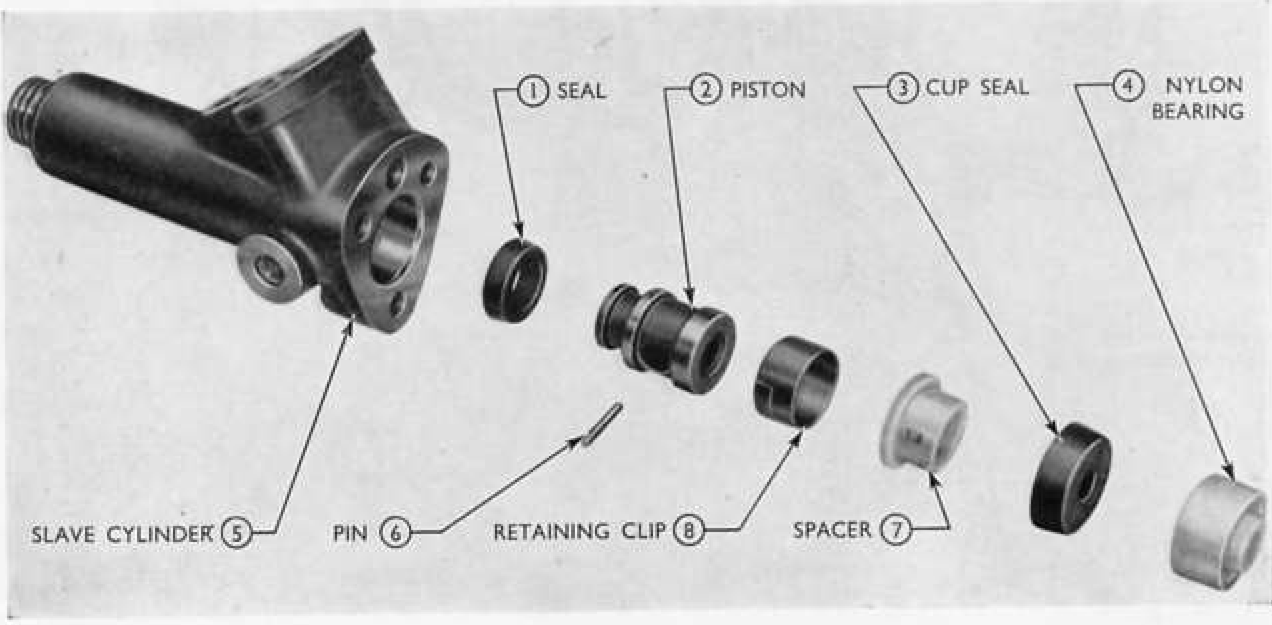


Fig. 26
Slave Cylinder and Seals

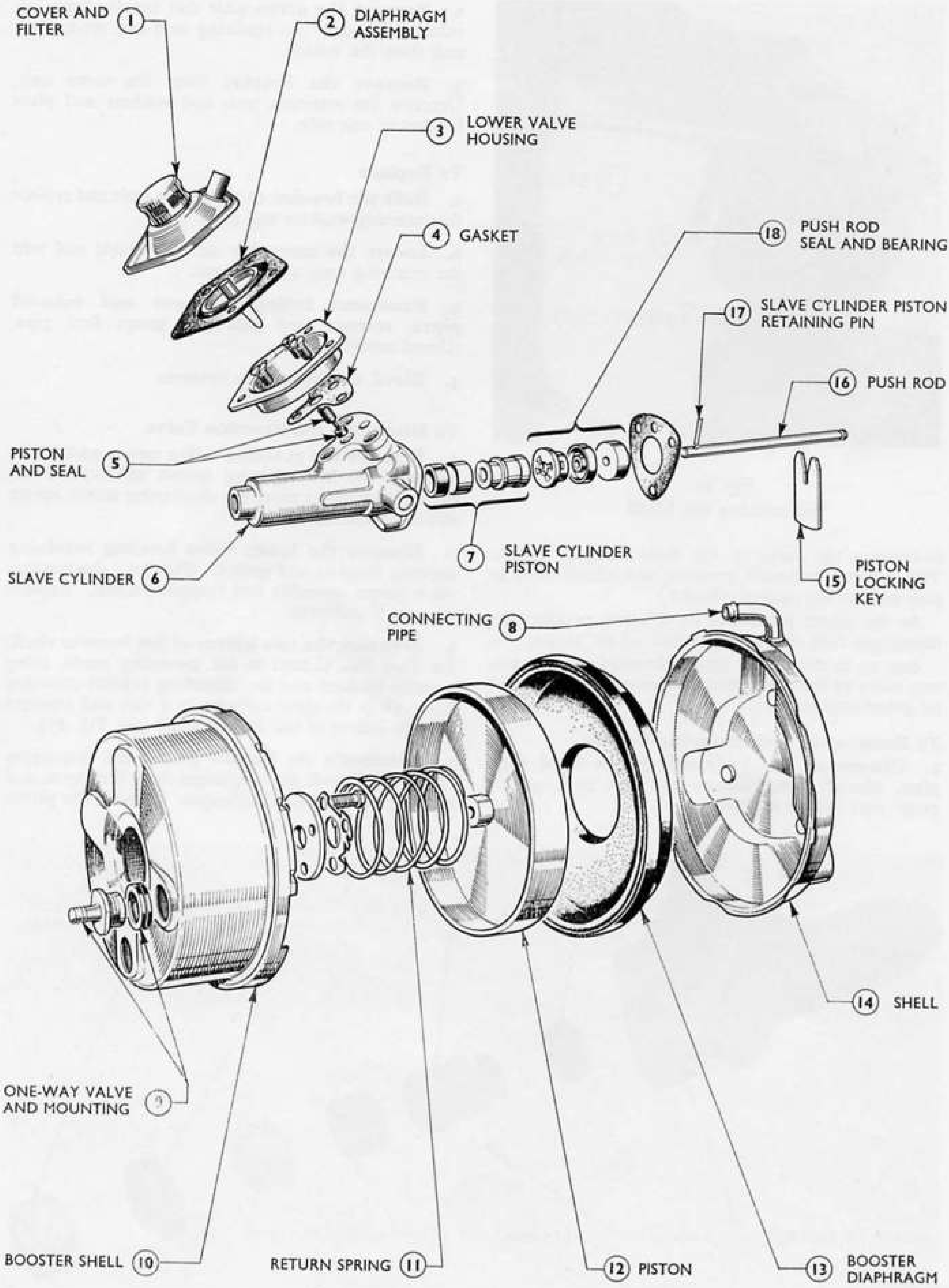


Fig. 27
Servo Unit—Exploded

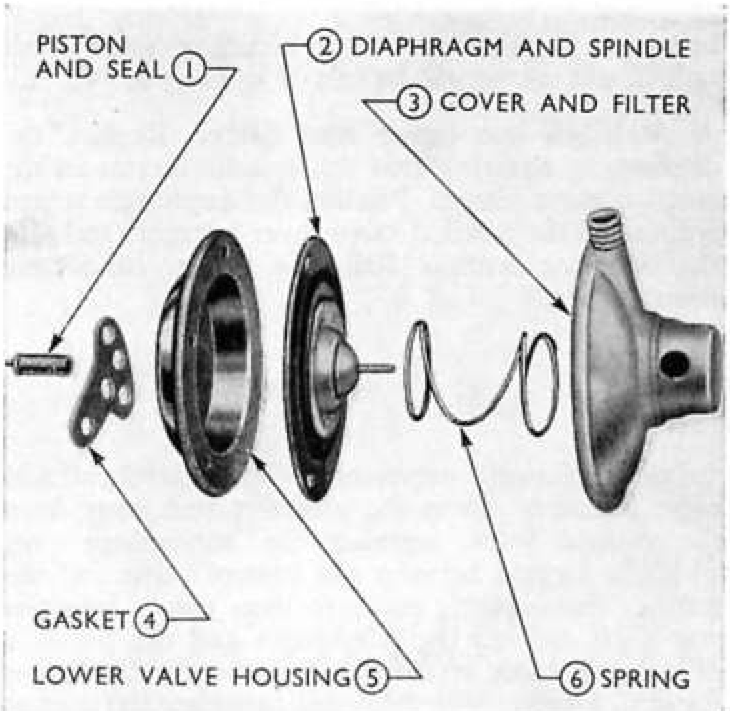


Fig. 28
Air Inlet Valve

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

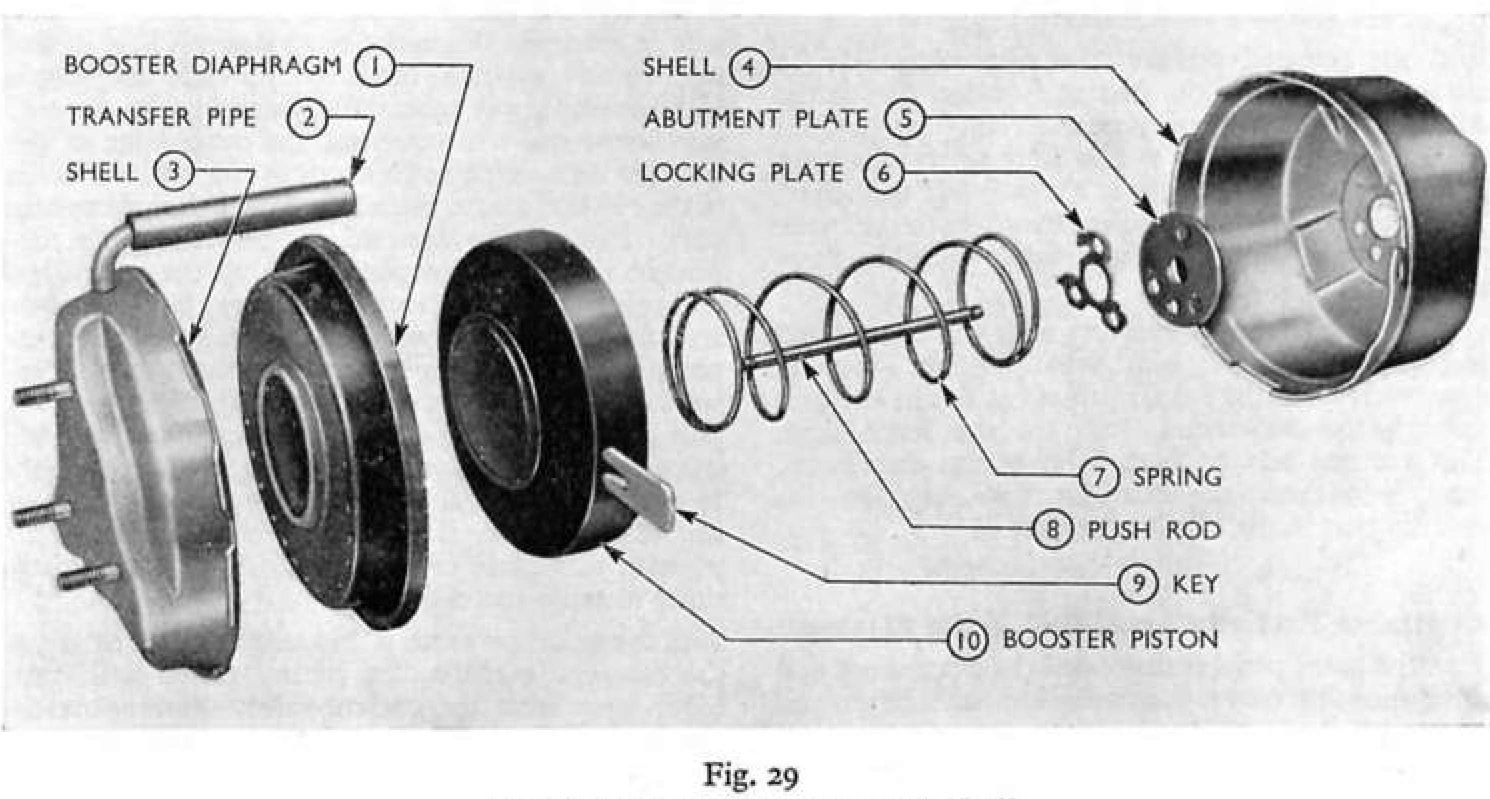


Fig. 29
Booster Piston Assembly and Shell

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

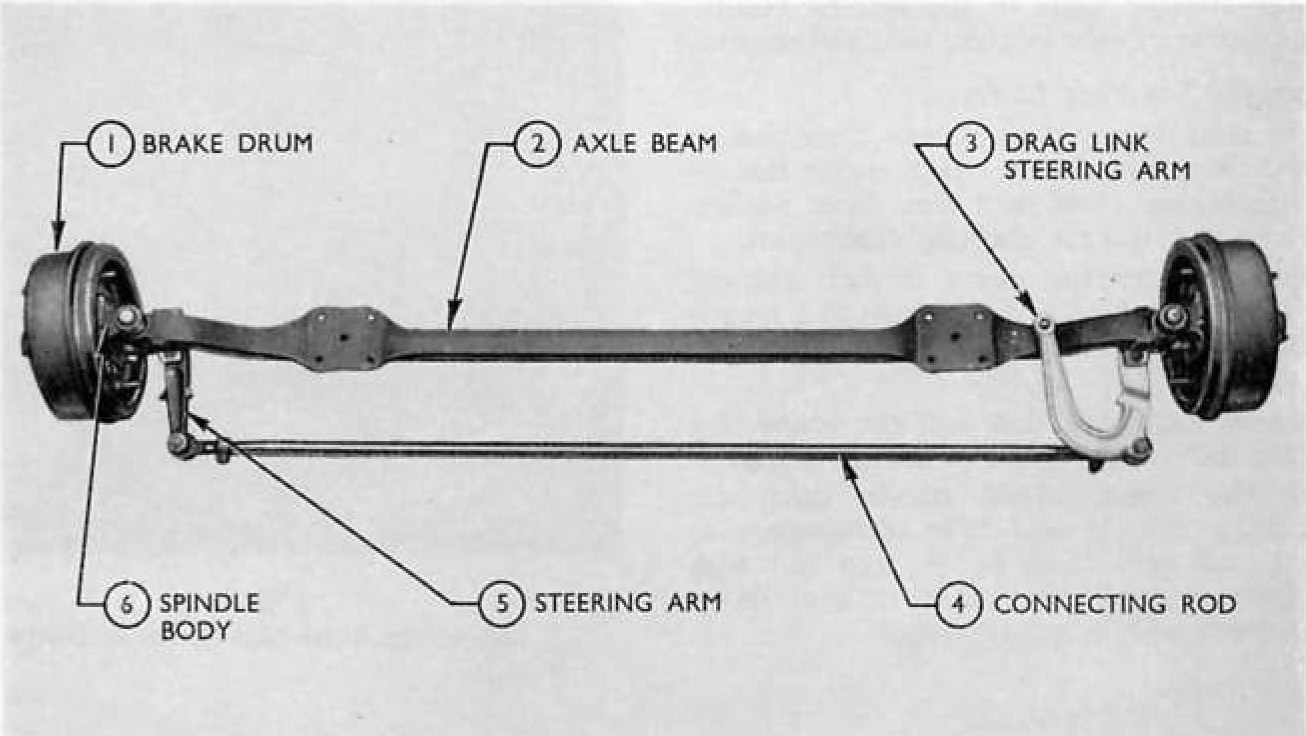


Fig. 1
The Front Axle Assembly

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.

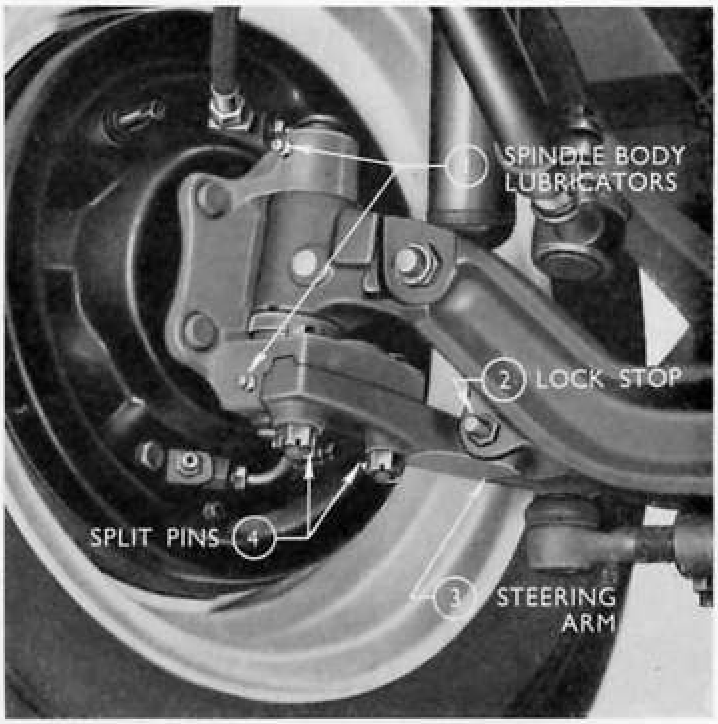


Fig. 2
Steering Arm and Spindle Body

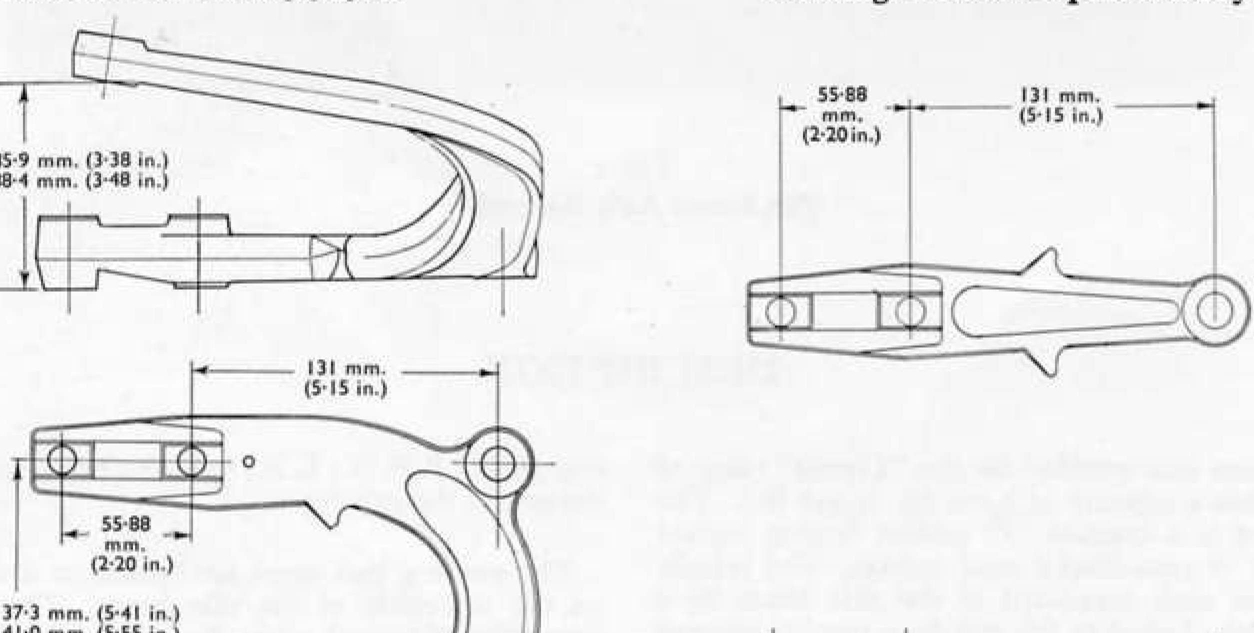


Fig. 3
Steering Arm Checking Dimensions

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.

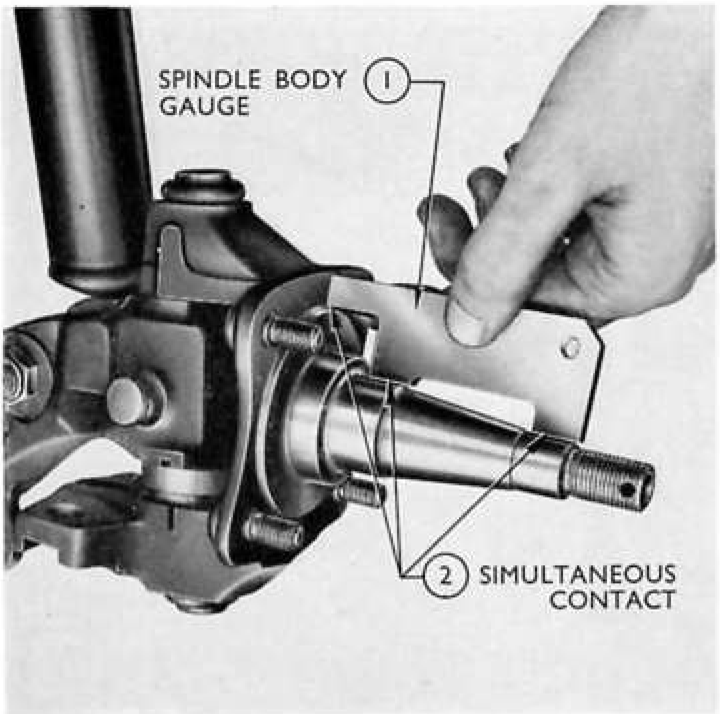


Fig. 4
Use of Tool No. C.3101

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.

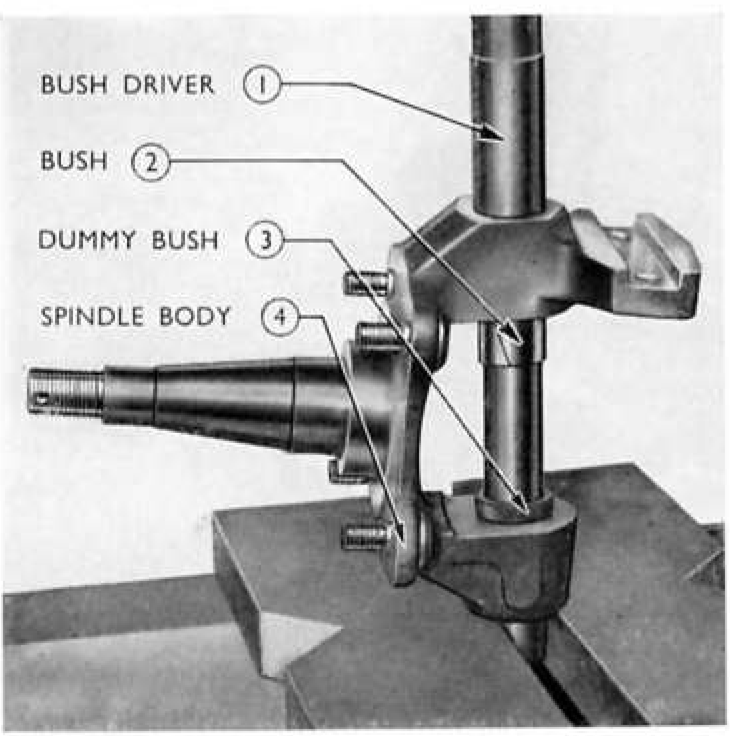


Fig. 5
Removing the Lower Spindle Bush

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.

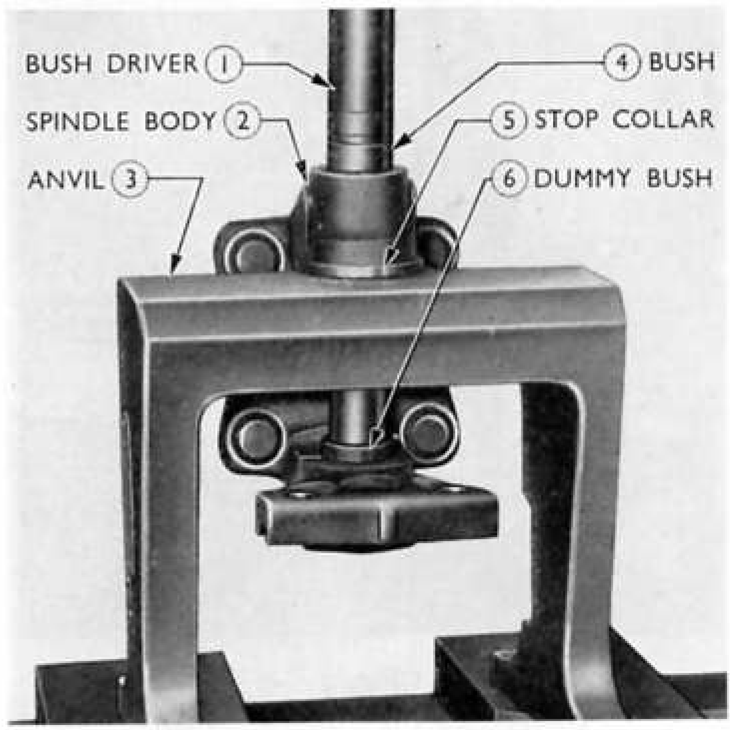


Fig. 6
Replacing the Upper Spindle Bush

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

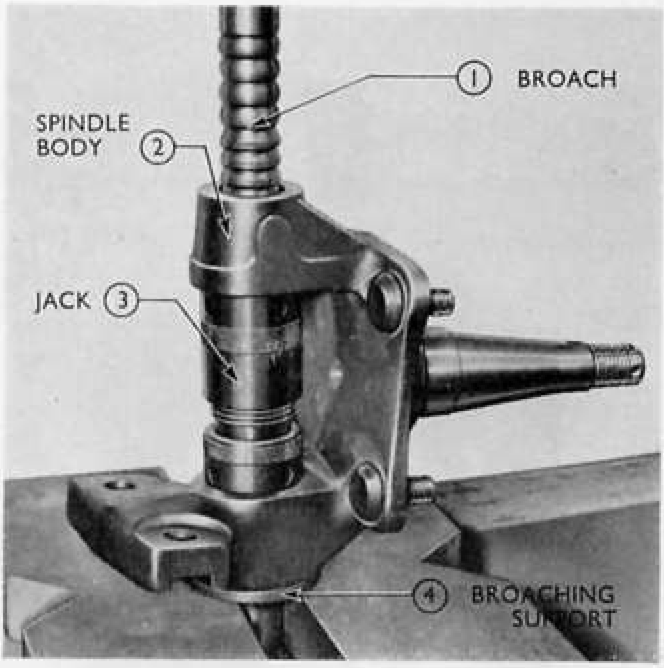


Fig. 7
Broaching the Spindle Bushes

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.

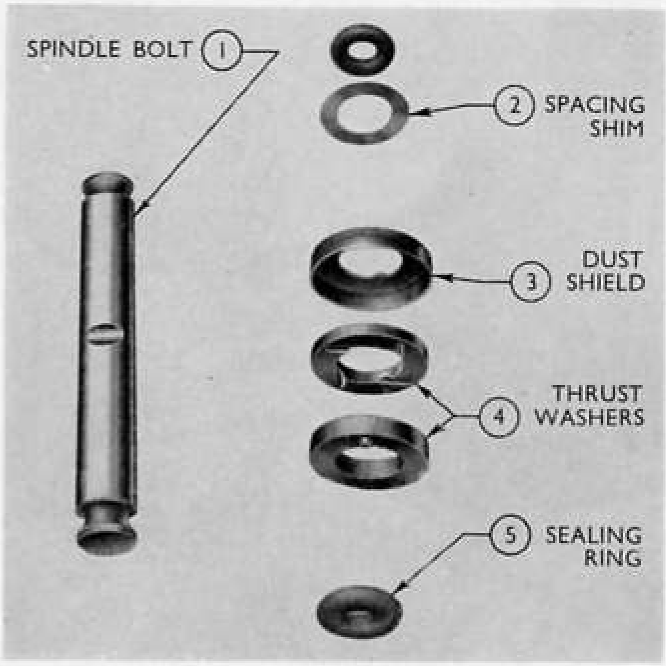


Fig. 8
Spindle, Bolt and Thrust Bearings

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).

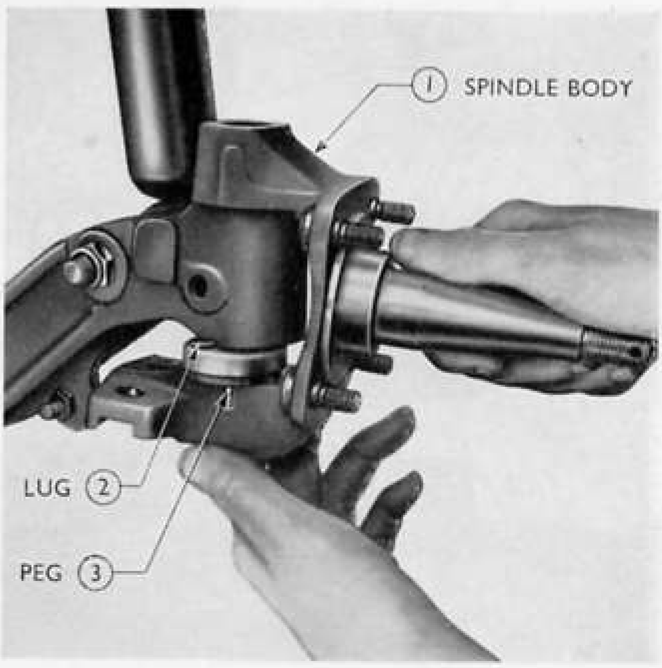


Fig. 9
Fitting the Spindle Body

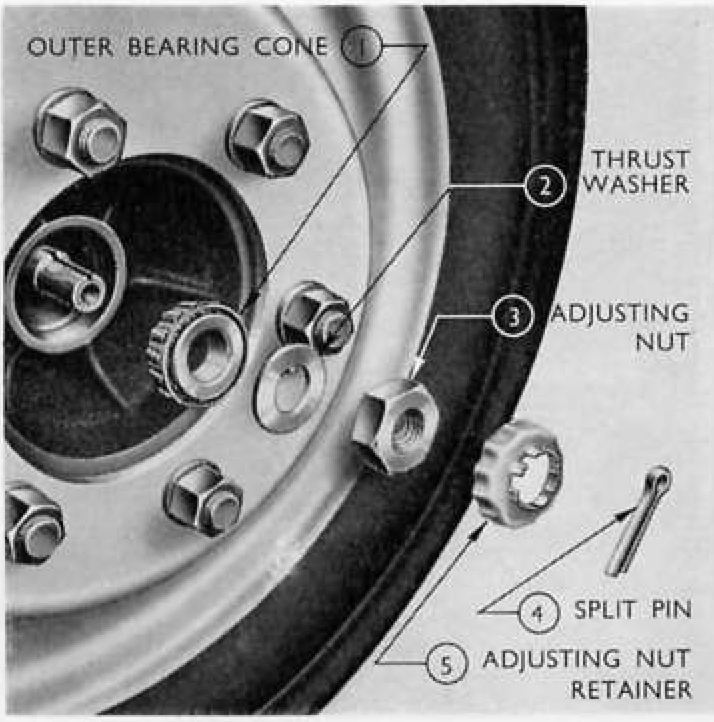


Fig. 10
Wheel Bearing Adjusters

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.

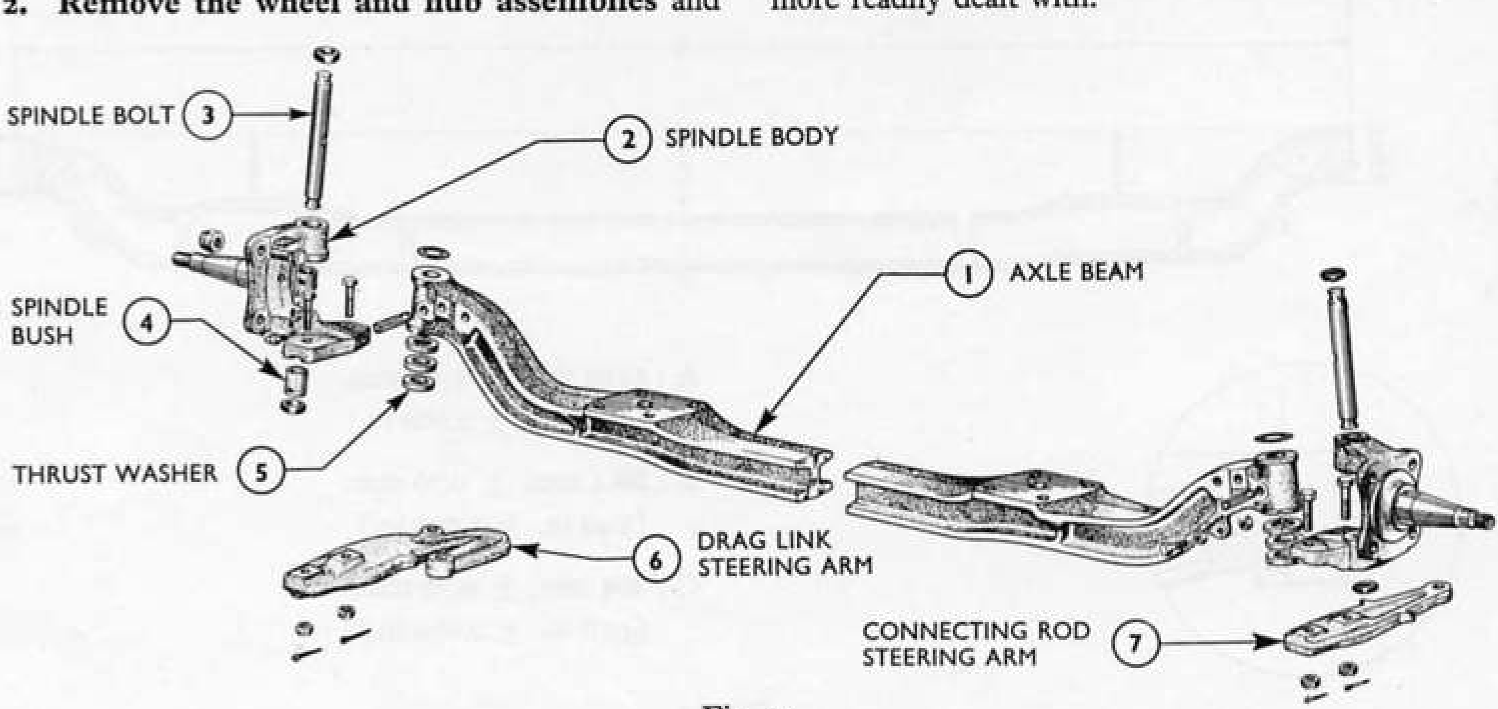


Fig. 11
Front Axle Assembly — Exploded

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.

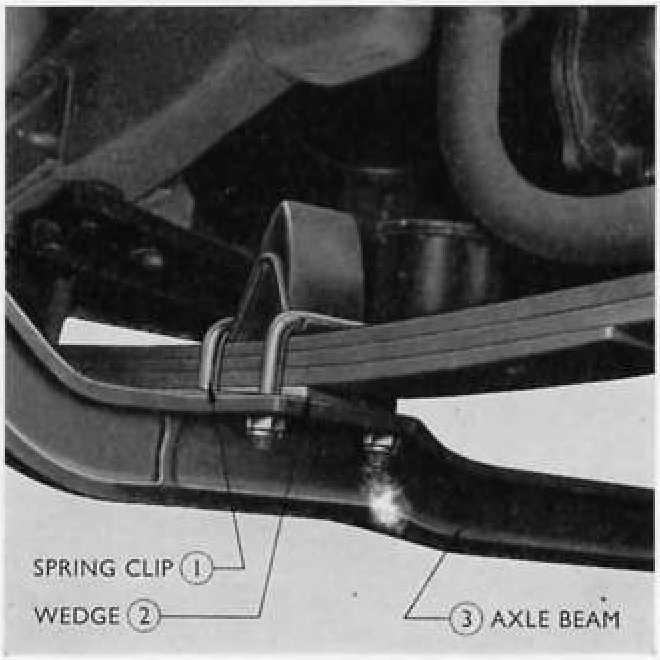


Fig. 13
Spring Clips and Spacer (Early Spring Shown)

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).

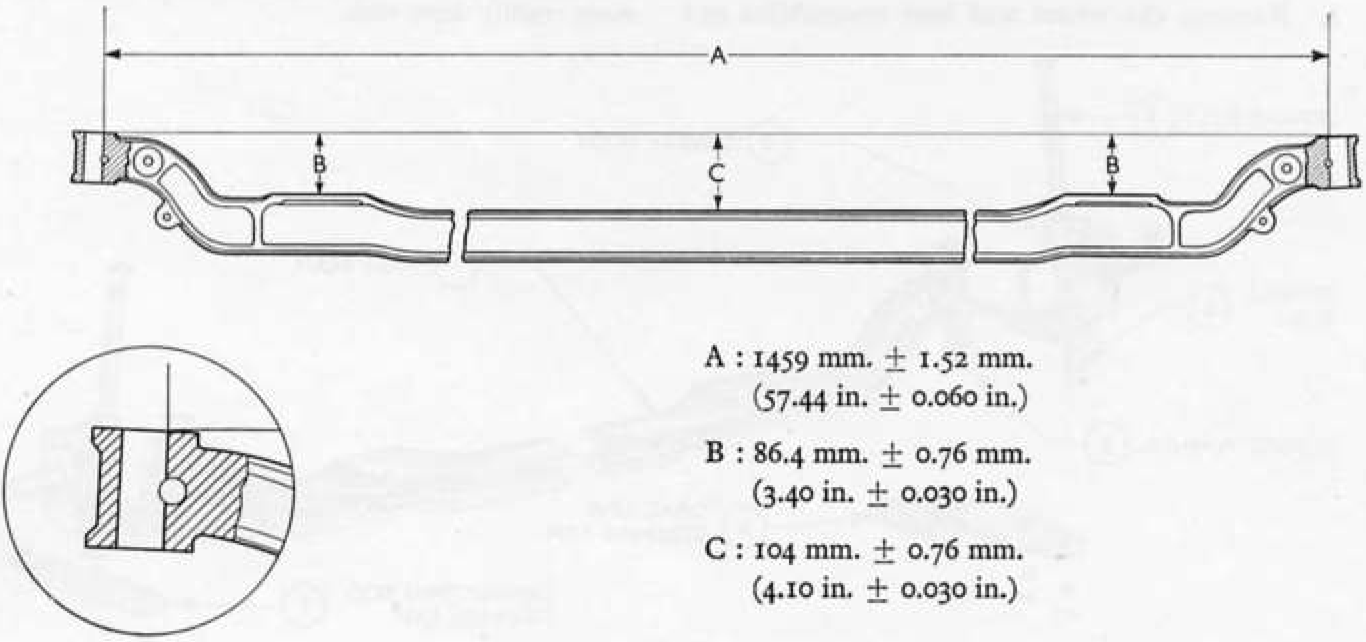
2. **Fit the spring clips** and tighten the nuts to a torque of 7.2 to 8.6 kg.m. (52 to 62 lb. ft.).

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. $\pm$ 0.8 mm. (0.13 in. $\pm$ 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.

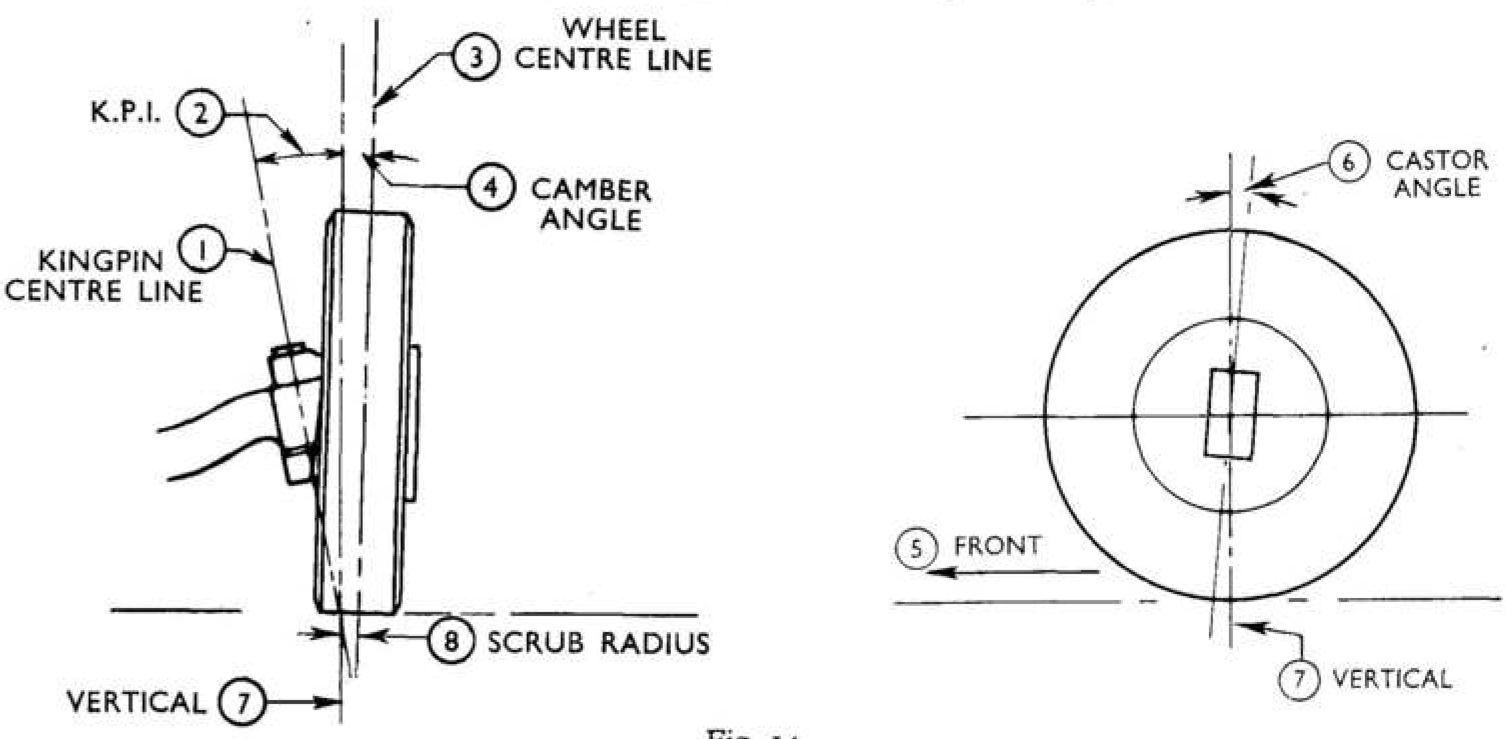


Fig. 14
Wheel Alignment

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.

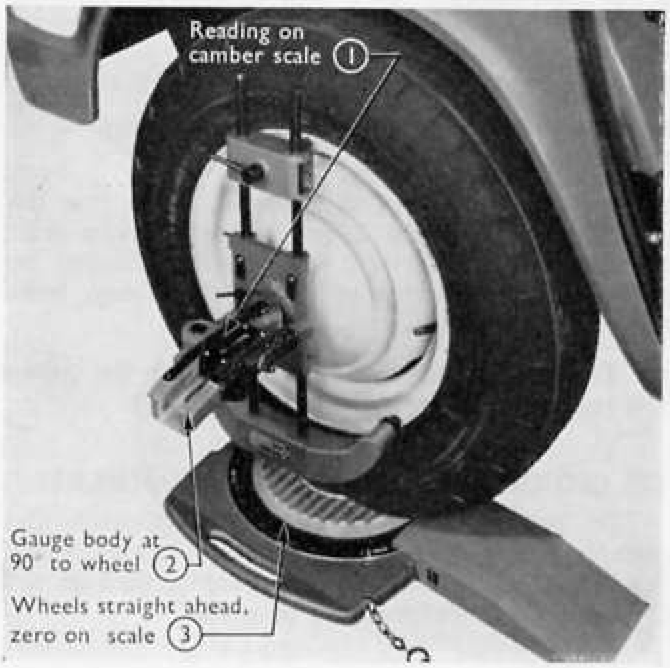


Fig. 15
Camber Angle

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).

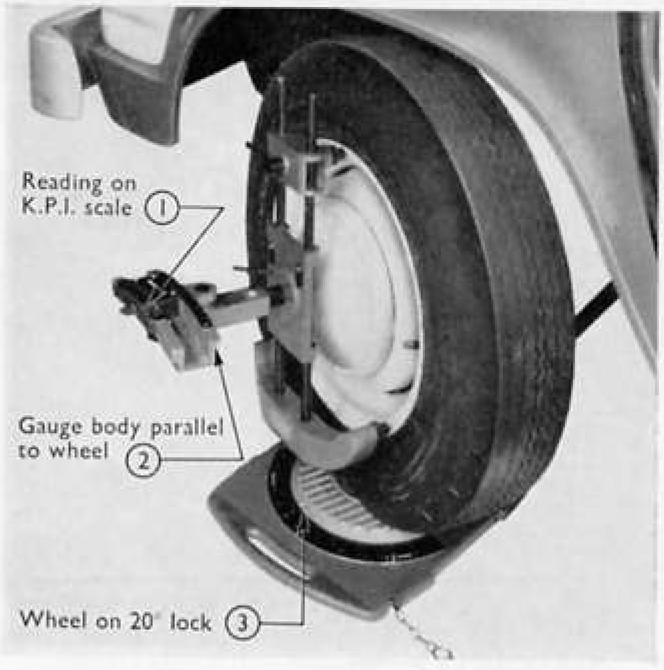


Fig. 17
King Pin Inclination

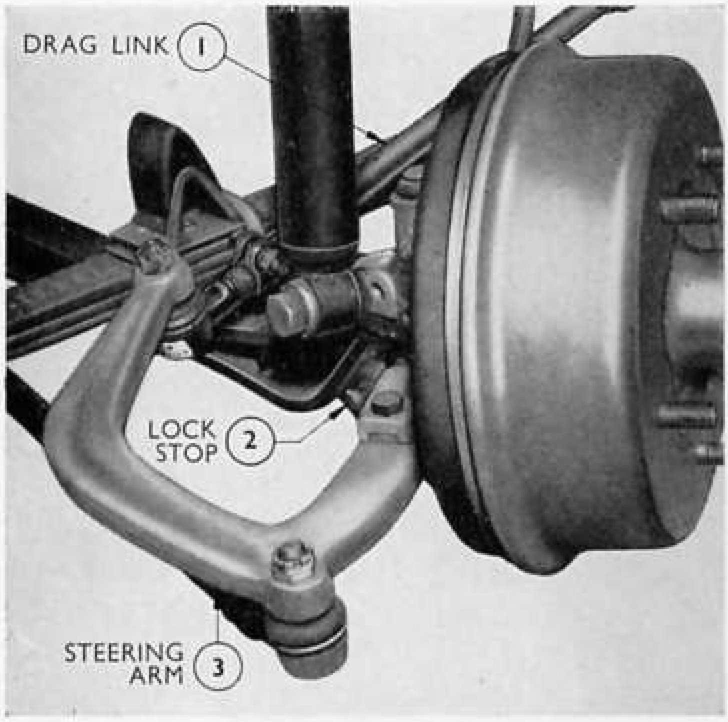


Fig. 18
Lock Stops

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.

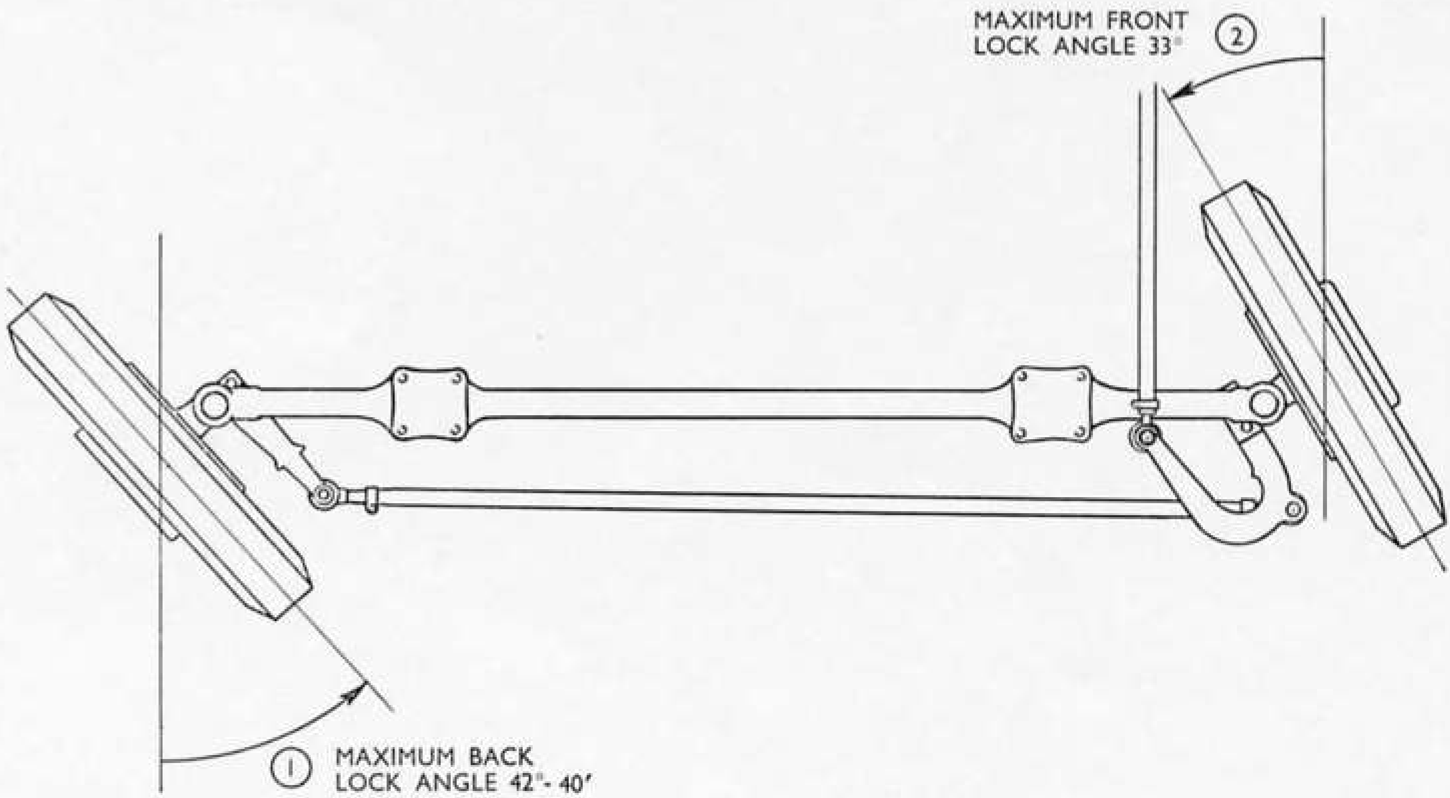


Fig. 19
Turning Angles

STEERING GEAR AND LINKAGE:

MAINTENANCE AND OVERHAUL PROCEDURES

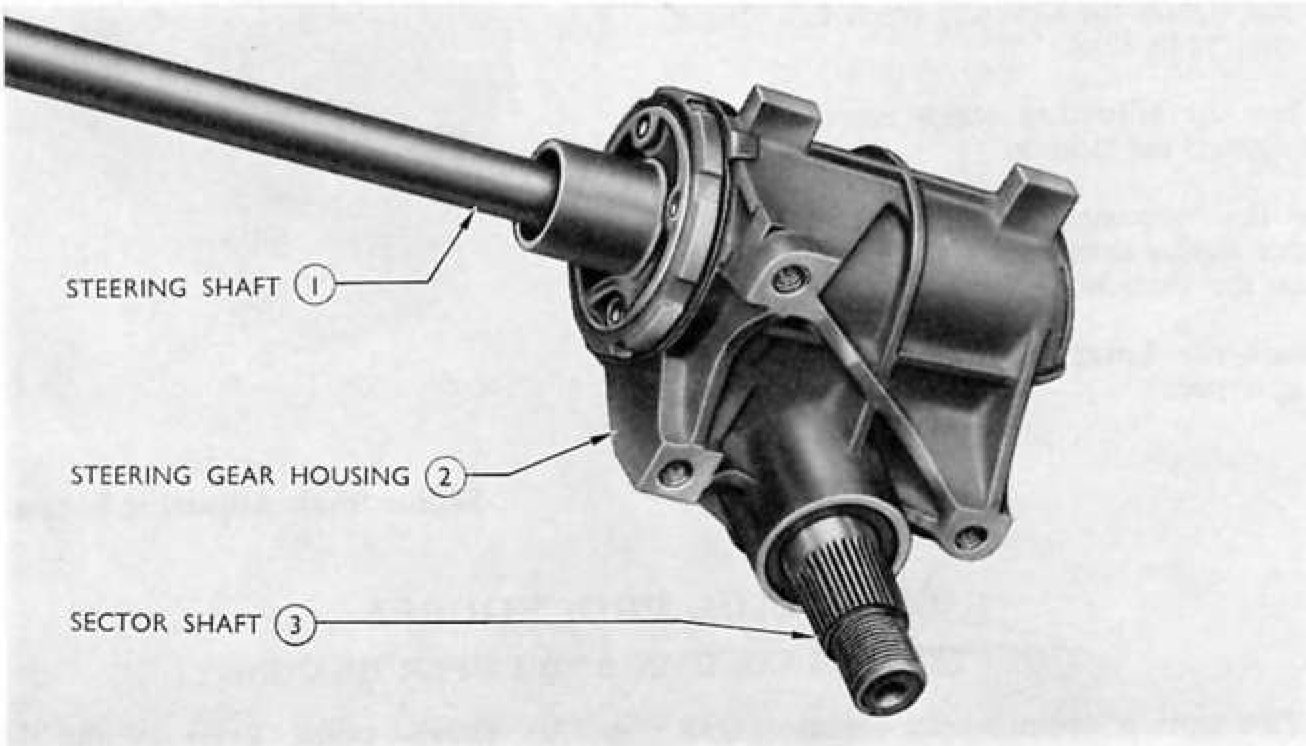


Fig. 20
The Steering Gear

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.

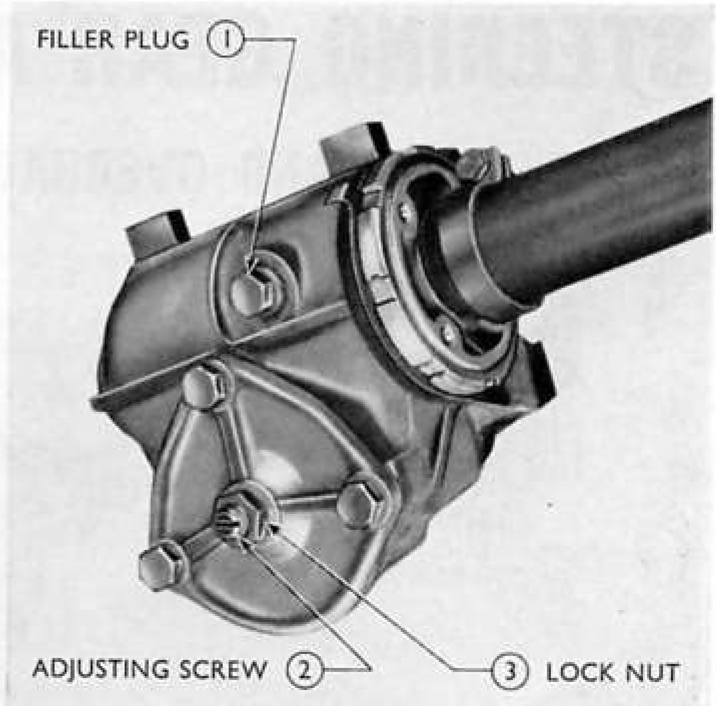


Fig. 21
Sector Shaft Adjusting Screw

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.

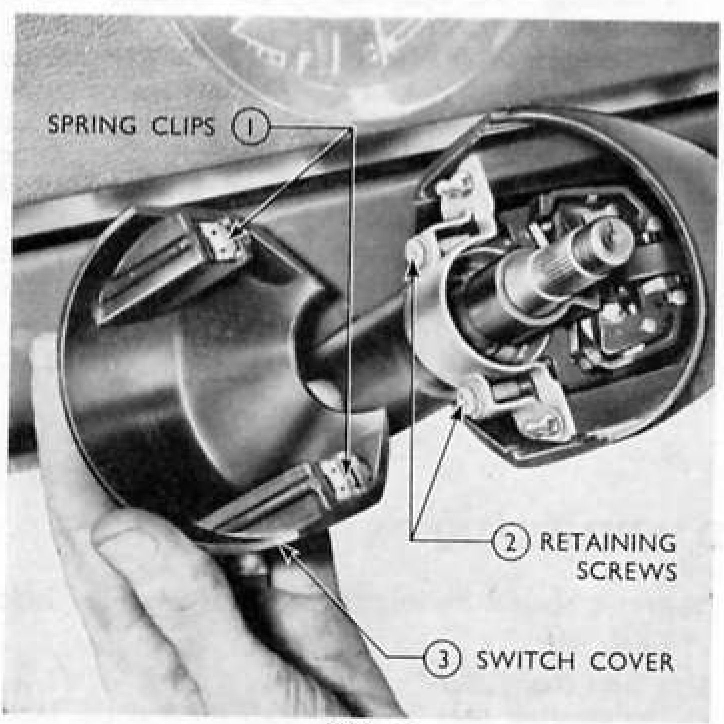


Fig. 22
Indicator and Light Switch (Prior to December 1970)

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.

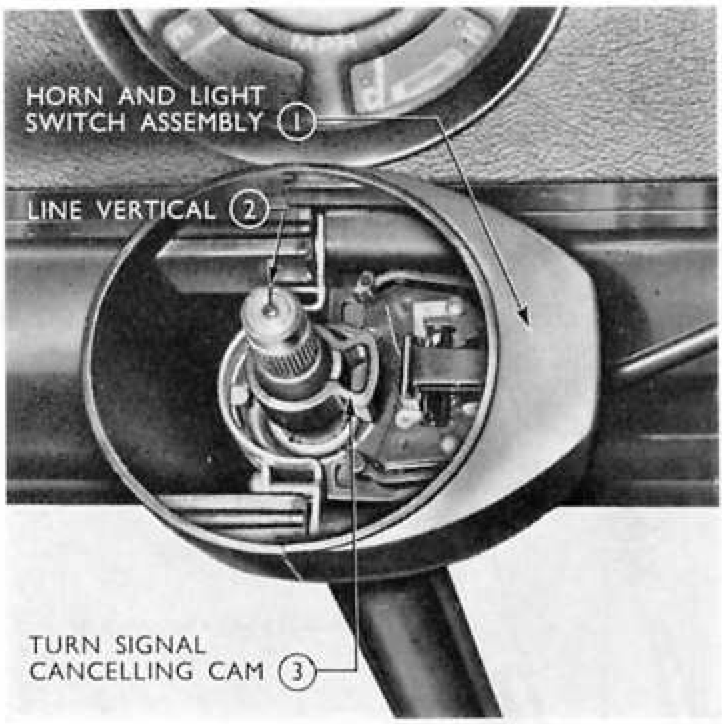


Fig. 23
Installation of the Cancelling Cam (Prior to September 1968)

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.

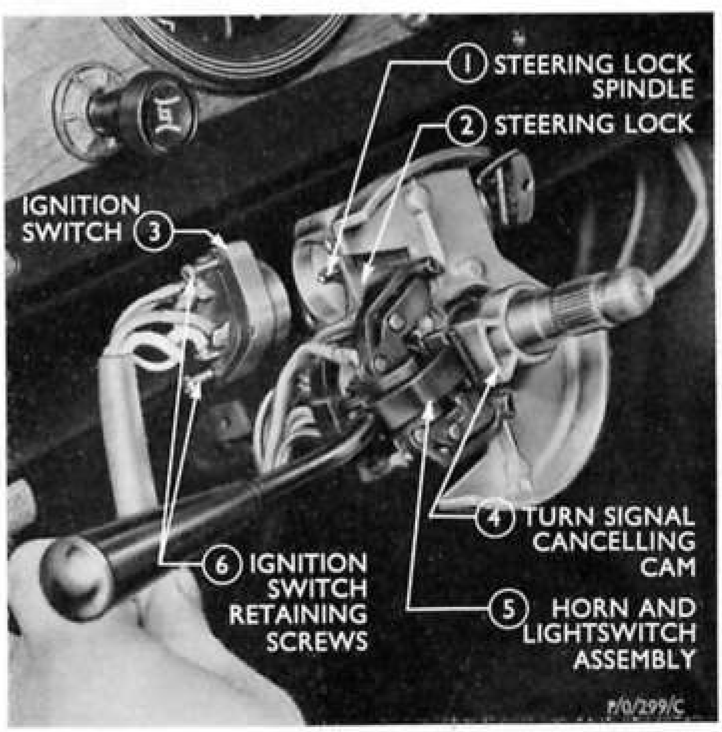


Fig. 24
Ignition Switch and Steering Lock (After September 1968)

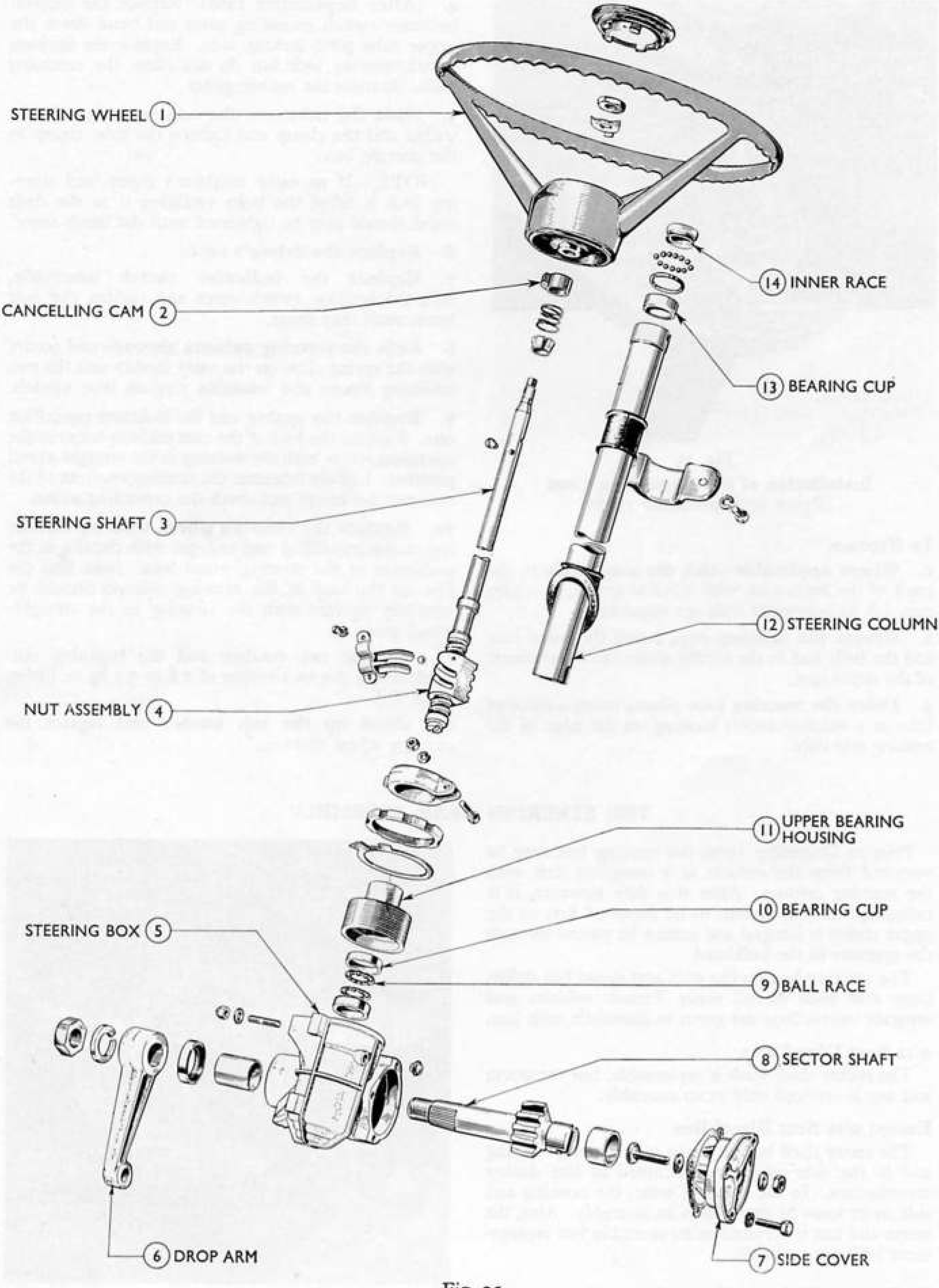


Fig. 25
The Steering Gear — Exploded (Except 9/12 Seat Diesel Bus)
(Prior to December 1970)

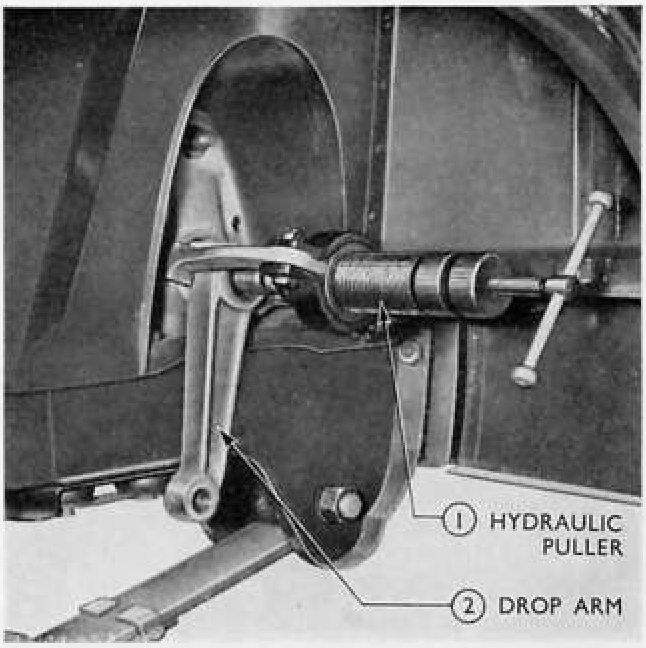


Fig. 26
Removing the Drop Arm

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.

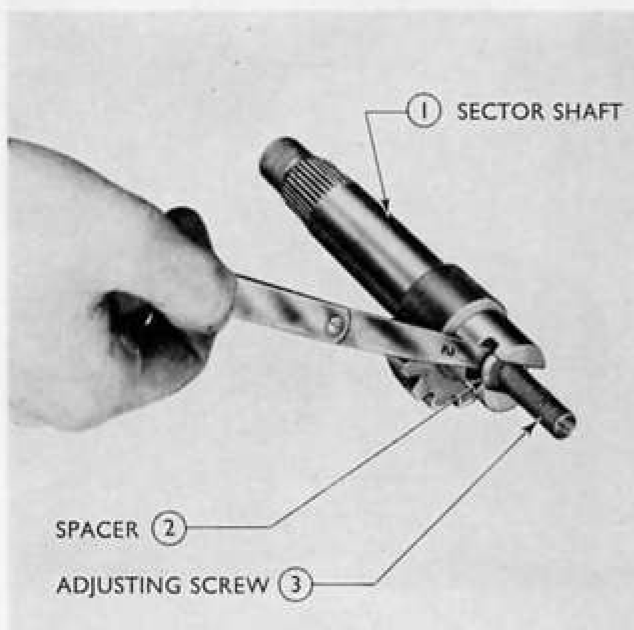


Fig. 27
Sector Shaft Spacer Selection

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.*)

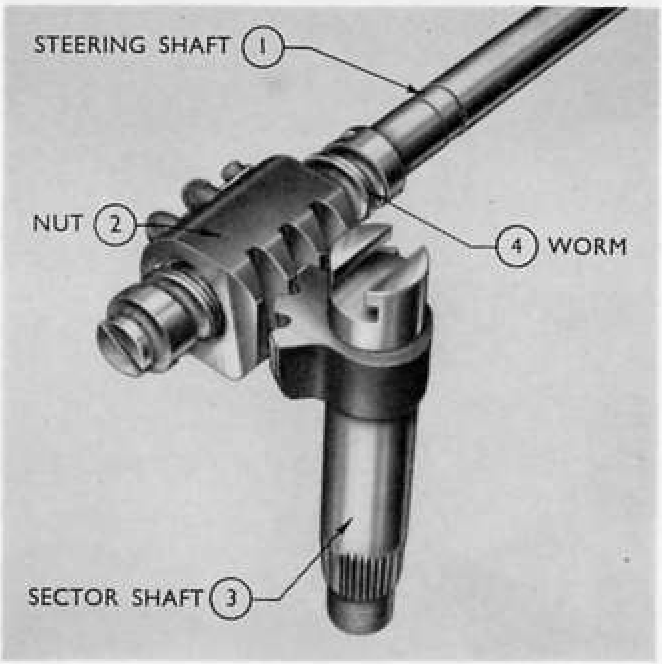


Fig. 29
Worm, Nut and Sector Shaft

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.

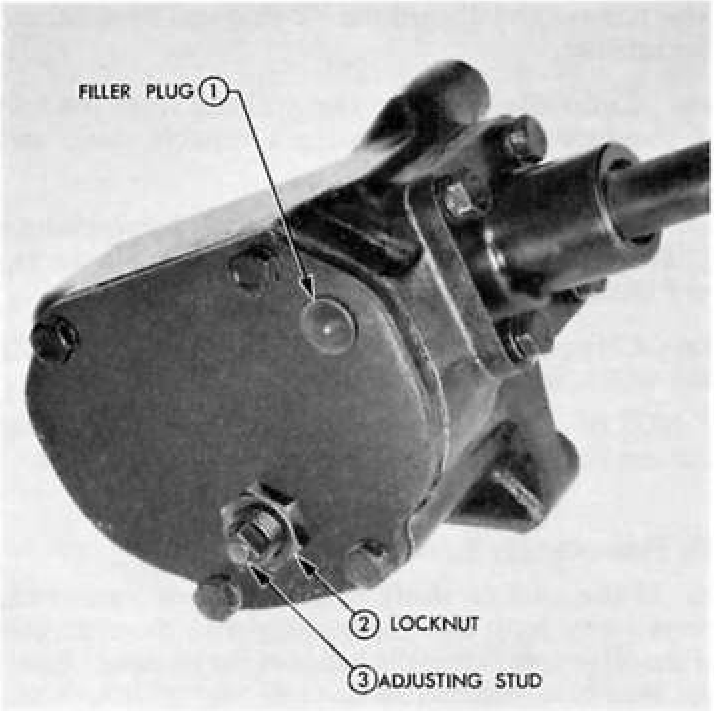


Fig. 30
Rocker Shaft Adjusting Stud

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.

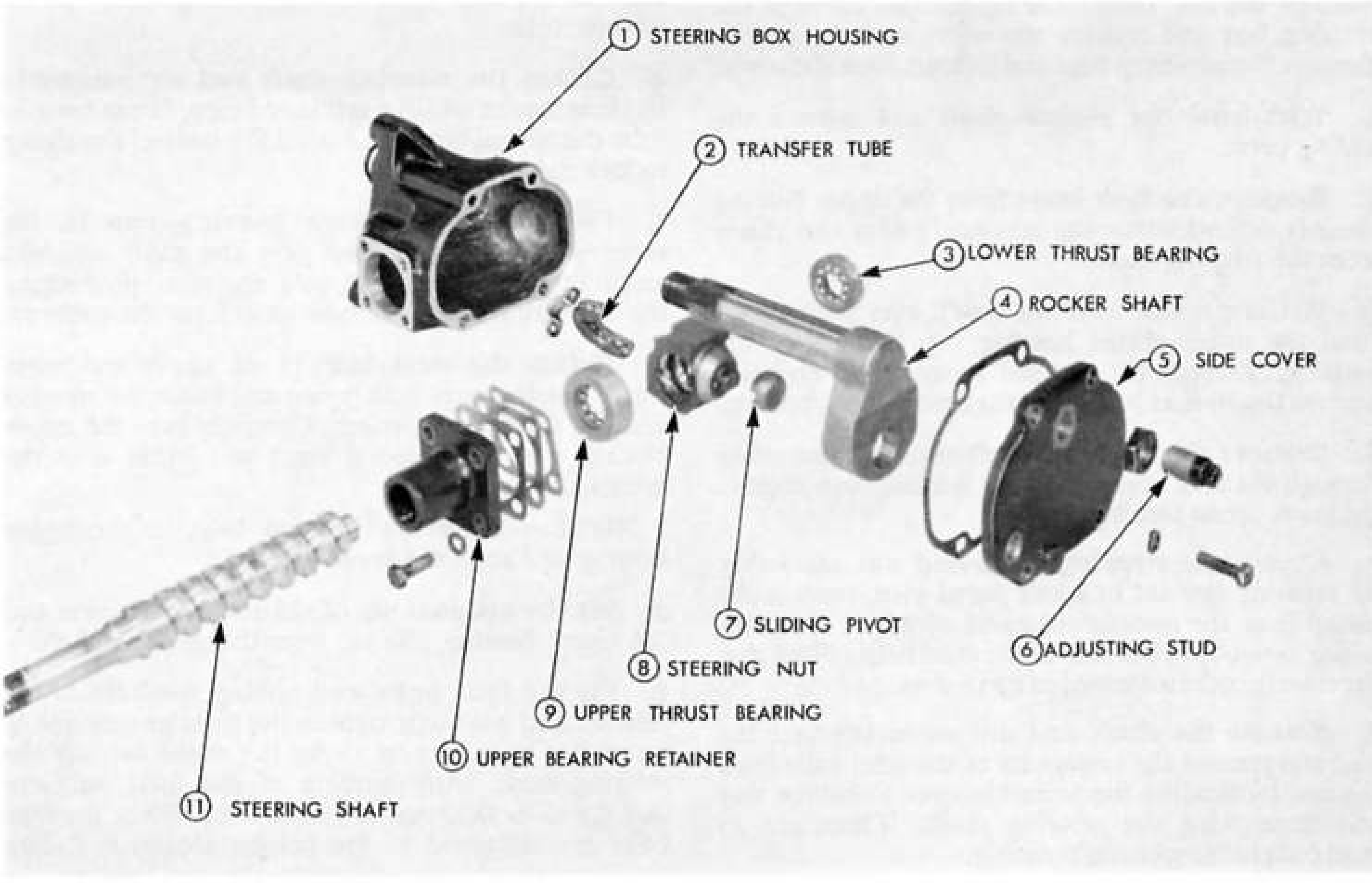


Fig. 31
The Steering Gear — Exploded (9/12 Seat Diesel Bus)

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 ⅞" 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 joint.

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.

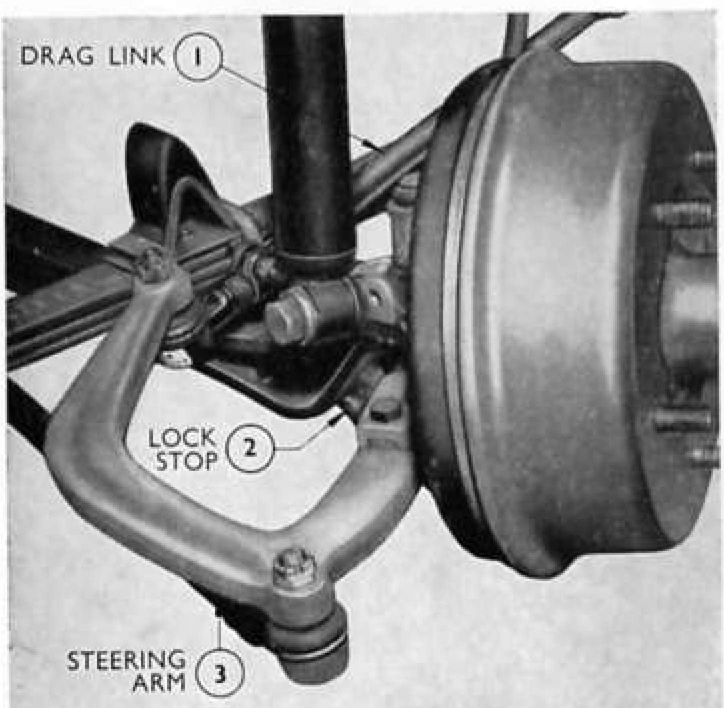


Fig. 32
Lock Stops and Steering Arm

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.

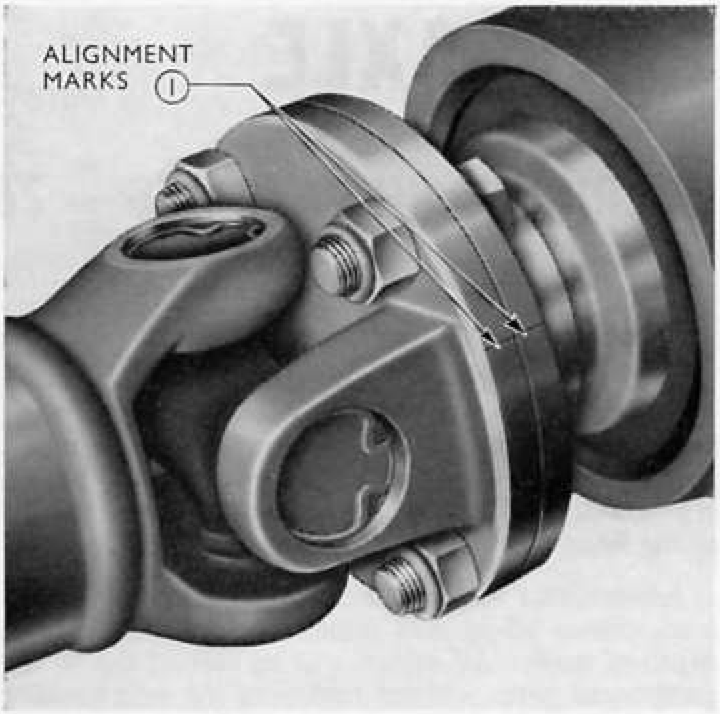


Fig. 2
Universal Joint

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.

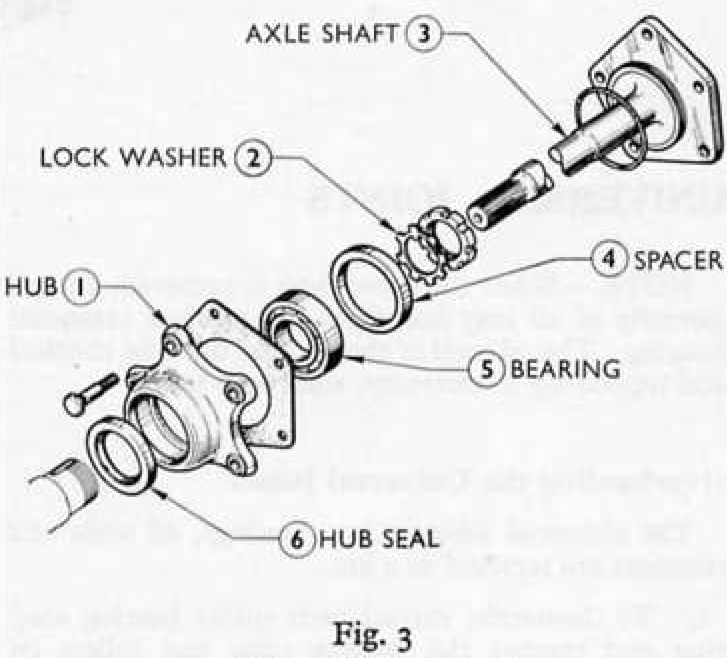


Fig. 3
Rear Hub 75—115

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.

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

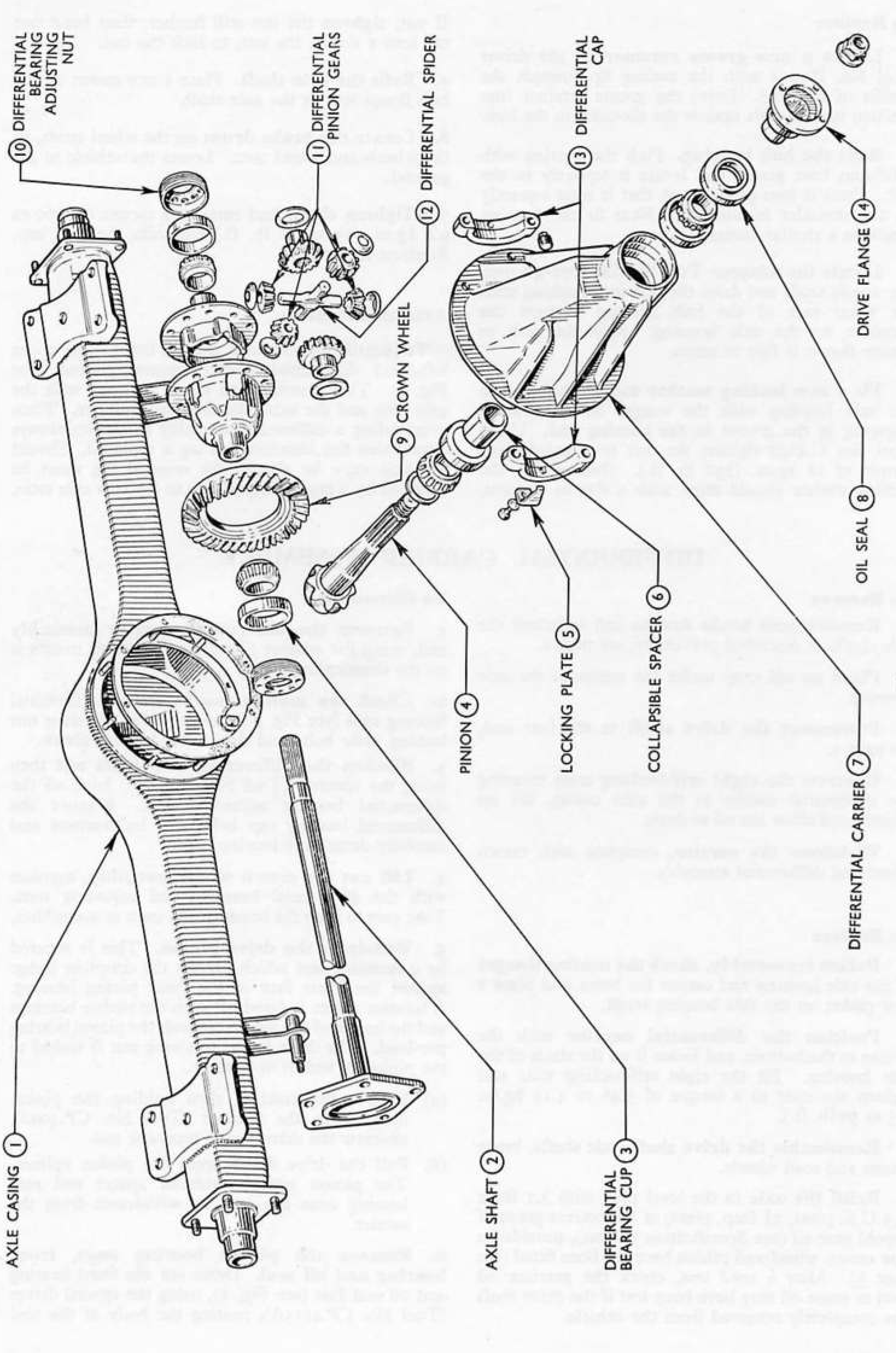


Fig. 4
Rear Axle—Exploded

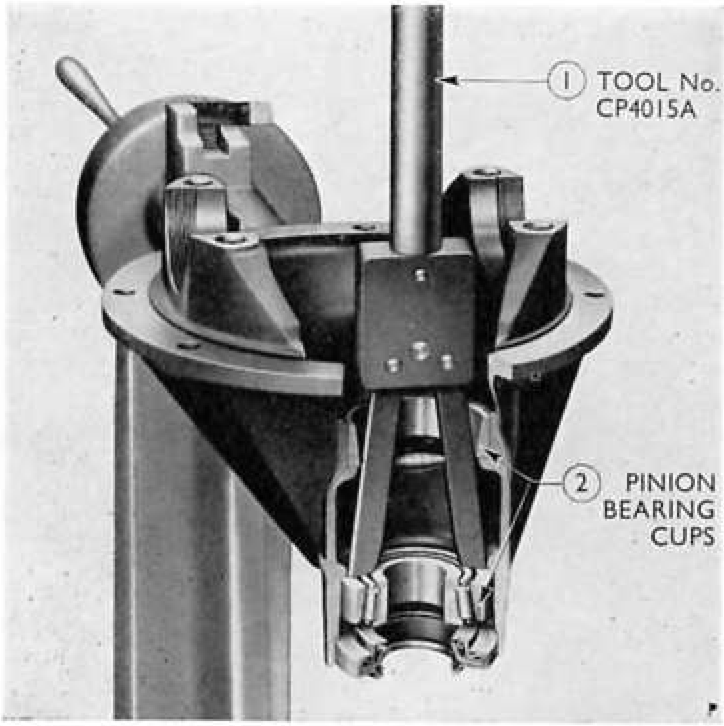


Fig. 5
Removing Front Pinion Bearing and Oil Seal

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.

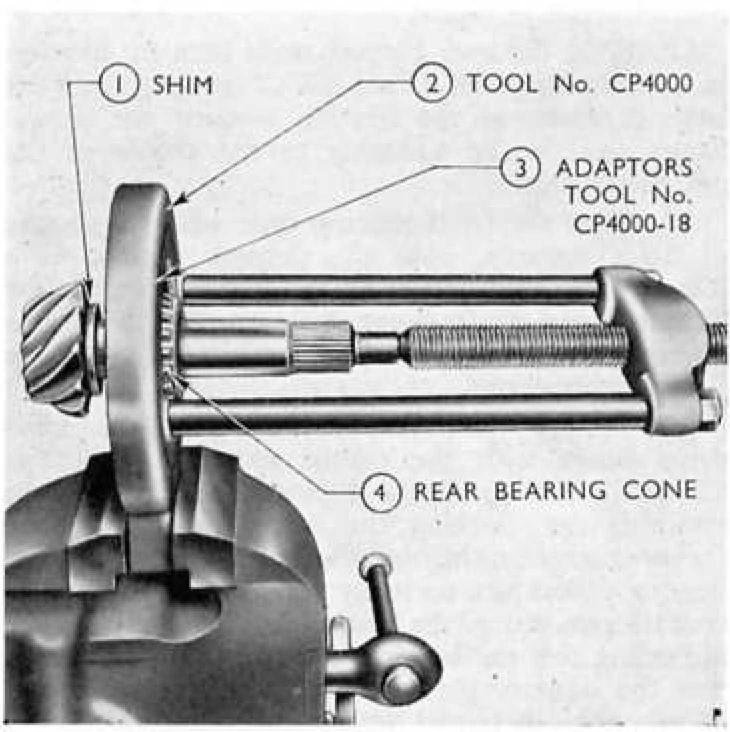


Fig. 6
Removing Rear Bearing Cone

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.

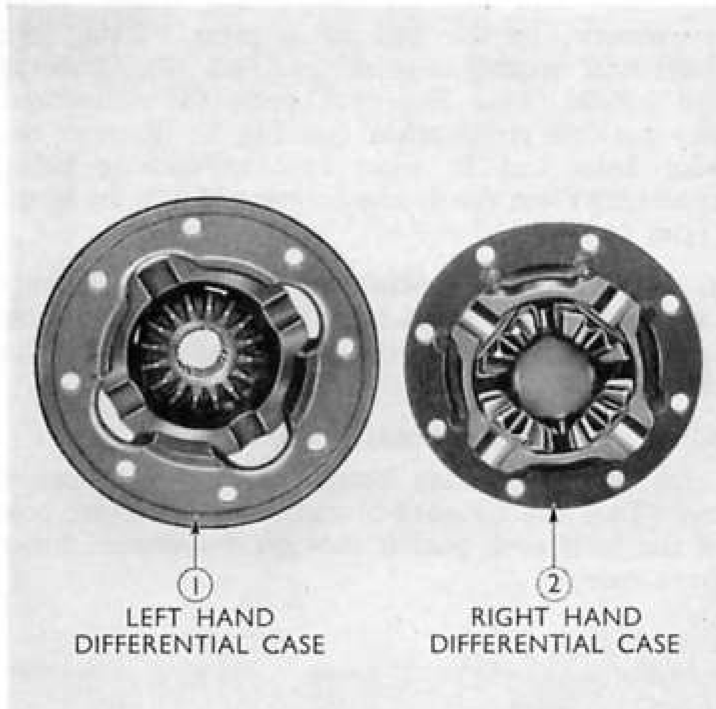


Fig. 7
Differential Case

(*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.

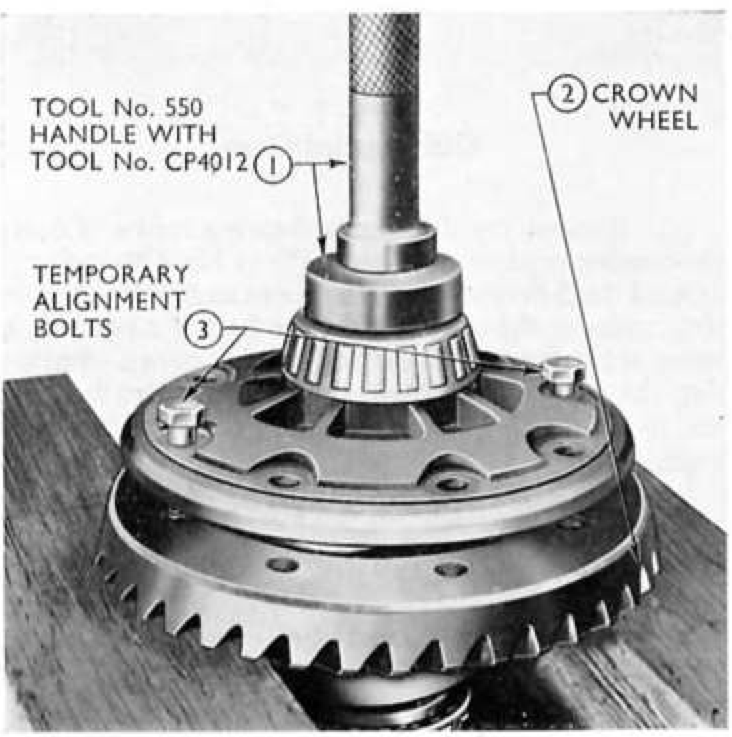


Fig. 8
Fitting the Crown Wheel to the Differential Case

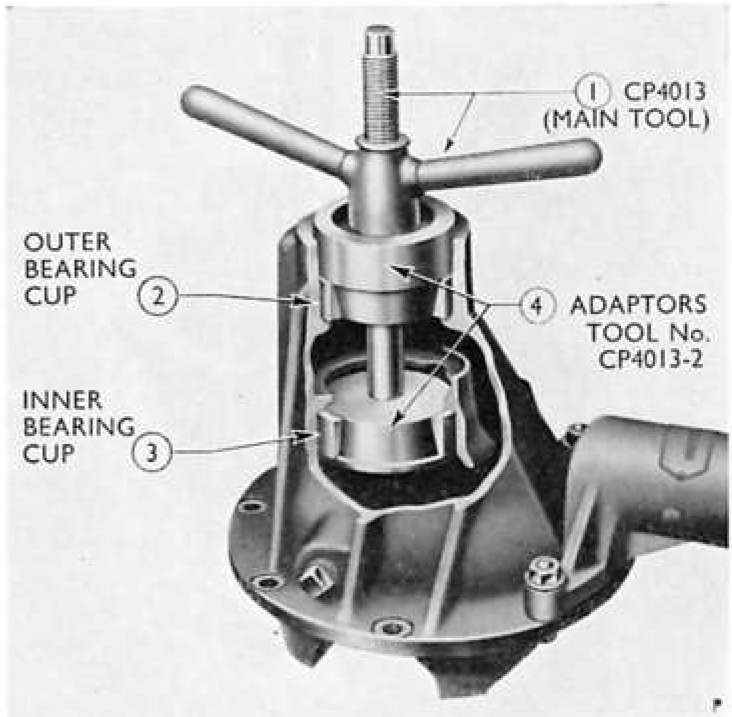


Fig. 9
Replacing Pinion Bearing Cups

(*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

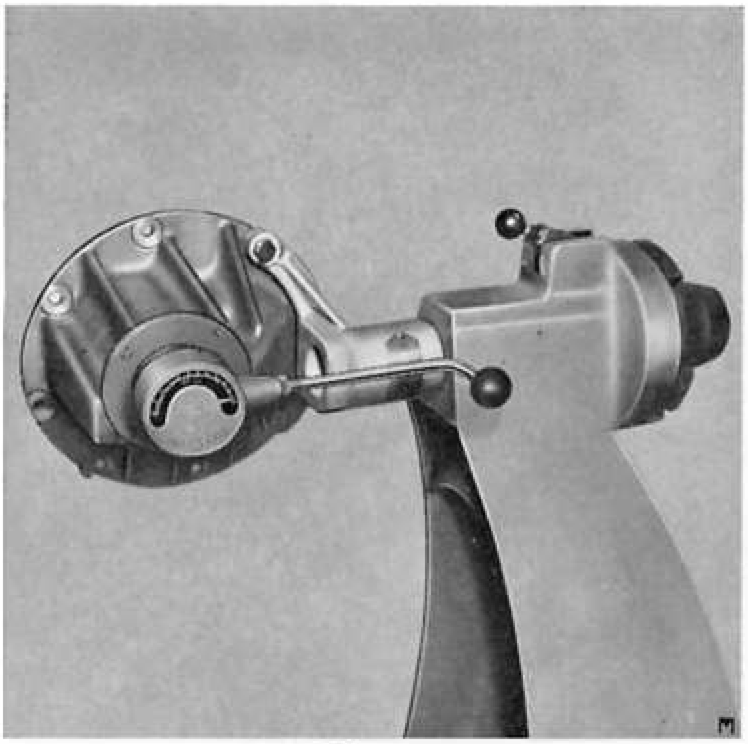


Fig. 10
Checking Pinion Bearing Pre-load (Tool No. P.4131)

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.

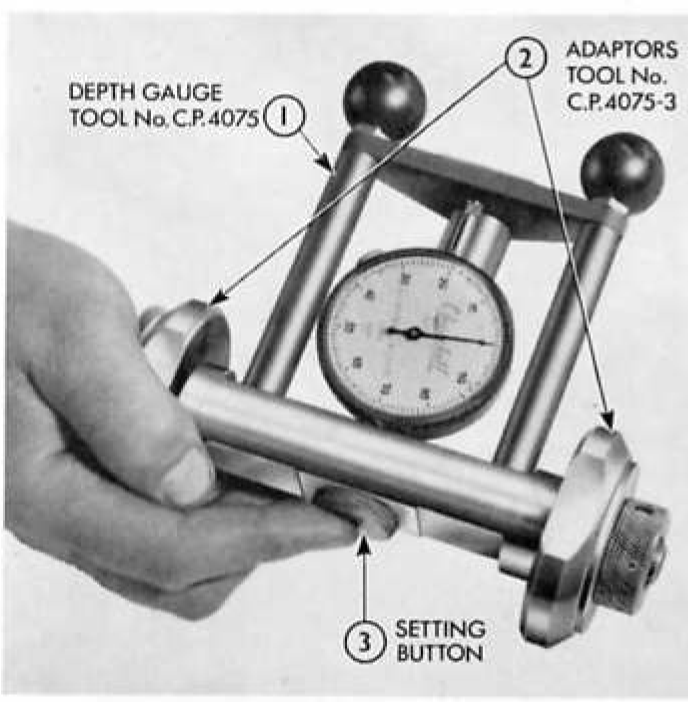


Fig. 11
Zeroing Depth of Mesh Gauge

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

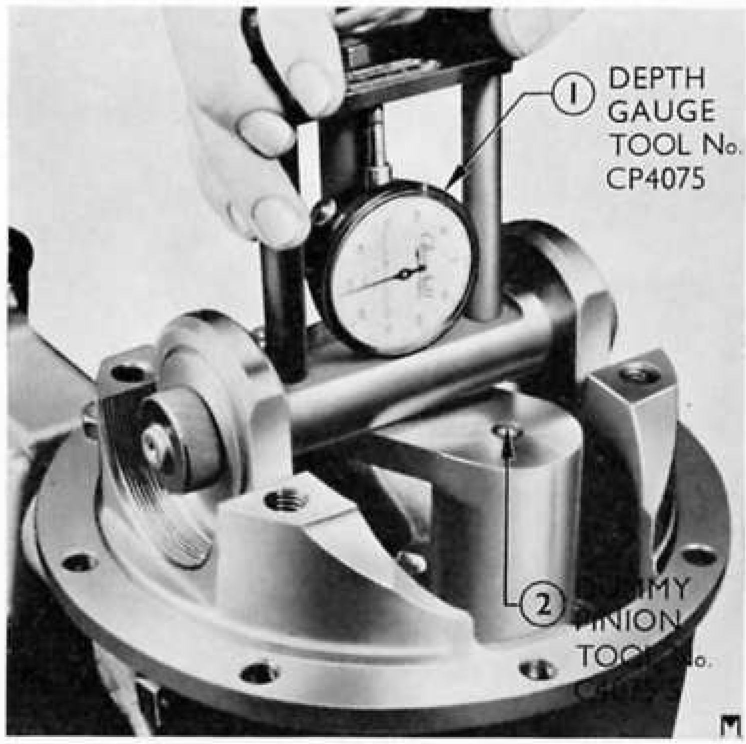


Fig. 12
Checking Pinion Depth of Mesh

between the two bearing locations, alter the shim thickness accordingly. If the pinion is marked with a plus figure, this 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

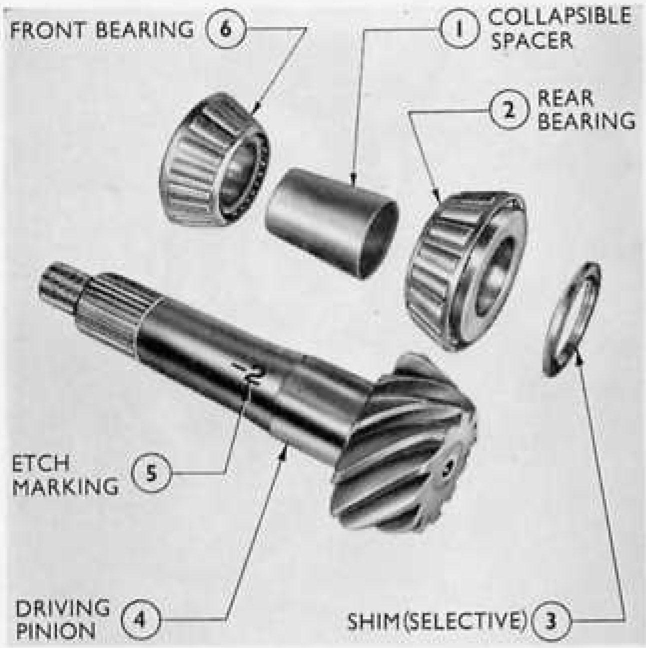


Fig. 13
Drive Pinion Components

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.

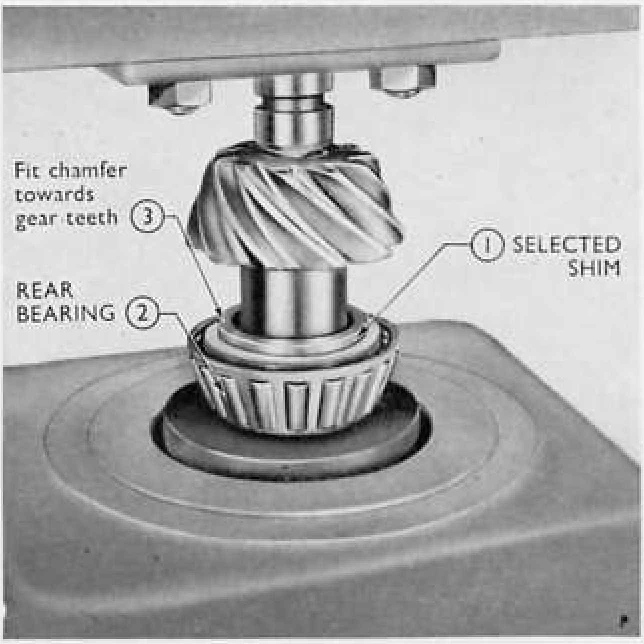


Fig. 14
Fitting Pinion Rear Bearing

(*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

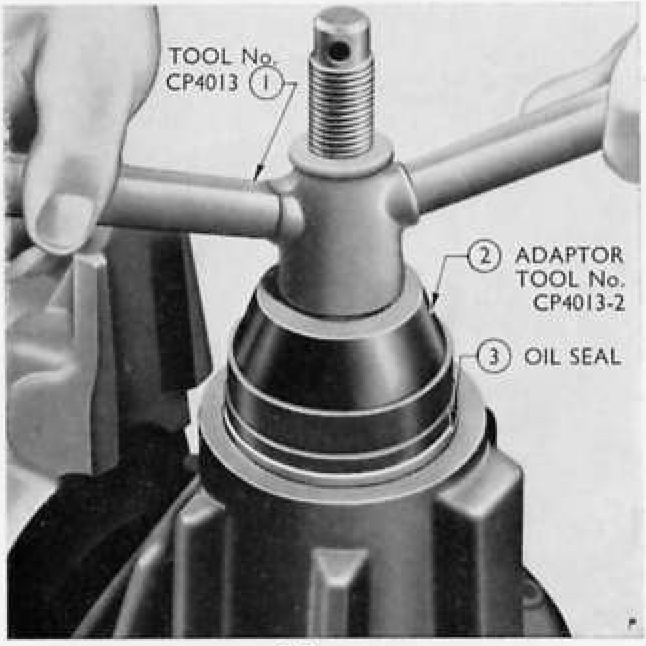


Fig. 15
Fitting the Drive Pinion Oil Seal

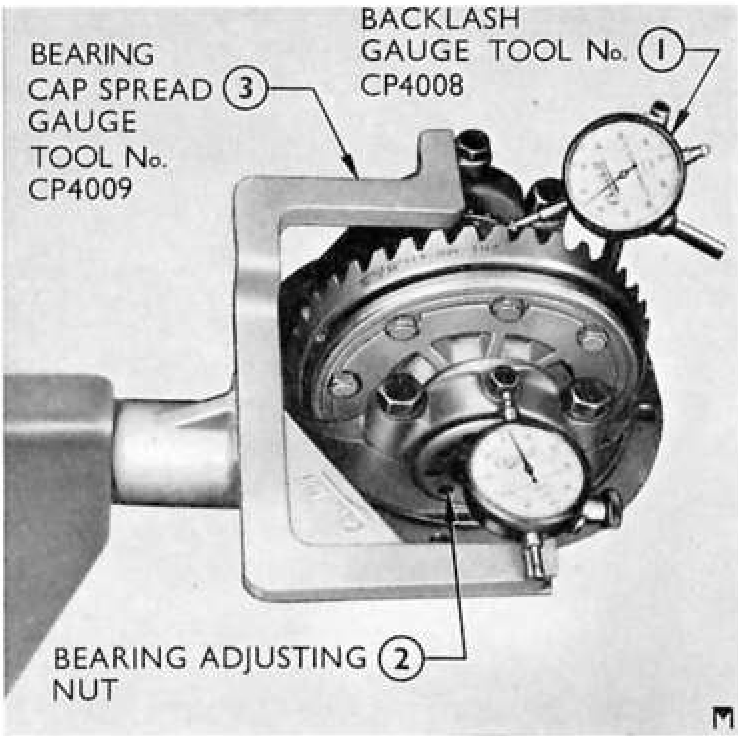


Fig. 16
Cap Spread and Backlash Gauges

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.

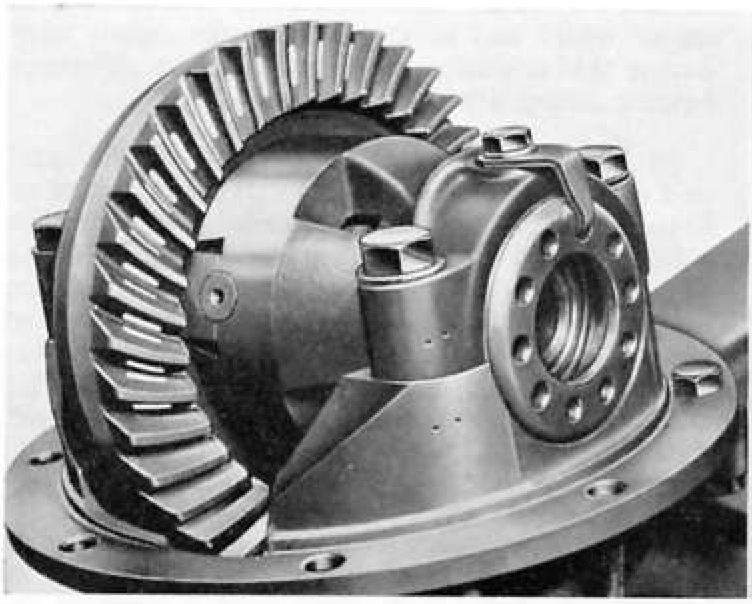
(*f*) Swing the backlash gauge out of position, and rotating the crown wheel all the time, screw in the bearing adjusting nut on the differential side with the spanner (Tool No. CP.4007), until a constant cap spread reading of between 0.127 and 0.178 mm. (0.005 and 0.007 in.) is obtained.

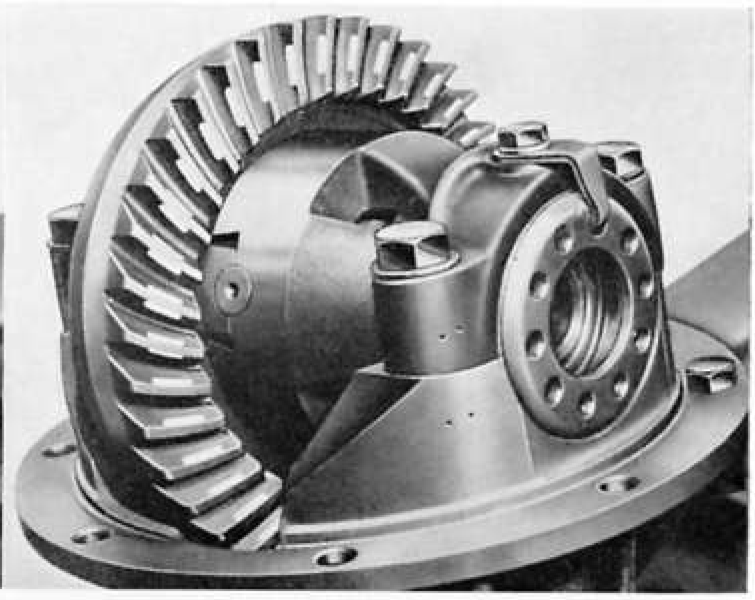
(*g*) Swing the backlash gauge back into position and zero the gauge. Hold the pinion and rock the crown wheel backwards and forwards noting the maximum and minimum readings on the gauge. The correct and final backlash between the crown wheel and pinion should be 0.127 to 0.178 mm. (0.005 to 0.007 in.).

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



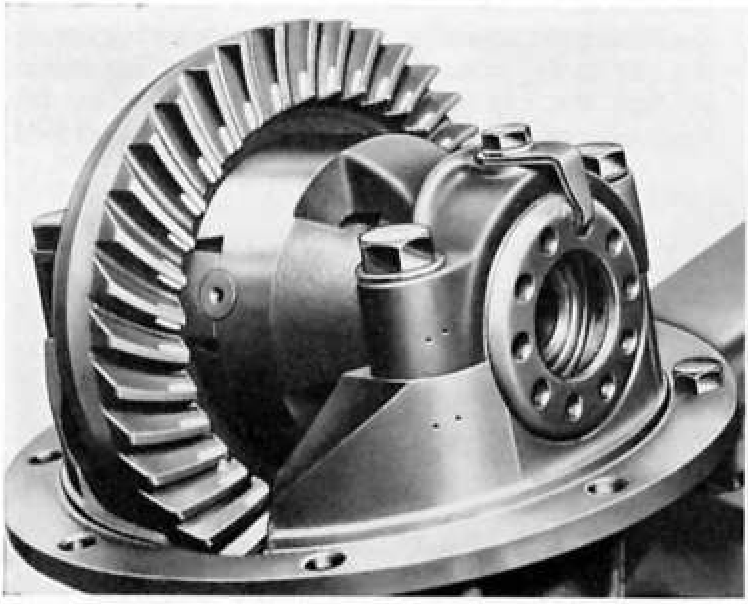


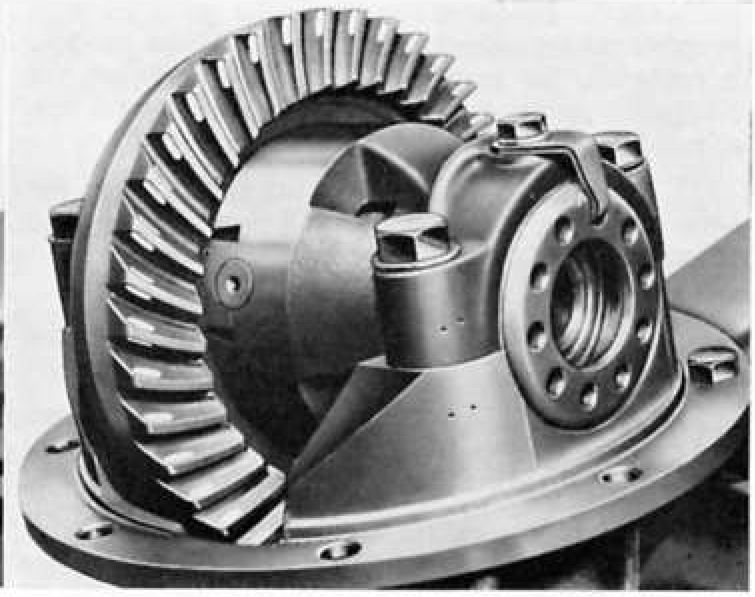
Heavy Flank Contact

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.**

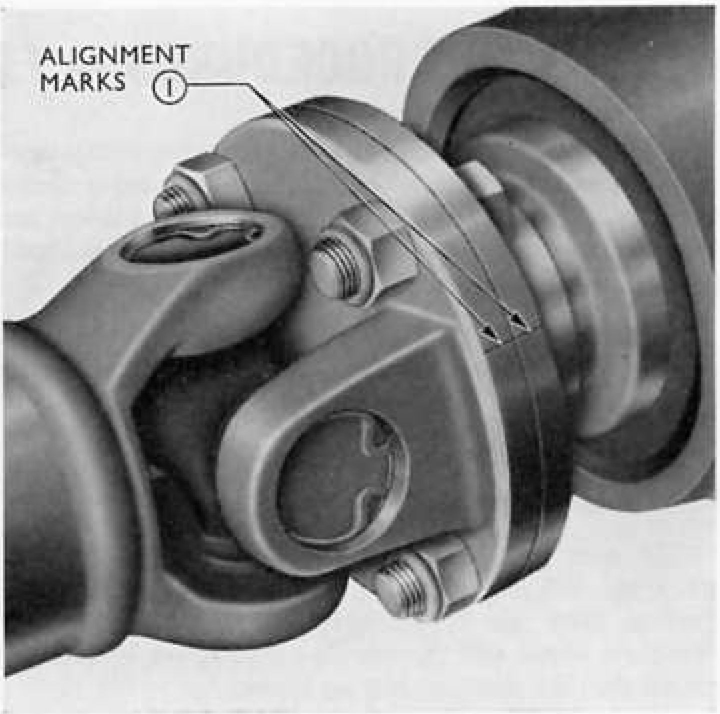


Fig. 19
Universal Joint

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:—

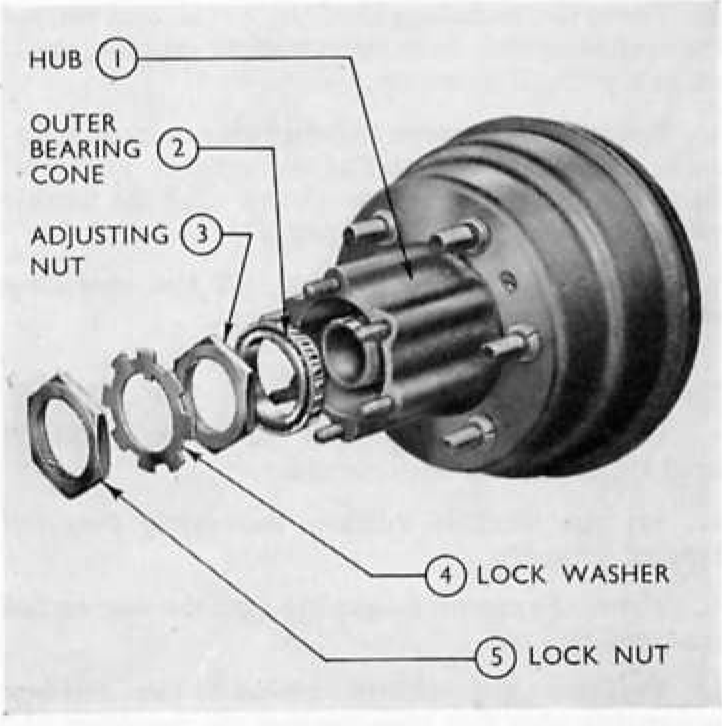


Fig. 20
Rear Hub—130 to 175

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 $\frac{1}{8}$ 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 lock-washers 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 pre-load. The drive flange retaining nut is staked to the pinion to lock it in position.

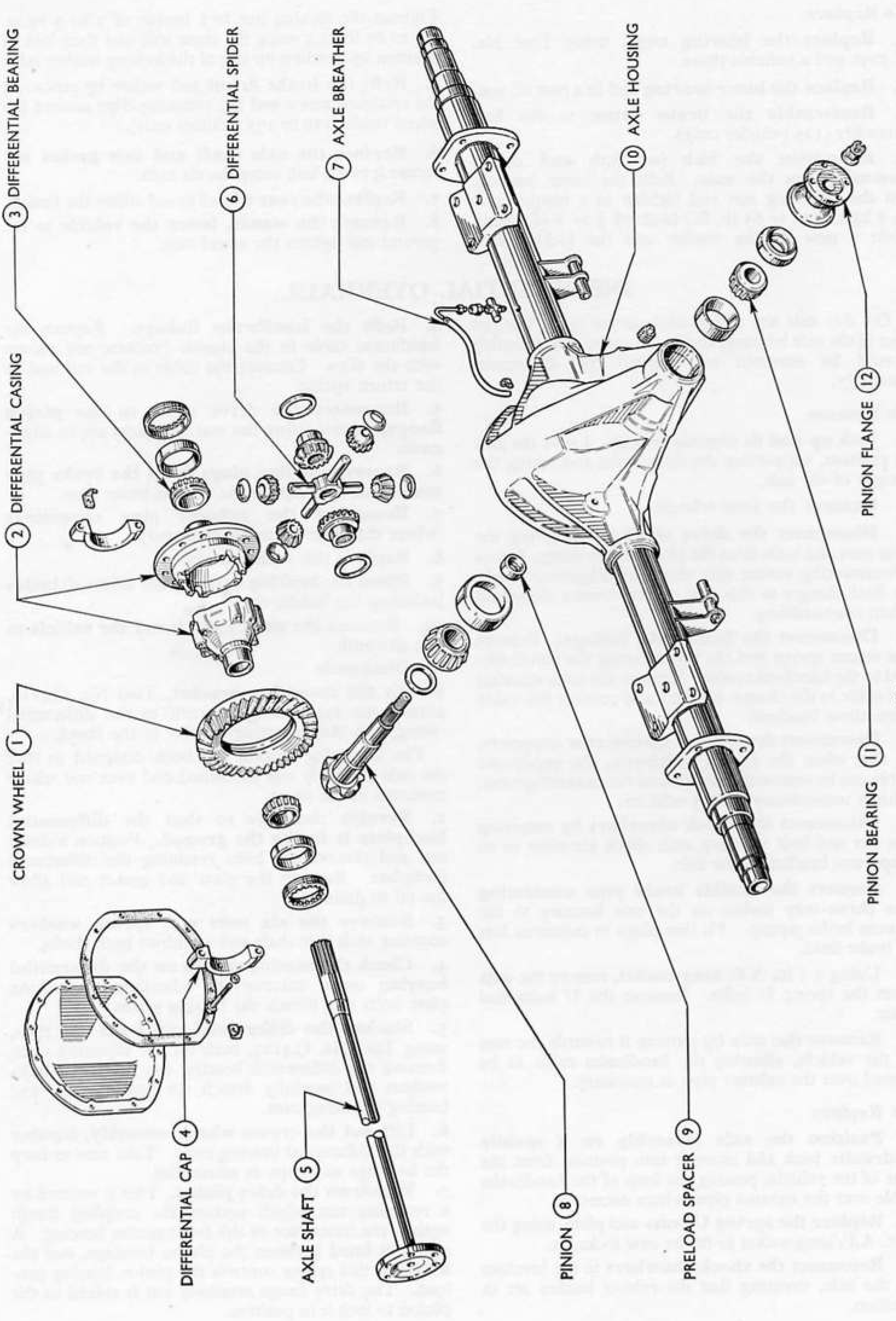


Fig. 21
Rear Axle — Exploded View (125 - 175)

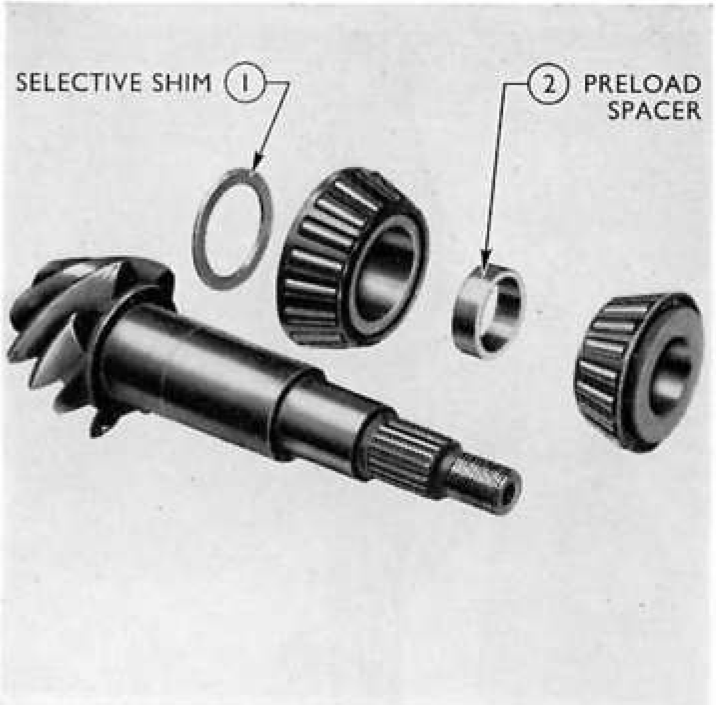


Fig. 22
Pinion Components

(*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.).

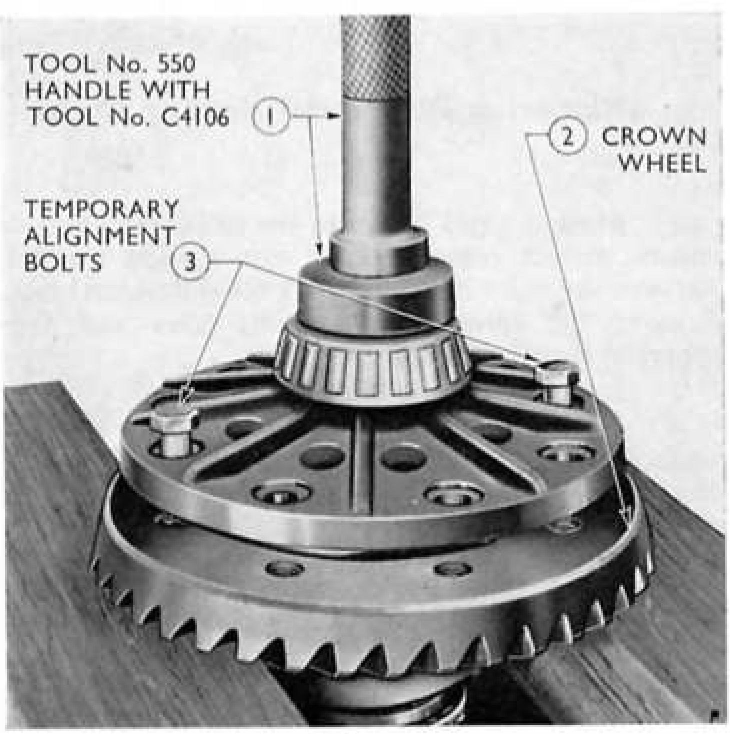


Fig. 25
Fitting the Crown Wheel

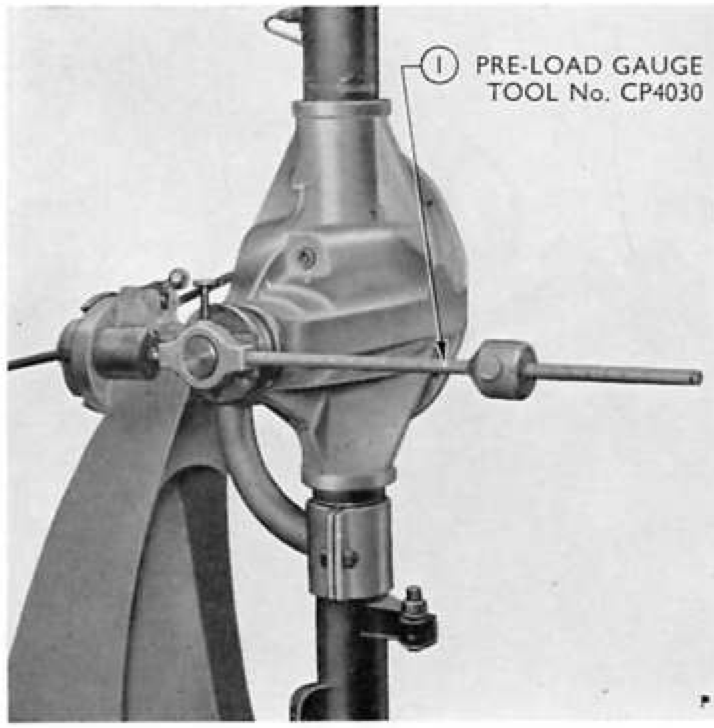


Fig. 26
Checking Pre-Load

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.

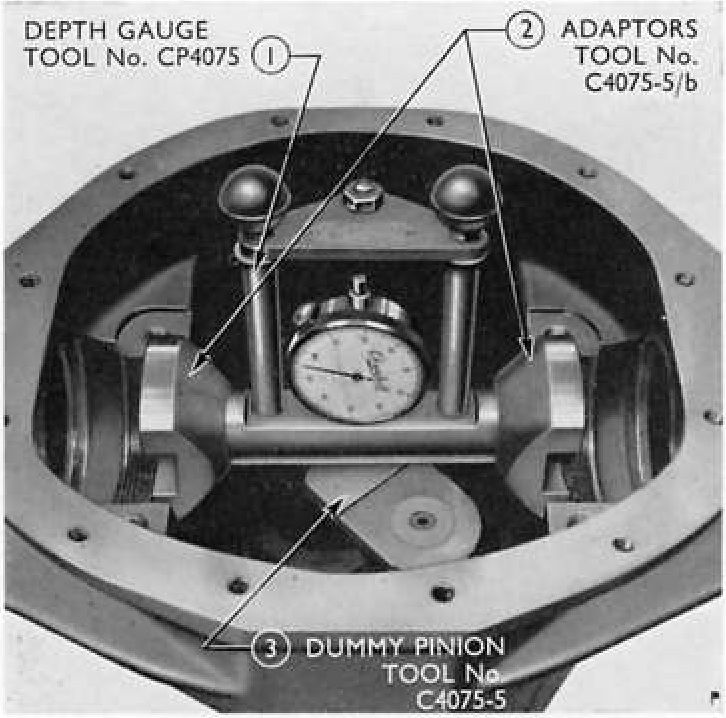


Fig. 27
Depth of Mesh Gauge

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.

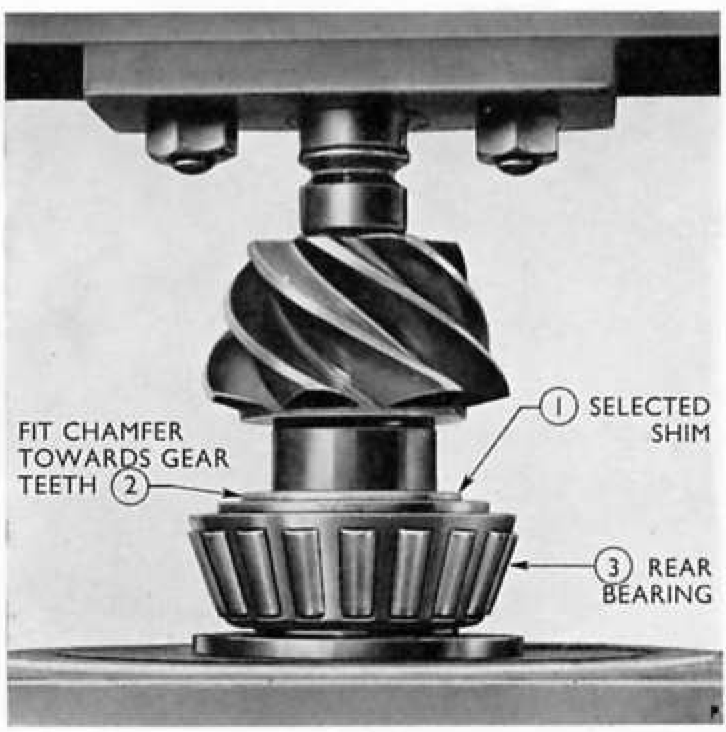


Fig. 28
Fitting Pinion Rear Bearing

(*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.

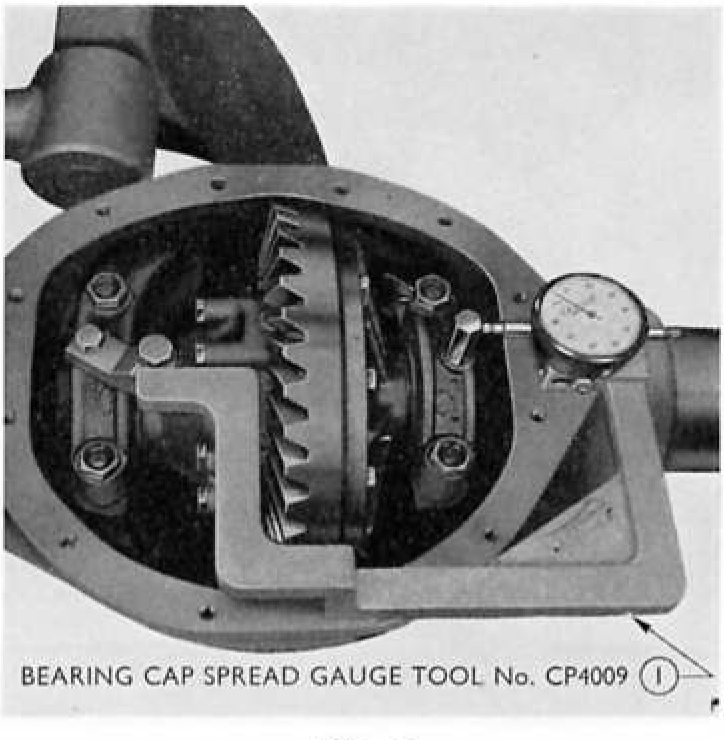


Fig. 29
Cap Spread Gauge

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.

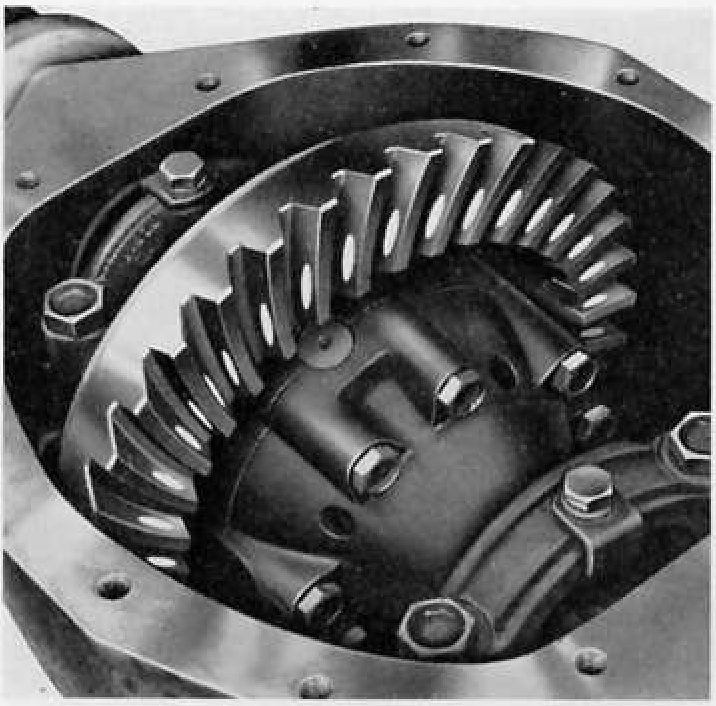


Fig. 31
Correct Tooth Contact

(*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.

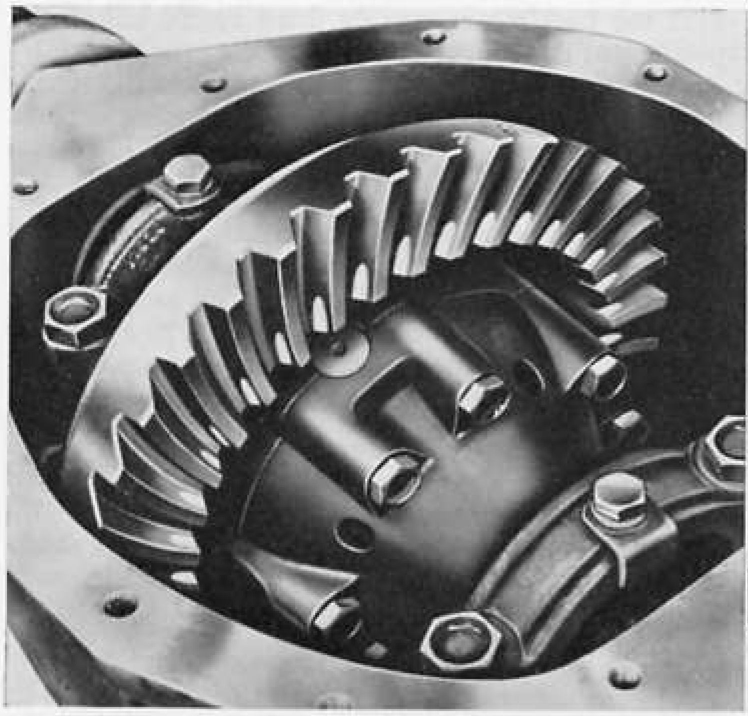
If the pinion pre-load and crown wheel backlash have been correctly set the area of contact should be as shown in Fig. 31. Margins above and below the area of contact should be the same and contact markings should run approximately for three-quarters of the tooth length. Check the patterns on both sides 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.).

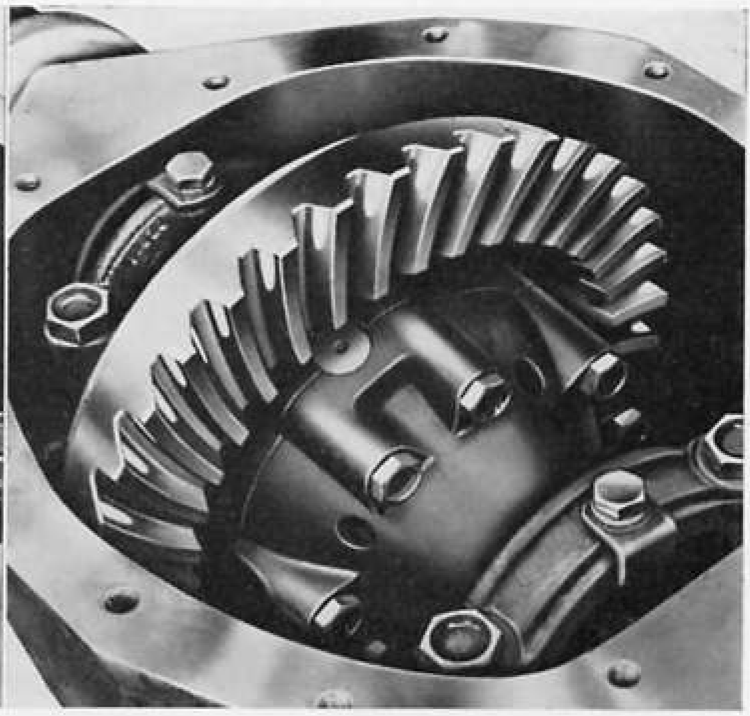
11. Replace the axle shafts with new gaskets and tighten the nuts to a torque of 7.0 to 7.6 kg.m. (50 to 55 lb. ft.).

12. Refill with oil.



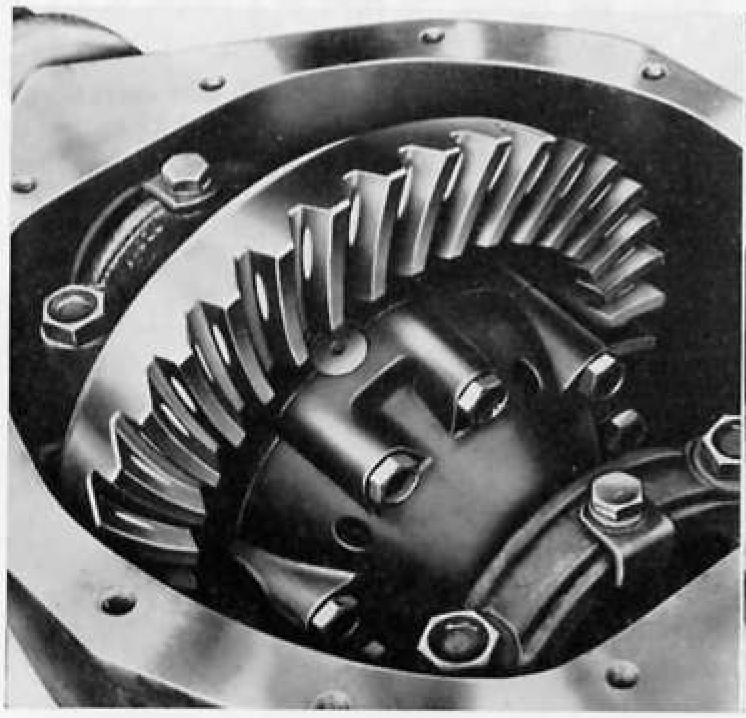
Contact on Heel

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.



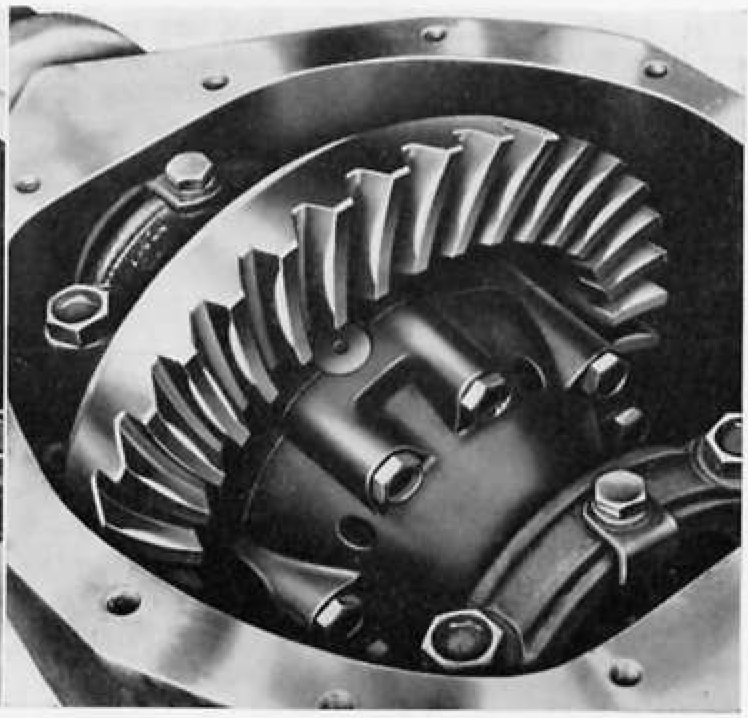
Contact on Toe

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.

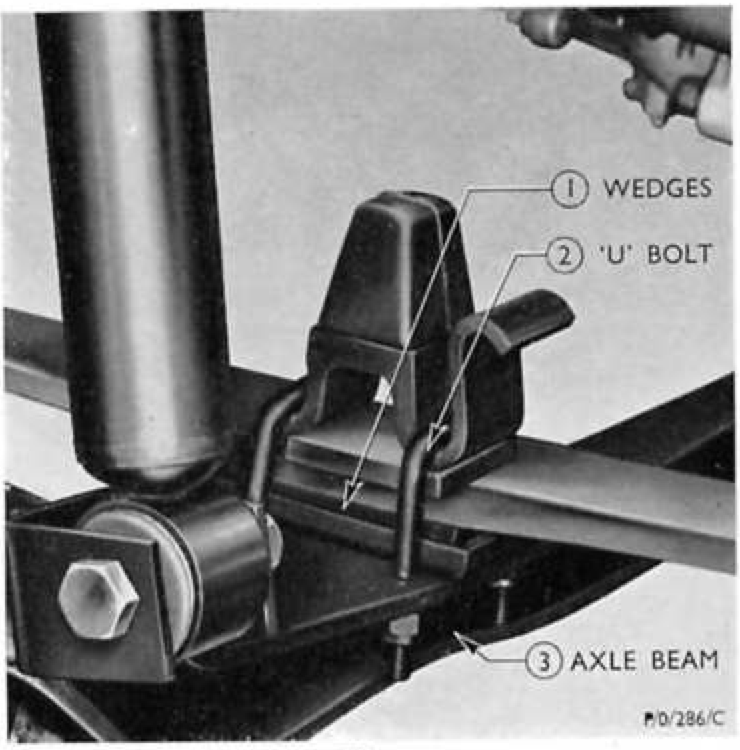


Fig. 1
"U" Bolts and Wedges

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.

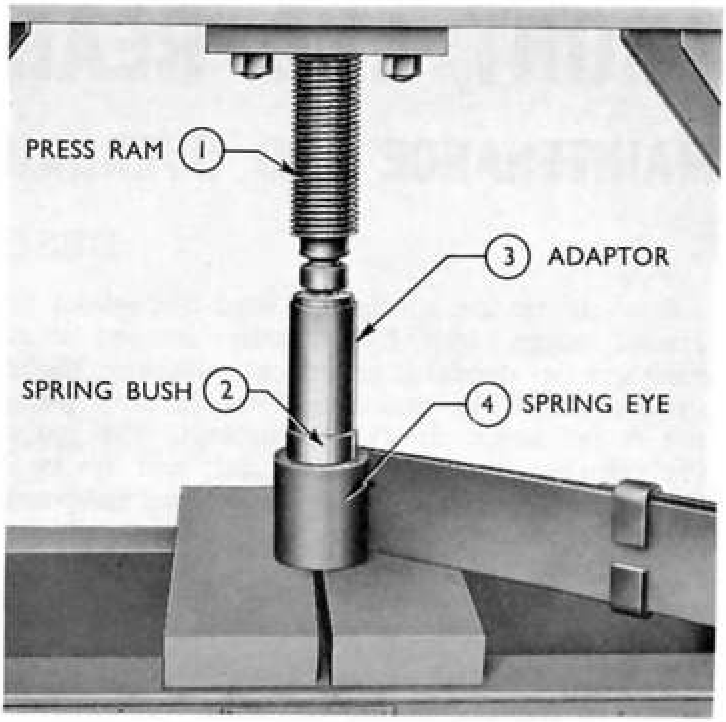


Fig. 2
Replacing the Front Spring Bush

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.

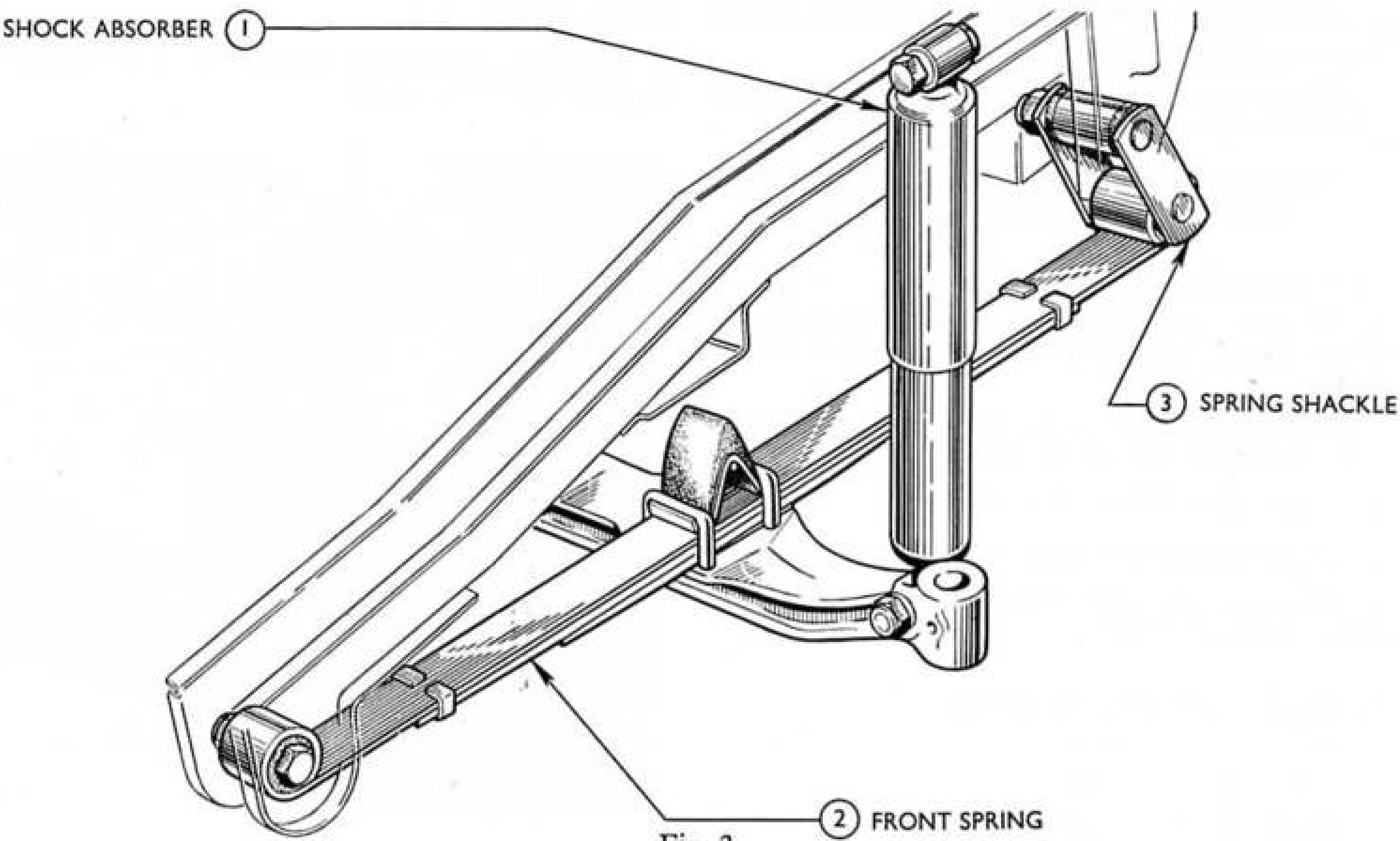


Fig. 3
Early Type Multi-leaf Front Spring and Shock Absorber

REAR SUSPENSION

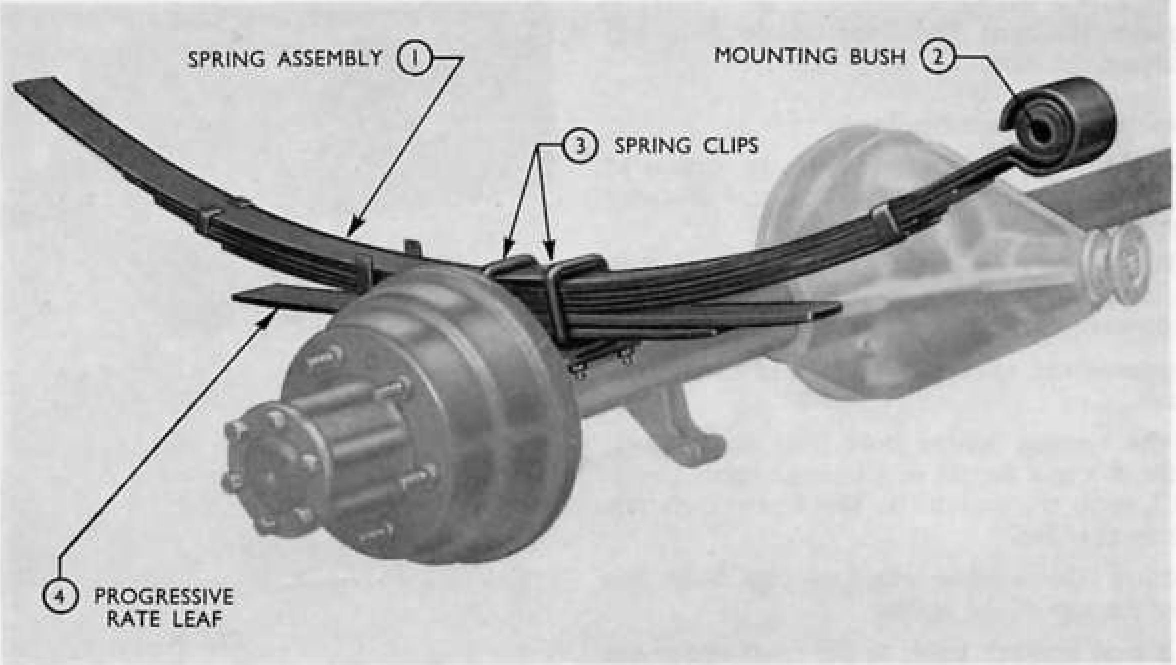


Fig. 4
Early Slipper Type Rear Spring (130 — 175)

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.

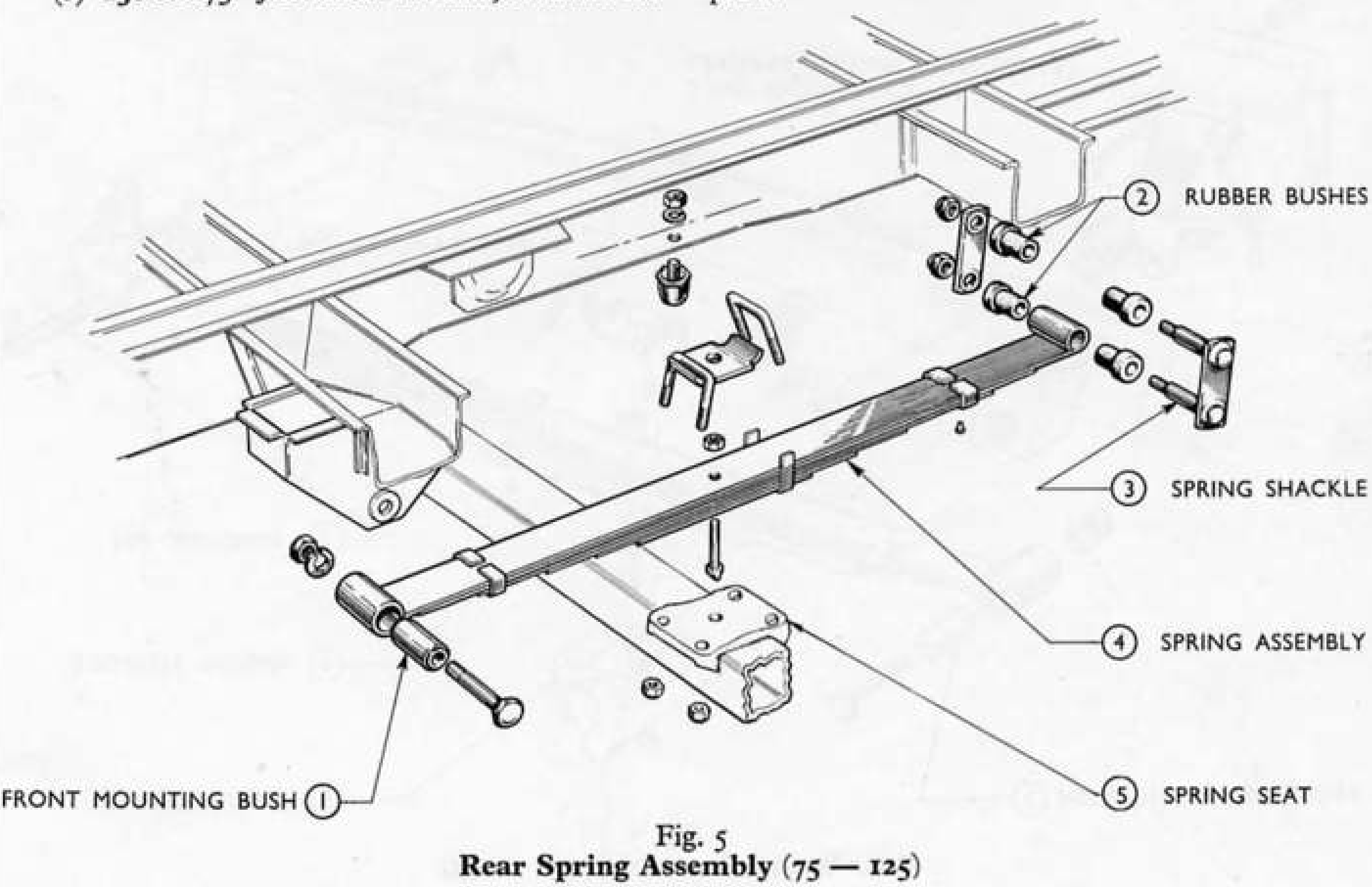


Fig. 5
Rear Spring Assembly (75 — 125)

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.

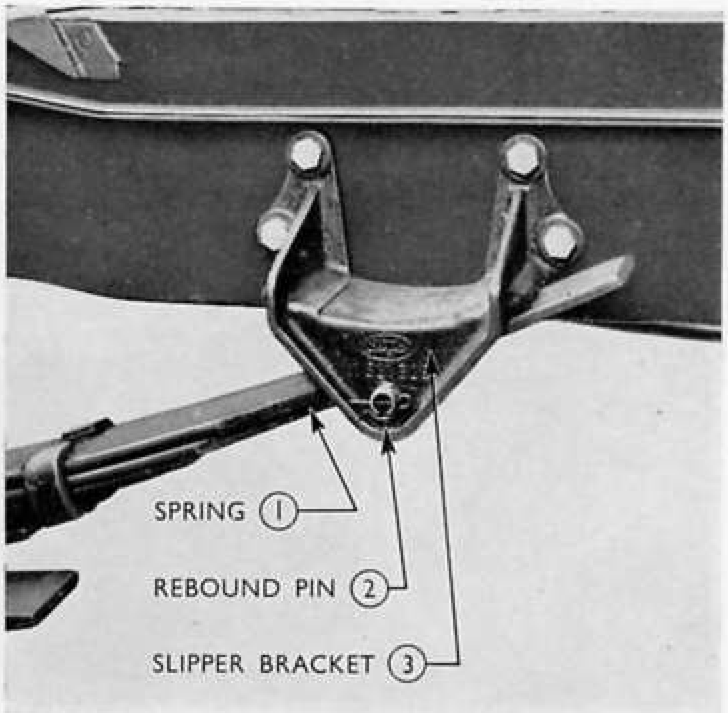


Fig. 6
Rear Slipper Bracket (130 — 175)

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.).

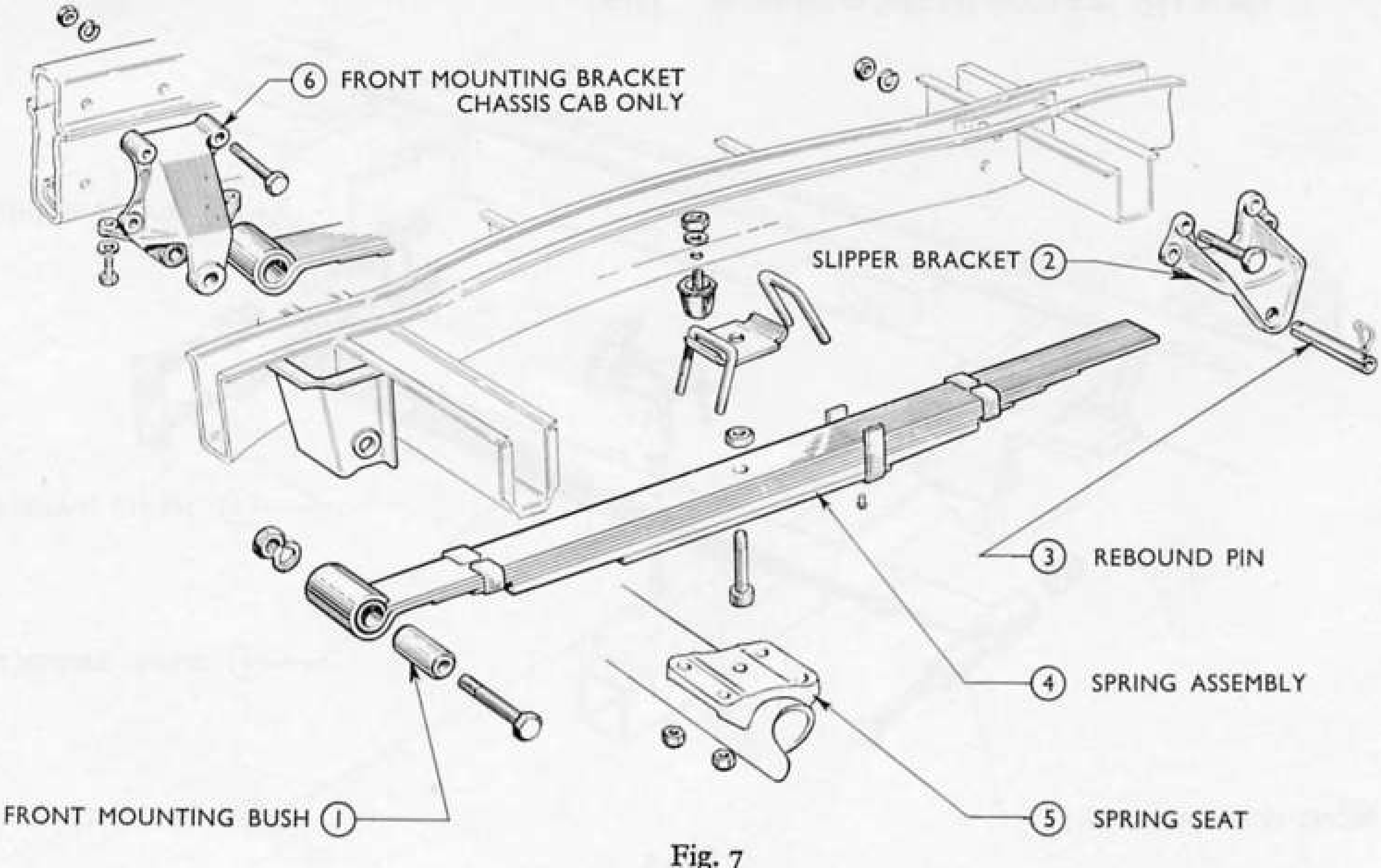


Fig. 7
Rear Spring Assembly (130 — 175)

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

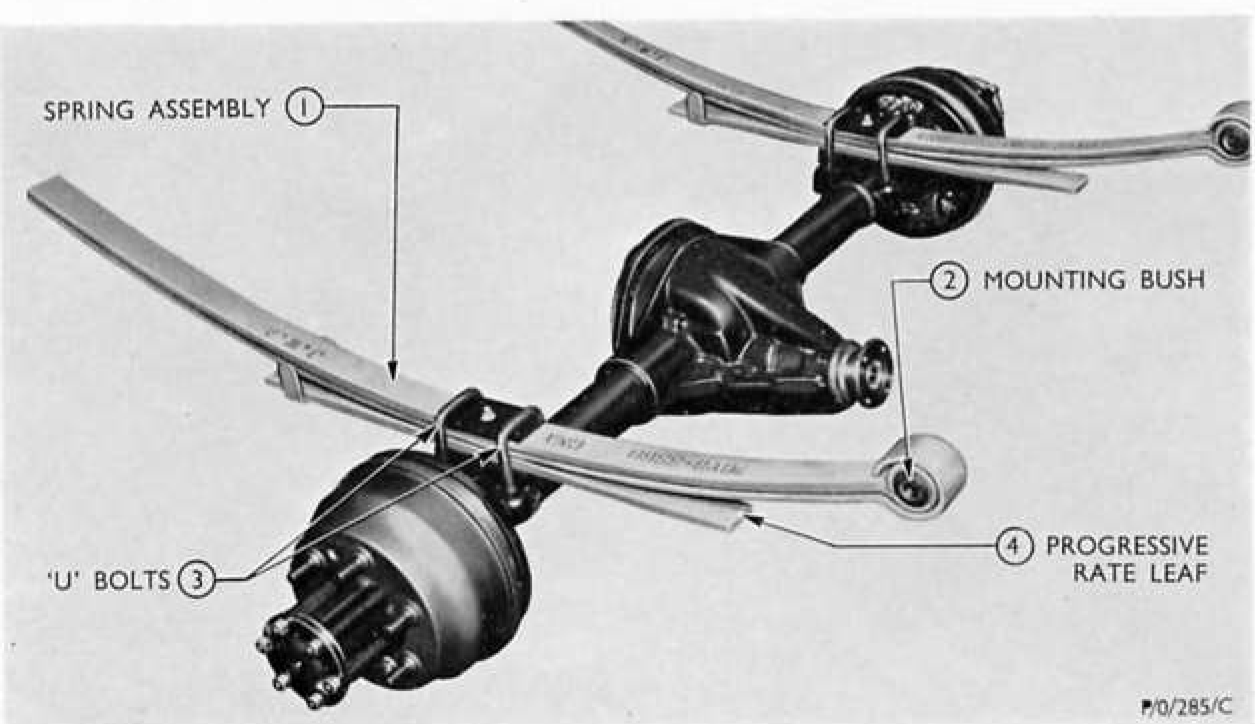


Fig. 10
Later Slipper Type Rear Spring (130 — 175)

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

PETROL ENGINE

DIESEL ENGINE

ENGINE: PETROL
OVERHAUL PROCEDURES

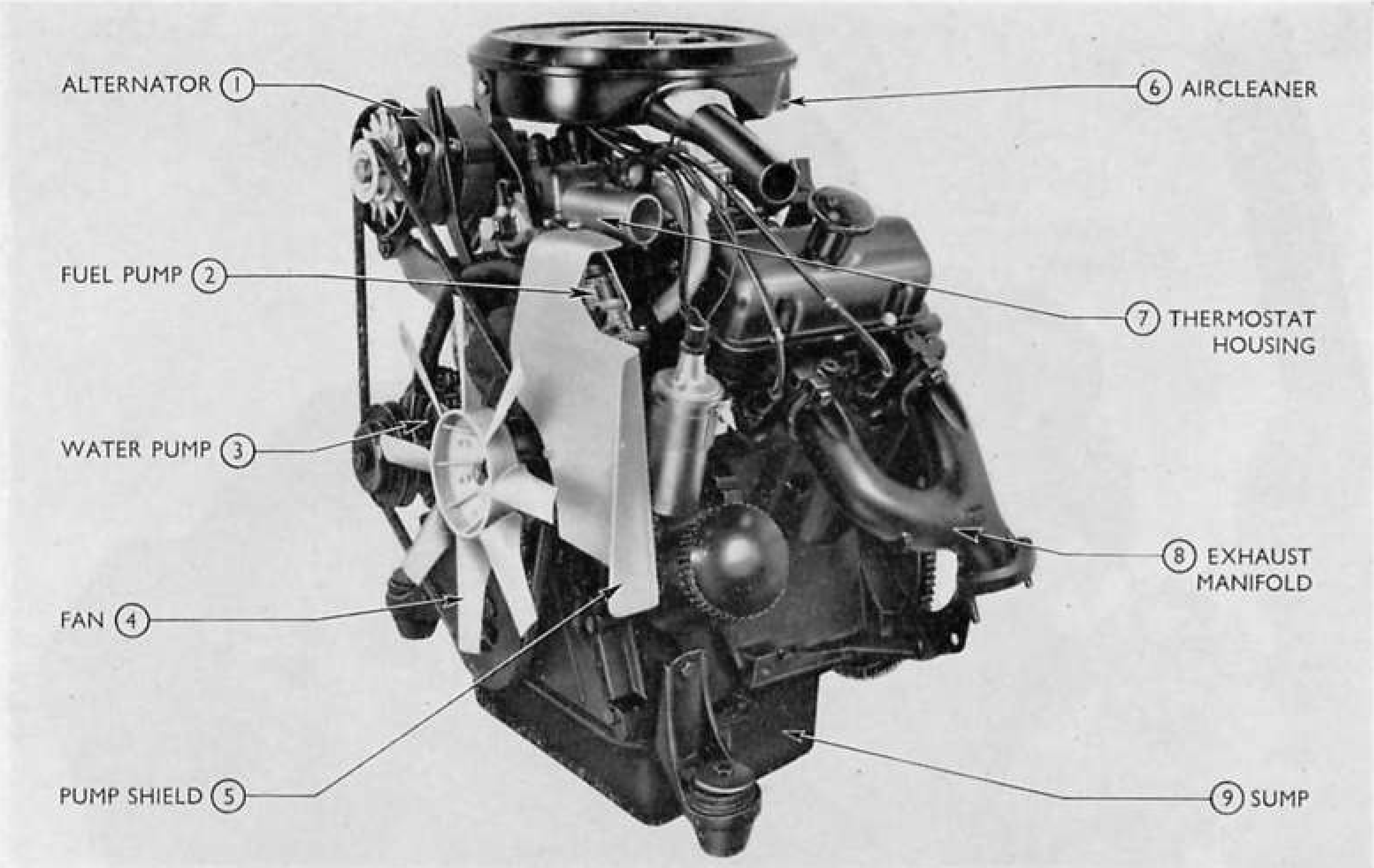


Fig. 1
The Engine Assembly

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.

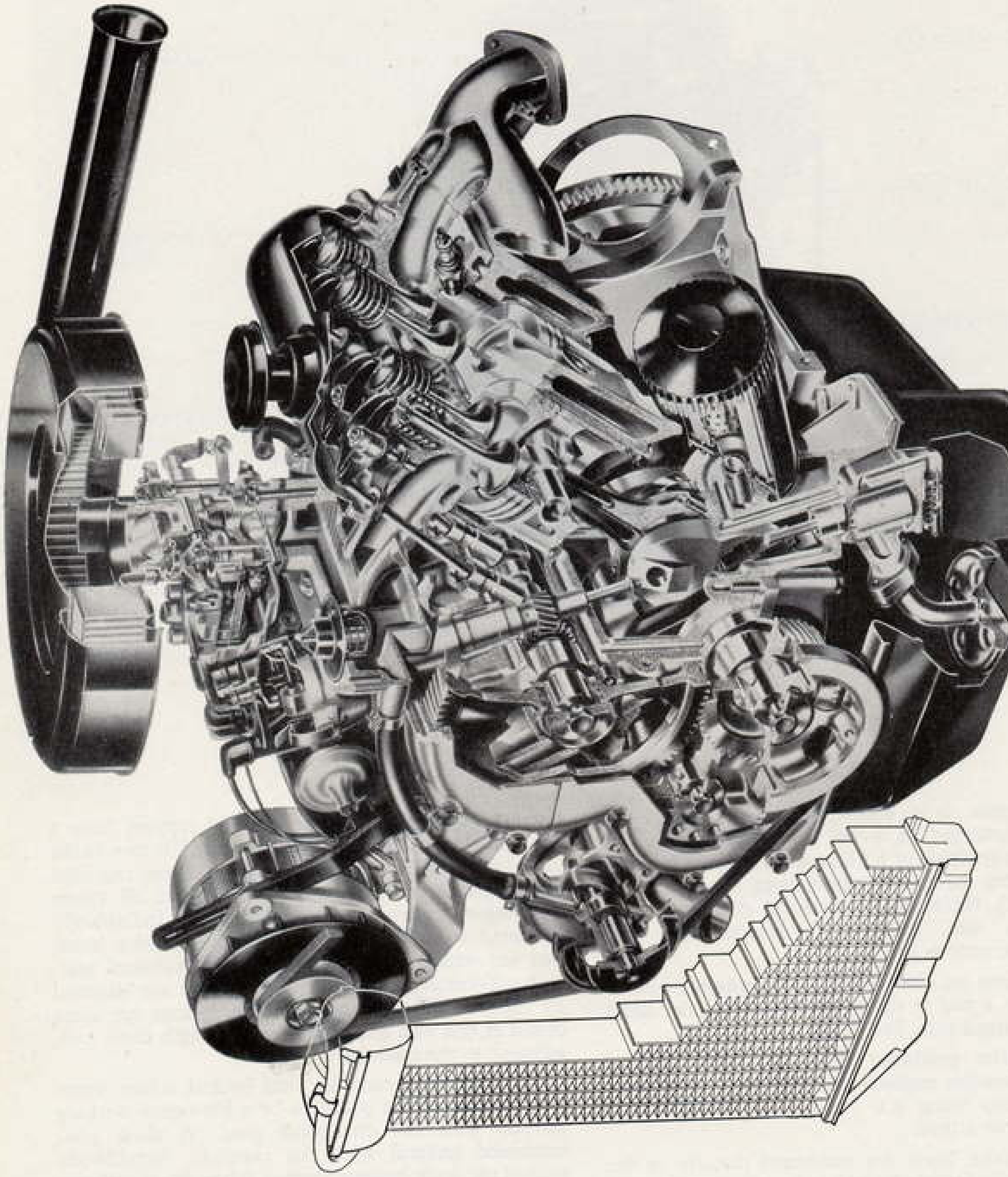


Fig. 2
The Engine Sectioned (Early Type)

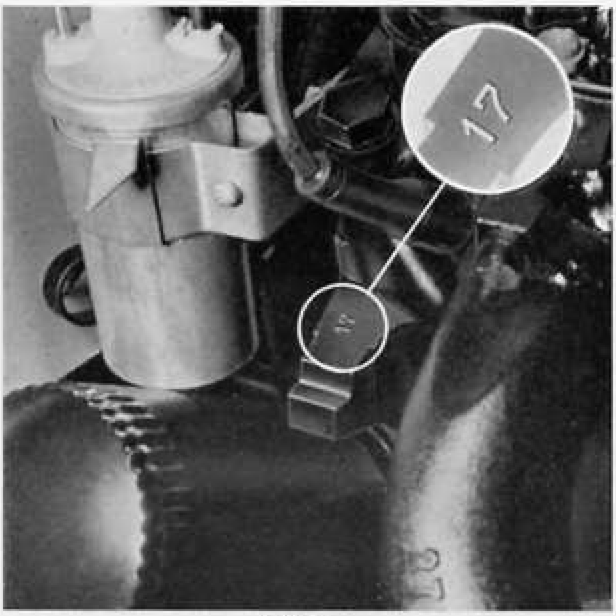


Fig. 3
Engine Identification

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.

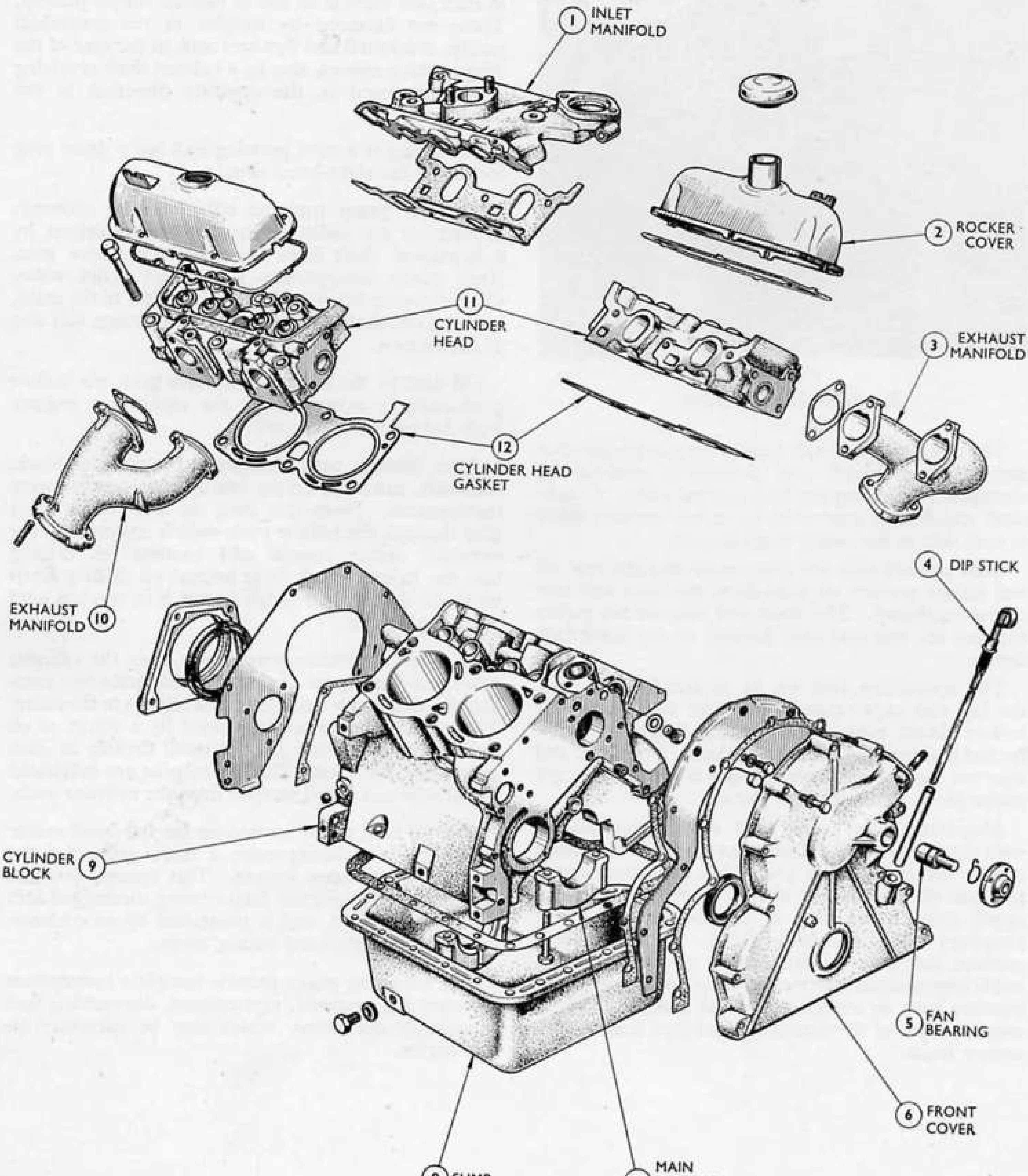


Fig. 4
The Engine — Exterior

ENGINE COMPONENTS

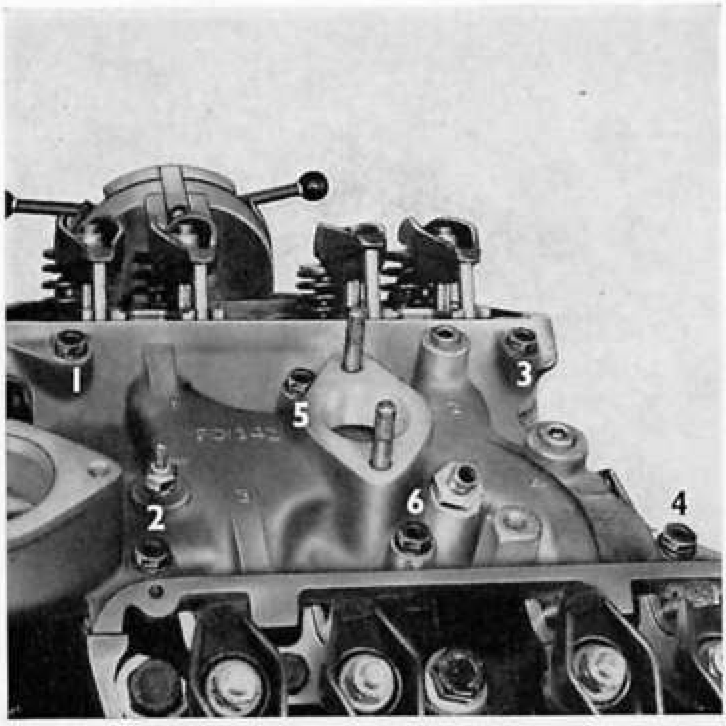


Fig. 5
Inlet Manifold Bolt Tightening Sequence

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.

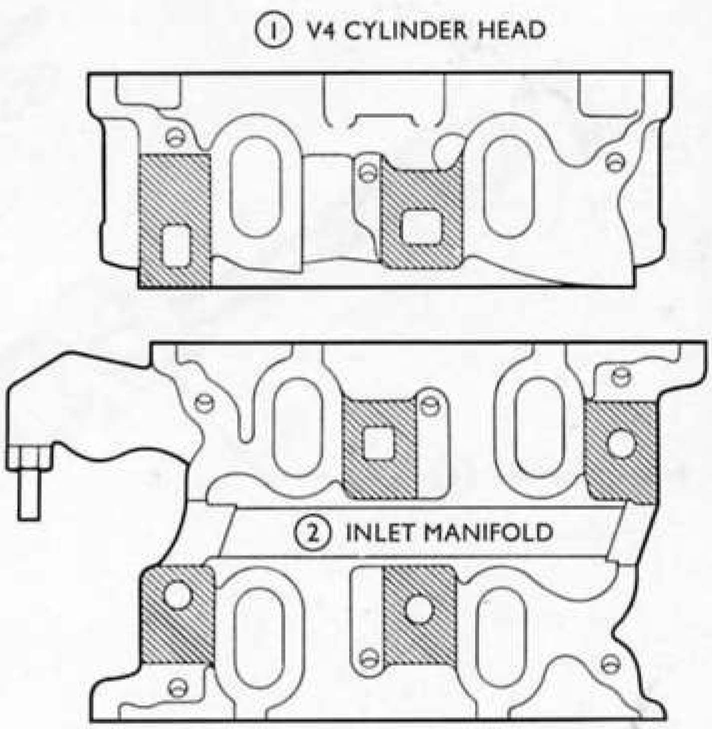


Fig. 6
Apply EM-4G-52 to Shaded Areas Shown

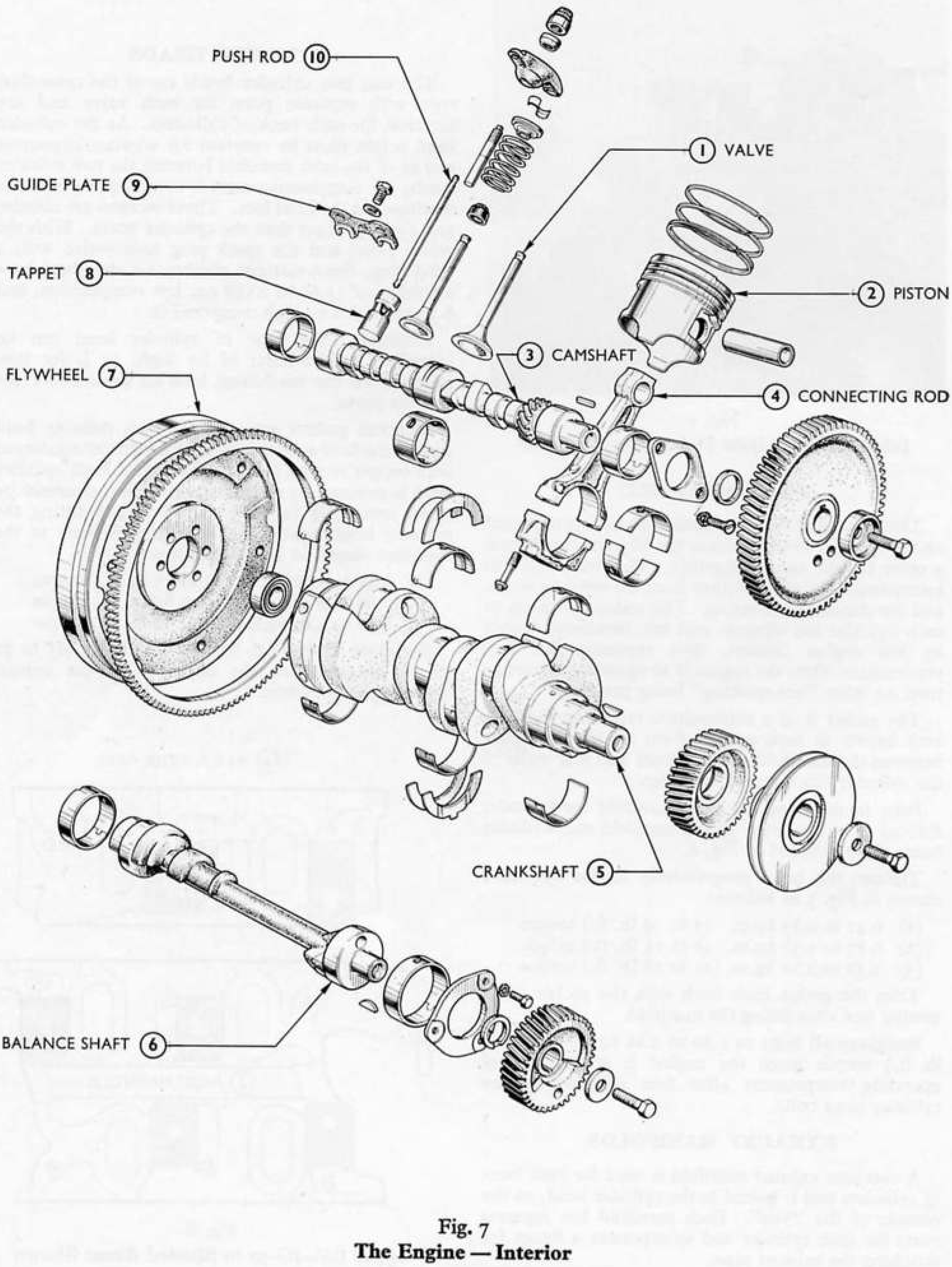


Fig. 7
The Engine — Interior

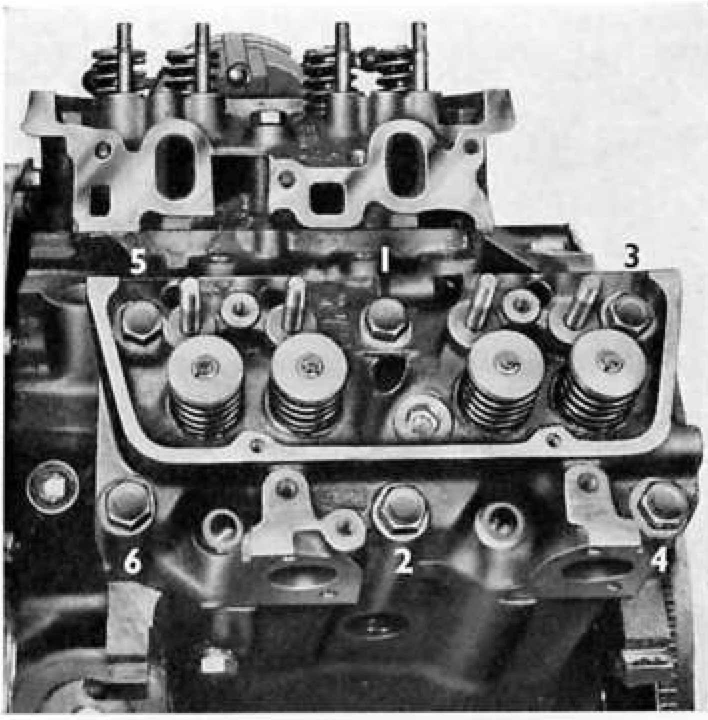


Fig. 8
Cylinder Head Bolt Tightening Sequence

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.

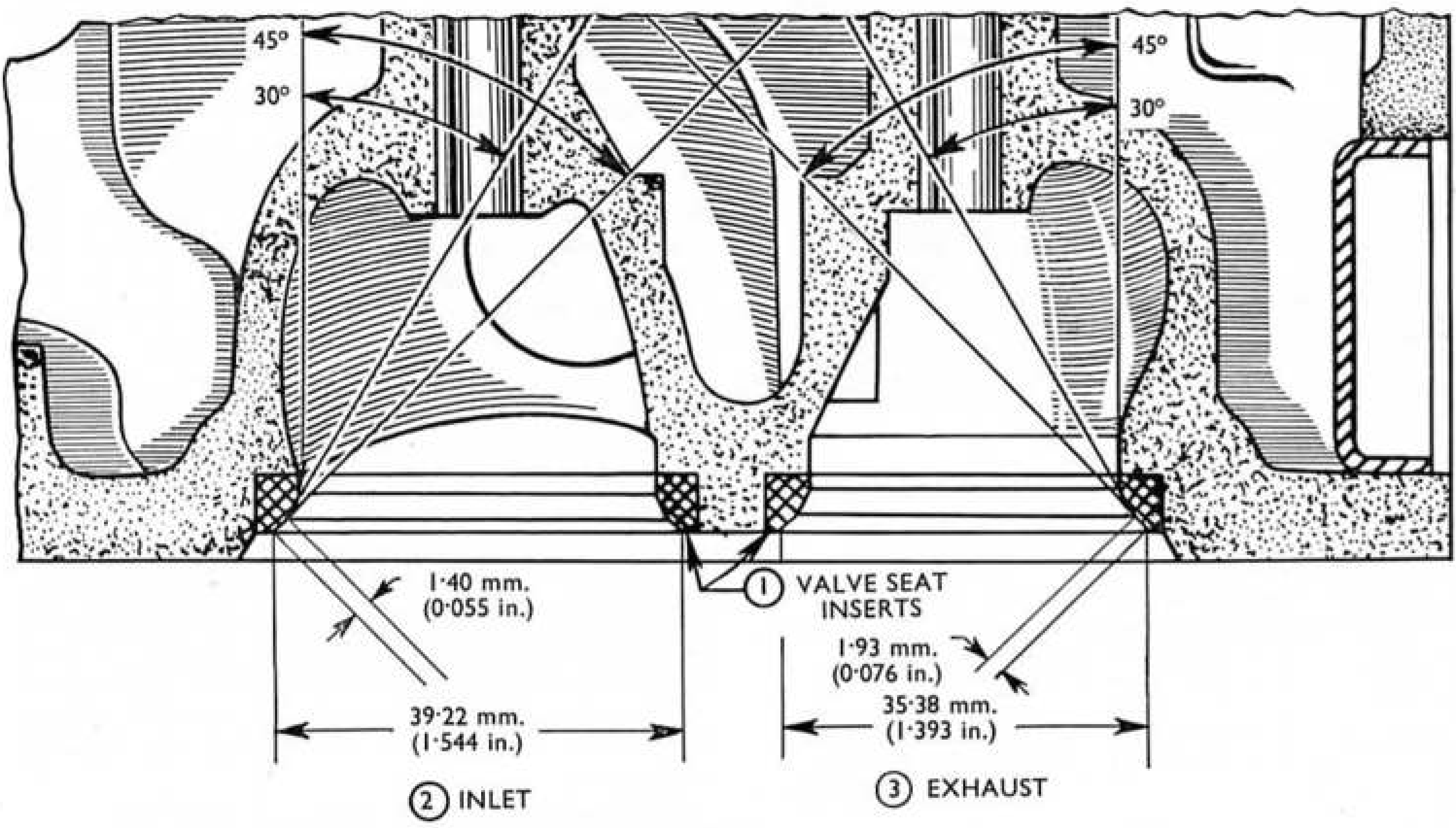


Fig. 9
Valve Seat Insert Machining Dimensions

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.

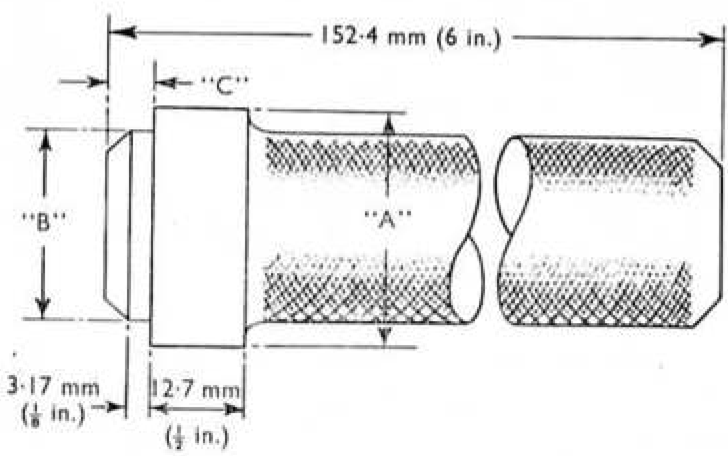
Fit the new studs using replacer Tool No. CP.6142A. Oversize studs can be identified by a single groove round the spigot end for 0.08 mm. (0.003 in.) oversize studs and by a double groove on the 0.38 mm. (0.015 in.) oversize studs. Standard size studs have no identification markings. Screw the stud fully 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. ($1\frac{19}{32}$ in.) and 36.51 mm. ($1\frac{7}{16}$ in.) and



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

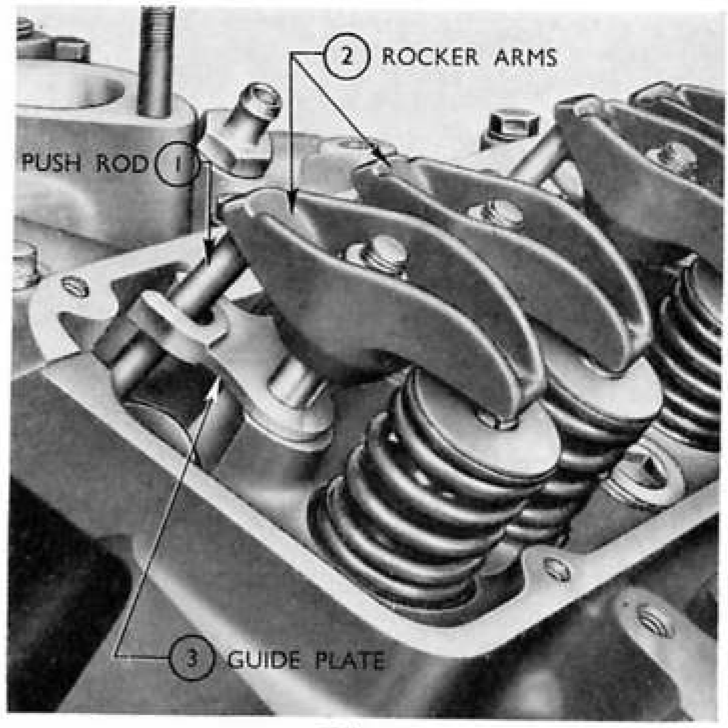


Fig. 11
Stud Mounted Rocker Arms

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.

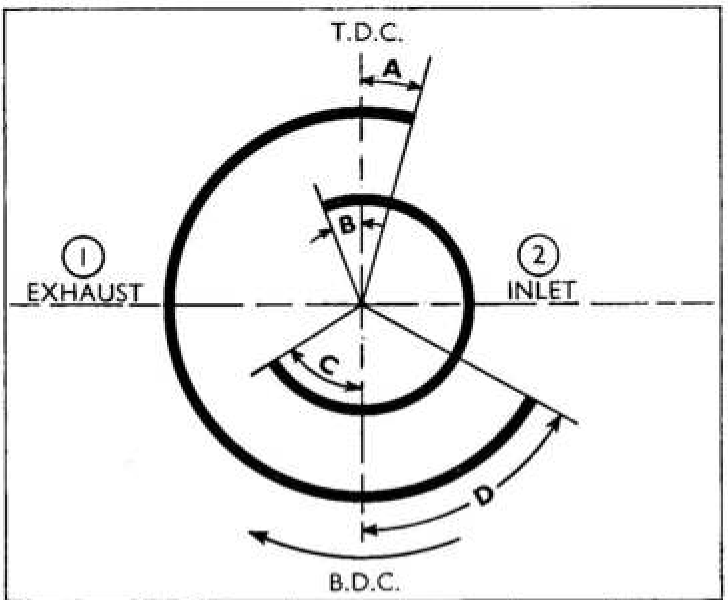
The inlet valve head has a diffused aluminium coating to increase the valves resistance to high temperature oxidisation and to form a hard wear-resistant surface on the seating area. In no circumstances should the faces of "aluminised" inlet valves be ground or the valves lapped in as this will remove 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

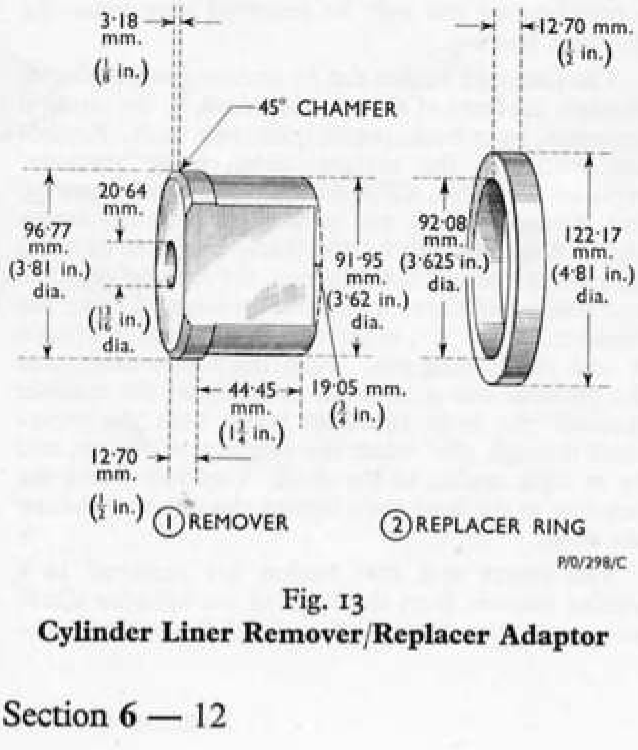


Fig. 13
Cylinder Liner Remover/Replacer Adaptor

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

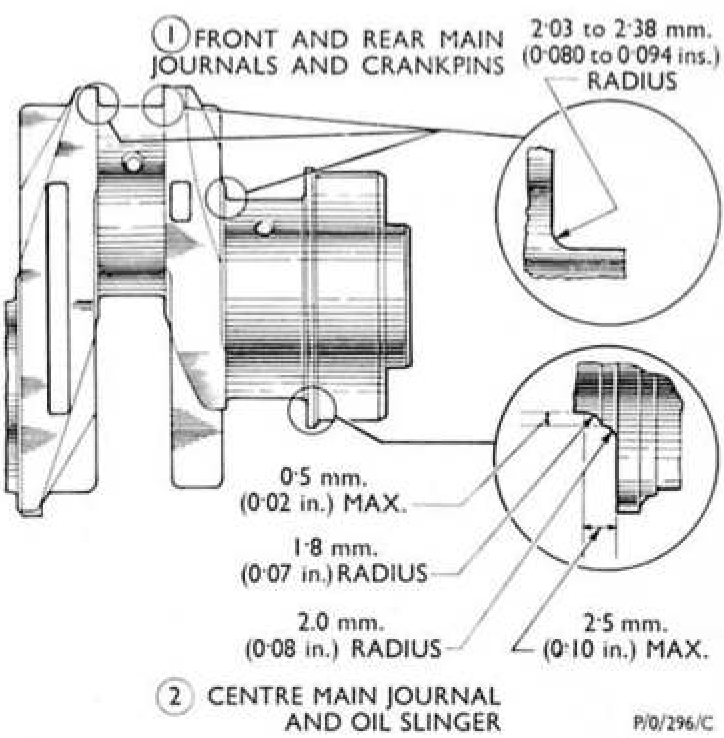


Fig. 14
Crankshaft Fillet Radii

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.).

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".

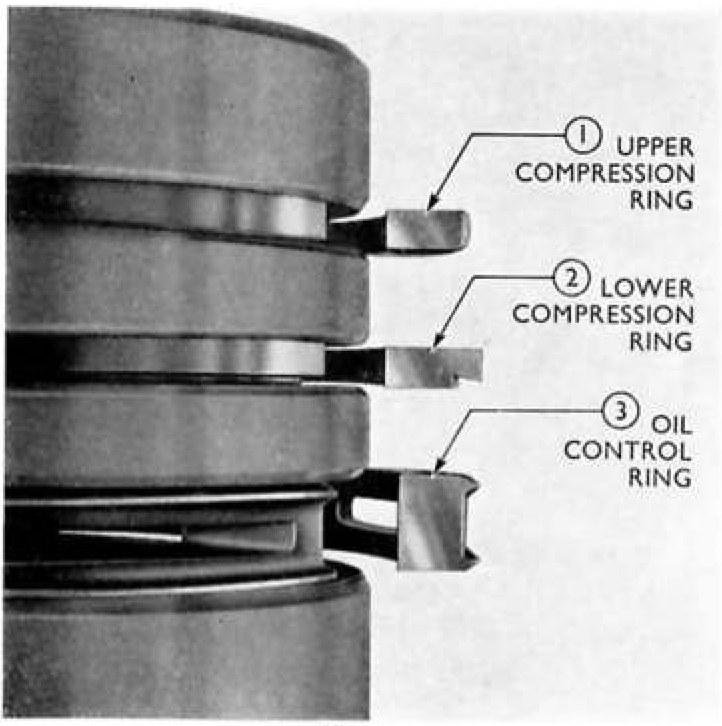


Fig. 15
Piston Ring Assembly

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. (⅜ 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

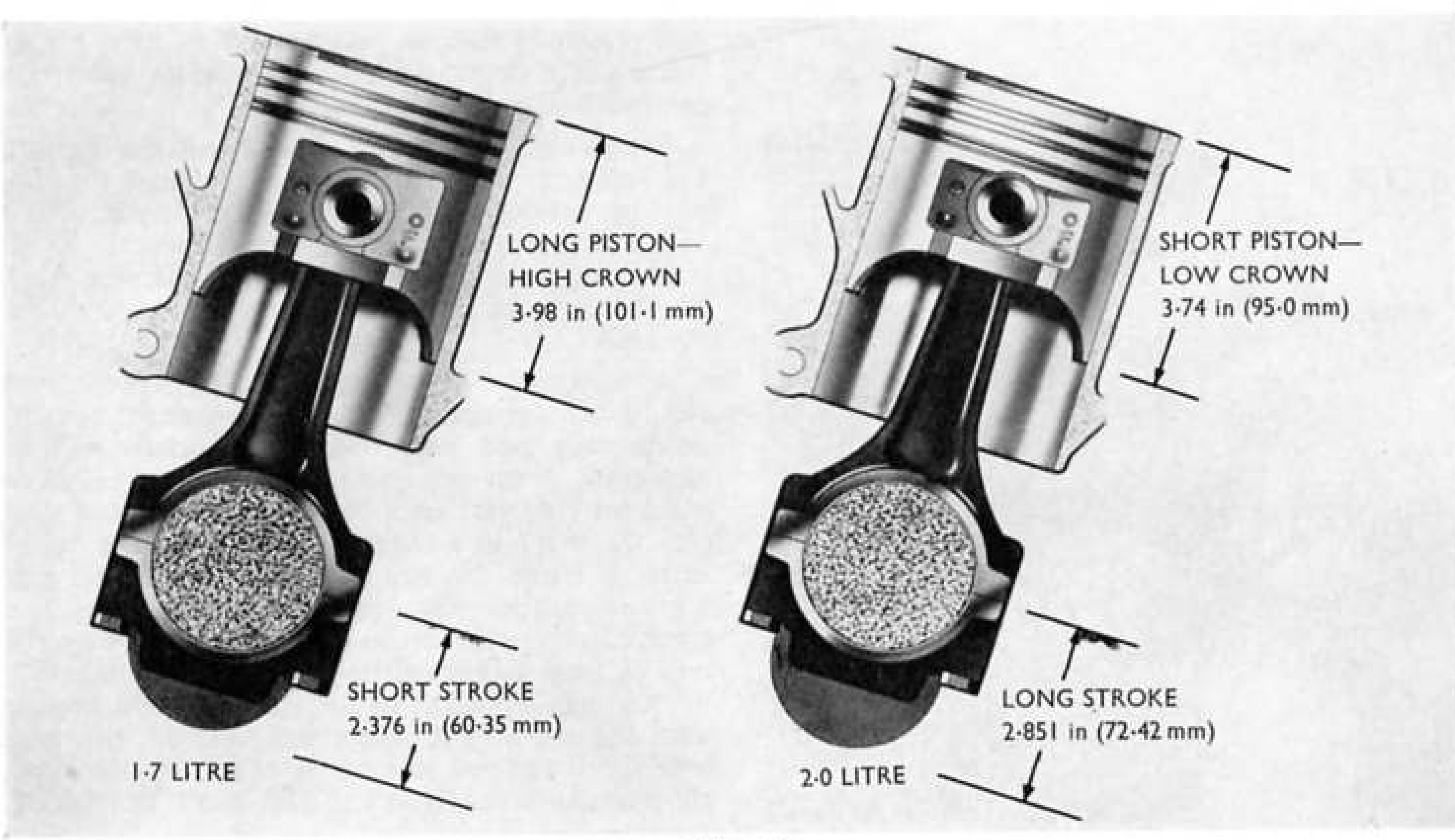


Fig. 16
Piston Identification

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.

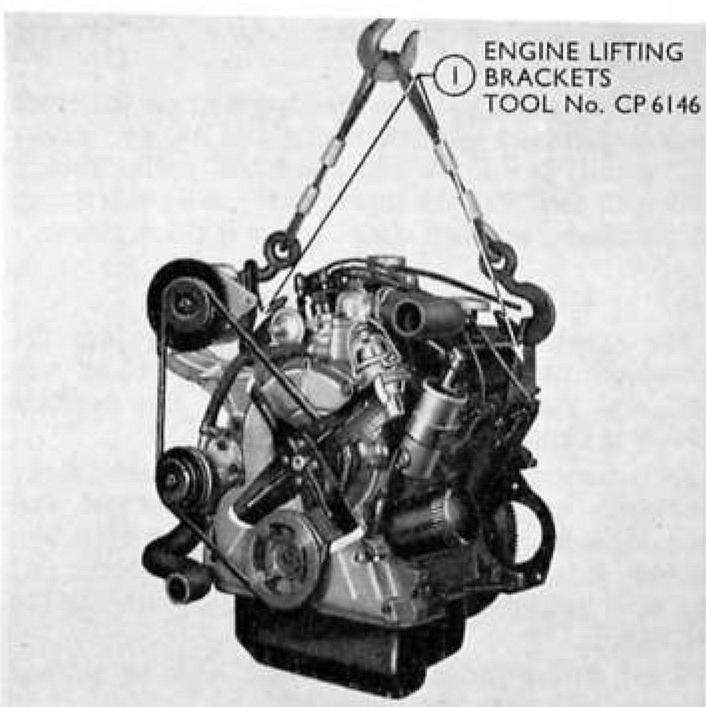


Fig. 18
Removing the Engine

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.

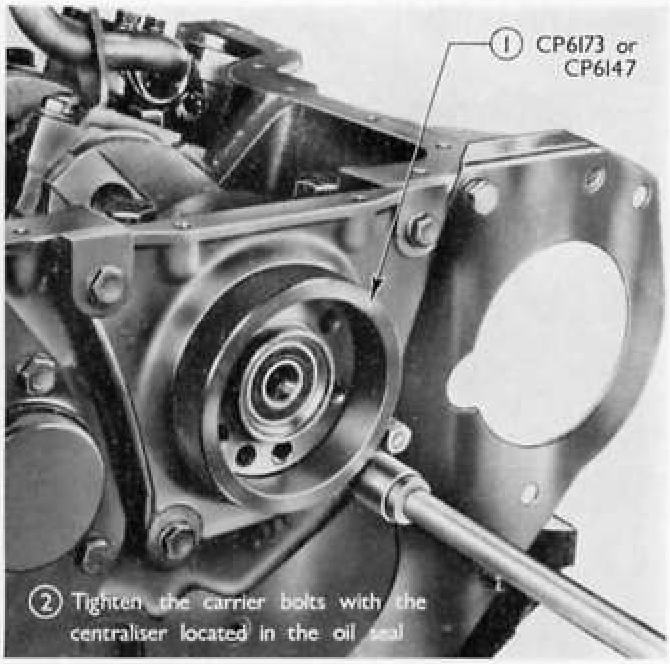


Fig. 20
Fitting Crankshaft Rear Oil Seal Carrier

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.

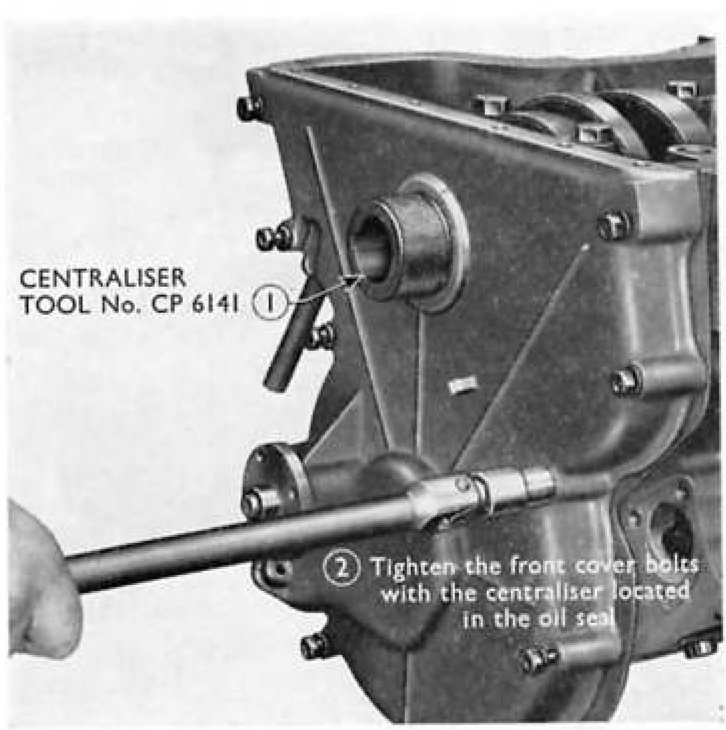


Fig. 22
Fitting the Front Cover

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 valve 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.

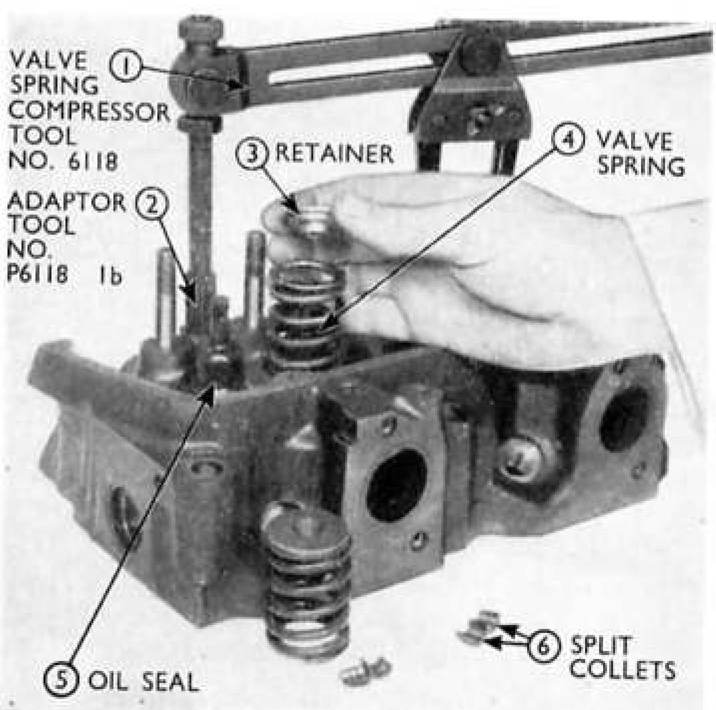


Fig. 23
Assembling the Valves

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.

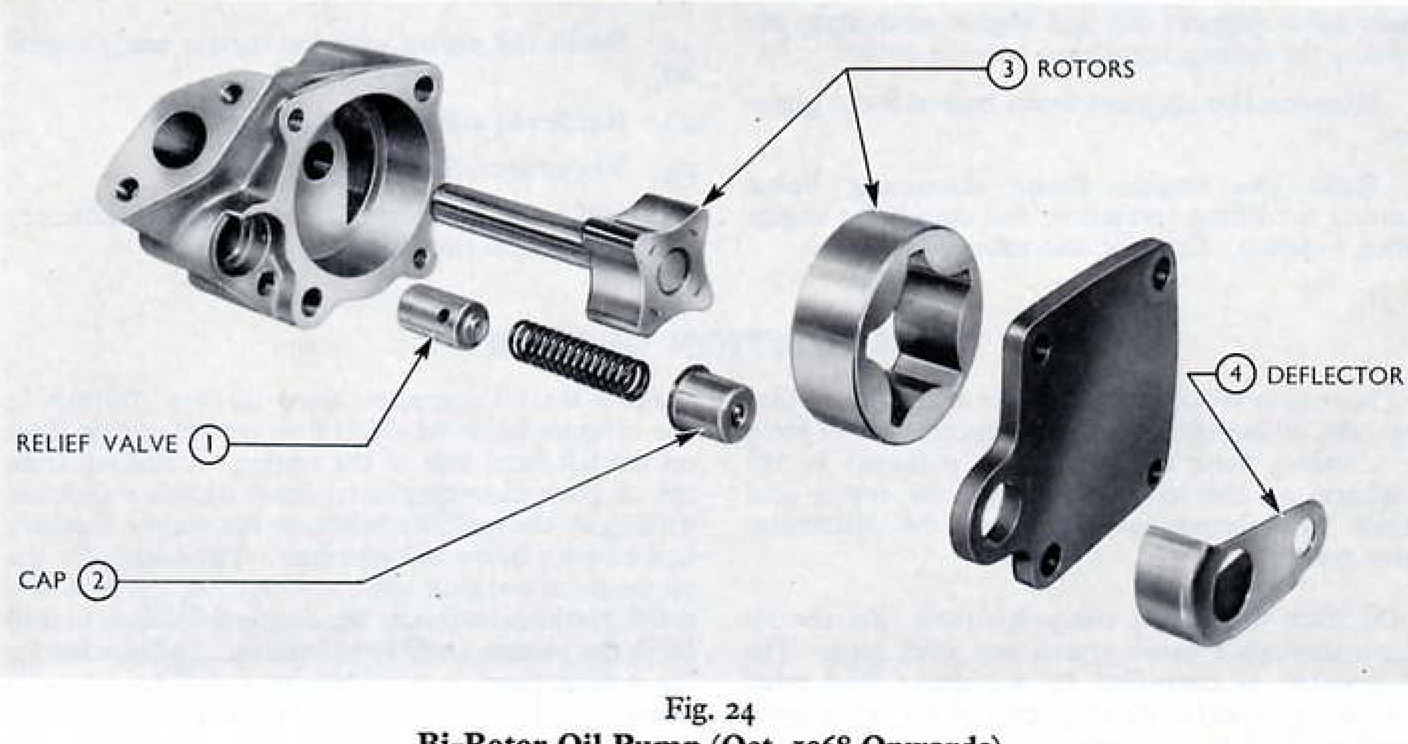


Fig. 24
Bi-Rotor Oil Pump (Oct. 1968 Onwards)

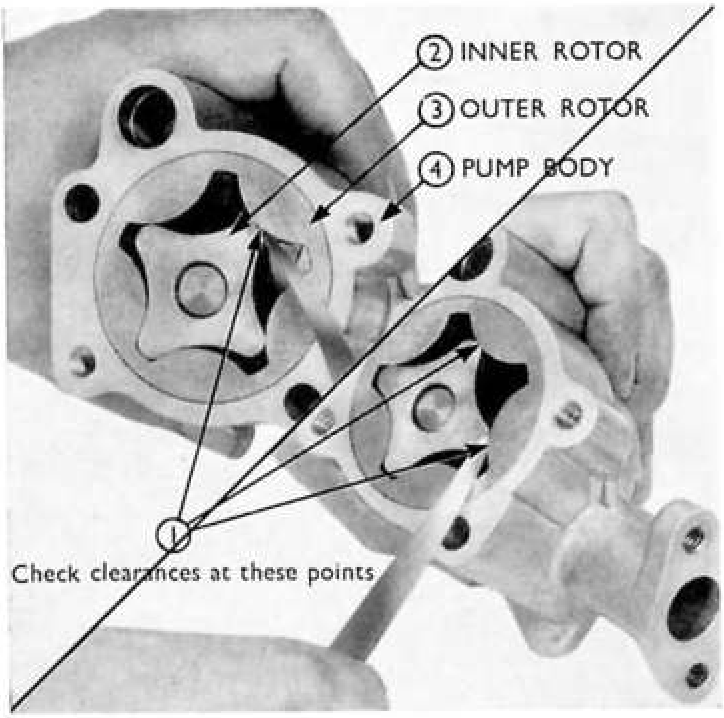


Fig. 25
Checking Rotor Clearance

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.

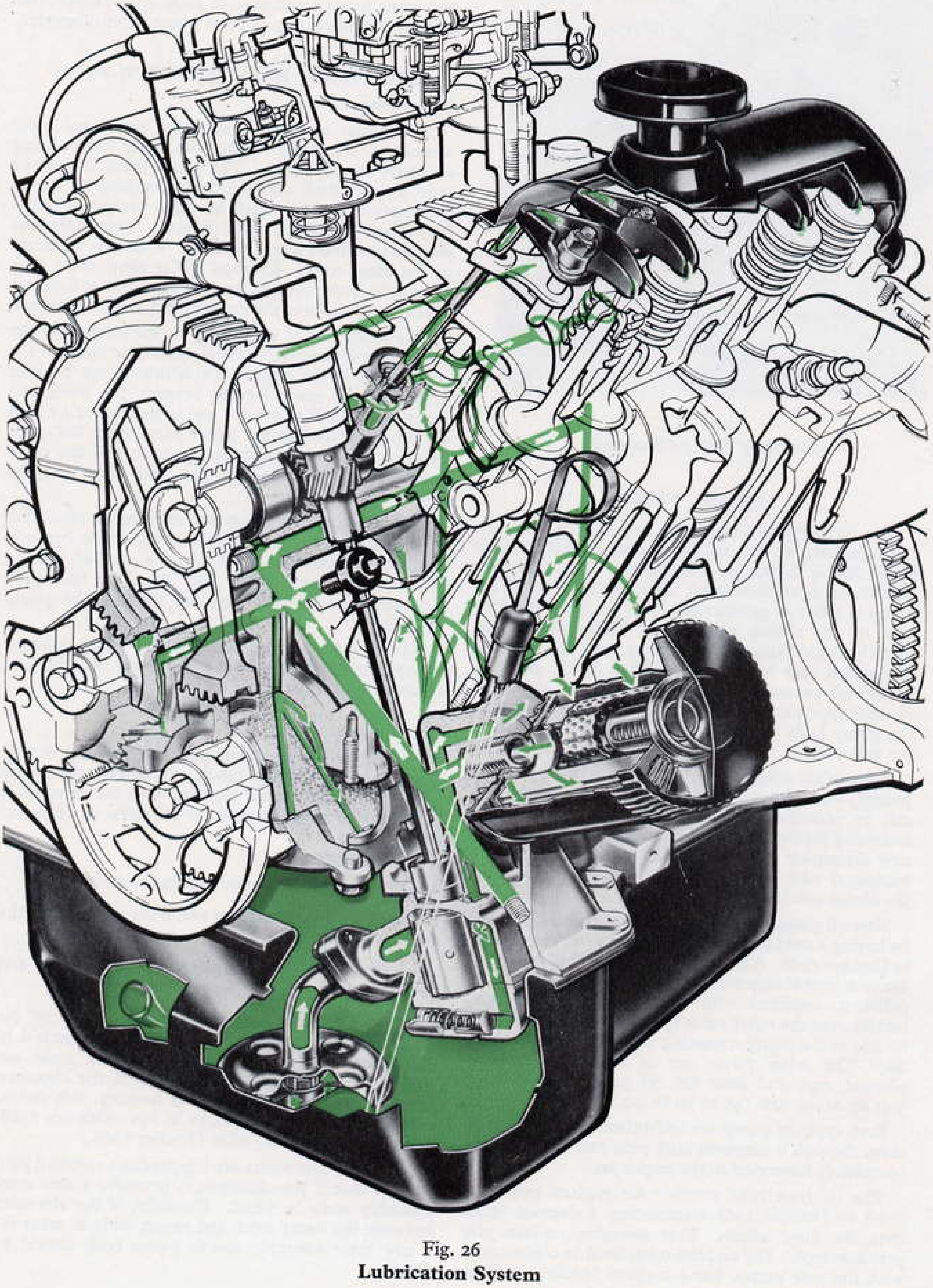


Fig. 26
Lubrication System

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.

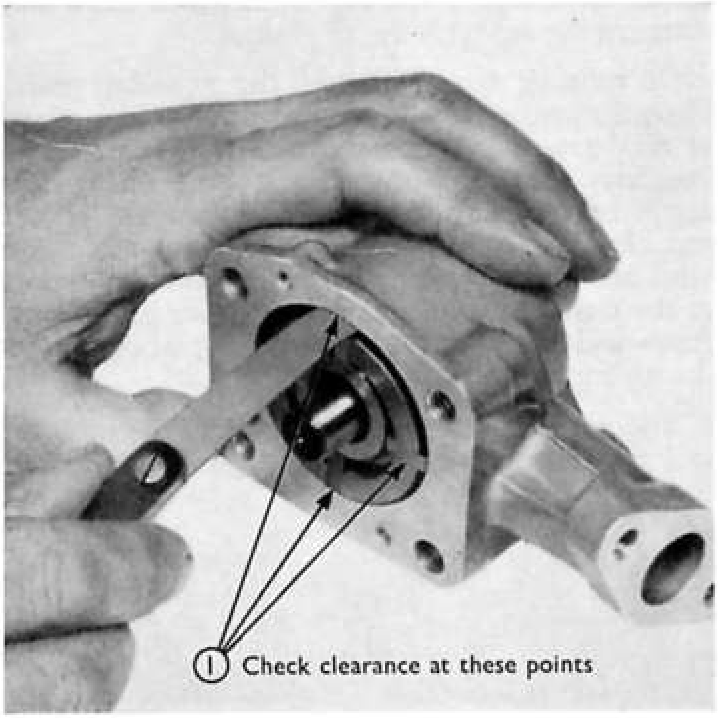


Fig. 27
Checking Vane and Rotor Clearance

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.

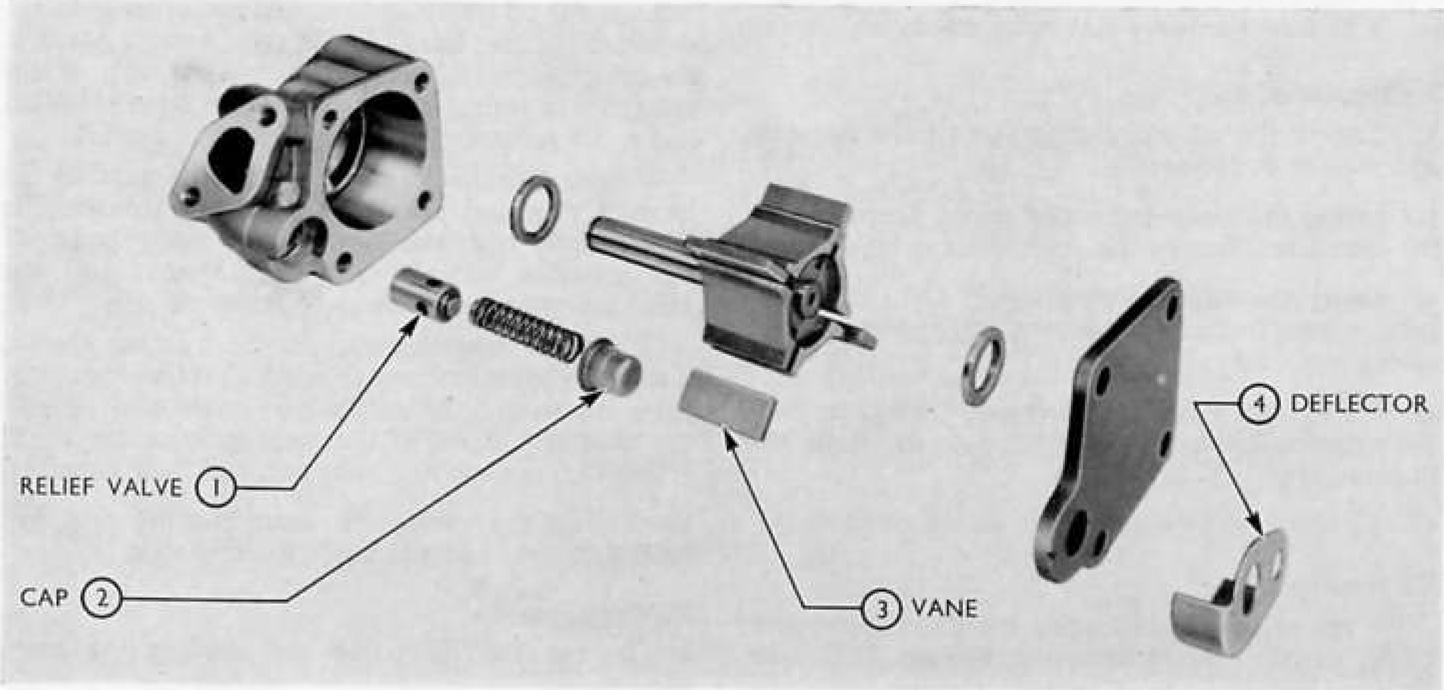


Fig. 28
Sliding Vane Oil Pump (Oct. 1968 onwards)

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

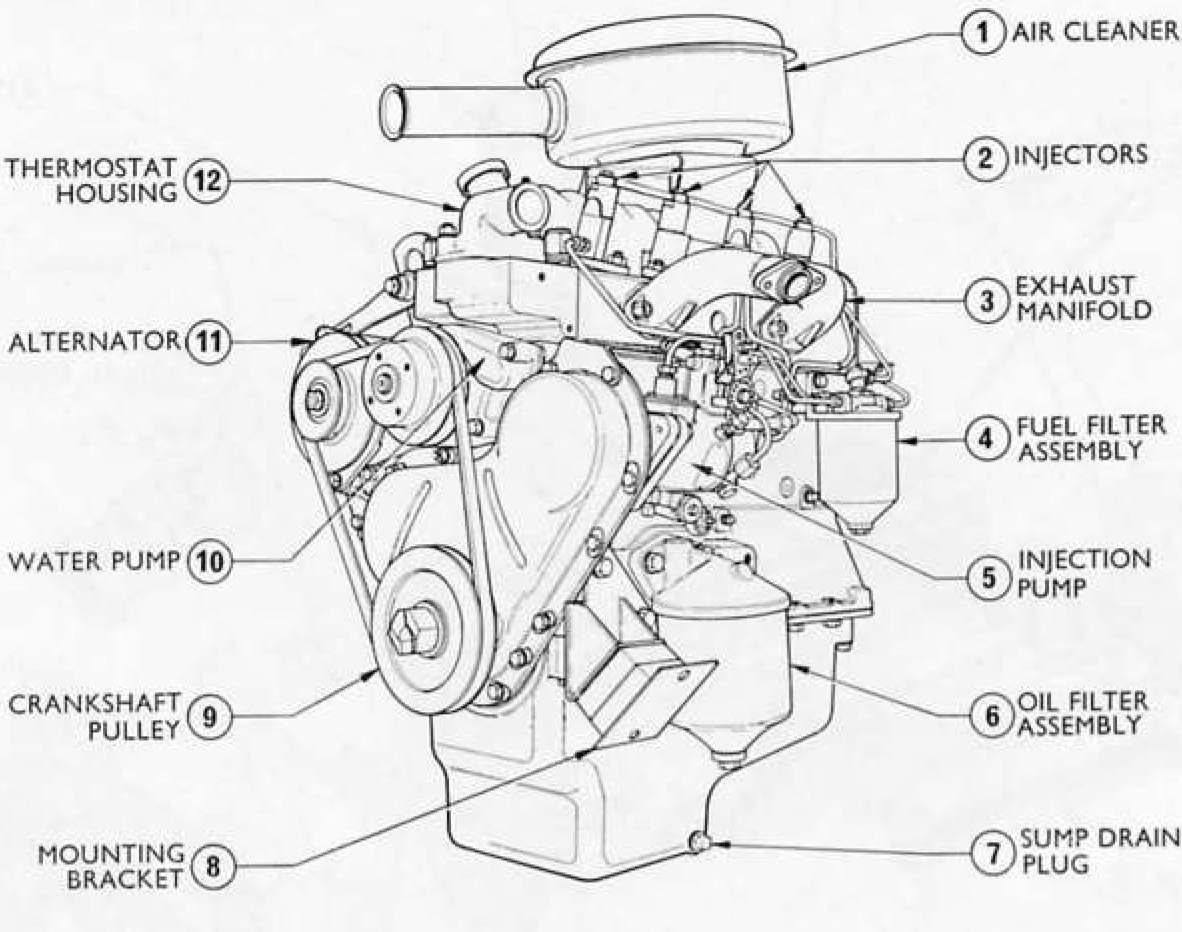


Fig. 30
Engine Assembly (4/108)

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.

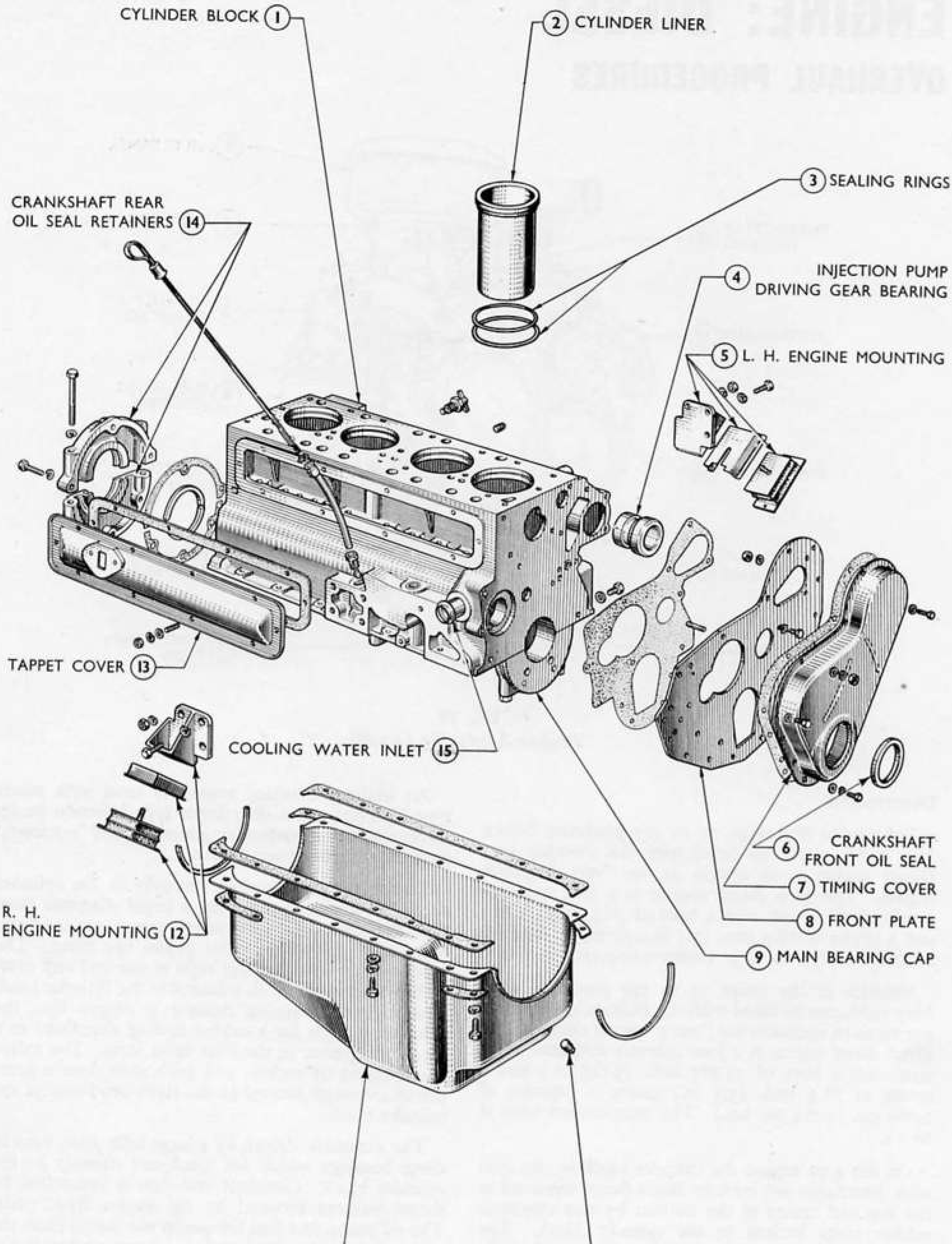


Fig. 31
Cylinder Block and Crankshaft Seals (4/99)

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.**

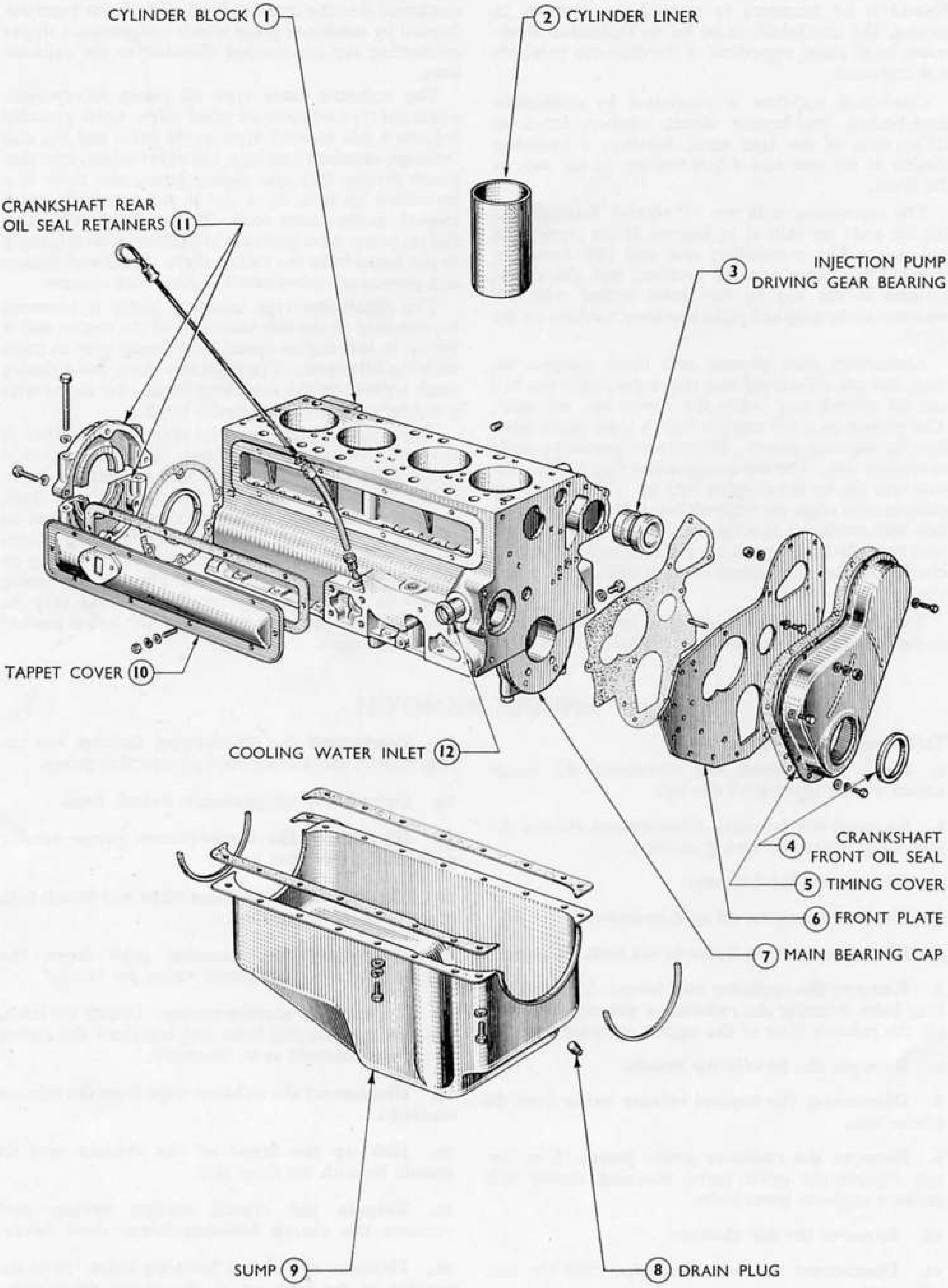


Fig. 32
Cylinder Block, Sump and Front Cover (4/108)

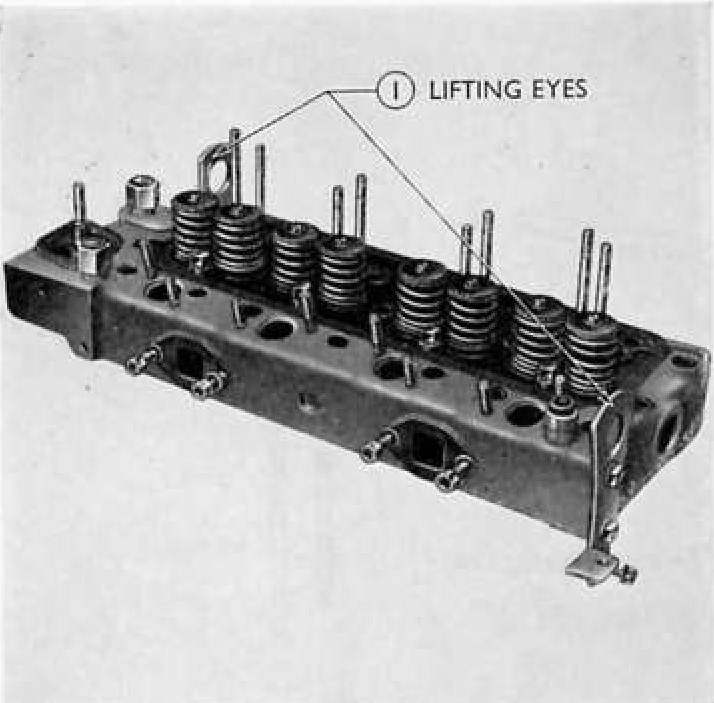


Fig. 33
Engine Lifting Eyes

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.

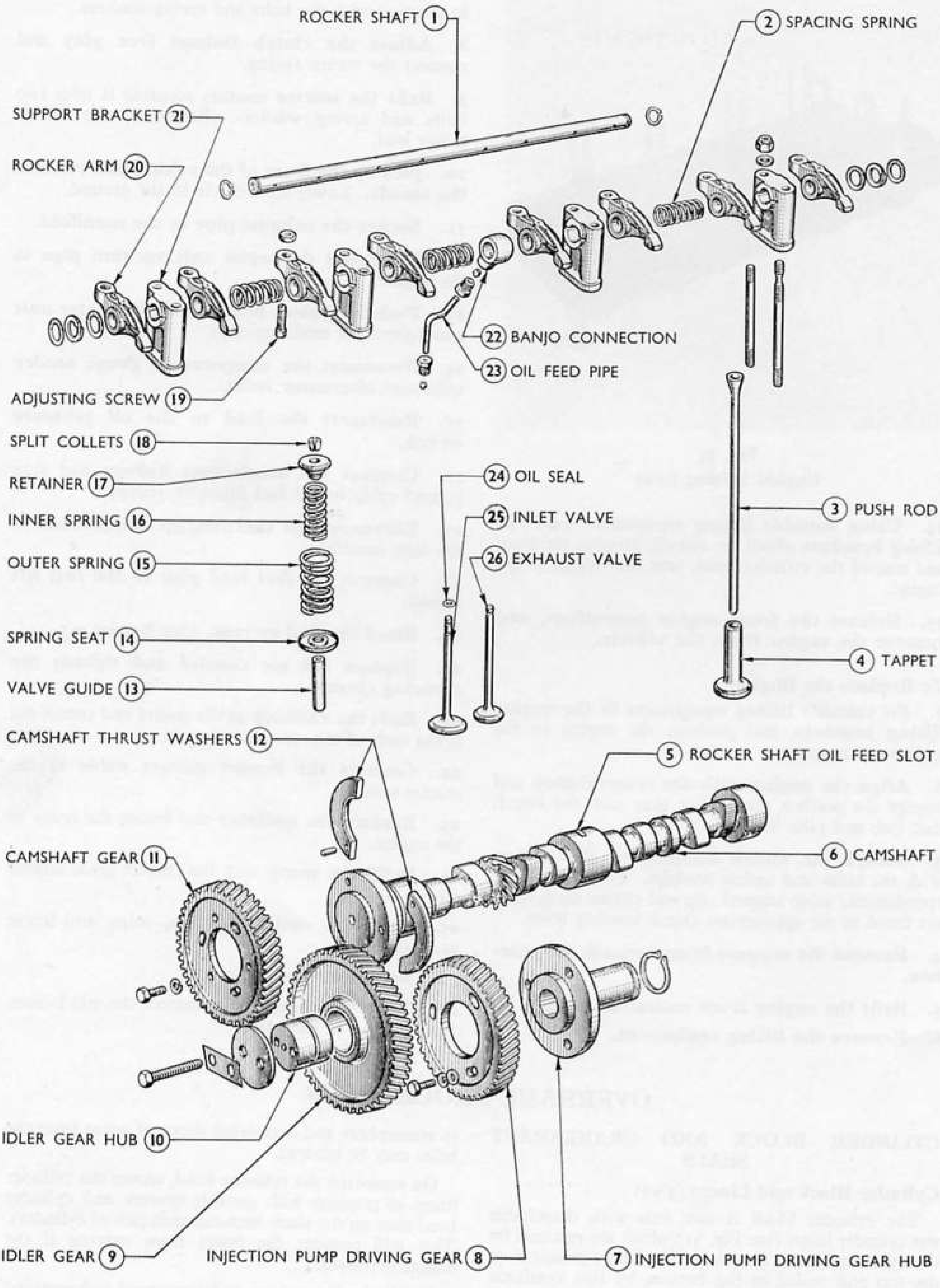


Fig. 34
Valves and Operating Mechanism

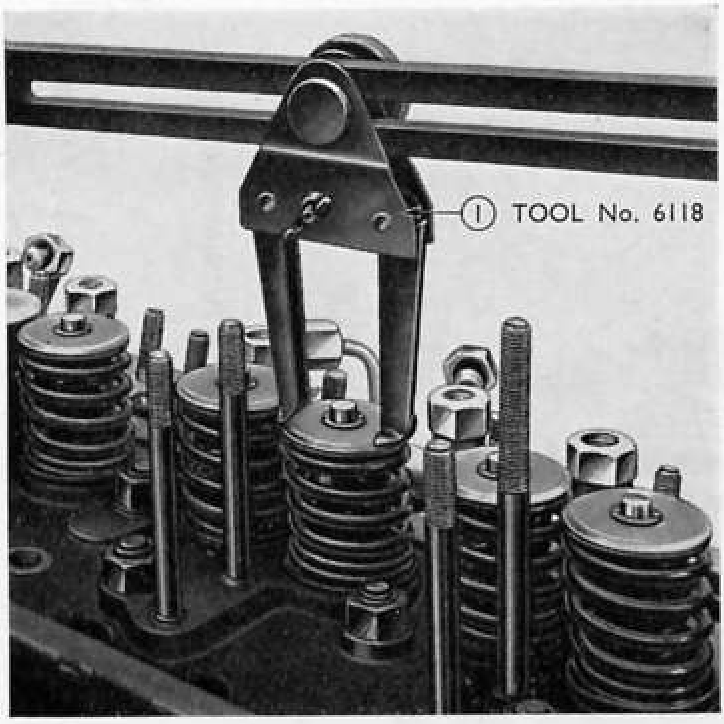


Fig. 35
Valve Spring Compressor

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.

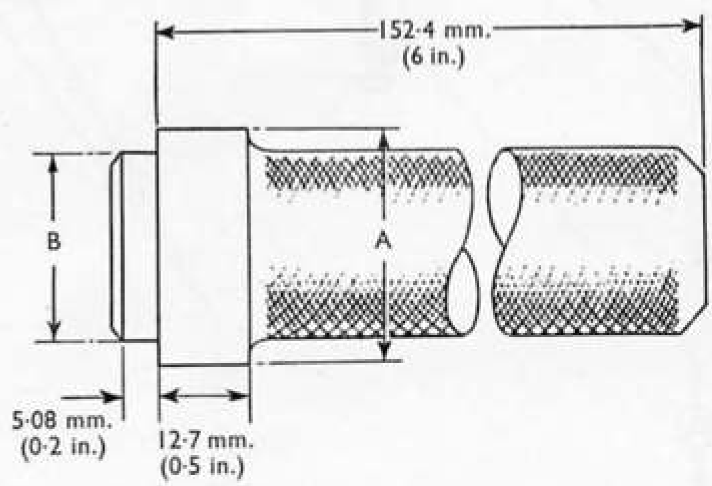
Each valve has two springs which are located on the cylinder head by pressed steel spring seats. The springs are attached to the valves by a spring retainer and split collets. The inlet valve spring retainer is deeper than the exhaust to accommodate a rubber sealing ring fitted in a groove machined in 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

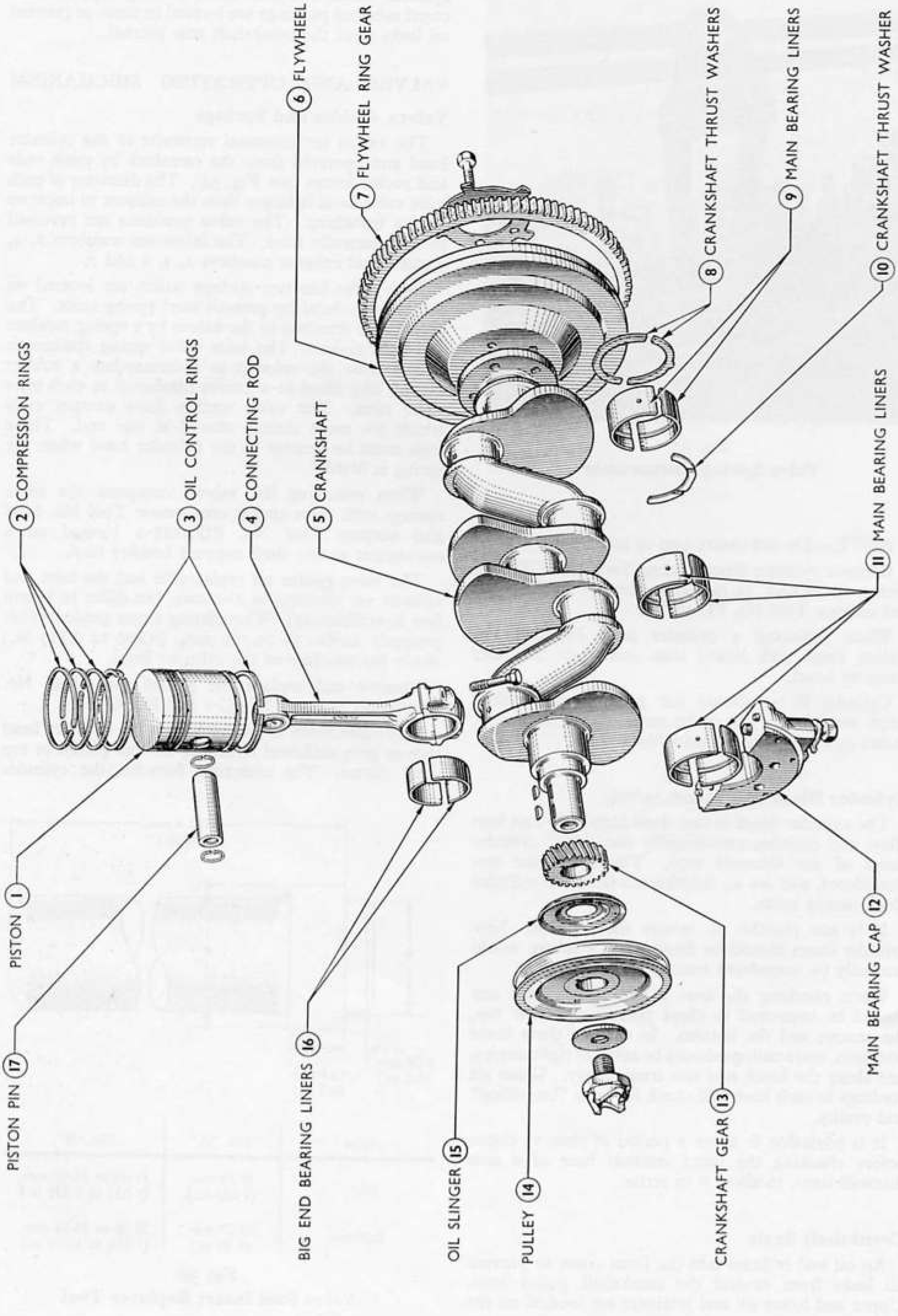


Fig. 37
Crankshaft, Connecting Rod, Piston and Flywheel (4/99)

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

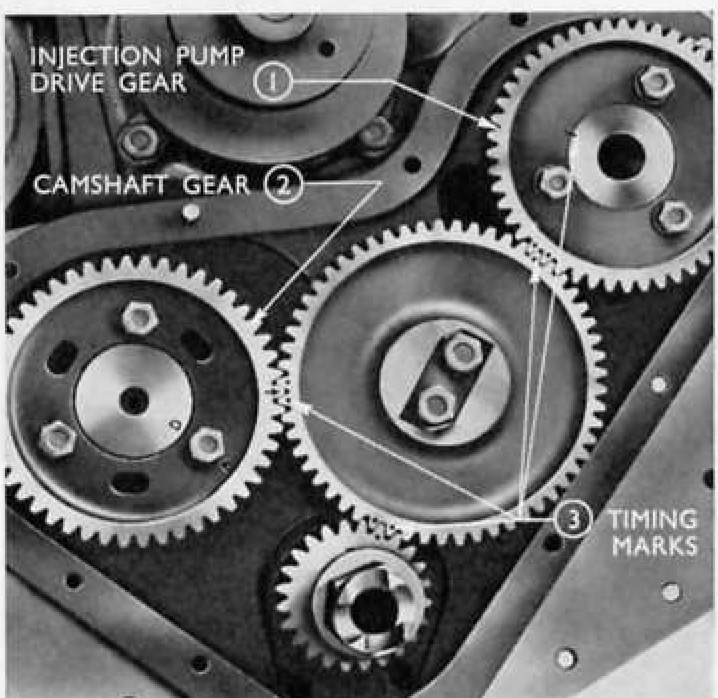


Fig. 39
Timing Gears

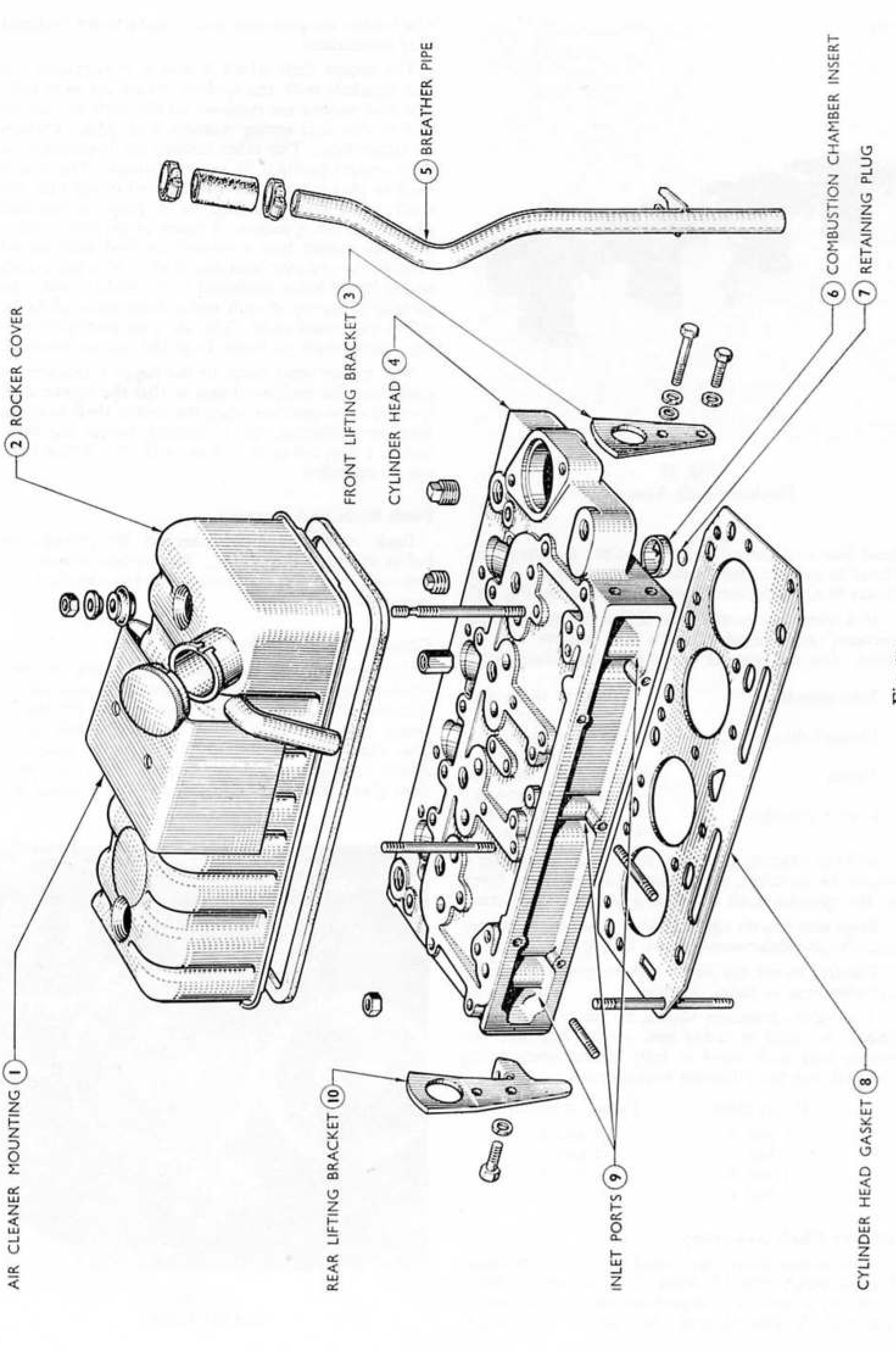


Fig. 40
Cylinder Head and Rocker Cover

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:—

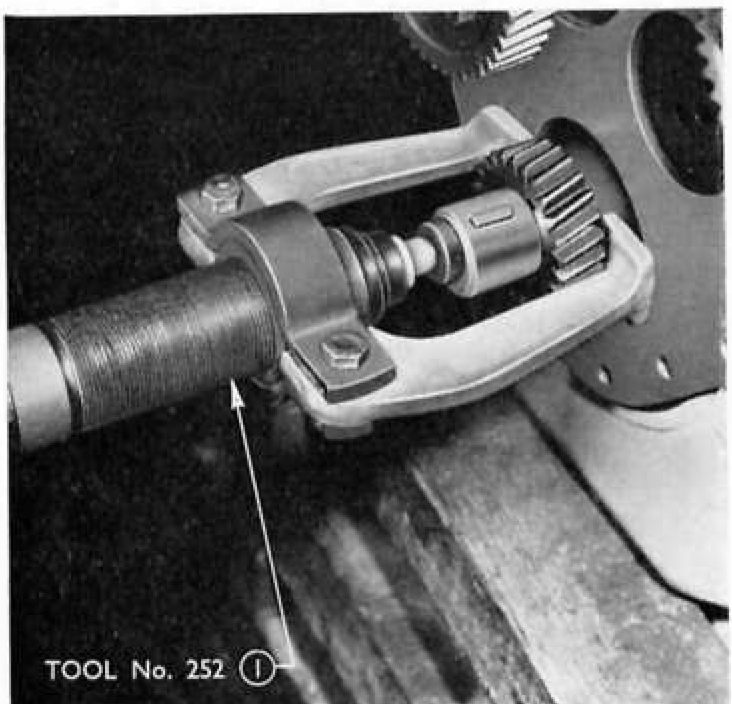


Fig. 41
Removing Crankshaft Gear

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.

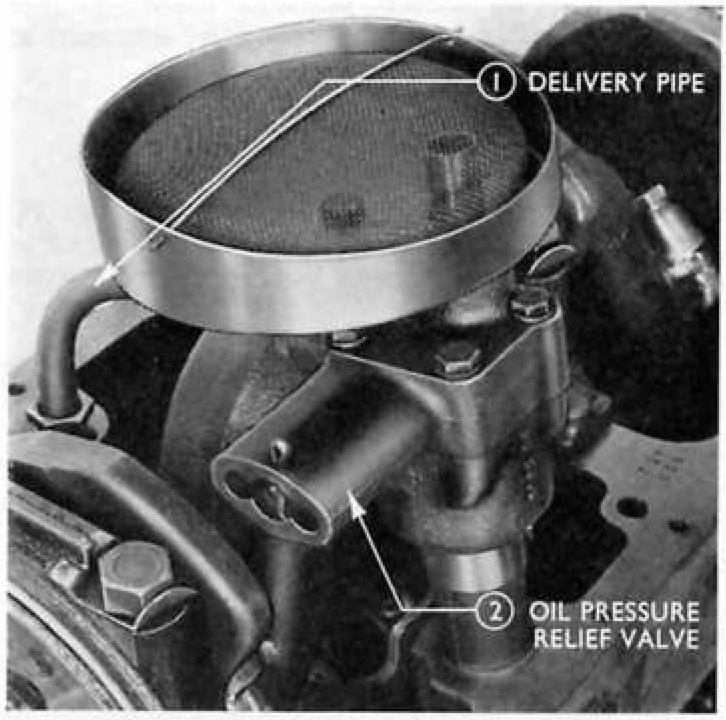


Fig. 44
Oil Pump

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

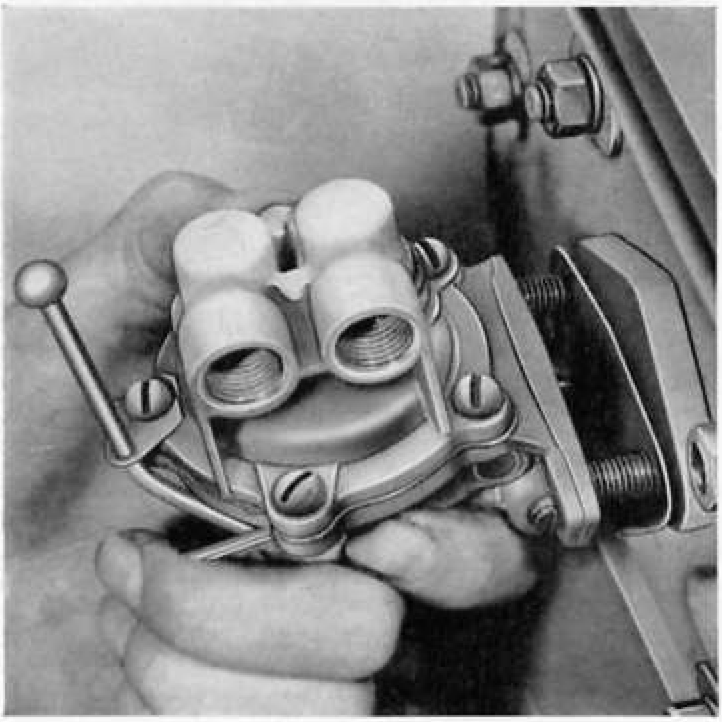


Fig. 45
Fuel Lift Pump

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.

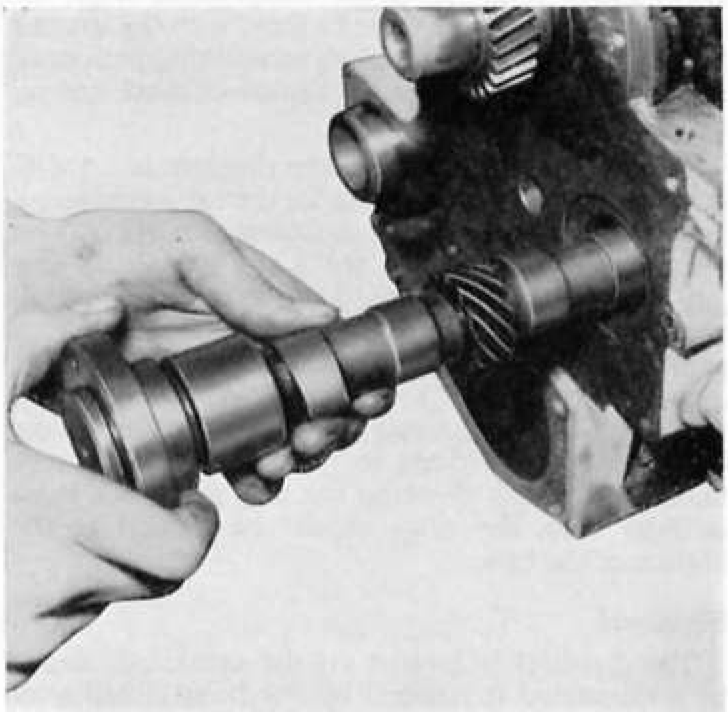


Fig. 46
Removing the Camshaft

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.

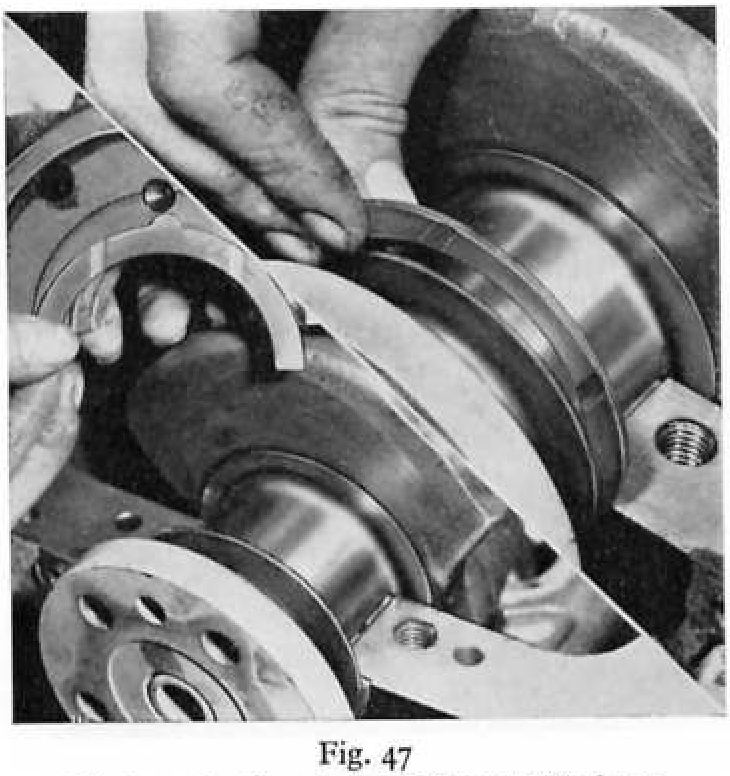


Fig. 47
Fitting the Crankshaft Thrust Washers

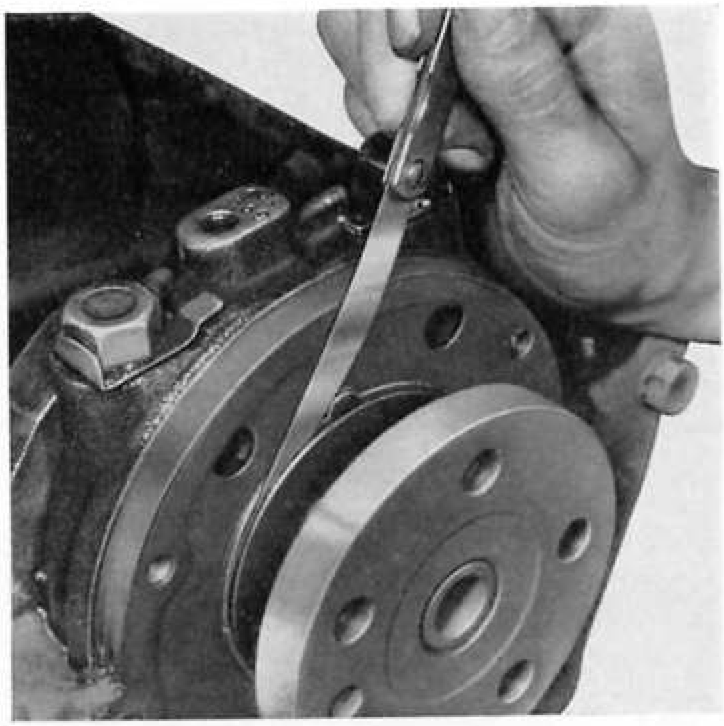


Fig. 48
Checking Crankshaft End-float

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.

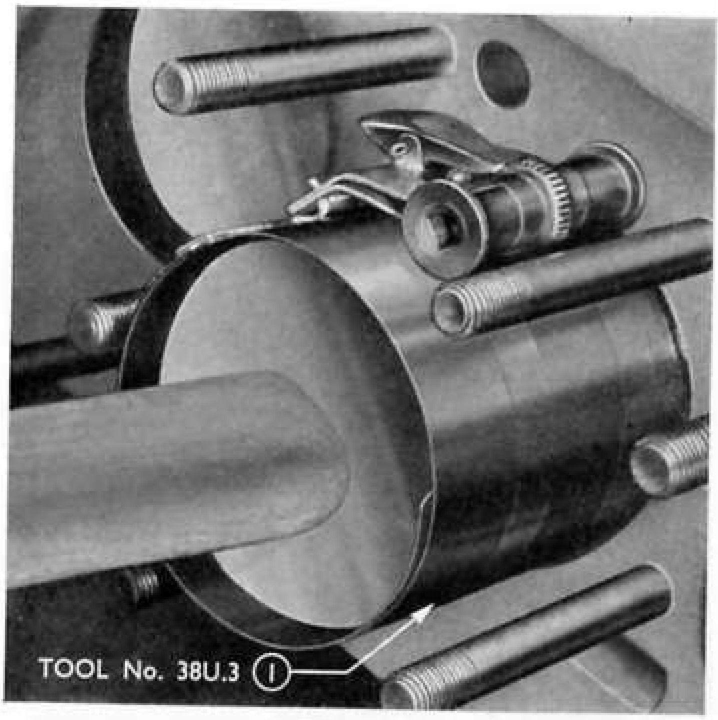


Fig. 49
Piston Replacement

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.

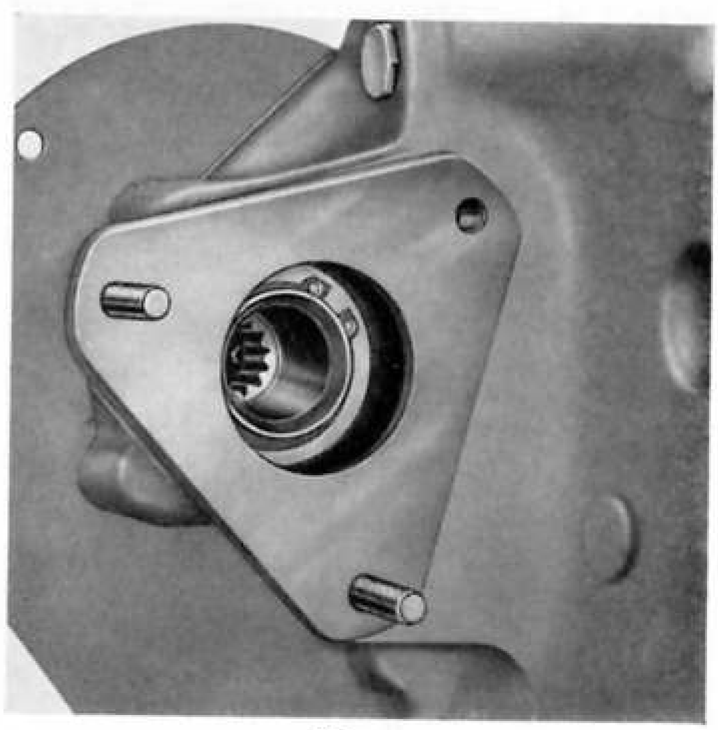


Fig. 50
Injection Pump Drive Hub

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.

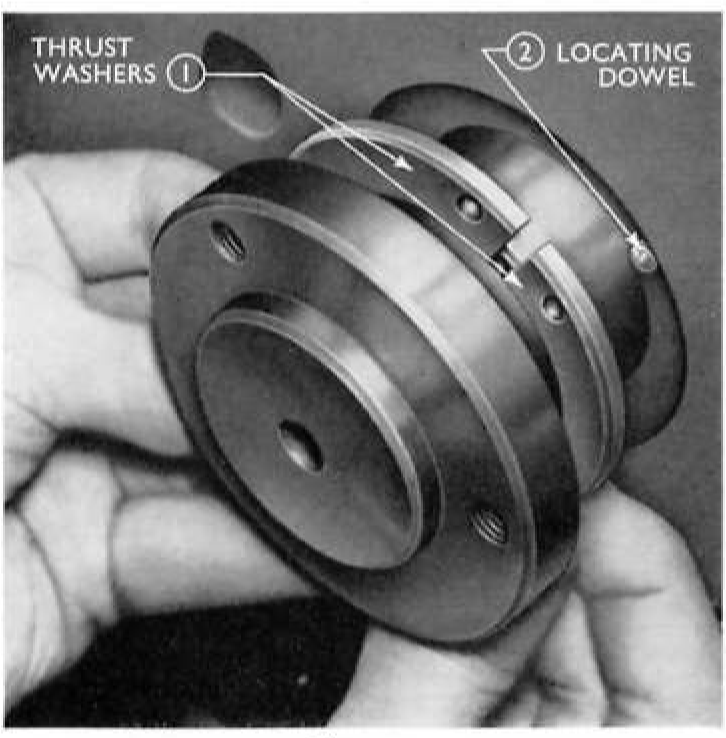


Fig. 51
Camshaft Thrust Washers

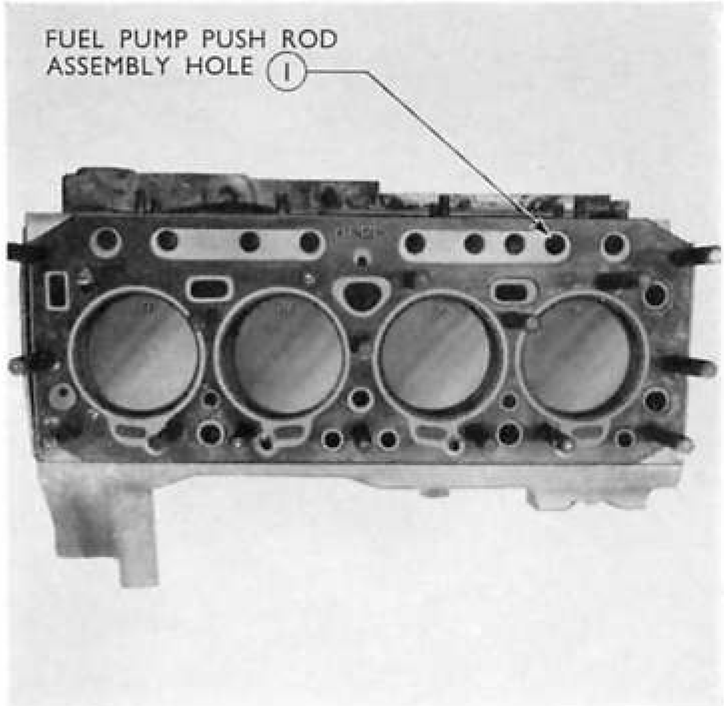


Fig. 52
Cylinder Head Gasket 4/108

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.

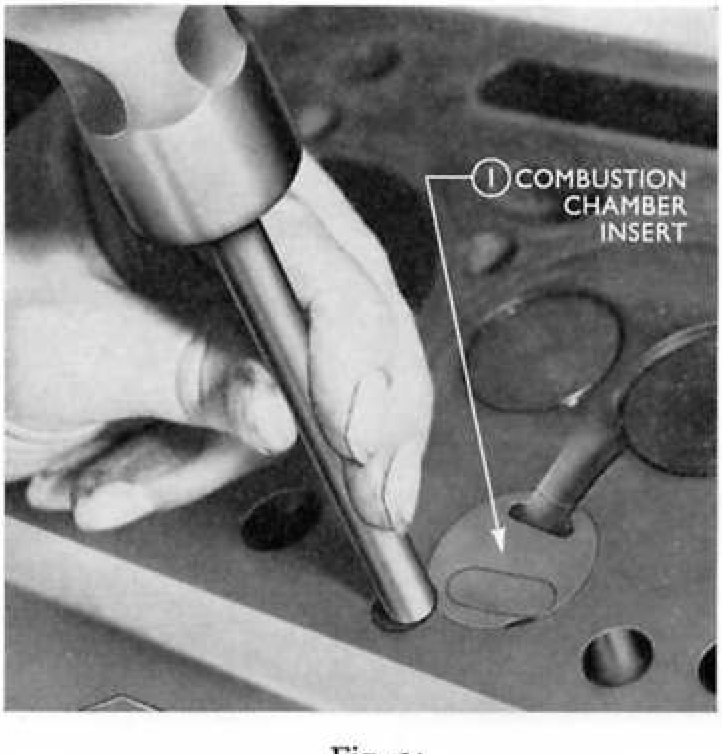


Fig. 54
Fitting the Expansion Washer

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.

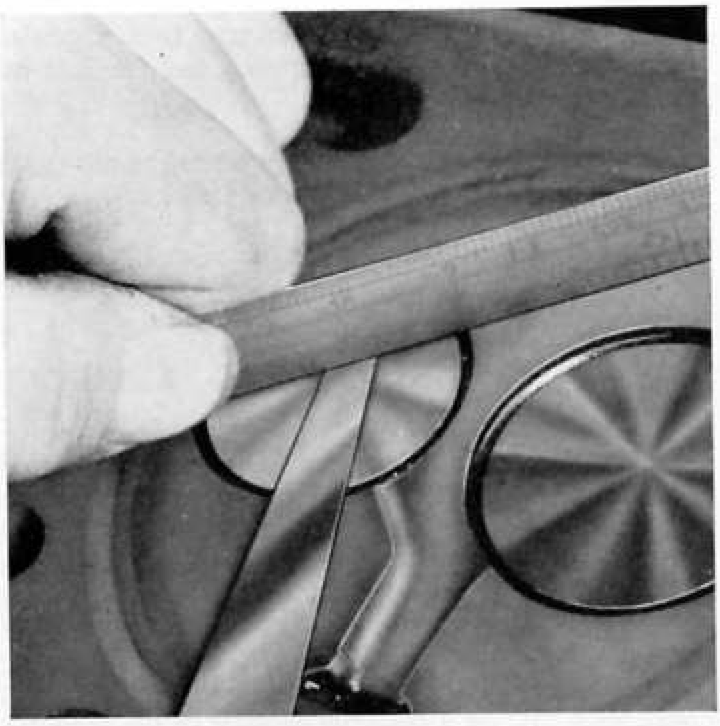


Fig. 55
Checking Valve to Cylinder Head Clearance

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.

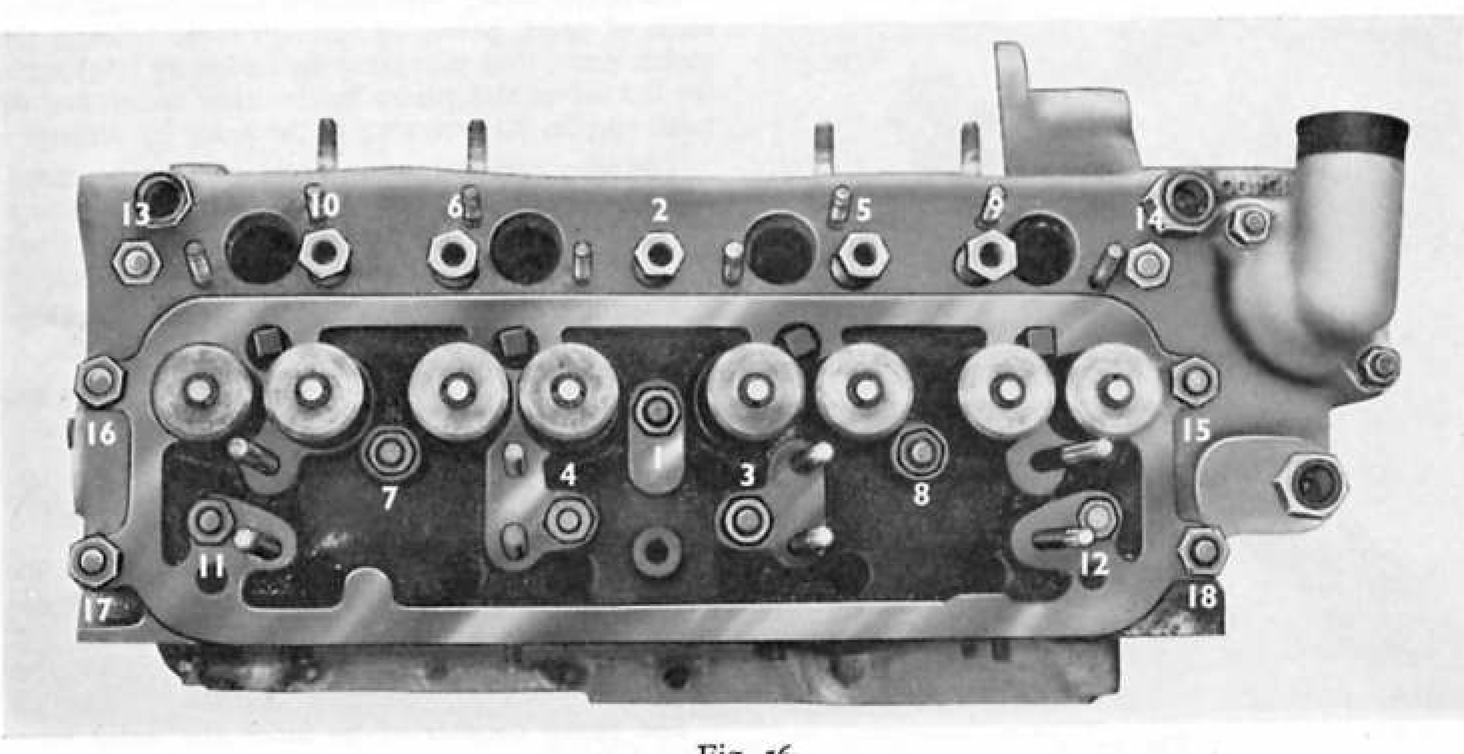


Fig. 56
Cylinder Head Bolt Tightening Sequence

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.

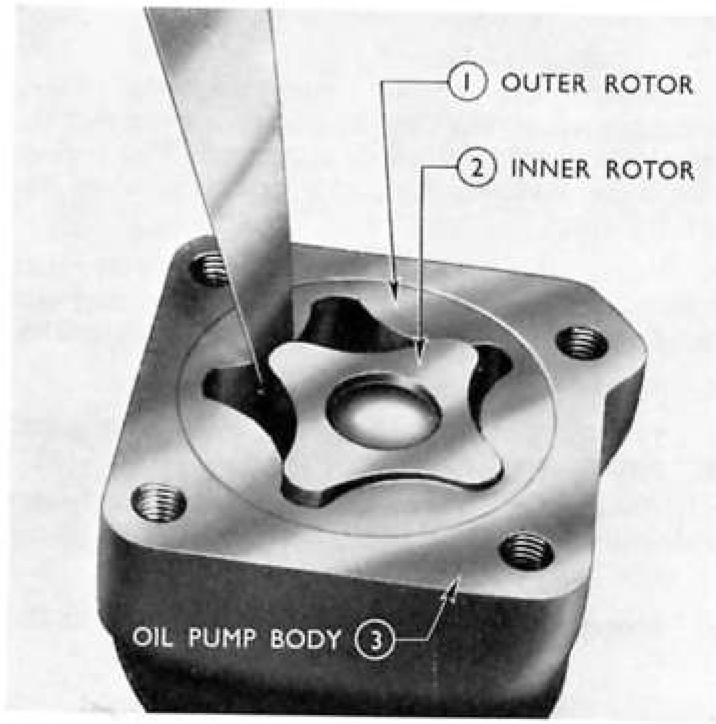


Fig. 58
Checking the Clearance Between the Inner and Outer Rotors

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.

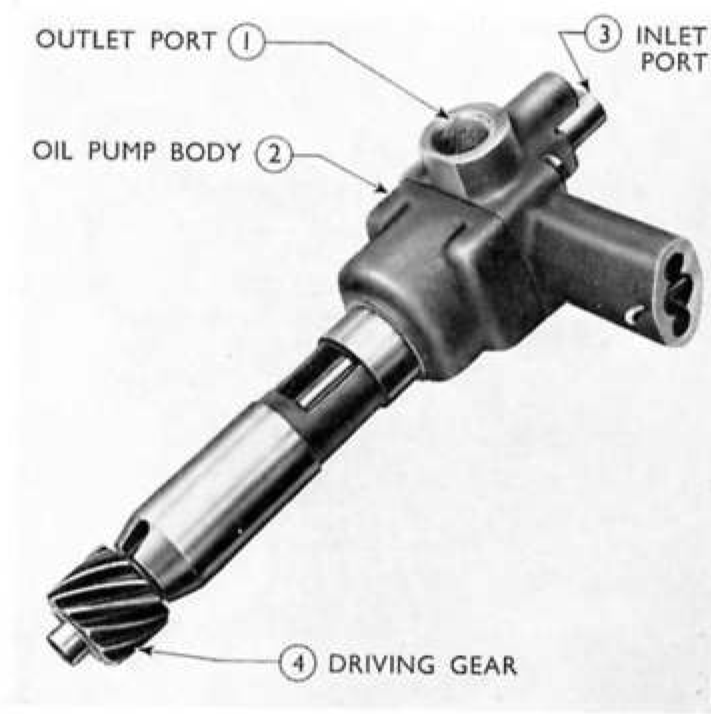


Fig. 57
Oil Pump

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

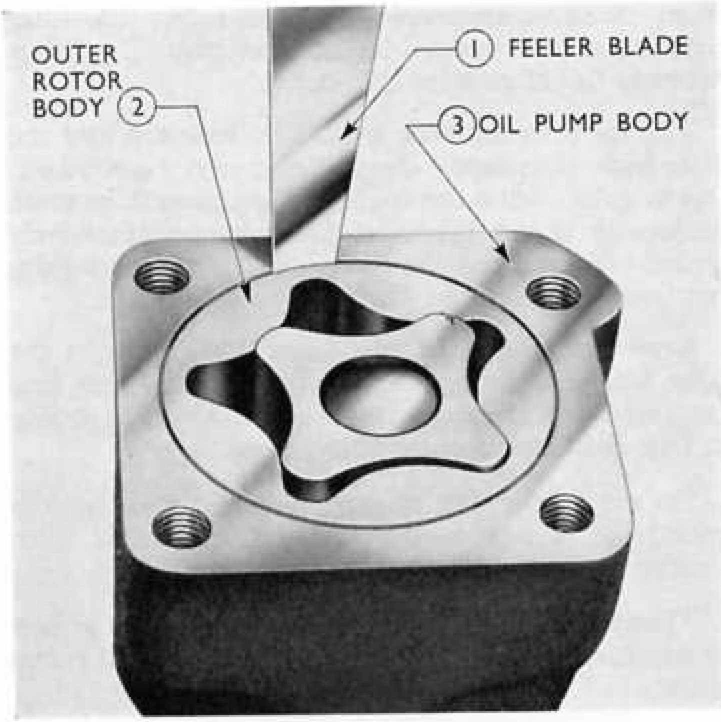


Fig. 59
Checking Outer Rotor to Pump Body Clearance

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.

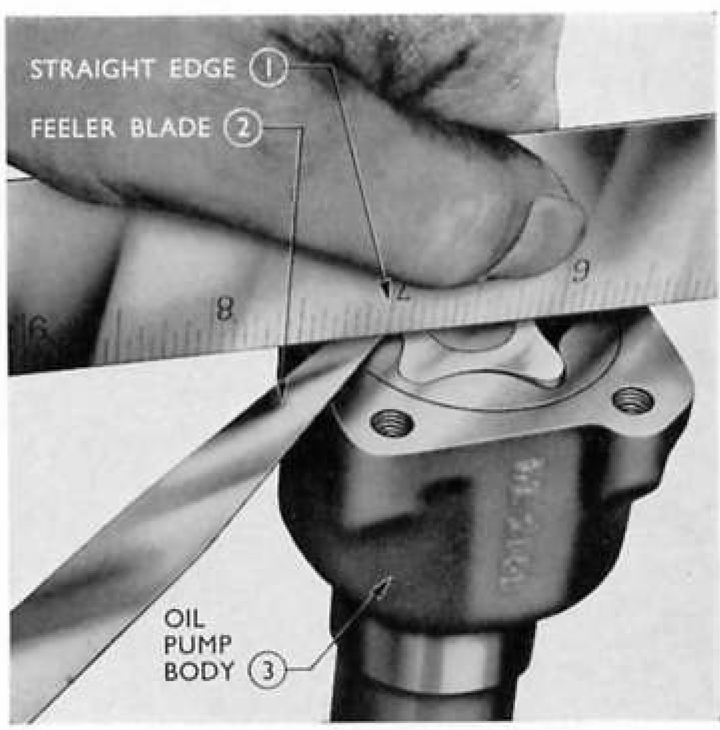


Fig. 60
Checking Rotor End Clearance

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

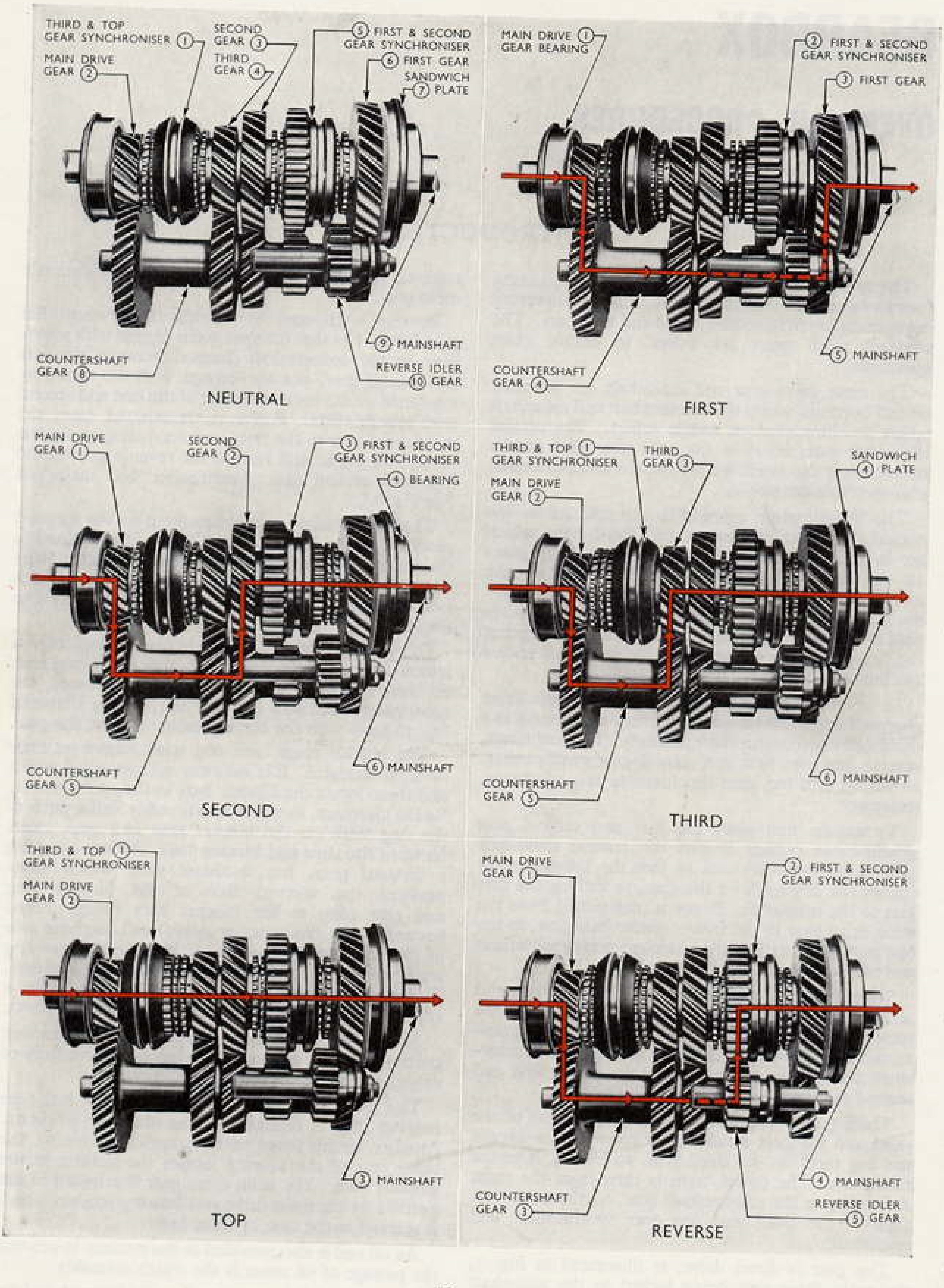


Fig. 1
Power Train Diagrams

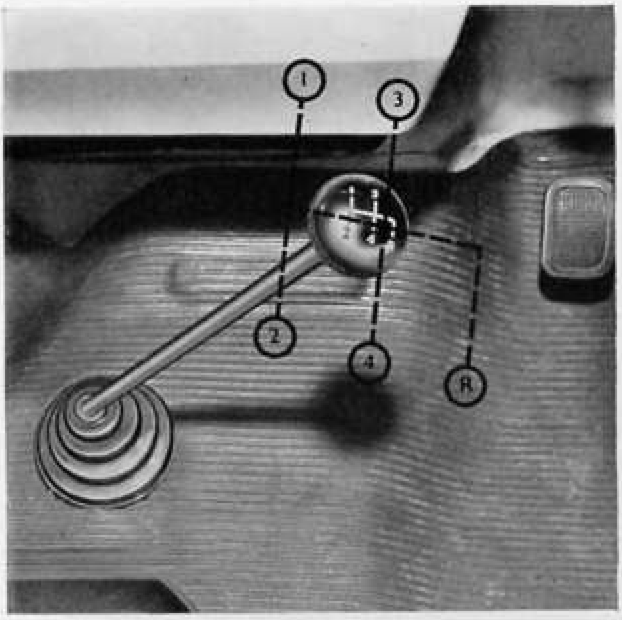


Fig. 2
Gear Lever Positions

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).

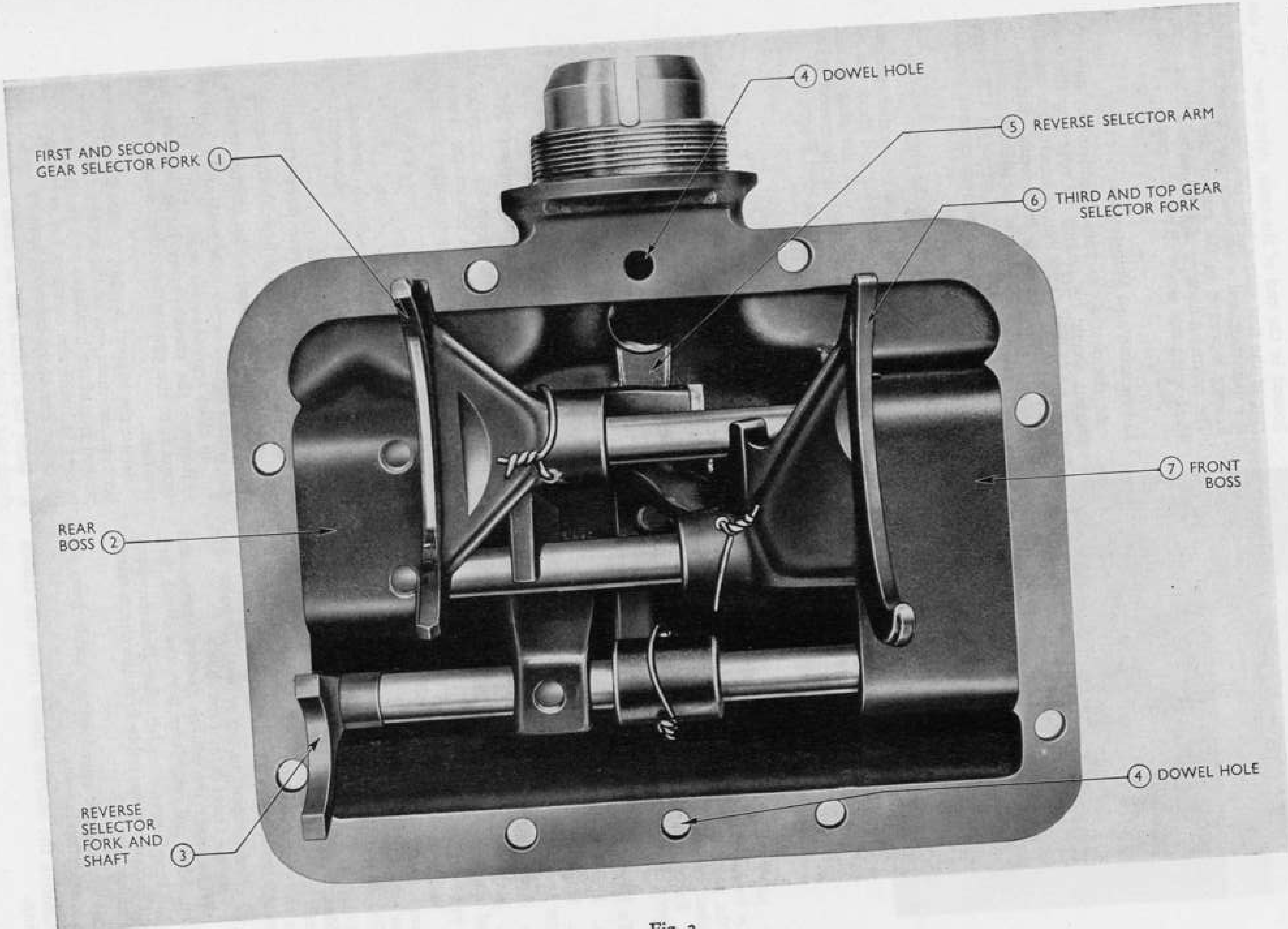


Fig. 3
Selector Housing (early casting)

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).

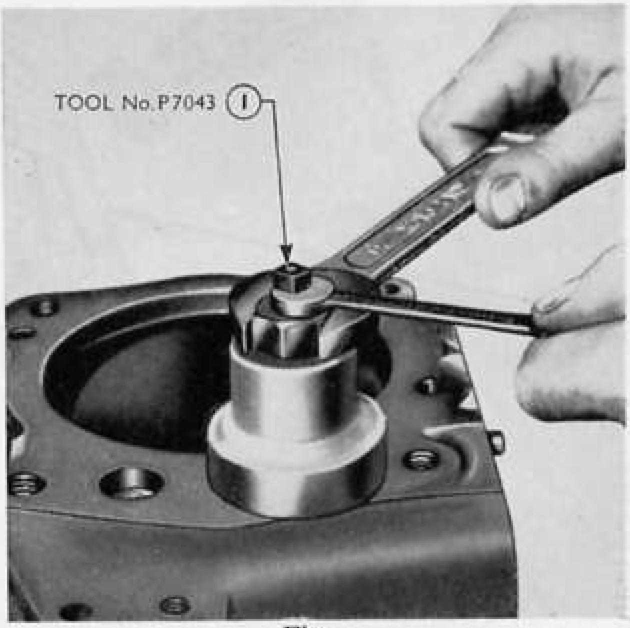


Fig. 4
Removing Reverse Idler Gear Shaft

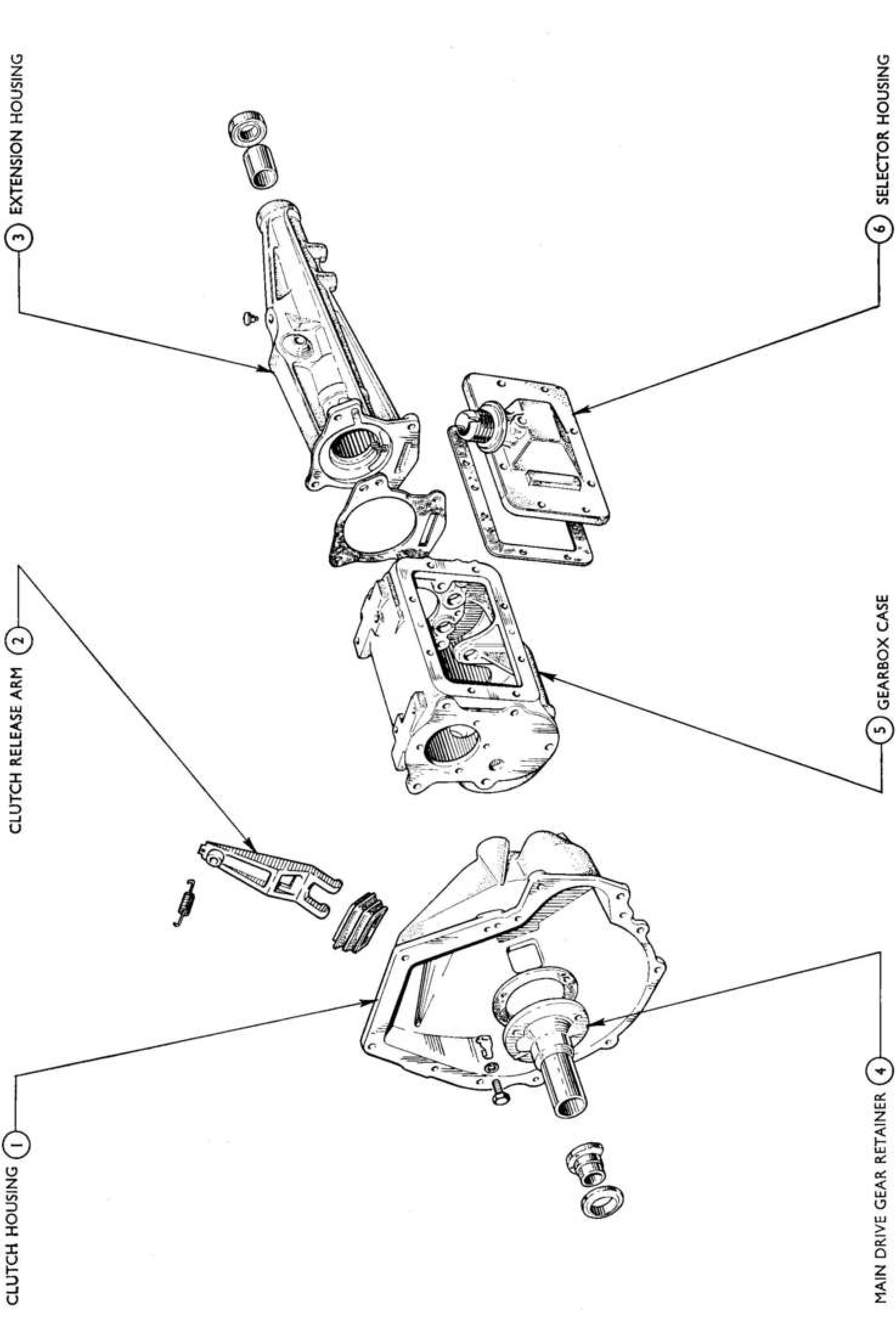


Fig. 5
Exploded View of Gearbox—External (Early type shown)

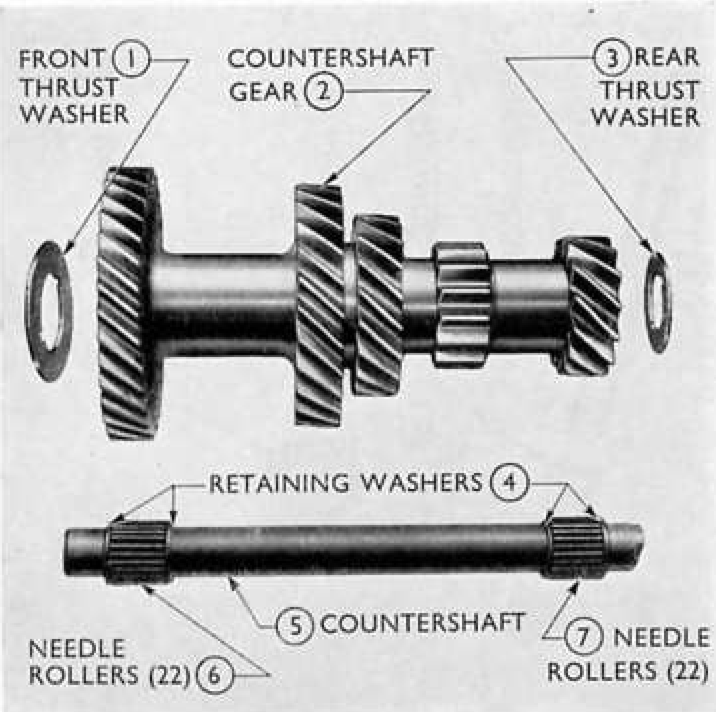


Fig. 6
Countershaft Assembly

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.

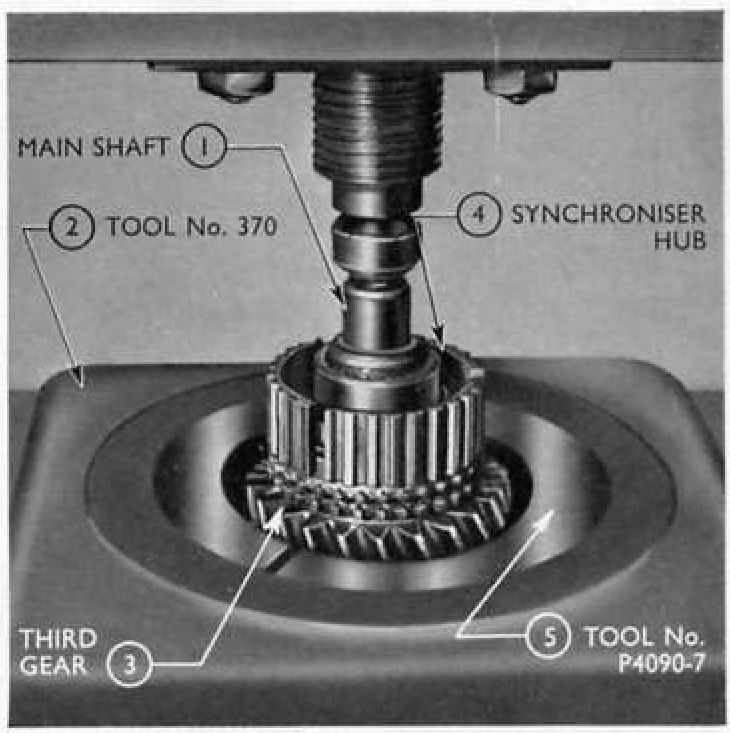


Fig. 7
Removing Third Gear

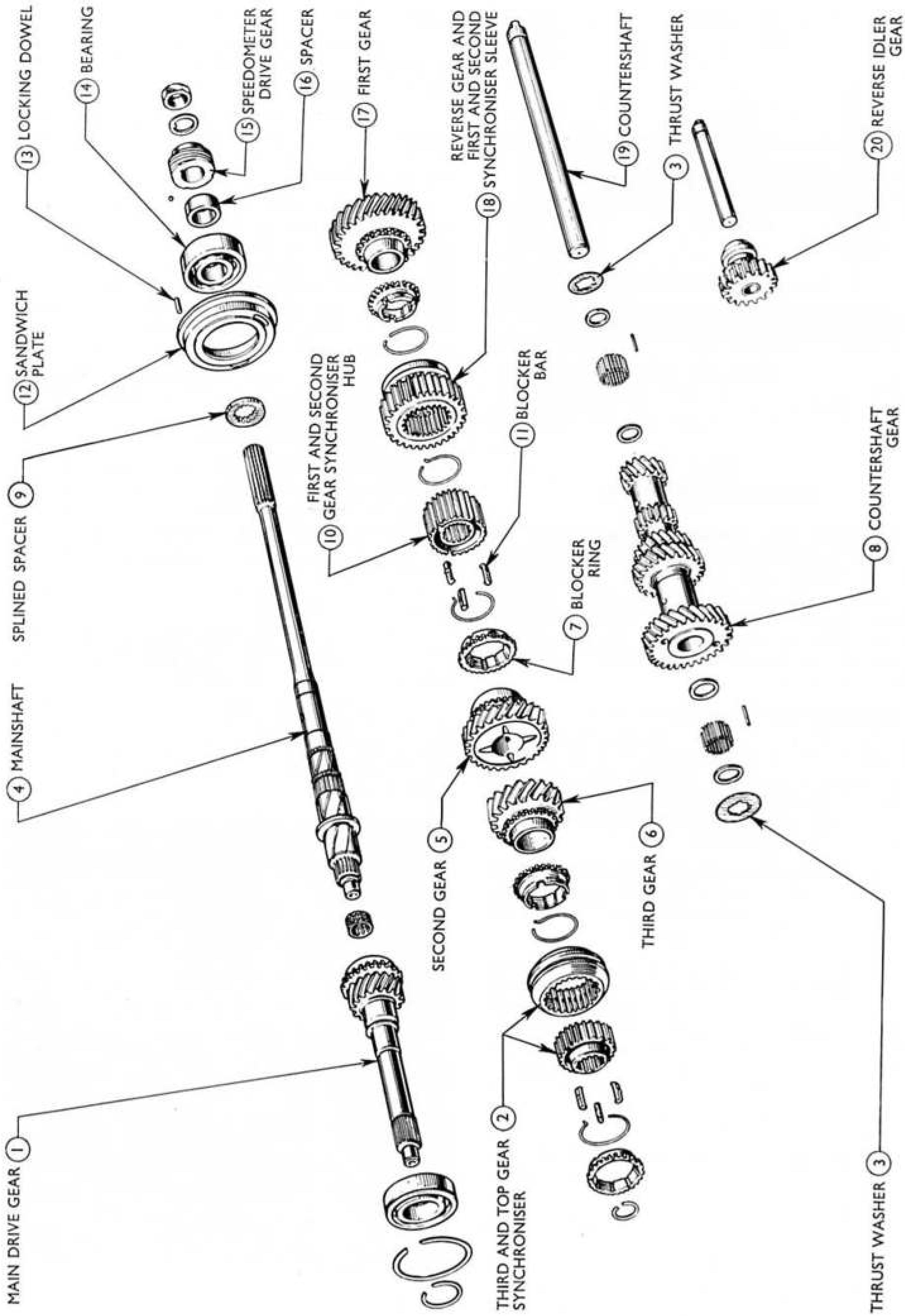


Fig. 8
Exploded View of Gearbox—Interior

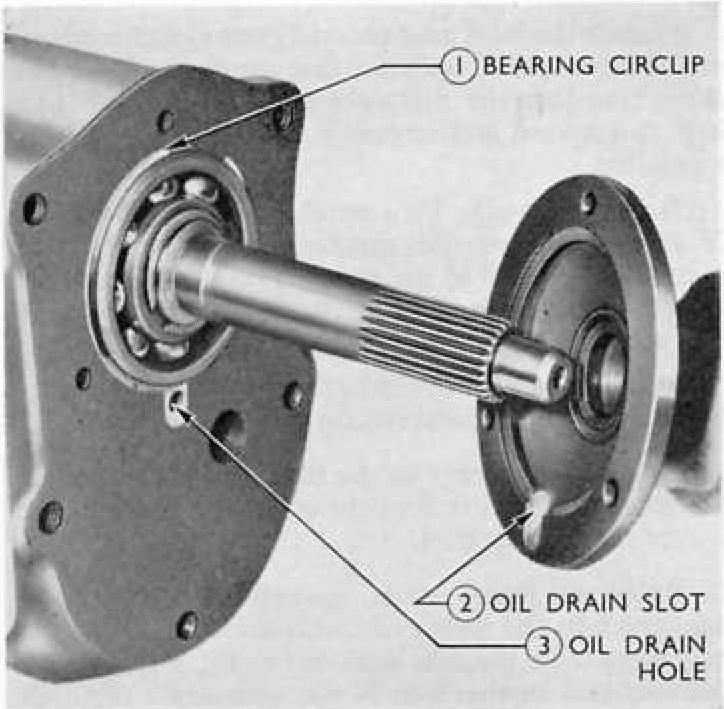


Fig. 9
Fitting the Main Drive Gear Retainer

(*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

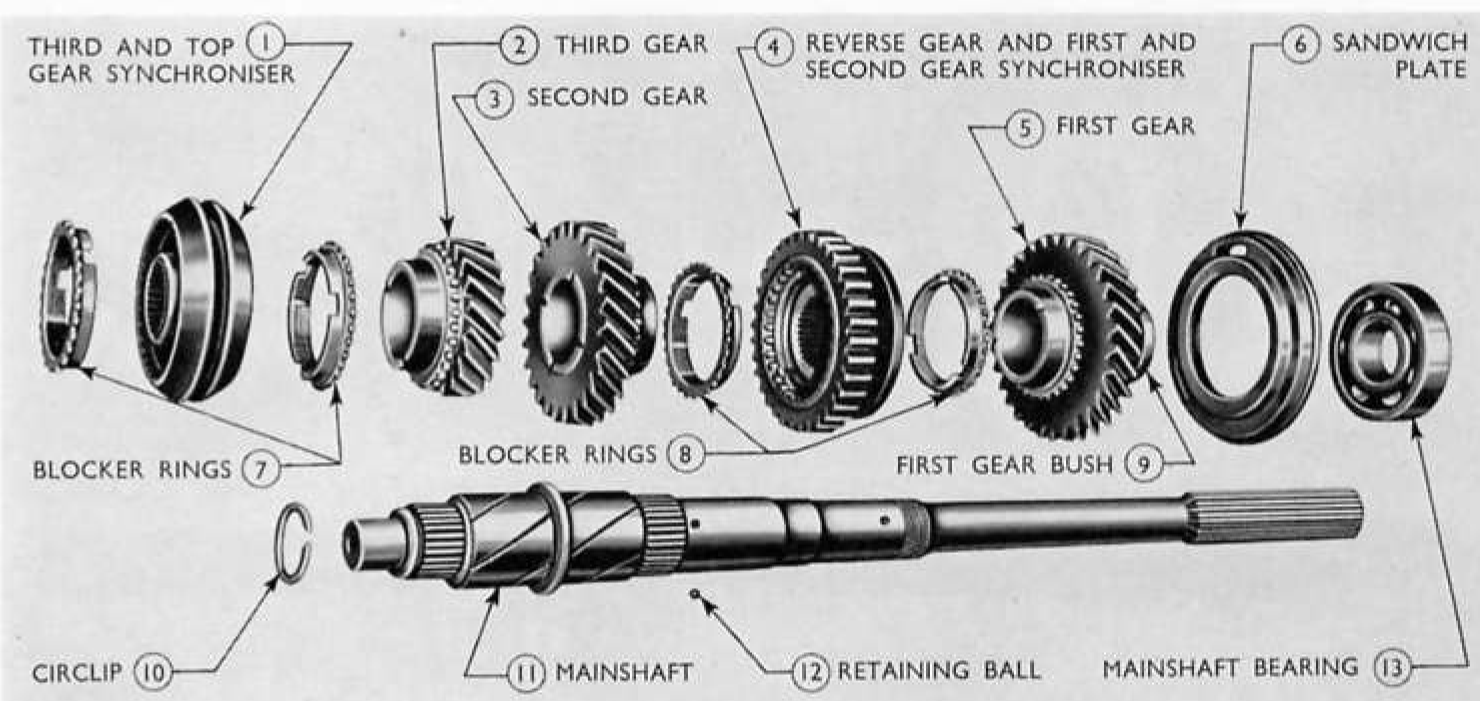


Fig. 10
Exploded View of Mainshaft Assembly (Prior to April 1966)

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.

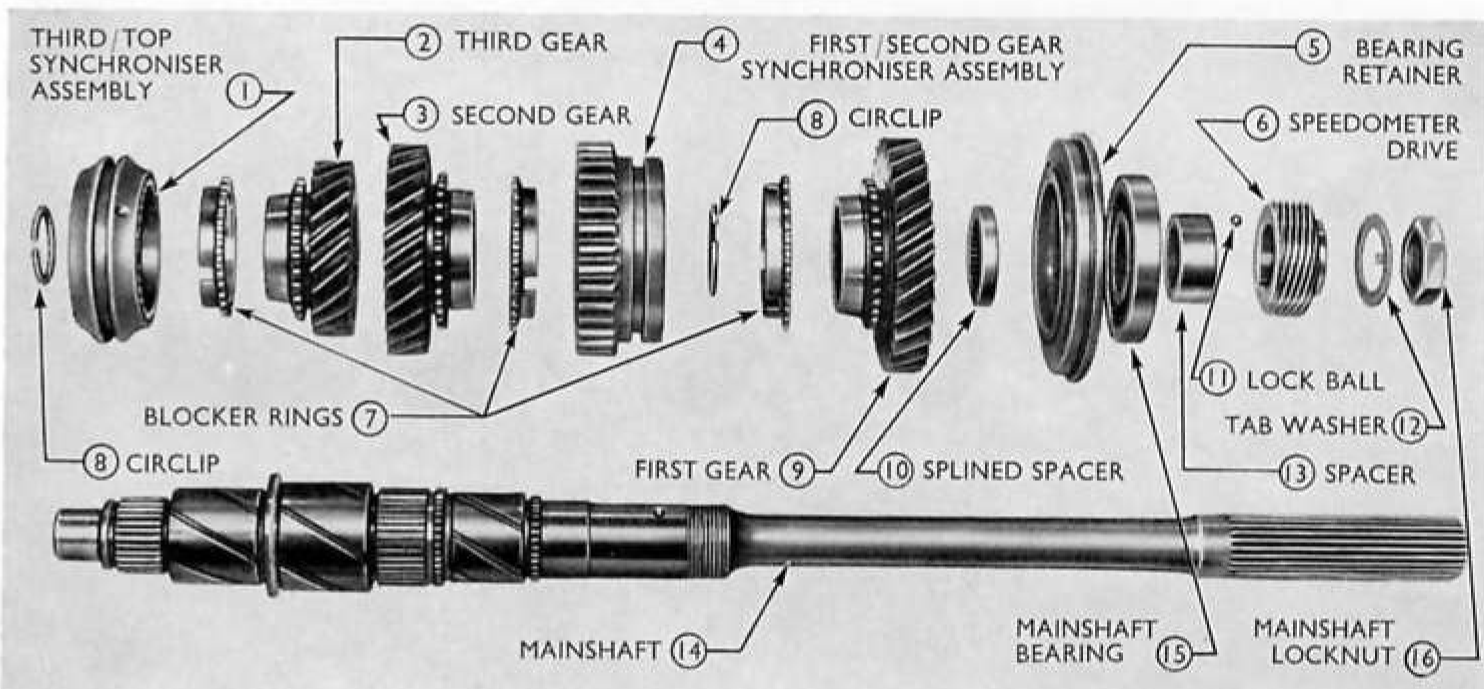


Fig. 11
Exploded View of Mainshaft Assembly (After April 1966)

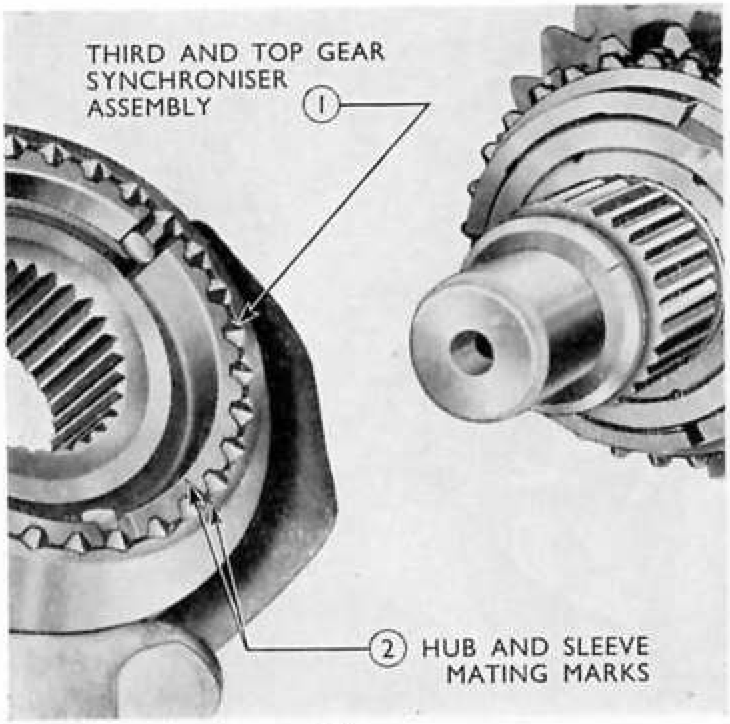


Fig. 12
Third and Top Gear Hub and Sleeve Mating Marks

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

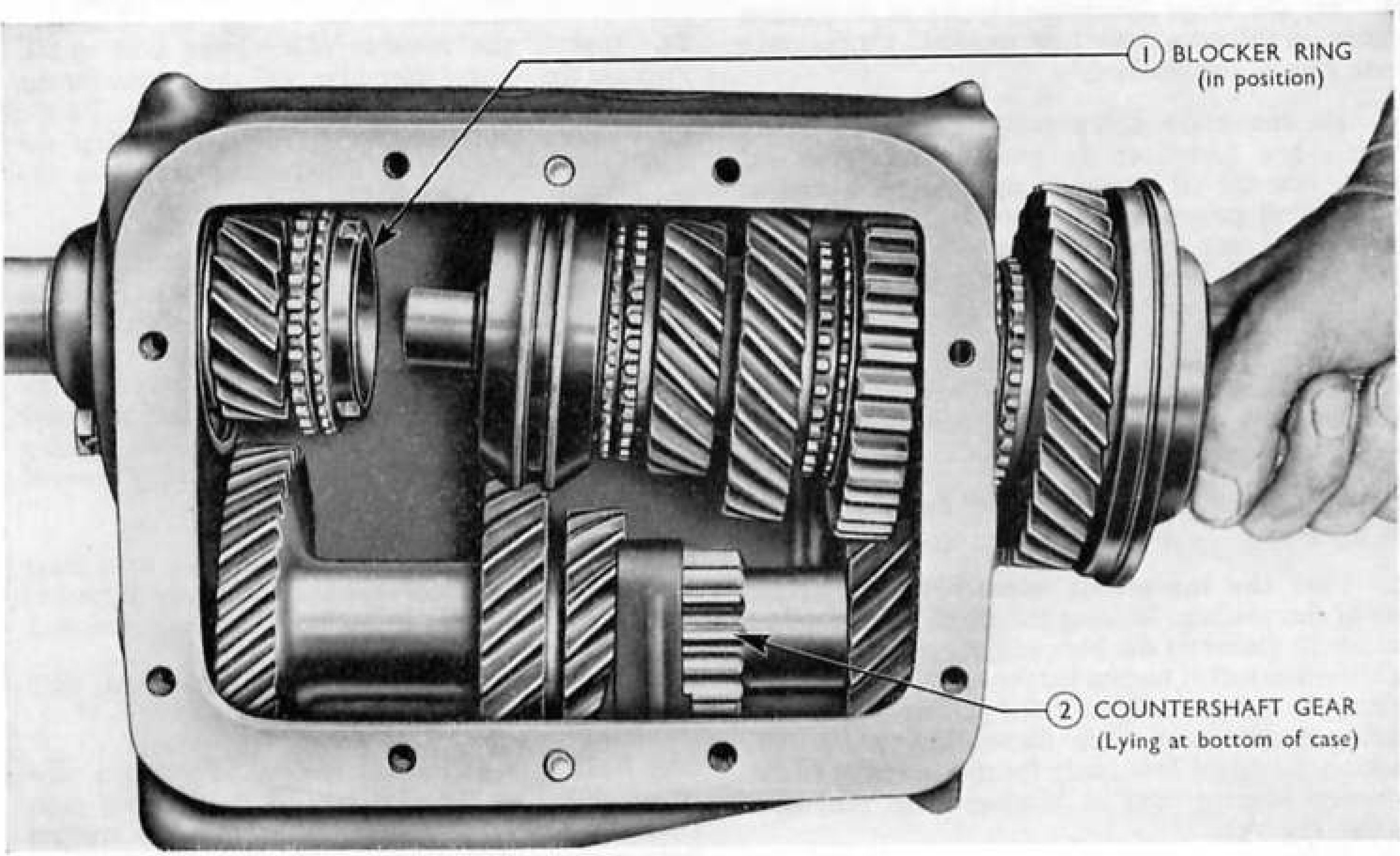


Fig. 13
Fitting the Mainshaft Assembly

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.

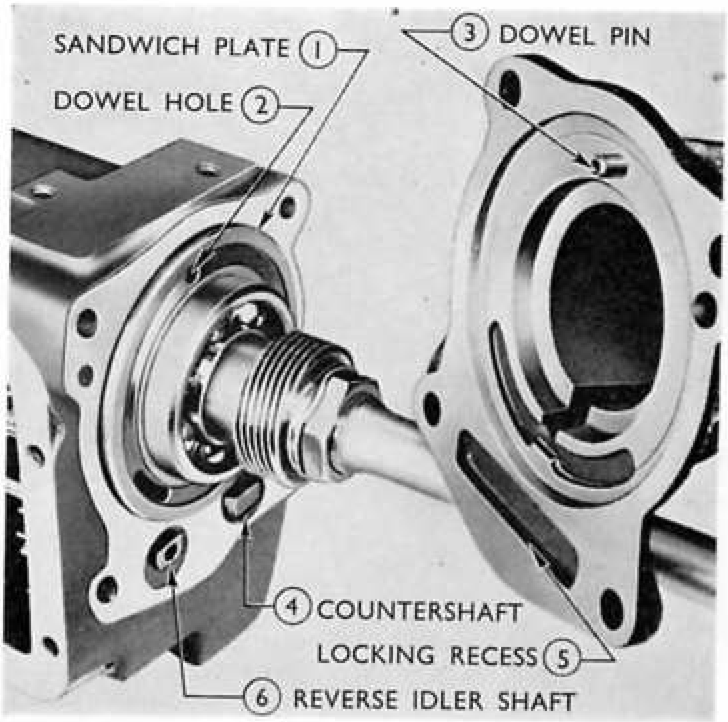


Fig. 14
Fitting the Extension Housing

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

Check clutch adjustment

- O.K.
- NOT O.K. — Adjust clutch

Check reinforcing plate is fitted under equaliser bar

- O.K.
- NOT O.K. — Fit reinforcing plate

Check that the linkage modifications detailed on page 35 have been carried out, if applicable

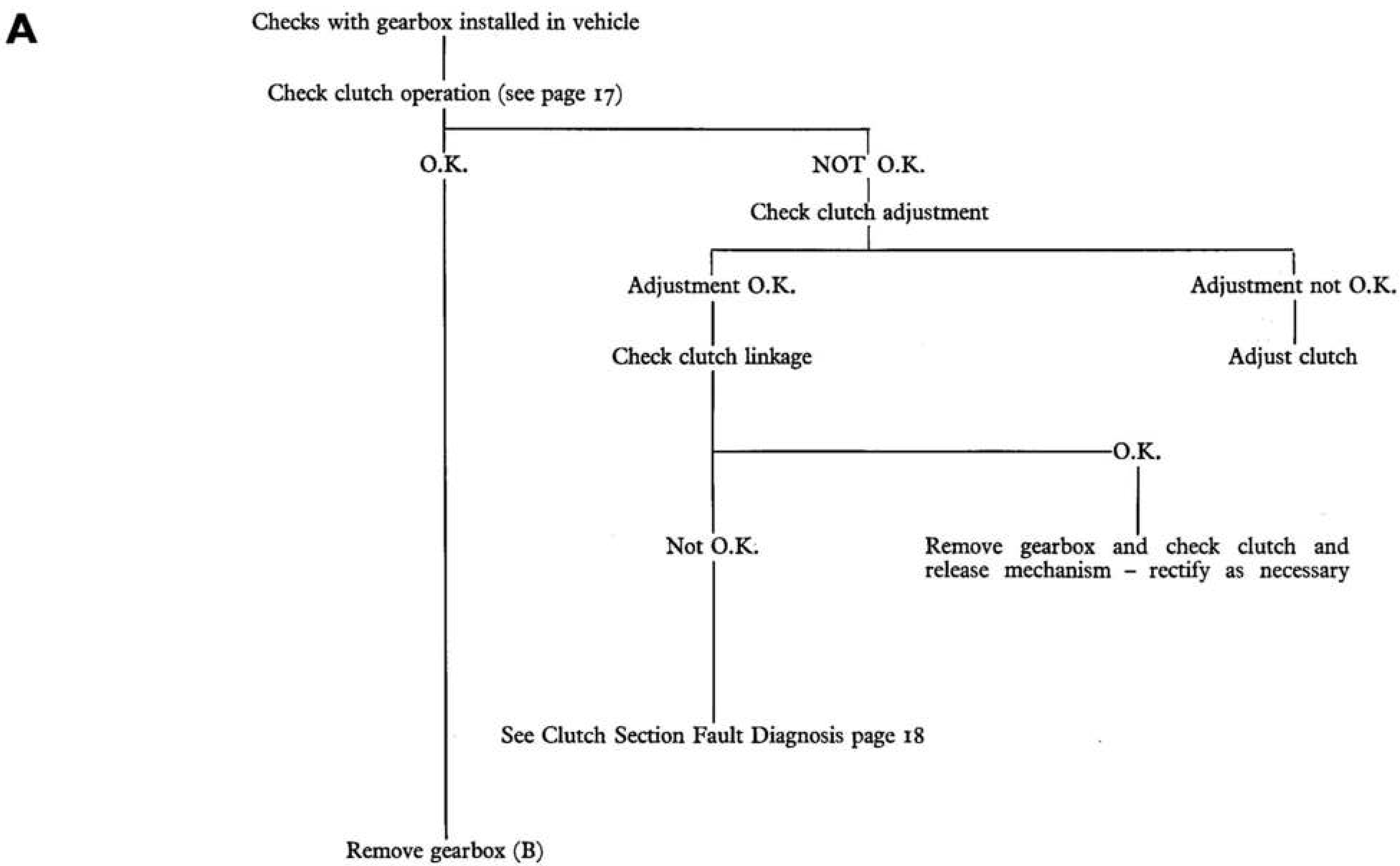
- O.K.
- NOT carried out — Modify as necessary

Remove gearbox and check release bearing clutch, disc and pressure plate. Renew as necessary

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



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.

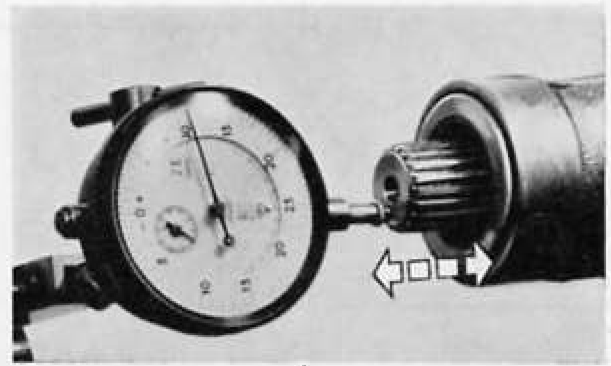
NOTE – This is not a 100% indication because the gearbox is not subject to normal operating conditions. Therefore, if after carrying out the following checks, no defects can be found the mainshaft checks should be performed.

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.

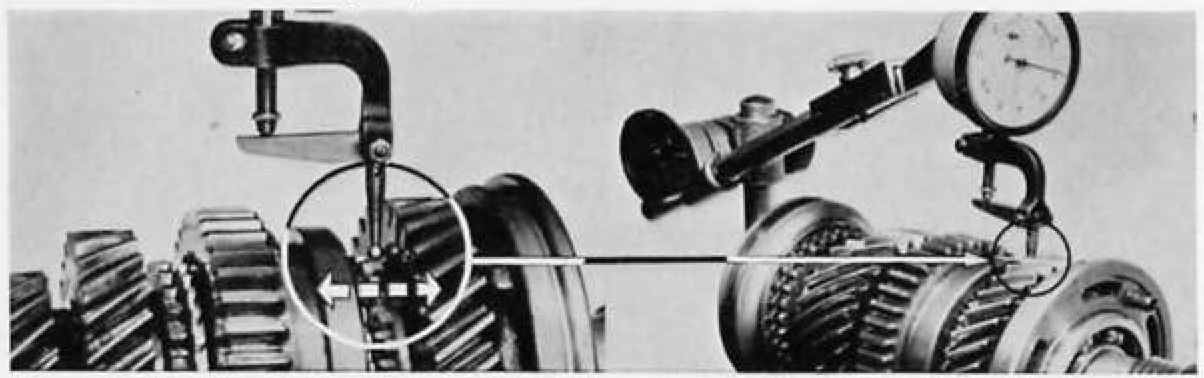


IF NOT O.K.

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).

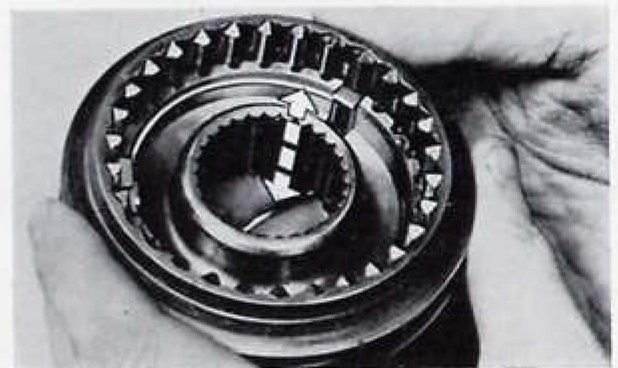


IF NOT O.K.

Dismantle the mainshaft and re-build using new components as required to give correct end-floats.

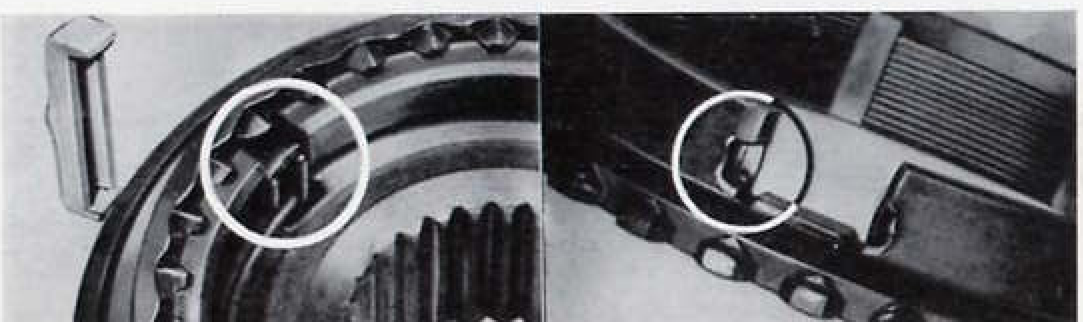
IF O.K.

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".



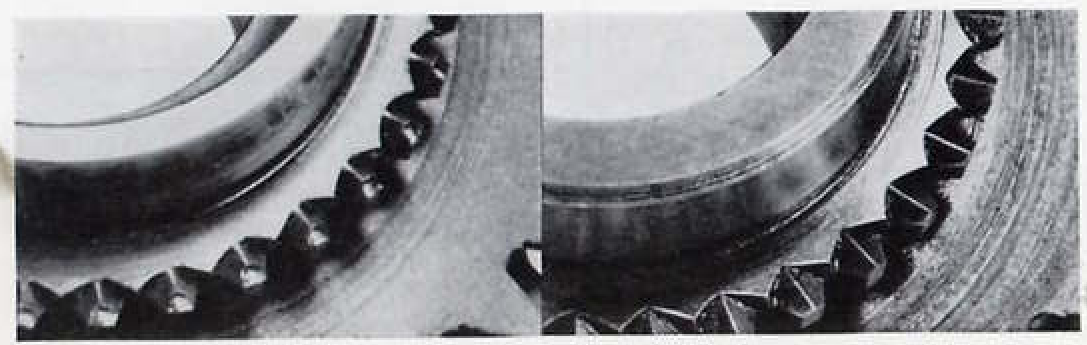
IF NOT O.K.

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.

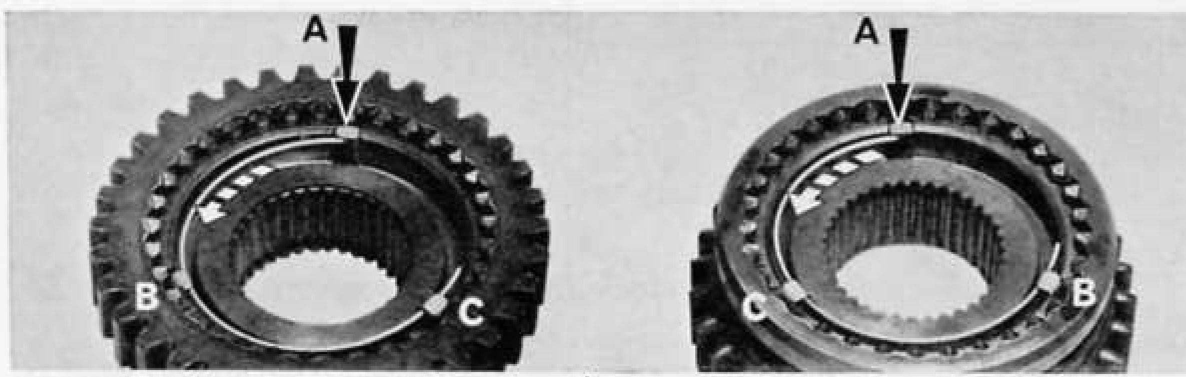
B Checks with the Gearbox removed from the vehicle.

Remove the selector housing.

Check that all the synchroniser rings are fitted.

IF O.K.

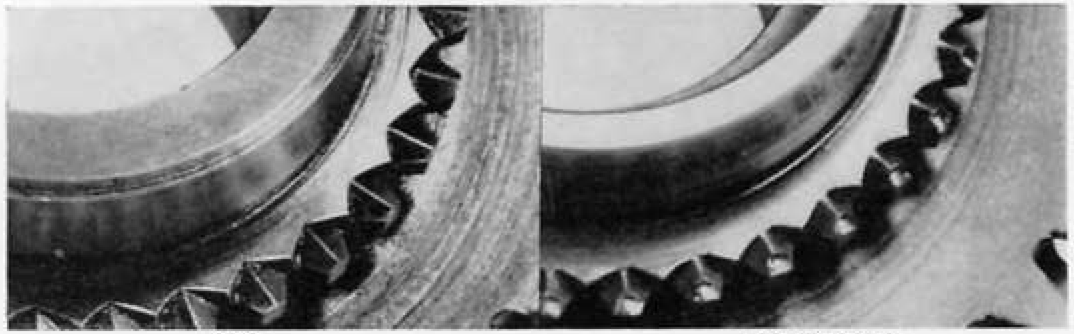
Remove the mainshaft assembly and dismantle the area required (i.e. if it crashes in first gear it is only necessary to dismantle the components associated with first gear). With the synchroniser still assembled check that the insert springs are correctly fitted. They should run anti-clockwise (starting 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.

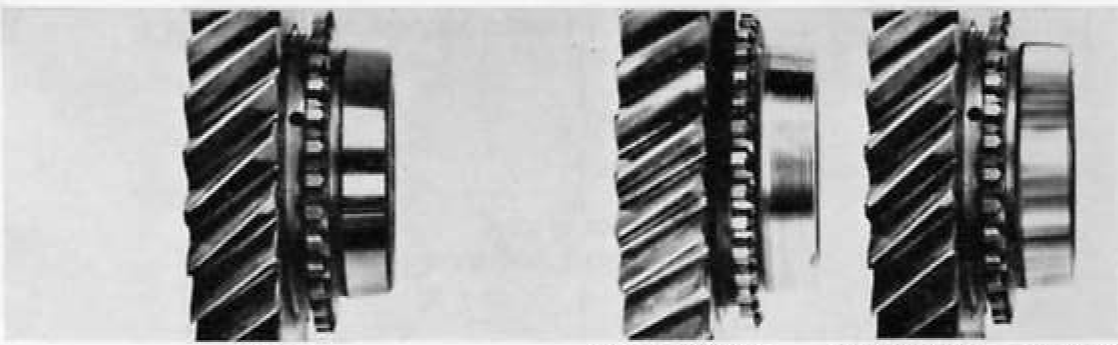
Inspect the dog teeth on the synchroniser ring, sleeve and the gear.



O.K. NOT O.K.

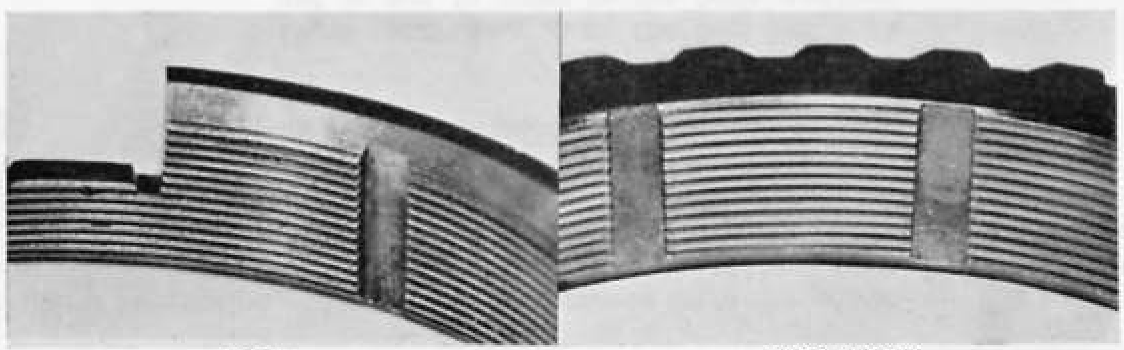
IF O.K.

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.

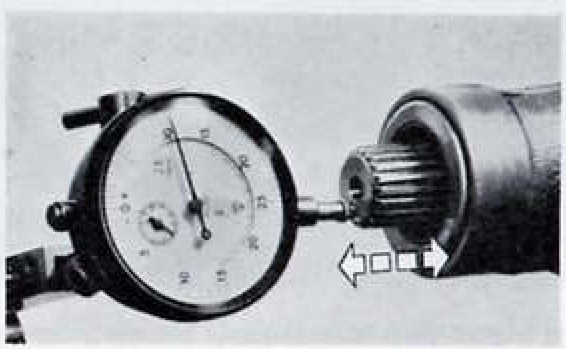
O.K.: Check gear lever retaining plate is secure.

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.



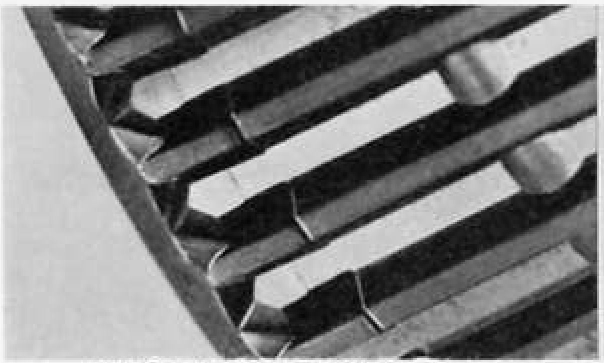
O.K.

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).

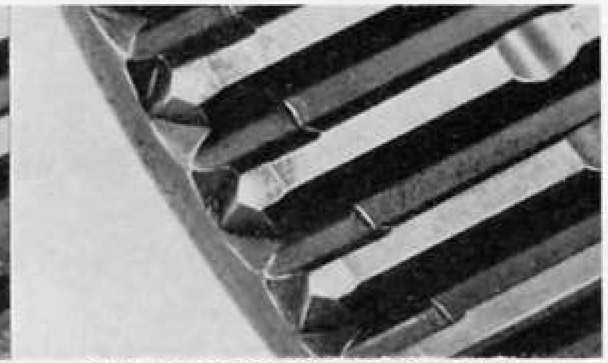
NOT O.K.

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.).



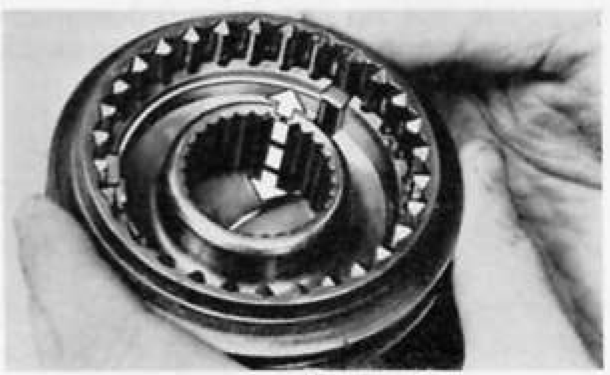
BACK-ANGLING O.K.



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.

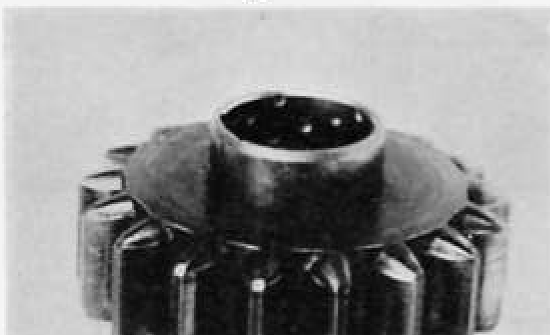
Renew the selector rail

(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.



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.

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.

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

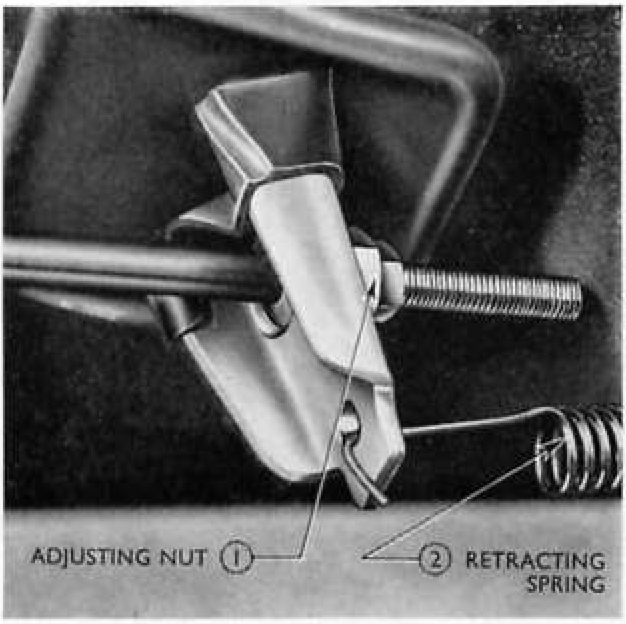


Fig. 15
Clutch Release Arm Adjustment
(Prior to December 1970)

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.

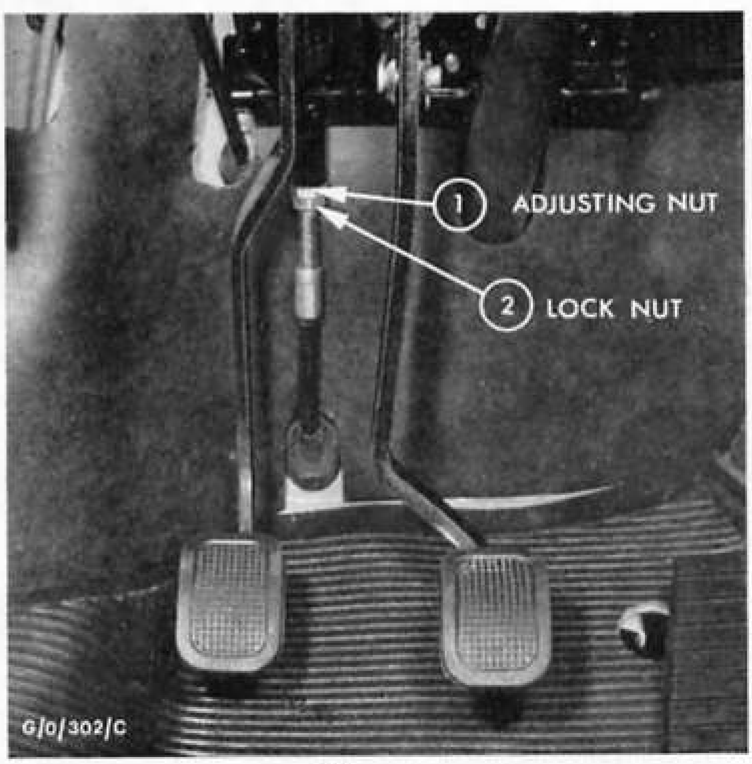


Fig. 16
Clutch Cable Adjustment
(Petrol Engined Models after December 1970)

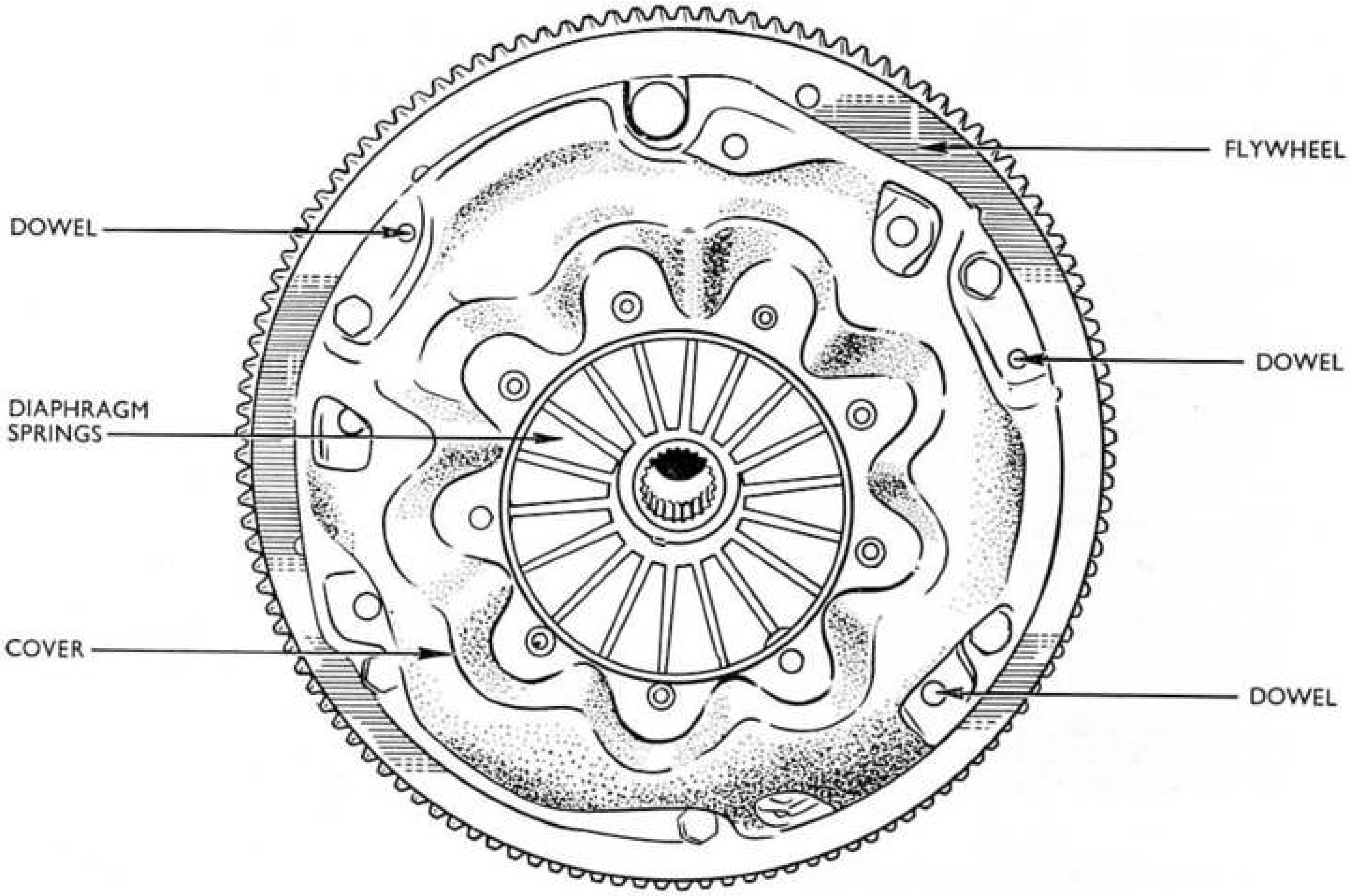


Fig. 17
Clutch Assembly (prior to March 1968)

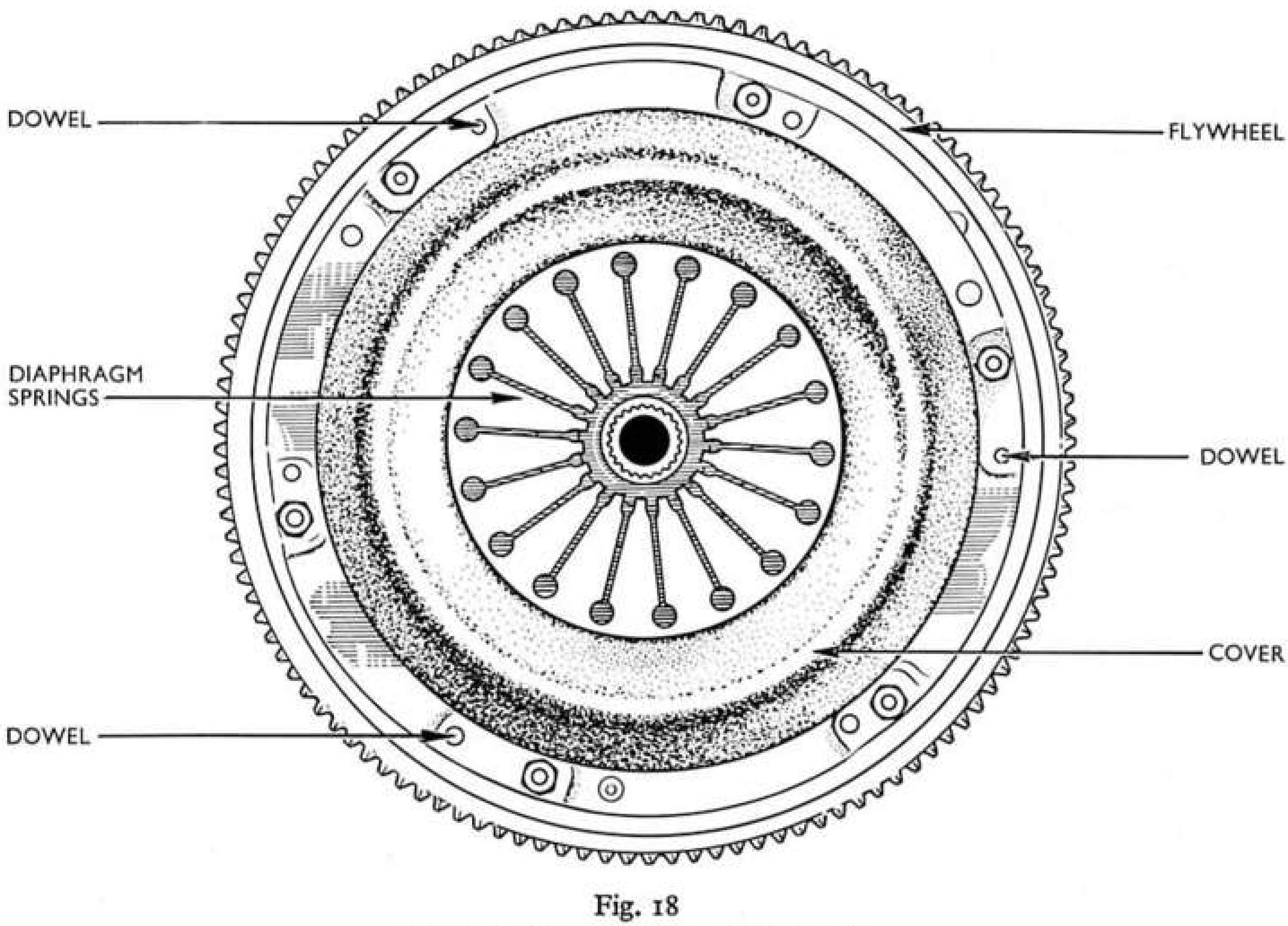


Fig. 18
Clutch Assembly (from July 1968)

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

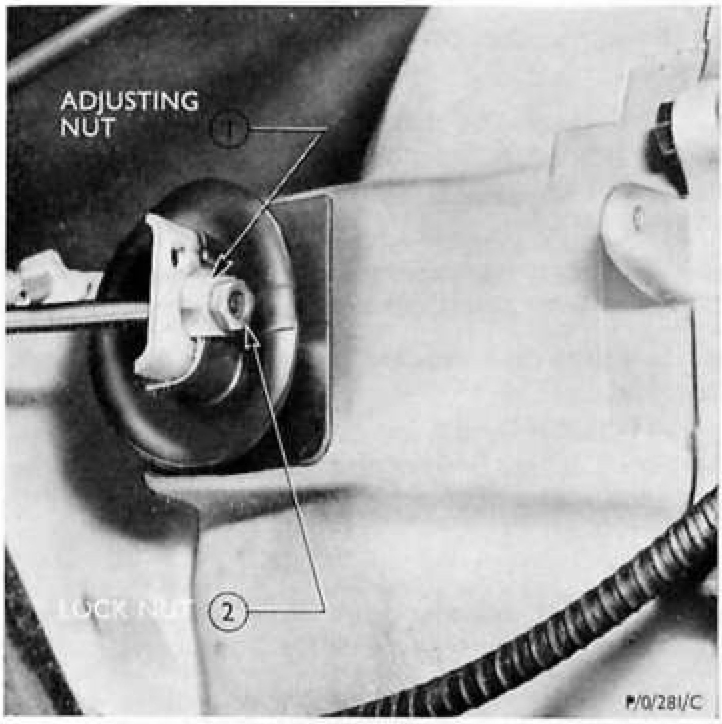


Fig. 19
Clutch Release Arm Adjustment
(Diesel Engined Models after December 1970)

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.

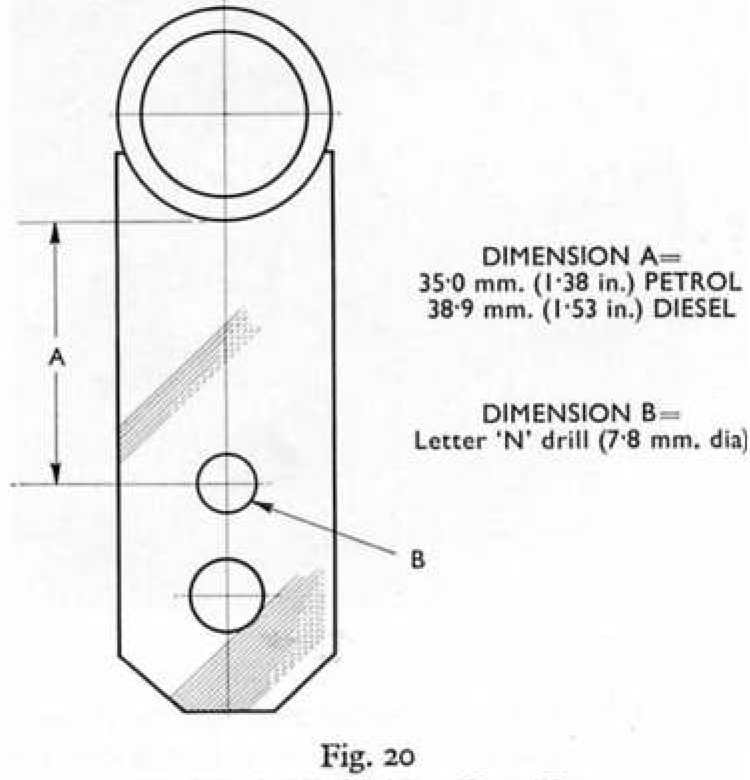


Fig. 20
Modified Clutch Equaliser Bar

(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.

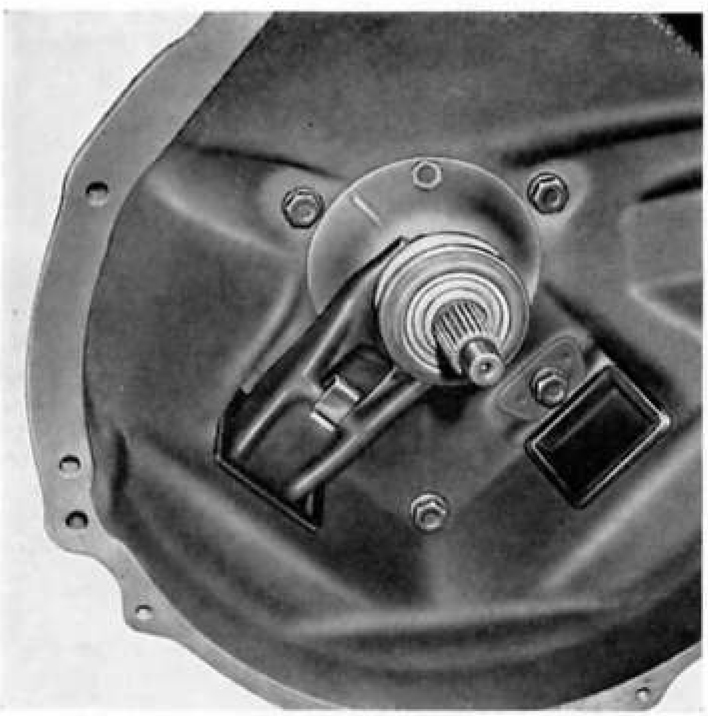


Fig. 21
Clutch Release Bearing and Release Arm (Petrol Engined Models prior to December 1970 and all Diesel Engined Models)

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).

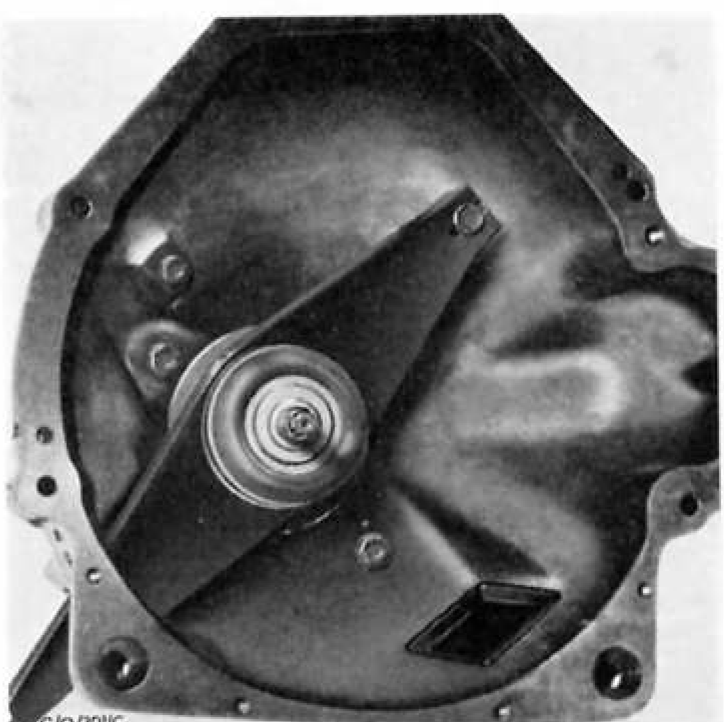


Fig. 22

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.

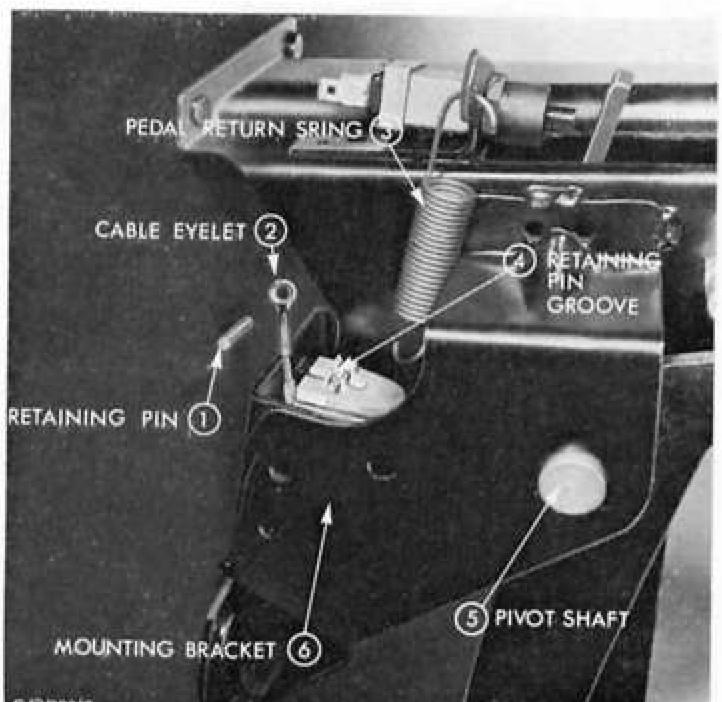


Fig. 23
Clutch Cable Location in Pedal
(All Models after December 1970)

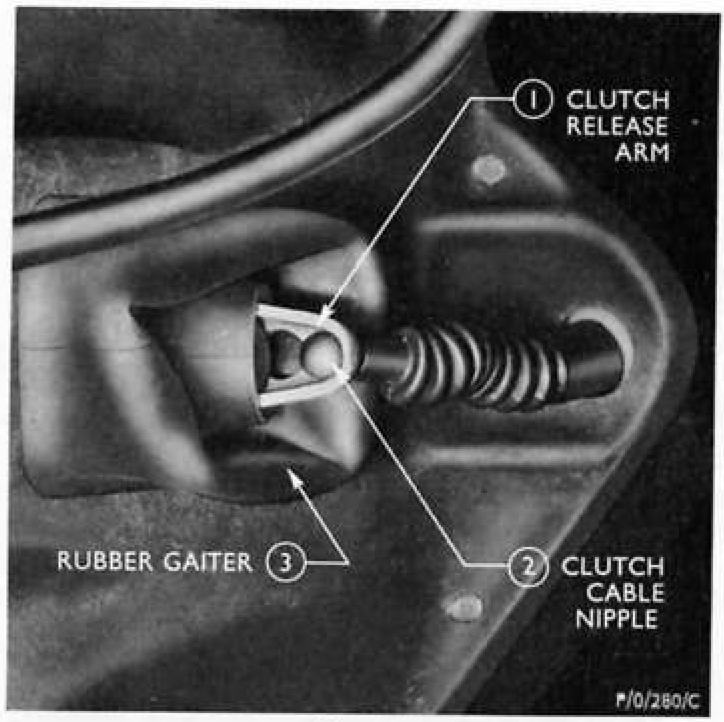


Fig. 24
Clutch Cable Location in Release Arm
(Petrol Engined Models after December 1970)

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.

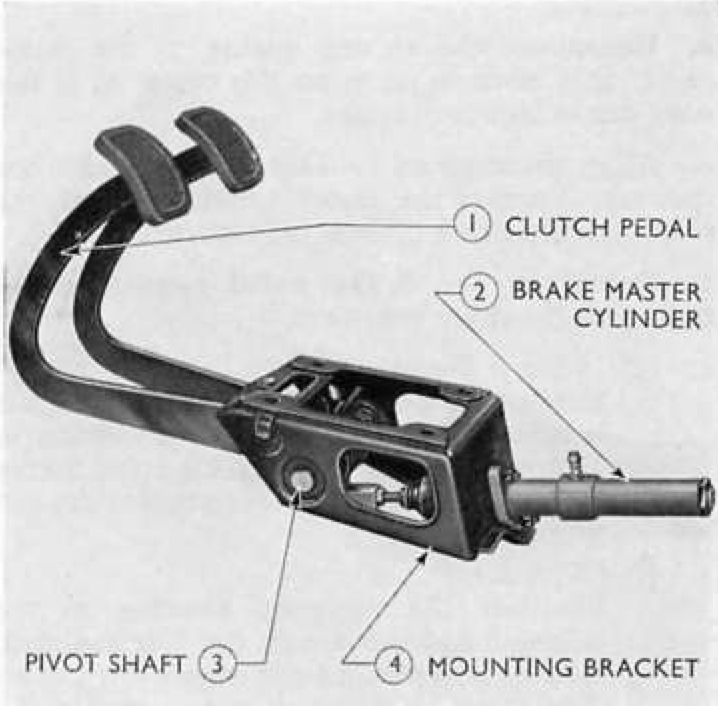


Fig. 25
Clutch Pedal Assembly
(Prior to December 1970)

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-

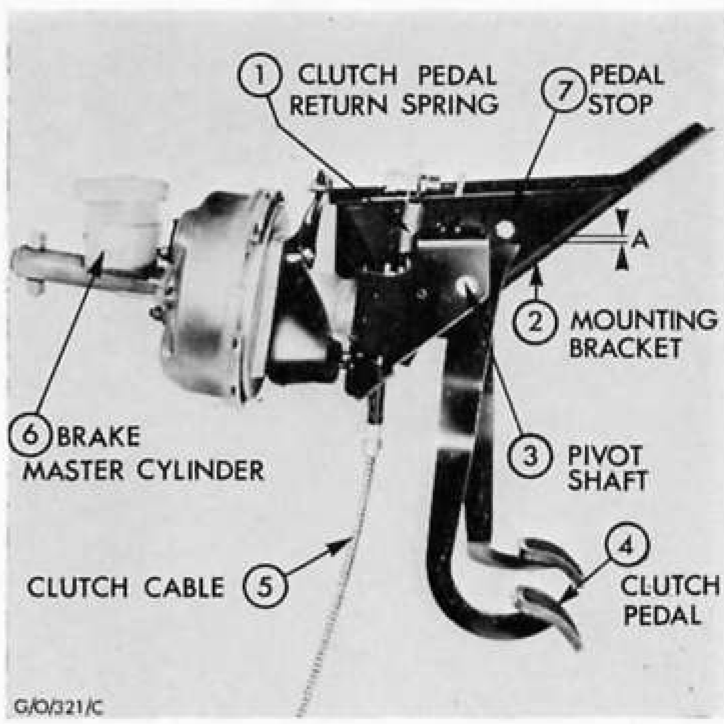


Fig. 26
Clutch Pedal Assembly (After December 1970)
NOTE: Dimension A = 3.5 to 4.5 mm. (0.13 to 0.18 in.)

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.

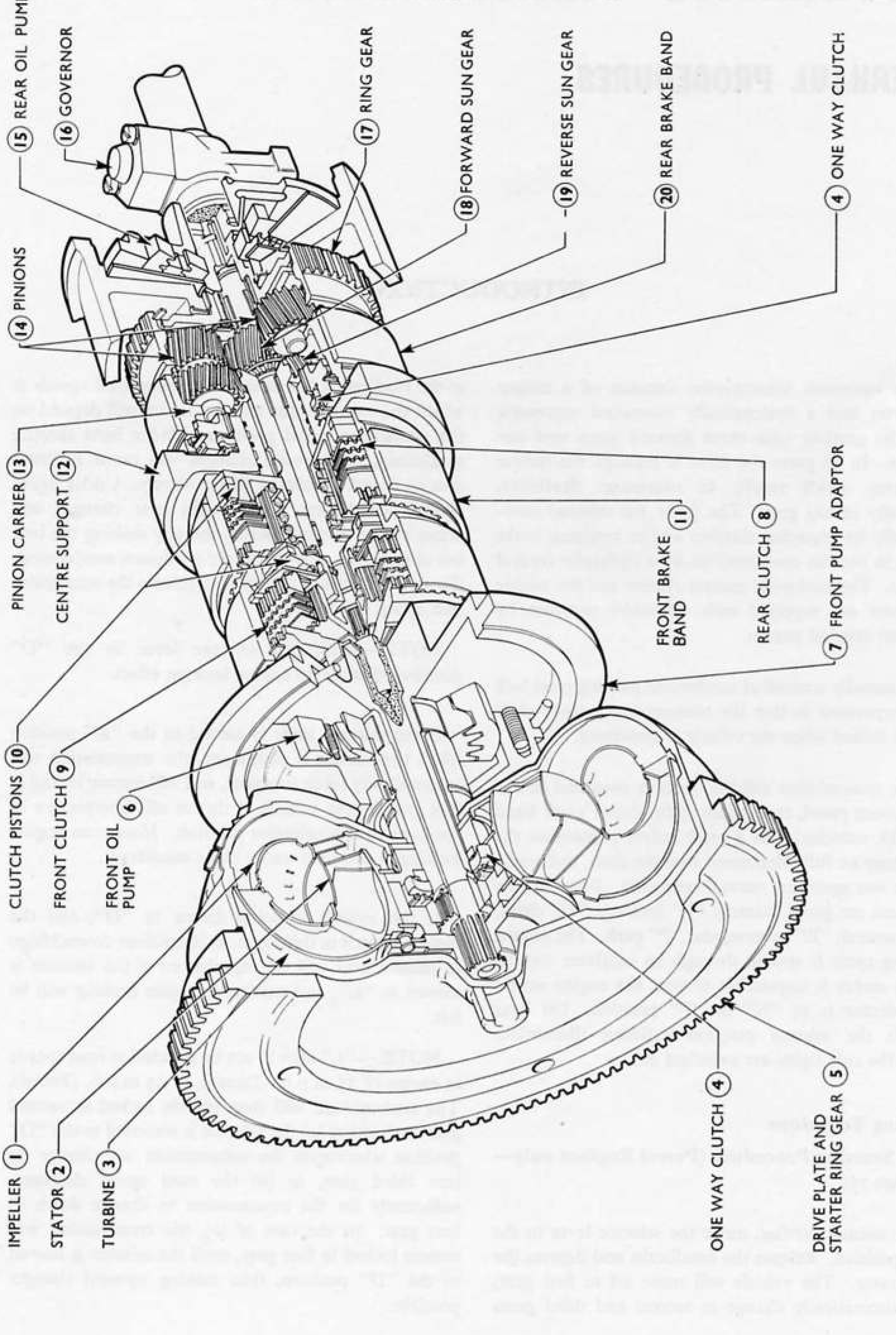


Fig. 27
Sectioned View of Transmission

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.

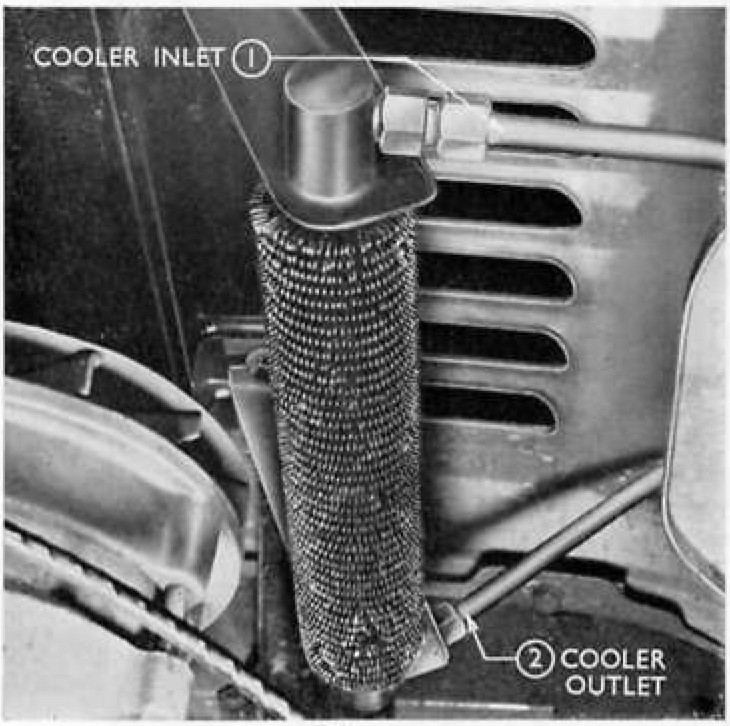


Fig. 29
Oil Cooler

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'.

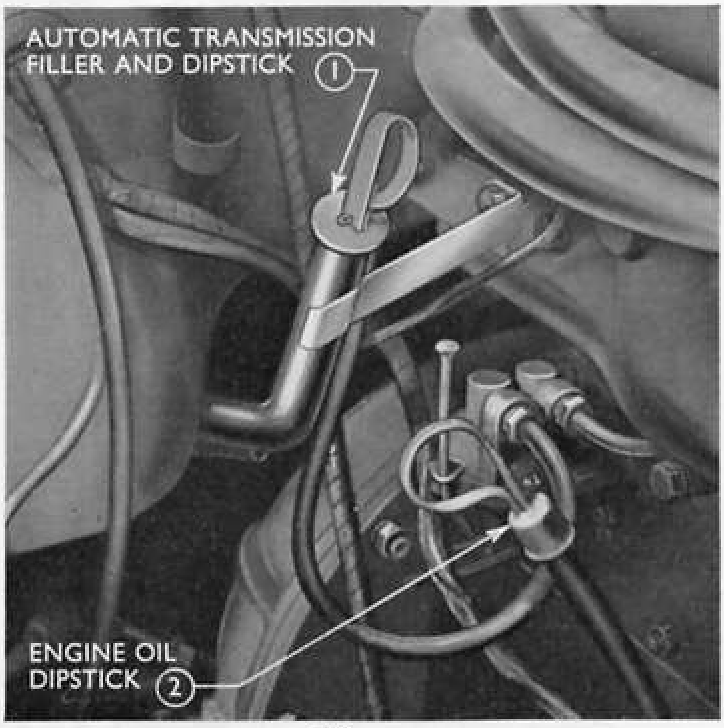


Fig. 30
Dipstick and Filler Tube (Diesel shown)

(*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.

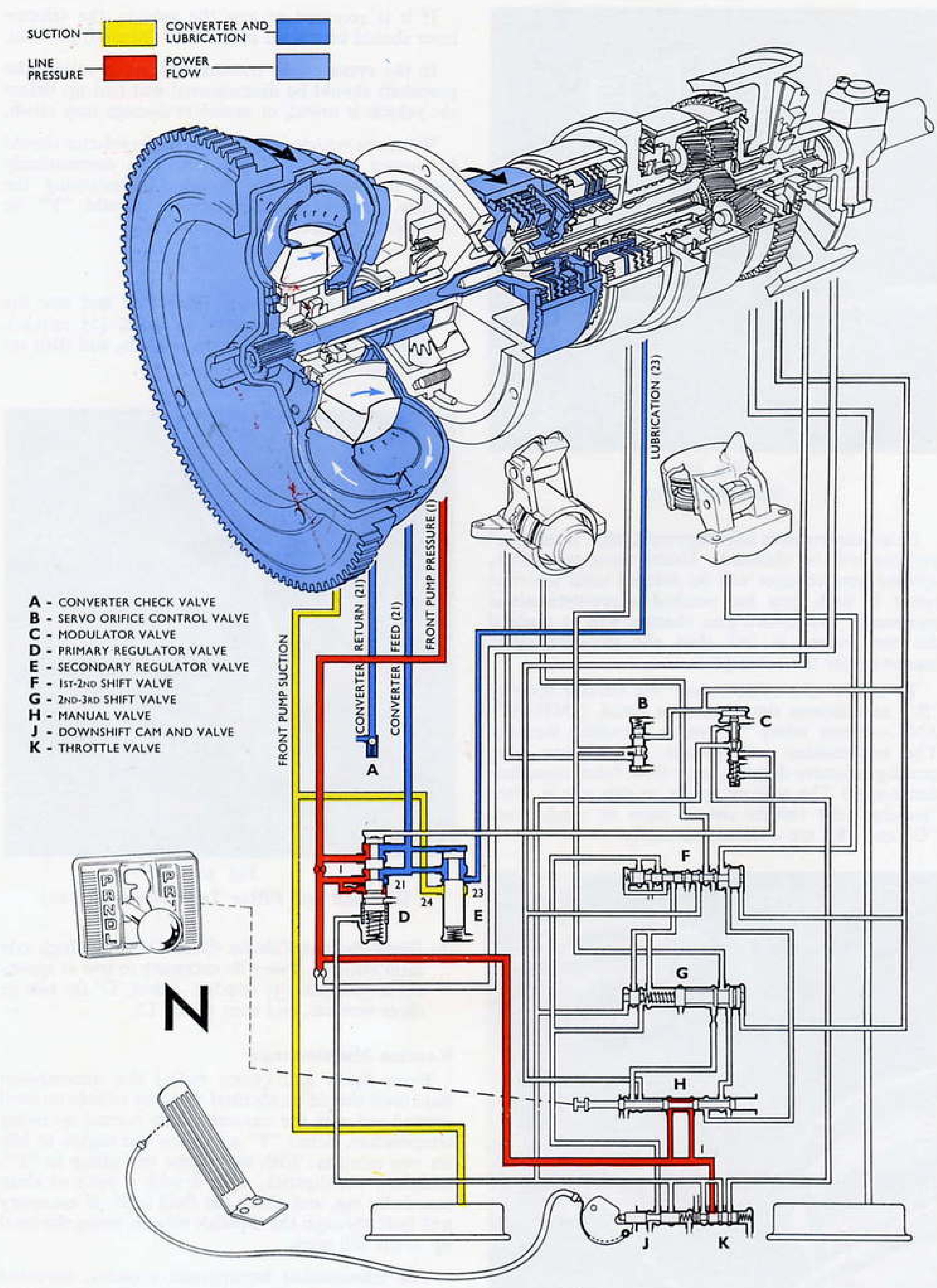


Fig. 31

Hydraulic Circuits and Power Flow "N"

(For details of hydraulic circuit numbers, see page 51)

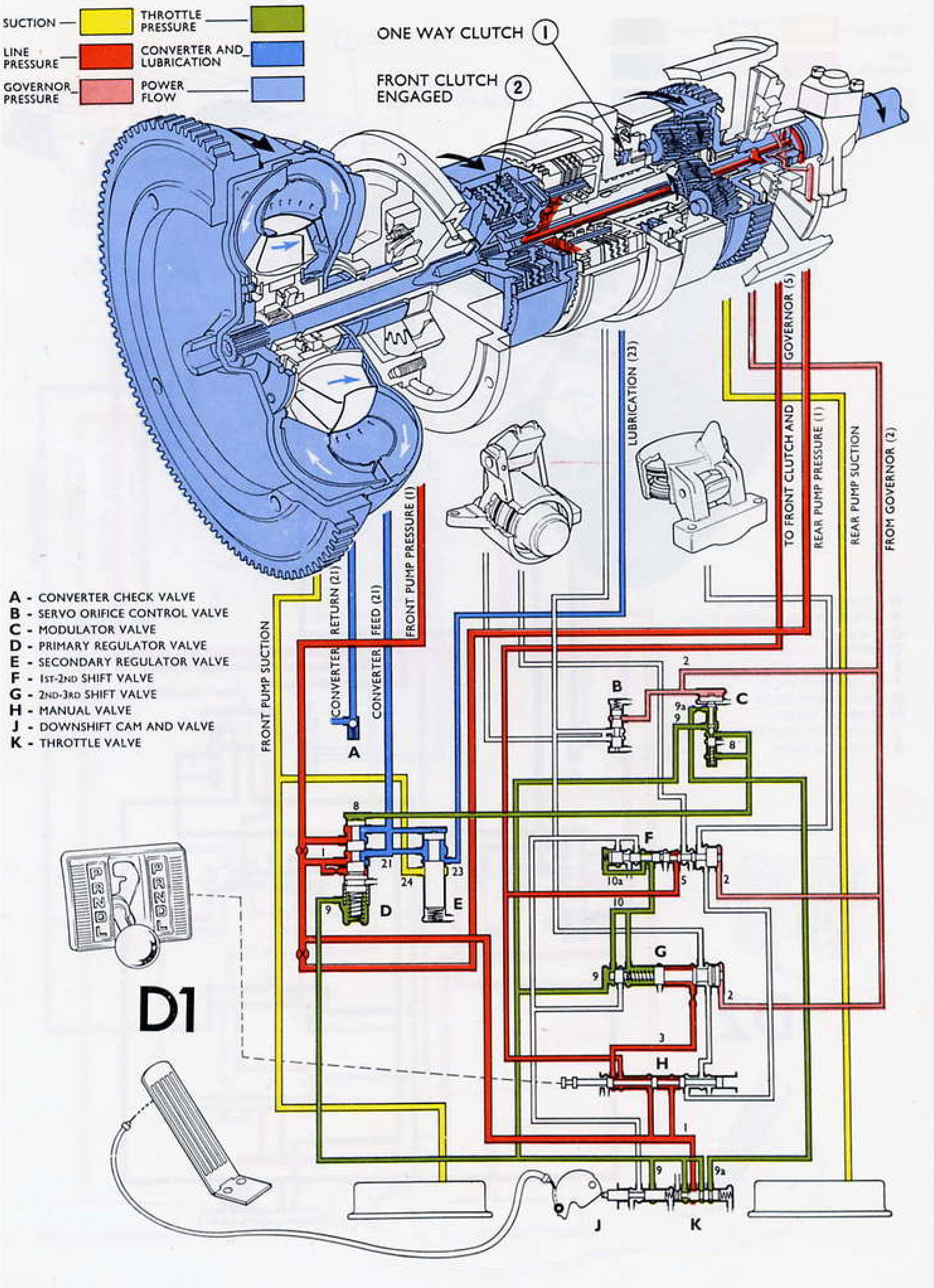


Fig. 32
Hydraulic Circuits and Power Flow "D1"
(For details of hydraulic circuit numbers, see page 51)

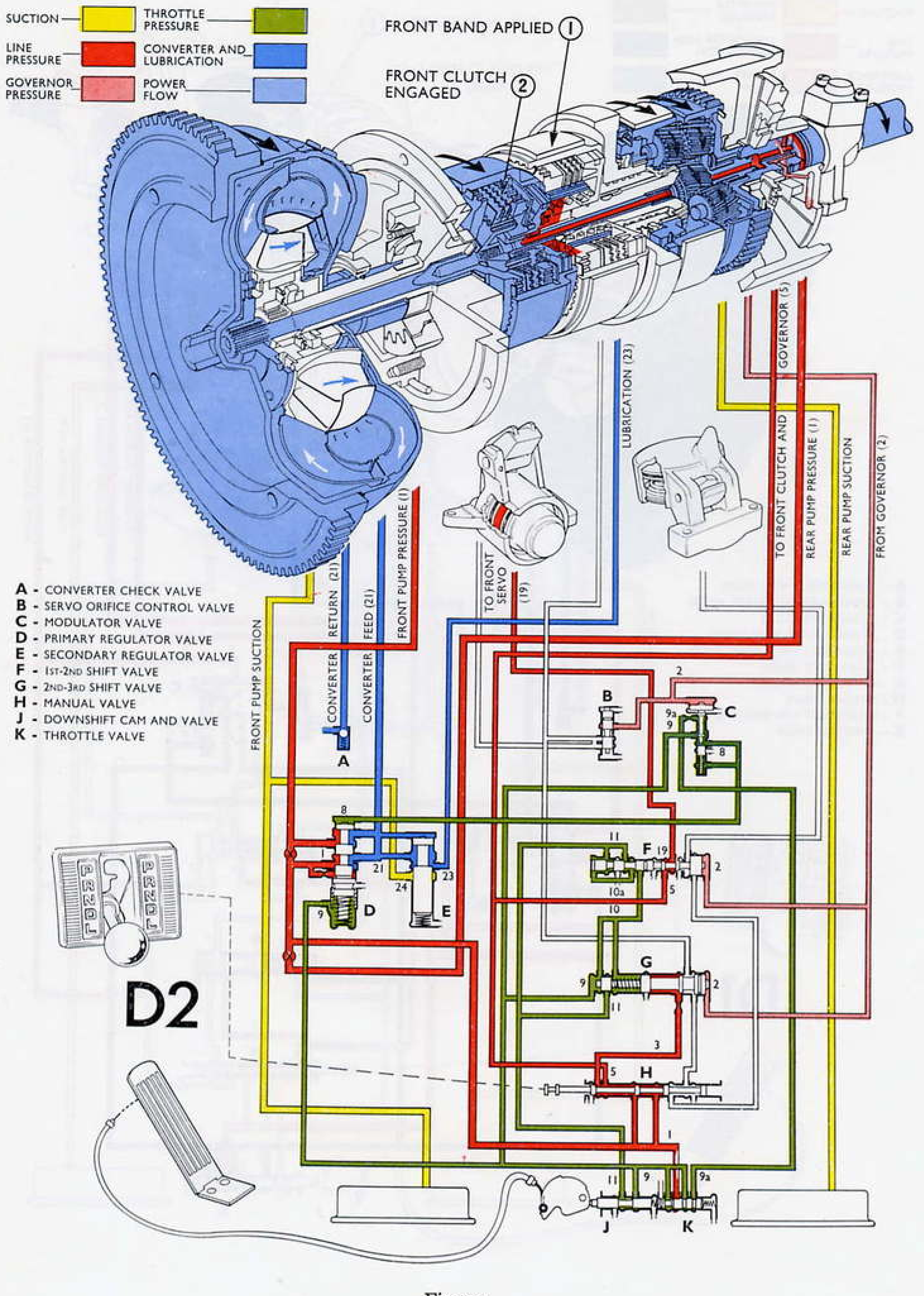


Fig. 33
Hydraulic Circuits and Power Flow "D2"
(For details of hydraulic circuit numbers, see page 51)

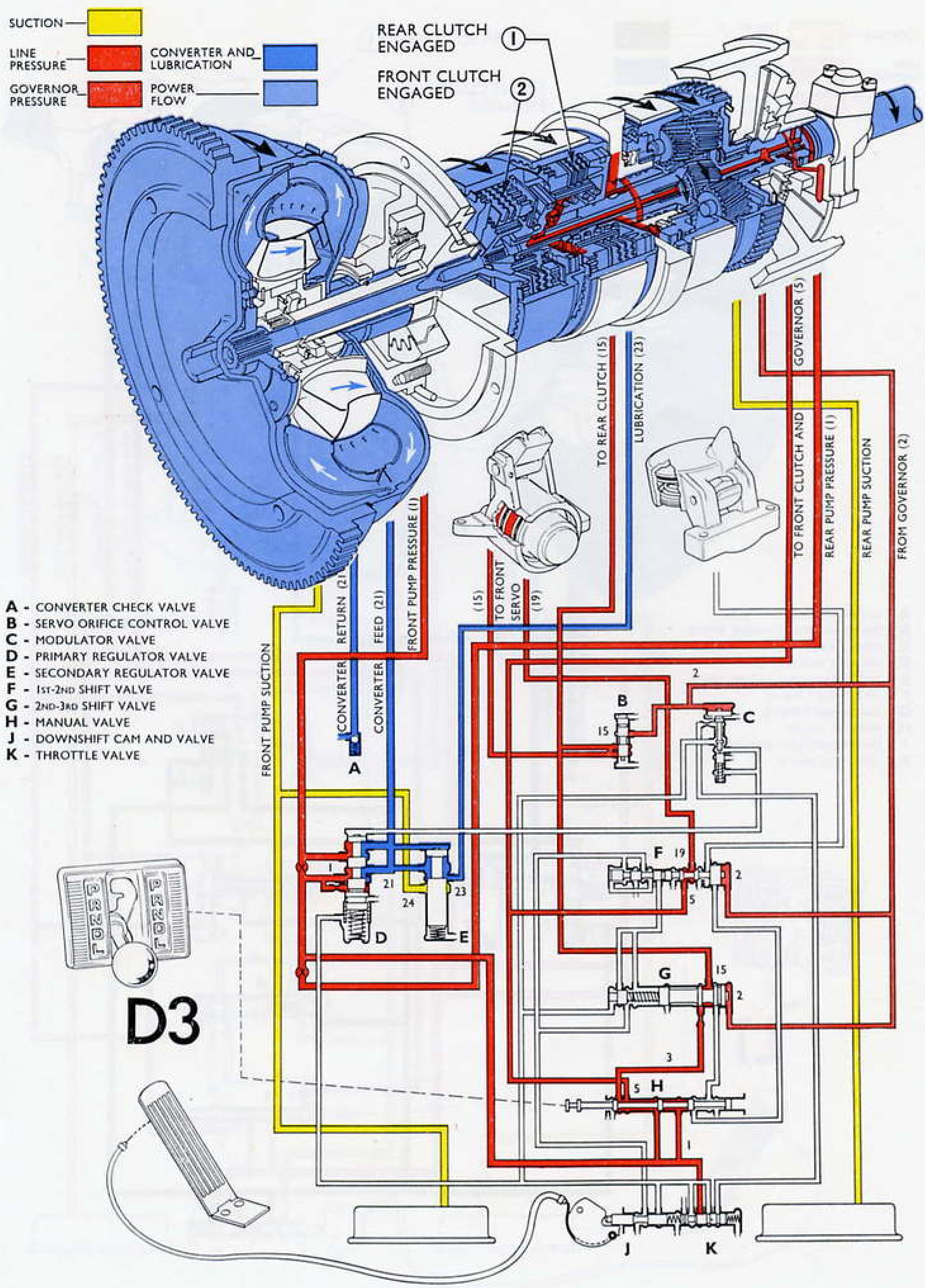


Fig. 34
Hydraulic Circuits and Power Flow "D3"
(For details of hydraulic circuit numbers, see page 51)

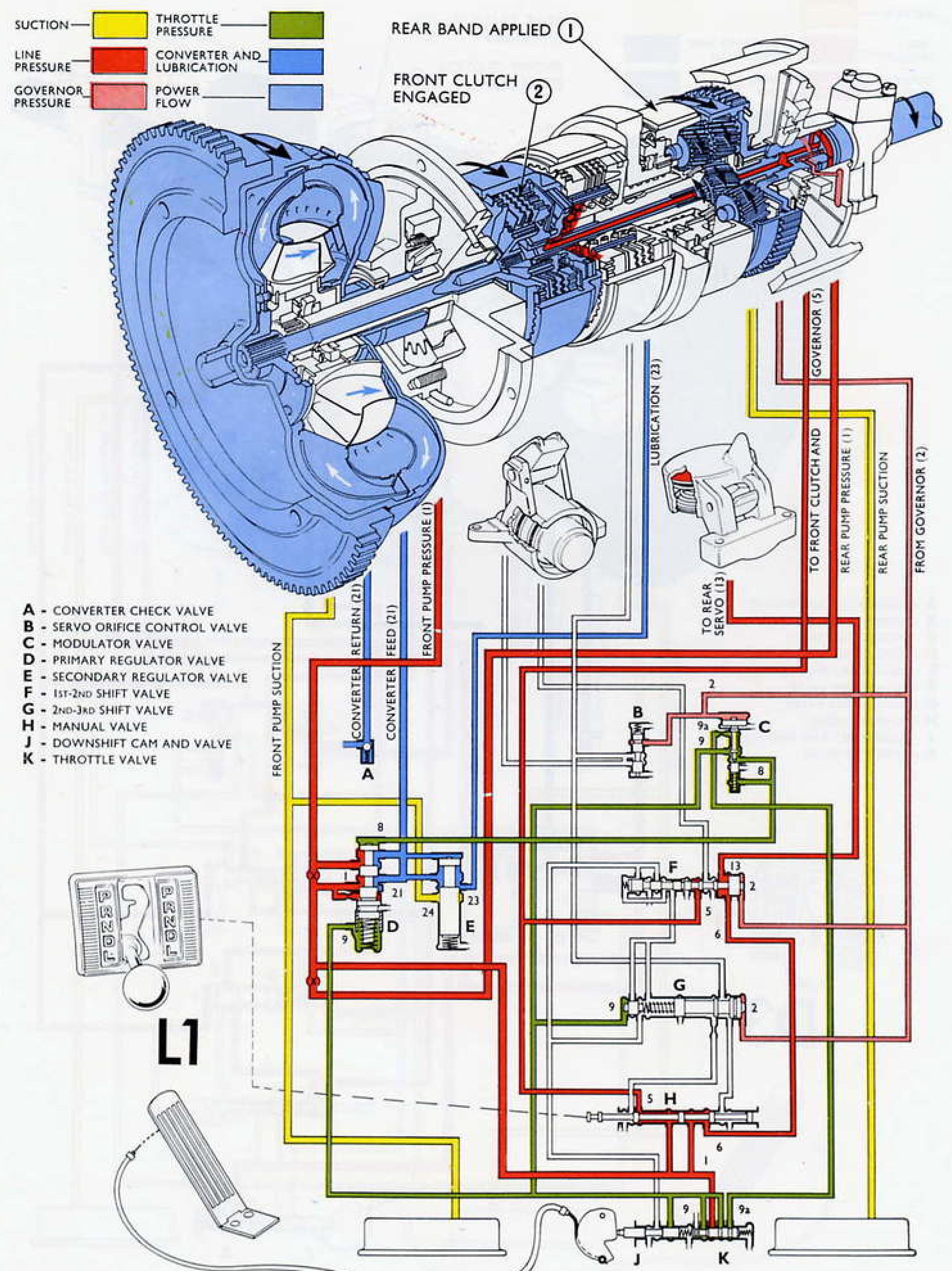


Fig. 35

Hydraulic Circuits and Power Flow "L1"

(For details of hydraulic circuit numbers, see page 51)

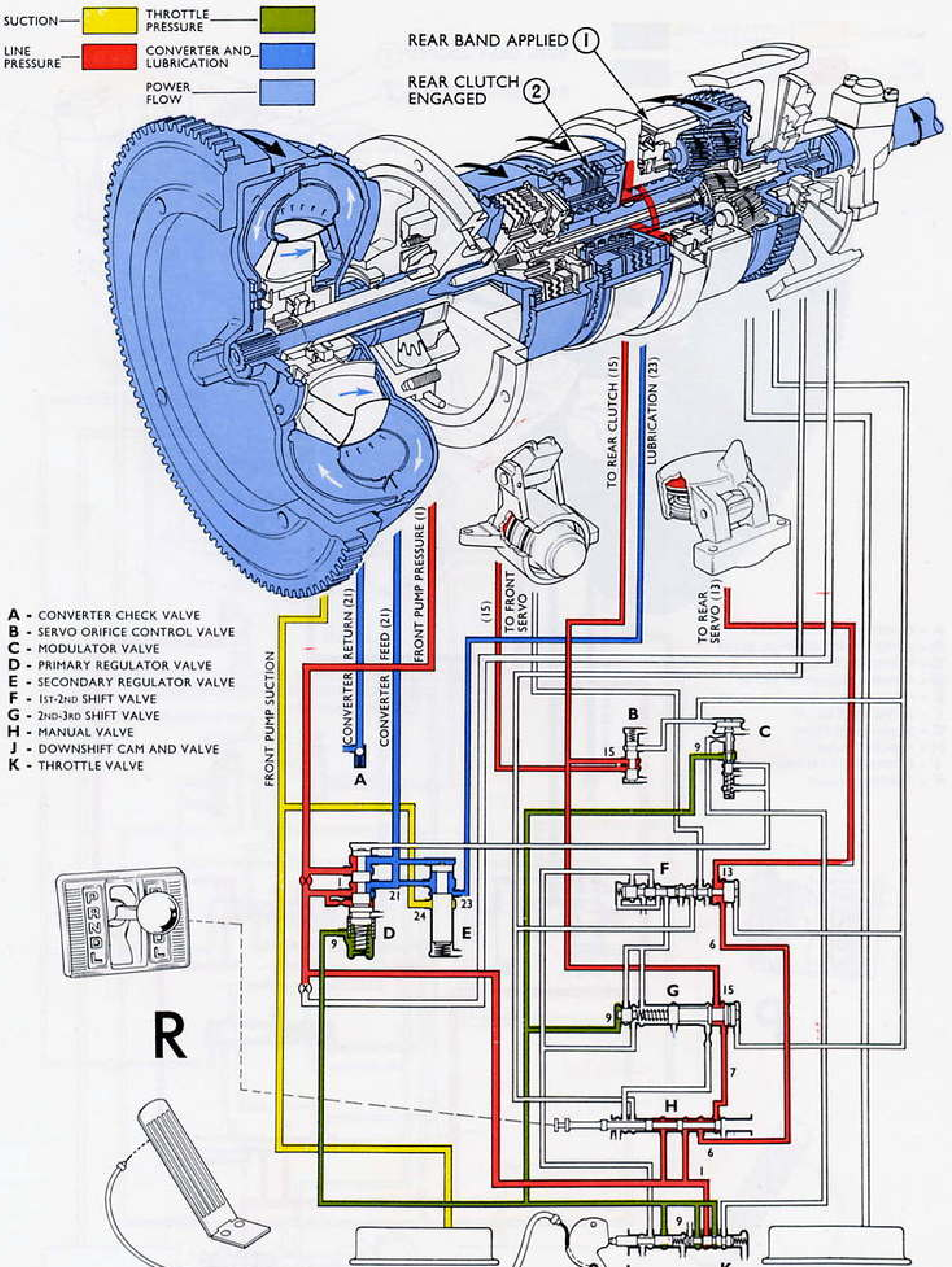


Fig. 36

Hydraulic Circuits and Power Flow "R"

(For details of hydraulic circuit numbers, see page 51)

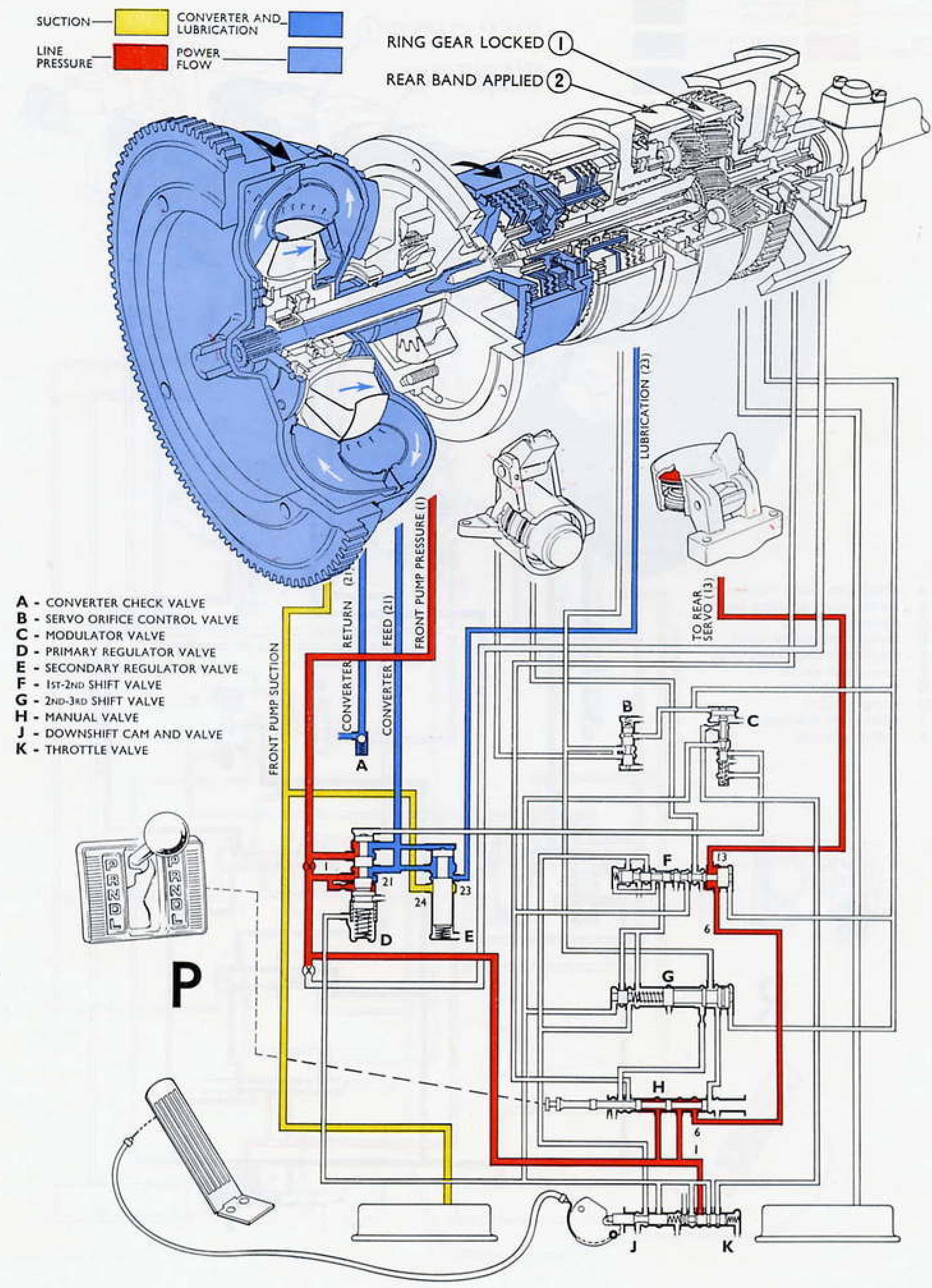


Fig. 37

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).

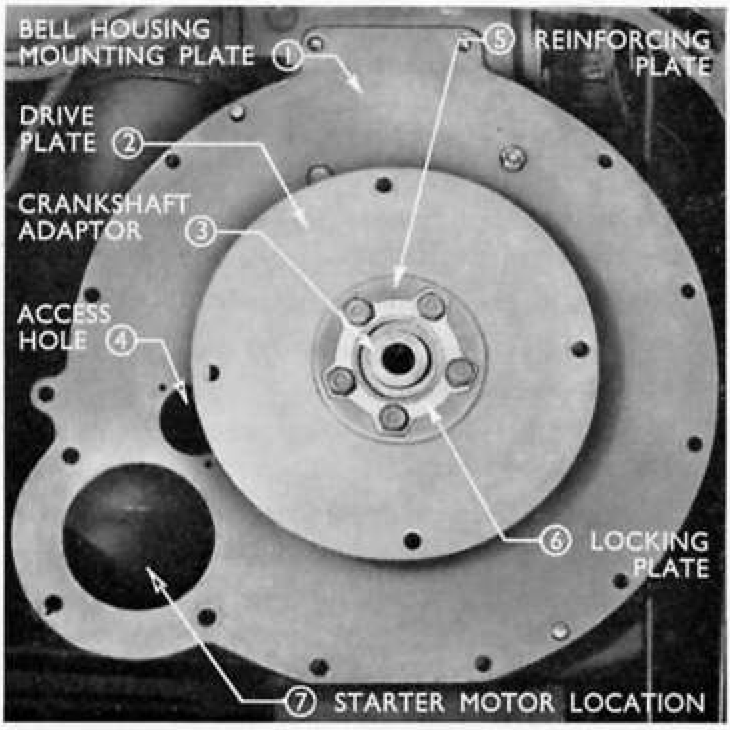


Fig. 38
Drive Plate Assembly
(Diesel shown)

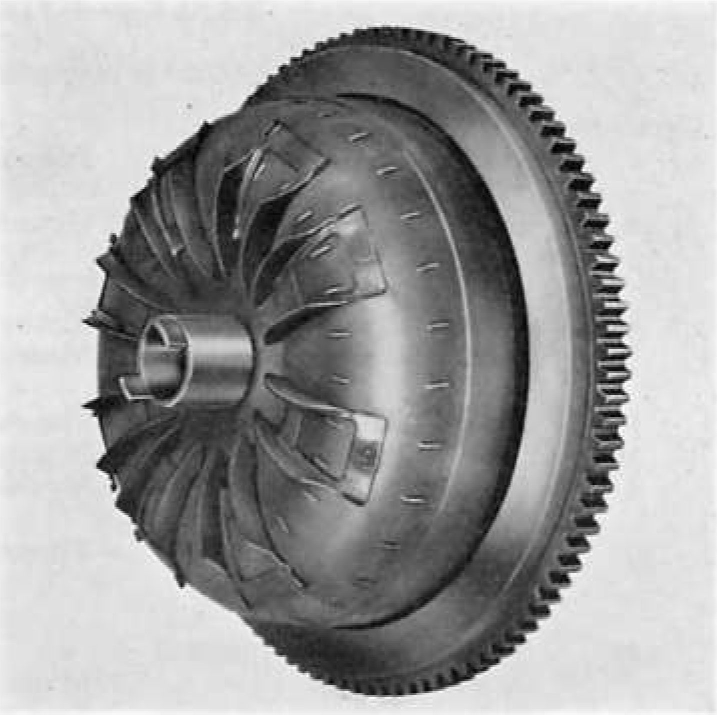


Fig. 39
Torque Converter and Ring Gear Assembly

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.

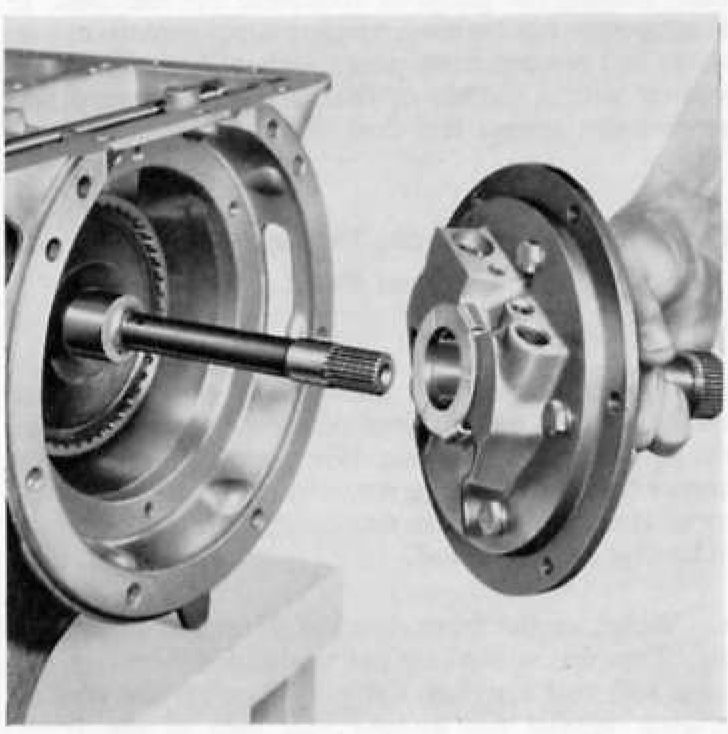


Fig. 40
Removing Front Pump

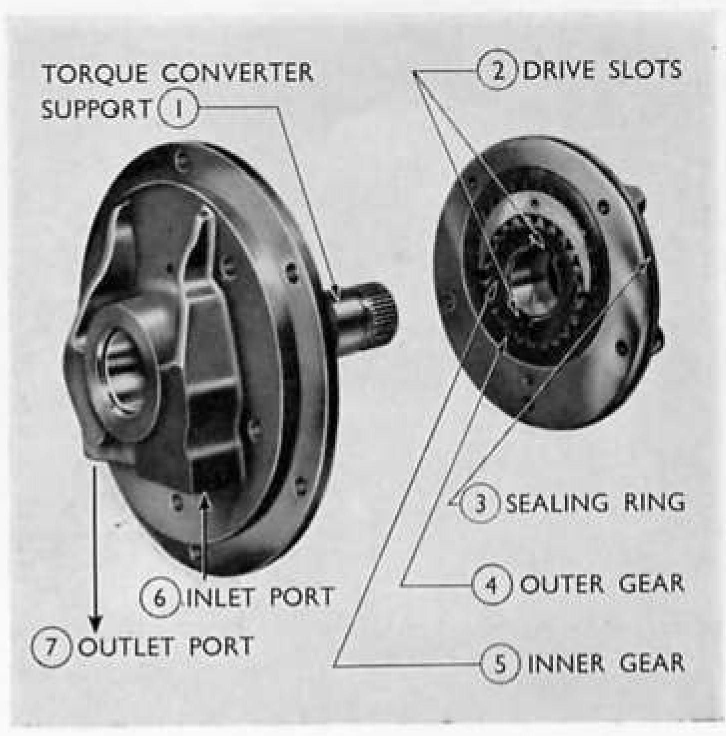


Fig. 41
Front Pump - Exploded

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.

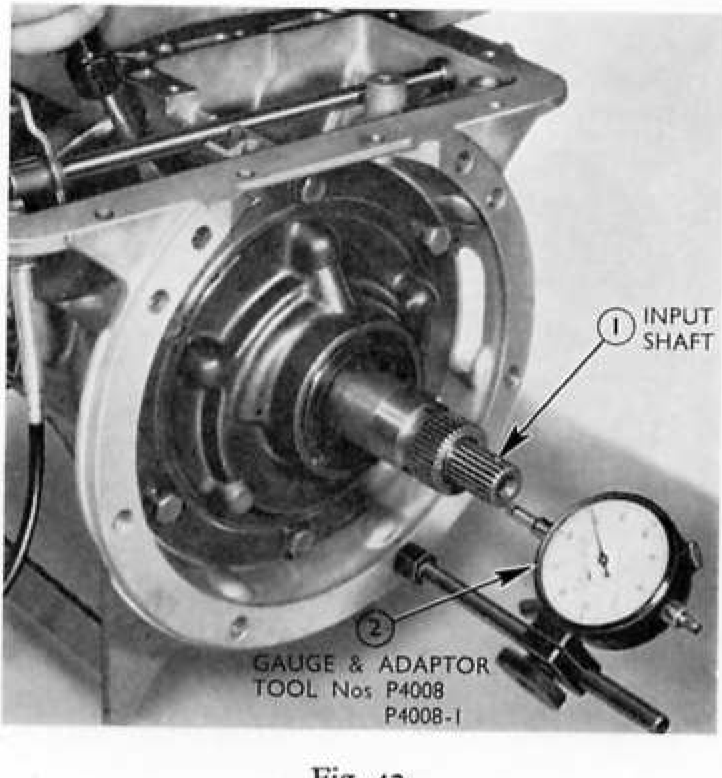


Fig. 42
Checking End-float of Input Shaft

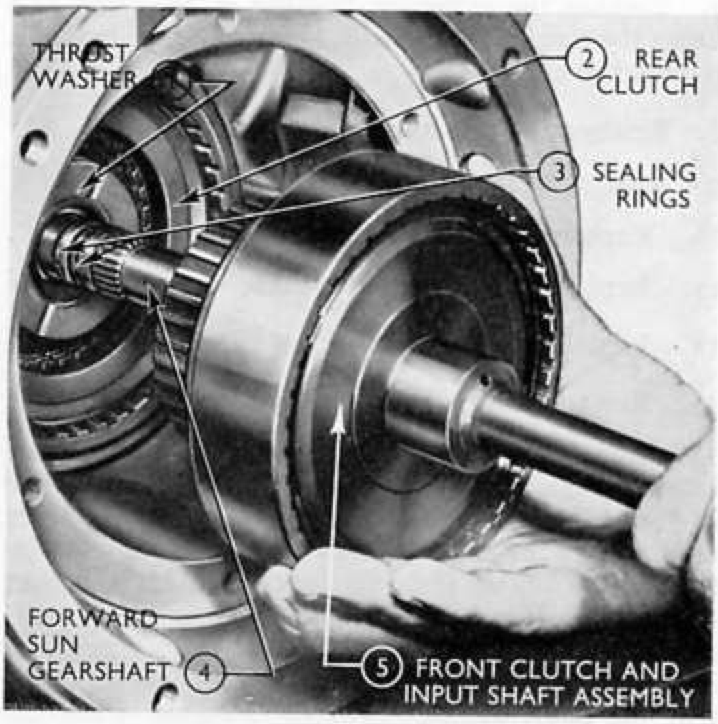


Fig. 43
Removing Front Clutch and Input Shaft

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.

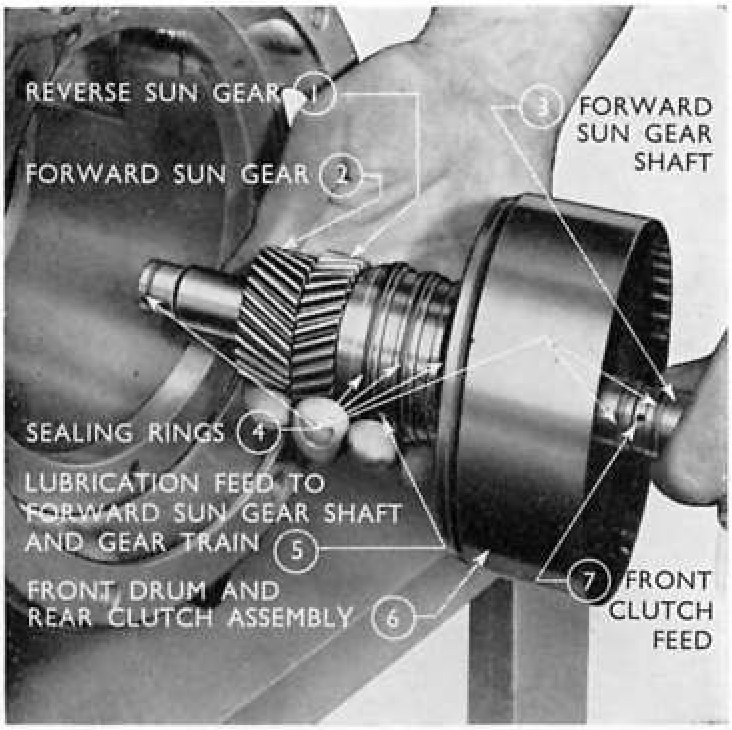


Fig. 44
Removing Rear Clutch and Sun Gears

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:—

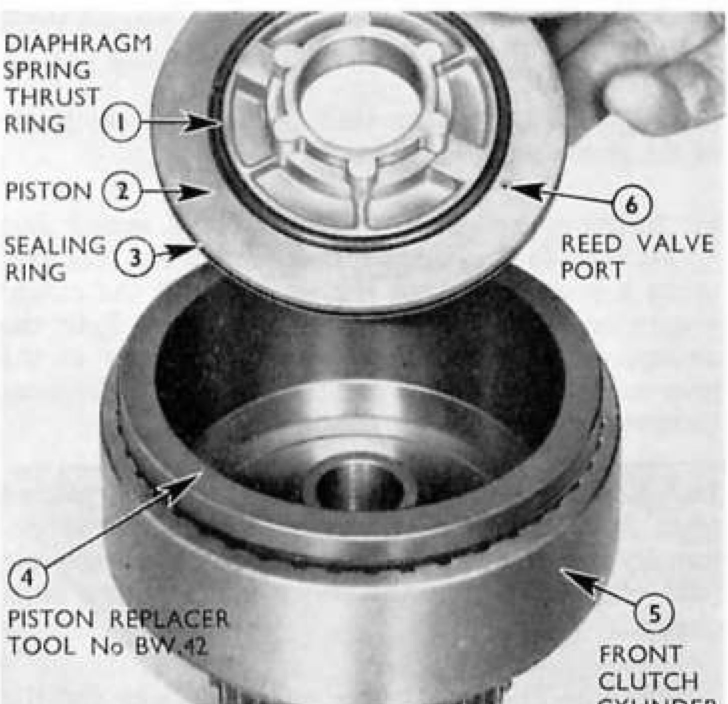


Fig. 45
Replacing Front Clutch Piston

(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.

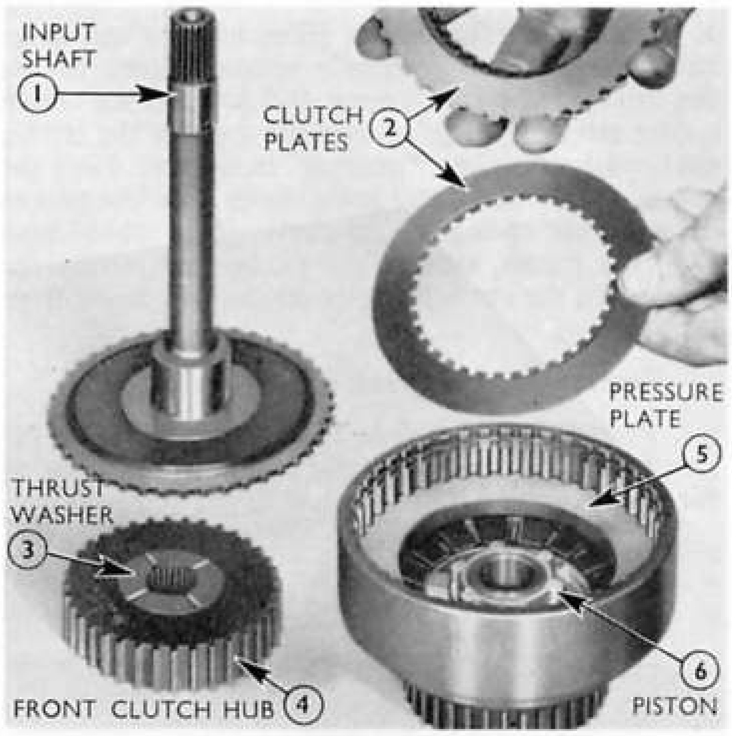


Fig. 46
Refitting Front Clutch Plates

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.

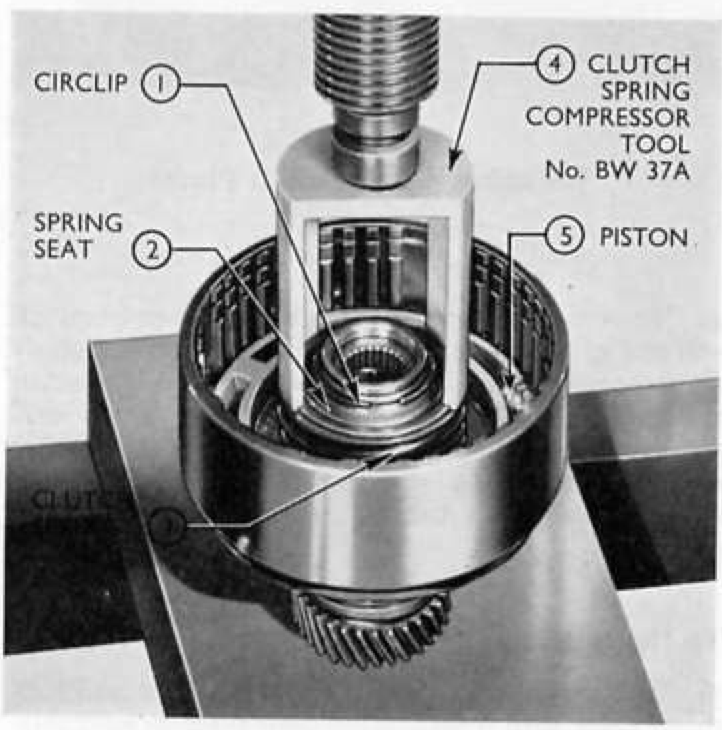


Fig. 47
Dismantling Rear Clutch

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.

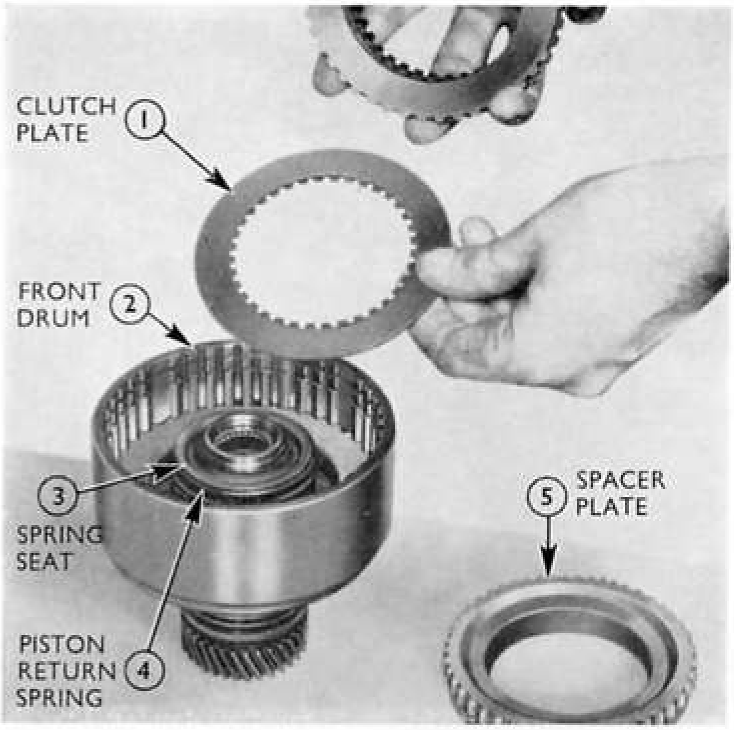


Fig. 49
Fitting Rear Clutch Plates

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.

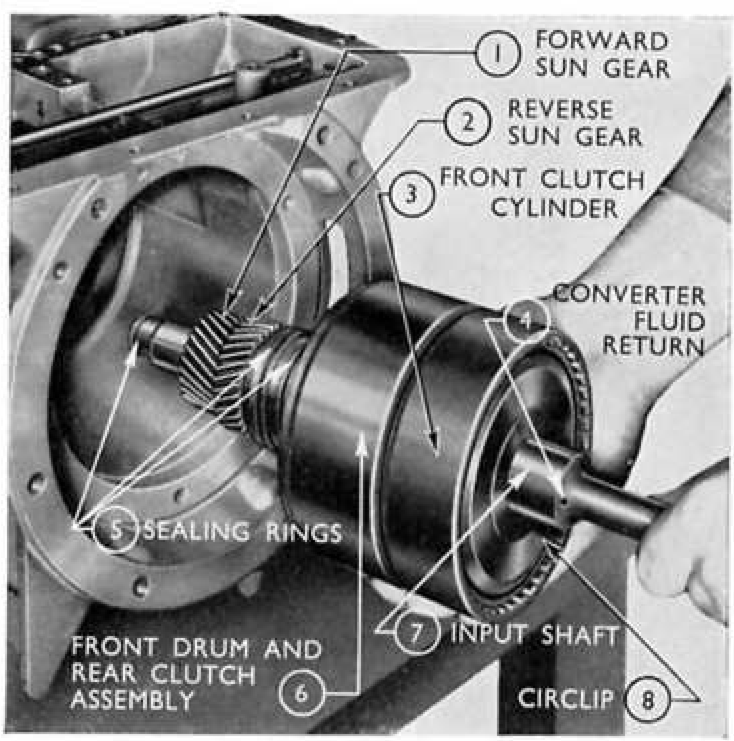


Fig. 50
Fitting Front and Rear Clutches

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.

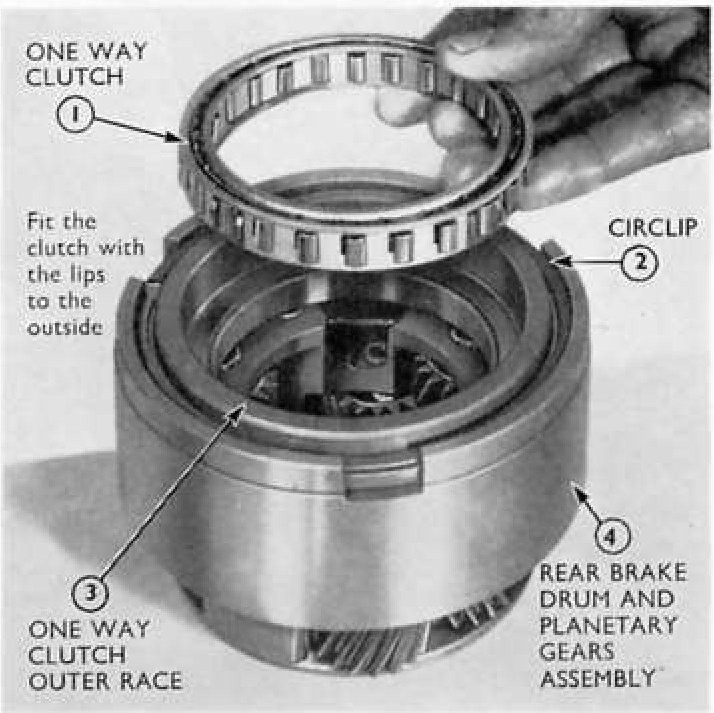


Fig. 52
Fitting One-way Clutch

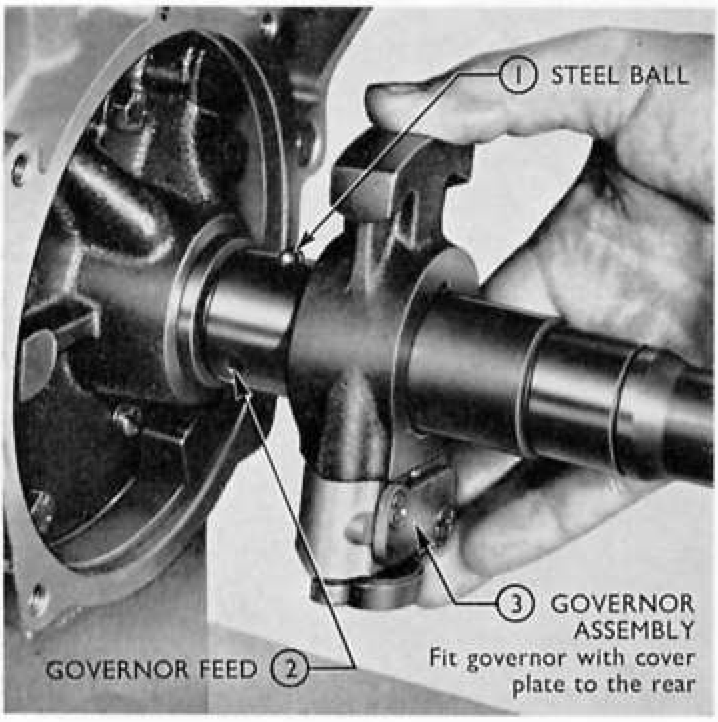


Fig. 51
Fitting the Governor

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.

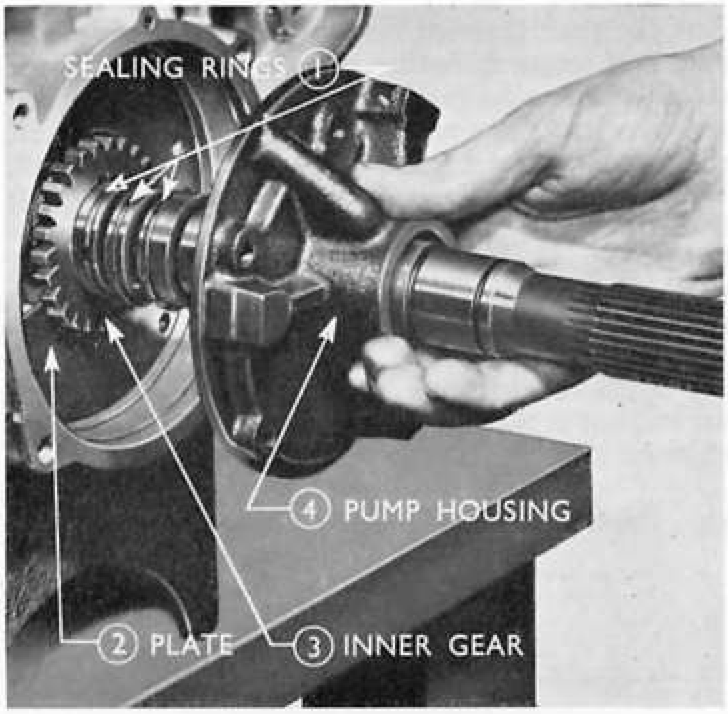


Fig. 53
Fitting the Rear Pump

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

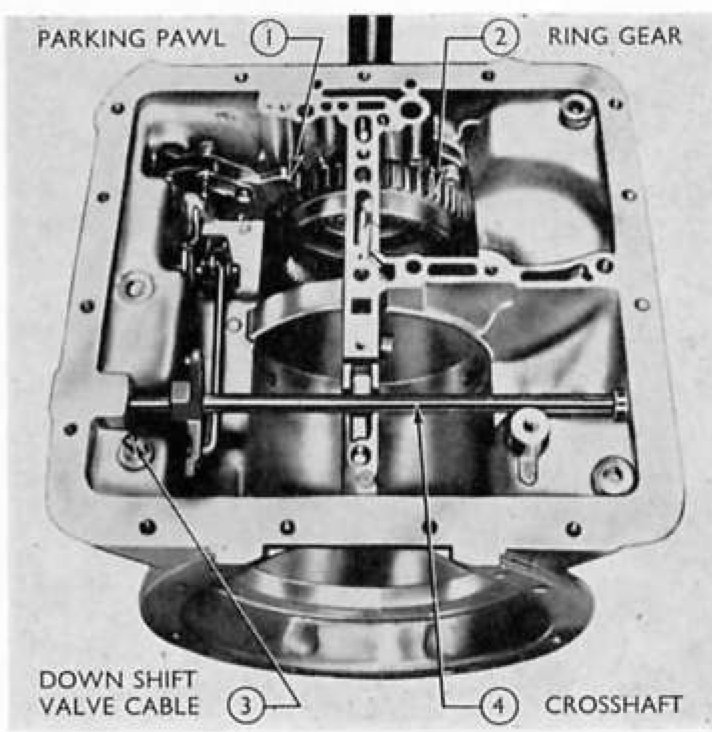


Fig. 54
Parking Pawl and Selector Levers

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.

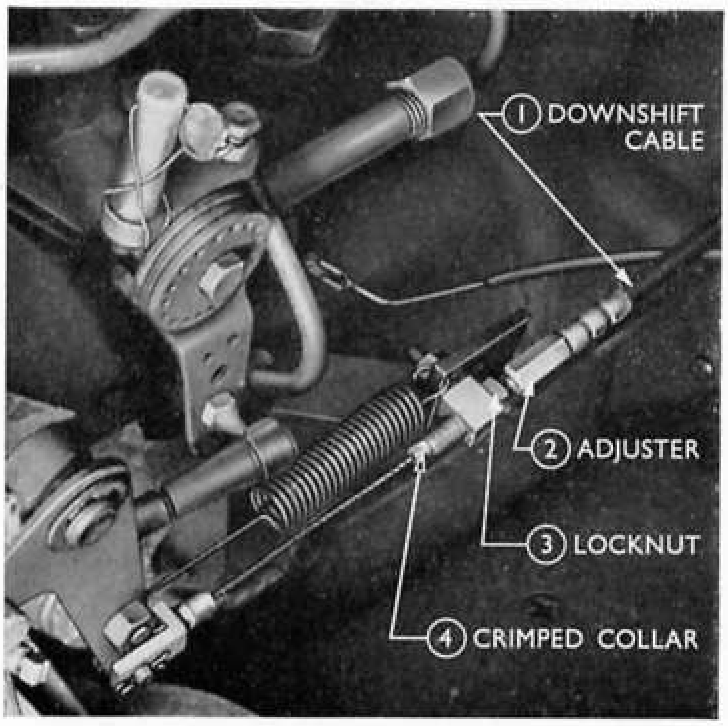


Fig. 55
Downshift Cable (Diesel shown)

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.

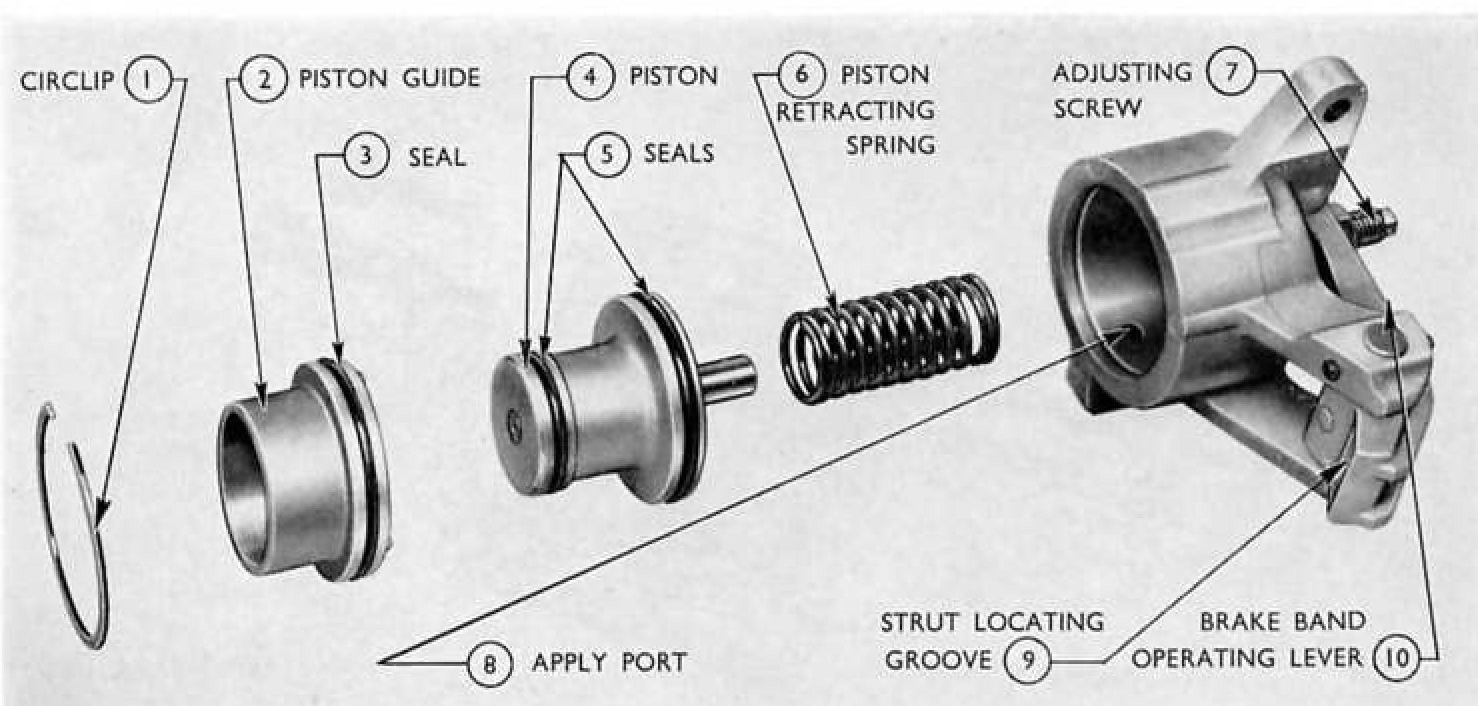


Fig. 56
Front Servo - Exploded View

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.

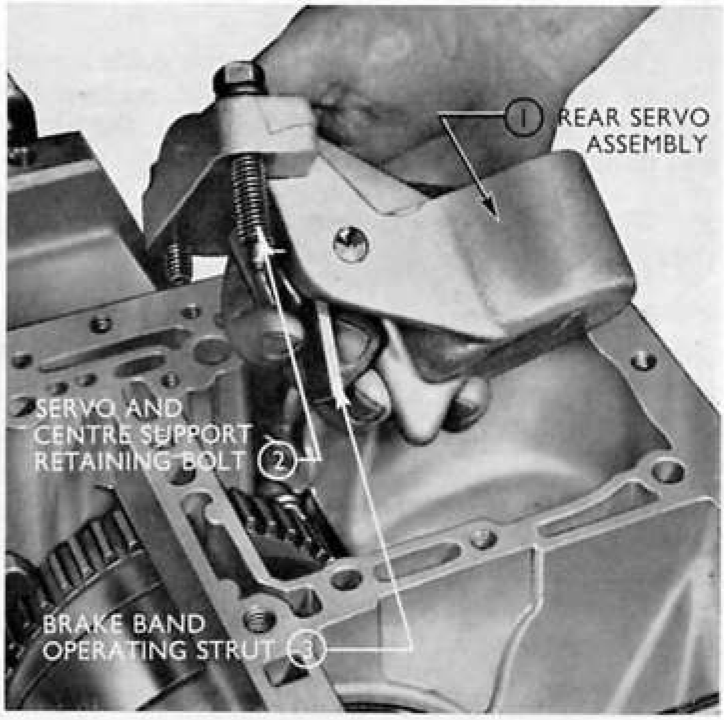


Fig. 58
Replacing Rear Servo

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.

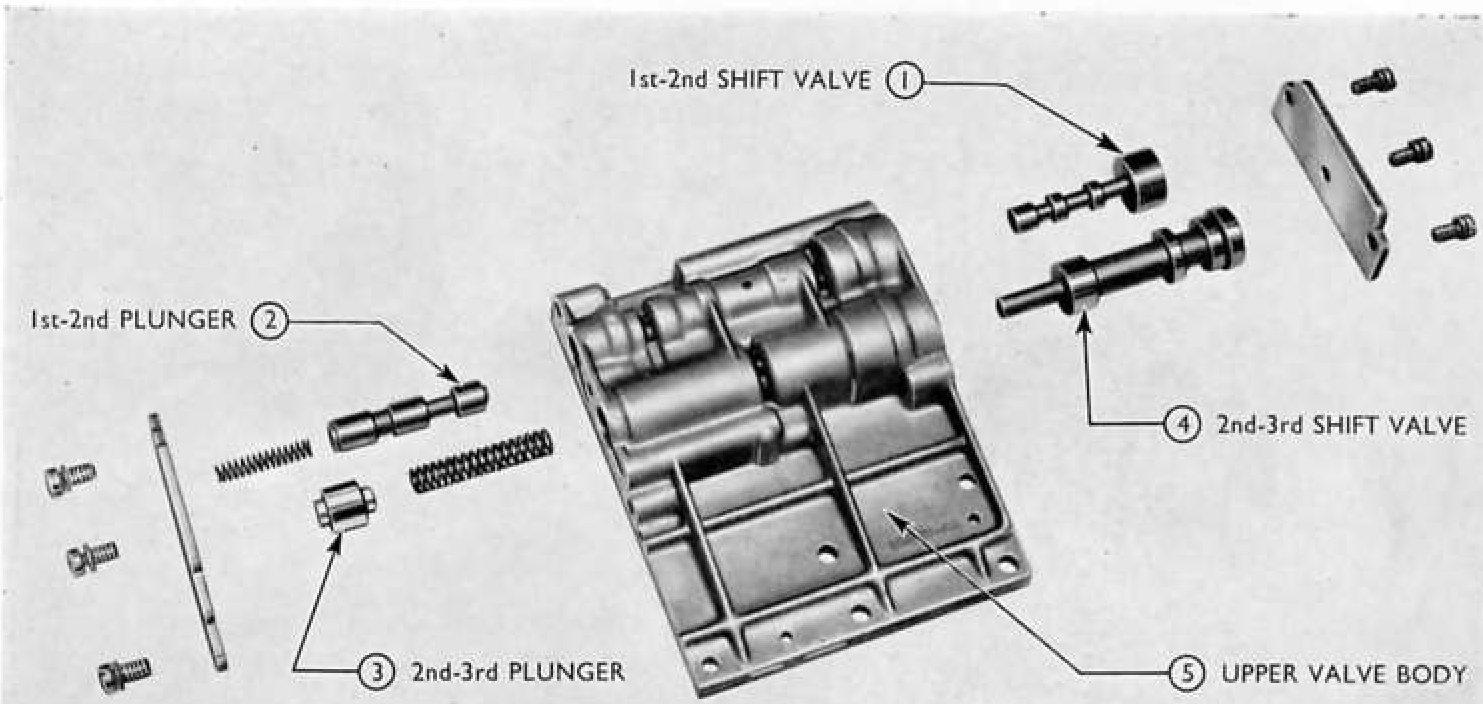


Fig. 57
Upper Valve Body and Valves

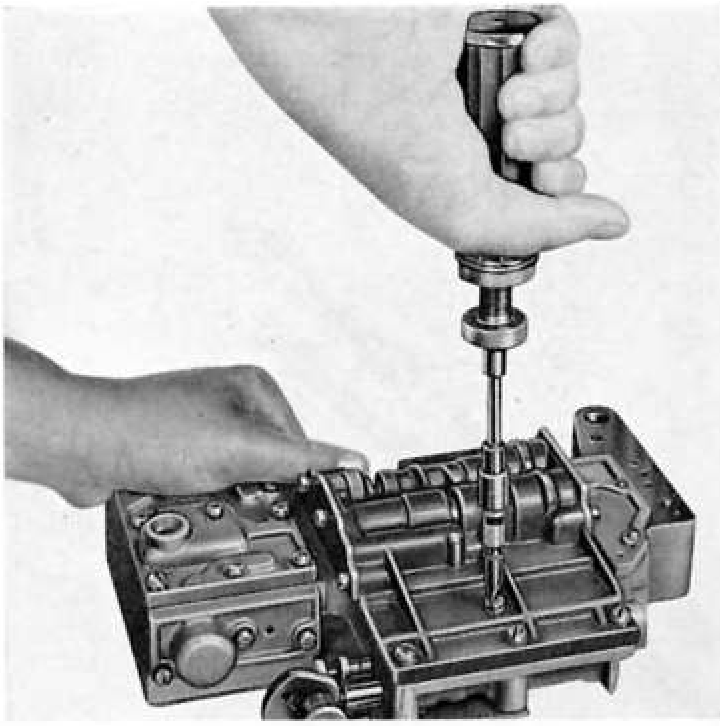


Fig. 59

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.

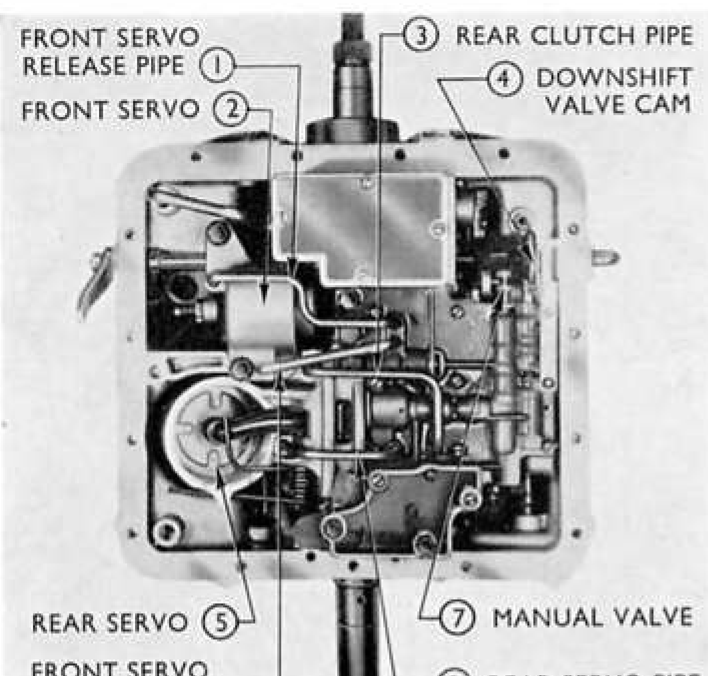


Fig. 60

Fluid Transfer Pipes

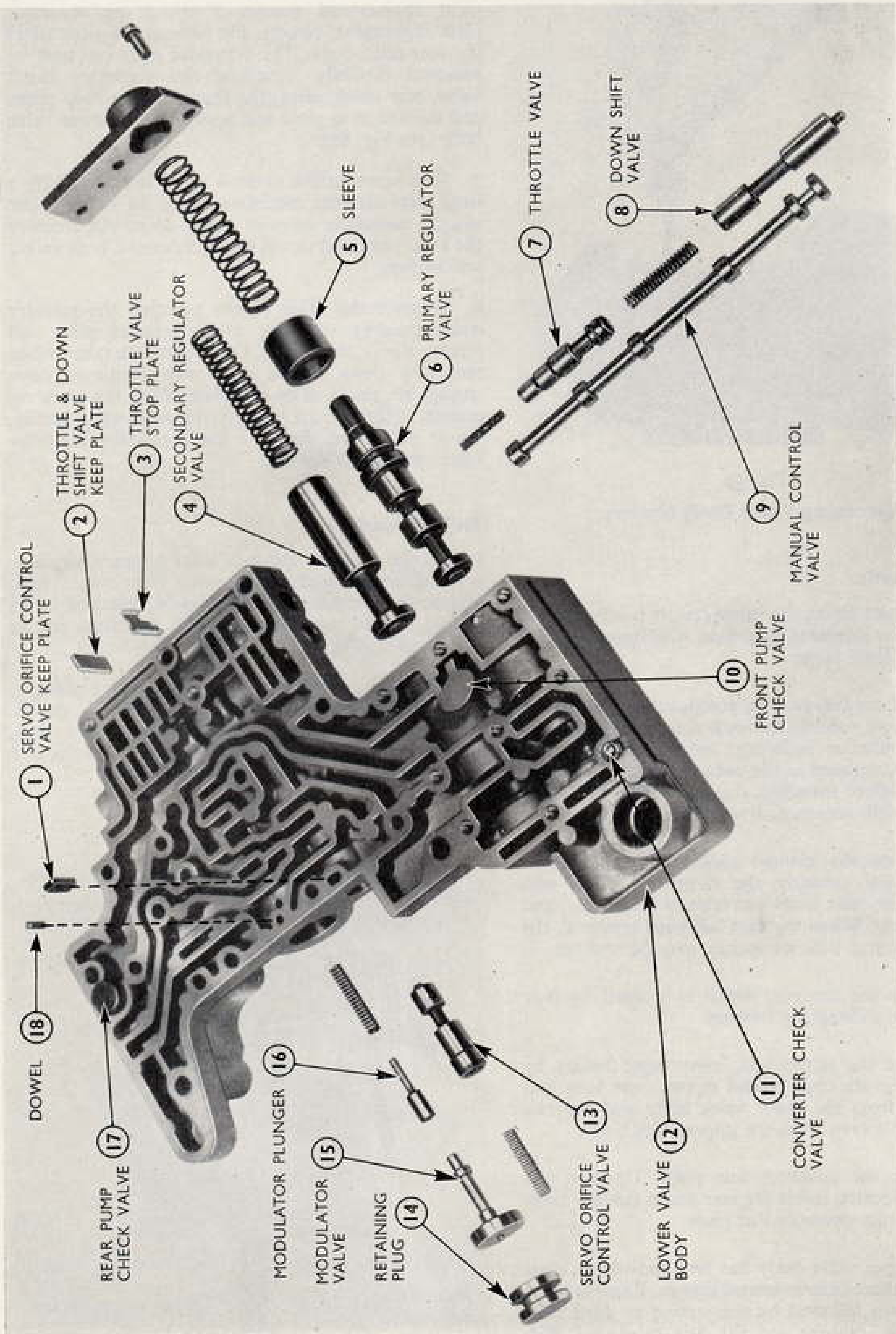


Fig. 61
Lower Valve Body and Valves

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.

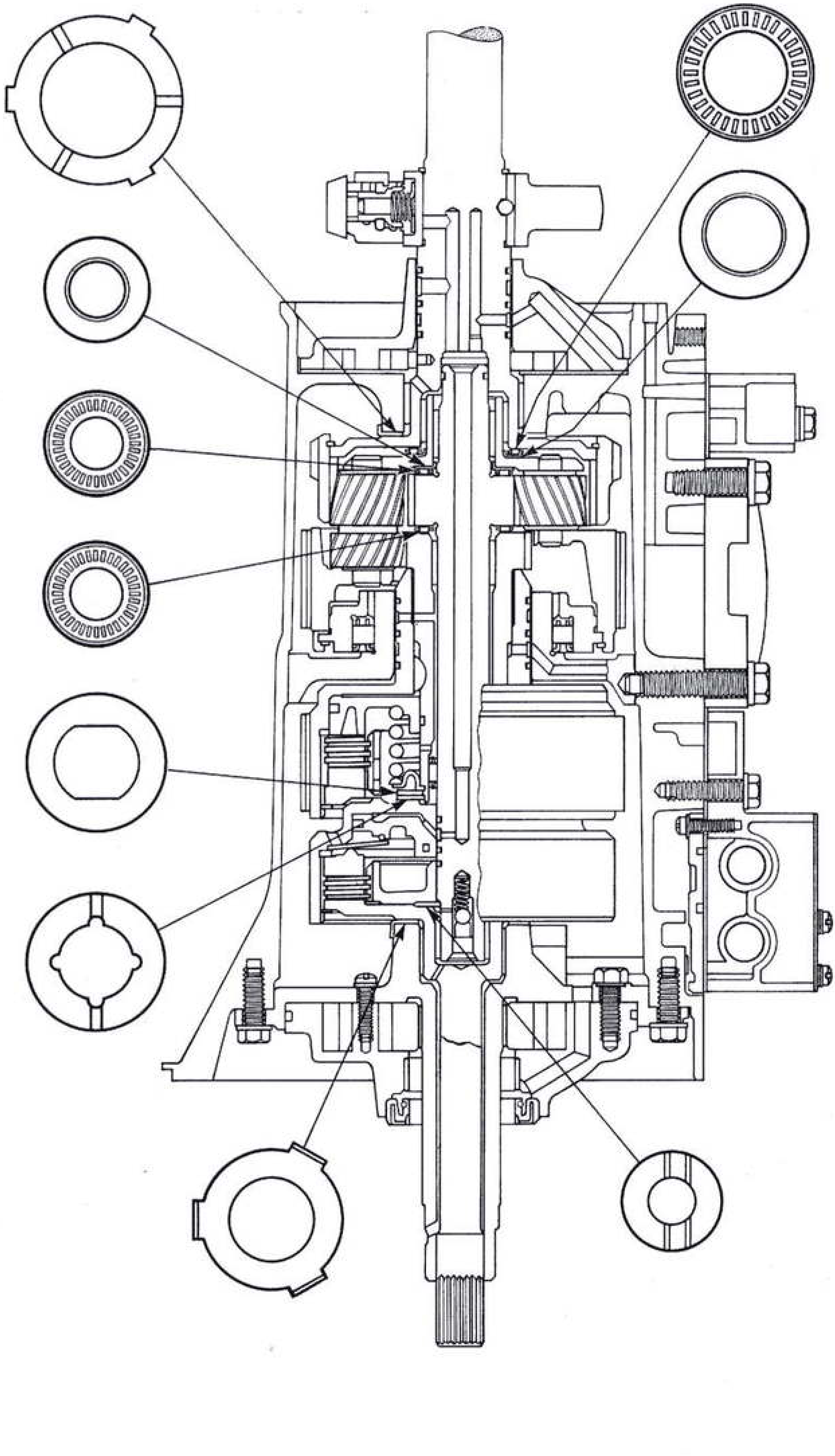


Fig. 62
Location of Thrust Washers

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.

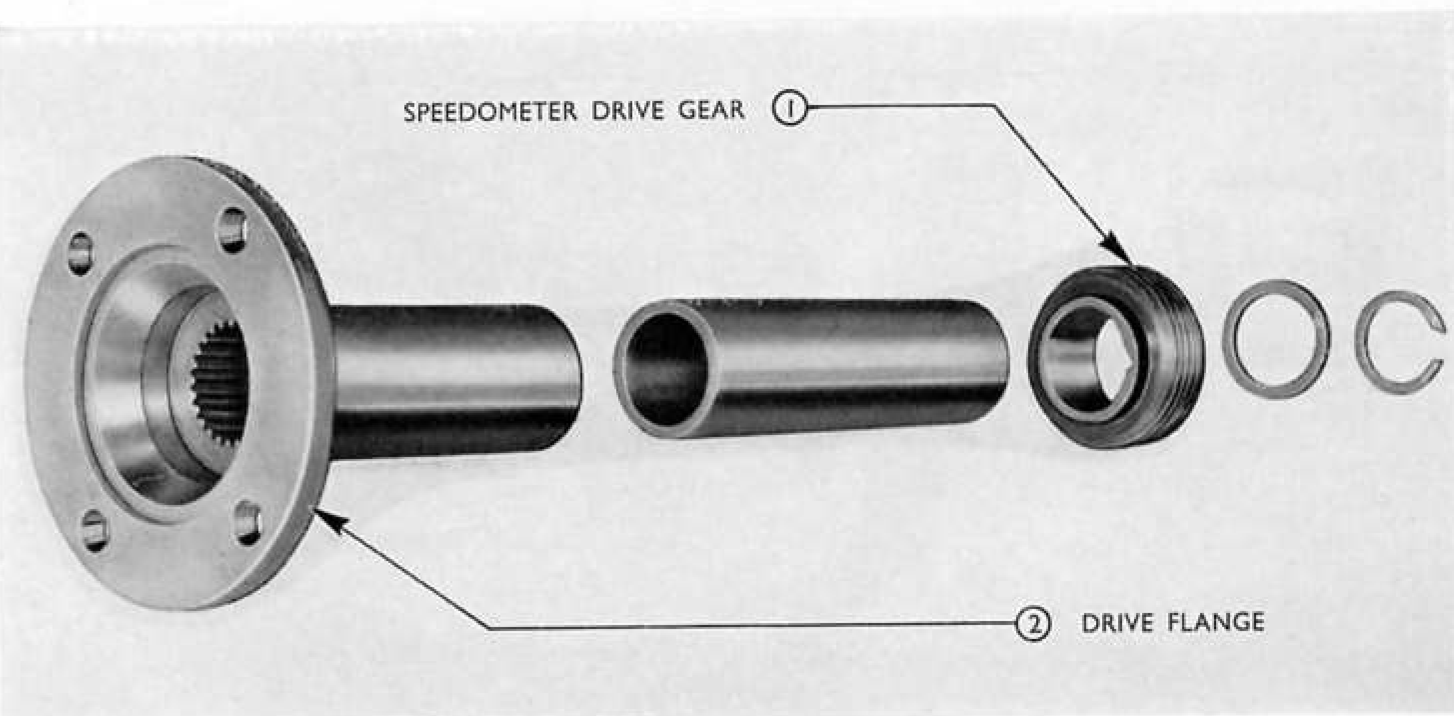


Fig. 63
Speedometer Drive Gear (130 Diesel)

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.

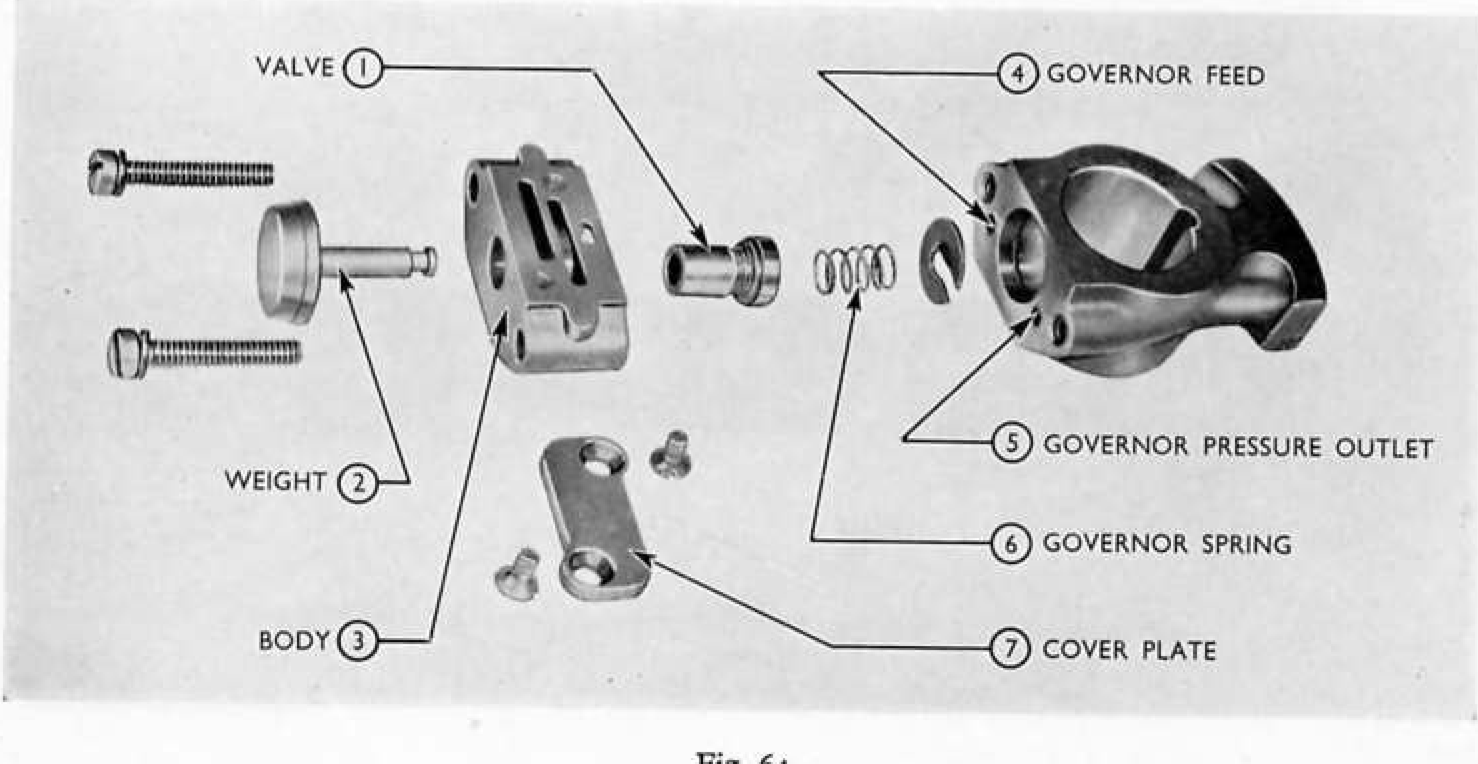


Fig. 64
Governor Assembly - Exploded

ADJUSTMENTS

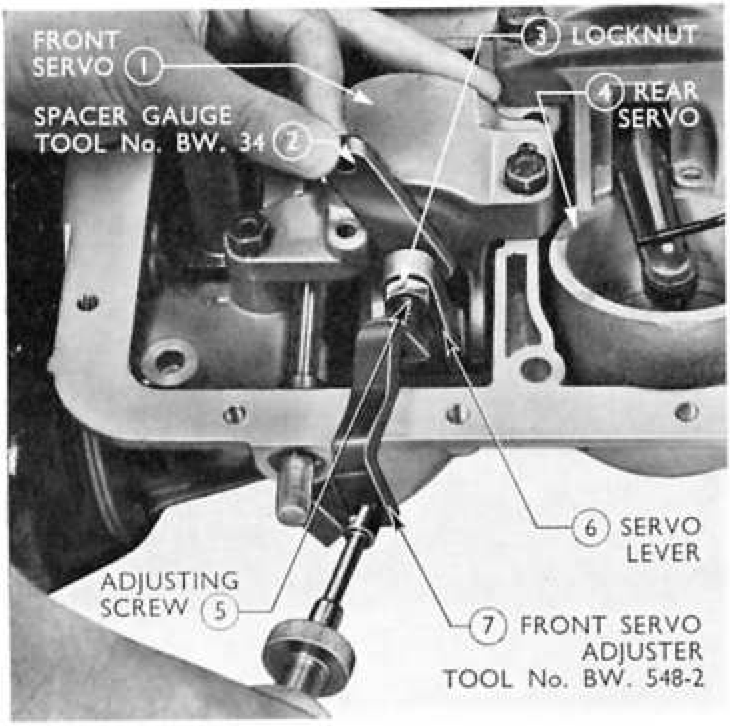


Fig. 65
Front Band Adjustments

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.).

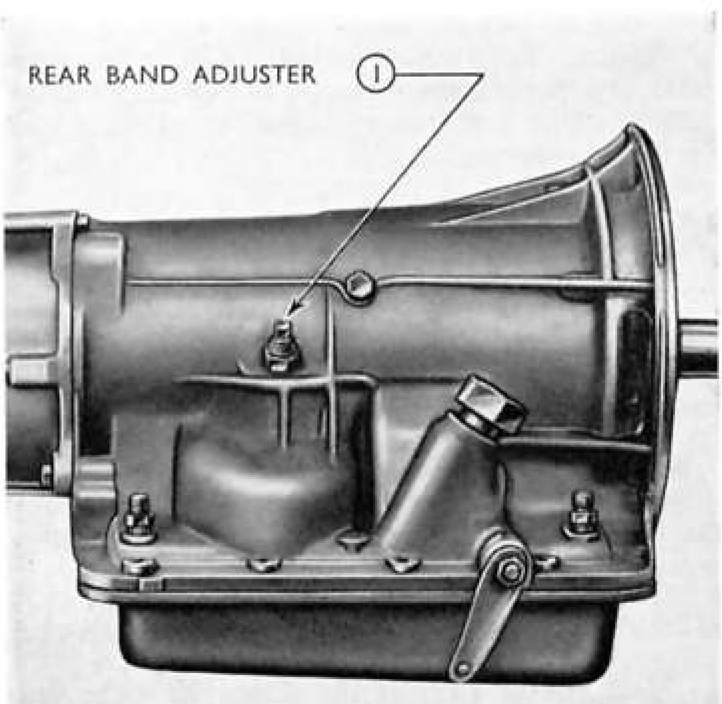


Fig. 66
Rear Band Adjustment

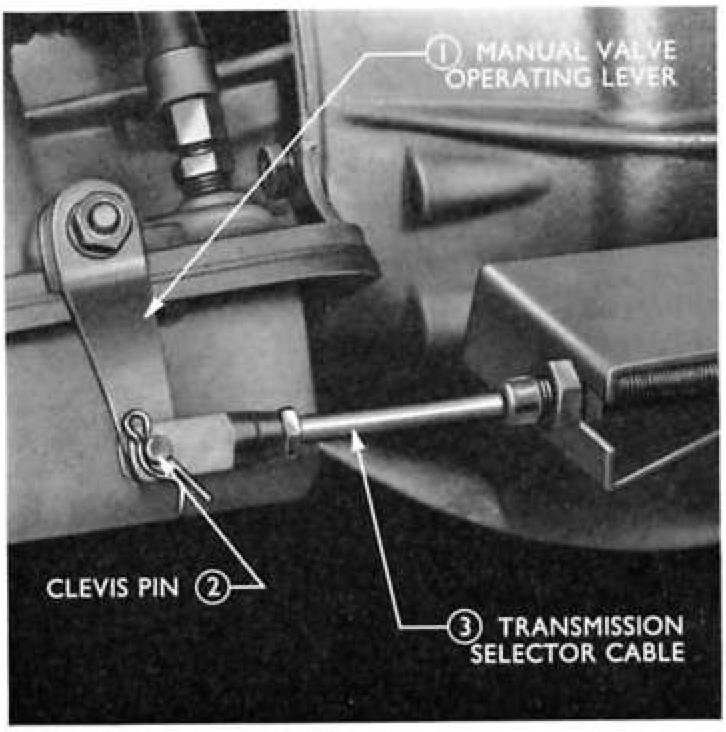


Fig. 67
Selector Cable Adjustment

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.

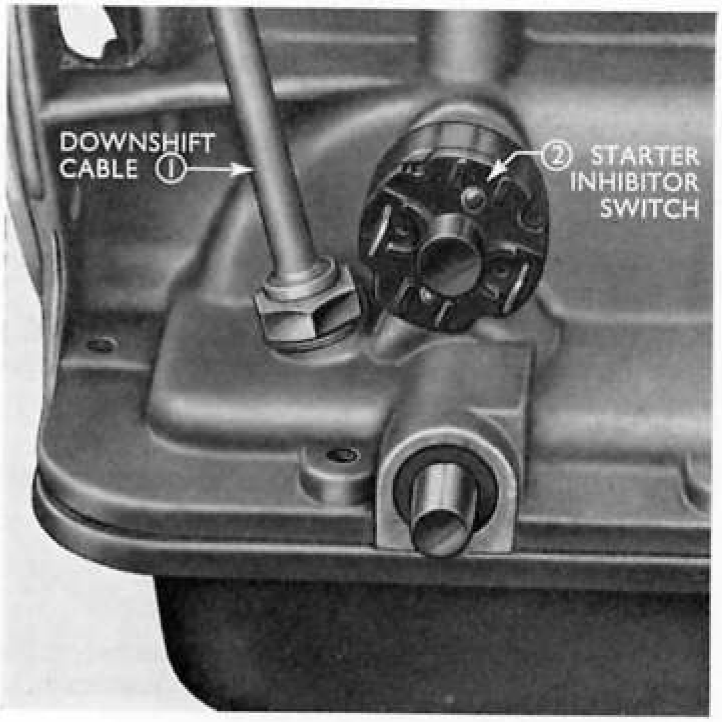


Fig. 68
Inhibitor Switch

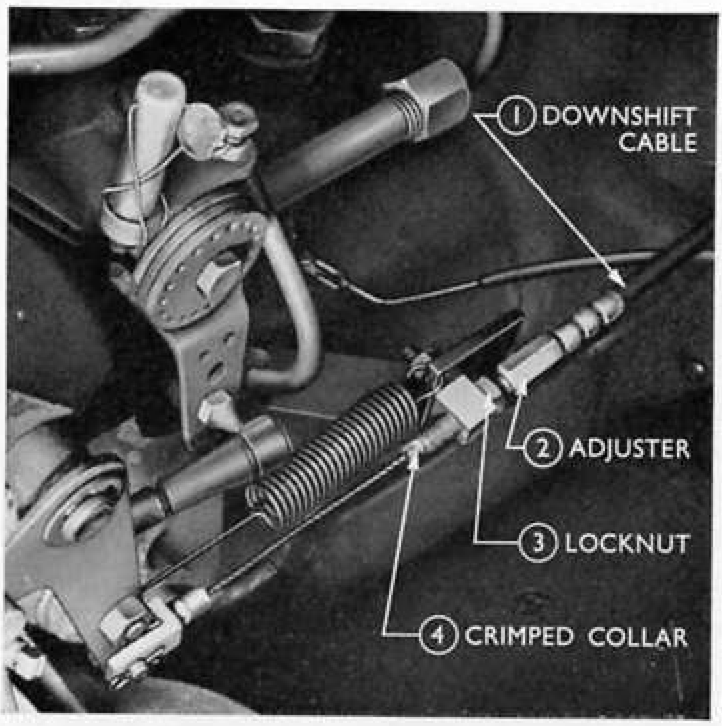


Fig. 69
Downshift Cable Adjuster

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.

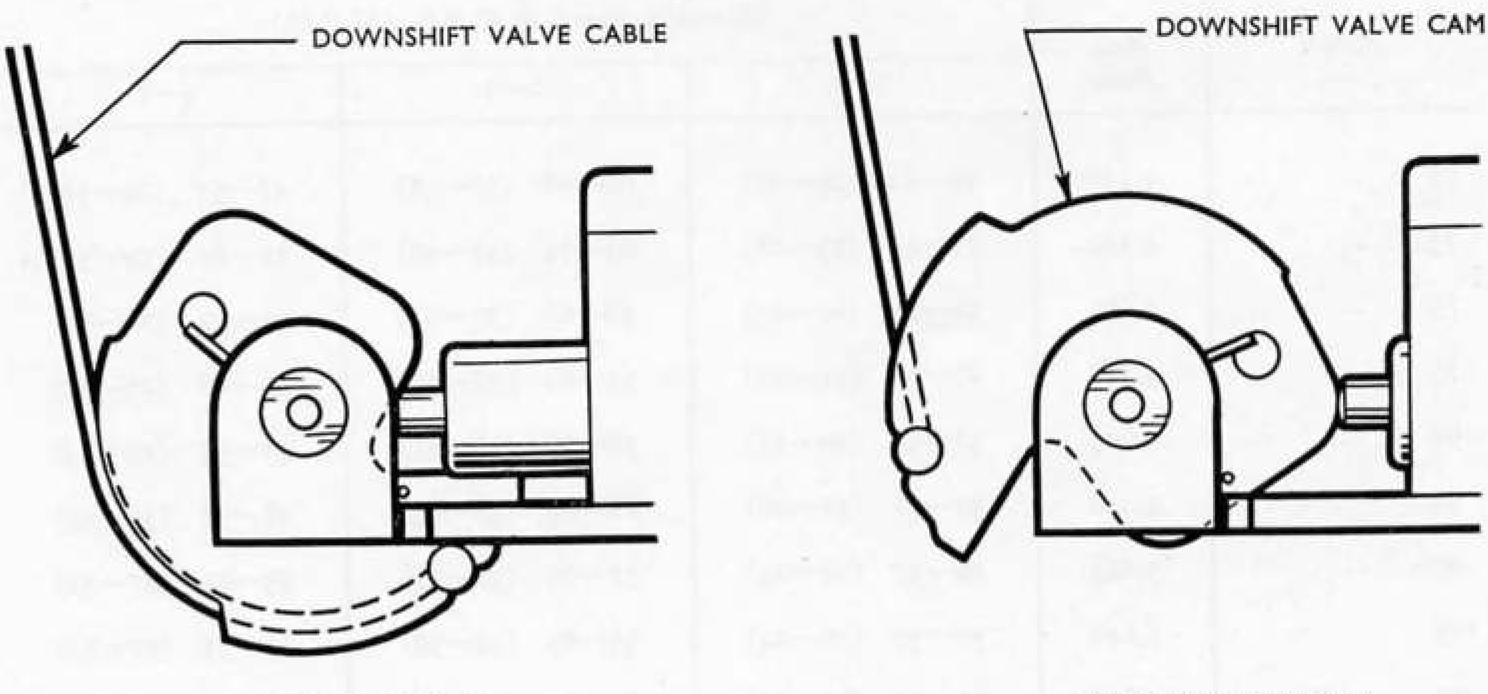


Fig. 71
Downshift Valve Cam and Cable

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.**

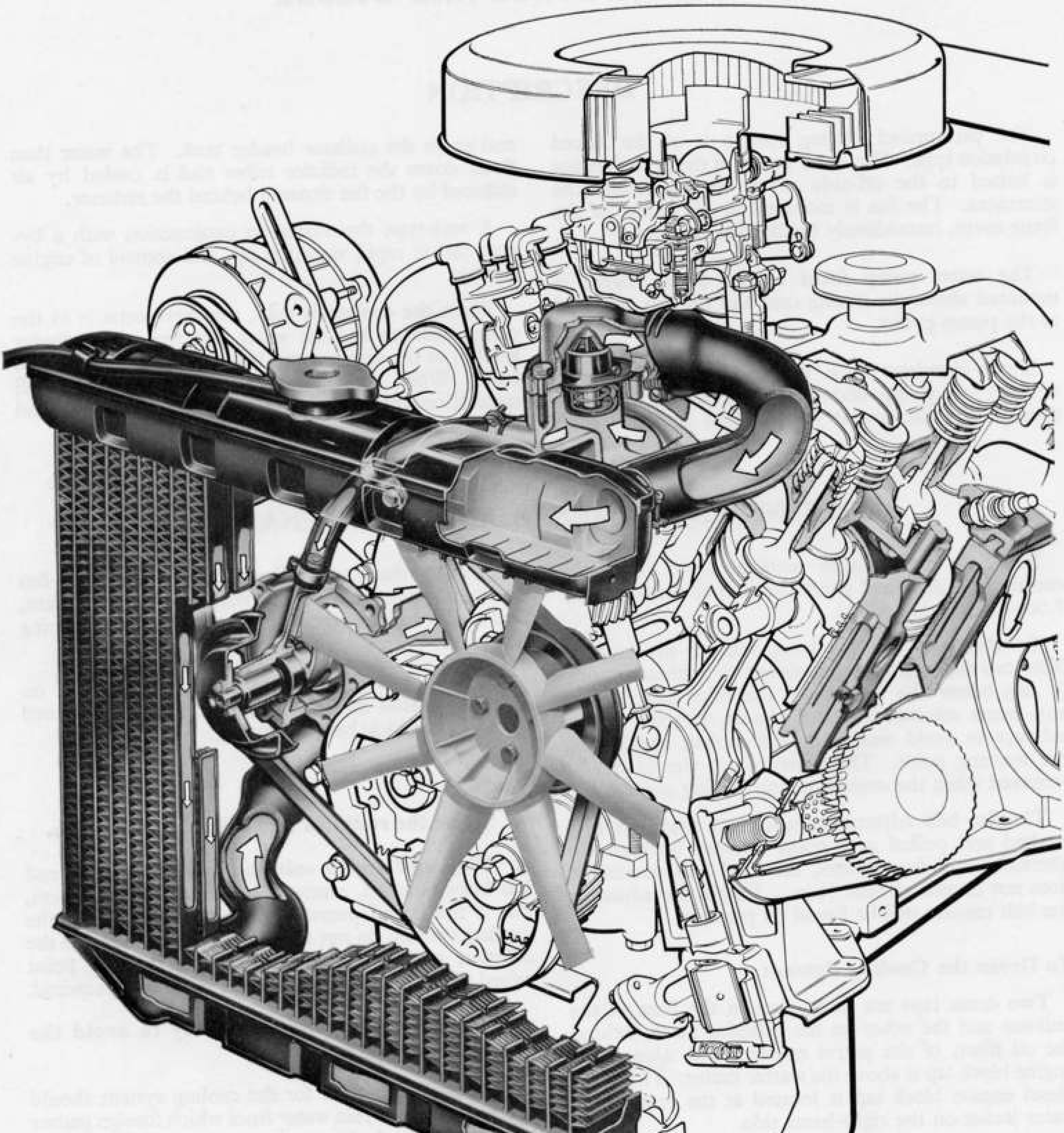
2. **If an anti-freeze solution has been in use** and has been retained, return this to the cooling system, but if the liquid present is not sufficient to fill the cooling system, do not add plain water, otherwise the solution may be weakened and the freezing point raised. Add additional anti-freeze 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.

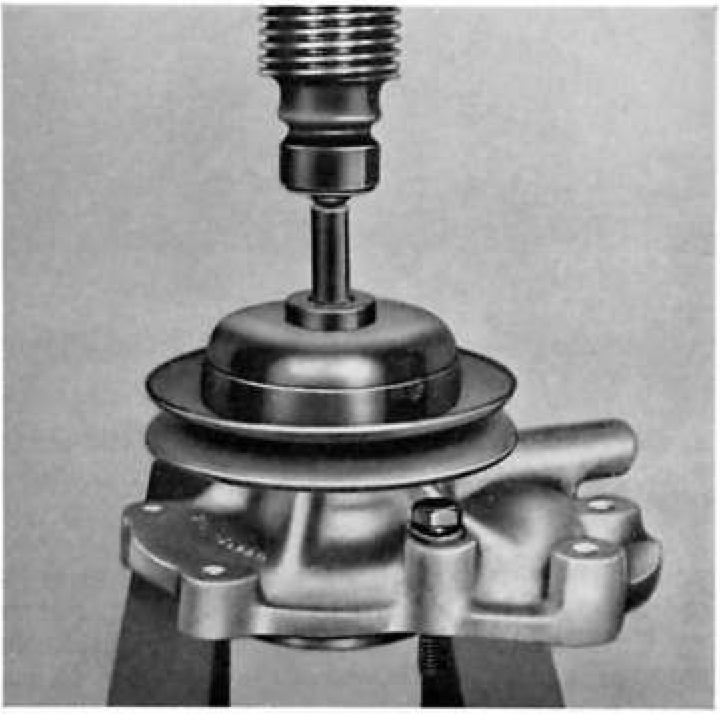


Fig. 2
Removing the Pump Pulley

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).

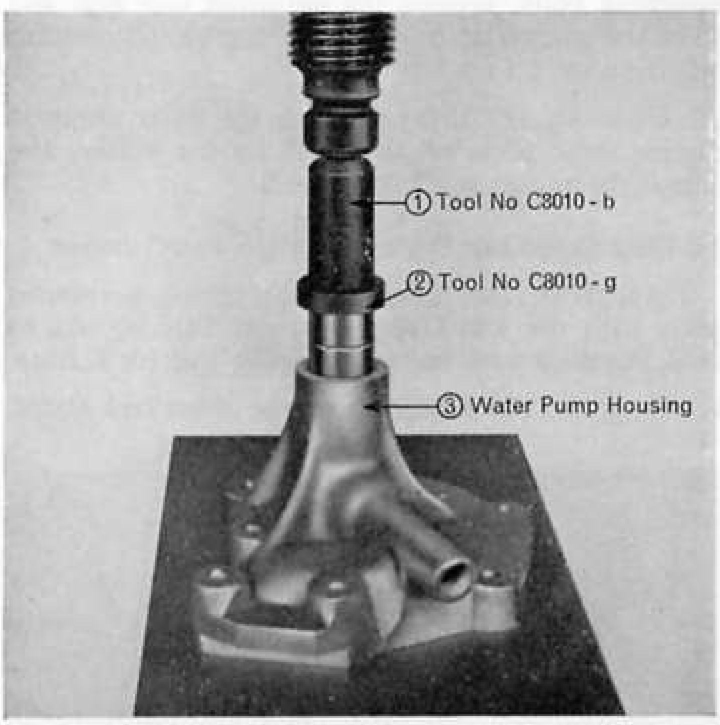


Fig. 3
Fitting Shaft Assembly to Housing

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.

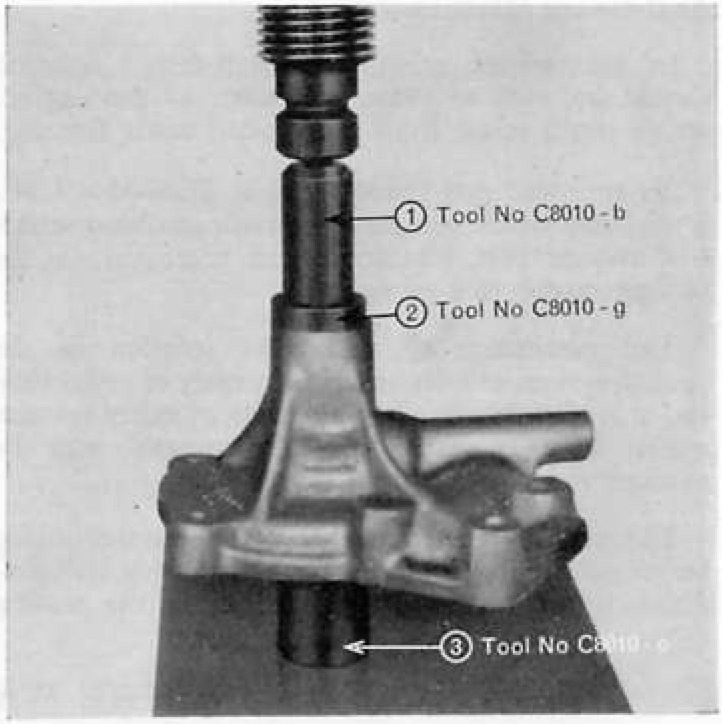


Fig. 4
Fitting Seal to Housing

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

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–4/99 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).

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

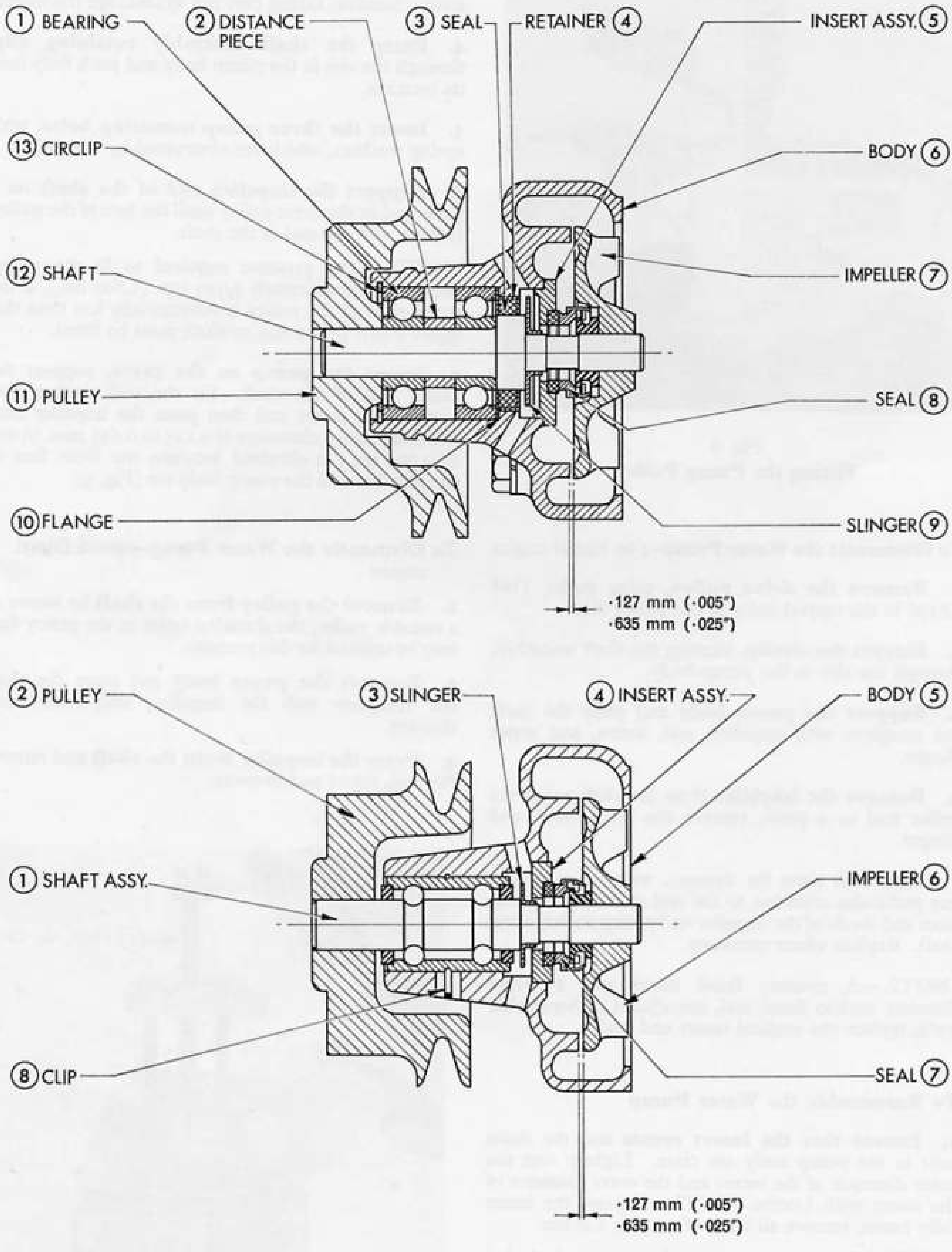


Fig. 8
Sectional Views of Diesel Engine Water Pumps
UPPER - 4/108 LOWER - 4/99

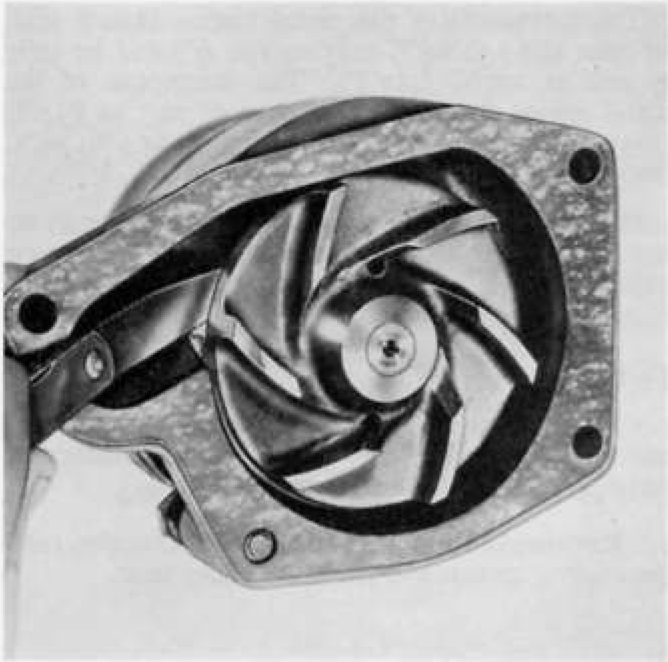


Fig. 9
Checking Impeller Clearance—Diesel

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.

Section 9

FUEL SYSTEM

CONTENTS

SUBJECT

FUEL SYSTEM: PETROL

OVERHAUL PROCEDURES

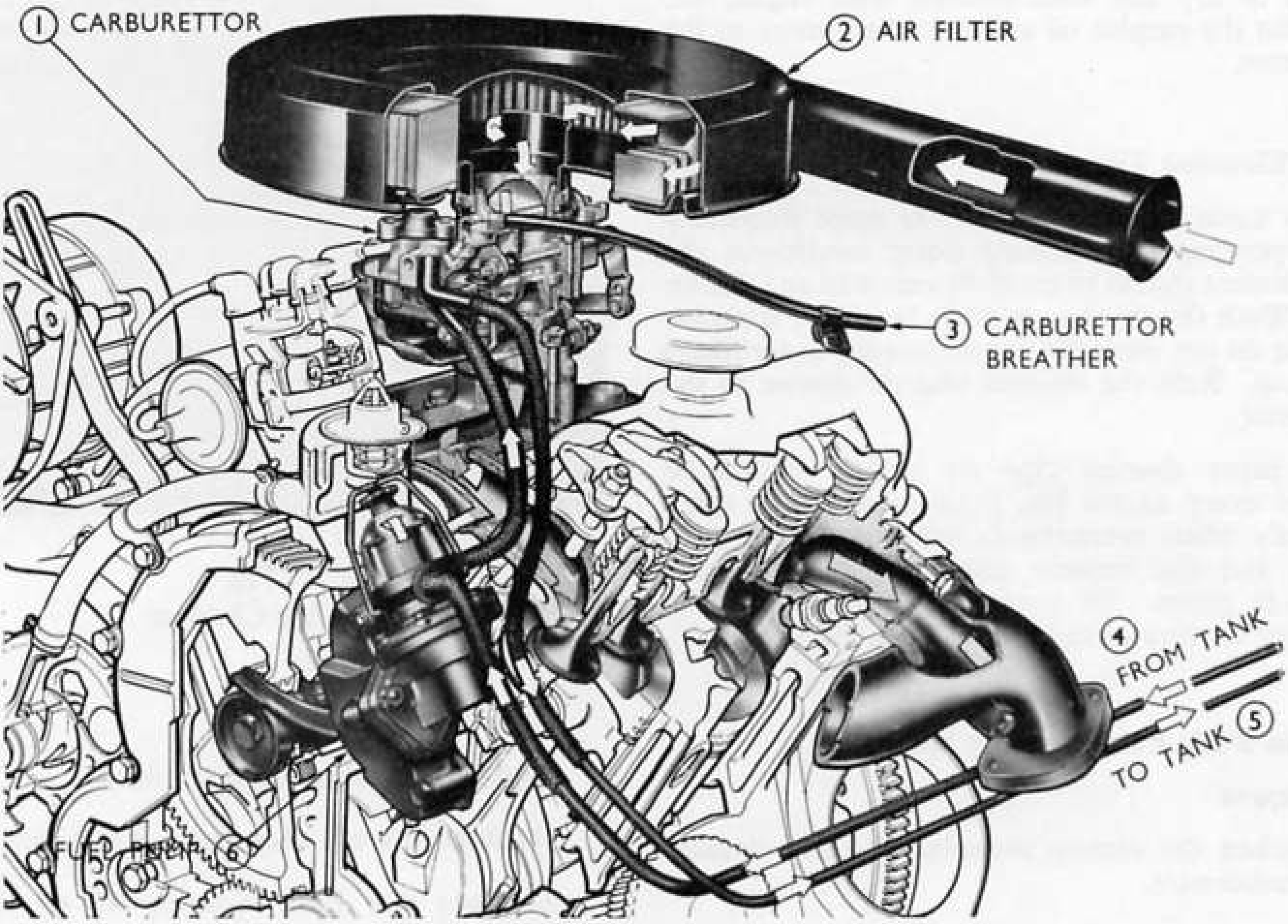


Fig. 1
Fuel System (Prior to September 1968)

Introduction

The fuel system of all standard and de-luxe models consists of a fuel tank, a mechanical fuel pump operated by the engine camshaft and a downdraught carburettor, with the necessary fuel lines.

A standard rectangular fuel tank is located at the left-hand side of the vehicle beneath the floor. The fuel pump is supplied from the tank by means of a rigid fuel line which runs beneath the floor of the vehicle, having flexible connector hoses to tank and engine.

A fuel tank vent pipe is fitted to the top of the tank adjacent to the fuel supply pipe, and the filler cap is also vented. A fuel return pipe is fitted to the tank from a tee piece in the fuel feed pipe adjacent to the carburettor, enabling a continuous flow fuel system to be employed.

The carburettor is of the single-venturi, down-draught type. An accelerator pump, to assist accelera-tion, and an economy device controlled by manifold depression are incorporated, together with a choke valve of the strangler type for cold starting.

The fuel gauge is designed to eliminate needle fluctuation whilst the vehicle is in motion. With this type of gauge the needle moves slowly, taking about 30 seconds to indicate the true reading after switching on the ignition.

Routine Maintenance

Routine maintenance for the fuel system consists of the following:

The fuel pump sediment bowl, gauze filter and sediment chamber should be cleaned every 8,000 km. (5,000 miles.)

Adjust the carburettor slow-running every 8,000 km. (5,000 miles) as described on pages 9 and 14.

The paper type air cleaner element should be renewed every 24,000 km. (15,000 miles) (see page 4). Should the vehicle be operated in dusty conditions it may be necessary to occasionally remove the element, shake it clean and refit.

AIR CLEANER

Wire Gauze Type

The wire gauze type air cleaner should be removed every 8,000 km. (5,000 miles), or more frequently when operating in extremely dusty conditions, and the element and body washed in petrol. Allow the element to dry and then saturate with engine oil. Shake out the surplus oil and refit the cleaner to the carburettor.

Paper Element Type

Every 8,000 km. (5,000 miles) or more frequently when operating in extremely dusty conditions, the paper element should be carefully removed and shaken clean. Wash the air cleaner body in petrol, if necessary, but do not wash the paper element or shrinkage will occur. Refit the element and air cleaner to the carburettor.

The paper element type air cleaner should be removed every 24,000 km. (15,000 miles), or more frequently when operating in extremely dusty conditions, and the element discarded and the body washed in petrol. Fit a new element and refit the cleaner to the carburettor.

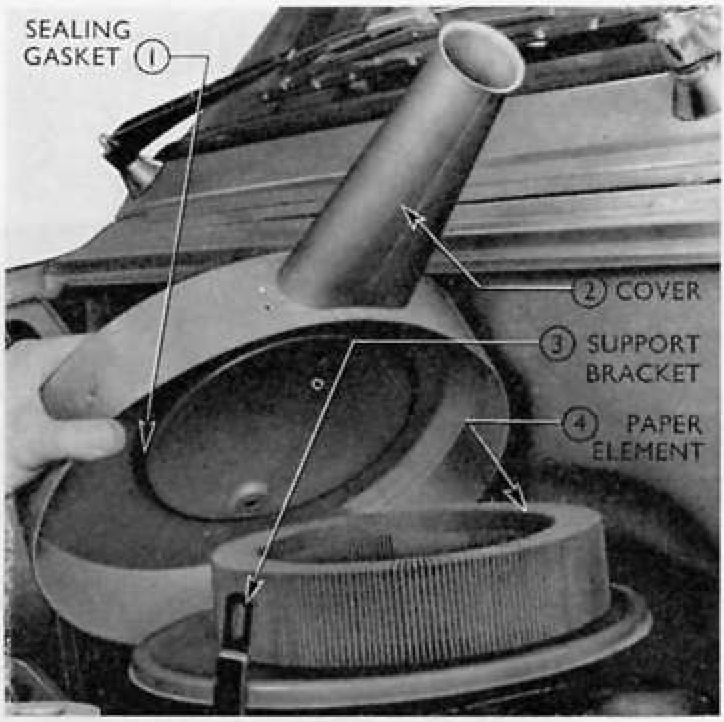


Fig. 2
Air Cleaner

Vehicles Built Prior to May 1967

To Remove

1. **Slacken the clamp securing the air cleaner** to the carburettor.

2. **Remove the bolt from the air cleaner support bracket** and pull off the breather pipe from the rocker cover.

3. **Remove the air cleaner.**

4. **Unscrew the two bolts** in the dished section of the air cleaner.

5. **Lift out and discard the paper element** and two rubber sealing rings.

6. **Thoroughly clean the body** in petrol and allow to dry.

To Replace

1. **Fit two new rubber sealing rings,** one round the boss inside the top cover, shown in Fig. 2, the other locating at the bottom, inside the body of the cleaner.

2. **Place the new paper element** in the centre of the body so that it seats on the lower sealing ring.

3. **Carefully replace the top cover** ensuring that the upper sealing ring remains in place on the boss.

4. **Tighten the two screws** securely.

5. **Replace the air cleaner** and breather pipe.

6. **Replace the bolt** retaining the air cleaner to the support bracket.

7. **Tighten the air cleaner clamp.**

Vehicles Built from May 1967 Onwards

To Remove

1. **Unscrew the hexagon-headed bolt** and steady bracket and lift the air cleaner assembly off the carburettor.

2. **Remove the cover** from the body.

3. **Remove the element** from the body.

To Replace

1. **Locate the body** on the carburettor with the spout facing towards the left-hand front cover of the engine compartment.

2. **Place the element** into the body and centralise it on its seat.

3. **Position the cover** on the body with the alignment arrow pointing along the spout and retain with the hexagon-headed bolt and steady bracket.

CARBURETTOR
(Prior to May 1967)

The carburettor is of the single venturi down-draught type. It incorporates an accelerator pump to ensure smooth and rapid acceleration, an economy unit, and a choke valve of the semi-automatic strangler type.

Description and Operation

The cold starting device consists of a choke plate which is connected by means of a flexible cable to a friction locking type control on the facia panel. Pulling the control closes the choke plate and at the same time, by means of an interconnecting rod opens the throttle plate a pre-determined amount; the degree of throttle opening allowing depression created by the induction strokes to reach the mixture chamber and choke tube areas, and ensuring a fast idle speed after starting.

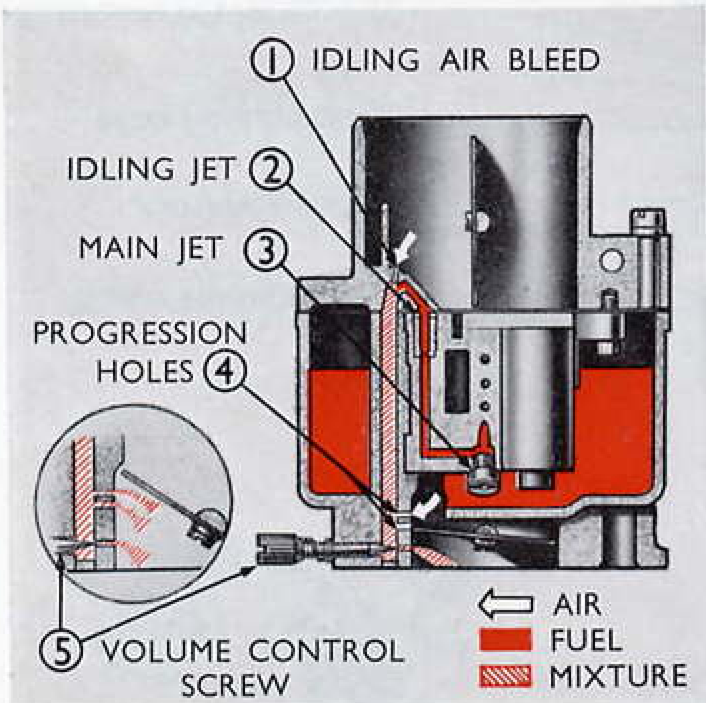


Fig. 3
Idling and Progression

As the engine is rotated by the starter motor, a high depression is created upon the emulsion block discharge beak, and fuel is thus drawn from the capacity well in the emulsion block. When the engine is running with the choke shut, the depression created in the manifold at low speed acts on the largest portion of the spring-loaded choke plate, this being offset on its spindle, thereby causing the choke plate to open admitting sufficient air to keep the engine running.

Idling Supply (Fig. 3)

With the accelerator released and the throttle plate in the idling position, petrol is supplied by the slow-running or idling jet which obtains fuel from the metered side of the main jet, located in the base of the emulsion block. The fuel is emulsified by air admitted through the idling air bleed hole in the main air intake. The resulting mixture is drawn down the vertical channel in the carburettor body to the idling discharge hole just below the throttle plate, and thence into the induction manifold. The quantity of mixture passing through the idling discharge hole is regulated by the needle-type volume control screw.

The two small holes above the idling discharge hole in the carburettor body also connect to the vertical channel supplying the idling mixture. These progression holes provide a smooth and progressive supply of mixture as the throttle plate is gradually opened.

Main System—Full Load (Fig. 4)

On opening the throttle further, the engine depression is imposed on the emulsion block beak. This depression draws fuel from the channels above the main and compensating jets and from the enrichment jet. Air is supplied simultaneously by the "full throttle" air bleed and the enrichment air bleed, which remains open under all conditions, and also, providing the economy device is operative, by air regulated through the larger "part throttle", or main air bleed. This fuel/air mixture is then drawn from the emulsion block beak into the induction manifold.

As the petrol level drops in the main jet channel, a number of small holes are progressively exposed. These admit more air, thus emulsifying the mixture, and maintaining a balanced fuel/air ratio.

Economy Device Main System—Part Load (Fig. 6)

This is incorporated in a small casting secured by three screws to the top of the carburettor body. A diaphragm inside this casting is held in a flexed

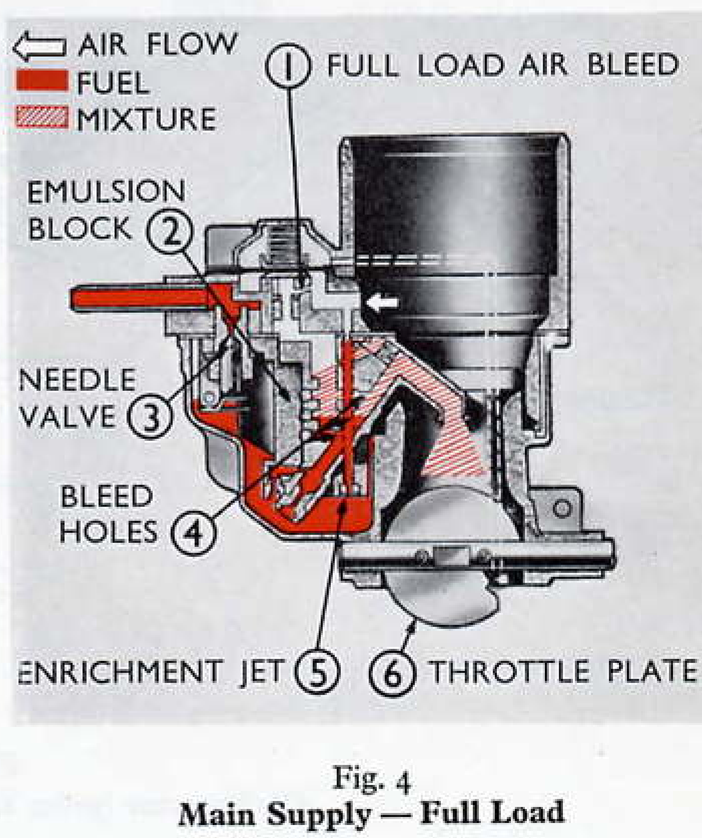


Fig. 4
Main Supply — Full Load

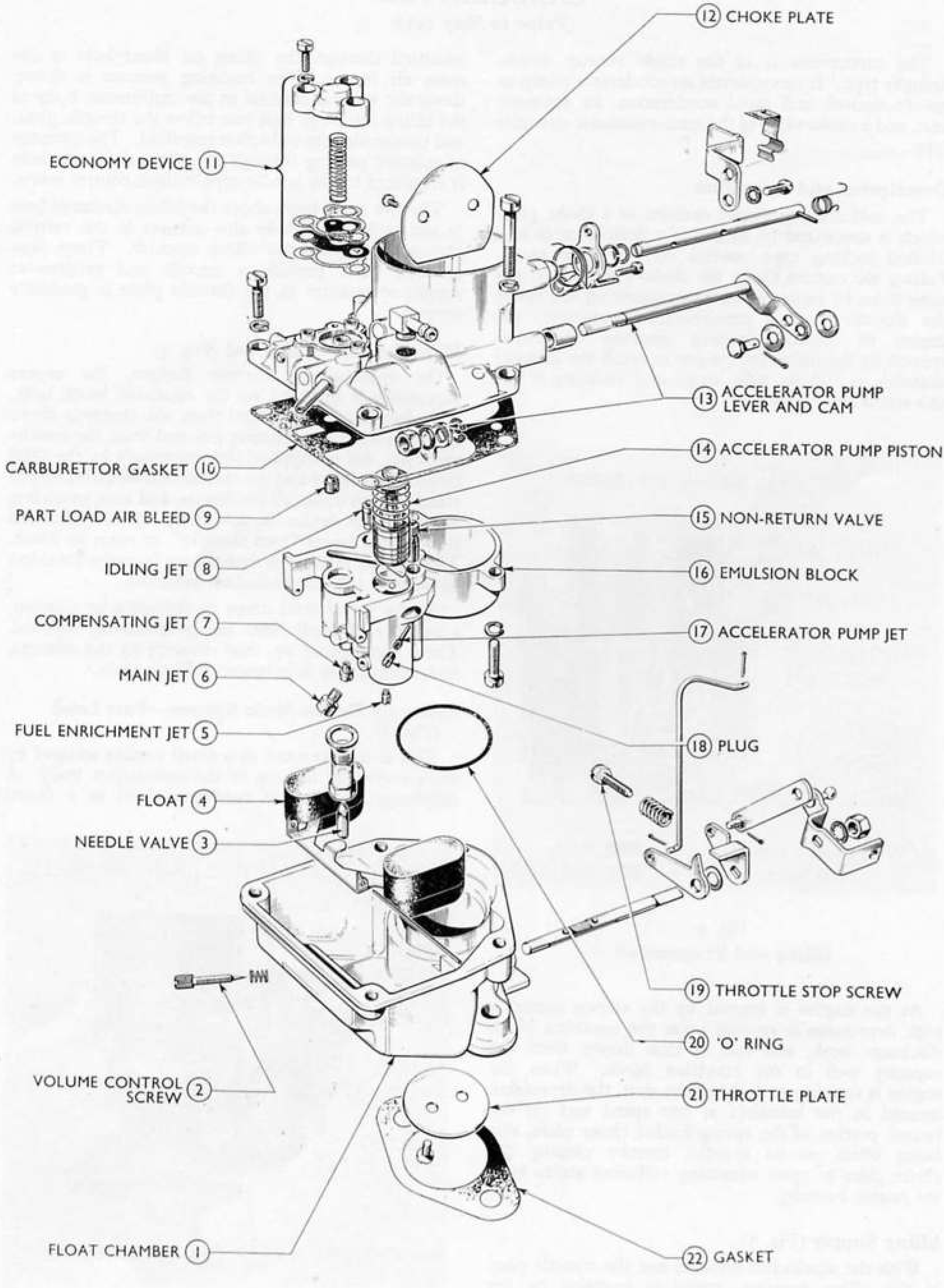


Fig. 5
Carburettor (prior to May 1967)—Exploded

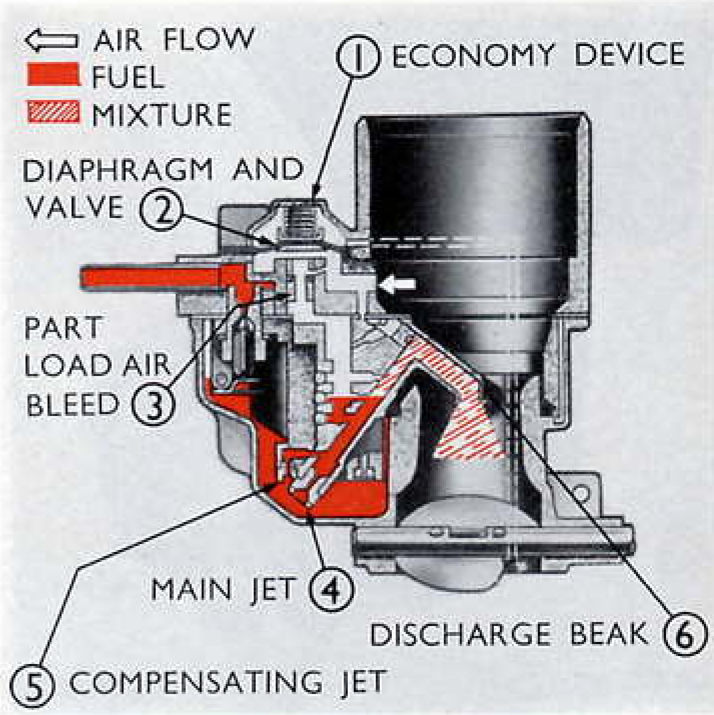


Fig. 6
Main Supply — Part Load

condition by spring pressure. The back of the diaphragm and valve (i.e. on the same side as the spring) is directly connected by an internal passage to the engine side of the throttle plate (see dotted lines Fig. 4).

On acceleration and "full throttle" conditions, when the manifold depression is low, the spring retains the valve attached to the diaphragm on its seating. The only air supply to the jets is through the "full throttle" air bleed.

Under part throttle conditions when the manifold depression is high, this depression is felt on the spring-loaded side of the diaphragm, drawing the diaphragm back and lifting the valve from its seat. Air is allowed past this valve, the quantity of air being controlled only by the "part throttle" air bleed, therefore increasing the degree of air bleeding to the emulsion well and consequently reducing the depression on the compensating and main jets, resulting in a weaker mixture being supplied by the carburettor.

The action of the economy device is completely automatic, being controlled by the demands of the engine.

Accelerator Pump System

The purpose of the accelerator pump is to ensure smooth acceleration, and prevent any hesitation when the throttle is suddenly opened. The richer mixture required to fulfil these conditions is provided by a controlled and metered supply of fuel from the accelerator pump into the carburettor venturi coincident with the sudden opening of the throttle plate.

When the pump piston is at the top of its stroke, the pump chamber is charged with fuel admitted from the float chamber through the check valve, (lower ball valve) at the base of the chamber. When the throttle is suddenly opened, a lever and cam connected to the throttle linkage, forces the pump piston down, discharging the fuel in the accelerator pump well through the discharge valve (upper ball valve) and the horizontal accelerator pump jet discharge nozzle into the air stream. The pump piston is returned to the charged position by the piston spring ready for the next stroke.

The travel of the piston and, consequently, the volume of fuel discharged at each stroke can be set in one of two positions (see Carburettor Maintenance, page 9).

To Remove

1. **Remove the air cleaner.**

2. **Disconnect the inner choke cable** and remove the outer cable retaining clip.

3. **Disconnect the throttle linkage** from the carburettor.

4. **Detach the fuel pipe union.**

5. **Disconnect the distributor vacuum pipe** at the rubber connection.

6. **Unscrew the carburettor flange nuts** and remove the spring washers, carburettor and gasket.

To Dismantle

1. **Disconnect the accelerator pump** control arm by removing the split pin retaining the arm to the accelerator pump operating lever.

2. **Disconnect the choke link rod** from the choke control lever by removing the split pin.

3. **Unscrew the four screws** retaining the two halves of the carburettor and separate the assembly.

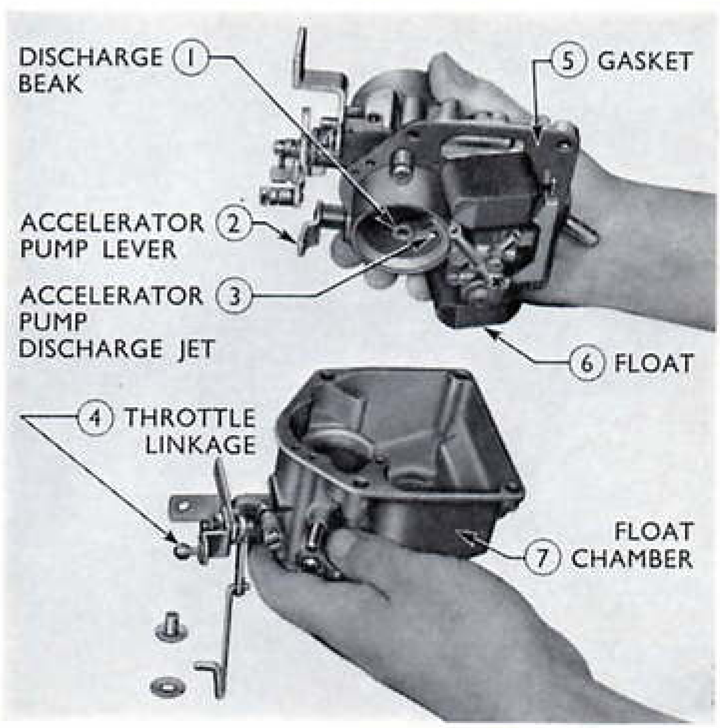


Fig. 7
Dismantling the Carburettor

4. Withdraw the float pivot pin and remove the float assembly, allowing the needle valve to be withdrawn.

5. Remove the emulsion block. Unscrew the needle valve housing and washer, and the screw either side of the choke tube. Remove the emulsion block and gasket.

6. Withdraw the accelerator pump piston assembly.

7. Remove the following jets from the emulsion block, using suitable screwdrivers, (**do not** damage the jet with an unsuitable or badly worn screwdriver), the main jet, compensating jet and enrichment jet from the lower section, and the idling fuel jet and accelerator pump non-return valve from the upper face. The accelerator pump jet can be removed after unscrewing the brass plug. The other non-return valve ball can be removed after hooking out the spring from the bottom of the accelerator pump bore. Do not scratch the bore.

8. Remove the economy valve housing by unscrewing the three retaining screws. Remove the housing, diaphragm and two gaskets and spring. The part throttle air bleed screw can be unscrewed from the opposite face of the carburettor body.

9. Unscrew the two screws retaining the choke plate to the spindle and withdraw the spindle and return spring assembly and washer.

10. Remove the accelerator pump operating lever. Unscrew the brass nut and shakeproof washer from the accelerator pump shaft, and withdraw the operating cam. Remove the circlip and withdraw the shaft and brass collar.

11. Remove the volume control screw and spring from the lower half of the carburettor body. Unscrew the throttle stop screw and spring.

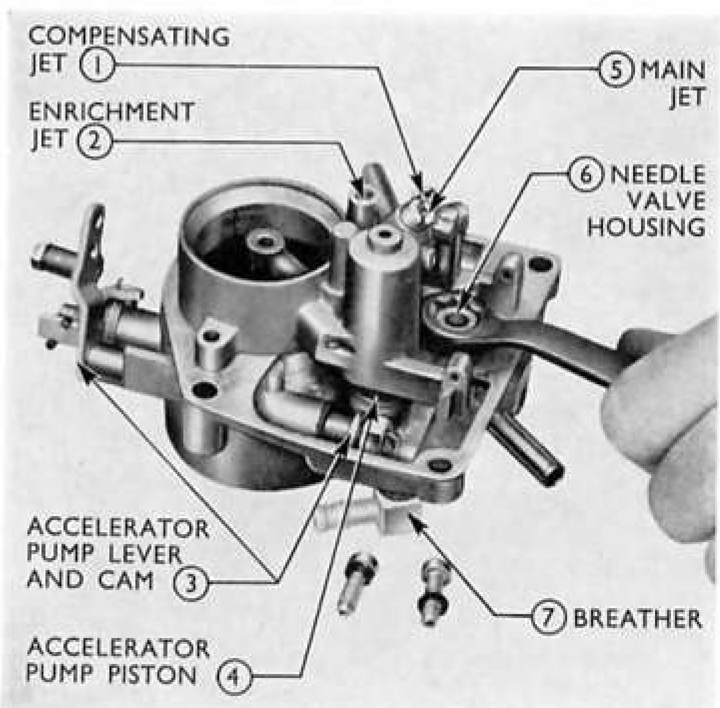


Fig. 8
Removing the Emulsion Block

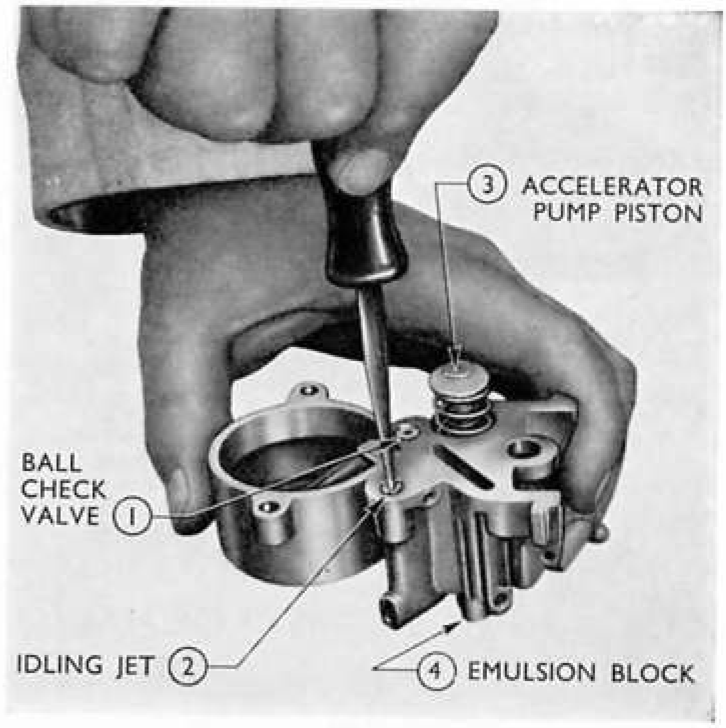


Fig. 9
Removing the Idling Jet

12. Unscrew the throttle plate retaining screws and remove the plate from the spindle. Withdraw the spindle assembly.

13. Remove and inspect the rubber 'O' ring around the choke tube.

To Reassemble

1. Replace the rubber 'O' ring around the choke tube in the lower half of the carburettor body.

2. Insert the throttle spindle assembly and replace the throttle plate and the two retaining screws. The larger flat on the spindle must face the lower flange when the throttle is closed. Lightly centre-punch the screw threads to retain the screws in position.

3. Replace the volume control screw and throttle stop screw with their respective springs.

4. Replace the accelerator pump operating lever. Slide the brass collar on the shaft and fit the shaft to the carburettor body. Replace the cam whilst holding the operating lever vertical. The cam must face the accelerator pump piston when assembled. Replace the shakeproof washer and nut and finally fit the circlip to the shaft.

5. Replace the choke spindle assembly and refit the choke plate and two retaining screws. The spindle flat should face towards the air cleaner when the choke is closed. Ensure that the choke plate return spring is correctly tensioned and fitted.

6. Replace the economy valve assembly. Locate the diaphragm, with a gasket either side, on the three spigots, ensuring that the air port is in alignment with the hole in the casting. Locate the spring in the diaphragm cup and refit the valve cover and retaining screws. The lug on the valve housing must cover the air port. Replace the part throttle air bleed jet in the opposite face of the carburettor cover.

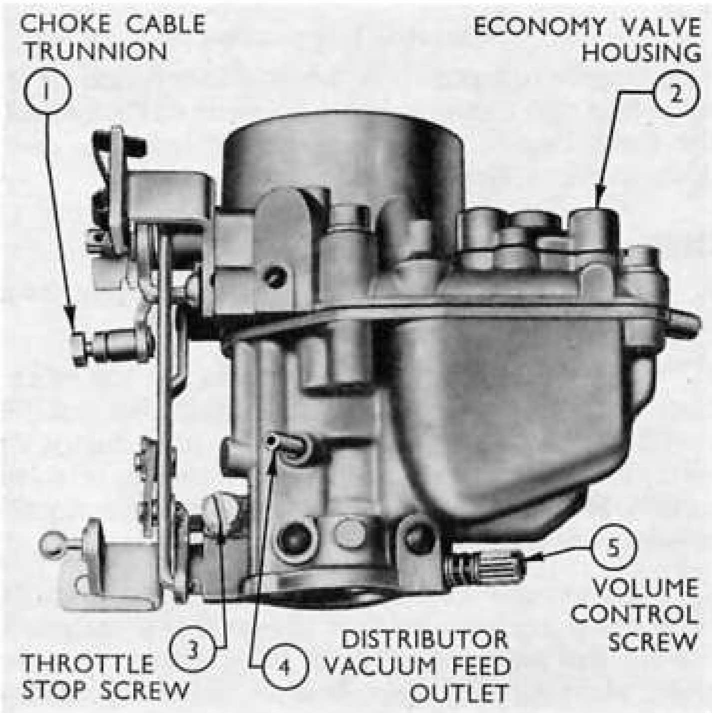


Fig. 10
Adjusting Screws

7. **Replace the jets** in the emulsion block. Replace the ball valve and spring in the accelerator pump bore, (do not scratch the bore). Refit the main jet, compensating jet and enrichment jet in the lower face and the idling fuel jet and accelerator pump non-return valve in the upper face. Replace the accelerator pump jet and plug and insert the accelerator pump piston assembly.

8. **Reassemble the emulsion block to the carburettor** body, locating a new gasket on the upper half of the body. Replace the screw and washer either side of the choke tube and the needle valve housing and washer. Check the movement of the accelerator pump piston.

9. **Locate the needle valve** and float assembly and refit the float pivot pin.

10. **Assemble the carburettor** together and replace the retaining screws, the longer screws fitting either side of the choke tube.

11. **Connect the choke link rod** to the choke control lever and fit a new split pin. Check the operation of the choke and ensure that the throttle is opened slightly by the link rod when the choke is closed.

12. **Connect the accelerator pump** control arm to the operating lever. Use the lower hole in temperate climates and the upper hole, which supplies more fuel, in cold climates. Ensure that a washer is fitted on the inside and outside of the clevis pin with the levers between the washers.

To Replace

1. **Fit the carburettor and a new gasket** to the inlet manifold. Replace the spring washers and nuts on the mounting studs and tighten them securely.

2. **Reconnect the distributor vacuum pipe** to the rubber connection.

3. **Reconnect the fuel supply pipe.**

4. **Locate the choke cable** and pass the inner cable through the choke lever trunnion and tighten the clamping screw. Replace the outer cable retaining clip and check the operation of the choke.

5. **Reconnect the throttle linkage.**

6. **Refit the air cleaner.**

CARBURETTOR MAINTENANCE

Cleaning the Carburettor

At periodic intervals the float chamber should be swilled in clean petrol to remove all sediment. The jets should occasionally be removed and cleared, using compressed air supply. Never use wire or anything which may enlarge the jets.

Carburettor Adjustments

Certain adjustments may be required from time to time, and these are detailed under the following headings:—

Choke Adjustments

The choke control cable is adjusted at the choke operating lever so that there is approximately 3 mm. ($\frac{1}{8}$ in.) free play in the cable when the control is pushed in fully.

Slow-Running Adjustment

To obtain the best slow-running adjustment, the engine should be tuned against a vacuum gauge connected to the inlet manifold. This connection can be made by removing the blanking plug from the inlet manifold and fitting the appropriate adaptor and gauge.

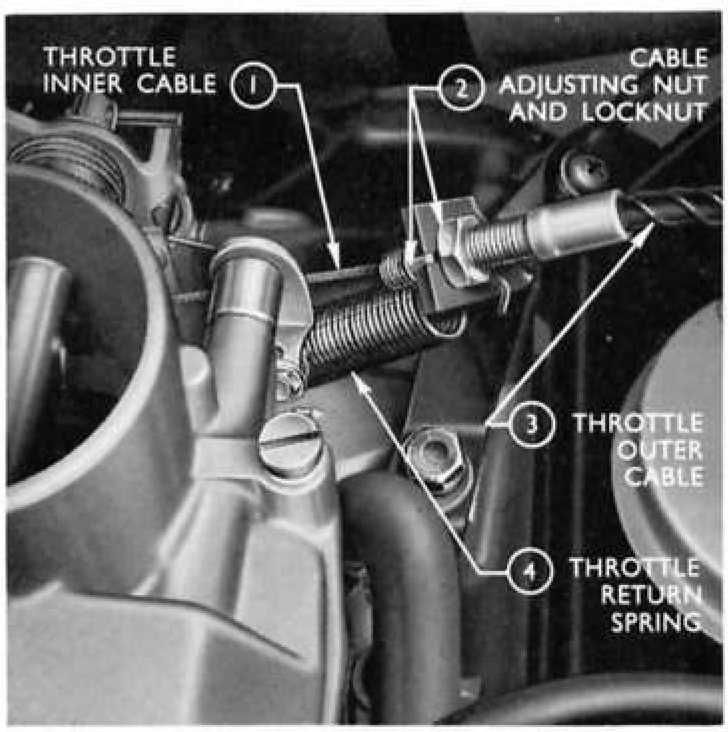


Fig. 11
Throttle Cable Adjustment

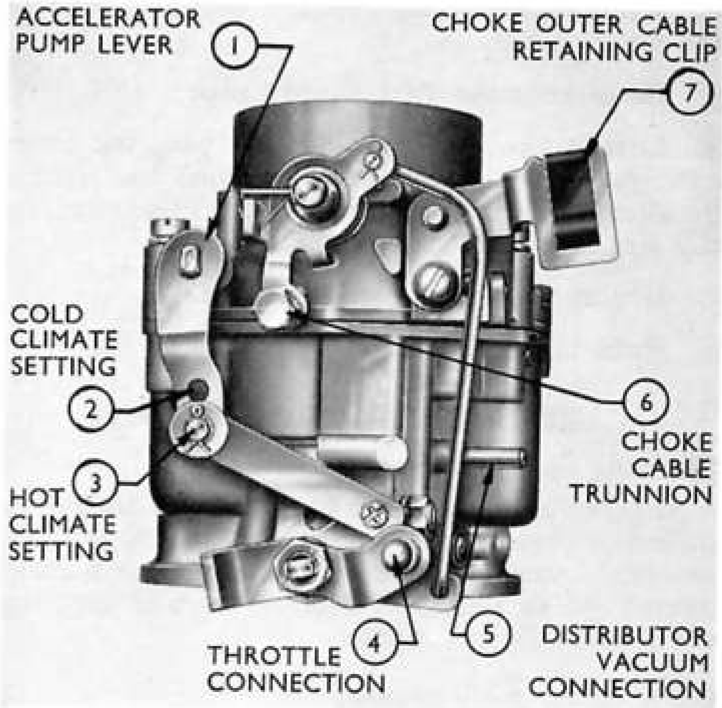


Fig. 12
Accelerator Pump Setting

Before commencing adjustment, check the air cleaner to ensure that the element is clean and remove any excessive free play from the throttle cable.

Run the engine allowing it to warm up. To adjust the slow-running, screw in the throttle stop screw (see Fig. 10) until a fast idling speed is obtained, then turn the volume control screw, illustrated in Fig. 10, either clockwise or anti-clockwise to obtain the maximum vacuum reading. Readjust the idling speed as necessary and continue the adjustment until the maximum possible vacuum reading is obtained with a reasonable slow-running speed. It may be necessary to adjust the ignition setting, see Section 10.

When a suitable vacuum gauge is not available, the engine should be warmed up and the throttle stop screw turned clockwise so that the engine is running at a fast idling speed. Screw the volume control screw in or out until the engine runs evenly. Readjust the throttle stop screw if the engine is running too fast, followed by a further readjustment of the volume control screw.

These operations should be repeated until the idling speed is satisfactory and, if necessary, followed by a readjustment to the ignition setting.

Accelerator Pump Stroke Adjustment

The accelerator pump stroke can be adjusted by altering the position of the accelerator pump link to the accelerator pump operating lever (Fig. 12). In warm or temperate climates set the link to the outer hole in the lever to give a short pump stroke. In cold climates set the link to the inner hole, thus allowing a longer pump stroke. To adjust the setting, remove the split pin and the clevis pin and washers. Refit the clevis pin in the desired position, ensuring that a washer is fitted either side of the arm and link before replacing the split pin.

General Diagnosis

If engine operation is unsatisfactory and it is suspected that the fault is due to **poor carburation,** the items listed under the following headings may, when checked, help to locate the cause.

Difficult Starting from Cold

1. **Ensure first that fuel is being supplied** from the fuel pump.

2. **Check that the needle valve** at the top of the float chamber is free to operate and that fuel is supplied through this valve when the engine is rotated. If the needle sticks on its seating, this can usually be overcome by washing the valve assembly in methylated spirit.

3. **Remove air cleaner** and check that the choke plate closes completely when the control is operated. Should this plate fail to close fully, ensure that the choke plate spindle is not bent or the return spring broken, also check that the spindle bearings are free from dirt, thus preventing full movement of the choke plate.

4. **Check the operation of the choke** and cable as described under the heading "Choke Adjustments."

Difficult Starting of a Warm Engine

This is usually due to an over-rich mixture which may normally be cleared by fully opening the throttle and turning the engine over on the starter motor. However, should this condition be recurrent, check the following items to determine the actual cause.

1. **Ensure that the air cleaner is serviceable,** cleaning as described on page 4 if necessary.

2. **Check the fuel pump delivery pressure** as described on page 22.

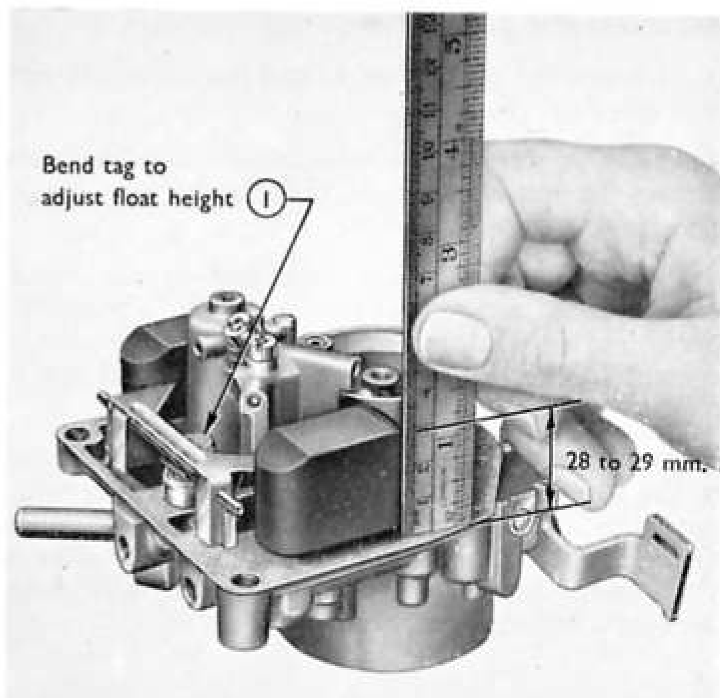


Fig. 13
Checking Float Level

3. **Ensure that the needle valve and seating** at the top of the float chamber are not damaged or dirty, and are screwed tightly in place.

4. **Examine the float,** ensuring that it has not been punctured, and the float arm to see that this is not damaged or bent. Check petrol level in the float chamber as indicated in Fig 13 – checking Float Level.

Stalling and Irregular Slow-Running

1. **Check adjustment of volume control and idling control screws** as described under the heading "Slow-Running Adjustment."

2. **Clean the idling jet,** and check that the internal drilling is free from obstruction. Ensure that the idling air bleed is free from obstruction.

3. **Check that the slow-running** and progression outlet holes are clear.

4. **Remove the volume control screw** and inspect to ensure that the tapered end has not been damaged and that the coil spring on the screw is in good condition, spring-loading the screw to prevent it from vibrating out of the set position.

Poor Acceleration

1. **Ensure that fuel is emitted into the venturi** when the accelerator pump lever is operated.

2. **Clean the accelerator pump jet,** remove the pump piston and check valves and wash in methylated spirit.

3. **Check the economy device** to ensure that the diaphragm and spring are in good condition, inspect the gaskets and evenly tighten the three screws retaining the casting to the carburettor.

Excessive Fuel Consumption

1. **Check that the air cleaner is serviceable** and, if necessary, clean as described on page 4.

2. **Ensure that the choke plate returns to the open position** when the control is released. Failure to do this may be caused by dirty spindle bearings or a broken return spring.

3. **Thoroughly clean all jets and passages,** making sure that the accelerator pump discharge valve is free to operate, and the valve ball falls onto its lower seat.

4. **Inspect the economy device diaphragm** and gaskets, and also ensure that the spring is in good condition, located on the metal seating in the centre of the diaphragm on reassembly.

5. **Examine the gasket between the emulsion block and float chamber body,** tightening the screws retaining the emulsion block securely when replacing.

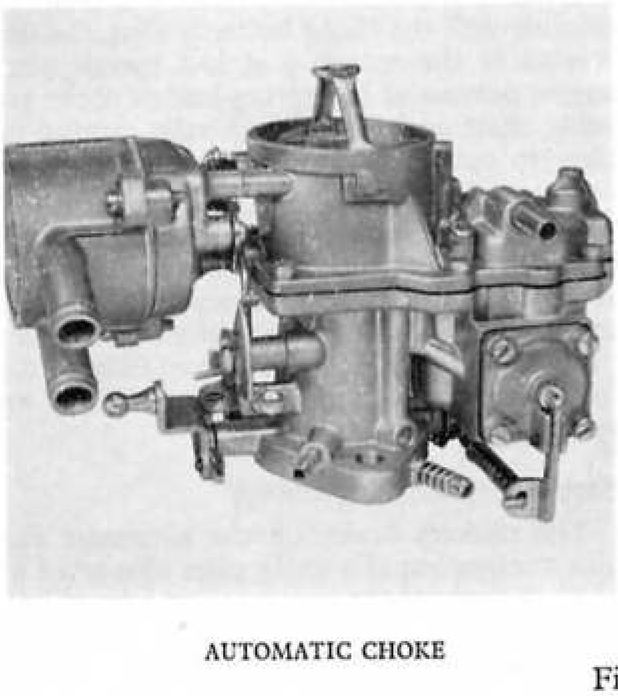
CARBURETTOR
(May 1967 onwards)

A Ford manufactured carburettor has been fitted in production from May 1967.

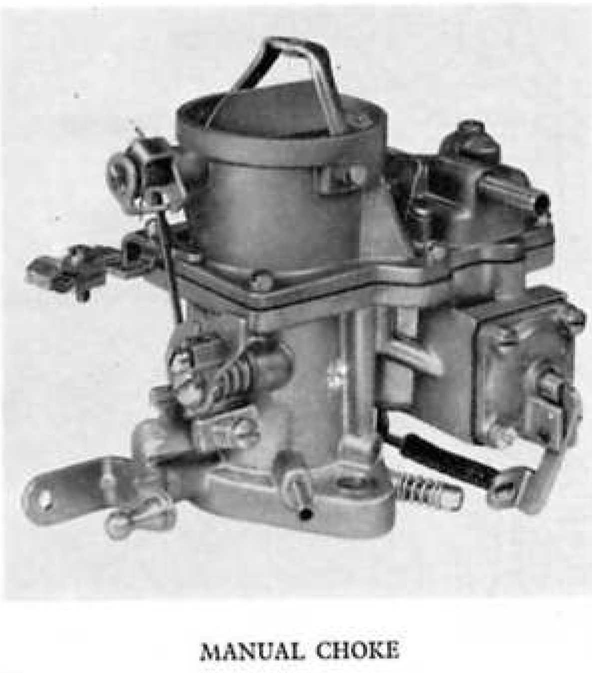
A later type Ford carburettor with a single and larger inlet pipe and revised settings has been fitted since September 1968.

All carburettors are of the single venturi, down-draught type and in addition to the usual idling and main jet systems an accelerator pump is incorporated. This ensures smooth and rapid acceleration when the throttle valve is opened quickly.

The carburettors consist of two castings forming the upper and lower bodies. On automatic choke carburettors a casting containing the thermostatic spring and choke mechanism is fitted. This is screwed to the upper body corresponding to the choke linkage. The upper body incorporates the float chamber cover,



AUTOMATIC CHOKE



MANUAL CHOKE

Fig. 14
The Carburettors

float pivot brackets, fuel inlet connection tube, needle valve, air intake, choke plate, the complete main system and discharge beak, idling jet and first idle air bleed of the idling system and the accelerator pump discharge nozzle. The lower body incorporates the float chamber, throttle barrel and integral choke tube, throttle plate, idling discharge orifices and adjustment screws, the accelerator pump, the distributor vacuum and the choke and throttle linkages.

POWER VALVE

Incorporated in these carburettors is a power valve. It consists of a piston, piston rod, adjusting spring and washers, valve, valve spring and valve body (Fig. 15). The piston is retained in its upper body by a washer staked to the upper body, and the valve body is closely fitted and pinned to the lower portion of the main well. The nylon adjusting washers are split to facilitate calibration.

The power valve provides a supply of additional fuel to meet increased power demands.

Under normal operating conditions with the engine running at part load, manifold depression holds the piston and rod in a raised position against the force of the adjusting spring, with the valve spring holding the valve against its seat.

When the power demand increases and the engine is working at full load the manifold vacuum decreases. The adjusting spring is allowed to expand, moving the piston and rod down and dislodging the valve from its seat. Fuel then passes through the valve body into the main well, increasing the supply of fuel to meet the increased power demand.

Fuel Supply

Fuel is supplied to the carburettor float chamber by a mechanical fuel pump. Fuel in the float chamber is automatically maintained at a pre-determined level by the slight rise and fall of the float, closing or opening the needle valve to cut off or admit fuel from the pump as required.

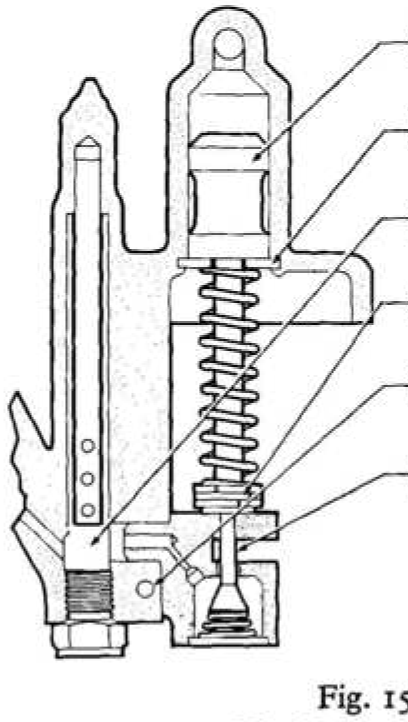


Fig. 15
The Power Valve

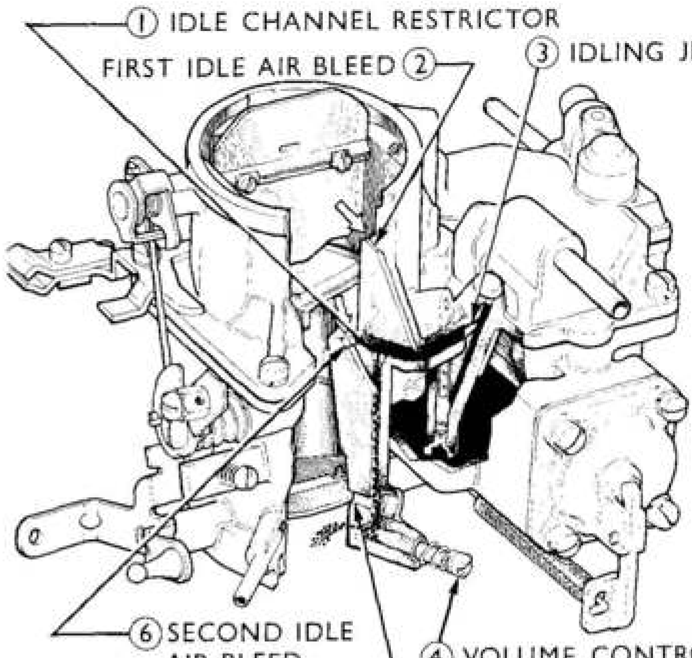


Fig. 16
Idling

OPERATION

Starting (Manual Choke)

The starting device on the manual choke carburettor consists of a choke plate which is connected by means of a link to the choke lever on the carburettor body. A flexible cable connects the choke lever to a friction locking type control on the facia panel. Pulling the control closes the choke plate and opens the throttle a pre-determined amount, the degree of throttle opening allowing depression created by the induction strokes to reach the mixture channels and choke tube area, ensuring a fast idle speed after starting.

As the engine is rotated by the starter motor, a high depression is created upon the emulsion block discharge beak and fuel is drawn from the capacity well situated in the emulsion block. When the engine is running with the choke butterfly shut, the depression created in the manifold at low speeds acts on the largest portion of the spring-loaded choke plate, this being offset on its spindle, thereby causing the choke plate to open, admitting sufficient air to keep the engine running.

As the temperature rises the control knob should be gradually pushed towards the 'off' position in accordance with the requirements of the engine. Once the normal operating temperature has been reached the control knob should be pushed fully in, the engine fuel requirements at idling being met by the idling system only.

Starting (Automatic Choke)

The starting device on the automatic choke carburettor consists of a choke plate connected by means of a link to the thermostatic spring housed in a casting screwed to the upper body of the carburettor. This is connected in series with the engine cooling system by-pass. As the engine coolant heats up the spring expands. This movement is transmitted by a link to

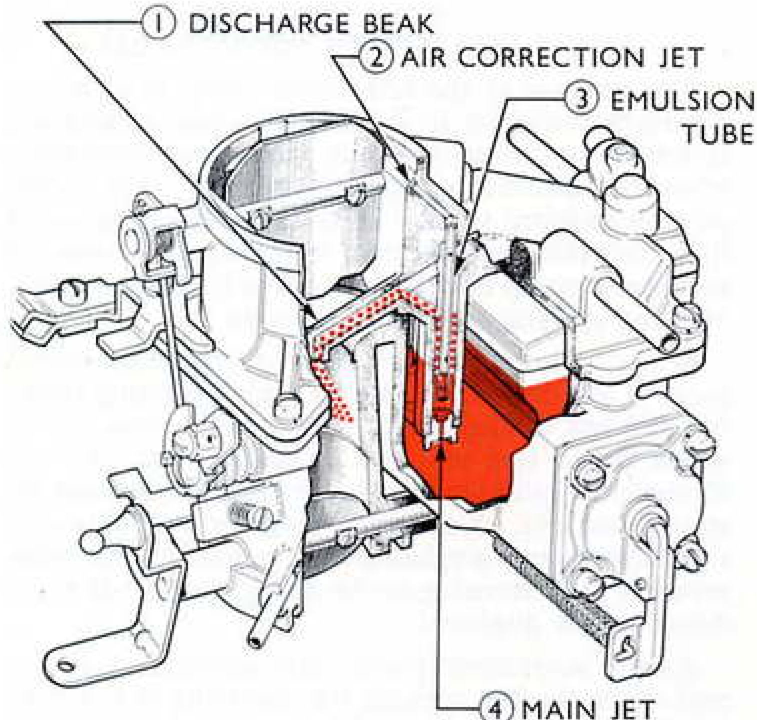


Fig. 17
Main System

the choke plate which opens, weakening the fuel/air mixture as required.

A vacuum piston connected by a rod to the crank operates in a bore in the choke housing and is connected by internal drillings to the throttle barrel below the butterfly.

A stepped fast idle cam and choke lever assembly is fitted between the lower body and the automatic choke housing. The choke lever is attached to the cam by a pin locating in a slot in the cam. This allows the choke plate to open without the throttle setting altering. The cam has three steps on it, giving different degrees of choke plate opening depending upon the temperature of the engine.

A rich mixture is required for starting. Prior to starting the accelerator pedal should be fully depressed once. This has the effect of releasing the fast idle cam so that it is free to return to the starting position, and returning the choke plate to the closed position.

When the engine is rotated by the starter motor a high depression is created upon the emulsion block discharge beak and fuel is drawn from the main system, in addition to the idling system, to start the engine. Immediately the engine starts to run increased depression in the choke tube acts, through the internal drillings, upon the underside of the vacuum piston. The piston is pulled down and, through the action of the crank, the choke plate is opened a pre-determined amount against the tension of the thermostatic spring. This admits sufficient air to weaken the mixture and keep the engine running without flooding. The throttle plate is also held open slightly. This is the automatic choke plate pull down, the measurement of which should be, for carburettors fitted from May 1967 to September 1968, 4.2 mm. (0.165 in.) for the 1700 c.c. engine and 3.4 mm. (0.135) for the 2000 c.c. engine.

From September 1968 onwards the measurement should be 3.94 to 4.45 mm. (0.155 to 0.175 in.) for the 1700 c.c. engine and 3.18 to 3.69 mm. (0.125 to 0.145 in.) for the 2000 c.c. engine.

Immediately after starting the engine, the throttle should be eased open a little and released. This releases the cam which, under its own weight, moves and brings the first fast idle notch to rest on the throttle lever.

As the engine warms up, the thermostatic spring is heated by the engine coolant circulating through the choke water chamber, causing the spring to expand. This has the effect of gradually rotating the crank and, through the linkage, moving the choke plate to the open position. During the warming up period the vehicle should be driven or the throttle blipped occasionally to allow the fast idle cam to move through its arc bringing the remaining two notches, in turn, into line with the throttle lever. When the engine has reached normal operating temperature the choke plate will be fully opened and the cam will have rotated clear of the throttle lever.

NOTE.—As the cam rotates and the three notches in turn line up with the throttle lever, the choke plate opens and the throttle plate closes ensuring a good and even tick-over.

IDLING AND PROGRESSION SUPPLY

With the engine running and the choke control pushed fully home, the throttle plate returns to the normal idling position. Manifold depression acting on the volume control screw orifice draws fuel up to the idling jet via the main jet. The fuel discharging through the idling jet is now emulsified by air drawn through the first idle air bleed situated in the carburettor air intake. The resulting mixture is drawn through the idle channel restrictor into the vertical duct in the carburettor body and is further emulsified by air bleeding in through the second idle air bleed and a small progression slot, before it finally reaches the idling discharge aperture just below the throttle plate (see

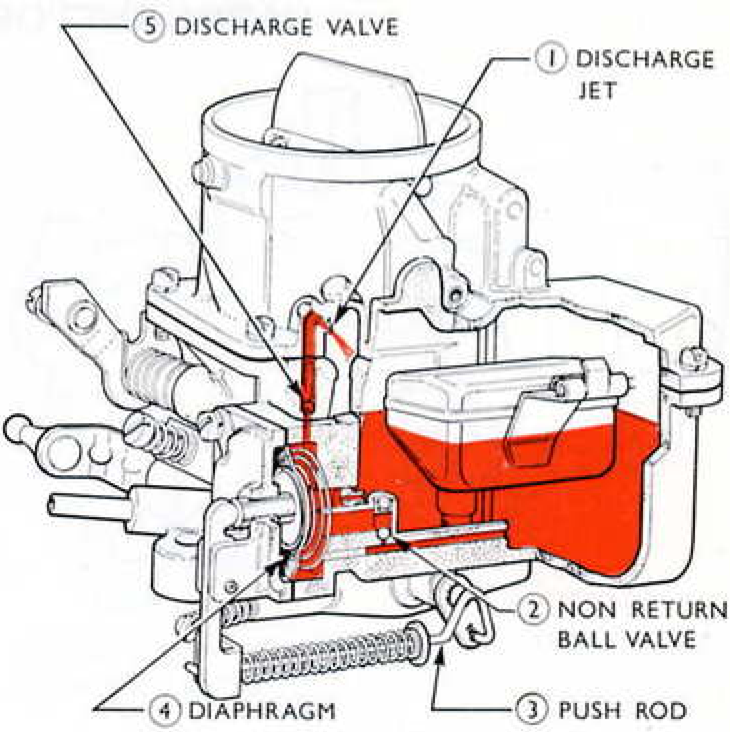


Fig. 18
Accelerator Pump System

Fig. 16). It will be noted that the progression slot is situated in a slightly offset horizontal position along the closed throttle plate line. The effect being to provide a more accurate progressively controlled delivery.

The quantity of fuel entering the inlet manifold of the engine is regulated by a needle-type volume control screw operating within the idling discharge orifice.

As the accelerator pedal is gradually depressed to increase the speed, the small air bleed or progression slot is covered by the throttle plate to cut off the air bleed at this point. The richer mixture, now supplied by the idling system, mixes with the greater volume of air flowing past the partially opened throttle plate to give the correct mixture strength for the engine. As the progression slot is uncovered by the throttle plate, mixture discharges from it into the inlet manifold, thus providing a smooth and progressive transition from the idling to the main system.

MAIN SYSTEM

On opening the throttle plate further, increased depression is created around the main discharge beak by the air passing through the choke tube. This depression on the discharge beak draws fuel from the main jet well, which is supplied with fuel by the main jet. The fuel is emulsified by air drawn into the system through the air correction jet and through lateral holes in the emulsion tube (see Fig. 17). As the engine speed increases, the depression is increased and the fuel level drops in the main jet well, progressively exposing the holes in the emulsion tube to maintain a balanced emulsified fuel/air ratio regardless of the engine speed.

ACCELERATOR PUMP SYSTEM

The purpose of the accelerator pump is to ensure a smooth transition from the idling and progression system on to the main system, without any hesitation, when the throttle is suddenly opened. The richer mixture required to fulfil these conditions is provided by a controlled and metered supply of fuel from the accelerator pump into the carburettor barrel coincident with the opening of the throttle plate.

When the accelerator pedal is depressed the movement of the throttle spindle actuates the pump push-rod and link to displace the pump diaphragm. This action forces fuel past the discharge valve and out through the calibrated discharge jet into the main air stream (see Fig. 18), thereby ensuring a condition of rapid and smooth acceleration. A non-return ball valve prevents fuel returning to the float chamber when the diaphragm is displaced.

As the accelerator pump only operates during a part of the throttle opening the operating link is connected to the push rod with a compression spring thus allowing full throttle opening after completing the pump operating stroke. This action also prevents a partial hydraulic lock occurring during very rapid throttle opening and provides a progressive feed at the start of acceleration. During very slow throttle opening the fuel in the pump chamber bleeds back through a small jet into the float chamber without any discharge into the carburettor barrel.

When the throttle plate is closed, and the push rod and link are in the released condition the diaphragm is returned by its spring to the 'charged' position ready for the next stroke. The travel of the diaphragm and, consequently, the volume of fuel discharged at each stroke, can be set by adjustment to the push-rod as outlined in the following maintenance chapters.

CARBURETTOR MAINTENANCE

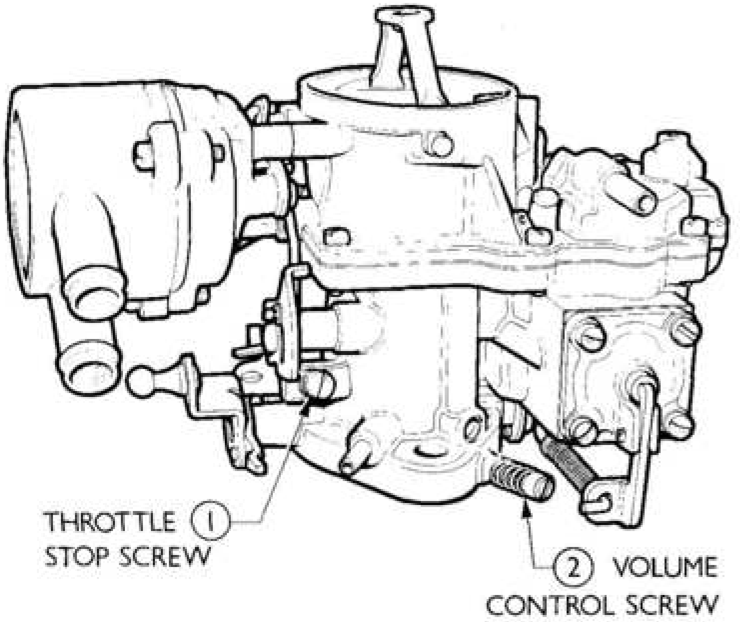


Fig. 19
Slow-Running Adjustments

1. Slow-Running Adjustment

After 800 km. (500 miles) and thereafter every 8,000 km. (5,000 miles) the carburettor slow-running should be checked and adjusted if necessary. Before commencing adjustment check that all other direct influences on engine behaviour, e.g. electrical system, valve clearances, etc., are correct and in working order. Check the air cleaner to ensure that the element is clean; also check that the throttle operation is free and unrestricted.

If the engine or carburettor has been disturbed, it will be necessary to check that the throttle and choke operations are correctly synchronised prior to effecting any slow-running adjustments.

To obtain the best slow-running adjustment, the engine should be tuned against a vacuum gauge connected to the inlet manifold. This connection can be made by removing the blanking plug from the inlet manifold and fitting the appropriate adaptor and gauge.

Run the engine until it has reached normal operating temperature. To adjust the slow-running, screw in the throttle stop screw until a fast idling speed is obtained then turn the volume control screw, illustrated in Fig. 19, either clockwise or anti-clockwise to obtain a maximum vacuum reading. Readjust the idling speed as necessary and continue the adjustment until the maximum possible reading is obtained, compatible with a reasonable slow-running speed.

When a vacuum gauge is not available, the engine should be warmed up as previously described and the throttle stop screw turned clockwise so that the engine is running at a fast idling speed. Screw the volume control screw in or out until the engine runs evenly. Readjust the throttle stop-screw if the engine is running too fast, followed by a further readjustment of the volume control screw. These operations should be repeated until the idling speed is satisfactory—this should be approximately 600 rev./min.

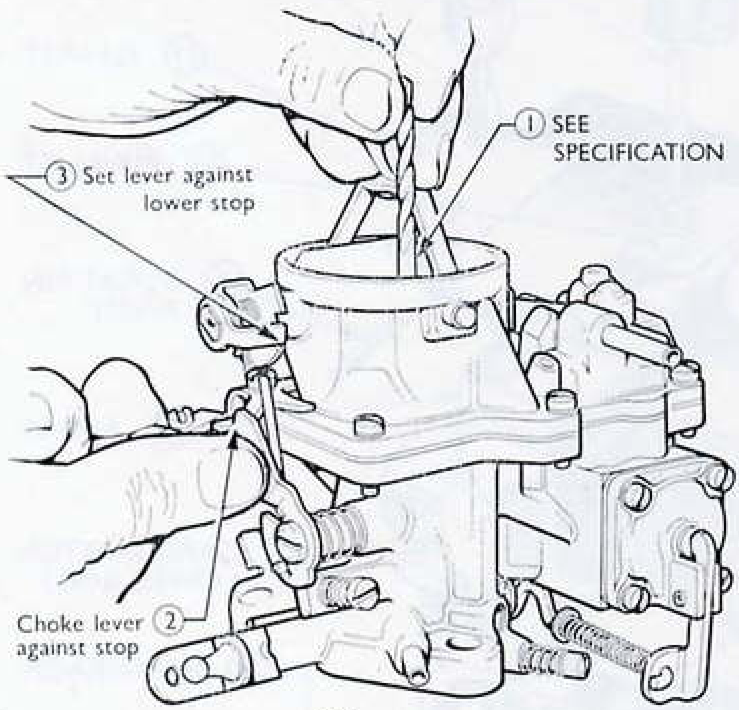


Fig. 20
Choke Pull Down Setting

2. Choke Adjustment

Choke Plate Pull-down (Manual choke carburettor)

Remove the air cleaner and rotate the choke lever to its stop. With the lever in this position the choke plate should now be depressed and the clearance between the lower edge of the choke plate and the inside of the carburettor air intake should be checked.

For carburettors fitted from May 1967 to September 1968 this measurement should be 2.8 mm. (0.110 in.) for the 1700 c.c. engine and 4.0 mm. (0.150 in.) for the 2000 c.c. engine.

From September 1968 onwards the measurement should be 2.54 to 3.05 mm. (0.100 to 0.120 in.) for the 1700 c.c. engine and 3.56 to 4.06 mm. (0.140 to 0.160 in.) for the 2000 c.c. engine.

It is suggested that a suitable drill or gauge rod be used in this operation and inserted between the choke plate and the inside of the carburettor air intake. The tab on the choke spindle should be bent to achieve this result (see Fig. 26).

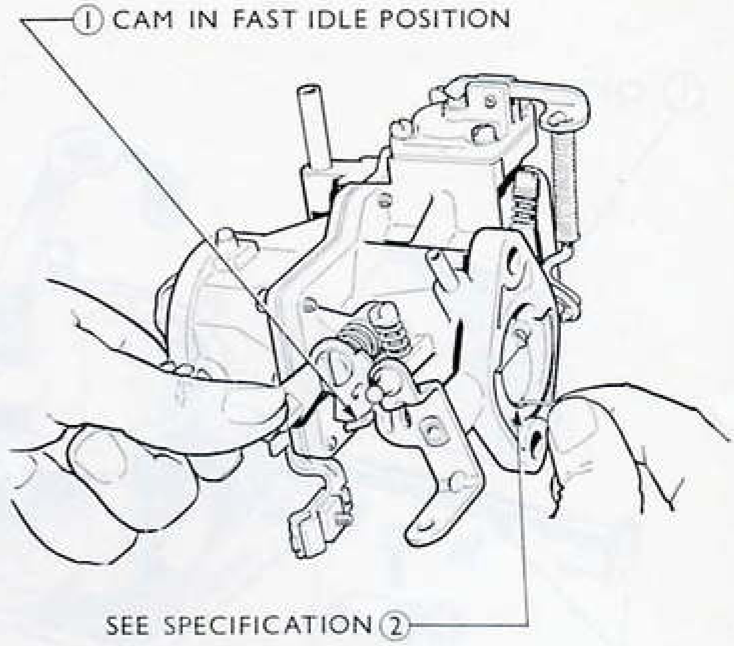


Fig. 21
Fast Idle Adjustment

Fast Idle

The fast idle adjustment can only be checked on the engine after first checking and adjusting (if necessary) the choke pull-down. If a tachometer is available this should be connected to the ignition. Run the engine until it reaches its normal operating temperature and idling speed (600 rev./min.). With the engine still running, hold the choke plate in the fully opened (vertical) position and rotate the choke lever until it is stopped by the choke linkage. With the choke lever in this position the fast idle cam will be opening the throttle plate a small amount and the engine speed should now rise to 750 to 850 rev./min. with manual choke, 2,000 to 2,200 rev./min. with automatic choke for carburettors fitted from May 1967 to September 1968.

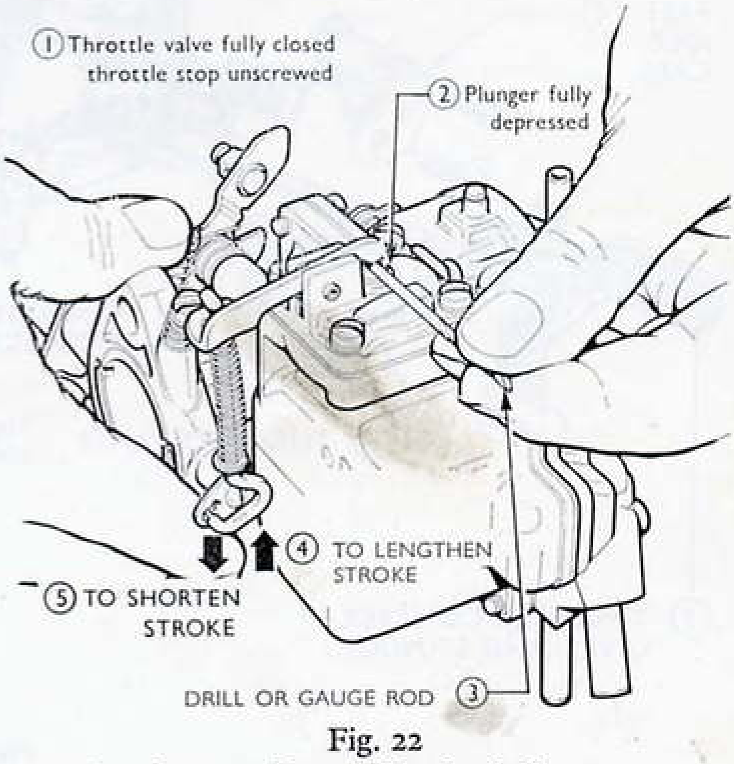


Fig. 22
Accelerator Pump Stroke Adjustment

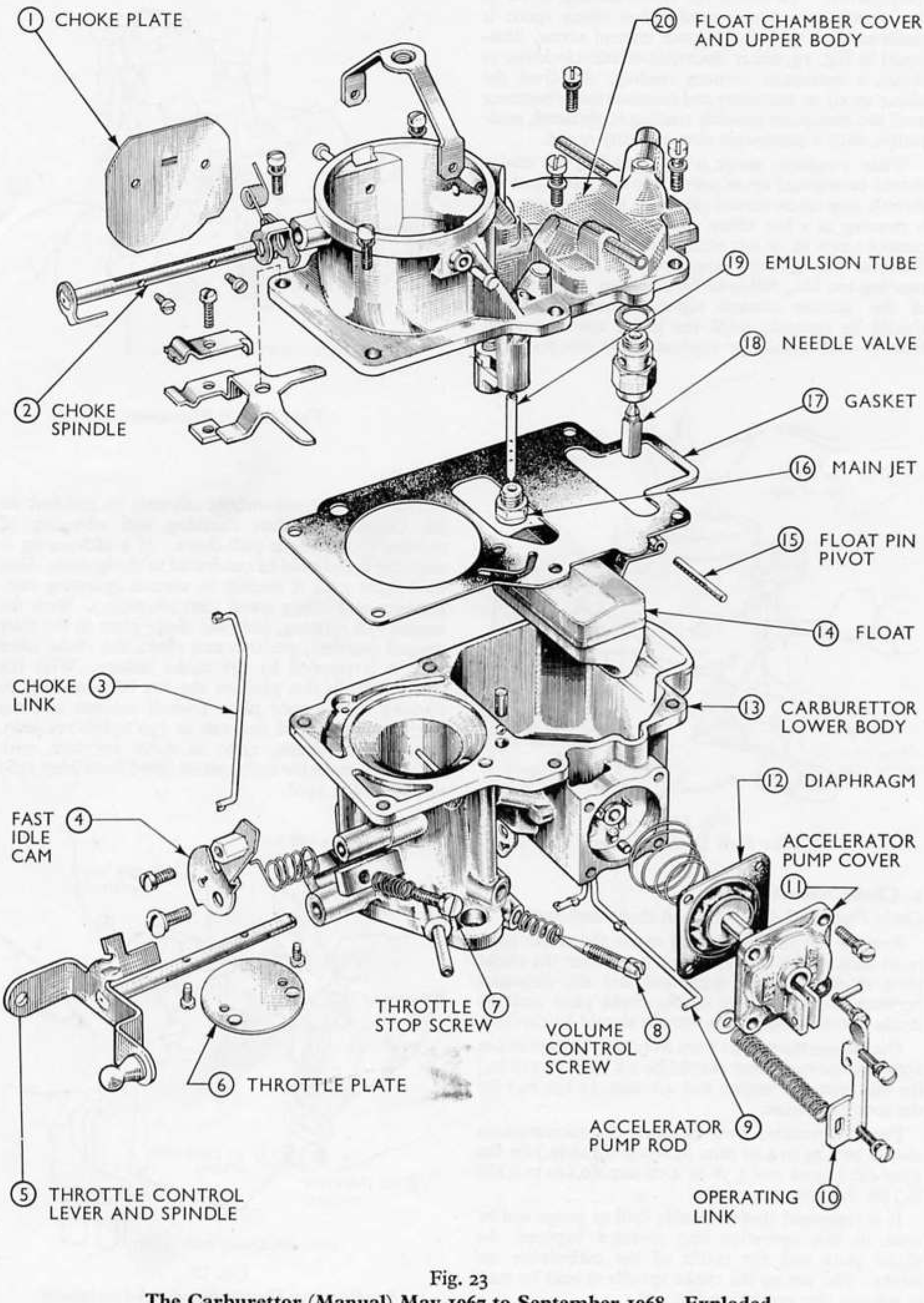


Fig. 23
The Carburettor (Manual) May 1967 to September 1968—Exploded

For carburettors fitted from September 1968 the engine speed should now rise to 750 to 850 rev./min. with manual choke, with automatic choke 2,000 to 2,200 rev./min. on the 1700 c.c. engine and 1,800 to 2,000 rev./min. on the 2,000 c.c. engine.

Ascertain the amount of radial movement required on the throttle lever to achieve this result and turn off engine. Clamp the throttle lever fully open with a pair of grips on the stop portion of the casting boss and bend up the tab to increase the fast idle or down to decrease. Repeat the operation and check as necessary.

If this operation is done off the engine, rotate the choke lever to its stop and check the clearance between the lower edge of the throttle plate and the inside of the carburettor barrel. This clearance should be 0.9 mm. (0.035 in.) for the manual choke (a number 64 drill may be used), and 3.8 to 4.3 mm. (0.15 in. to 0.17 in.) for the automatic choke carburettors fitted from May 1967 until September 1968. Check the clearance with a suitable drill or gauge rod (see Fig. 21).

If necessary adjust the throttle lever tab (as described previously) to obtain the correct clearance.

3. Accelerator Pump Adjustment

The accelerator pump has been set on manufacture for optimum requirements under normal operating conditions giving a pre-determined stroke and delivery of fuel at normal ambient temperatures.

The only adjustment to check is the stroke.

With the throttle stop screw backed off so that the throttle plate is fully closed, depress the diaphragm plunger. Check the clearance between the operating lever and the plunger which should be 4.5 mm. (0.175 in.) for the 1700 c.c. engines and 3.4 mm. (0.135 in.) for 2000 c.c. engines. This clearance can be checked with a drill or gauge rod (see Fig. 22). Bend the gooseneck of the pump push rod to adjust the stroke. Close the gooseneck to lengthen the stroke or expand it to shorten the stroke.

4. Float and Fuel Level Setting

To check the float or set the fuel level it is necessary to remove the air cleaner and the float chamber cover.

Release the outer choke cable from its clamped position to the carburettor top by undoing the clamp screw.

Remove the idling cam locating screw on the automatic choke carburettor.

Undo the six screws and spring washers retaining the upper body to the lower part of the carburettor body (one of these screws retains the choke cable bracket) lift off the upper body carefully, unlatch the choke link and at the same time observe that the gasket is not adhering to the lower body. Examine the float, ensuring that it has not been punctured, and the float arm to see that this is not damaged or bent.

With the carburettor upper body vertical, the distance from the bottom of the float to the mating surface of the gasket, distance 'A', (see Fig. 24), for carburettors fitted from May 1967 to September 1968, must be 28.5 mm. to 29.0 mm., (1.12 in. to 1.14 in.), for carburettors fitted from September 1968, 30.73 mm. to 31.24 mm. (1.21 in. to 1.23 in.). The position of the float is determined by the tab resting on the fuel inlet needle valve. Bend as necessary to achieve the desired measurement. Turn the upper body upright when the same measurement, distance 'B', (see Fig. 24), for carburettors fitted from May 1967 to September 1968, must be 35.1 mm. to 35.6 mm. (1.38 in. to 1.40 in.), for carburettors fitted from September 1968, 35.81 mm. to 36.32 mm. (1.41 in. to 1.43 in.), this can be adjusted by bending the tab resting on the needle valve housing.

Before replacing the carburettor upper body it is advisable to swill the chamber out with clean fuel to remove all sediment and to check on the correct functioning of the needle valve in the upper body.

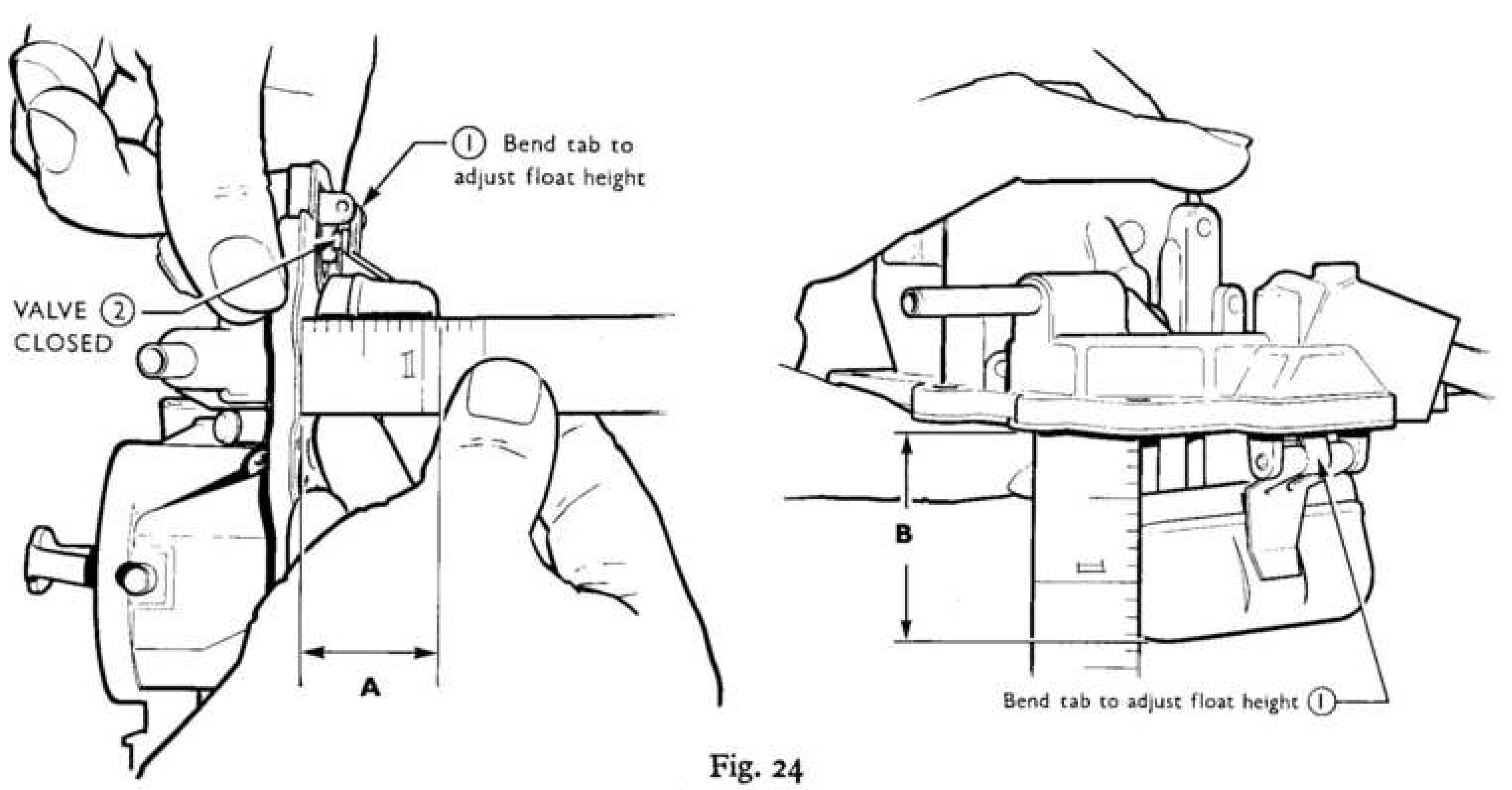


Fig. 24
Float Settings

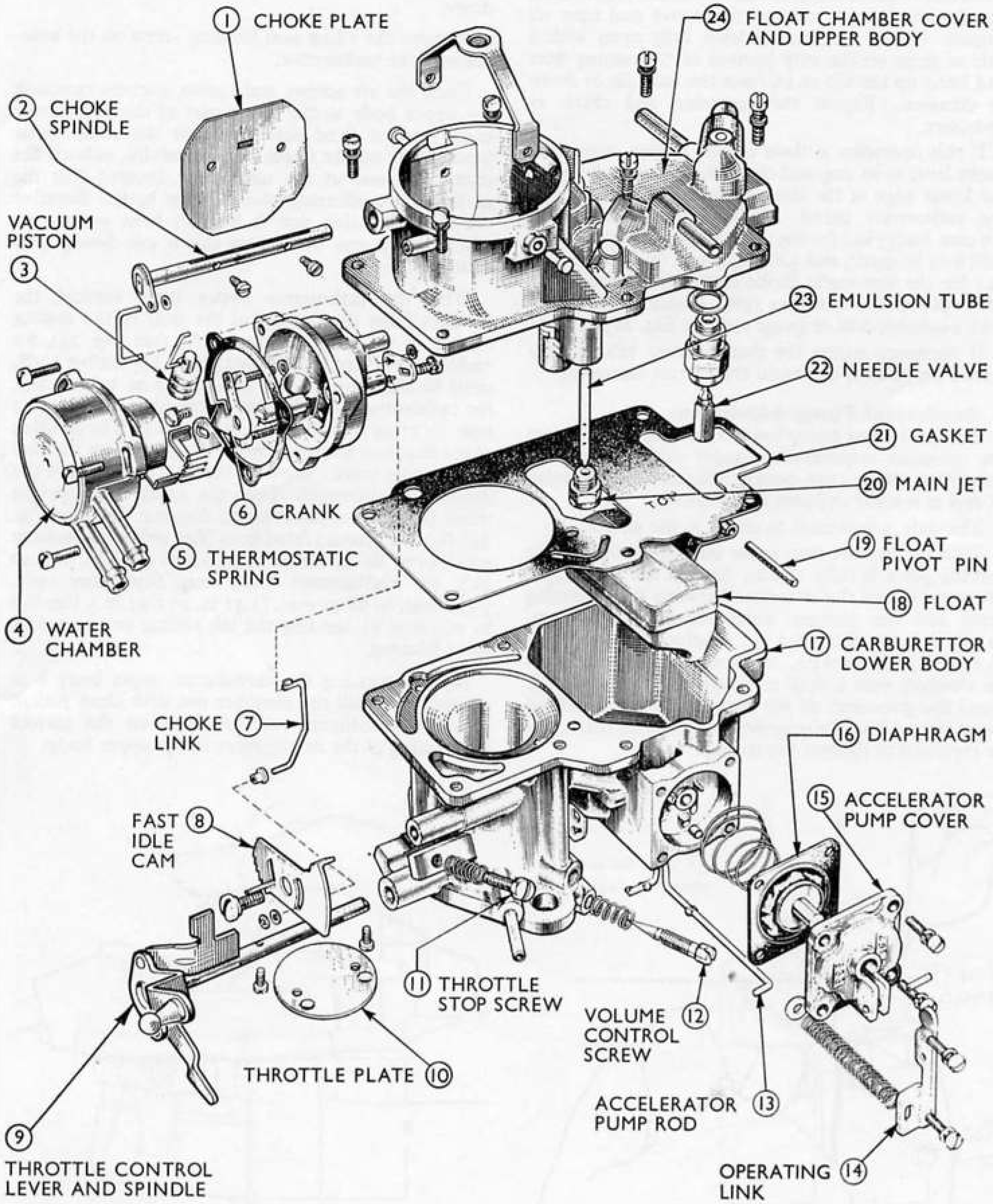


Fig. 25
The Carburettor (Automatic) May 1967 to September 1968—Exploded

REPAIR OPERATIONS

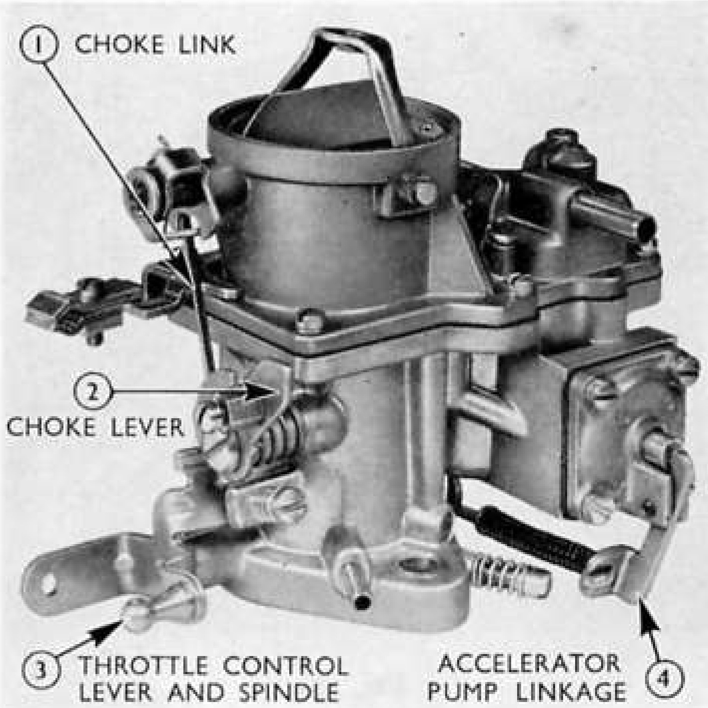


Fig. 26
Carburettor Linkages (Manual)

To Remove

1. Remove the air cleaner.

2. Disconnect the fuel feed pipe and the distributor vacuum pipe at the carburettor.

3. Disconnect the choke cable control by undoing the screw of the trunnion on the choke lever and releasing the inner cable. Undo the screw clamping the outer cable to the upper carburettor body cable bracket and withdraw the cable.

4. Disconnect throttle linkage.

5. Remove the two nuts and spring washers securing the carburettor to the manifold and lift off the carburettor.

6. Remove the carburettor to manifold gasket.

To Dismantle (Manual Choke)

1. Remove the six screws and spring washers securing the carburettor upper body to the lower body. Carefully lift off the upper body (see Fig. 27) and unlatch the choke link at the same time. The gasket should come away with the upper component and care should be exercised to see it is not adhering to the lower body.

2. Withdraw the float arm pivot pin and remove the float. This will allow the needle valve to be withdrawn.

3. Lift off the gasket from the upper body.

4. Remove the air cleaner retainer pins and retainer from the upper body.

5. Undo the two screws clamping the choke plate within its spindle and remove the plate.

6. Withdraw the choke spindle and slide the choke pull-down stop and spring off the spindle.

7. Undo the needle valve housing using a suitable socket or box spanner.

8. Unscrew the main jet using a $\frac{5}{16}$ in. AF socket.

9. Undo the screw and lockwasher retaining the accelerator pump push rod arm to the throttle spindle. Remove the arm and detach the push rod and spring.

10. Unscrew the four screws securing the accelerator pump in position and remove the accelerator pump body and operating arm, diaphragm and return spring.

11. Unscrew the cheese head pivot screw and remove the choke lever and return spring.

12. Undo the two screws clamping the throttle plate within its spindle and remove the plate.

13. Withdraw the throttle spindle from the body and remove the return spring.

14. Undo the volume control needle screw and remove the spring.

To Reassemble

1. Slide the pull-down spring and stop on to the choke spindle and insert the spindle into the carburettor body. Refit the choke plate.

It will be observed that there is a small rectangular stamping on the choke plate itself. This should be situated adjacent to the spindle, the indentation side upwards, i.e. alongside the screw head recesses of the spindle with the plate in the closed position.

2. Refit the air cleaner retainer and pins to the upper body.

3. Refit the main jet.

4. Replace the needle valve housing.

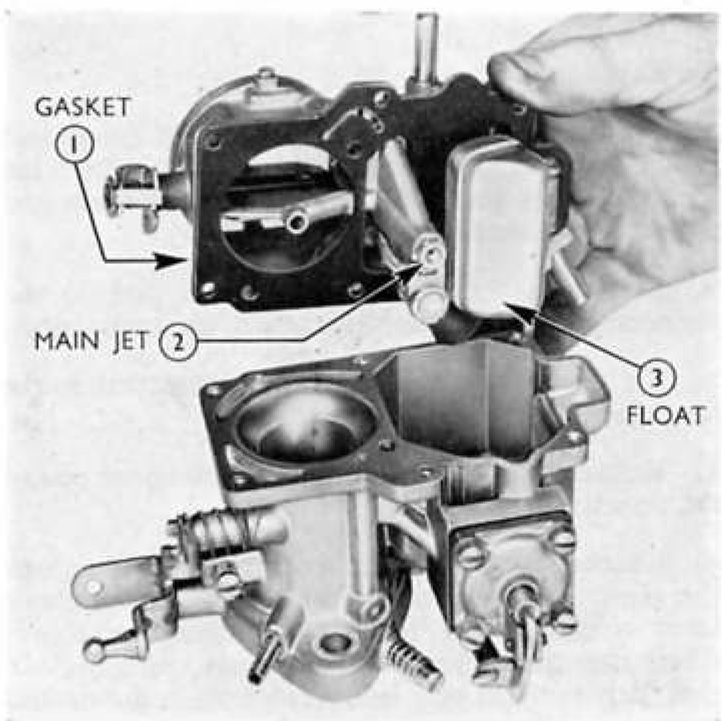


Fig. 27
Separating the Upper and Lower Bodies

5. Position a new gasket on the upper body.

6. Install the needle in the needle valve housing, needle end inwards.

7. Replace the float assembly, sliding the pivot pin into position.

8. Place the return spring on the bearing abutment of the body and refit the choke lever with its pivot screw.

9. Insert one end of the choke link into the pull-down stop and the other into the fast idle cam, hold the choke butterfly in the closed position and carefully refit the upper body to the lower body.

10. Secure the upper body with five screws and spring washers, the sixth screw and spring washer serving to retain the choke cable abutment bracket.

11. Refit the throttle return spring onto the bearing abutment of the body and slide the throttle spindle into the body.

12. Refit the throttle plate ensuring that the recessed sides of the two small indentations are adjacent to the screw head recesses with the throttle plate in the closed position.

13. Refit the diaphragm and plunger into the cover of the accelerator pump.

14. Replace the spring, locating its larger diameter over the three abutments within the pump housing and carefully replace the cover, securing it with the four screws and spring washers.

15. Connect the spring and push rod to the accelerator pump lever and attach the gooseneck end to the throttle arm. Secure this arm to the throttle spindle and with the screw and lockwasher.

16. Refit the volume control screw and spring.

To Replace

1. Locate a new gasket on the manifold flange and position the carburettor over the studs. Refit the spring washers and nuts on the mounting studs and tighten them securely.

2. Reconnect the distributor vacuum pipe to the connection on the right-hand side of the carburettor.

3. Fit the fuel pump line to its connection at the float chamber.

4. Refit the throttle control rod to the upper end of the throttle lever.

5. Connect the choke control outer cable and tighten the clamp. Pass the inner cable through the choke lever trunnion and tighten the clamping screw. Check that the choke opens and closes correctly, and that there is slight play in the cable when the control is pushed fully home.

6. Refit the air cleaner.

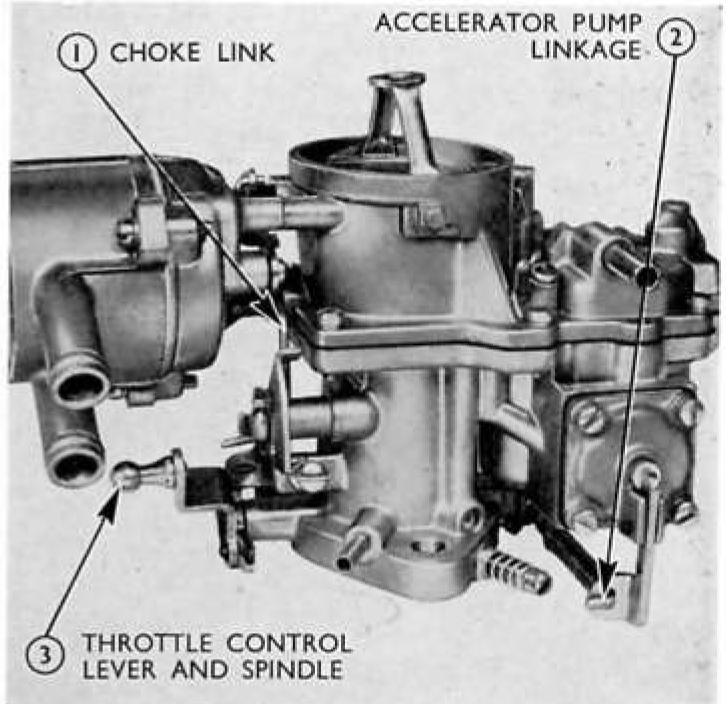


Fig. 28
Carburettor Linkages (Automatic)

Extra Operations for Automatic Choke (To be carried out before previous dismantle operations)

To Dismantle

1. Remove the idling cam locating screw.

2. Remove the three screws securing the thermostatic spring cover.

3. Undo the two screws holding the automatic choke cover to the carburettor body.

4. Remove the screw holding the automatic choke assembly to the cover.

5. Remove the vacuum piston and crank assembly from the choke housing.

6. Remove the remaining choke linkage arms.

To Reassemble

1. Pre-assemble the choke linkage arms.

2. Reassemble the vacuum piston, linkage and crank with the piston link in the inner crank arm hole, to the choke housing.

3. Reassemble choke housing to carburettor upper body.

4. Replace the screw holding the choke assembly to cover.

5. Relocate thermostatic spring into the centre slot in the choke crank.

6. Secure the spring cover to the choke housing

7. Locate and replace the idling cam screw.

THE FUEL TANK

The position of the fuel tank varies, depending on the type of vehicle and is usually retained in position by two straps secured at one end by adjustable hooks and, at the other, by brackets attached to the floor pan. Anti-squeak pads are fitted between the tank and the support straps, and also between the upper surface of the tank and the floor pan.

To Remove

1. **Disconnect the fuel line** and hose connectors from the pipes and detach the hoses from the clip under the floor.

2. **Disconnect the vent pipe** from the filler pipe connection and detach hose. Remove the fuel drain plug and drain the fuel from the tank.

3. **Disconnect the fuel filler pipe** by slackening the rubber pipe clamps.

4. **Disconnect the lead** connected by the terminal to the fuel gauge sender unit.

5. **Suitably support the fuel tank,** and unscrew the nuts on the threaded clamps. Unhook the straps from the holes on the floor member and lower the tank towards the ground.

To Replace

1. **Raise the fuel tank** sufficiently to connect the lead to the fuel gauge sender unit.

2. **Position the tank in its location** and engage the hooks on the end of each support strap in their respective holes on the floor member, ensuring that these support straps have the anti-squeak pads attached. Do not fully tighten the nuts on the hook clamps.

3. **Connect the fuel feed hose** and return hose to the rigid fuel pipes. Connect the vent hose to the filler pipe connection. Re-insert fuel hoses and vent hose in their respective clips.

4. **Tighten up the nuts on the hook clamps** until the fuel tank is firmly located.

5. **Reconnect the fuel filler pipe** and tighten the clamps. Refill the tank with fuel.

Maintenance

In course of time, sediment may collect in the fuel tank, its presence usually being denoted by sediment deposits on the fuel pump screen.

If it is suspected that either excessive deposits, or water, are present in the tank, the tank should be removed and throughly flushed with clean petrol.

When repairs involving the application of a flame or heat are necessary to a fuel tank, this should be flushed, "steamed" and allowed to stand for at least 24 hours to evaporate all fumes from the tank.

THE FUEL LINE

The fuel pipe is clipped to the underside of the floor pan. Occasionally, the unions and securing clips should be checked for tightness, and the pipe inspected to ensure that no chafing against the floor has occurred.

FUEL PUMP

Description and Operation

The fuel pump is a self-priming unit operated through a spring-loaded arm from an eccentric on the camshaft.

As the engine camshaft revolves, the eccentric moves the pump rocker arm upwards, causing the diaphragm to be moved downwards against the pressure of the diaphragm spring, by means of the diaphragm pull rod. This creates a partial vacuum in the pump chamber sufficient to open the inlet valve and draw fuel from the tank, entering at the inlet port and thence to the sediment chamber.

The fuel is then drawn through the filter screen and down past the non-return valve into the pump chamber immediately above the diaphragm.

Further movement of the engine camshaft allows the spring loaded-rocker arm to move downwards, allowing the diaphragm spring to push the diaphragm upwards. This forces the fuel in the pump chamber past the outlet valve into the outlet pipe connecting the pump to the carburettor float chamber.

When the carburettor bowl is full, the floats will close the needle valve, thus preventing further petrol supply from the fuel pump. The pressure thus created will hold the fuel pump diaphragm downwards against the pressure of the diaphragm spring and it will remain in this position until the carburettor requires more fuel and the needle valve opens.

The operating linkage of the pump is such that idling movement of the rocker arm is allowed when there is no movement of the fuel pump diaphragm. A spring holds the rocker arm in constant contact with the eccentric to minimise operating noise.

The fuel pump incorporates valve assemblies which are serviced as complete units. Each unit consists of a small brass cage holding the valve and spring which can be fitted in either inlet or outlet position.

Every 8,000 km. (5,000 miles)

Cleaning the Fuel Pump

The filter screen, glass sediment bowl and the sediment chamber should be cleaned with petrol every 8,000 km. (5,000 miles), and the flange screws checked with a hand screwdriver for tightness. If any screws are found to be loose the pump assembly must be removed, the diaphragm located and the flange screws torqued as in part 6 of the reassemble instructions on page 24.

To Remove the Filter Screen

1. **Unscrew the sediment bowl** retainer clamp and lift off the bowl and filter screen.

2. **Carefully wash the screen in petrol** and flush all traces of sediment from the sediment chamber and bowl.

To Refit

1. **Refit the screen to the fuel pump body.**

2. **Ensure that the gasket is in good condition** and will make an airtight joint. Refit the sediment bowl and tighten the clamp to retain the sediment bowl in position.

Testing the Fuel Pump

Providing there are no leaks or obstructions in the fuel line, a quick check of the fuel pump efficiency can be made as follows:

1. **Disconnect the fuel pump** to carburettor pipe at the pump outlet.

2. **Crank the engine by means of the starter motor,** when a well-defined spurt of fuel should be apparent for each revolution of the camshaft. If the pump does not operate correctly, check the inlet depression and delivery pressure using suitable gauges. (The gang gauge set (Tool No. 500) or a Diagnosis Test Set have suitable gauges and adaptors for this work.)

Fuel Pump Inlet Depression Test

1. **Fill the carburettor float chamber with petrol.**

2. **Disconnect the fuel line** from the fuel tank at the pump inlet, suitably plugging the end of the pipe to prevent loss of fuel from the tank or the ingress of foreign matter. Sharp plugs i.e. screws should not be used.

3. **Connect the vacuum gauge to the inlet union,** start the engine and allow it to run at idling speed, when a vacuum reading of at least 21.59 cms. (8½ in.) mercury should be obtained.

4. **Stop the engine,** when the gauge needle should take at least one minute to return to zero.

Fuel Pump Delivery Pressure Test

1. **Fill the carburettor** float chamber with petrol.

2. **Disconnect the fuel pump** to carburettor pipe at the carburettor and connect the pressure gauge to the pump outlet. Leave the return flow pipe in the circuit (if fitted).

3. **Start the engine** and observe the pressure when running at idling speed. Momentarily race the engine and observe the pressure. This should not be less than 0.070 kg. per sq. cm. (1 lb. per sq. in.) and should be between 0.25 and 0.35 kg. per sq. cm. (3.5 and 5 p.s.i.) at idle with needle seat valve closed.

Low fuel pump outlet pressure may limit engine performance. An excessive pressure may result in a high float chamber level, with possible flooding. High fuel pump pressure may also cause the engine to stall, due to an over-rich mixture.

4. **Disconnect the pressure gauge** from the pump and reconnect the fuel pump to carburettor pipe.

Overhauling the Fuel Pump

To Remove

1. **Disconnect the fuel pump to carburettor pipe** and remove the pipe.

2. **Detach the fuel supply pipe** from the petrol tank. The pipe should be suitably plugged to prevent loss of fuel or the ingress of foreign matter. Sharp plugs i.e. screws should not be used.

3. **Unscrew and remove the two bolts** and spring washers securing the fuel pump to the cylinder block and detach the fuel pump, lifting the operating lever to clear the eccentric and the slotted hole in the block. Remove the gasket.

4. **Slacken the clamp** and remove the sediment bowl and gasket.

5. **Pull off the filter gauze** and wash thoroughly in clean petrol.

6. **Mark the position of the tab** on the side of the body and unscrew the upper body retaining screws and remove the body.

7. **Carefully remove the valve assemblies** and gaskets if they require a replacement. These assemblies are staked in position.

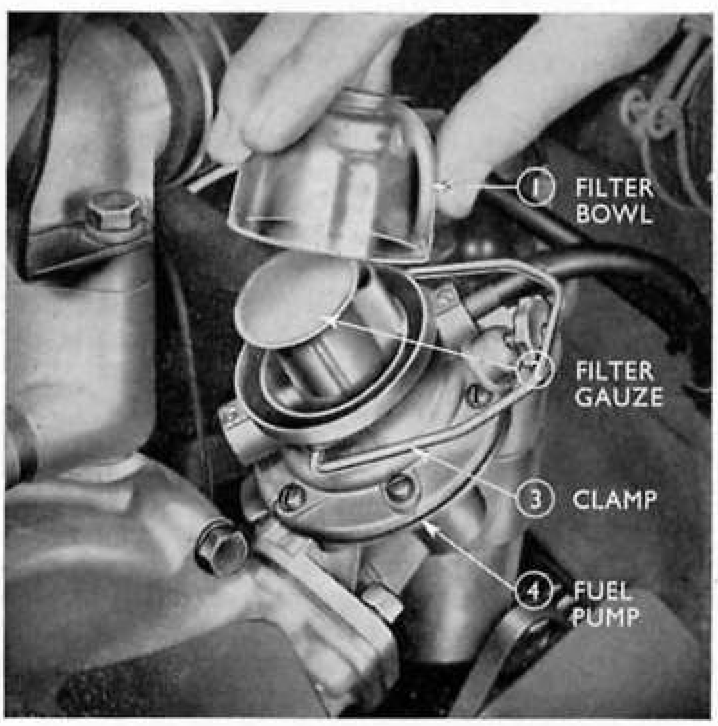


Fig. 29
Removing the Sediment Bowl

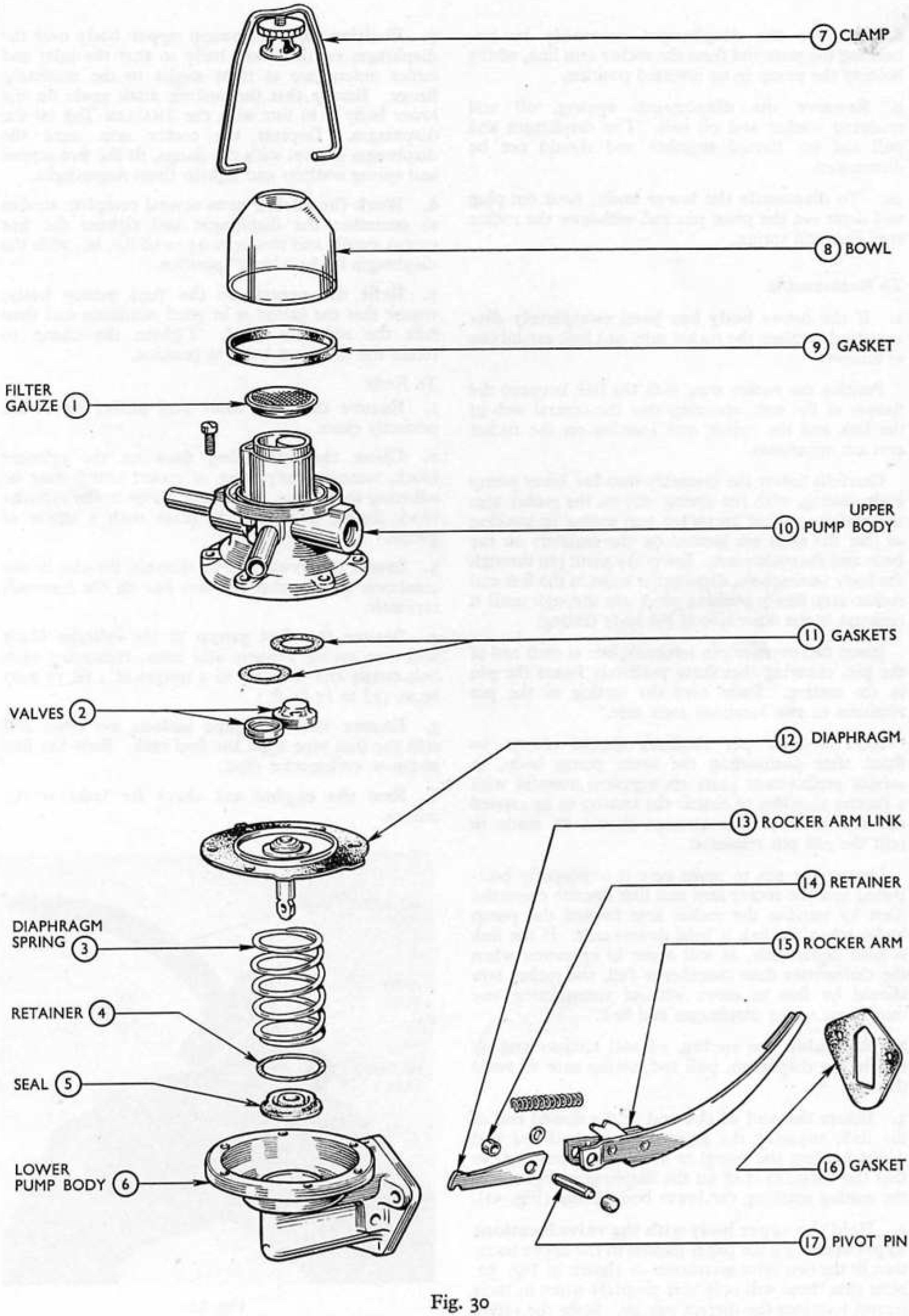


Fig. 30
Fuel Pump — Exploded

8. **Remove the diaphragm assembly** by unhooking the push rod from the rocker arm link, whilst holding the pump in an inverted position.

9. **Remove the diaphragm spring,** oil seal retaining washer and oil seal. The diaphragm and pull rod are riveted together and should not be dismantled.

10. **To dismantle the lower body,** hook out plug and drive out the pivot pin and withdraw the rocker arm, link and spring.

To Reassemble

1. **If the lower body has been completely dismantled,** replace the rocker arm and link assemblies as follows:

Position the rocker arm, with the link between the flanges of the arm, ensuring that the central web of the link and the spring seat location on the rocker arm are uppermost.

Carefully insert the assembly into the lower pump body casting, with the spring seat on the rocker arm uppermost, placing the rocker arm spring in position so that the ends are located by the registers on the body and the rocker arm. Insert the pivot pin through the body casting hole, aligning the holes in the link and rocker arm, finally pushing pivot pin through until it registers in the other side of the body casting.

Insert two oversize pin retainers, one at each end of the pin, ensuring that these positively locate the pin in the casting. Stake over the casting to the pin retainers in two locations each side.

NOTE.—New pin retainers should always be fitted after dismantling the lower pump body, as service replacement parts are supplied oversize with a shorter shoulder to enable the staking to be carried out satisfactorily. No attempt should be made to refit the old pin retainers.

Inspect the pin to make sure it is properly positioned and the rocker arm and link operate correctly. Test by moving the rocker arm toward the pump body, when the link is held downwards. If the link is held downwards, as will occur in operation when the carburettor float chamber is full, the rocker arm should be free to move without transmitting any movement to the diaphragm and link.

2. **Assemble the spring,** oil seal retainer and oil seal to the diaphragm pull rod, taking care to avoid damage.

3. **Insert the end of the rod** in the slotted end of the link, engaging the groove in the pull rod end whilst holding the pump in an inverted position, so that the SMALLER TAB on the diaphragm aligns with the mating mark on the lower body flange (Fig. 31).

4. **Hold the upper body with the valve locations uppermost.** Fit the paper gaskets in the upper body, then fit the two valve assemblies as shown in Fig. 30. Note that these will only seat properly when in their correct locations the correct way up. Stake the valves in position.

5. **Position the fuel pump upper body** over the diaphragm on the lower body so that the inlet and outlet unions are at right angles to the mounting flange. Ensure that the mating mark made on the lower body is in line with the SMALLER TAB on the diaphragm. Depress the rocker arm until the diaphragm is level with the flange, fit the five screws and spring washers and tighten them finger-tight.

6. **Work the rocker arm** several complete strokes to centralise the diaphragm and tighten the five screws evenly and torque to 25 to 30 lbs. in., with the diaphragm in the "down" position.

7. **Refit the screen to the fuel pump body,** ensure that the gasket is in good condition and then refit the sediment bowl. Tighten the clamp to retain the sediment bowl in position.

To Refit

1. **Ensure that the inlet and outlet ports** are perfectly clean.

2. **Clean the mounting face** on the cylinder block, removing any trace of gasket which may be adhering to the face. Fit a new gasket to the cylinder block flange, holding it in place with a smear of grease.

3. **Insert the rocker arm** through the slot in the crankcase wall so that the arm lies on the camshaft eccentric.

4. **Secure the fuel pump** to the cylinder block with two spring washers and bolts, tightening each bolt evenly and securely to a torque of 1.66 to 2.07 kg.m. (12 to 15 lb. ft.).

5. **Ensure that the pipe unions** are clean and refit the fuel pipe from the fuel tank. Refit the fuel pump to carburettor pipe.

6. **Run the engine** and check for leaks at the unions.

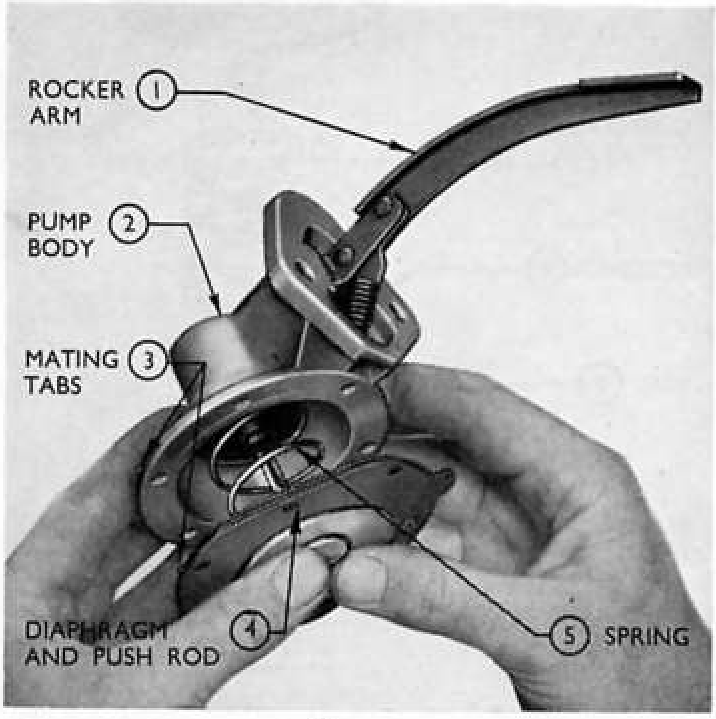


Fig. 31
Assembling Fuel Pump

FUEL SYSTEM: DIESEL

OVERHAUL PROCEDURES

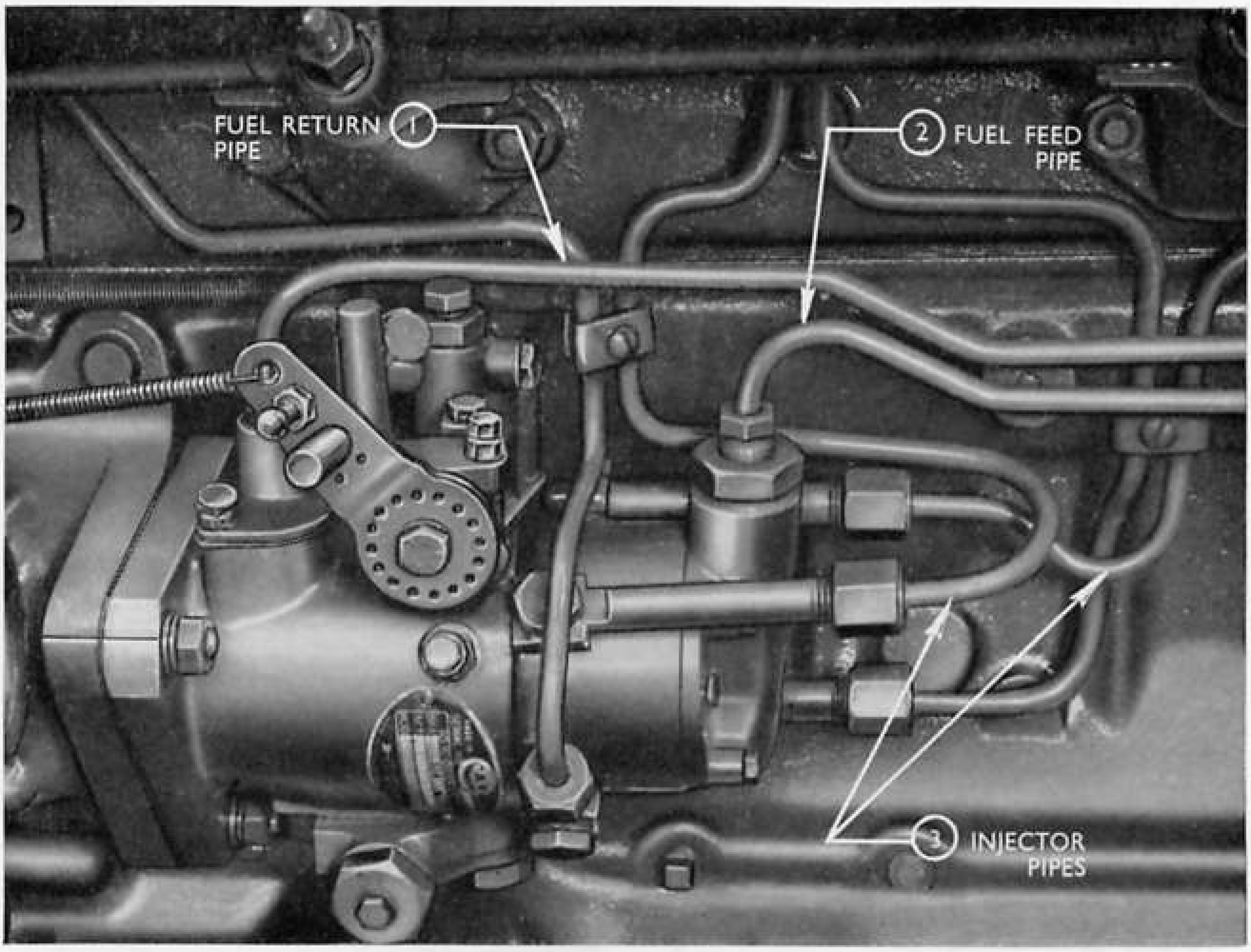


Fig. 32
The Fuel Injection Pump (4/99)

Introduction

The Fuel System consists of a fuel tank, sediment bowl, lift pump, filter, injection pump and injectors. There is also a small reservoir mounted behind the engine to provide a gravity feed to the cold starting device in the manifold.

The fuel lift pump is of the diaphragm type mounted on the engine tappet chamber cover and operated by a push rod from an eccentric on the engine camshaft. This pump incorporates a hand priming lever to enable the fuel system to be bled. The lift pump draws fuel from the fuel tank through a sediment bowl mounted inside the engine compartment.

From the fuel lift pump the fuel passes through a replaceable element-type filter to a distributor-type fuel injection pump. Fuel at high pressure is then passed, in turn, to each of the four delay-type pintle nozzle injectors mounted in the cylinder head. The injectors are lubricated by fuel oil leaking back past the needle valve stems. This fuel is returned to the fuel tank, via the starting device reservoir, by a "leak-off" pipe.

Service Precautions

It should be stressed that as the fuel injection equipment is extremely accurate and finely finished, it is essential that every care be exercised to prevent damage when carrying out repairs or overhauls.

Special equipment must be used when carrying out the pump test procedures and re-setting injector pressures. For all operations a dust-proof room should be provided.

To protect the pump and injectors when they are removed prior to servicing, and to protect them before refitting to an engine, special dust caps and plugs from the pump repair kit should be used for blanking fuel connections.

For cleaning and testing an odourless kerosene, or a special substitute test fuel must be used, see Specification and Repair Data.

The mechanic should protect his hands with a good quality barrier cream prior to commencing any work

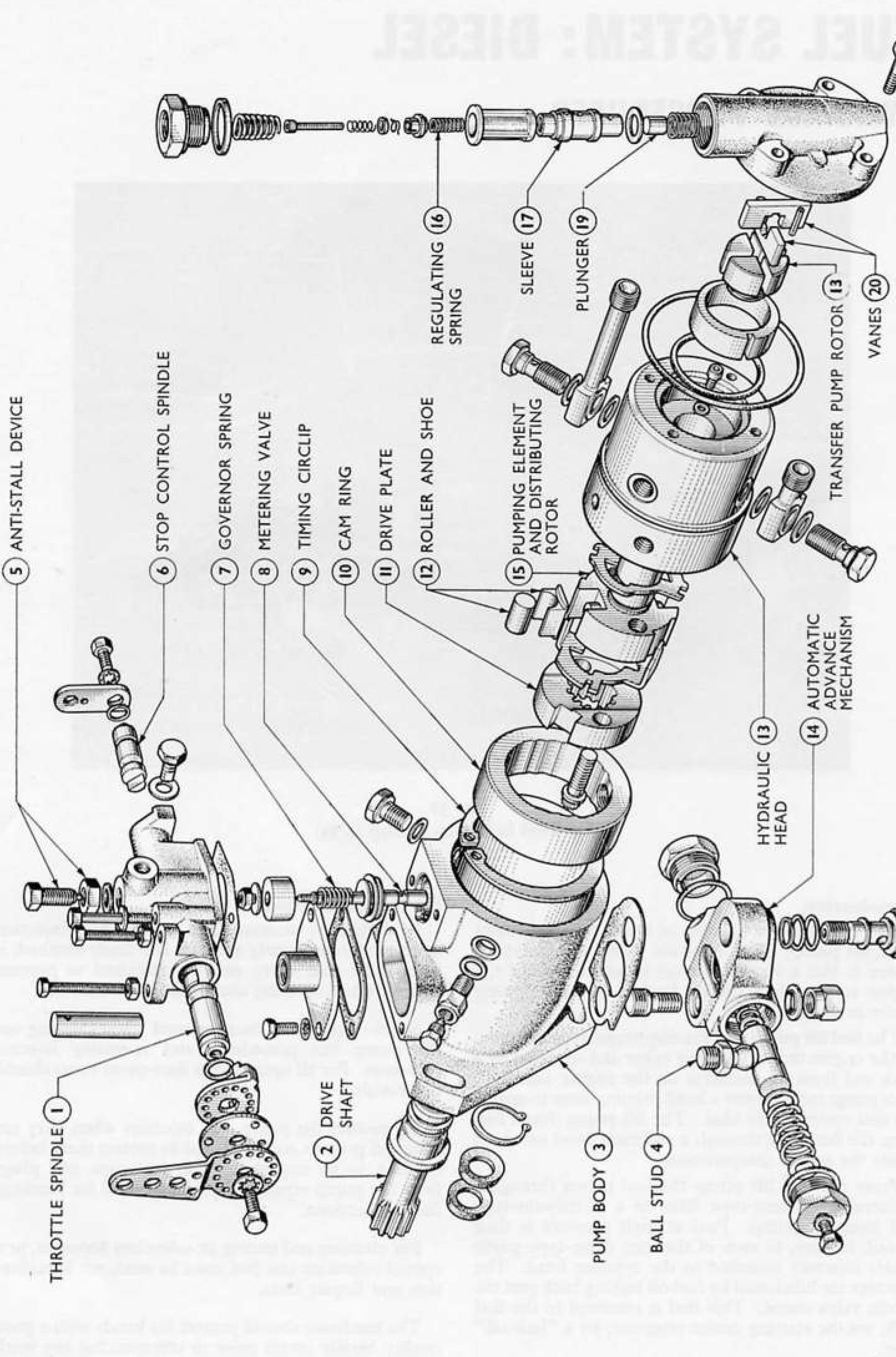


Fig. 33
Fuel Injection Pump — Exploded

of this nature, as a certain amount of fuel oil is bound to be present in pumps and injectors which have been in service.

Care should also be taken when testing injectors to prevent spray from the injectors coming into direct contact with the hands, as the working pressure is such that it will easily penetrate the skin.

Remember ! Cleanliness is essential.

THE DISTRIBUTOR TYPE INJECTION PUMP

Description

The distributor type injection pump consists of a single pumping element (two opposed plungers, revolving in a cam ring). This pumping element delivers fuel at high pressure to all injectors in turn by means of a distributing rotor integral with the pump rotor. A vane type transfer pump at the end of the distributing rotor supplies fuel to the pumping element via an annular groove in the distributing rotor, the metering valve and port. Transfer pressure is determined by a regulating valve in the end cover. The maximum fuel delivery is controlled by the stroke of the pumping element plungers which is determined by stop plates attached to either side of the pump rotor.

The hydraulic governor consists of the governor spring, control sleeve damper and metering valve. As the accelerator is depressed or released the throttle shaft increases or decreases the pressure on the control sleeve and governor spring.

A stop plate, attached to the throttle shaft and two adjusting screws limit the movement of the shaft and set the maximum and idling speeds.

The 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 an idler gear driven by the engine crankshaft.

Operation

Injection Pump

Fuel from the fuel pump is filtered by a replaceable element-type filter and enters the injection pump at the fuel inlet connection (see Fig. 36). After passing through a nylon filter an eccentric sliding vane-type transfer pump increases the pressure. This pressure increase is proportional to the engine speed and is controlled by a regulating valve. The regulating valve is a spring-loaded plunger in a sleeve situated beneath the inlet connection between the inlet and outlet side of the transfer pump. The fuel pressure lifts the plunger up against the regulating spring until the regulating port is partially open and fuel bleeds back to the inlet side of the transfer pump, thus regulating the transfer pressure.

Fuel at transfer pressure flows through a drilling in the hydraulic head and then, via an annular groove in the distributor rotor to the metering valve. The metering valve is controlled by a hydraulic governor which is operated by fuel at transfer pressure acting on one side of the metering valve and is balanced on the other side by a governor spring. The governor spring load is varied by a cam, machined on the inner end of the throttle spindle. A throttle lever attached to the end of the spindle is connected to the accelerator pedal. At low engine speeds the action of the governor spring is compensated by an idling spring.

An increase in the governor spring load, by depressing the accelerator pedal, moves the metering valve downwards to uncover more of the metering port and increase the fuel delivery. As the engine speed increases the transfer pressure increases, until it is sufficient to move the metering valve upwards to a reduced fuel position and balance the increased spring load, thus effectively governing the engine speed.

To prevent the engine stalling when decelerating from high to idling speed, an anti-stall device is fitted in the top of the governor housing. This device is a spring-loaded adjustable stop which limits the movement of the metering valve upwards, ensuring that fuel delivery is not completely cut off during deceleration.

A metered quantity of fuel flows to the pumping element each time one of the four inlet ports in the distributor rotor is in alignment with the metering port. The single pumping element consists of opposed plungers in a radial bore machined through the pump rotor. Rollers located in shoes sliding in the rotor are displaced by internal lobes in a stationary cam ring and operate the plungers as the rotor revolves at half engine speed. The metered quantity of fuel flowing into the pumping element moves the plungers apart. Different quantities of fuel, depending on operating conditions, will cause different displacements. At full load the maximum quantity of fuel is limited by a stop restricting the outward movement of the shoes.

As the rotor revolves the inlet port, which has communicated with the metering port, moves away and injection commences as each roller rides up the flank of diametrically opposed lobes to force the plungers together (see Fig. 36). At this instant, the distributing port will be in alignment with one of the four delivery ports and fuel at high pressure will be delivered to the appropriate injector. Each cam lobe has two peaks and injection ceases when the roller reaches the first, which is the highest. The valley between the two peaks ensures a rapid reduction in pressure in the injector pipe line preventing dribble and carbon formation at the injector nozzle at the end of injection. The second, lower, peak maintains residual pressure in the pipe lines. The cam ring between the lobes is relieved and the rollers do not at any time contact this surface which, therefore, is not ground.

Advance Mechanism

The cam ring is not fixed to the injection pump body but is attached by a ball stud to the advance and retard mechanism (see Fig. 33). This consists of inner and outer pistons located in a transverse bore machined through a housing attached to the underside of the injection pump body. Fuel at transfer pressure acting on the outer piston crown is opposed by a spring. The ball pin is located in the inner piston, which is also spring-loaded, and transmits any movement of the outer piston to the cam ring. As transfer pressure increases with speed, the piston moves, compressing the spring and advancing the injection pump timing. A decrease in speed causes the transfer pressure to drop and the spring pressure moves the piston back, retarding the injection pump timing.

At full load the pumping element plungers are operated by the rollers earlier than at light loads, when the reduced quantity of fuel restricts outward movement of the plungers and, therefore, plunger operation does not commence until the rollers are nearer to the cam peaks. If the cam ring were fixed this would result in the injection pump timing being retarded. However, at light loads the inner spring-loaded piston (Fig. 33) holds the cam ring in an advanced position to compensate for this. At full load the increased plunger displacement causes a higher torque to be applied to the cam ring. This torque, transmitted to the inner piston by the ball pin, overcomes the spring pressure and retards the cam ring to give correct injection pump timing advance characteristics.

The injection pump is lubricated by fuel oil which is permitted to bleed past the rotating parts and completely fills the pump body.

Surplus fuel oil is returned to the inlet side of the fuel filter from the low pressure outlet.

Regulating Valve

The regulating valve performs an additional function to transfer pressure regulation, described previously. Provision is made in the regulating valve for by-passing the sliding vane type transfer pump to enable the injection pump to be primed or bled. When the injection pump is not operating the regulating plunger is in the lower part of the regulating sleeve bore and rests on a priming by-pass spring (see Figs. 33, 36 and 39). Operation of the lift pump priming lever forces fuel at lift pump pressure through the inlet connection and into the regulating sleeve bore. This pressure forces the plunger downwards compressing the priming by-pass spring and uncovering the priming port in the sleeve (see Figs. 33, 36 and 39). The transfer pump is then by-passed and the injection pump may then be primed and bled. The regulating plunger returns to its normal position after bleeding has been completed.

Stop Control

To stop the engine, the stop lever is turned, by pulling the control in the cab, moving the metering valve upwards against the governor and anti-stall device spring pressures to close the metering port completely.

Cold Starting Device

As there is no excess fuel device incorporated in this injection pump a cold starting device is fitted in the inlet manifold. The "Thermostart" is described on page 51.

Lubrication

The body of the injection pump is completely filled with fuel oil, which is continuously being re-circulated, and requires no additional lubrication.

OVERHAUL PROCEDURES

Fig. 34
Timing the Injection Pump (4/99)

The injection pump has a timing mark scribed on the mounting flange that aligns with a similar mark on the cylinder block (see Fig. 34).

The injection pump may be removed and/or replaced regardless of the engine's rotational position, providing the engine timing gears are not disturbed.

The pump drive shaft has a master spline, which locates in a corresponding spline in the engine timing gear hub. When fitting an injection pump, maintain the correct injection timing by engaging the master splines and aligning the timing marks on the injection pump mounting flange and the cylinder block.

To Remove

1. **Raise the bonnet** and secure with the stay.
2. **Unscrew the exhaust pipe clamp bolts** and remove the clamp and circular steel insert (4/99 only).
3. **Remove the exhaust manifold clamp bolts,** and remove the manifold (4/99 only).
4. **Disconnect the four injector pipes.**
5. **Remove the inlet and outlet pipes** from the injection pump and filter.
6. **Disconnect the stop and throttle controls.**
7. **Unscrew the nuts** securing the injection pump to the engine. Remove the pump.

NOTE.—The 4/108 pump is secured by two studs and a bolt.

Preliminary Checking

Before the injection pump is dismantled or a replacement unit fitted to an engine, the pump that has been removed should be thoroughly cleaned and its operation checked on a calibrating machine. It is also advisable to remove and check the operation of the fuel injection pump whenever the engine is undergoing major attention. Even pumps that have seen very extensive service should be checked for general performance to ascertain (*a*) if any faults exist, and (*b*) whether a complete overhaul is necessary.

To check the operation of the pump it is only necessary to complete the operations marked thus † on the test procedure on page 41.

To Replace or Refit a Fuel Injection Pump

1. **Locate the injection pump** on the mounting studs on the cylinder block, at the same time engaging the master spline on the pump drive shaft with a corresponding spline on the engine timing gear hub.
2. **Align the timing mark** scribed on the injection pump mounting flange with the timing mark on the cylinder block (see Fig. 34). Fit the nuts (and the bolt on the 4/108), then tighten securely.
3. **Connect the throttle and stop controls,** adjusting the throttle lever position, if necessary. Locate the throttle linkage in **the lever inner hole.**
4. **Refit the inlet and outlet pipes** to the fuel pump and filter. Ensure that the inlet pipe to the injection pump is connected to the connection marked " OUT " on the filter.
5. **Fit the fuel injector pipes** to their respective connectors on the fuel injection pump.

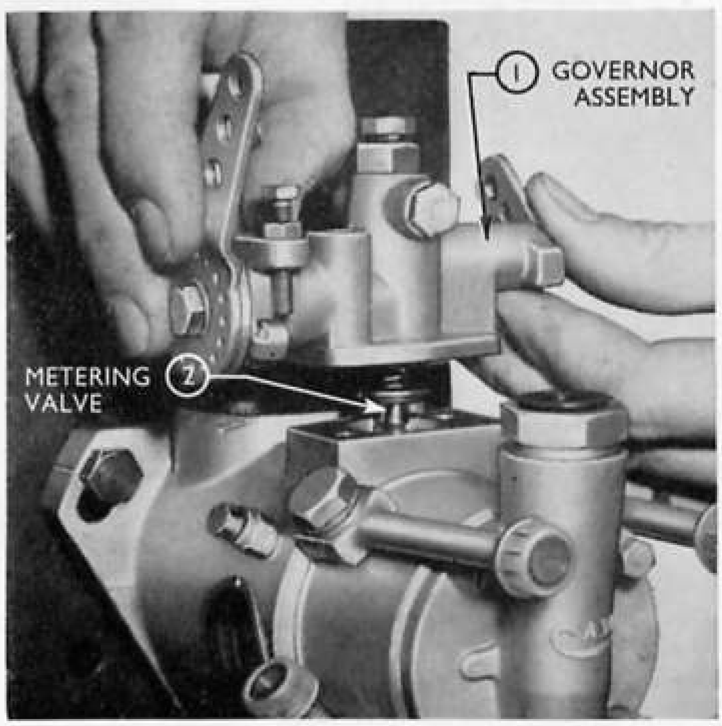


Fig. 35
Removal of Governor Assembly

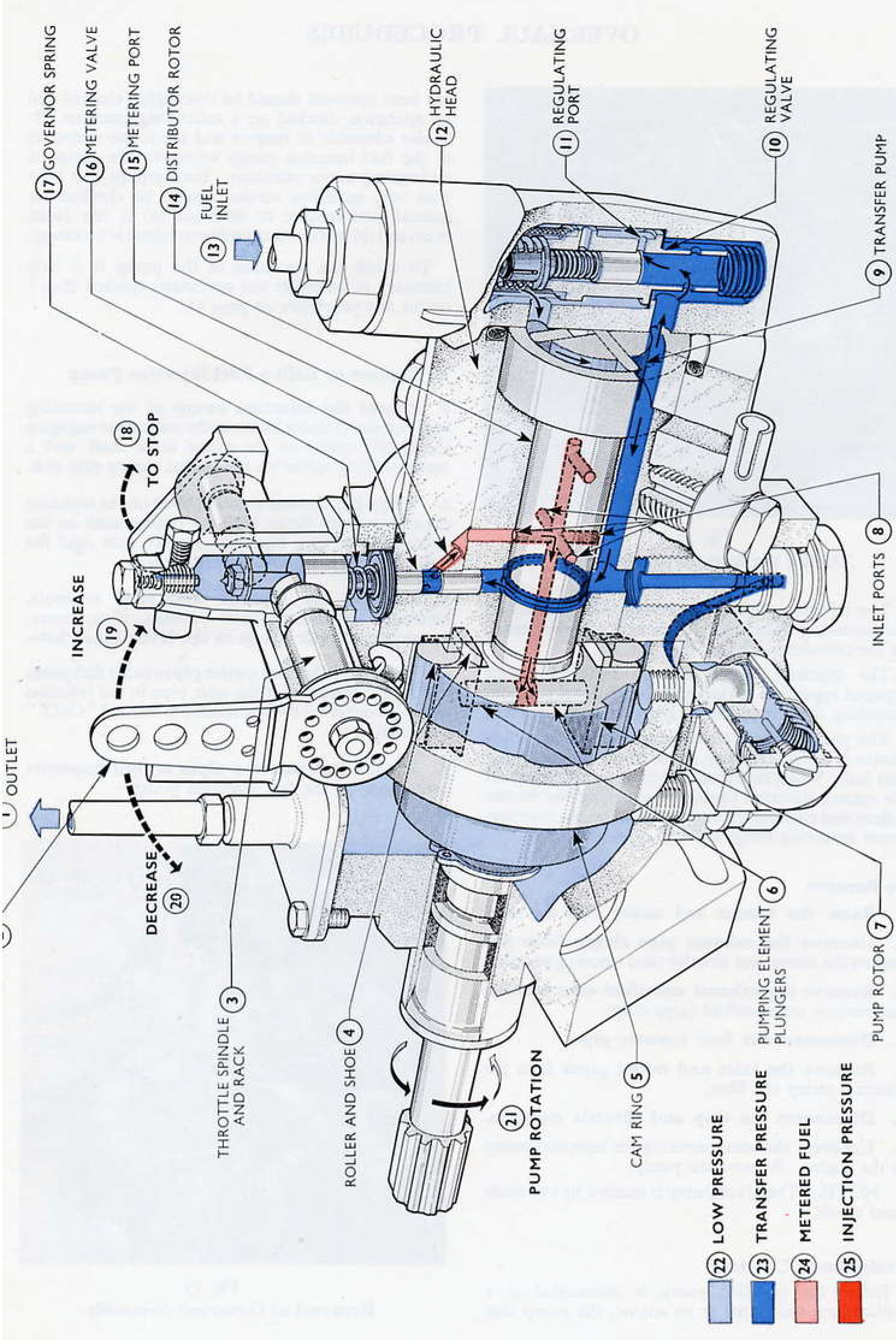


Fig. 36
Operation of Fuel Injection Pump (Metering)

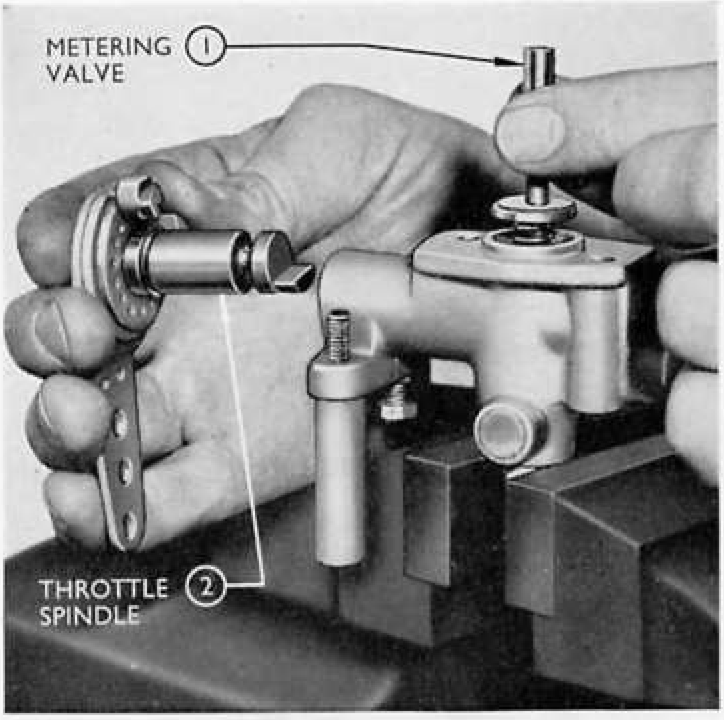


Fig. 37
Removing the Metering Valve

6. **Locate the exhaust manifold** on its mounting flanges and fit the clamp. Secure each clamp with two nuts (4/99 only).

7. **Fit the circular steel insert** between the exhaust manifold and exhaust pipe, fit the clamps and secure in position (4/99 only).

8. **Bleed the fuel injection pump** (see page 51).

9. **Adjust the engine idling speed** (see page 40).

10. **Lower the bonnet** and secure.

To Dismantle

1. **Break the seal,** unscrew the two screws and remove the pump inspection cover plate.

NOTE.—This seal should only be removed by experienced personnel authorized by the pump manufacturers who can reseal the pump with identifiable seals. Unauthorized breaking of the fuel pump seals may render the guarantee void.

2. **Drain the fuel oil from the pump housing.**

3. **Mount the pump with the governor uppermost on a dismantling jig** Tool No. CA.62. Three nuts and bolts are provided with the jig for this purpose.

4. **Unscrew and remove the two bolts securing the governor assembly** to the pump body. This must be carried out without applying any side thrust, as it is possible to damage or break the metering valve (see Fig. 35).

5. **Dismantle the governor assembly as follows:**

(*a*) Remove the anti-stall device from the governor housing.

(*b*) Pull the stop control spindle out of the governor housing.

(*c*) Pull the throttle spindle out of the governor housing.

(*d*) Withdraw the metering valve from the housing (see Fig. 37).

6. **Unscrew the four banjo bolts** and remove the four injector pipe banjos.

7. **Slacken the inlet union** on the end cover.

8. **Unscrew the four bolts retaining the end cover to the pump body.** Remove the end cover assembly.

9. **Dismantle the regulating valve.** Remove the inlet union and placing your hand over the inlet union recess, invert the end cover assembly to carefully remove the filter and regulating valve assembly (see Fig. 43). Care should be taken not to lose the regulating spring and plunger located in the sleeve.

10. **Remove the transfer pump 'O' ring** from the pump body using the assembly rod Tool No. CA.60.

11. **Holding the carbon vanes in position,** withdraw the transfer pump eccentric liner (see Fig. 38) and carefully remove the carbon vanes.

NOTE.—These carbon vanes are very brittle and may chip or break if not handled with care.

12. **Remove the two hydraulic head locking screws.**

13. **Invert the dismantling jig in the vice.**

14. **Slacken the advance mechanism end plugs.**

15. **Remove the advance mechanism** by unscrewing the securing nut and banjo bolt.

16. **Dismantle the advance mechanism** by unscrewing the end plugs. Remove the pistons and springs.

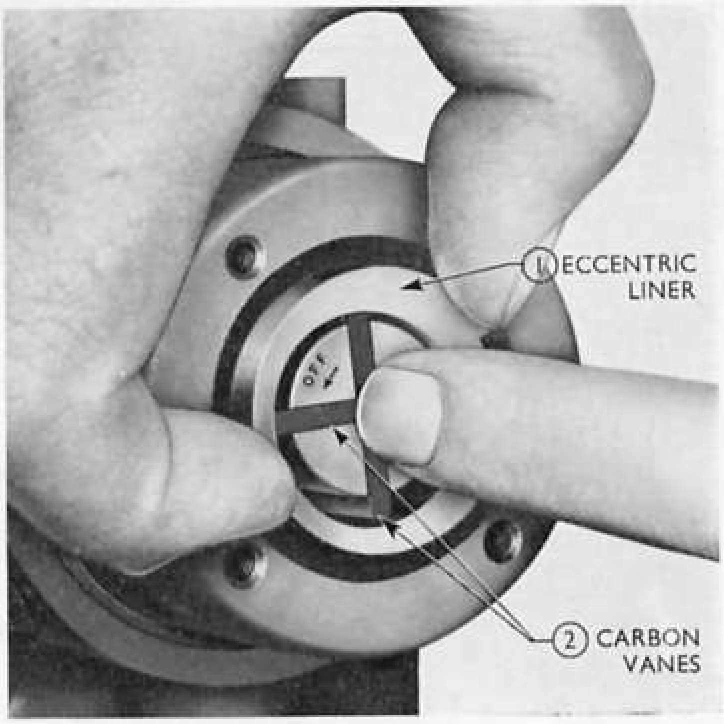


Fig. 38
Removing the Transfer Pump Eccentric Liner

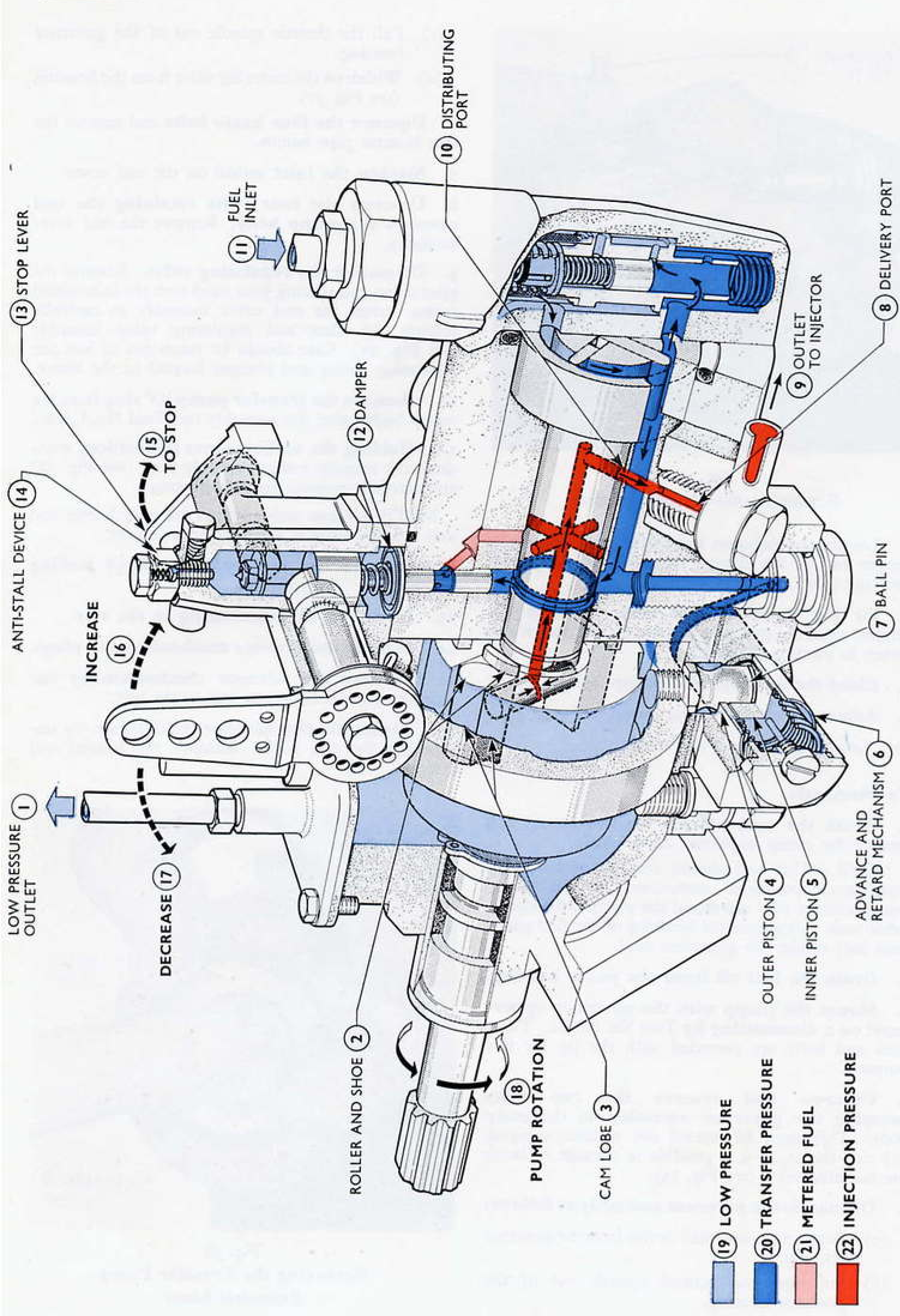


Fig. 39
Operation of Fuel Injection Pump (Injecting)

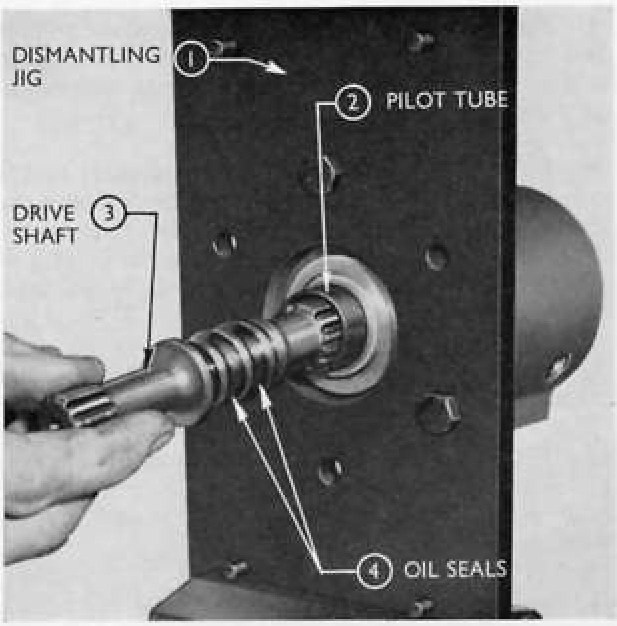


Fig. 40
Fitting the Splined Drive Shaft

17. **Remove the inner piston and spring** from the outer piston. Note the number of adjusting shims.

18. **Slacken the transfer pump rotor** in the direction of rotation, using rotor socket Tool No. CA.58 and drive shaft ring key Tool No. CA.61. Ensure that the socket is fully home to prevent damage to the rotor.

19. **Withdraw the hydraulic head assembly.**

20. **Unscrew the advance ball stud** and remove the cam ring.

21. **Using circlip pliers, compress and remove the timing circlip.**

22. **Using circlip pliers, expand and remove the driveshaft circlip.**

23. **Withdraw the driveshaft** from the pilot tube in the pump body.

24. **Dismantle the hydraulic head assembly:—**

(*a*) Remove the ' O ' ring from the annular groove in the periphery of the hydraulic head.

(*b*) Hold the drive plate with Tool No. CA.59 and unscrew the drive plate bolts. Adaptor Tool No. CA.57 can be used for this operation.

(*c*) Remove the drive plate and the outer fuel adjusting plate.

(*d*) Withdraw the rollers and shoes keeping them in their respective positions.

(*e*) Retain the twin pumping plungers in position with corks.

(*f*) Unscrew the transfer pump rotor and remove the pump and distributor rotor from the hydraulic head.

(*g*) Remove the inner fuel adjusting plate from the distributor rotor.

To Reassemble

Wash all components, ensure that they are clean and leave them in the cleaning fluid until they are required for assembly. All components should be fitted " wet " and not dry, to provide initial lubrication.

1. (*a*) Inspect the pump body machined surfaces for wear or damage.

(*b*) Check governor mounting and inspection window surfaces for flatness and scoring.

(*c*) Check the hydraulic head locating bore for damage. Inspect all threaded holes to ensure that no threads are damaged or stripped.

(*d*) Inspect the advance mechanism locating pad to ensure that it is free from burrs or other damage that would affect its normal operation.

(*e*) Check the pilot tube for wear or scoring.

(*f*) Inspect the mounting flange for cracks. Any part or parts that are worn or damaged and which in any way appear unserviceable should be replaced. Wash both existing and replacement parts thoroughly.

2. **Inspect the driveshaft,** and if serviceable, fit two new oil seals, using Tool No. CA.55. The seals are separated from each other by the flange machined on the shaft (see Fig. 40). Both seals are fitted with the lip towards the pump body.

3. **Insert the short splined end of the driveshaft into the pilot tube** from the rear of the dismantling jig (see Fig. 40). Special pliers Tool No. CA.56 should be used to fold these seals to facilitate assembly and prevent damage.

4. **Retain the driveshaft by fitting a new circlip.** This circlip is located inside the pump body.

5. **Compress the timing circlip** with circlip pliers (see Fig. 41) and seat it against the shoulder in the

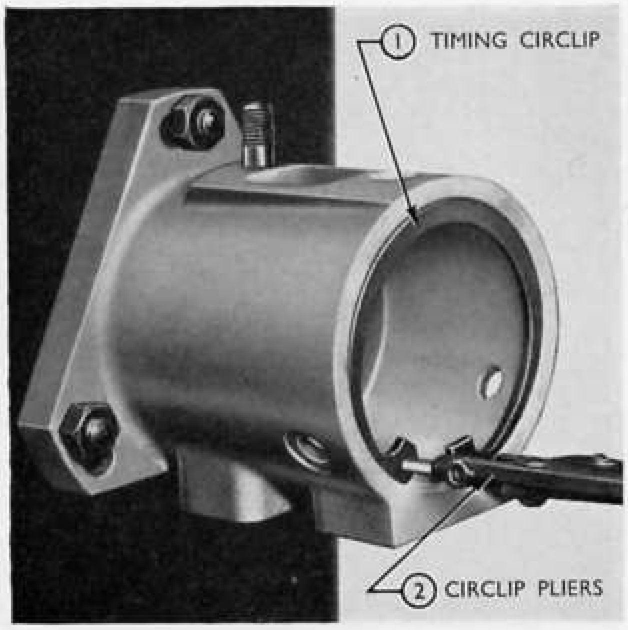


Fig. 41
Installing the Timing Circlips

pump body so that the square end of the circlip is in the centre of the inspection window.

6. Inspect the cam ring. The cam lobes and outer surfaces of the cam ring must be free from any dirt, corrosion and wear, or any other defects. Fit the cam ring into the pump body so that the arrow is in the same direction as the arrow on the injection pump name plate.

It is important that the cam ring is fitted the correct way round. Check this by seeing if, in the normal direction of rotation, the rollers will rise up the steepest ramp to the highest peak of the cam lobe first.

Check that the cam ring is quite free to turn in the injection pump body.

7. Fit the advance ball pin to the cam ring and tighten to a torque of 345 kg.cm. (300 lb. in.). Again check that the cam ring is free to rotate the limited amount permitted by the ball pin.

8. Inspect the distributor rotor for wear. Any bore wear in the hydraulic head will be reproduced on the rotor. Wash and fit the inner fuel adjusting plate so that the locating slots and roller shoe locations line up with the slots in the pump rotor. Wash the hydraulic head and insert the distributor rotor.

9. Fit the transfer pump rotor.

10. Check the rollers for wear, fine circumferential lines may be ignored. Remove the corks retaining the twin pumping plungers in position and fit the rollers and shoes to the injection pump rotor with the wide end of the lug to the wide end of the slot in the fuel adjusting plate.

11. Fit the outer fuel adjustment plate so that the scribed line in the injection pump rotor is adjacent to the centre of the small adjusting slot. (Approximate maximum fuel setting.)

12. Fit the drive plate with the channel to the rollers and shoes, and the slot to correspond with the scribed line in the injection pump rotor. Secure the drive plate with two new high tensile bolts and tighten to a torque of 185 kg.cm. (160 lb. in.), holding the drive plate with Tool No. CA.59.

13. Wash the hydraulic head assembly and ensure that it spins freely on the distributor rotor.

14. Fit a new 'O' ring to the hydraulic head. Lubricate the pump body and install the hydraulic head with the bolt holes and drive master splines lined up (see Fig. 42).

15. Fit the bleed screw to the side of the pump bearing the direction of rotation plate and a transfer pressure adaptor to the other. Do not tighten until the advance and retard mechanism is fitted.

16. Tighten the transfer pump rotor, using the drive shaft spanner Tool No. CA.61 and the rotor socket Tool No. CA.58 to a torque of 75 kg.cm. (65 lb. in.). Check pump movement.

17. Assemble the advance mechanism. Place the inner piston and spring in the outer piston together with any adjustment shims removed. Insert the outer piston in the housing bore with the piston crown to the same end as the drilling from the banjo bolt. Fit the plain end plug to the housing, adjacent to the piston crown.

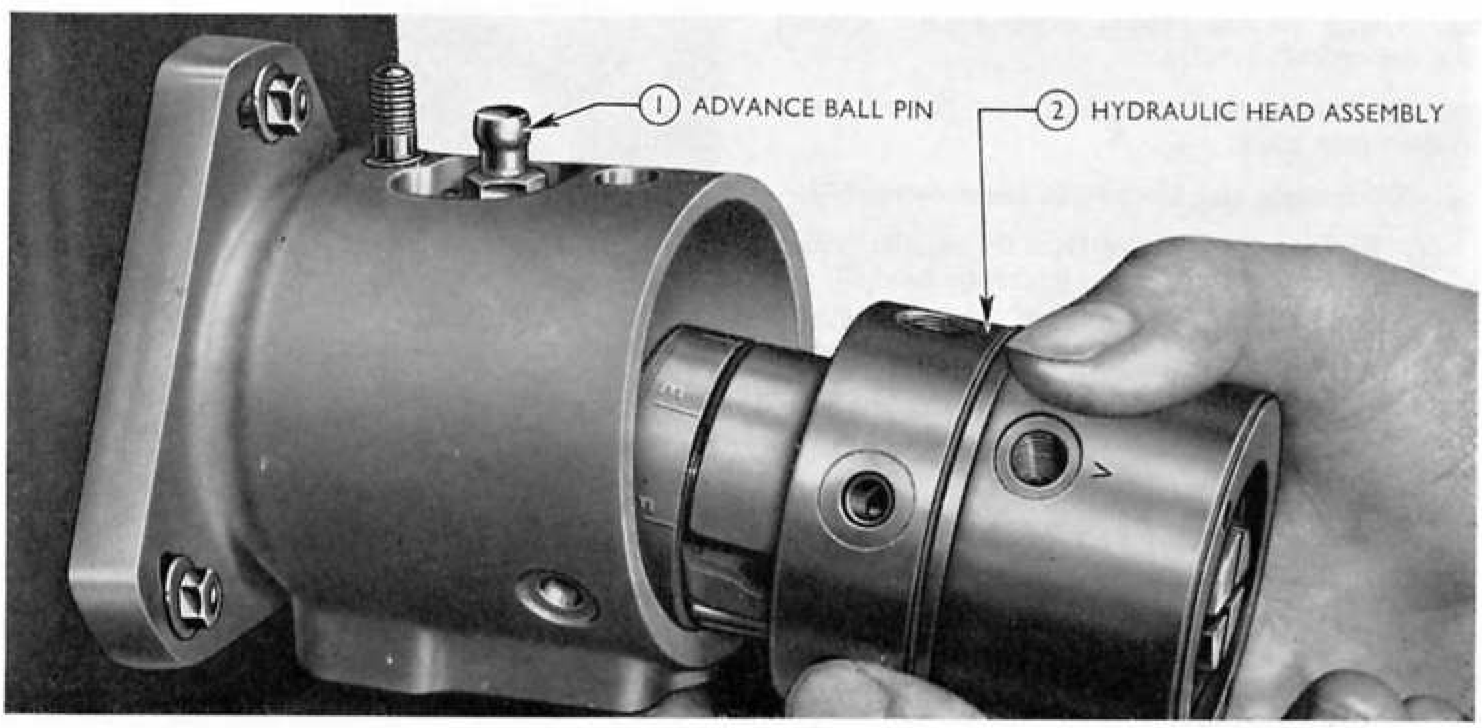


Fig. 42
Fitting Hydraulic Head Assembly

Should either end plug " O " ring be unserviceable a new " O " ring should be fitted, using Tool No. CA.52.

18. Place the spring seat washer on the step machined in the outer piston and then insert the outer piston spring. Fit the end plug incorporating the stop pin, together with any adjustment shims removed, to the housing.

NOTE.—A 0.5 mm. thick assembly shim must be fitted in this end plug to prevent damage by the spring end.

19. Fit the advance mechanism to the pump body with a new gasket on the mating faces. Assemble two 'O' sealing rings to the banjo bolt, one under the head and one under the flange. Use Tool No. CA.53 for the head seal and Tool No. CA.54 for the flange. Ensure that the advance mechanism is a snug fit on the body and install the banjo bolt with the steel washer under the inner " O " ring. Tighten the banjo bolt to a torque of 403 kg.cm. (350 lb. in.) and the securing nut to 127 kg.cm. (110 lb. in.).

Fit the hydraulic head alignment tool No. CA.79 in the metering valve location and ensure that it is seated fully.

Tighten the hydraulic head locking screw and the transfer pressure adaptor to 195 kg.cm. (170 lb. in.) torque.

Raise the hydraulic head alignment tool and allow it to fall. It should seat fully without binding.

Check that the pump is free to rotate.

20. Invert the dismantling jig and fit the inspection cover plate with a new gasket.

21. Assemble the governor assembly as follows:

(*a*) Fit an ' O ' sealing ring to the throttle spindle, using Tool No. CA.50.

(*b*) Insert the metering valve into the governor housing. Fit the throttle spindle into the governor housing with the eccentric cam above the control sleeve and below the shut off washer.

(*c*) Fit an ' O ' sealing ring to the stop control spindle, using Tool No. CA.51 and insert in the governor housing. Ensure that the stop control spindle eccentric cam is beneath the shut off washer. If this shaft is assembled with the cam above the washer the pump will be set in the maximum fuel position with no means of shut off.

(*d*) Fit the throttle adjustment plate to the throttle spindle and place the throttle lever on the shaft so that it is vertical with the throttle adjustment plate in the mid position.

NOTE.—This is only a provisional setting for test purposes and will have to be reset to suit the throttle linkage on the vehicle.

22. Fit the governor assembly to the injection pump body with a new gasket. The metering valve must be entered squarely into the hydraulic head as this component may be easily broken. Guide the large damping washer into its bore with a suitable probe.

Tighten the bolts securely and use copper washers under the heads to prevent oil leaks.

23. Fit the anti-stall device to the governor housing and screw in three or four turns before tightening the locknut. Final adjustment of this device will, of course, be carried out on the engine.

24. Install the transfer pump eccentric liner.

25. Fit the carbon vanes to the rotor. These vanes must be perfectly free and must not pick up on the eccentric liner when the pump is rotated. Fit new vanes if the old ones are not satisfactory.

26. Assemble the regulating valve and filter (see Fig. 43) to the end plate as follows:—

(*a*) Insert the priming by-pass spring in the end plate bore. Ensure that the spring is correctly located.

(*b*) Place the regulating plunger in the regulating sleeve. This plunger must be free to slide easily under its own weight.

(*c*) Locate a new gasket on the regulating sleeve and insert the sleeve and plunger in the end plate bore so that the plunger does not fall out. Check the plunger operation on the priming spring, with the assembly rod Tool No. CA.60.

(*d*) Fit the regulating spring to the sleeve bore. This may be done by threading the spring onto the assembly rod Tool No. CA.60.

(*e*) Push the nylon filter onto its seating on the upper end of the sleeve.

(*f*) Place the sleeve retaining spring seat onto the sleeve with the smaller spigot located in the bore.

(*g*) Place the sleeve retaining spring inside the filter and locate on the spring seat.

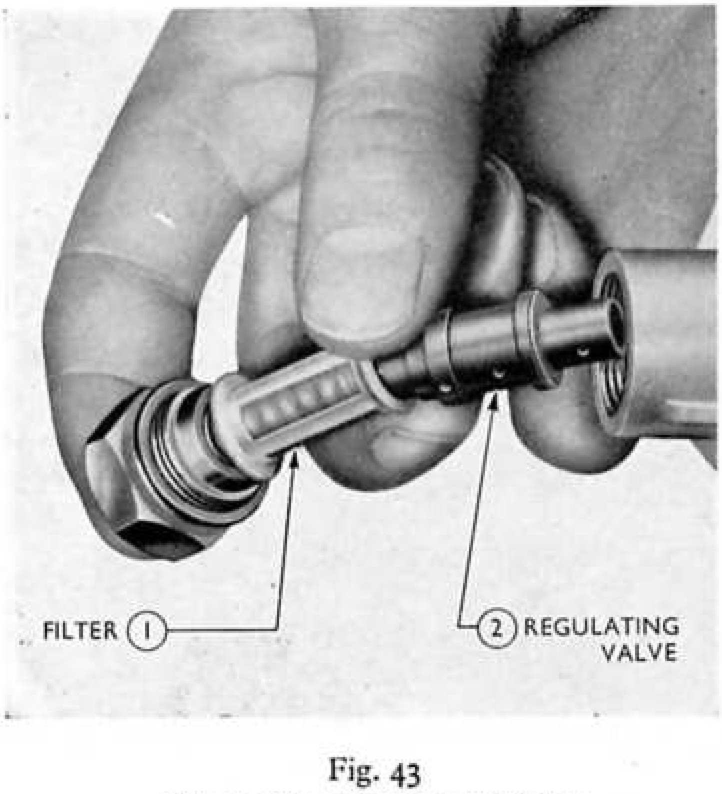


Fig. 43
Regulating Valve and Filter

(*h*) Secure the regulating valve assembly by screwing the fuel inlet valve connection in.

27. Fit an 'O' ring to the transfer pump groove.

28. Fit the end plate to the hydraulic head, locating the dowel in the slot in the periphery of the eccentric liner.

The dowel is fitted to the hole marked with a letter 'C' on the outer face.

Tighten the bolts diagonally to a torque of 52 kg.cm. (45 lb. in.).

29. Tighten the inlet connection to 415 kg.cm. (360 lb. in.) torque.

30. For test purposes fit radial connections, with copper washers, in place of the four injector pipe banjos.

TESTING AND ADJUSTING THE FUEL INJECTION PUMP

The distributor type pump has only one pumping element, thus each injector receives an equal volume of fuel when the engine is operating at constant speed and load. Also, injection will occur at regular intervals as the cam lobes which operate the single pumping element (two opposed plungers) are evenly spaced and accurately machined in the cam ring. Phasing and calibration, operations which are essential when a conventional multi-element type injection pump is overhauled are, therefore, not required. Pre-set timing marks are also accurately machined on the cam ring and drive plate and, as these are fixed, no timing adjustment is necessary.

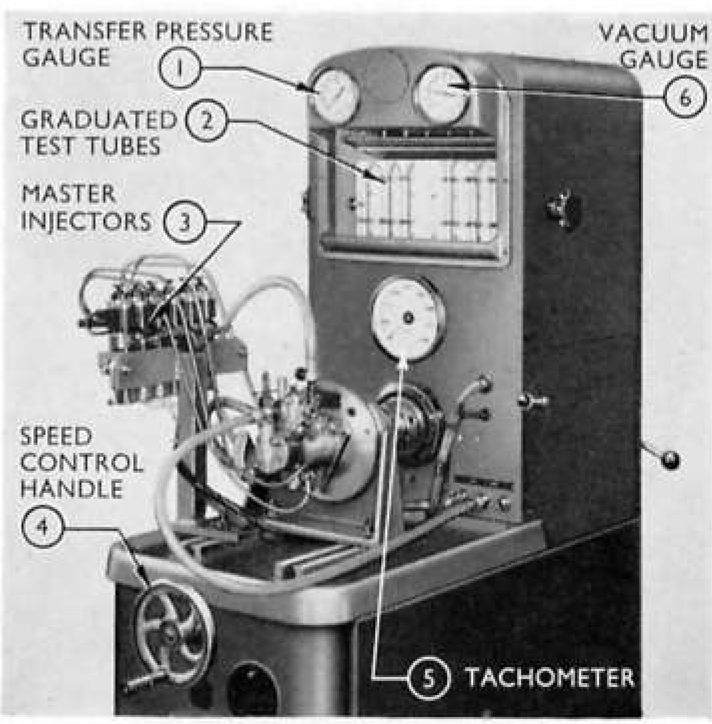


Fig. 44
A Typical Variable Speed Test Bench

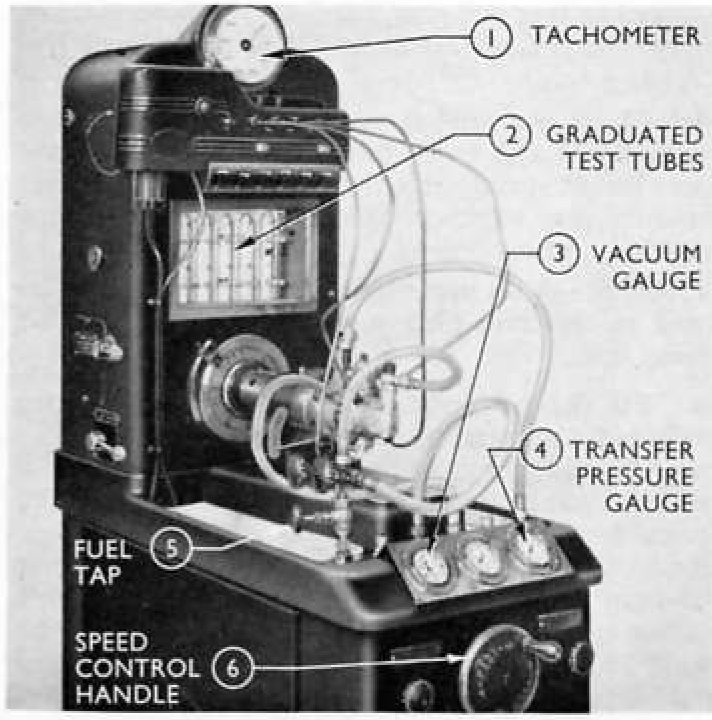


Fig. 45
A Typical Variable Speed Test Bench

It is necessary, however, to check and adjust the maximum fuel delivery and also to check the operation of the injection pump on a calibrating machine. As this injection pump has to be tested at varying speeds, the calibrating machine used must have a variable speed drive (see Figs. 44 and 45).

Where it is only necessary to check the operation of the pump, i.e. when a fault is suspected or prior to overhaul, complete the operations on the test procedure on page 41, but do not make any adjustments.

Test Bench Adjustments

Fuel injection pumps must be accurately tested and to ensure this, it is essential that the master injectors fitted to the calibrating machine are maintained as an accurately balanced set. To ensure maximum life and efficiency from master injectors the following points should be strictly observed:—

1. The calibrating machine should be housed in a dustproof room, and suitably covered when not in use.

2. The fuel tank should be drained and cleaned out frequently, and after testing 200 pumps, the filter element renewed.

3. Where testing is not carried out frequently, an injection pump should be mounted on the machine and test fuel passed through the master injectors at least once a week.

NOTE.—It is advisable to use only a substitute test fuel in the calibrating machine as the variation of this fuel is less than that of diesel fuel so that more accurate readings can be obtained. Also the test fuel gives better protection to the master injectors.

Master Injectors

The master injectors must be checked regularly for balance. To carry out this test, mount an in-line

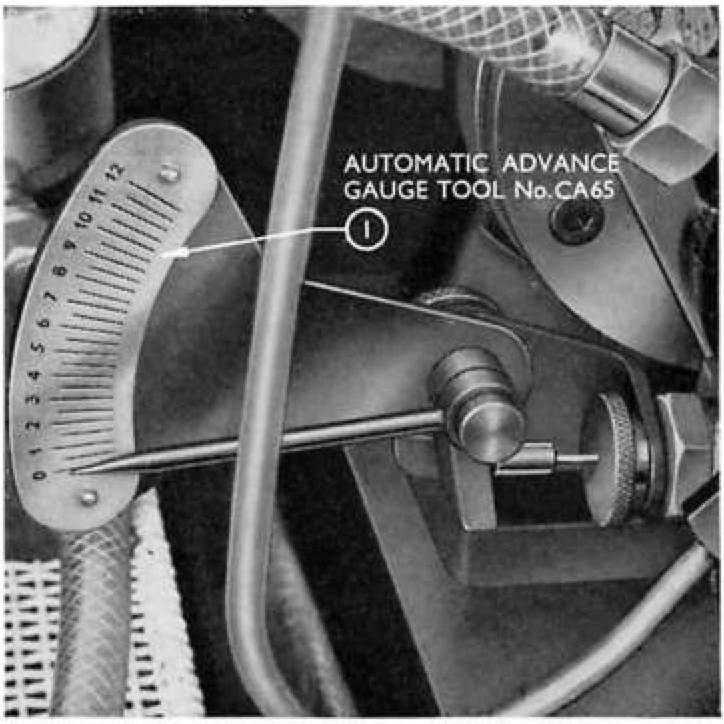


Fig. 46
The Automatic Advance Gauge

injection pump on the calibrating machine, connect all pipes and run the machine for at least 15 minutes to allow everything to reach normal operating temperature. It is essential that this is strictly observed when carrying out this test.

Adjust one pump element to deliver 15 c.c. for three consecutive readings, running at 600 rev./min. for 300 shots of fuel. **Note: All readings must be taken from the bottom of the meniscus.** Connect this pump element to each master injector in turn, using the same pipe and test tube throughout this test. Running at 600 rev./min. collect 300 shots of fuel, allowing 15 seconds after delivery has ceased for the fuel to settle before taking the readings, and 30 seconds for the tube to drain when emptying. Take the mean of three readings from each injector in turn and the variation between the highest and lowest readings should not exceed 0.3 c.c. If the variation exceeds this figure a fresh set of master injectors should be fitted. Do not attempt to balance master injectors by cleaning or pressure adjustment.

Injector Pipes

After a prolonged period of use on the calibrating machine it may be found that the ends of the injector pipes have closed up slightly thus reducing the bore. This condition will affect the pump delivery and if it is found to exist, the pipes should be renewed. As an emergency measure the ends of the pipes can be cleared by using a 2 mm. diameter drill to a depth of 20 mm. ($\frac{3}{4}$ in.) and then the pipe bore thoroughly cleaned (preferably with pressure equipment) before refitting.

(a) **Test Equipment Specification**

Master injectors fitted with BDN12SD12 nozzles set at 175 atmospheres opening pressure. Nozzle back leakage must not be less than 10 secs. for a drop from 150 to 100 atmospheres.

High pressure pipes 6 mm. by 2 mm. by 86.4 cm. (34 in.) long with special radial connections identified by a drilling through a corner of the hexagon.

Gravity to 0.07 kg./sq. cm. (1 lb./sq. in.) feed with a minimum flow of 1,000 c.c./min.

Special substitute fuel oil, see Specification and Repair Data.

Oil temperature 15.6 to 48.9°C (60 to 120°F).

(b) **Basic Specification of Fuel Injection Pump**

(1) Pump Rotation: Clockwise, looking on drive end.

(2) Combined speed and light load advance mechanism and anti-stall device fitted.

(3) Transfer pressure adjuster in the end plate assembly.

(4) Hydraulic governor.

(c) **Mounting the Fuel Injection Pump on the Test Equipment**

(1) Mount the fuel injection pump on the test equipment, using the distributor type pump mounting adaptor and drive. (This is usually supplied with the test equipment.)

(2) Align the master spline on the injection pump drive shaft with the corresponding spline of the test equipment drive. Secure the pump in position with three bolts fitted through the pump mounting flange.

(3) From the base of the injection pump remove the stop pin located in one of the end plugs fitted to the advance and retard mechanism. In place of the stop pin fit an automatic advance gauge Tool No. CA.65. Zero the gauge before commencing any test as described in section (*d*) General Data.

(4) Unscrew the hydraulic head locking screw that does not incorporate a vent screw, if a pressure adaptor has not already been fitted. In its place fit a pressure adaptor. Couple up the test pressure gauge pipe to this adaptor.

(5) Connect up the pipe line from the back leakage measuring cylinder of the test equipment to the outlet port on the fuel injection pump.

(6) If the banjo unions are fitted to the four injector outlet ports on the pump, (i.e. on a pump just removed from a vehicle) remove these banjo unions and fit radial connectors in their place. Couple up the radial connectors to the four pipes leading to the test equipment injectors.

(7) Fit the fuel supply pipe from the test equipment to the inlet union on the regulating valve connection of the fuel injection pump with a transfer pressure adjusting Tool No. CA.113. Prime all test bench fuel lines, including the line to the vacuum gauge.

(d) **General Data**

Test the injection pump in accordance with "Test Procedure" detailed on page 41. The throttle and stop control levers to be fully opened except where otherwise stated.

Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking a reading.

Leaks. All pumps must be completely free from leaks both while running and when stationary.

Delivery values. All calibration and setting values are for 200 strokes except where otherwise stated.

Unscrew the maximum stop screw and idling stop screw to allow full movement of the throttle arm before commencing tests.

Screw out the transfer pressure adjusting screw fully and then screw in 1½ turns before commencing test.

Do NOT run the pump for long periods with the shut-off lever closed.

Do NOT run the pump for long periods at high speed with small delivery.

Zero the advance gauge Tool No. CA.65, before commencing any tests, by pressing the pin fully inwards and adjusting the scale to zero. Upon release, the inner piston should cause the indicator to show 4° to 4½° advance.

Unscrew the anti-stall device and lock so that it does not interfere with movement of the metering valve before commencing the test. Adjustment of the anti-stall device must be made on the engine.

Note the points in the test procedure where priming and venting is required.

(e) **Priming and Venting**

With this pump, correct and consistent operation of the auto-advance is dependent upon the exclusion of air from the auto-advance housing.

Venting should be carried out at the vent screws whilst running the injection pump at 100 r.p.m.

Operate the throttle lever and press inwards and release the automatic advance gauge Tool No. CA.65 indicator pin several times to ensure venting.

(f) **Automatic Advance**

The automatic advance mechanism is adjusted by shimming the inner and outer piston springs (see Fig. 33) as follows :—

Speed Advance

(1) Remove the automatic advance gauge Tool No. CA.65 and the end plug into which it is screwed.

(2) If the advance is low remove shims to rectify.
NOTE.—A 0.5 mm. shim is fitted to this end plug on assembly. This must NOT be removed.

(3) If the advance is high add shims to rectify.
NOTE.—The amount of shimming, in addition to the 0.5 mm. assembly shim, that may be added to meet the test requirements may vary from 0 to 2.4 mm. Shims 0.2, 0.5, 1 and 2 mm. thick are available.

(4) Replace the end plug and the advance gauge Tool No. CA.65, zero if necessary. Prime and vent the injection pump as described previously.

Light Load Advance

(1) Remove the automatic advance gauge Tool No. CA.65 and then unscrew the banjo bolt and securing nut to remove the advance mechanism.

(2) Unscrew the end plug incorporating the tapped hole and carefully remove the inner and outer pistons and springs. Do not disturb the outer piston adjustment shims.

(3) Remove the inner piston from the outer and remove shims if the fuel delivery is too high. Add shims if the fuel delivery is too low.
NOTE.—The amount of shimming that may be added to meet the test requirements may vary from 0 to 1.2 mm. Shims 0.2, 0.5 and 1 mm. thick are available.

(4) Reassemble the advance mechanism and replace on the injection pump body. Tighten the banjo bolt to 403 kg.cm. (350 lb. in.) torque and the securing nut to 127 kg.cm. (110 lb. in.). Fit the advance gauge Tool No. CA.65 to the end plug and zero if necessary. Prime and vent the injection pump as described previously.

(g) **Transfer Pressure**

The transfer pressure is adjusted by means of an adjusting screw in the end plate assembly, accessible through the inlet connection. This can be adjusted with the pump running with adjuster Tool No. CA.113 (see Fig. 47). Screw the adjuster in to increase pressure and out to reduce the pressure.

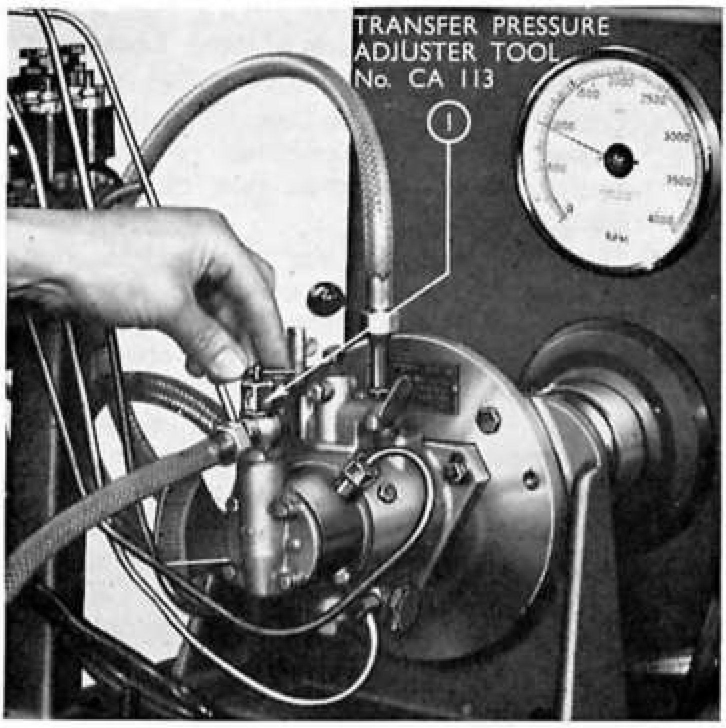


Fig. 47
Adjusting Transfer Pressure

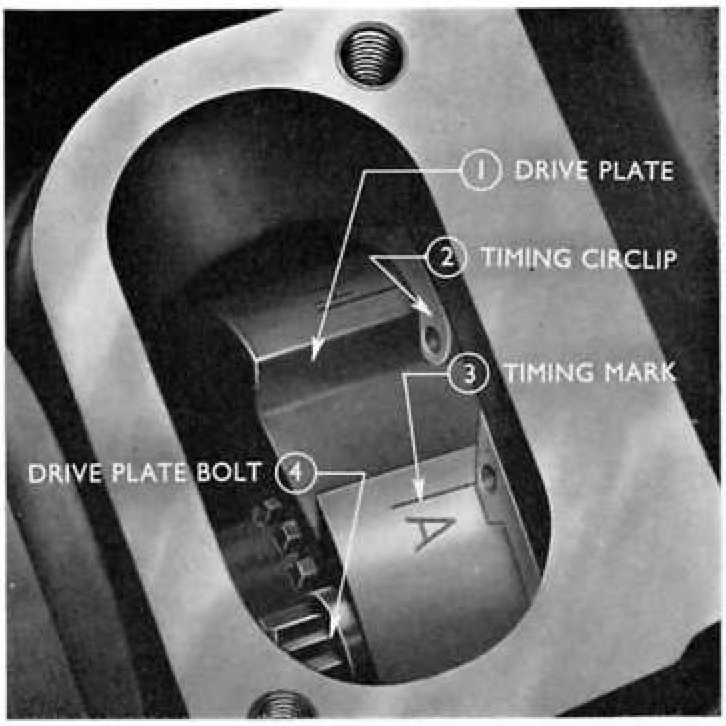


Fig. 48
Injection Pump Timing

(h) **Maximum Fuel Delivery**

The maximum fuel delivery is controlled by the stroke of the pumping element plungers. The plunger stroke is limited by lugs, on the roller shoes, which protrude into slots cut in the inner edge of annular adjustment plates situated on either side of the pump rotor. The base of these slots are curved to form a small section of a spiral so that one side is longer than the other. The lugs are machined to follow the contour of this curve. Any movement of the adjustment plates relative to the pump rotor will vary the maximum plunger stroke and hence the maximum fuel delivery. The outer adjustment plate (i.e. the one nearest to the drive end) is clamped between the drive plate and the pump rotor and is connected to the inner plate by two connecting bars. The outer adjustment plate has a small slot in its outer edge in which a suitable lever is engaged when making adjustments. A slot is provided in the drive plate to facilitate this.

To adjust the maximum fuel delivery, slacken the drive plate bolts, using adaptor Tool No. CA.57 and using a suitable lever move the adjustment plates clockwise to increase the fuel delivery and anti-clockwise to decrease. Tighten the drive plate bolts using the adaptor Tool No. CA.57 and a torque wrench. A torque reading of 144.0 kg.cm. (125 lb. in.) will ensure that a torque of 185 kg.cm. (160 lb. in.) is applied to the bolt.

NOTE.—The torque wrench and adaptor must be in line.

Replace the inspection cover plate and refill the pump body. Re-test the maximum fuel delivery and readjust if not within the specified limits.

When the maximum fuel delivery is within the specified limits repeat operations Nos. 5, 6, 8 and 9 in the test procedure and then re-check operation No. 11 (Maximum Fuel Delivery).

(i) **Timing**

The injection pump drive shaft has a master spline which locates in a corresponding spline in the engine timing gear hub. Accurate timing of the injection pump in relation to the engine is ensured by setting timing marks within the pump and externally by scribing a line on the pump mounting flange during testing. This scribed line aligns with a similar mark on the cylinder block. It is, therefore, 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 mounting flange and the cylinder block (see Fig. 34), providing the engine timing gears are not disturbed (relative to each other).

Set the injection pump timing by connecting a stirrup pipe Tool No. CA.64 to outlets U and W on the hydraulic head with pressure relief valve Tool No. CA.71 to an injector tester. Turn the pump clockwise until the scribed line marked with a letter "B" on the drive plate is visible in the inspection window. Apply a pressure of 30 atmospheres with an injector tester to expand the plungers to their limit. The use of a stirrup pipe across diametrically opposed delivery ports balances the pressure applied to the distributor rotor. Hold the inner advance piston in the fully retarded position by pressing the advance gauge pin and continue turning the pump clockwise until the plunger rollers contact the cam lobe when resistance to further movement will be encountered. At this point align the square end of the circlip with the scribed line marked with a letter "A," (see Fig. 48).

The timing mark on the pump mounting flange is also made with the pump held in this position. Mount a flange marking gauge Tool No. CA.63, set to 300°, onto the drive shaft and scribe a line on the pump mounting flange.

Fuel Injection Pump Removal from the Test Equipment

1. Disconnect all pipes and remove the automatic advance gauge Tool No. CA.65 from the injection pump. Replace the stop pin in the advance mechanism end plug.

2. Unscrew the transfer pressure adjuster Tool No. CA.113 and remove the adjuster assembly and banjo connection.

3. Remove the transfer pressure adaptor and replace the hydraulic head locking screw. Tighten to 196 kg.cm. (170 lb. in.) torque.

4. Unscrew the radial connections from the hydraulic head and refit the long banjo unions, with the pipes horizontal, to outlet ports U, V and X. Fit the short banjo union, with the pipe upwards, to outlet W. Use new copper washers and tighten securely to prevent leaks.

5. Fit dust caps or plugs to all connections.

6. Unscrew the three bolts through the injection pump mounting flange and remove the pump from the test equipment.

Idling Adjustment

The idling adjustment can only be made when the injection pump is on the engine.

Fit the injection pump to the engine, as described previously (see page 29), and adjust the idling speed, with the engine and gearbox at normal working temperature as follows :—

1. Ensure that the idling control knob is screwed fully home.

2. Slacken the lock nut and unscrew the anti-stall device until it is out of contact with the metering valve.

3. Start the engine and, when running at the normal operating temperature adjust the idling speed to 625 rev./min. with the idling stop screw (see Fig. 49).

4. Screw in the anti-stall device slowly until a slight increase in engine speed is noticed and then slacken by approximately one third of a turn. Lock in this position with the lock nut.

5. Run up the engine and gently throttle back to the idling position to check for stalling or slow deceleration.

(a) If the engine stalls the anti-stall device should be screwed in slightly.

(b) If the rate of deceleration is too slow the anti-stall device should be screwed out slightly.

After adjustment (a) or (b) run the engine up and recheck for stalling or slow deceleration. Re-adjust the anti-stall device if necessary.

Note: After every adjustment check that the engine is not idling directly on the anti-stall device. If it is, it must be readjusted immediately.

6. Pull the stop control knob to check that the engine stops.

Fig. 49
Idling Stop Screw and Anti-Stall Device (4/99)

CHECKING INJECTION PUMP TIMING

1. Disconnect the fuel return pipe from the injection pump.

2. Remove the inspection cover to expose the injection pump drive plate.

3. Turn the engine until the scribed line "A" is in alignment with the squared end of the timing circlip (see Fig. 49).

4. Unscrew the timing pin located in the timing cover backplate. The pin should locate in one of the two holes in the rear face of crankshaft pulley. This is the point of injection, 26° (4/99) or 19° (4/108) before top dead centre static advance, for No. 1 cylinder. The second hole in the back of the crankshaft pulley indicates top dead centre for No. 1 piston when the notch in the pulley rim is uppermost.

5. After checking the timing, screw home the timing pin, refit the inspection cover to the injection pump and reconnect the fuel return pipe.

INJECTION PUMP TEST PROCEDURE—4/99

	Description	R.P.M.	Requirements
†(1)	Operation	100 max.	Prime and vent the injection pump, see Note (*e*), to ensure fuel delivery from all nozzles.
(2)	Transfer pump vacuum	100	Turn the two-way tap, in the fuel feed pipe, to connect the vacuum gauge. 16 in. Hg. must be reached within 60 seconds. Prime the pump after this test.
(3)	Transfer pressure	100	0.8 kg./sq.cm. (11 lb./sq. in.) minimum.
(4)	Transfer pressure	1,000	2.55 to 3.4 kg./sq. cm. (36 to 48 lb./sq. in.).
†(5)	Transfer pressure	1,900	Set end plate pressure adjuster to give 2.9 kg./sq. cm. (41 lb./sq. in.). higher than (4).
†(6)	Advance position	1,600	$3\frac{1}{2}°$ to $4\frac{1}{4}°$
†(7)	Advance position	1,900	$5\frac{1}{2}°$ to $6\frac{1}{4}°$
†(8)	Advance position	1,000	$1\frac{1}{2}°$

N.B.—If adjustment is required to obtain the correct advance characteristics shim the OUTER PISTON spring only, see Note (*f*) Speed Advance. Prime and vent the injection pump after adjustment, see Note (*e*), before continuing the test.

	Description	R.P.M.	Requirements
†(9)	Light Load Advance		
(*a*)	Set throttle by adjustment of idling stop screw to give a minimum of 3° advance	250	Delivery to be 2.6 c.c. minimum average.
(*b*)	Set throttle by adjustment of idling stop screw to give a minimum of 4° advance	650	Delivery to be 2.0 c.c. minimum average.
(*c*)	Set the throttle by hand to give a maximum of 2° advance	1,100	Delivery not to exceed 3.6 c.c. average.

N.B.—If adjustment is required to obtain the correct fuel delivery, shim the INNER PISTON spring only, see Note (*f*) Light Load Advance. Prime and vent the injection pump after adjustment, see Note (*e*), before continuing test.

	Description	R.P.M.	Requirements
(*d*)	Reset idling stop screw to position 9 (*a*) above		
†(10)	Maximum fuel delivery*	1,000	Average delivery to be 5.0 ± 0.1 c.c. Spread between lines not to exceed 0.4 c.c. Adjust if incorrect, see Note (*h*). If alteration required re-test 6, 7 and 8 and then re-check Test 10.
†(11)	Maximum fuel delivery*	100	Average delivery to be not less than average at (10) minus 0.5 c.c.
†(12)	Stop control operation with the throttle fully open	200	With stop control lever closed, average delivery not to exceed 0.4 c.c.
(13)	Back leakage	1,000	5 to 35 c.c. in the same time as 100 strokes.
(14)	Fuel delivery check	1,700	Minimum average delivery to be average at (10) plus 0.8 c.c.
†(15)	Governor setting	2,000	Set delivery by adjusting maximum speed screw to 1.0 to 1.6 c.c.
†(16)	Fuel delivery check	1,700	Average delivery to be not less than average at (14) plus 0.4 c.c. with throttle as set at (15).
†(17)	Timing	—	Using outlet 'W,' (30 atmospheres pressure) press inner advance piston to full retard position by means of advance gauge pin, and set the circlip to letter 'A' on the drive plate. With the pump in this position scribe a line on the housing flange using Tool No. CA.63, see Note (*i*).

INJECTION PUMP TEST PROCEDURE — 4/108

Pump Type: 3246960-3246969 (with setting code on nameplate)

Fit auto-advance measuring device and set scale to zero before commencing test.

Where marked thus* use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking reading.

Screw back transfer pressure adjuster in end plate to the maximum extent and then screw in 1½ turns before commencing test.

Shimming of Automatic Speed Advance Device

(a) A 0.5 mm. shim is fitted to the piston spring cap on assembly. This must NOT be removed.

(b) The amount of additional shimming that may be added to meet test requirements may vary from 0 to 3.0 mm.

Test No.	*Description*	*R.P.M.*	*Requirements*
1	Priming	100 max.	Fuel delivery from all injectors.
2	Transfer pump vacuum	100	Note time to reach 406 mm. (16 in.) Hg. Max. time allowed 60 seconds.
3	Transfer pressure	100	0.8 kg./cm.² (11 lb./in.²) min.
4	Transfer pressure	1,200	3.2 to 4.0 kg./cm.² (45 to 57 lb./in.²).
5	Transfer pressure	2,000	Set end plate pressure adjuster to give 1.8 kg./cm.² (26 lb./in.²) higher than (4).
6	Advance position	1,200	1½° to 2°.
7	Advance position	1,700	3¾° to 3¼°.
8	Back leakage	1,200	5 to 70 c.c. for 100 stroke time cycle.
9	Maximum fuel delivery check ..	*	Set to code shown on pump nameplate. Delivery tolerance +0 —0.2 c.c. Spread between lines not to exceed 0.8 c.c.
10	Maximum fuel delivery check ..	100*	Average delivery to be not less than average at (9) minus 3.2 c.c.
11	Cut-off operation with throttle lever open	200	Average delivery not to exceed 0.6 c.c.
12	Fuel delivery check	1,640	Record average delivery.
13	Governor setting	2,140	Set throttle by maximum speed adjustment screw to give maximum average delivery of 1.0 c.c. No line to exceed 1.5 c.c.
14	Fuel delivery check	1,640	With throttle set as (13) average delivery to be not less than average at (12) minus 0.4 c.c.

Final transfer pressure and governor setting are related to the engine no load r.p.m. shown on the pump name plate.

Engine no load r.p.m. shown on pump nameplate	Test 15 Transfer pressure difference	Test 16 Governor setting r.p.m.
	1.8 kg./cm.² (26 lb./in.²)	2140

15	Transfer pressure	2,000	Unscrew maximum speed adjustment screw and set end plate pressure adjuster to give (see table) higher than (4).
16	Governor setting	See table	Set throttle by maximum speed adjustment screw to give maximum average delivery of 1.0 c.c. No line to exceed 1.5 c.c.
17	Timing	—	Using outlet 'W', (30 atmospheres pressure) press inner advance piston to full retard position by means of advance gauge pin, and set the circlip to letter 'A' on the drive plate. With the pump in this position scribe a line on the housing flange using Tool No. CA 63, see Note (i).

NOTE: THE GOVERNOR SETTING SPEED QUOTED IN THIS TEST PLAN IS FOR TEST PURPOSES ONLY. THE GOVERNOR MAXIMUM SPEED SCREW MUST BE FINALLY SET ON ENGINE ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS FOR THE PARTICULAR APPLICATION.

INJECTION PUMP TEST PROCEDURE—4/108

Pump Type: **3246990 – 3246999 (With setting code on nameplate).**

Test Procedure

Fit auto-advance measuring device and set scale to zero before commencing test.

Where marked thus* use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking reading.

Screw back transfer pressure adjuster in end plate to the maximum extent and then screw in 1½ turns before commencing test.

Shimming of Automatic Speed Advance Device

(a) A 0.5 mm. shim is fitted to the piston spring cap on assembly. This must NOT be removed.

(b) The amount of additional shimming that may be added to meet test requirments may vary from 0 to 3.0 mm.

Test No.	*Description*	*R.P.M.*	*Requirements*
1	Priming	100 max.	Fuel delivery from all injectors.
2	Transfer pump vacuum	100	Note time to reach 406 mm. (16 in.) Hg. Max. time allowed 60 seconds.
3	Transfer pressure	100	0.8 kg./cm.^{2} (11 lb./in.^{2}) min.
4	Transfer pressure	1,200	3.2 to 4.0 kg./cm.^{2} (45 to 57 lb./in.^{2}).
5	Transfer pressure	2,000	Set end plate pressure adjuster to give 2.0 kg./cm.^{2} (29 lb./in.^{2}) higher than (4).
6	Cambox pressure	2,000	0.3 to 0.5 kg./cm.^{2} (4 to 7 lb./in.^{2}).
7	Advance position	1,200	1½° to 2°.
8	Advance position	1,700	2¾° to 3¼°.
9	Back leakage	1,200	5 to 70 c.c. for 100 stroke time cycle.
10	Maximum fuel delivery	*	Set to code shown on pump nameplate. Delivery tolerance +0 —0.2 c.c. Spread between lines not to exceed 0.8 c.c.
11	Maximum fuel delivery check ..	100	Average delivery to be not less than average at (10) minus 3.2 c.c.
12	Cut off operation throttle lever fully open	200	Average delivery not to exceed 0.6 c.c.
13	Fuel delivery check	1,640	Record average delivery.
14	Governor setting	2,140	Set throttle by maximum speed adjustment screw to give maximum average delivery of 1.0 c.c. No line to exceed 1.5 c.c.
15	Fuel delivery check	1,640	With throttle set as at (14) average delivery to be not less than average at (13) —0.4 c.c.

Final transfer pressure and governor settings are related to the engine no load r.p.m. shown on the pump nameplate and must be obtained from the following table.

Engine no load r.p.m. shown on pump nameplate	Test 16 Transfer pressure difference	Test 17 Governor setting r.p.m.
	2.0 kg./cm.^{2} (29 lb./in.^{2})	2140

16	Transfer pressure	2000	Unscrew maximum speed adjustment screw and set End plate pressure adjuster to give (see table) higher than (4).
17	Governor setting	See Table	Set throttle by maximum speed adjustment screw to give maximum average delivery of 1.0 c.c. No line to exceed 1.5 c.c.
18	Timing	—	Using outlet 'W' (30 atmospheres pressure), press inner advance piston to full retard position by means of advance gauge pin, and set the circlip to letter 'A' on the drive plate. With the pump in this position scribe a line on the housing flange using Tool No. CA.63, see Note (i)

THE GOVERNOR SETTING SPEED QUOTED IN THIS TEST PLAN IS FOR TEST PURPOSES ONLY. THE GOVERNOR MAXIMUM SPEED SCREW MUST BE FINALLY SET ON ENGINE ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS FOR THE PARTICULAR APPLICATION.

Injection Pump—Fault Finding

Incorrect Vacuum

(1) Loose or damaged inlet connections.
(2) Unserviceable copper washer on inlet adaptor to end plate.
(3) Damaged gasket or regulating sleeve.
(4) Regulating spring missing or broken.
(5) End plate not tightened square to hydraulic head.
(6) Faulty transfer pump seal.
(7) Worn or damaged transfer pump blades.
(8) Transfer pump liner not located by dowel pin.
(9) Air in pipe to vacuum gauge.
(10) Priming spring missing or broken.

Low Transfer Pressure

(1) Incorrect adjustment.
(2) Regulating spring or piston missing.
(3) Regulating sleeve gasket damaged.
(4) Incorrect regulating spring.
(5) Worn or damaged transfer pump blades.
(6) Faulty transfer pump seal.
(7) Loose or incorrectly tightened end plate.
(8) Faulty washers on head locking and head locating screws.
(9) Damaged seals on head locating fitting.

High Transfer Pressure

(1) Incorrect adjustment.
(2) Sticking regulating plunger.
(3) Incorrect regulating spring—too strong.
(4) Test equipment operating on pressure feed.

Low and Fluctuating Transfer Pressure

(1) One transfer pump blade chipped or broken.

Low Advance Reading

(1) Low transfer pressure.
(2) Too many shims fitted.
(3) Spring too stiff, incorrect type fitted.
(4) Sticking advance piston.
(5) Sticking cam ring.
(6) Excessive clearance between piston and housing.

High Advance Reading

(1) High transfer pressure.
(2) Insufficient shims fitted.
(3) Incorrect spring, too weak.

Incorrect Maximum Fuel Delivery

(1) Throttle not fully open.
(2) Incorrect maximum fuel setting.
(3) Faulty washer on rotor plug screw.
(4) Loose rotor plug screw.
(5) Sticking metering valve.
(6) Air in the fuel system.
(7) Sticking plungers or roller shoes.
(8) Damaged washers on radial connections.
(9) Incorrect transfer pressure.
(10) Stop control spindle fouling metering valve.
(11) Cam ring reversed.
(12) Cam ring worn.

Low Fuel Delivery at 100 R.P.M.

(1) Low transfer pressure.
(2) Throttle not fully open.
(3) Rotor plug screw washer damaged.
(4) Rotor plug screw loose.
(5) Sticking metering valve.

Low fuel Delivery at 100 R.P.M. — contd.

(6) Sticking plungers and roller shoes.
(7) Damaged washers on radial connections.
(8) Plungers scored.
(9) Outlet ports scored.
(10) Excessive clearance, rotor to hydraulic head
(11) Air in the fuel system.
(12) Scored metering valve.

Stop Control Not Working

(1) Stop control lever incorrectly fitted to spindle.
(2) Stop control lever not turning spindle.
(3) Sticking metering valve.
(4) Slack metering valve nut.

Low Delivery during Fuel Delivery Check at Maximum Speed

(1) Maximum speed stop screw incorrectly adjusted.
(2) Faulty or incorrect governor spring.
(3) Sticking metering valve.

Difficulty in Setting Delivery by Maximum Speed Stop Screw

(1) Governor spring damaged or of wrong type.
(2) Sticking metering valve.

THE INJECTORS

Fuel from the distributor-type injection pump enters the injector inlet adaptor and passes through the injector body before reaching the delay-type pintle nozzle. The injectors are lubricated by fuel oil leaking back past the needle valve stems. This fuel is returned to the fuel tank by a 'leak-off' pipe.

Each injector flange is secured to two studs on the cylinder head by means of two nuts. The joint between the injector and the cylinder head is made by a copper washer between the lower face of the nozzle cap nut and the recess provided.

Under normal operating conditions, the injectors should be removed from the engine and cleaned at every 8,000 km. (5,000 mile) service. When the vehicle is operating continuously under stop-start conditions or in regular use on short journeys, it may be necessary to clean the injectors more frequently. Operating conditions and subsequent engine performance will be the best guide to individual service requirements.

To ensure that the injectors and other fuel system components have a long and efficient life, absolute cleanliness of the fuel and handling are most essential.

Diagnosis

In service a faulty injector will usually give one or more of the following symptons:—

(*a*) Knocking in one or more cylinders.

(*b*) Lack of power.

(*c*) Black smoke emission from exhaust.

(*d*) Overheating.

(*e*) Misfiring.

(*f*) Increased fuel consumption.

To detect a "missing" injector, remove an injector pipe, connect a serviceable injector and run the engine. Repeat this procedure for the other cylinders. Using this method systematically it will be possible to identify the "missing" injector. It is not advisable to run the engine with an injector removed as the air noise and uneven compression will make diagnosis very difficult. The normal method of slackening an injector pipe union will usually cut out two cylinders and give misleading results.

To Remove an Injector

1. **From the top of the injector** unscrew the banjo bolt securing the leak-off banjo union to the injector body.

2. **Remove the two washers** located one either side of the leak-off banjo union.

3. **Unscrew the two pressure pipe union nuts,** one at either end of the injector pressure pipe.

4. **Unscrew the two injector retaining nuts** and remove the injector.

5. **Remove and discard the copper washer** which provides a gas-tight joint between the injector and the cylinder head.

6. **Blank off the delivery** and leak-off connections and thoroughly clean the injector externally.

To Test

Care should be taken when testing injectors to ensure that the fuel spray does not come into contact with the hands of personnel operating the test equipment.

The characteristics of this delay-type pintle nozzle differ from the normal in that the spray, with slow hand pumping, presents rather an inefficient appearance in comparison, and is inclined to be more "ragged," "wet," or "soft," than with the normal pintle-type injector.

The nozzle can only be completely and satisfactorily tested with expensive and special stroboscopic equipment, but a good general test can be applied with a nozzle testing machine as follows:—

(1) Depress the Nozzle Testing Machine lever at about 20 strokes per minute, when a serviceable nozzle should emit a soft "buzzing" noise or a series of "grunts." Atomization will, however, appear to be streaky and generally unsatisfactory, at the same time there should be no appreciable wetness at the orifice.

(2) Raise and maintain the pressure at 110 atmospheres, when no fuel seeping or leaking should occur at the orifice

(3) It is difficult to obtain fuel "atomization" with these nozzles on a normal testing machine, and the spray will always appear to be streaky. Fast operation of the lever (about 100 strokes per minute) should give a reasonable spray.

(4) Back leakage should not be less than six seconds for a natural fall of 100 atmospheres to 75 atmospheres.

If any of the above checks show that the injector is faulty, it should be cleaned internally, re-adjusted and re-tested. If the injector again fails the tests, a serviceable replacement must be fitted.

To Dismantle

1. **Fit the injector** to a dismantling jig.

2. **Remove the injector cap nut** and the tab washer, then, with a screwdriver, unscrew the spring adjusting nut. Lift off the spring seat, injector spring and spindle, taking care not to lose the small steel washer located between the spring and spring seat.

3. **Unscrew the nozzle nut,** and remove the nozzle and the needle valve.

NOTE.—As nozzles and needle valves are a lapped fit, **they should never be interchanged.**

4. **Wash all the injector parts** in clean fuel or substitute fuel oil and using a soft brass wire brush remove all carbon from the nozzle and needle valve.

Inspect the Injector Parts

1. If the tip of the needle is blued from overheating, or if the seat is seriously scored or damaged, the nozzle and needle valve are unfit for further service.

2. Check that the spring is not broken or rusty and that the ends are perfectly square.

3. Inspect all the components for wear or damage and check joint faces for scratches or trapped foreign particles.

4. Ensure that the needle is free to fall under its own weight in the nozzle, when wet with substitute fuel oil, and falls freely from the nozzle seat when inverted.

If any of the components are faulty the injector must be renewed.

To Clean

Use the tools in the injector cleaning kit, Tool No. CT.9014, to remove all carbon from the interior of the nozzle.

When a hard carbon deposit is formed, it may be softened by immersing the nozzle in "Acetone" for a short period. Up to half an hour is normally sufficient.

WARNING.—"Acetone" is a highly inflammable liquid and must not be brought near a naked flame.

NOTE.—It is important that immediately the nozzle is removed from the fluid, it must be rinsed in clean fuel or substitute fuel oil to prevent corrosion on the highly-finished surfaces.

Alternatively, the nozzles may be treated as follows:—

1. Dissolve 55 gm. (2 oz.) of caustic soda in 0.5 litre (1 pint) of water. Also add 14 gm. (½ oz.) of detergent.

2. Place the nozzles in the liquid and boil for a minimum period of 1 hour and not more than 1½ hours.

NOTE.—The concentration of caustic soda must not exceed 15% and water should be added to replace that lost by evaporation. Should the concentration of caustic soda exceed 15%, then the needle valve bore and joint face on the nozzle body may be roughened, making the injector unserviceable.

3. Remove the nozzles, after treatment, and wash in running water to remove all traces of caustic soda. After washing, immerse the nozzle in a de-watering oil, remove surplus oil by draining.

4. The carbon can now be easily removed with a wire brush and a standard pricker wire.

5. Flush out the interior of the nozzle using a suitable reverse wash adaptor fitted to the injector testing machine. When all particles of carbon have been removed, enter the needle valve into the nozzle and ensure that it is quite free.

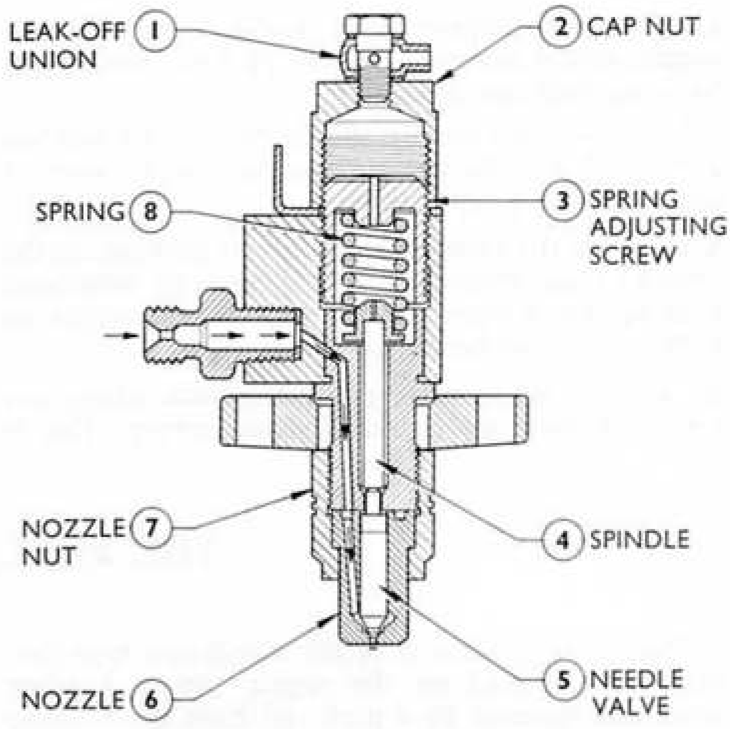


Fig. 50
Fuel Injector—Sectioned

To Reassemble

All injector parts should be reassembled wet, after rinsing in clean fuel or substitute fuel oil. *Do not use rag to clean any of the internal parts.*

1. **Fit the nozzle and the needle valve to the injector body.** Screw on the nozzle nut and tighten securely to a torque of 6.22 to 6.91 kg.m. (45 to 50 lb. ft.).

NOTE.—*It is essential that this figure is not exceeded otherwise serious distortion of the nozzle assembly may occur.*

2. **Fit the injector spindle, spring, upper spring disc and spring adjusting nut.** Screw down the adjusting nut until pressure can be felt on the spring.

3. **Connect the injector to the testing machine pipe.** Adjust the nozzle opening pressure to 150 atmospheres (4/108), 130 atmospheres (4/99).

4. **Fit the injector cap nut** and the tab washer. Tighten securely and recheck the nozzle opening pressure.

5. **Test the injector** as previously outlined on page 46.

NOTE.—If, after cleaning, the injector fails to pass these tests it should be replaced by a serviceable injector and the faulty one reconditioned. On no account should attempts be made to reclaim injector nozzles and valves through hand-lapping with metal polish or any other abrasive.

To Replace

1. **Clean the mating faces** of the recess in the cylinder head and the corresponding mating face on the injector nozzle cap nut.

2. **Fit a new copper joint washer** on the injector nozzle, always ensuring that the previous washer has been removed and discarded.

NOTE.—This washer should be an easy but not a loose fit on the injector nozzle. On no account use a spark plug type washer.

3. **Locate the injector** in the recess provided in the cylinder head, ensuring that it is correctly positioned to allow the injector pressure pipe to be coupled up without stress or bending.

4. **Fit the two injector retaining nuts,** taking care that these nuts are tightened down evenly. This is most important and failure to observe this often results in a gas leak past the copper joint washer and the injector.

5. **Position the injector pressure pipe** between the fuel injection pump and the appropriate injector and tighten the two union nuts evenly. When fitting these pressure pipes, tighten the unions alternately a little at a time, first one end then the other until both are tight.

6. **Fit a washer** either side of the leak-off pipe banjo union, fit the banjo union bolt and tighten securely.

THE FUEL LIFT PUMP

The fuel lift pump is of the diaphragm type (see Fig. 51), mounted on the engine tappet chamber cover and operated by a push rod from an eccentric on the engine camshaft. This pump incorporates a hand priming lever to enable the fuel system to be primed and bled.

On rotation of the engine, the eccentric on the camshaft lifts the push rod which in turn pivots the fuel lift pump rocker arm and link and pulls the diaphragm downwards against the pressure of the return spring. This creates a partial vacuum in the pump chamber, causing the inlet valve to open and draw fuel from the tank, through the pipe line, into the diaphragm chamber.

Further movement of the camshaft eccentric allows the rocker arm to return and the diaphragm is pushed up by the return spring, causing the inlet valve to close and the outlet valve to open. The fuel is then forced through the replaceable element filter to the injection pump.

When the filter and injection pump are filled with fuel, surplus fuel bleeds through a restricting orifice from the filter to the thermostart reservoir. Any back pressure created in the diaphragm chamber, by this restricting orifice, holds the diaphragm down and damps the action of the return spring.

Until the back pressure has fallen, the push rod and rocker arm idle on the camshaft eccentric without operating the link. As the pressure drops the diaphragm and link move upwards until the link makes contact with the rocker arm when the cycle will be repeated.

To Test

Providing there are no air leaks or obstructions in the fuel system, a quick check on the pump efficiency can be made as follows:—

1. Remove the air bleed screw from the fuel filter.

2. Operate the hand priming lever in the normal manner when there should be a well defined surge of fuel for each working stroke of the pump.

If there is no resistance of the diaphragm spring it is likely that the diaphragm is held down, due to the push rod being on the high point of the eccentric, and it will be necessary to rotate the engine approximately one turn.

If the pump does not operate correctly, check the inlet depression and delivery pressure, using the Diagnosis Test Set, the Gang Gauge Set No. 500-X or a suitable vacuum/pressure gauge.

Fuel Lift Pump Inlet Depression Test

1. Operate the lift pump hand priming lever to fill the injection pump and filter.

2. Disconnect the fuel inlet pipe from the lift pump and connect the vacuum gauge to the pump inlet union.

3. Connect a gravity feed supply of clean fuel to the inlet connection of the filter.

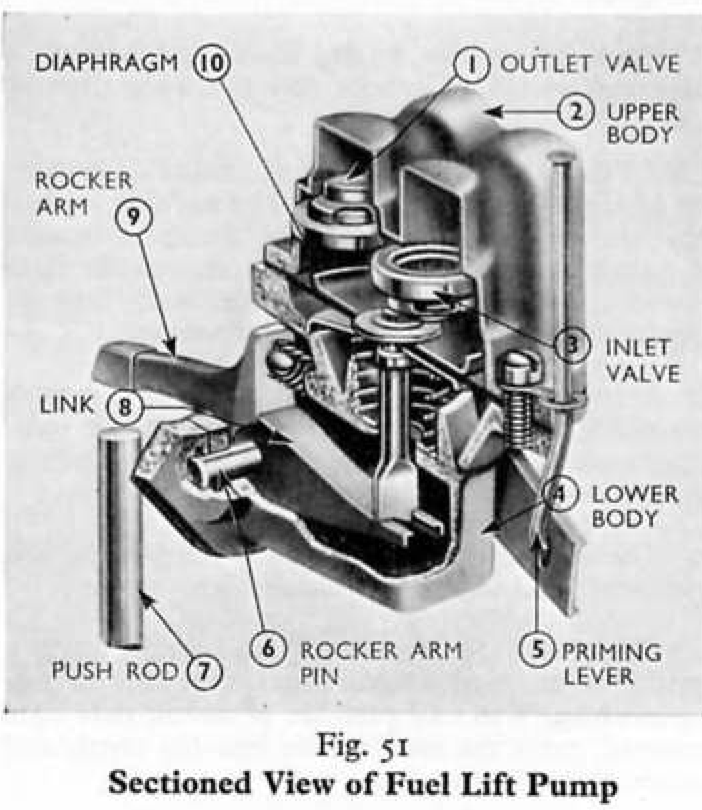


Fig. 51
Sectioned View of Fuel Lift Pump

4. Start the engine and allow it to run at idling speed. The vacuum reading should be at least 8½in. of mercury.

5. Stop the engine and the needle should take at least a minute to drop from 8½ in. of mercury to zero. Should the reading drop quicker than this, it indicates an air leak or faulty outlet valve.

6. Disconnect the vacuum gauge and gravity feed, replace the fuel inlet pipe and bleed the fuel system as described on page 51.

NOTE.—This test can be carried out at any point between the lift pump and fuel tank to check for air leaks in the fuel system as a whole. By starting the tests at the fuel tank and working towards the fuel lift pump, it will be possible to determine the faulty component.

Fuel Lift Pump Delivery Pressure Test

1. Operate the lift pump hand priming lever to fill the injection pump and filter.

2. Disconnect the fuel outlet pipe from the lift pump and connect the pressure gauge to the pump outlet union.

3. Connect a gravity feed supply of clean fuel to the inlet connection of the filter.

4. Start the engine and observe the pressure at idling speed. Increase the speed and check throughout the speed range that the pressure is between 0.42 to 0.70 kg./sq. cm. (6 and 10 lb./sq. in.).

NOTE.—Low fuel pump pressure may affect engine performance due to lack of fuel.

5. Disconnect the pressure gauge and gravity feed, replace the fuel outlet pipe and bleed the system as outlined on page 51.

To Remove

1. **Disconnect the fuel inlet and outlet pipes** from the fuel lift pump.

2. **Unscrew the two nuts securing the pump to the engine tappet cover** and detach the pump. Remove the pump gasket.

To Dismantle

1. **Mark the upper and lower body flanges to facilitate their correct reassembly** and remove the five screws securing the fuel pump upper body to the lower body. Remove the upper body, taking care not to damage the diaphragm when separating these parts.

2. **Push down the diaphragm and turn it 90°** in either direction when the diaphragm pull rod will be disconnected from the operating link and the diaphragm can then be detached.

3. **Remove the fabric oil seal from the diaphragm pull rod.** Turn the oil seal washer through 90° and detach the washer and diaphragm return spring. The diaphragm and pull rod are riveted together and should not be dismantled.

4. **The inlet and outlet valve assemblies** are retained by a plate secured by two round-headed screws. Remove the two screws, lift off the plate, valve assemblies and gasket.

Should it be necessary to dismantle the lower half of the pump body, remove the staking from around the rocker arm pin retainers and pull them from the slots in the body. The rocker arm pin, rocker arm, link, spring and thrust washers will then be freed and may be removed, leaving the priming lever in position.

To Reassemble

If the lower body has been dismantled, replace the rocker arm and link as follows:—

1. **Insert the rocker arm pin, rocker arm, link, spring** and thrust washers into the lower pump body, replace the rocker arm pin retainers in their slots, and securely stake them in position.

Test the operation of the rocker arm and link by moving the rocker arm towards the body when the link should be moved downwards. Depress the link, and the rocker arm should move freely without transmitting movement to the link. Ensure that the priming lever operates correctly and returns freely to the normal position.

2. **Locate the diaphragm return spring on the pull rod,** fit the oil seal washer, depress the washer and turn it through 90° to lock it on the pull rod. Fit a new fabric oil seal washer.

3. **Enter the diaphragm pull rod in the slotted end of the link** and turn it through 90° to lock it in position. Check that when assembled the small tab on the diaphragm is located directly below the outlet port in the top body.

4. **Inspect the valve assemblies** to see that the valves are seating properly. Locate a new gasket in the upper body and replace the valve assemblies. Secure the valves in position with the retaining plate and two round-headed screws. The retaining plate fits with the bowed centre towards the diaphragm.

5. **Fit the upper body to the lower** so that the mating marks, previously made, line up. Fit the five securing screws and spring washers, operate the rocker arm to compress the spring and tighten the screws evenly and securely.

To Replace

1. **Ensure that the lift pump mounting faces are clean,** fit a new gasket, and secure the pump with two nuts and spring washers.

2. **Reconnect the fuel inlet and outlet pipes.**

3. **Bleed the fuel system** as described on page 51.

THE FUEL FILTERS

It must be emphasised that fuel oil must be kept clean at all times. Contamination by dirt and/or water will result in premature wear and possible failure of finely machined components in the injection pump and injectors.

When filling the fuel tank, the fuel must not be poured from or have been stored in a dirty container.

Even when operating under the most favourable conditions a certain amount of dirt may be present in the fuel oil and, to prevent this reaching the injection pump and injectors, filters are provided in the fuel system.

Fuel is drawn from the fuel tank through a sediment bowl, mounted on the engine compartment bulkhead, by a mechanical lift pump on the engine tappet chamber cover.

Fuel from the lift pump passes through a replaceable element-type filter bolted below the rear of the exhaust manifold. A permanent fuel bleed, from the inlet side of this filter, flows through a restricting orifice to the cold starting device reservoir, which is mounted at the rear of the engine compartment.

Sediment Bowl

Every 8,000 km. (5,000 miles) or sooner if required, the fuel sediment bowl and filter screen should be removed and cleaned.

To Clean the Filter Screen

1. Unscrew the retaining nut and move the retainer to one side.

2. Remove the sediment bowl and gauze filter screen. Thoroughly wash the bowl and filter screen in clean fuel oil or substitute test fuel. **Do not wipe with cloth.**

3. Ensure that the gasket fitted to the body is in good condition. Refit the filter screen and bowl and tighten the retaining nut.

4. Bleed the fuel system, see page 51.

The Element Type Fuel Filter

This fuel oil filter fitted to the diesel engine has a renewable paper element which should be changed every 24,000 km. (15,000 miles).

Renewing the Filter Element

1. **Unscrew the filter securing bolt** and withdraw the filter body and element (see Fig. 52). Remove the rubber sealing ring from the filter head.

2. **Clean the interior of the body** using a brush and clean fuel oil.

On no account use rag for this operation.

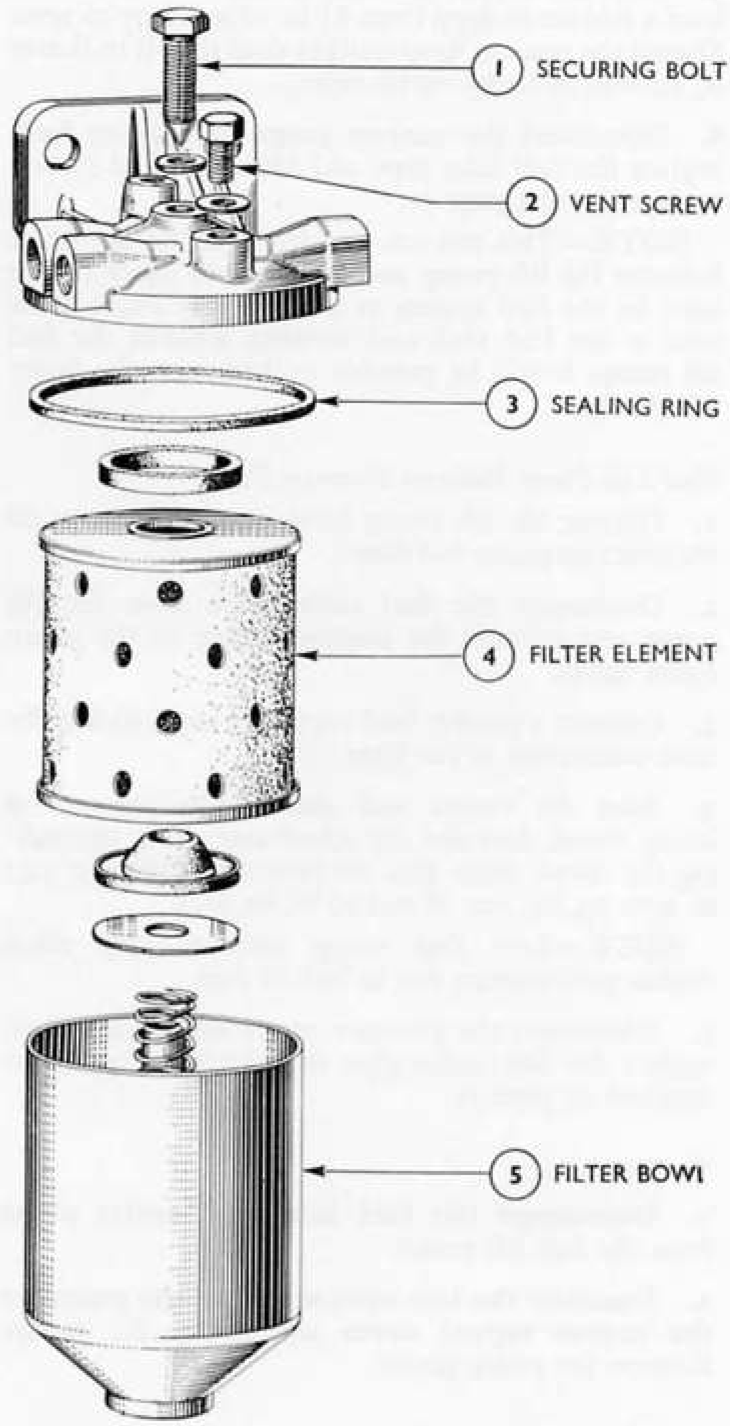


Fig. 52
The Fuel Filter

3. **Unpack the new element and fit it into the filter body.**

The element must not be removed from its packing until it is required for fitting to the filter body, otherwise it may become contaminated by foreign matter, which may pass to the fuel injection pump.

4. **Fit the rubber sealing ring,** supplied with each new filter element, to the filter head and refit the filter body.

5. **Tighten the filter securing bolt firmly.**

6. **Bleed the fuel system,** see page 51.

THE FUEL TANK

The position of the fuel tank varies, depending on the type of vehicle and is usually retained in position by two straps secured at one end by adjustable hooks and, at the other, by brackets attached to the floor pan. Anti-squeak pads are fitted between the tank and the support straps, and also between the upper surface of the tank and the floor pan.

To Remove

1. **Disconnect the fuel line** and return pipe from the tank.
2. **Disconnect the vent pipe** also from the tank, adjacent to the fuel line.
3. **Drain the fuel** from the tank via the drain plug and replace the plug.
4. **Disconnect the fuel supply pipe** by slackening the rubber supply pipe clip.
5. **Disconnect the lead** connected by the terminal to the fuel gauge sender unit.
6. **Suitably support the fuel tank,** and unscrew the nuts on the threaded clamps. Unhook the brackets from the slots on the floor pan and lower the tank towards the ground.

To Replace

1. **Raise the fuel tank** sufficiently to connect the lead to the fuel gauge sender unit.
2. **Position the tank in its location** and engage the brackets on the end of each support strap in their respective slots on the floor pan, ensuring that these support straps run over the anti-squeak pads attached to the underside of the tank. Do not fully tighten the nuts on the hook clamps.
3. **Connect the fuel pipe line** and return pipe and vent pipe to the tank.
4. **Tighten up the nuts on the hook clamps** until the fuel tank is firmly located.
5. **Reconnect the supply pipe** and tighten the clip. Refill the tank with fuel.

Maintenance

In course of time, sediment may collect in the fuel tank, its presence usually being denoted by sediment deposits on the fuel pump screen.

If it is suspected that either excessive deposits, or water, are present in the tank, the tank should be removed and thoroughly flushed with clean petrol.

When repairs involving the application of a flame or heat are necessary to a fuel tank, this should be flushed, "steamed" and allowed to stand for at least 24 hours to evaporate all fumes from the tank.

THE FUEL LINE

The fuel pipe is clipped to the underside of the floor pan. Occasionally, the unions and securing clips should be checked for tightness, and the pipe inspected to ensure that no chafing against the floor has occured.

COLD START AIDS

The fuel injection pump does not incorporate an excess fuel device and, therefore, to facilitate cold engine starting a cold starting device is fitted in the inlet manifold. This device, known as the "Thermostart" consists of a coil of wire heated electrically and controlled by the switch key. A valve, incorporated in the thermostart allows fuel to flow onto the coil. The valve is opened when the coil reaches its operating temperature, by expansion of the valve body. Fuel flowing onto the coil ignites, to facilitate cold starting on subsequent operation of the starter motor. The level of the fuel reservoir is maintained by a permanent bleed from the inlet side of the fuel filter. Surplus fuel drains through a leak-off pipe to the fuel tank.

If the device has not been used for a long period or the feed pipe has been disturbed, the system must be bled. When bleeding, ensure that there is adequate fuel in the reservoir, slacken the feed pipe union at the thermostart and when fuel flows freely, tighten the union.

For extreme climatic conditions, an alternative cold start aid is available. This is known as a "start pilot" and consists of an ether pump controlled from the dash. A disposable cartridge is used and ether is injected directly into the inlet manifold via a nozzle when the pump is operated.

BLEEDING THE FUEL SYSTEM

If any part of the fuel system is disconnected or air has entered the system, it will be necessary to remove all air from the fuel and to prime the injection pump by bleeding.

To enable the injection pump to be primed or bled provision is made in the regulating valve for bypassing the sliding vane type transfer pump which only passes fuel when the rotor is turning. When the injection pump is not operating the regulating plunger is in the lower part of the regulating sleeve bore and rests on a priming by-pass spring, see Figs. 33, 36 and 39. Operation of the lift pump priming lever forces fuel at lift pump pressure through the inlet connection and into the regulating sleeve bore. This pressure forces the plunger downwards compressing the priming by-pass spring and uncovering the priming port in the sleeve, see Figs. 33, 36 and 39. The transfer pump is then by-passed and the injection pump may then be primed and bled. The regulating plunger returns to its normal position after bleeding has been completed.

Bleed the Fuel System as follows:—

1. **Fuel injection pump—**
   (*a*) Slacken the governor vent screw located at the top of the governor housing (see Fig. 53).
   (*b*) Slacken the hydraulic head vent screw, on the side of the pump body, again see Fig. 53.

2. **Fuel filter**—Slacken, by two or three turns, the fuel filter vent screw on the top of the filter cover (see Fig. 52). Do not slacken the return pipe to the tank.

3. **Operate the priming lever** on the lift pump, and when fuel, free from air bubbles, appears from each venting point, tighten the vent screws in the following sequence:—

(*a*) Fuel filter vent screw. (Fig. 52.)

(*b*) Hydraulic head vent screw. (Fig. 53.)

(*c*) Governor vent screw. (Fig. 53.)

4. **Slacken the pump inlet union nut** and operate the lift pump priming lever, retighten when fuel, free from air bubbles, issues from around the threads.

5. **Slacken the unions** at the injector ends of two of the high pressure pipes. Set the accelerator at the fully open position and ensure that the "stop" control is in the "off" (or "run") position.

Turn the engine over until fuel oil, free from air bubbles, issues from both high pressure fuel pipes, then tighten the unions.

The fuel system has now been bled, and the engine is ready for starting.

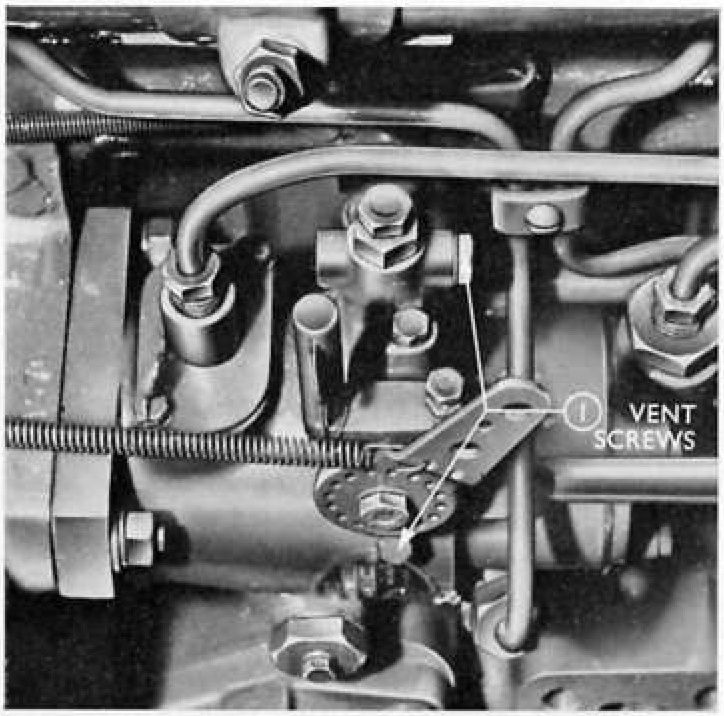


Fig. 53
Injection Pump Bleed Points

NOTE.—If the cam on the engine camshaft is on maximum lift, it will render the fuel lift pump priming lever inoperative. If this occurs, rotate the engine until the priming lever can be operated.

AIR CLEANER

An oil bath-type air cleaner is fitted to these vehicles and in normal operating conditions this should be cleaned and the oil changed every 4,000 km. (2,500 miles). However, should the vehicle be operating in a heavily dust-laden atmosphere it should be cleaned more frequently.

To Remove

1. **Slacken the hose clamp** securing the air cleaner trunk to the inlet manifold.

2. **Unscrew the wing bolt** from the top of the air cleaner and remove the top cover.

3. **Remove the oil bath reservoir.**

To Clean

1. **Wash the gauze element,** incorporated in the top cover, with paraffin or petrol. Dip the element in clean engine oil and allow to drain.

2. **Empty the oil bath reservoir** and wash with paraffin or petrol.

3. **Clean the air cleaner casing** thoroughly with a non-fluffy rag moistened with paraffin or petrol.

4. **Place the oil bath reservoir** on a level surface and fill with clean engine oil to the level mark indicated by the arrow inside the reservoir.

To Replace

1. **Place the oil bath reservoir** (filled to the correct level) in the air cleaner casing.

2. **Fit the air cleaner top cover,** ensuring that the trunk locates in the hose on the inlet manifold.

3. **Refit the wing bolt.**

4. **Tighten the wing bolt** and hose clamp.

Section 10

ELECTRICAL SYSTEM

CONTENTS

SUBJECT

ELECTRICAL SYSTEM

MAINTENANCE AND OVERHAUL PROCEDURES

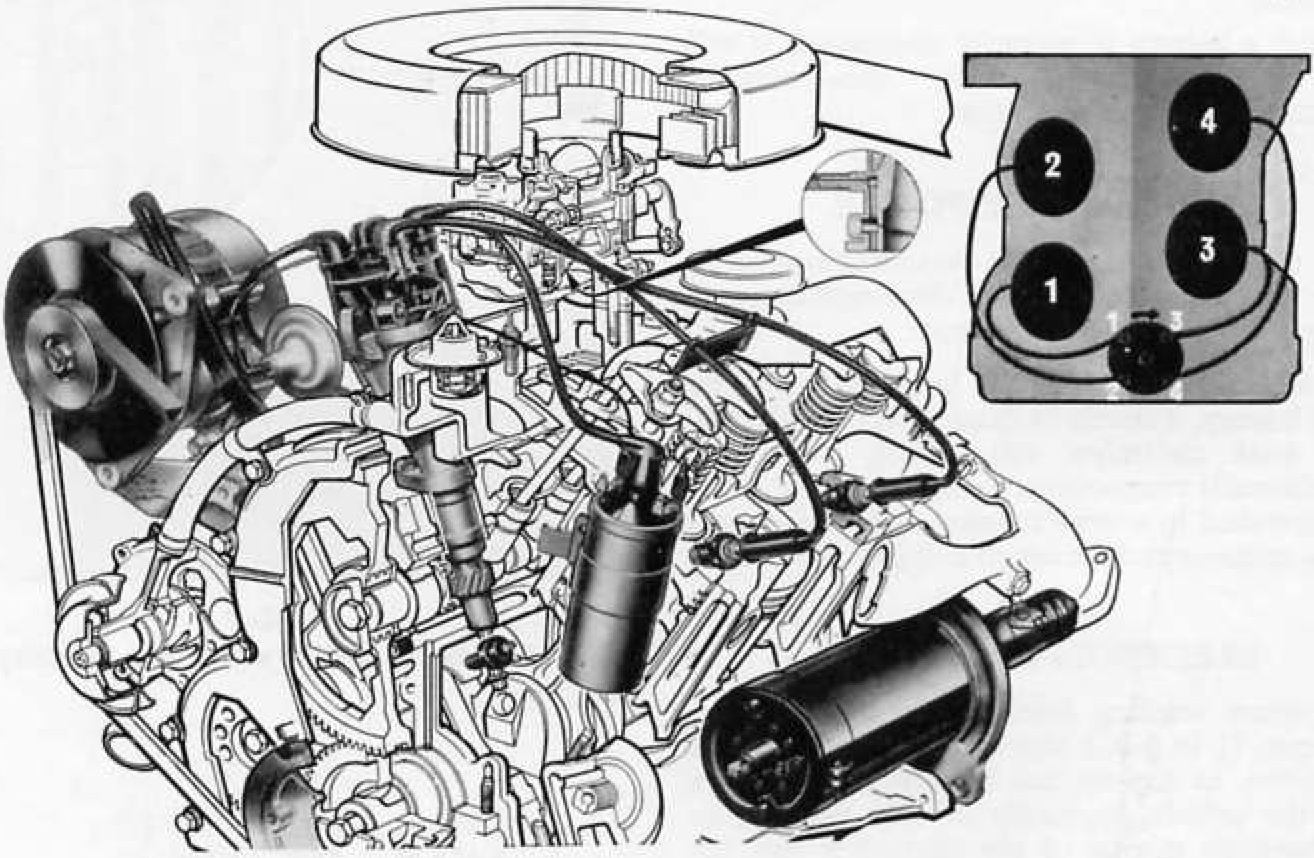


Fig. 1
Electrical System

ELECTRICAL SYSTEM PRECAUTIONS

The "Transit" Range of vehicles is fitted with an Alternator Charging System instead of the more commonly known generator.

Certain precautions must be observed to avoid serious damage to the alternator, battery, or vehicle wiring on vehicles fitted with this charging system.

When carrying out work the precautions are as follows:—

1. Always disconnect the battery earth lead before removing the alternator output lead as this is live at all times.

2. Disconnect both battery and alternator leads when electric arc welding is being carried out on a vehicle.

3. Check battery polarity before installing, as it may be reverse charged. (Use a voltmeter for this check.)

4. Ensure that the battery is connected to the vehicle correctly, i.e. Negative lead to Negative post, and Positive lead to Positive post.

5. Always connect a booster battery in parallel, i.e. Negative to Negative and Positive to Positive.

6. Disconnect the earth battery cable from the battery before connecting a battery charger.

7. Do not attempt to polarize or motor an alternator.

8. Never operate the alternator on open circuit with the rotor (field) coil energised.

9. When adjusting the fan belt always apply the tightening lever to the front mounting bracket and not to the stator or rear housing.

10. Do not use a high voltage source to test diodes. (Use a maximum of 12 volts.)

11. Do not disconnect battery cables from the battery, charging or control circuit, while the engine is running.

12. Do not "flash" any charging or control cables to earth.

13. Do not use a high voltage resistance tester for testing alternator circuits.

THE BATTERY

The electrical system is of the 12 volt earth-return type, the negative terminal of the battery being earthed.

The battery is located in the nearside of the engine compartment.

Provided a battery is properly maintained it will function satisfactorily between the extreme temperatures of summer and winter.

GENERAL MAINTENANCE

Keep the battery and the surrounding parts, particularly the tops of the cells, clean and dry, and brush away any dirt or dust present.

If distilled water or electrolyte has been spilled on top of the battery, it should be cleaned off immediately, as even weak electrolyte will quickly attack and corrode the cable connections, clamp plates and bolts. Use a rag soaked in a weak solution of hot water and ammonia, to counteract the action of spilled electrolyte.

ELECTROLYTE LEVEL

The correct working level of the electrolyte is 6 to 10 mm. ($\frac{1}{4}$ to $\frac{3}{8}$ in.) above the separators. It is good practice to top-up the battery just prior to running the vehicle, especially in cold weather, to ensure thorough mixing of the electrolyte and the water and so prevent freezing.

When topping-up use distilled water from a clean lead, glass or earthenware container, and a funnel.

If the battery is found to need frequent topping-up, steps should be taken to determine the reason. For example, the battery may be receiving an excessive charge, in which case the regulator setting should be checked. If one cell in particular needs topping-up more than another, check the condition of the battery case. If there are signs of an electrolyte leak, trace the fault and take corrective action. The battery tray should then be cleaned and repainted.

SPECIFIC GRAVITY

The specific gravity reading indicates the state of charge of the battery and should be checked with a hydrometer.

If the level of the electrolyte is so low that a hydrometer reading cannot be taken, no attempt should be made to take a reading after adding distilled water until the battery has been on charge for at least one hour.

Table "A" gives the specific gravity of the electrolyte at various electrolyte temperatures when the battery is fully charged.

Table "B" gives the approximate low limits of specific gravity at various electrolyte temperatures when the battery has been fully discharged at the normal rate.

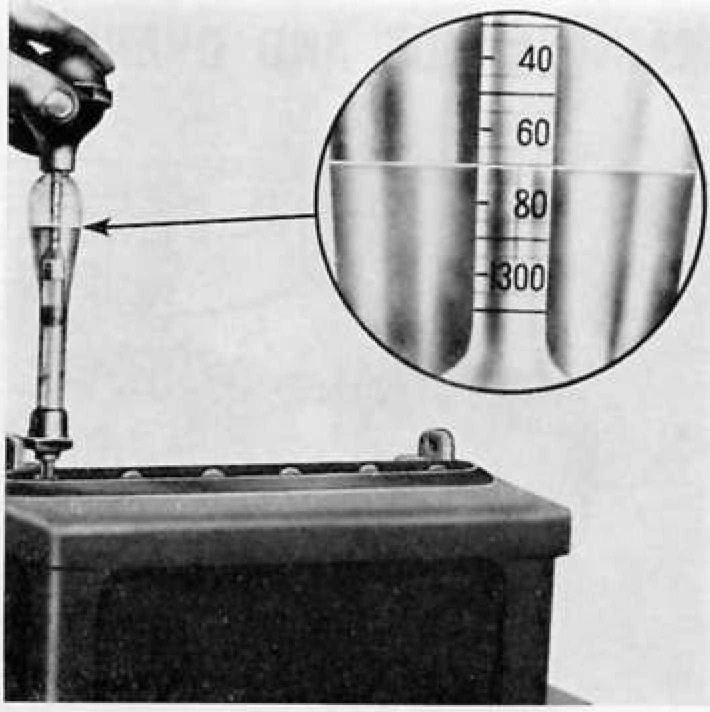


Fig. 2
Checking Battery Specific Gravity

Table "A"

1.259 at	43°C.	(110°F.)	
1.263 at	38°C.	(100°F.)	
1.267 at	32°C.	(90°F.)	
1.271 at	27°C.	(80°F.)	
1.275 at	**21°C.**	**(70°F.)**	**(normal)**
1.279 at	16°C.	(60°F.)	
1.283 at	10°C.	(50°F.)	
1.287 at	4°C.	(40°F.)	
1.295 at	— 7°C.	(20°F.)	
1.303 at	—18°C.	(0°F.)	
1.311 at	—29°C.	(—20°F.)	

Table "B"

1.089 at	43°C.	(110°F.)	
1.093 at	38°C.	(100°F.)	
1.097 at	32°C.	(90°F.)	
1.101 at	27°C.	(80°F.)	
1.105 at	**21°C.**	**(70°F.)**	**(normal)**
1.109 at	16°C.	(60°F.)	
1.113 at	10°C.	(50°F.)	
1.117 at	4°C.	(40°F.)	
1.126 at	— 7°C.	(20°F.)	
1.133 at	—18°C.	(0°F.)	
1.142 at	—29°C.	(—20°F.)	

There should be little variation in the specific gravity readings from cell to cell on any battery in reasonably good condition. If the variation is greater than 0.025, then the reason should be investigated.

If electrolyte has been spilled at any time, or lost owing to a leak, topping-up the level with distilled water will lower the specific gravity.

This can be corrected when next charging the battery by adding a dilute solution of sulphuric acid which has a specific gravity approximating to the values tabulated below, until the specific gravity of the electrolyte is again standard.

1.255 (29.5° Baumé) temperate climates
1.239 (28° Baumé) tropical climates*

*A tropical climate may be taken as one in which water will never freeze and where the air temperature is frequently above 32°C. (90°F.) in the shade.

Never use concentrated acid alone for this purpose. Always add the acid to the water when preparing the electrolyte: it is dangerous to add water to acid.

A large variation, which is not the result of electrolyte loss, is probably an indication of an internal short circuit and an early inspection of the battery by a competent electrician is advisable.

Temperature Correction

When the electrolyte temperature varies from the standard of 21°C. (70°F.), the specific gravity will also vary—see Tables "A" and "B".

The equivalent hydrometer reading at 21°C. (70°F.) can be determined by applying the following correction:—

Add four points (0.004 specific gravity) for every 5½°C. (10°F.) above 21°C. (70°F.).

Subtract four points (0.004 specific gravity) for every 5½°C. (10°F.) below 21°C. (70°F.).

CHECKING BATTERY CONDITION

There are three methods of checking battery condition: (*a*) open circuit voltage test, (*b*) high rate discharge test, and (*c*) checking the specific gravity.

(*a*) The open circuit voltage of a 12 volt battery should be above 12.6 volts (2.1 volts per cell) for a battery in good condition.

However, the voltage reading on open circuit is liable to be misleading. If the voltage is low then the cells are definitely in poor condition, but a high voltage reading on open circuit does not necessarily indicate that the cells are in good condition.

(*b*) The high rate discharge test gives an indication of the condition and capacity of the battery. On test, the battery should maintain 100 amp. flow for 10 seconds with no appreciable fall in voltage.

Where a hand instrument (incorporating a low resistance device) is used for checking the individual cells of a battery, the actual reading obtained will depend upon the exact type of instrument used, but the cell voltage on a 5 to 6 seconds test should remain steady between 1.2 and 1.7 volts.

Variations in individual cell readings can indicate faults, but if all cells in any one battery fall below standard, re-charge and again test before rejecting the battery.

Never make a high rate discharge test on a battery known to be low in charge.

c) A further method of checking the state of charge of a battery is by means of a specific gravity reading, taken on a suitable hydrometer. A fully charged battery should give specific gravity readings of:—

1.272 to 1.283 (31° to 32° Baumé) temperate climates

1.239 to 1.255 (28° to 29½° Baumé) tropical climates

checked with a hydrometer and corrected to 21°C. (70°F.).

CHARGING FROM AN EXTERNAL SOURCE

Before starting the charge, the electrolyte level should be topped-up with distilled water to 6 to 10 mm. (¼ to ⅜ in.) above the separators.

NOTE:—When a battery is on boost charge the ignition must always be switched off to avoid damaging the vehicle charging system.

The normal charge rates are shown in the table below.

Battery	*Bench Charge Normal Rate*	*Initial Charge Rate (converting uncharged batteries)*	
		Rate	*Hours*
38 amp hr.	3 amps	2.25 amps	48 to 60
57 amp hr.	3.5 amps	2.5 amps	48 to 60

The charge should be continued until the specific gravity and cell voltage in each cell show no further rise during five hours on continuous charging and all cells gas freely. If the specific gravity of the electrolyte in any cell or cells fails to rise while on charge and gassing does not take place, the cells should be tested for internal short circuits.

The maximum permissible temperature of electrolyte during external charging is 43°C. (110°F.) and, if this is exceeded, the charge should be suspended or reduced to one-half to allow the temperature to fall.

If, at the end of the charge, the specific gravity varies by more than 10 points (i.e. 0.010), from the figures given in table "A" (see page 4), the specific gravity must be adjusted, either raised by adding fresh electrolyte, the S.G. of which should be 1.343 (37° Baumé), or lowered by the addition of distilled water. The specific gravity of any two cells of a battery should not vary more that 0.015.

To test a cell suspected of being short circuited, take the individual voltage of each cell of the battery while it is on charge and when charged, carry out a high rate discharge test. The cell voltage between individual cells should not vary more than 0.15 volt. The voltage of a faulty cell on high rate discharge will fall rapidly. If it is confirmed that a cell is internally shorted, the battery must be renewed or suitable repairs made.

SPECIAL INSTRUCTIONS

Cold Climates

In cold climates, the electrolyte of a partially discharged battery (specific gravity approximately 1.151, 19° Baumé) will be frozen at temperatures below —18°C. (0°F.), and a fully discharged battery (specific gravity approximately 1.111, 14½° Baumé) will freeze at —9°C. (16°F.). For this reason, special precautions should be taken when operating in cold climates to prevent the battery state from falling below the conditions indicated by the following specific gravities:—

1.198 (24° Baumé) specific gravity at −18°C. (0°F.)
1.245 (28½° Baumé) specific gravity at −29°C. (−20°F.)
1.266 (30½° Baumé) specific gravity at −35°C. (−30°F.)

The electrolyte level in each cell should be frequently checked and adjusted to 6 to 10 mm. (¼ to ⅜ in.) above the separators. When topping-up, use clean distilled water. This should be done only during charging and preferably when the cells are gassing freely, so that the water becomes mixed with the electrolyte before it has time to freeze.

Tropical Climates

A topical climate may be taken as one in which water will never freeze, or where the air temperature is frequently above 32°C. (90°F.) in the shade.

Wet batteries supplied with new vehicles or as service replacements have an electrolyte specific gravity of 1.272 to 1.283 (31° to 32° Baumé) when in a fully charged condition. These readings are corrected to 21°C. (70°F.).

The specific gravity of the electrolyte in batteries to be used under tropical conditions should, however, be between 1.239 and 1.255 when corrected to 21°C. (70°F.) (Baumé equivalent—28° to 29½°). It will, therefore, be necessary to adjust the specific gravity of all wet batteries supplied in service or with vehicles, on arrival at their destination.

Methods of Adjusting Specific Gravity in Tropical Climates

1. Immediately the battery arrives at its destination, check and top-up the electrolyte level with distilled water. Then place the battery on charge at its normal rate (see table).

2. Continue the charge until the specific gravity has reached its maximum, i.e. until the gravity of each cell remains constant for a period from 2 to 5 hours and all cells are gassing freely.

3. Discontinue the charge, turn the battery upside down and allow it to drain.

4. Turn the battery back to its normal upright position and clean the exterior surface of the casing thoroughly, using a cloth moistened with ammonia. This will counteract the effect of spilled electrolyte.

5. Immediately refill each cell with electrolyte of 1.142 specific gravity (18° Baumé).

If the cells are not refilled directly after draining, the negative plates will tend to oxidise.

6. Again place the battery on charge at its normal rate and continue the charge for 4 to 6 hours.

7. If the specific gravity following the charge is above 1.255 (29½° Baumé) when corrected to 21°C. (70°F.), adjust by withdrawing the electrolyte from the cells with a squeeze ball and restoring the level with distilled water.

If the specific gravity is below 1.239 (28° Baumé) when corrected to 21°C. (70°F.), adjust by adding electrolyte of specific gravity greater than 1.250.

8. Following an adjustment to the electrolyte specific gravity, replace the battery on charge at the normal rate until the specific gravity of the electrolyte in each cell has stabilised.

9. Before putting the battery into service again, check the electrolyte levels, adjusting if necessary to 6 to 10 mm. (¼ to ⅜ in.) above the separators. Remove electrolyte if the levels are too high or add electrolyte of the correct specific gravity if too low.

Always give idle batteries a freshening charge at least once a month.

THE LIGHTING SYSTEM

The Headlamps

Each headlamp is a sealed beam unit, consisting of a filament, lens and reflector. It is replaceable only as a complete unit.

To Replace a Headlamp

1. **Remove the headlamp surround retaining screw.** Insert a screwdriver through the hole in the bottom of the headlamp surround, and remove the crosshead retaining screw. Remove the surround.

2. **Unscrew the three crosshead screws** retaining the inner rim and remove the rim.

NOTE.—Do not disturb the two slot-head screws as these control headlamp alignment.

3. **Lift forward the sealed beam unit** and detach the plug from the three contacts on the rear of the unit.

Fig. 3
Headlamp Adjustment

4. **Refit a new sealed beam unit.**

5. **Replace the inner rim** and secure with the three crosshead screws.

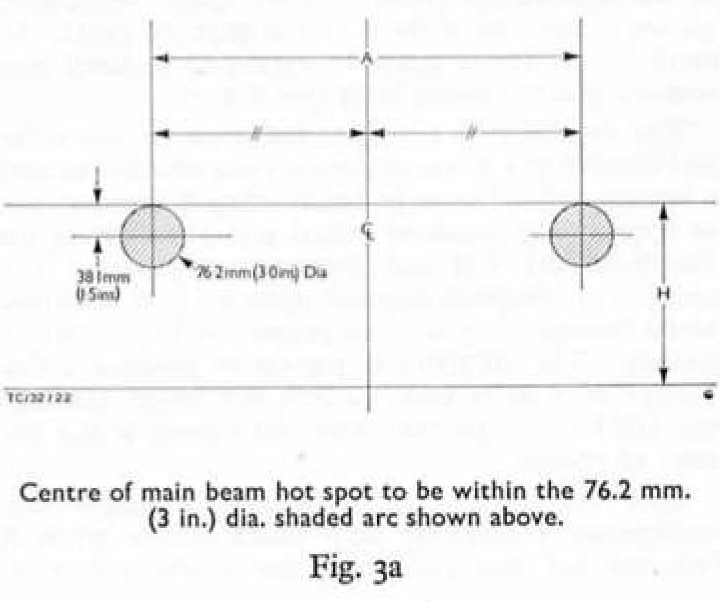
6. **Press the headlamp surround into position** over the retaining clips and refit the screw through the hole in the bottom of the surround.

Headlamp Alignment

The headlamps can be aligned with any suitable alignment equipment, but if this is not available, the following procedure should be carried out:

1. Position the vehicle on level ground 3 m. (10 ft.) in front of a suitable darkened board which is marked with a vertical and horizontal line.

This board must be at right-angles to the vehicle centre-line.



Centre of main beam hot spot to be within the 76.2 mm. (3 in.) dia. shaded arc shown above.

Fig. 3a

2. Measure the height 'H' from the ground to the centre of the headlamps.

3. **Position the board** so that the vertical line is exactly in line with the vehicle centre-line.

Position the board, also, so that the horizontal line is parallel to the ground and at a height 'H' from the ground.

4. **Remove the headlamp** surrounds and switch on the main beam.

5. **By means of the horizontal** and vertical adjusting screws, adjust each headlamp in turn so that the centres of brightest illumination lie on the horizontal dividing line 161 cm. (63.5 in.) apart (A) and equidistant from the vertical dividing line (see Fig. 3a).

It is advisable to cover one headlamp whilst adjusting the other.

6. **Switch off the headlamps** and refit the surrounds.

Side Lamps and Front Direction Indicator Lamps

To renew a side lamp or front direction indicator bulb, unscrew the three crosshead screws securing the combined lens, and remove the lens, bezel and gasket.

The bulbs are the normal bayonet type.

When refitting a lens, ensure that the gasket is located evenly behind the lens so that the assembly is completely watertight.

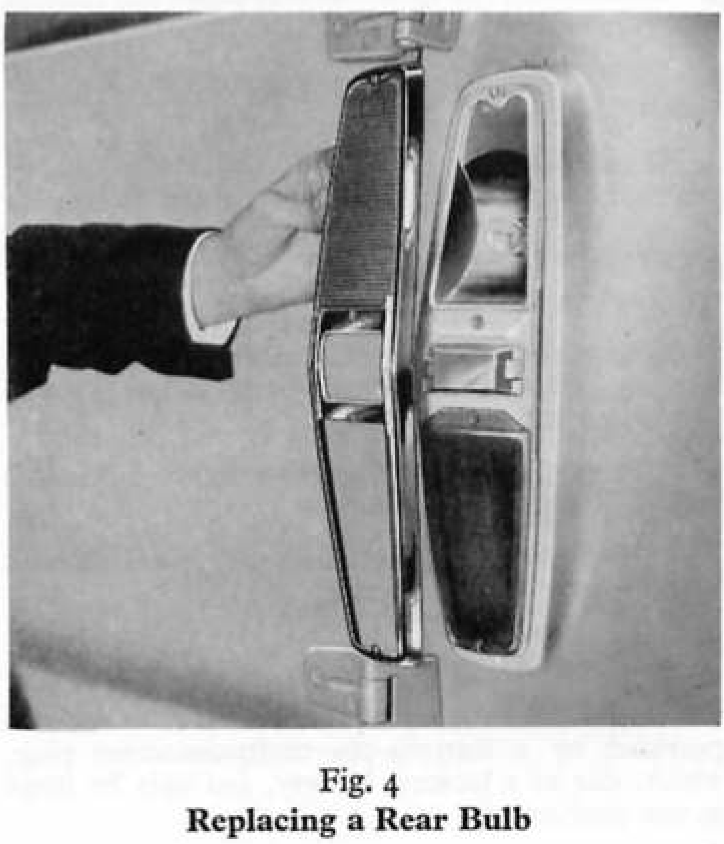


Fig. 4
Replacing a Rear Bulb

Rear, Stop and Rear Direction Indicator Lamps

To renew either a rear and stop lamp bulb (dual filament), or a direction indicator bulb (single filament) remove the two screws retaining the rubber door stop, and then the two screws retaining the lens bezel. This will enable the two lenses and the gasket to be removed (Fig. 4).

Replace the faulty bulb, position the gasket and lenses, and replace the bezel and two outer screws. Replace the door stop and secure it with the two inner screws.

When replacing the lenses, ensure that the gasket is evenly located.

Stop Light Switch (*pre-September* 1970)

The stop light switch is hydraulically operated and is located in a four-way union mounted on the bulkhead below the regulator.

(*September* 1970 *onwards*)

The stop light switch is mounted on top of the pedal box assembly, and is operated directly by an extension of the brake pedal.

To replace the stop light switch, remove the two wires from the unit and unscrew it. Refit the new switch and connect the two wires to their respective terminals. Bleed the braking system (pre-September 1970 models only).

THE INSTRUMENT PANEL

The instrument panel assembly incorporates the central instrument cluster, and other instruments such as a vacuum gauge, where fitted.

To Remove

1. **Unscrew the four panel retaining screws** and ease the panel rearwards.

2. **Disconnect the speedometer cable** and vacuum pipe (where fitted).

3. **Pull the multi-connector plug** from the panel socket.

4. **If necessary,** the instrument cluster can be removed by unscrewing the two retaining clamps.

To Replace

1. **Replace the instrument cluster.**

2. **Reposition the multi-connector plug.** The locating keyway on the plug ensures it can only be replaced in one position.

3. **Reconnect the speedometer drive cable** and vacuum gauge pipe (where fitted).

4. **Present the panel into its location** and retain it with the four crosshead screws.

THE INSTRUMENT CLUSTER

The electrical supply to the instrument cluster is provided by a thirteen-pin multi-connector plug, which, due to a locating keyway, can only be fitted in one position.

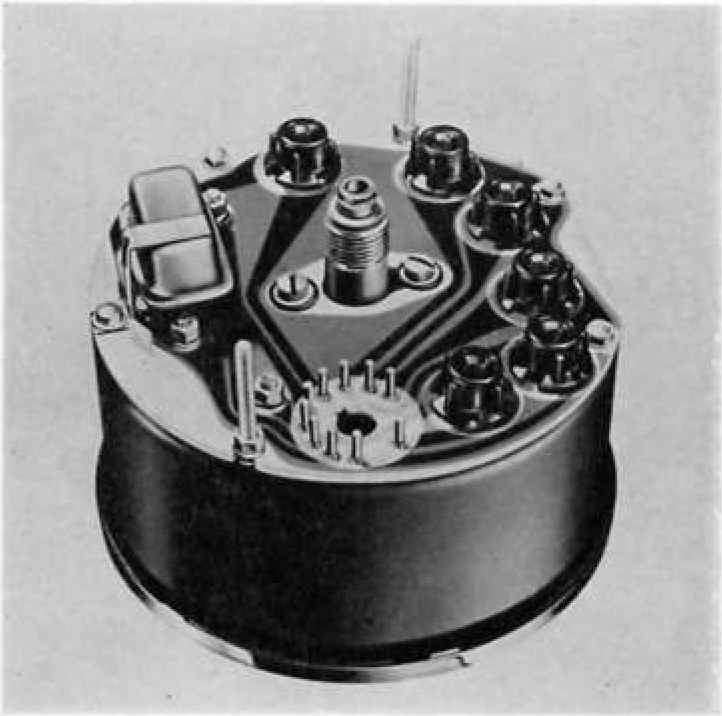


Fig. 5
Instrument Cluster

The circuit fed by each multi-connector pin is shown in the wiring diagrams.

The rear face of the instrument cluster incorporates a printed circuit which is coated with a protective plastic film.

The cluster consists of the speedometer, fuel gauge, temperature gauge, main beam warning light, direction indicator light, generator warning light and oil pressure warning light.

Panel Light Bulbs

The instrument illumination, direction indicator and warning bulbs are housed in plastic holders with metal inserts which contact the printed panel.

To remove a bulb, simply turn the holder a quarter-of-a-turn anti-clockwise after which the holder and bulb can be removed. Each is a normal bayonet fitting in its respective holder.

Instrument Regulator and Gauges

The instrument regulator is located on the rear face of the instrument cluster. Two spade connection blades locate into sockets in the printed panel, the earth connection is made by means of a clamp bolt screwed into the casing body (see Fig. 5).

The regulator is a voltage/temperature controller and consists of a bi-metal strip around which is wound a heating coil. The strip bends when it becomes hot so opening the regulator points and interrupting the circuit to the fuel and temperature gauges. The speed of interruption depends upon the heat produced and is consequently in direct proportion to the current flowing. The regulator is pre-set to produce a line voltage of 5 volts consequently the gauge readings will still be accurate even when the battery is in a low state of charge.

Both the petrol and temperature gauges also incorporate a bi-metal strip which bends when it becomes hot thus producing the needle deflection.

A theoretical layout of the instruments and regulator is shown in Fig. 6.

When the petrol tank is empty, the tank unit float arm falls to its lowest position inserting the whole of the unit resistance in the fuel gauge circuit. This reduces the current flowing and the gauge will read "empty".

When the tank is full the tank unit resistance is "shorted out" causing maximum current flow and the gauge to read "Full".

The temperature sender unit is also a variable resistance, but this takes the form of tightly packed discs of a material which has a high resistance when cold and a low resistance when hot.

When the ignition is first switched "on" it takes approximately 30 seconds for the bi-metal strips to attain their static temperature. During this period the needles of both gauges slowly rise to the correct reading on their respective dials.

Fault Finding

If **both** gauges record what is known to be an incorrect reading then a **common** fault is indicated, these are:—

(*a*) Battery—poor condition, loose or dirty connections.

(*b*) Electrical Wiring—loose connections or poor earthing.

(*c*) Voltage Stabiliser—faulty or poorly earthed.

If **one** gauge only registers an incorrect reading then the fault is confined to the gauge, its sender unit or its wiring.

Do not remove any components until tests on the vehicle have been completed.

General Check

Check that all the wiring connections are clean and secure and that all the components are well earthed. Also check that the battery open circuit voltage is greater than 11 volts.

Both Gauges register incorrectly

Voltage Stabiliser earth test

Provide an alternative good earth for the stabiliser and observe the gauge readings. If they are still incorrect then renew the stabiliser.

Fuel Gauge only registers incorrectly

1. *Tank Unit earth test*

Provide an alternative good earth for the tank unit and observe the gauge reading. If the reading is now correct then a poor tank unit earth is indicated.

2. *Wiring Continuity test*

Connect a lead between the tank unit terminal and the fuel gauge (tank unit) terminal and observe the gauge reading. If the reading is now correct then faulty wiring or connection are indicated.

3. *Tank Unit test*

Remove the tank unit from the vehicle and reconnect the feed wire to the tank unit terminal. Earth the tank unit to the vehicle chassis. Switch on the ignition and slowly move the float arm between its limits of travel. Check the gauge readings for correct response.

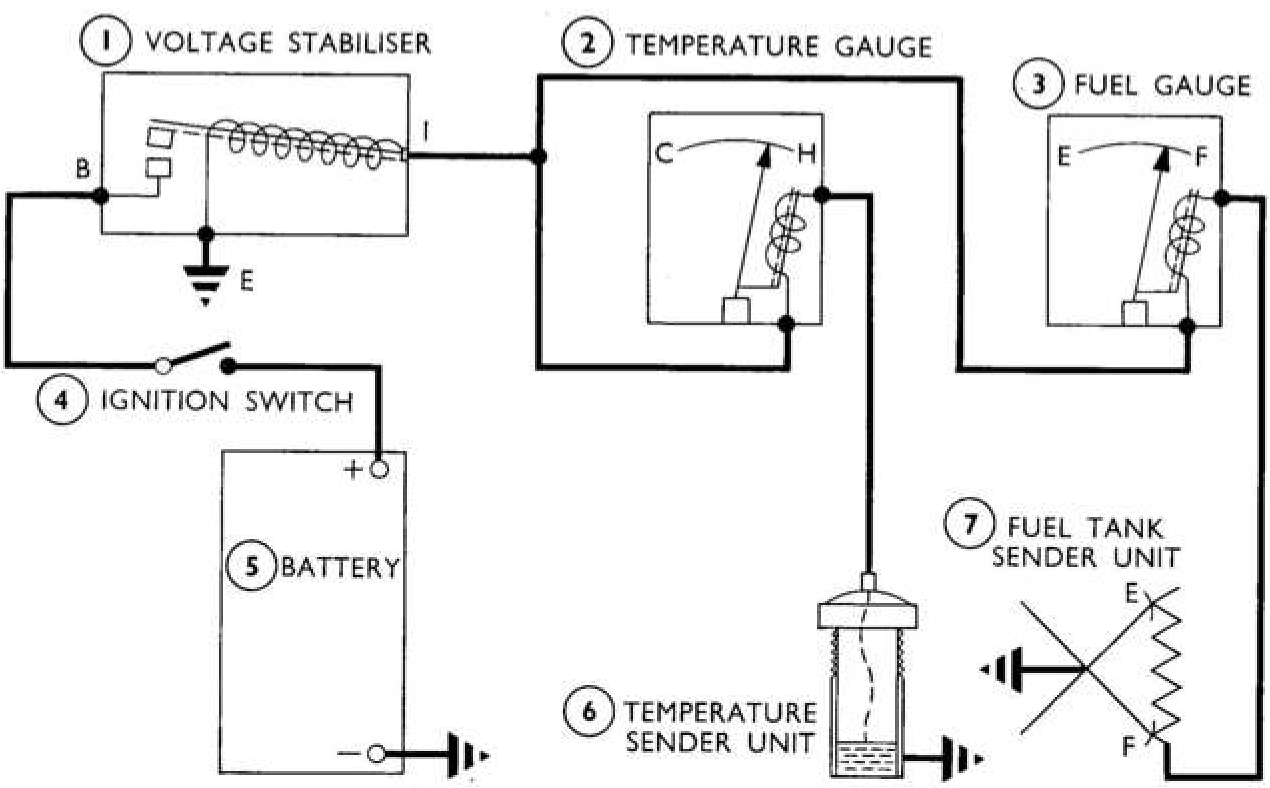


Fig. 6
Theoretical Layout of Instruments and Regulator

4. *Tank Unit substitution test*

If the readings from test 3 are incorrect, connect up a new tank unit and repeat test 3. If incorrect readings are still obtained then a faulty gauge is indicated.

Temperature Gauge only registers incorrectly

1. *Wiring Continuity test*

Connect a wire between the sender unit terminal and the temperature gauge (sender unit) terminal and observe the gauge reading with the engine at normal running temperature. If the reading is now correct then faulty wiring or connections are indicated.

2. *Sender Unit substitution test*

Replace the sender unit with a new one and observe the gauge reading. If the reading is still incorrect then renew the temperature gauge and replace the original sender unit.

HEADLAMP FLASHER, DIRECTION INDICATOR, DIP SWITCH AND HORN BUTTON ASSEMBLY

This assembly is mounted on the right-hand side of the steering column.

The self-cancelling direction indicators operate only when the ignition is switched on. The lever is pressed downwards for right-hand turns (Fig. 7, position 2) and upwards for left-hand turns (Fig. 7, position 1).

To change the headlamp main beam from "low" to "high" beam, push the lever away from the steering wheel (Fig. 7, position 4). The lever should be returned to its original position when "low" (dipped) beam is required.

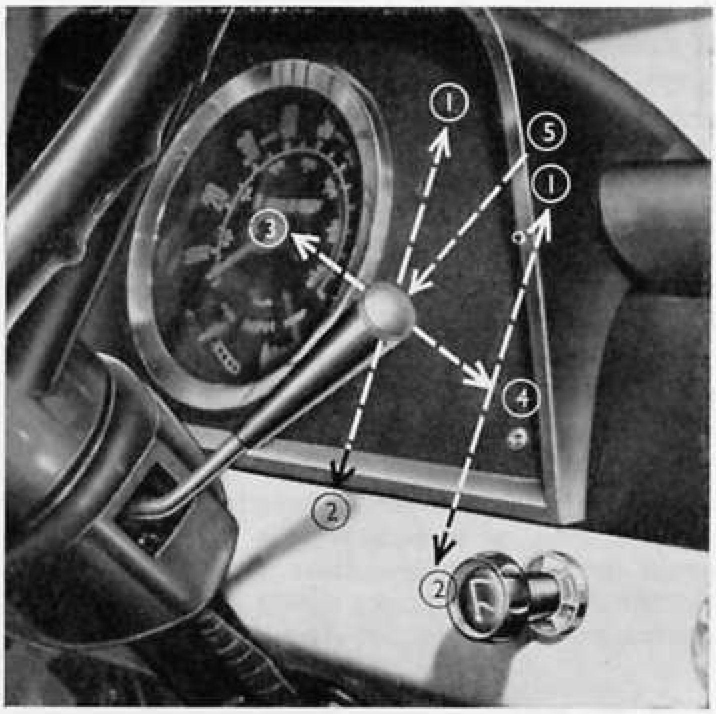


Fig. 7
Switch Positions

To flash the headlamps at any time, pull the lever towards the steering wheel (Fig. 7, position 3). When released the lever will return to its original position.

To operate the horn, press the end of the control towards the steering column (Fig. 7, position 5).

To Remove

1. **Disconnect the battery.**

2. **Remove the left-hand half of the casing.** This is a press fit, locating on two ball-ended studs. Carefully insert a small screwdriver in the point between the two halves of the casing and prise off.

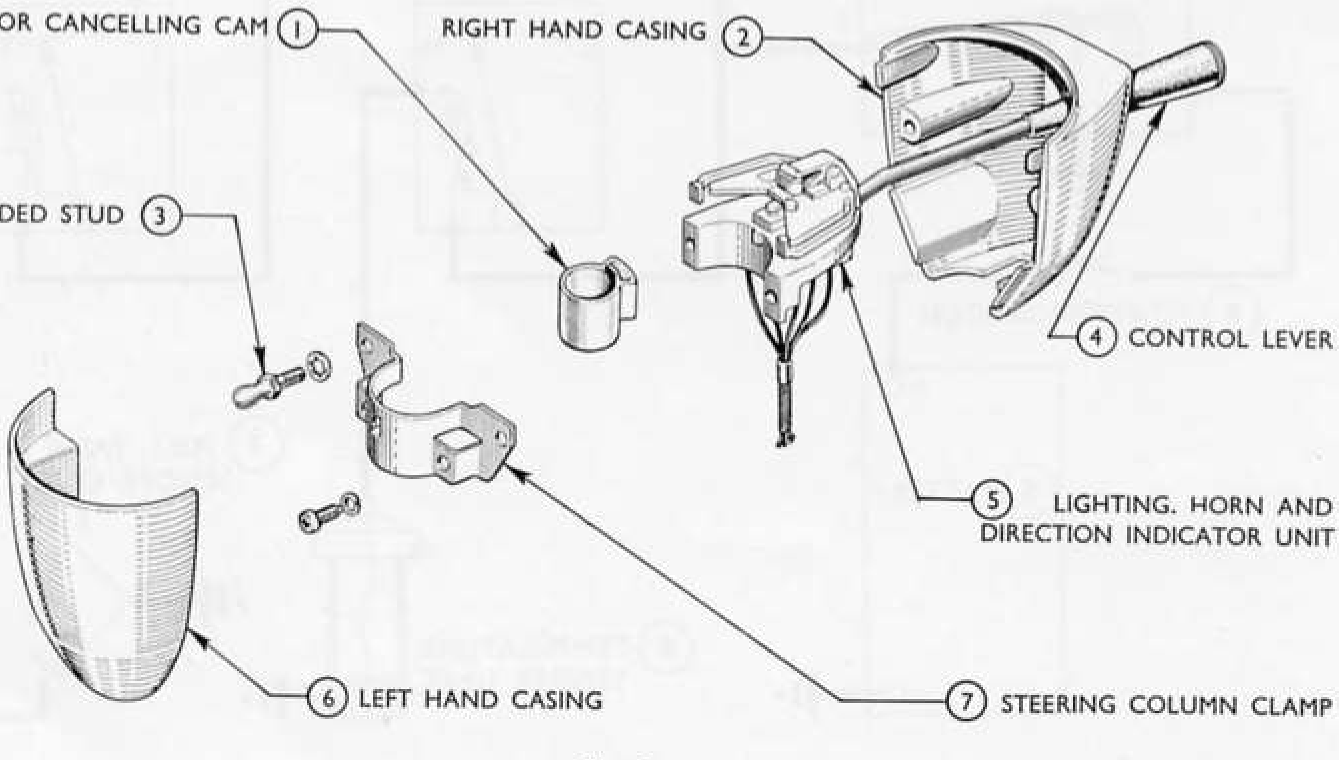


Fig. 8
Exploded View of Switch Assembly

3. **Remove the two ball-ended locating studs,** using a 2 B.A. spanner. Remove the right-hand half of the casing.

4. **Remove the two crosshead screws** securing the unit to the steering column.

5. **Disconnect the wiring** from the unit, noting the positions and colours of the wires for reassembly.

To Reassemble

1. **Reconnect the wiring.**

2. **Position the clamp** around the steering column and refit the unit using the two crosshead screws. Ensure that the lugs locate in the slots in the steering column tube.

3. **Refit the right-hand half of the casing** over the operating arm, and secure with the two ball-ended studs.

4. **Press the left-hand half of the casing** into position.

5. **Reconnect the battery,** switch on the ignition and test the action of the switch, checking all exterior lights.

THE INERTIA STARTER MOTOR

The starter is mounted on the front of the flywheel housing on the R.H. side of the engine.

The motor has four pole pieces and four sets of field coils. Four commutator brushes are fitted, two of which are earthed, the other two being insulated and connected to the ends of the field coils.

A square is machined on the end of the armature shaft, beneath a small metal cap. This will assist in freeing the pinion if, at any time, it jams in mesh with the flywheel ring gear.

TO TEST THE STARTER MOTOR ON THE ENGINE

If the starter does not operate, check the condition of the battery and the battery connections.

If the battery is in good condition, check the starter switch. If the starter still does not operate, the motor should be removed for examination.

To Remove

1. **Disconnect the battery** and the cable at the terminal on the starter motor end plate.

2. **Unscrew the three starter motor securing bolts** evenly and detach the starter motor.

To Replace

1. **Pass the drive end of the starter motor into the flywheel housing aperture** and locate the motor on the mounting flange with the cable terminal to the R.H. side of the vehicle.

2. **Replace the three bolts** and spring washers and tighten securely.

3. **Reconnect the cable to the starter motor terminal,** ensure that the cable does not foul the exhaust pipe and reconnect the battery.

4. **Check that the starter motor turns** the engine when the starter switch is operated.

STARTER BRUSHES

To Examine the Brushes

1. **Remove the starter motor.**

2. **Loosen the screw** and slide the brush cover away from the brush apertures.

3. **Lift the brush springs** using a piece of wire shaped into a hook and check the movement of the brushes in the holder.

4. **If the brushes are sticking,** clean them with a petrol moistened cloth and, if necessary, ease the sides of the brushes by polishing on a smooth file. When satisfactory, replace the starter motor.

NOTE.—If the brushes are worn so that they do not bear on the commutator or the brush lead is exposed on the wearing face, new brushes must be fitted.

If the commutator is blackened or dirty, clean by holding a petrol moistened cloth against it while the armature is rotated.

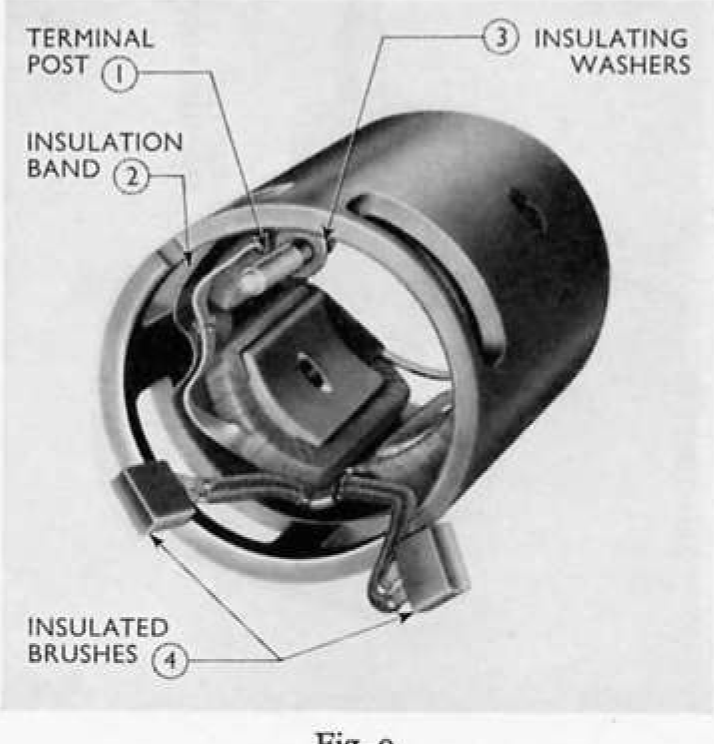


Fig. 9
Position of Starter Field Coils

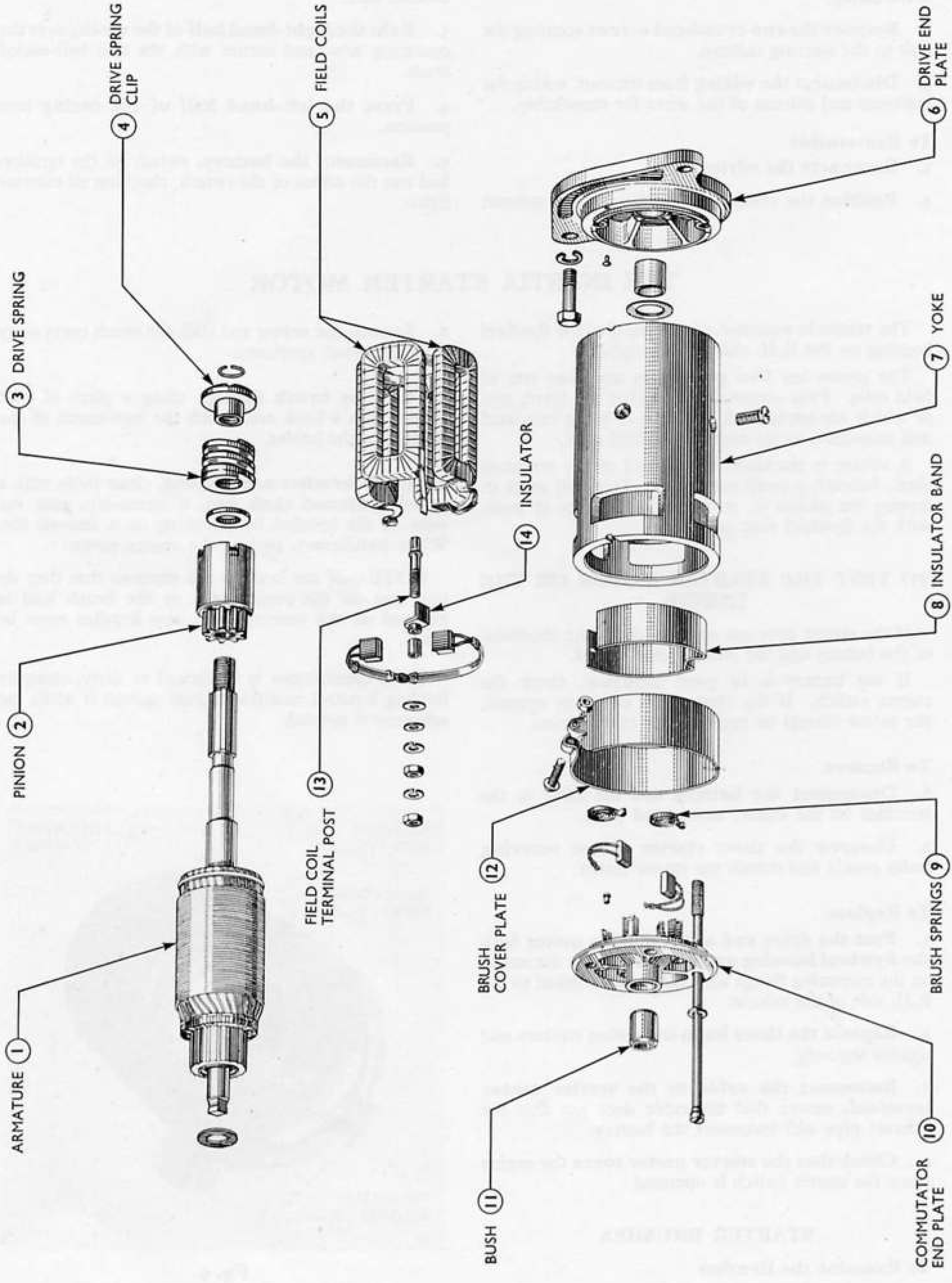


Fig. 10
Starter Motor — Exploded View

COMMUTATOR END PLATE AND BRUSHES

To Remove

1. Remove the starter motor.

2. Slacken the cover band screw and slide the cover band away from the brush apertures.

3. Lift the brush springs and pull the brushes out of their holders.

4. Unscrew the starter cable terminal nuts and detach the spring, flat and fibre washers.

5. Unscrew the two through-bolts and carefully pull the commutator end plate from the starter motor, together with the earth brushes. Remove the armature if necessary.

6. Unsweat the earthed brush leads from the connections and detach the brushes.

To Replace

1. Check the brushes for freedom of movement in the brush holders (see previously) and then resolder the brush leads to the field coils and earthed brush holders.

The field coil or insulated brushes are longer than the earthed brushes and have a braided covering. Fit these brushes so that they both point towards the field coil terminal, when the starter motor yoke is viewed from the commutator end as shown in Fig. 9.

2. Before fitting the end plate, check the brush springs and renew if necessary. Take care to close the ends of the brush spring posts after fitting new springs.

It is also advisable to check the insulated brush holders to ensure that they are not earthing. Use a battery and bulb for this test.

3. Check that the fibre washers are fitted on the field coil terminal post and a fibre sleeve is located in the terminal post hole in the commutator end plate.

4. Check that the insulator band is located between the yoke and the end of the field coils, and pass the insulated brushes through the apertures in the yoke.

5. Replace the commutator end plate on the starter motor yoke, passing the earthed brushes through the other apertures in the yoke and engage the dowel pin in the end plate with the notch in the yoke end.

6. Replace a fibre washer, flat washer, spring washer, nut, spring washer and nut (in that order) on the field coil terminal post and tighten the inner nut securely.

7. Replace the armature and drive end plate, if removed, engaging the dowel pin on the plate in the notch at the drive end of the yoke.

Replace the two through-bolts and tighten securely.

8. Lift the brush springs and insert the brushes into their holders, ensuring that they slide freely. (The field coil brushes locate in the insulated brush holders.)

9. Slide the brush cover band over the brush apertures and tighten the screw securely.

10. Replace the starter motor as described earlier in this Bulletin.

STARTER COMMUTATOR

The commutator should be inspected when the starter motor is dismantled. A commutator in good condition should be smooth and free from pitting or burned spots.

Clean the commutator with a petrol-moistened cloth. If this is ineffective, carefully polish with a strip of fine glass paper, *not emery cloth*, while the armature is rotated.

If the commutator is badly worn or scored, remove the starter drive as described previously in this Bulletin and detach the drive end plate. Mount the armature in a lathe, rotate at high speed, and take a light cut with a very sharp tool.

Polish the commutator with very fine glass paper.

Do not undercut the mica insulation between the segments as is the normal practice with generators.

Check that the commutator segments are not earthing to the armature shaft and core by checking with a battery and bulb.

STARTER ARMATURE

The armature can be inspected after it has been removed from the starter motor yoke. Visual examination will, in many cases, reveal any cause of failure, i.e., conductors lifting away from the commutator due to the starter pinion being jammed in the engaged position while the engine is running.

A damaged armature must be replaced in all cases. No attempt should be made to machine the armature core or to true a distorted armature shaft.

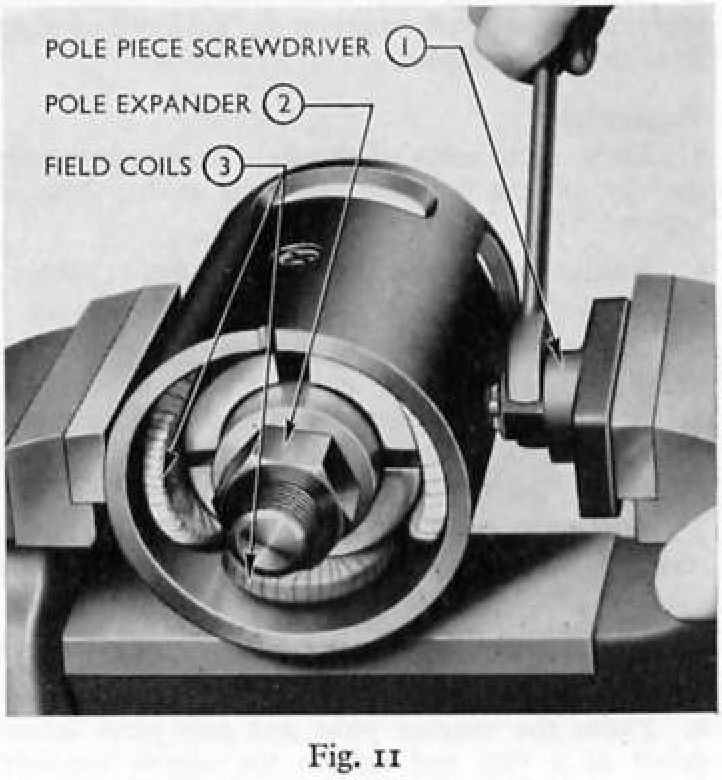


Fig. 11

Removing Starter Field Coils

STARTER FIELD COILS

To Test

1. Remove the commutator end plate as described previously, and withdraw the armature and drive end plate.

2. Test the field coils for continuity and earth as follows:—

Check for continuity between the two ends of the field coils, using a mains operated line tester, having a suitable bulb in circuit. Alternatively, the test prods on a Diagnosis Test Set can be used.

If the lamp does not light, there is an open circuit in one of the field coils. If the lamp lights, it does not necessarily mean that the field coils are in order, as it is possible that one of the coils may be earthing to the pole pieces or starter yoke.

This may be checked by touching one of the test prods on the starter yoke and the other onto one of the field coil tappings. If the bulb now lights, the coils are earthed.

NOTE.—The field coils are not serviced separately, as invariably it is found that if one fails the others are affected.

To Remove

1. **Mark the yoke and pole shoes** so that the shoes can be refitted in their original positions.

2. **Detach the fibre insulating washers** and sleeve from the field coil terminal post and the insulation band from the commutator end of the yoke.

3. **Locate the pole piece expander** CP.9509 in the starter yoke and tighten the nut to expand the tool against the pole pieces. Mount the starter yoke and pole piece screwdriver CP.9504 in a vice as shown in Fig. 11, and slacken the pole piece screws one at a time. Finally, remove the screws with a crosshead screwdriver.

4. **Withdraw the field coils** and pole pieces from the yoke and carefully unsweat the field coil tappings from the terminal post.

To Replace

1. **Locate the ends of the field coil tappings** in the slot of the terminal post and solder them in position.

2. **Solder new brush leads** to the smaller connections on the field coils as previously described.

3. **Temporarily replace the commutator end plate** on the starter yoke and note the position of the field coil terminal in relation to the yoke. Reassemble the pole pieces to the field coils so that the mating marks on the yoke and pole pieces are together.

4. **Insert the field coils and pole pieces** into the starter yoke, align the securing screw holes and locate the pole pieces with the cross-head screws.

5. **Insert the pole piece expander** and tighten the nut to press the pole pieces against the yoke.

6. **Place the starter yoke** and pole piece screwdriver in a vice and tighten the screws securely.

7. **Slacken off the nut and remove the expander.**

8. **Replace the insulator band** around the commutator end of the field coils between the coil tappings and the yoke.

9. **Replace the insulator sleeve** and washers on the field coil terminal post and check that the post is pointing along the axis of the yoke.

10. **Replace the armature** and commutator end bracket.

STARTER END PLATE BUSHES

The bushes in the drive and commutator end plates are serviced and should be renewed if the bushes are found to be excessively worn or scored.

The bushes can be removed and replaced with suitable drivers.

After reassembling the starter motor, check that the armature shaft is free to rotate in the bushes without binding.

Starter Motor Drive

The starter drive is of the outboard drive type, the pinion moving towards the body of the starter motor when the switch is operated.

When a starter motor is removed, it is important that the drive is thoroughly cleaned and is checked for freedom of action. If necessary, wash the parts in paraffin to remove any grease, oil or dirt present.

Do not lubricate the components as this may eventually cause the pinion to stick.

The front face of the pinion sleeve is cut-away at four points and the rear face of the pinion is correspondingly machined to act as a ratchet.

If the pinion fails to engage or the engine kicks back when the starter control is operated, the pinion sleeve is screwed rearwards against the tension of the main spring until it disengages from the pinion and rotates independently of it. This prevents any excessive strain being imposed on the armature shaft.

When the starter control is released the pinion re-engages the sleeve and returns to the disengaged position under the influence of the spring.

To Dismantle

1. **Compress the drive spring cup and drive spring,** using a suitable press and spring compressor, and remove the retaining circlip.

2. **Release the press** and remove the drive spring cup, drive spring and retaining washer. Pull the drive pinion barrel assembly from the armature shaft.

NOTE.—The pinion barrel assembly cannot be dismantled, it is serviced as a complete assembly.

To Reassemble

1. **Refit the pinion barrel assembly** on the armature shaft with the pinion teeth towards the armature windings.

2. **Locate the drive spring retaining washer** and drive spring on the shaft and refit the drive spring cup. Compress the cup and drive spring and refit the circlip, ensuring that it is fully seated.

THE PRE-ENGAGED STARTER MOTOR WITH PARALLEL SOLENOID

Description and Operation

The starter motor is mounted at the side of the flywheel housing on the left-hand side of the engine. It is of the pre-engaged type and incorporates an externally mounted parallel solenoid.

The purpose of the pre-engaged feature of this starter is to protect the flywheel ring gear and the starter pinion gear teeth, by the self-indexing operation.

When the ignition key is operated, current flows from the battery to the solenoid. The solenoid plunger moves inwards and operates a pivoted drive engaging lever which pushes the drive pinion into mesh with the flywheel ring gear. As the solenoid plunger reaches the end of its travel it closes an internal contact and full starting current flows to the starter field coils. The armature then revolves and drives the engine.

The starter drive pinion is fitted with a one-way clutch so that when the engine starts it does not drive the starter motor. The drive pinion will remain in mesh with the flywheel ring gear as long as the ignition key is held on. Therefore, release the key as soon as the engine is running.

To Test the Starter Motor on the Engine

If the starter does not operate, check the condition of the battery and the battery connections.

If the battery is in good condition, check the starter switch. If the starter still does not operate, the motor should be removed for examination.

To Remove the Starter Motor

1. Disconnect the battery earth cable and the heavy duty solenoid cable. Disconnect the ignition switch-to-solenoid wires at the solenoid end.

2. Unscrew the three starter motor securing bolts and detach the starter from the engine.

To Replace the Starter Motor

1. Pass the drive end of the starter motor into the flywheel housing aperture and locate the motor on the mounting flange with the solenoid uppermost.

2. Replace the three securing bolts and spring washers and tighten securely.

3. Reconnect the solenoid wiring and the battery earth lead.

4. Check that the starter motor turns the engine when the ignition key is operated.

THE SOLENOID

The solenoid has two sets of windings; a main series winding and a parallel shunt winding. Both of these windings are energised when the ignition key is turned and the solenoid plunger is drawn inwards, engaging the drive pinion in the starter ring gear. At the end of its travel the plunger closes a contact switch and the series winding is cut out; the current flows to the starter motor and it revolves at high speed. The parallel shunt winding, however, remains energised and holds the pinion gear in mesh until the ignition key is released.

In the event of the pinion gear meeting the flywheel ring gear tooth to tooth and not engaging, the solenoid plunger can still move inwards against a spring and close the contact switch. The starter then revolves slowly and the teeth engage.

To Test the Solenoid

1. It is first necessary to set the pinion gear travel (see Fig. 12), using the eccentric pivot pin as follows: first energise the solenoid with a 12 volt supply. Slacken the eccentric pivot pin locknut and turn the pin until the correct setting of 1.27 mm. (0.050 in.) is obtained between the pinion and thrust washer. Note that the arc of adjustment is 180° as indicated by arrows on the casing.

2. Remove the connection from the solenoid to the starter body terminal.

Connect, through a switch, a 6 volt supply between the solenoid small unmarked terminal and the large terminal "STA". Connect a separately energised test lamp circuit across the solenoid main terminals (see Fig. 14.)

3. Insert a stop of $\frac{1}{8}$ in. thickness between the pinion and drive end bracket to prevent the pinion moving fully outwards.

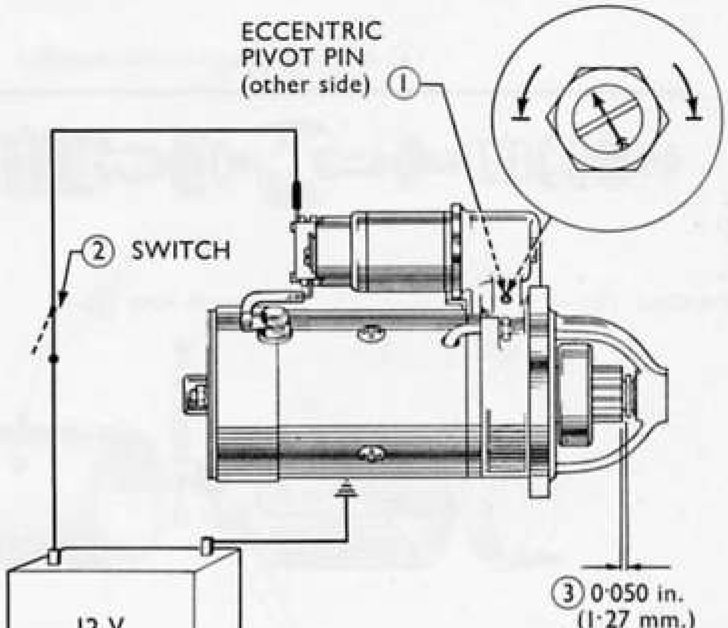


Fig. 12
Pinion Clearance Setting

4. Close the switch, thus causing the 6 volt supply to energise the shunt winding. The test lamp should now light, indicating the solenoid contacts have closed satisfactorily.

5. Switch off and remove the 0.32 cm. ($\frac{1}{8}$ in.) stop restricting the pinion movement.

Switch on again and hold the pinion in the fully engaged position by hand.

6. Switch off and observe the test lamp which should go out, indicating that the solenoid contacts have opened satisfactorily.

To Remove the Solenoid

1. Remove the starter motor as previously described.
2. Disconnect the solenoid to starter motor yoke terminal connection.
3. Unscrew the two solenoid securing bolts.
4. Withdraw the solenoid body from the solenoid plunger.

To Replace the Solenoid

1. Reposition the solenoid body over the solenoid plunger with the terminal "STA" against the starter motor yoke.
2. Replace the two securing bolts and spring washers and tighten securely.
3. Replace the starter motor as previously described.

STARTER BRUSHES

To Examine the Brushes

1. Remove the starter motor as described previously.
2. Loosen the screw and slide the brush cover away from the brush apertures.
3. Lift the brush springs using a piece of wire shaped into a hook and check the movement of the brushes in the holder.
4. If the brushes are sticking, clean them with a petrol-moistened cloth and, if necessary, ease the sides of the brushes by polishing on a smooth file.

NOTE.—Brushes should be renewed when they are worn to 7.5 mm. (0.3 in.) in length.

To Remove the Brushes

1. Remove the starter motor.
2. Loosen the screw and slide the brush cover away from the brush apertures.
3. Lift the brush springs with a wire hook and pull the brushes out of their holders.
4. Prise back the through bolt locking tabs and unscrew the two through bolts and carefully pull the commutator end plate from the starter motor, together with the earth brushes. Remove the armature if necessary.
5. Cut the brush leads and discard the brushes.

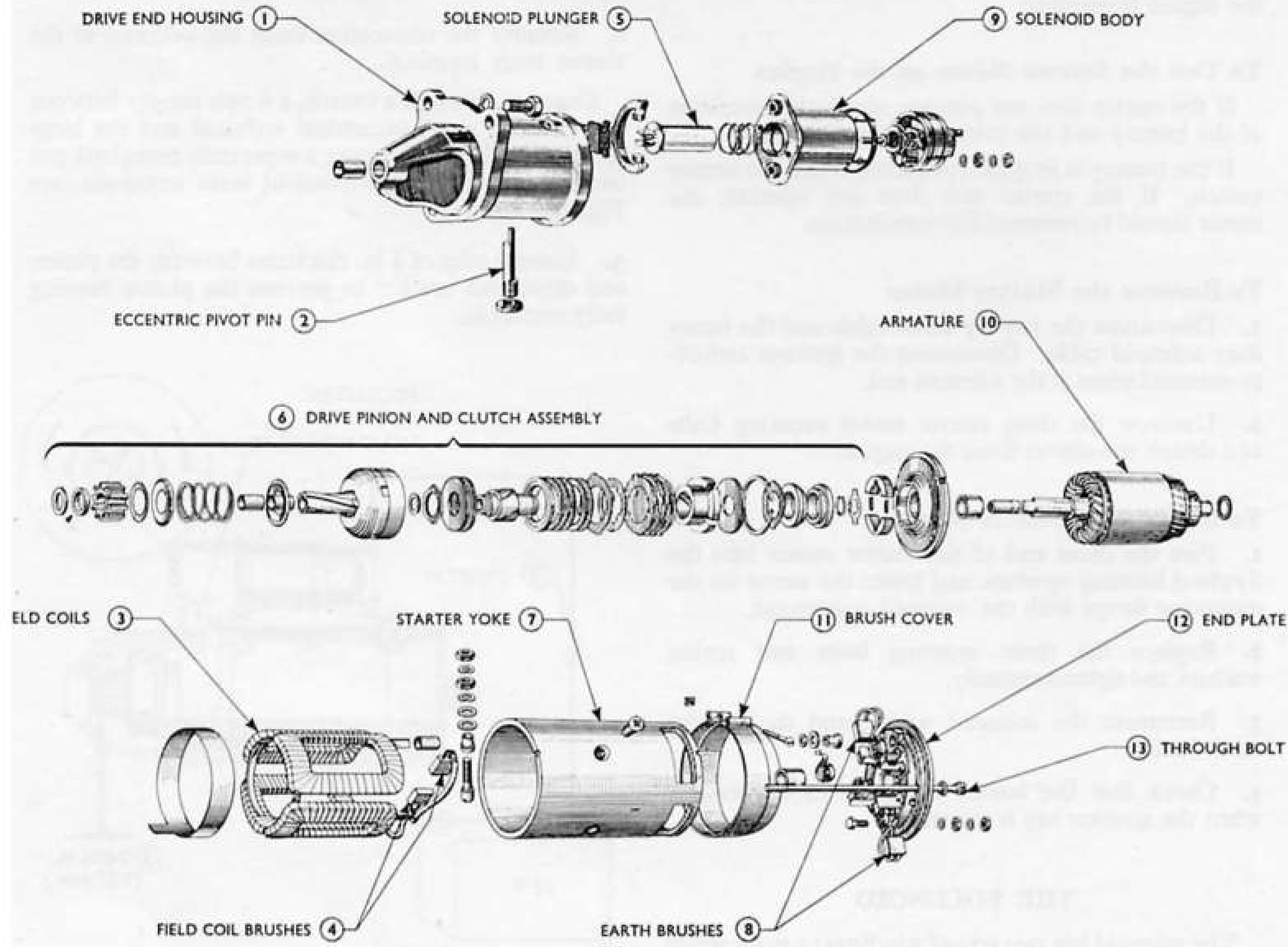


Fig. 13a

Pre-engaged Starter Motor — Diesel

Do not attempt to unsolder the brushes because, as aluminium field coils are fitted, difficulty will be experienced unless special equipment is used.

To Replace the Brushes

1. Check the brushes for freedom of movement in the brush holders (see previously) and then solder the new brushes to the old leads. If necessary trim the new brush leads to the required length.

The field coil or insulated brushes have a braided covering. Fit these brushes so that they both point towards the field coil terminal, when the starter motor yoke is viewed from the commutator end.

2. Before fitting the end plate, check the brush springs and renew if necessary.

It is also advisable to check the insulated brush holders to ensure that they are not earthing. Use a battery and bulb for this test.

3. Check that the insulator band is located between the yoke and the end of the field coils, and pass the insulated brushes through the apertures in the yoke.

4. Replace the commutator end plate on the starter motor yoke, passing the earthed brushes through the other apertures in the yoke and engage the dowel pin in the end plate with the notch in the yoke end.

5. Refit the through bolts, tab washers and spring washers. Tighten to 0.83 kg.m. (6 lb. ft.) and bend up the tab washers against the through bolts.

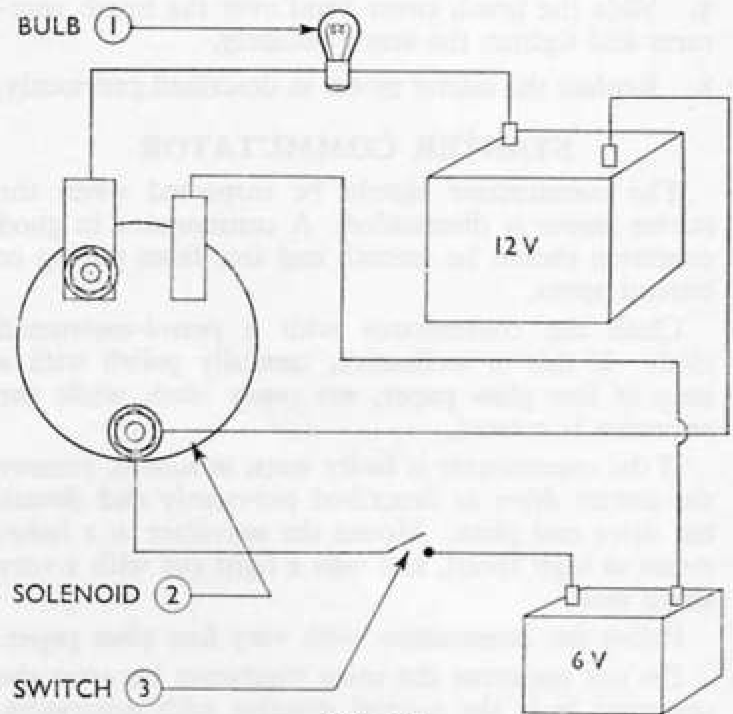


Fig. 14
Testing the Solenoid Operation

6. Lift the brush springs and insert the brushes into their holders, ensuring that they slide freely. (The field coil brushes locate in the insulated brush holders.)

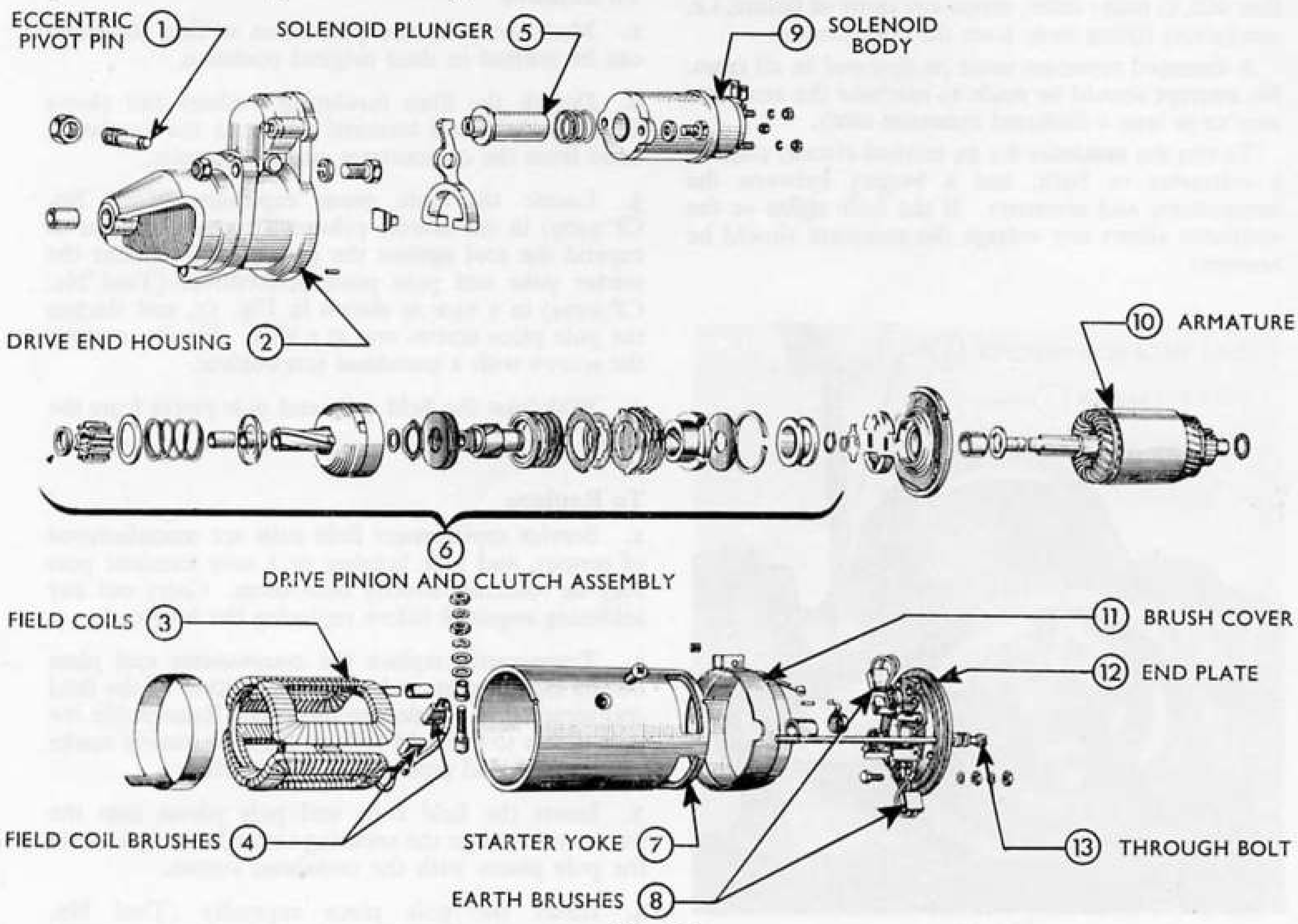


Fig. 13b
Pre-engaged Starter Motor — Automatic Transmission

7. Slide the brush cover band over the brush apertures and tighten the screw securely.

8. Replace the starter motor as described previously.

STARTER COMMUTATOR

The commutator should be inspected when the starter motor is dismantled. A commutator in good condition should be smooth and free from pitting or burned spots.

Clean the commutator with a petrol-moistened cloth. If this is ineffective, carefully polish with a strip of fine glass paper, *not emery cloth*, while the armature is rotated.

If the commutator is badly worn or scored, remove the starter drive as described previously and detach the drive end plate. Mount the armature in a lathe, rotate at high speed, and take a light cut with a very sharp tool.

Polish the commutator with very fine glass paper.

Do not undercut the mica insulation between the segments as is the normal practice with generators.

Check that the commutator segments are not earthing to the armature shaft and core by checking with a battery and bulb.

STARTER ARMATURE

The armature can be inspected after it has been removed from the starter motor yoke. Visual examination will, in many cases, reveal any cause of failure, i.e. conductors lifting away from the commutator.

A damaged armature must be renewed in all cases. No attempt should be made to machine the armature core or to true a distorted armature shaft.

To test the armature for an earthed circuit, connect a voltmeter or bulb, and a battery between the commutator and armature. If the bulb lights or the voltmeter shows any voltage the armature should be renewed.

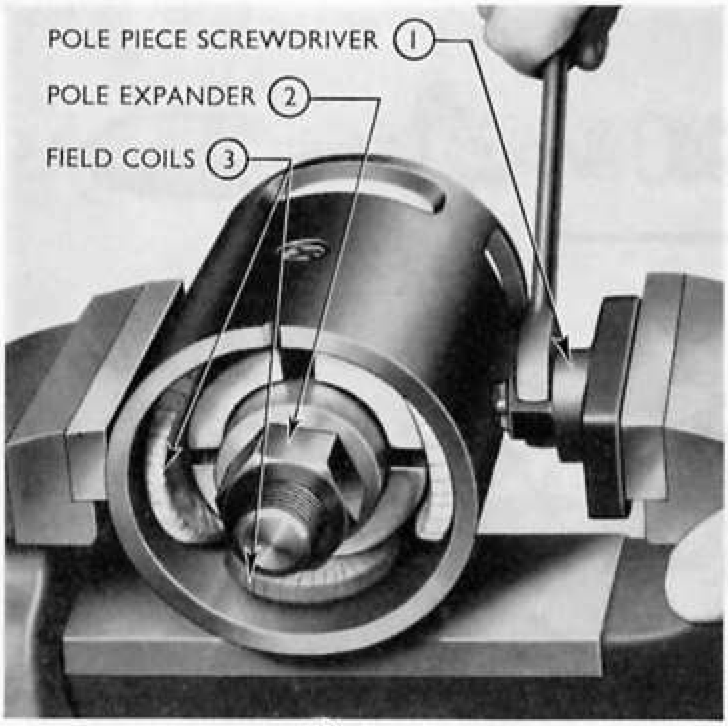


Fig. 15
Pole Shoe Expander

STARTER FIELD COILS

To Test

1. Remove the commutator end plate and solenoid as described previously.

Slacken the eccentric pivot locknut and remove the eccentric pivot, housing, armature, pinion gear and drive engaging lever.

2. Test the field coils for continuity and earth as follows:—

Check for continuity between the two ends of the field coils, using a mains operated line tester, having a suitable bulb in circuit. Alternatively, the test prods on a Diagnosis Test Set can be used.

If the lamp does not light, there is an open circuit in one of the field coils. If the lamp lights, it does not necessarily mean that the field coils are in order, as it is possible that one of the coils may be earthing to the pole pieces or starter yoke.

This may be checked by touching one of the test prods on the starter yoke and the other onto one of the field coil tappings. If the bulb now lights, the coils are earthed.

NOTE.—The field coils are not serviced separately, as invariably it is found that if one fails the others are affected.

To Remove

1. Mark the yoke and pole shoes so that the shoes can be refitted in their original positions.

2. Detach the fibre insulating washers and sleeve from the field coil terminal post and the insulation band from the commutator end of the yoke.

3. Locate the pole piece expander (Tool No. CP.9509) in the starter yoke and tighten the nut to expand the tool against the pole pieces. Mount the starter yoke and pole piece screwdriver (Tool No. CP.9504) in a vice as shown in Fig. 15, and slacken the pole piece screws one at a time. Finally, remove the screws with a crosshead screwdriver.

4. Withdraw the field coils and pole pieces from the yoke.

To Replace

1. Service replacement field coils are manufactured of copper, and new brushes or a new terminal post may be soldered directly onto them. Carry out any soldering required before replacing the field coils.

2. Temporarily replace the commutator end plate on the starter yoke and note the position of the field coil terminal in relation to the yoke. Reassemble the pole pieces to the field coils so that the mating marks on the yoke and pole pieces are together.

3. Insert the field coils and pole pieces into the starter yoke, align the securing screw holes and locate the pole pieces with the crosshead screws.

4. Insert the pole piece expander (Tool No. CP.9509) and tighten the nut to press the pole pieces against the yoke.

5. Place the starter yoke and pole piece screwdriver (Tool No. CP.9504) in a vice and tighten the screws securely.

6. Slacken off the nut and remove the expander.

7. Replace the insulator band around the commutator end of the field coils between the coil tappings and the yoke.

8. Replace the insulator sleeve and washers on the field coil terminal post and insert it through the aperture in the starter yoke.

9. Reassemble the starter motor. Refit the solenoid and set the pinion clearance as described previously.

STARTER END PLATE BUSHES

The bushes in the drive and commutator end plates are serviced and should be renewed if the bushes are found to be excessively worn or scored.

The bushes can be removed and replaced with suitable drivers.

NOTE.—Before fitting a new porous bronze bush it should be completely immersed for 24 hours in clean thin engine oil.

Porous bushes must not be opened out after fitting, or their porosity will become impaired.

After reassembling the starter motor, check that the armature shaft is free to rotate in the bushes without binding.

THE STARTER DRIVE PINION ASSEMBLY

To Remove

1. Remove the starter motor from the vehicle and dismantle it as described previously.

2. Locate the armature in a soft jawed vice, remove the circlip and detach the drive pinion assembly.

3. Remove the spring from the pinion assembly after removing the retaining circlip.

NOTE.—Do not grip the one-way clutch in a vice whilst carrying out this operation as it will be damaged.

The drive pinion and clutch are serviced as a complete unit as repairs to the unit are impractical.

To Replace

1. Refit the spring and retainer plate to the drive pinion and clutch unit; secure them with the circlip.

2. Reassemble the starter motor and refit it to the engine.

3. Check the operation of the starter motor on the vehicle.

THE PRE-ENGAGED STARTER MOTOR WITH MOVING POLE SHOE SOLENOID

Description and Operation

The starter motor is mounted at the side of the flywheel housing on the left-hand side of the engine. It is of the pre-engaged type incorporating a moving pole shoe solenoid (see Fig. 16).

The purpose of the pre-engaged feature of this starter is to protect the flywheel ring gear and the starter pinion gear teeth, by the self-indexing operation of the starter.

When the ignition switch is operated a current flows from the battery to the solenoid switch, which becomes energised and its plunger moves inwards, closing an internal switch. The battery is then connected directly to the starter terminal via the solenoid.

The starter terminal is joined to the field coils, one of which is directly earthed through a pair of contact points. Therefore, this field coil receives a large current and the magnetic field induced in the windings pulls down a pole shoe that is pivoted above it. A lever is attached to one side of the pole shoe and is engaged with the drive pinion. The movement of the pole shoe is thus transmitted to the drive pinion which slides along the armature shaft and into engagement with the starter ring gear.

When the pinion is fully in mesh and the pole shoe is fully seated it opens the earthing contact points and full starting current flows through all four field coils. The armature then rotates and turns the engine.

The starter drive pinion is fitted with a one-way clutch so that when the engine starts it does not drive the starter motor. The drive pinion will remain in engagement with the starter ring gear as long as the ignition key is held on. Therefore, release the ignition key as soon as the engine is running.

TO TEST THE STARTER MOTOR ON THE ENGINE

If the starter motor does not operate, check the condition of the battery and the battery connections.

If the battery is in a good condition, check the starter switch and solenoid. If the starter motor still does not operate, it should be removed for examination.

To Remove

1. Disconnect the battery and the starter cable at the terminal on the side of the starter.

2. Unscrew the two bolts securing the starter to the engine and detach the starter.

To Replace

1. Enter the starter into the aperture in the flywheel cover and locate it with the pole shoe cover uppermost.

2. Replace the two retaining bolts and spring washers and tighten securely.

3. Reconnect the cable to the starter motor and reconnect the battery.

4. Check that the starter motor turns the engine when the starter switch is operated.

STARTER BRUSHES

To Examine

1. Remove the starter motor.

2. Loosen the brush cover band clamp screw and slide the band from the starter.

3. Lift off the moving pole shoe cover and the brush cover insulation strip.

4. Lift the brush springs with a piece of wire shaped into a hook and check the movement of the brushes in their holders.

5. If the brushes are sticking, clean them with a petrol moistened cloth and, if necessary, ease the sides of the brushes with a smooth file.

NOTE.—Brushes should be replaced when they are worn to 6.4 mm. (0.25 in.).

To Remove

1. Remove the starter motor from the vehicle.

2. Loosen the brush cover band clamp screw and slide the band from the starter.

3. Lift off the moving pole shoe cover and brush cover insulation strip.

4. Lift the brush springs with a piece of wire shaped into a hook and pull the brushes from their holders.

5. Remove the two through bolts from the commutator end of the starter and carefully remove the end plate.

6. Remove the drive end housing and the return spring from the starter.

7. Push out the moving pole shoe pivot pin and lift off the pole shoe (see Fig. 16).

8. Withdraw the armature, complete with drive pinion, from the starter body.

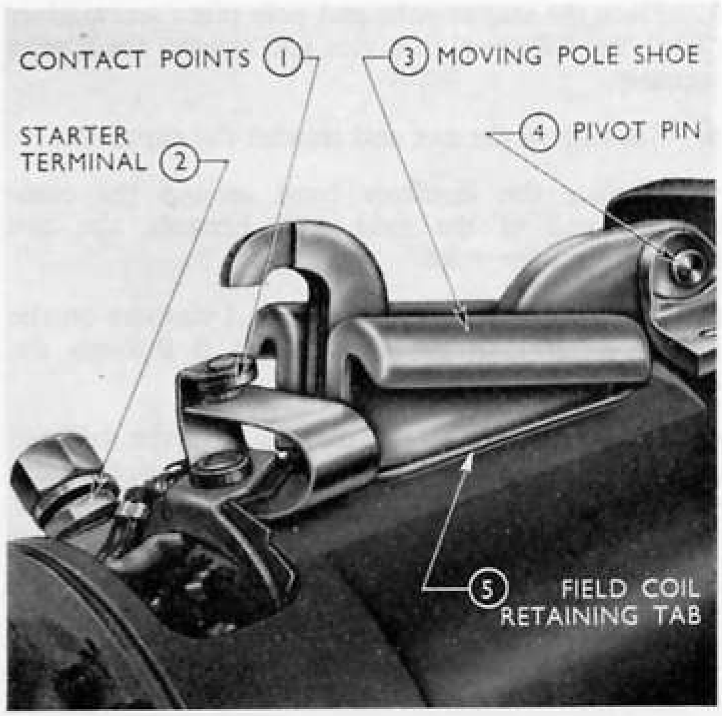


Fig. 16
Moving Pole Shoe and Pivot

9. Unscrew the two screws retaining the earth leads to the starter yoke. One lead is also soldered to one side of the contact points and this lead should be cut as near to the connection as possible. Remove the brushes (see Fig. 17).

10. Cut the insulated field coil brush leads as near to the field coil connections as possible and remove these brushes.

To Replace

1. Pull the insulated copper field coil connecting strip from behind the field coil brush terminal to prevent damage during subsequent soldering operations.

2. Position the leads of the new insulated brushes on the field coil terminal and solder them securely to it. Push the insulated copper connecting strip back down behind the exposed copper strip and ensure that the exposed strip is not touching the starter yoke.

3. Solder the new earth brush lead to the contact point connection and screw both earth brush leads to the starter yoke.

4. Slide the armature into the starter yoke, ensure that the fibre washer is fitted at the commutator end, and fit the commutator end plate.

5. Install the moving pole shoe on the starter yoke, engaging the forked end with the arms on the drive pinion (see Fig. 18) and replace the pivot pin.

6. Partially engage the drive end housing on the shaft. Fit the return spring between the arm on the moving pole shoe and the recess in the drive end housing. Push the drive end housing fully home.

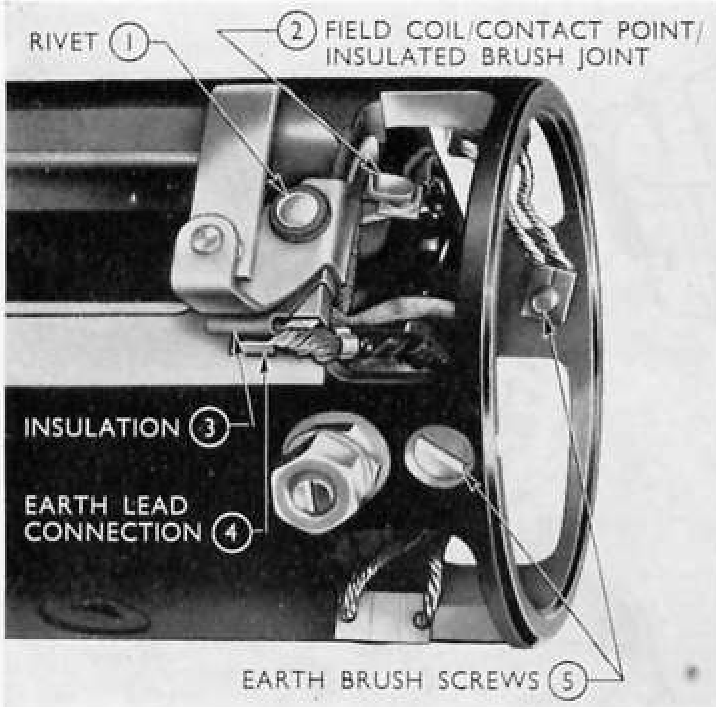


Fig. 17
Brush Lead Connections

7. Fit the two through bolts and spring washers from the commutator end and tighten securely.

8. Lift the brush springs with a hook-shaped piece of wire and slide the brushes into their holders. Ensure that the insulated brushes are fitted in the insulated brush holders.

9. Fit the brush cover insulating strip around the brush apertures, position the moving pole shoe cover on the starter, and slide on the brush cover band. Tighten the clamp screw.

10. Before refitting the starter motor, check its operation as follows:—

Securely clamp the starter motor in a vice. Connect the positive terminal of a battery to the starter terminal and the negative terminal of the battery to the starter motor yoke.

11. Replace the starter on the vehicle and check its operation.

STARTER COMMUTATOR

The commutator should be inspected when the starter motor is dismantled. If it has a rough surface or is burned, it should be cleaned with very fine glass paper, *not emery cloth*, whilst the armature is rotated.

If the commutator is badly worn or its run-out exceeds 0.127 mm. (0.005 in.) it should be mounted in a lathe, rotated at high speed and a light cut taken with a sharp tool. Re-polish it with fine glass paper.

The mica insulation should not be under-cut as is the normal practice with generators.

Check that the commutator segments are not earthing to the armature shaft and core by checking with a battery and bulb.

THE ARMATURE

The armature should be inspected when the starter is dismantled.

An open circuit may sometimes be detected by examining the commutator for excessive burning, the burned spot being caused by an arc formed every time the commutator segment, which is connected to an open circuit armature winding, passes under a brush.

To test the armature for an earthed circuit, connect a voltmeter or bulb, and a battery between the commutator and armature. If the bulb lights or the voltmeter shows a voltage, the armature should be renewed.

FIELD COILS

To Remove

1. Remove the starter from the vehicle and dismantle it as described previously.

2. The field coil that operates the moving pole shoe is retained in the starter by a metal tab. Bend up the tab and remove the retainer (see Fig. 16).

3. Unscrew the three pole shoe retaining screws with a square-headed pole shoe screwdriver (Tool No. CP.9504, see Fig. 15) and remove the pole shoes.

4. The contact points are connected to the field coils by a soldered joint. Unsweat this joint and break the connection.

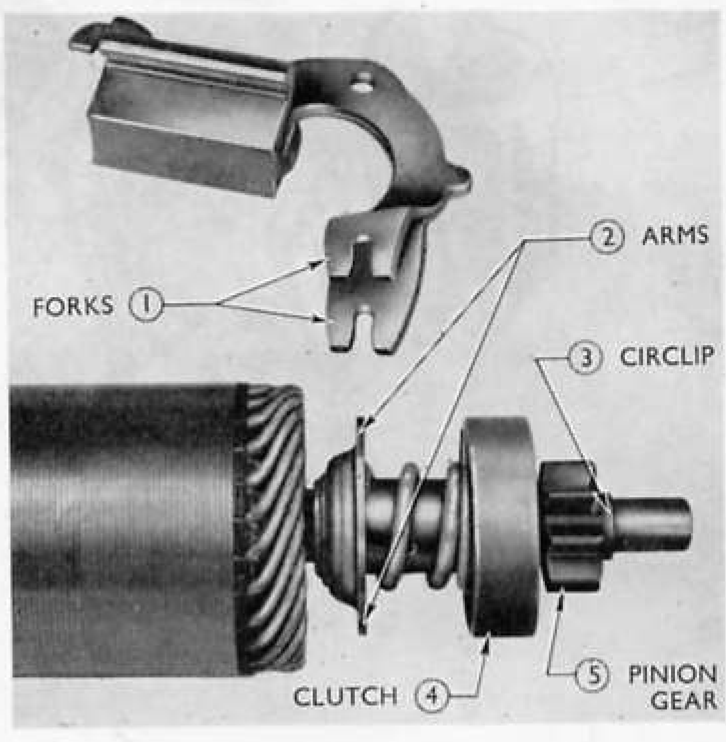


Fig. 18
Drive Pinion and Pole Shoe Lever

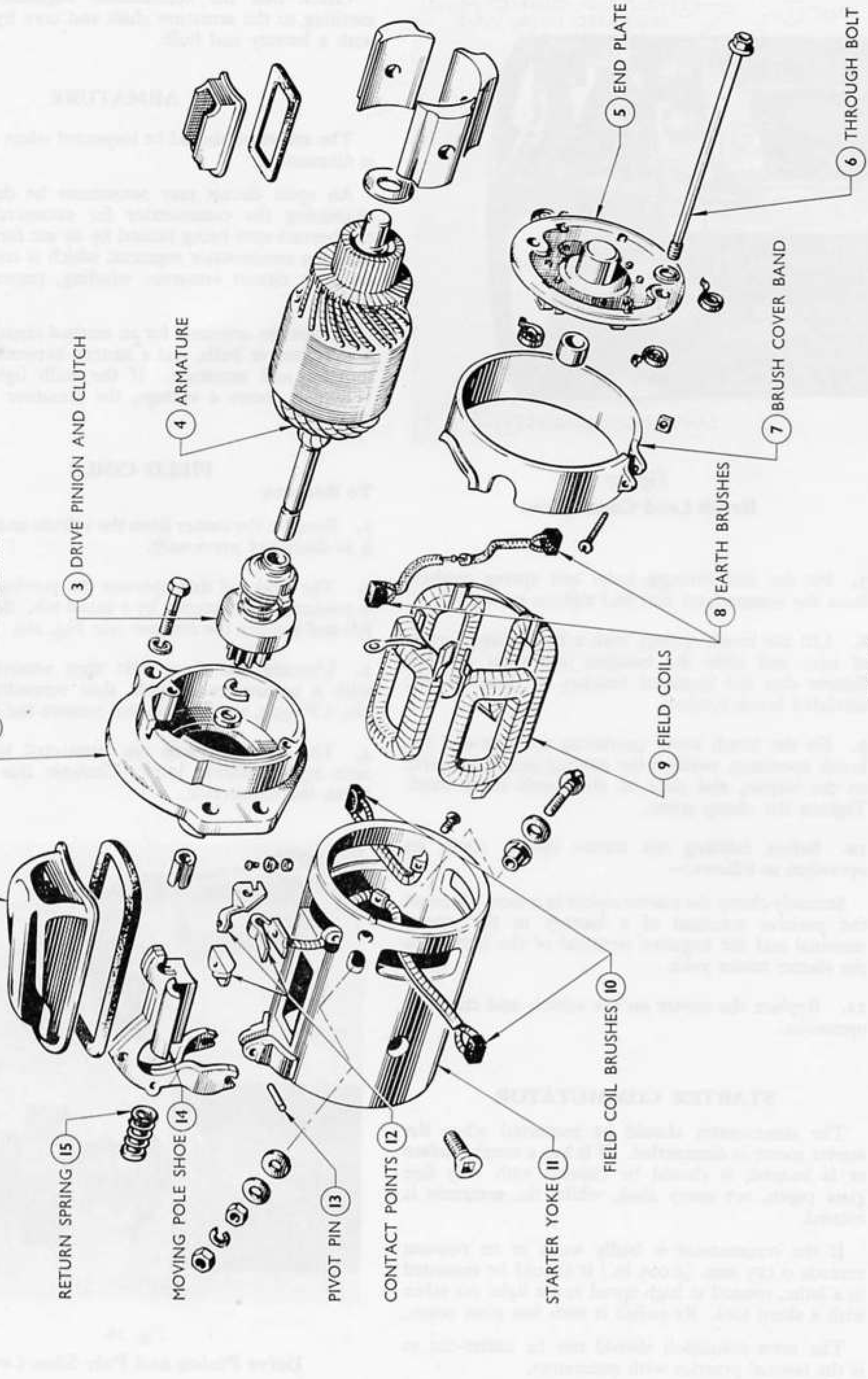


Fig. 19
Moving Pole Shoe Starter Motor

5. Unsweat the starter terminal from the field coils and remove the field coils from the starter.

6. If desired, the insulated brushes can be cut off from the field coils, for re-use.

To Replace

1. Solder the insulated brushes to the field coils as required.

2. Insert the field coils into the starter body, and solder to the starter terminal.

3. Resolder the connection between the field coils and the contact points.

4. Replace the three pole shoes and retain them with their screws. Replace the moving pole shoe field coil and retain it with the metal tab.

Fit the pole shoe expander (Tool No. CP.9509) inside the starter and expand the segments (Fig. 15). Fully tighten the pole shoe screws with the square-headed driver (Tool No. CP.9504).

5. Reassemble the rest of the components as previously described.

6. Before refitting the starter, check its action as previously described.

7. Refit the starter and check its action on the vehicle.

CONTACT POINTS

To Remove

1. Remove and dismantle the starter motor as previously described.

2. Unsweat the connection joining the field coils to the earth brush lead and the contact points (see Fig. 17).

3. Drill out the rivet fixing the contact points to the starter body. Remove the points.

To Replace

1. Install the contact points on the starter body with the insulating strip in position between the two halves of the points.

2. Position the insulation washer on top of the outer points and rivet the assembly to the starter body.

3. Re-solder the field coil terminal to the earth brush lead and the contact points.

4. Reassemble the starter and refit it to the engine.

5. Check the action of the starter on the vehicle.

THE STARTER DRIVE PINION ASSEMBLY

To Remove

1. Remove the starter motor from the vehicle and remove the drive end housing as described previously.

2. Remove the circlip retaining the drive pinion assembly to the armature shaft and then slide off the pinion.

3. Dismantle the drive pinion assembly by removing the circlip behind the spring retainer plate.

NOTE.—Do not grip the one-way clutch in a vice whilst carrying out this operation as it will be damaged.

The drive pinion and clutch are serviced as a complete unit as repairs to the unit are impractical.

To Replace

1. Refit the spring and retainer plate to the drive pinion and clutch unit; secure them with the circlip.

2. Replace the assembly on the armature shaft with the spring retainer nearest the starter, and retain it with the circlip.

3. Ensure that the retaining ring is fitted over the circlip before refitting the drive end housing as described previously.

4. Refit the starter to the vehicle and check its operation.

THE LUCAS DISTRIBUTOR

(Prior to May 1967)

Description

The distributor is mounted on the front of the inlet manifold and is driven by a skew gear from the camshaft. The ignition advance is mechanically controlled, according to engine speed by governor weights inside the distributor body, and according to engine load by vacuum control acting directly on the contact breaker plate, which is movable in relation to the distributor body.

Correction to spark advance is necessary because of the wide variation in engine speed and load under normal operating conditions. When accelerating or climbing hills, the engine load can be high and the range of spark advance required is not necessarily as much as it would be on level ground at an equivalent constant engine speed.

In the vacuum control mechanism, one side of the diaphragm is linked to the breaker plate and the other side is connected by a vacuum line to the carburettor, just above the throttle plate. A spring is fitted between the vacuum side of the diaphragm and the vacuum unit connection.

The vacuum applied at the diaphragm, combined with the action of the diaphragm spring, gives correct spark advance according to the load placed on the engine. Maximum advance is obtained when manifold depression on the vacuum diaphragm is between 43.2 and 45.7 cm. (17 and 18 in.) of mercury. As the vacuum advance does not operate at idling speed, due to the throttle plate being almost closed, a correctly retarded spark is obtained for starting.

The mechanical governor mechanism consists of two weights pivoted so that they move outwards from the distributor shaft as the engine speed rises. As the weights move outwards they turn the cam relative to the distributor shaft and thus advance the firing point. The weights are restrained by two springs of different tension thus giving a progressive advance action, and the amount the weights move outwards is in direct proportion to the distributor shaft speed. To maintain a smooth operation throughout the engine speed range the weights follow the contours of fixed cam segments as they move outwards, and this system has the advantage of reducing the number of moving parts to a minimum.

Remember that, in practice, the total advance provided by the distributor at a constant engine speed is determined by a combination of both engine speed and manifold depression, according to engine load.

Lubrication

The cam (and contact breaker plate pivots and bushings when assembling after overhaul) should be lubricated with petroleum jelly and the cam spindle, governor weights and breaker arm pivot lubricated with engine oil every 8,000 km. (5,000 miles). To lubricate the cam spindle remove the rotor and apply two drops of oil to the centre of the spindle, and to lubricate the governor weights apply a few drops of oil through the apertures in the breaker plate. Only a film of engine oil should be applied to the breaker arm pivot, ensuring that none contaminates the distributor points (see Fig. 20).

CAUTION: Do not over-lubricate any part of the distributor, otherwise lubricant may reach the breaker contacts, resulting in burning and difficult starting.

CONTACT BREAKER POINT ADJUSTMENT

To Adjust

1. **Remove the distributor cap and rotor arm.**

2. **Turn the engine** so that the heel of the contact breaker is on the highest point of the cam.

3. **Slacken the one locking screw** and by means of the slot in the end of the adjustable contact bracket, adjust the points gap to 0.356 to 0.406 mm. (0.014 to 0.016 in.) (see Fig. 21). If necessary, align the breaker points to make full face contact by bending the adjustable contact bracket. Do not bend the breaker arm.

4. **Tighten the screw securing the adjustable contact breaker** in position and re-check the gap.

5. **Refit the rotor arm** squarely on the distributor cam boss with the slot and lug in line. Press the rotor into position so that the lower face abuts the cam.

6. **Check that the high tension leads are securely retained** and then refit the distributor cap.

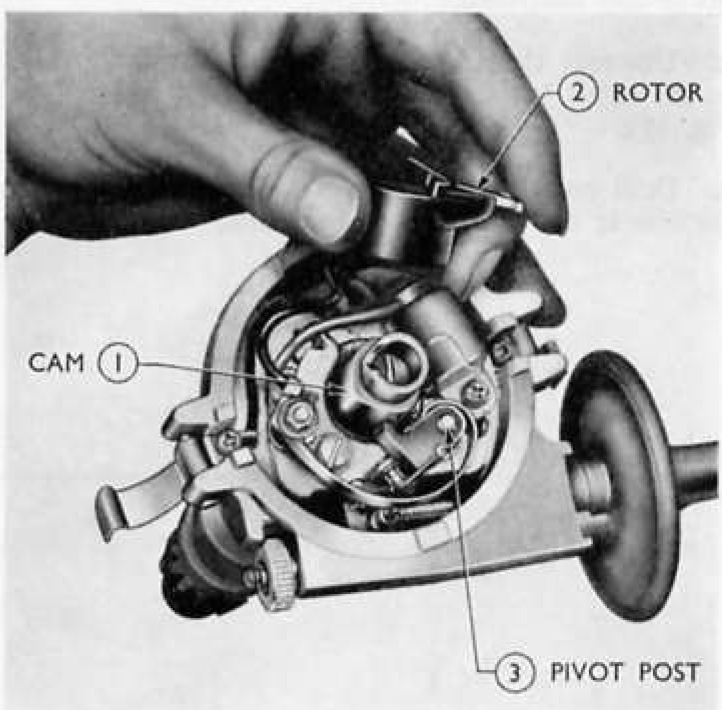


Fig. 20
Distributor Lubrication

To Remove

1. **Detach the distributor cap** and rotor from the distributor cam.

2. **Remove the breaker arm** after unscrewing the terminal nut and detaching the flanged nylon bush, together with the primary and condenser leads. The breaker arm and spring assembly can now be lifted off followed by the fibre washers from the terminal and pivot posts.

3. **Detach the adjustable contact** after removing the one locking screw.

To Replace

Check the condition of the points and fit new parts if the contacts are worn or burnt. Contacts showing a greyish colour and only slightly pitted need not be renewed. If necessary, contacts can be smoothed with a very fine emery stone and then thoroughly cleaned with carbon-tetrachloride.

1. **Secure the adjustable contact to the breaker plate** (see Fig. 22) with one flat washer, lockwasher and screw, but do not tighten the screw fully at this stage.

2. **Locate the fibre washer on the pivot post** and breaker arm terminal post and refit the breaker arm assembly so that the contact points are together (see Fig. 23).

3. **Locate the primary and condenser leads** on the shouldered bush and pass this over the terminal post and through the looped end of the breaker spring. Replace the terminal nut on the post and tighten the nut securely.

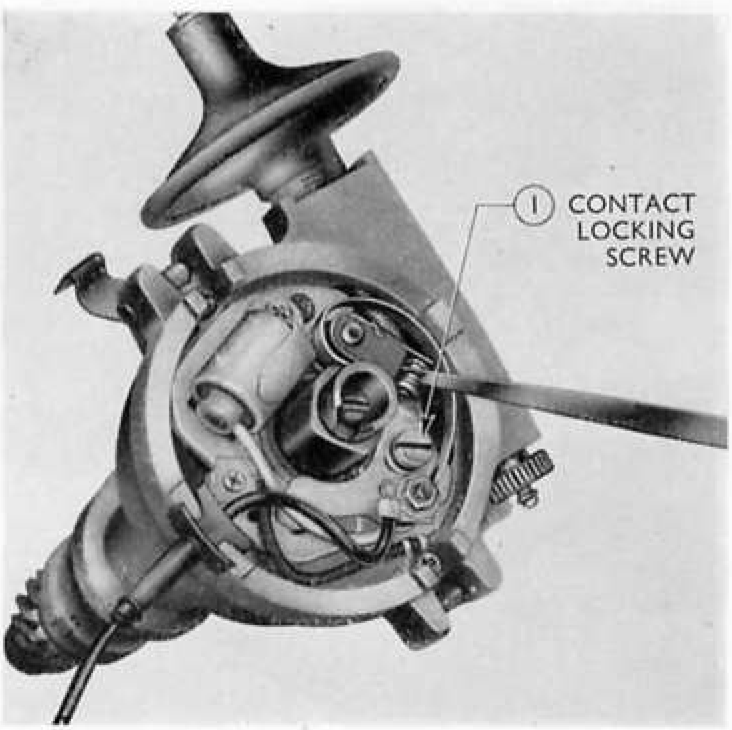


Fig. 21
Checking Contact Breaker Points Gap

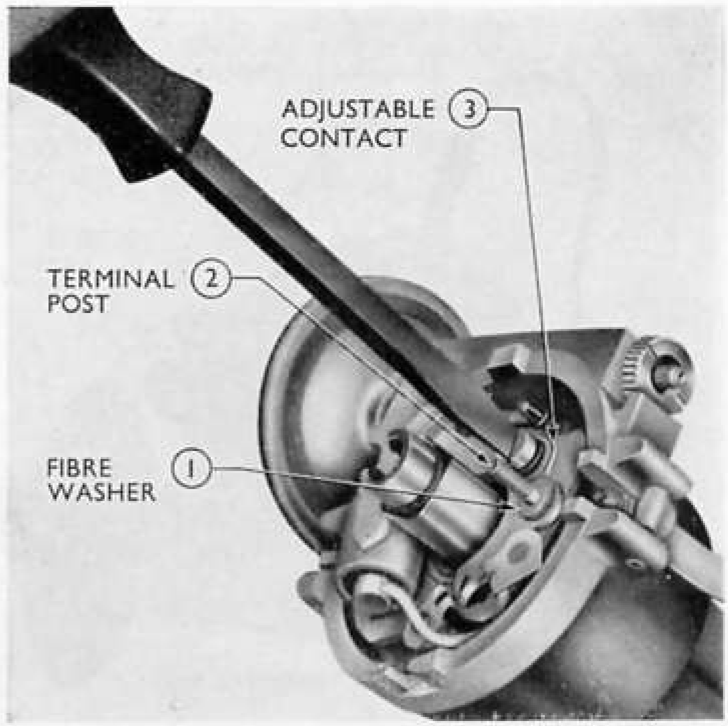


Fig. 22
Replacing Adjustable Contact

4. **Ensure that the contact points abut squarely** and check the breaker arm spring tension with the spring scale (see page 30).

5. **Adjust the contact breaker points** as described previously.

6. **Refit the rotor** squarely on the distributor cam boss with the slot and lug in line. Press the rotor into position so that the lower face abuts the cam. Replace the distributor cap.

DISTRIBUTOR CONDENSER

The condenser is fitted in parallel across the contact breaker points and a short circuit in the condenser will cause ignition failure as the points will no longer interrupt the low tension circuit. In such cases the condenser will have to be renewed.

An open circuit, however, cannot readily be checked without the use of specialised equipment, such as a Diagnosis Test Set. The usual signs of this are excessively burnt contact breaker points and difficult starting.

The capacity of the condenser is 0.18 to 0.22 microfarad.

To Remove the Condenser

1. **Remove the distributor cap and rotor,** unscrew the breaker arm terminal nut and detach the nylon bush, condenser and primary leads.

2. **Unscrew the screw retaining the condenser** to the breaker plate and remove the condenser.

To Replace

1. **Locate the condenser in the slot on the breaker plate** and refit the securing screw and lockwasher.

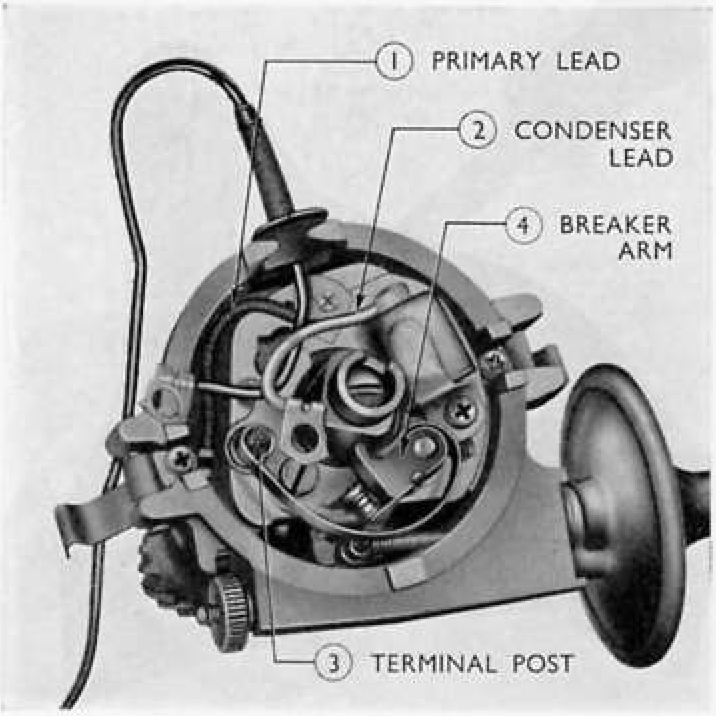


Fig. 23
Fitting the Breaker Arm Assembly

2. Refit the condenser and primary leads on the breaker arm terminal and refit the nylon bush and retaining nut, tightening it securely.

3. Check that there is no possibility of a short circuit between the condenser lead and the breaker plate and refit the rotor and distributor cap.

OVERHAULING THE DISTRIBUTOR

To Remove

1. Disconnect the spark plug leads from the plug terminals, taking care not to pull the leads, but pull the terminals from each plug.

2. Disconnect the low tension lead from the coil primary terminal and the high tension lead from the coil.

3. Disconnect the vacuum line from the distributor vacuum housing.

4. Remove the distributor body clamp bolt and remove the distributor assembly.

To Dismantle (refer to Fig. 25)

1. Remove the distributor cap.

2. Lift the rotor straight up from the distributor cam.

3. Remove the contact breaker points as described on page 25.

4. Unscrew the condenser retaining screw and detach the condenser.

5. Remove and dismantle the contact breaker plate assembly.

(*a*) Unhook the vacuum unit spring from its mounting pin on the breaker plate assembly.

(*b*) Remove the two screws and lockwashers securing the assembly to the distributor body sides (note that the screw opposite to the vacuum unit retains the other end of the contact breaker plate earth wire).

(*c*) Remove the low tension rubber block and wire by sliding the assembly up from its location on the distributor body.

(*d*) Lift out the breaker plate assembly.

(*e*) Twist the breaker plate fully anti-clockwise until the locating peg enters the opening at the end of the slot in the breaker bearing plate. Separate the breaker plate and breaker bearing plate by disengaging the spring clip (see Fig. 24).

6. Unhook the governor weight springs from the pegs on the cam plate.

7. Remove the screw retaining the cam to the distributor shaft, and carefully lift the cam clear of the governor weights.

8. Disconnect the springs from the pegs on the action plate and lift off the weights.

9. If it is necessary to remove the distributor driving shaft due to wear or excessive end-float (see Specification section), drive out the driving gear retaining pin through the collar with a suitable thin punch. Remove the collar and washer.

10. Remove the distributor shaft and action plate from the distributor body together with the nylon spacing washer beneath the action plate.

11. To remove the vacuum unit, detach the small circlip securing the advance adjustment nut and unscrew the nut, when the vacuum unit may be pulled out of the distributor body.

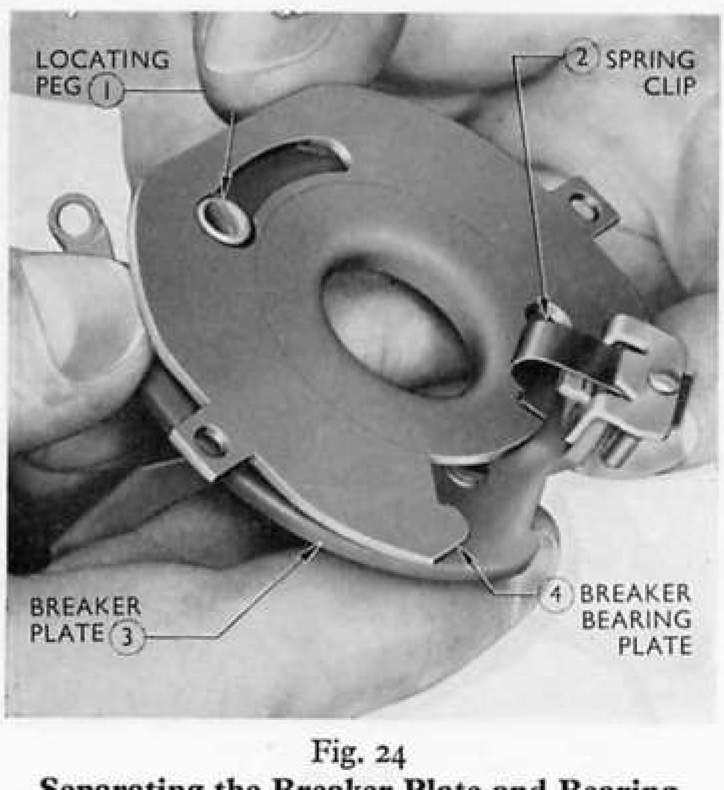


Fig. 24
Separating the Breaker Plate and Bearing Plate

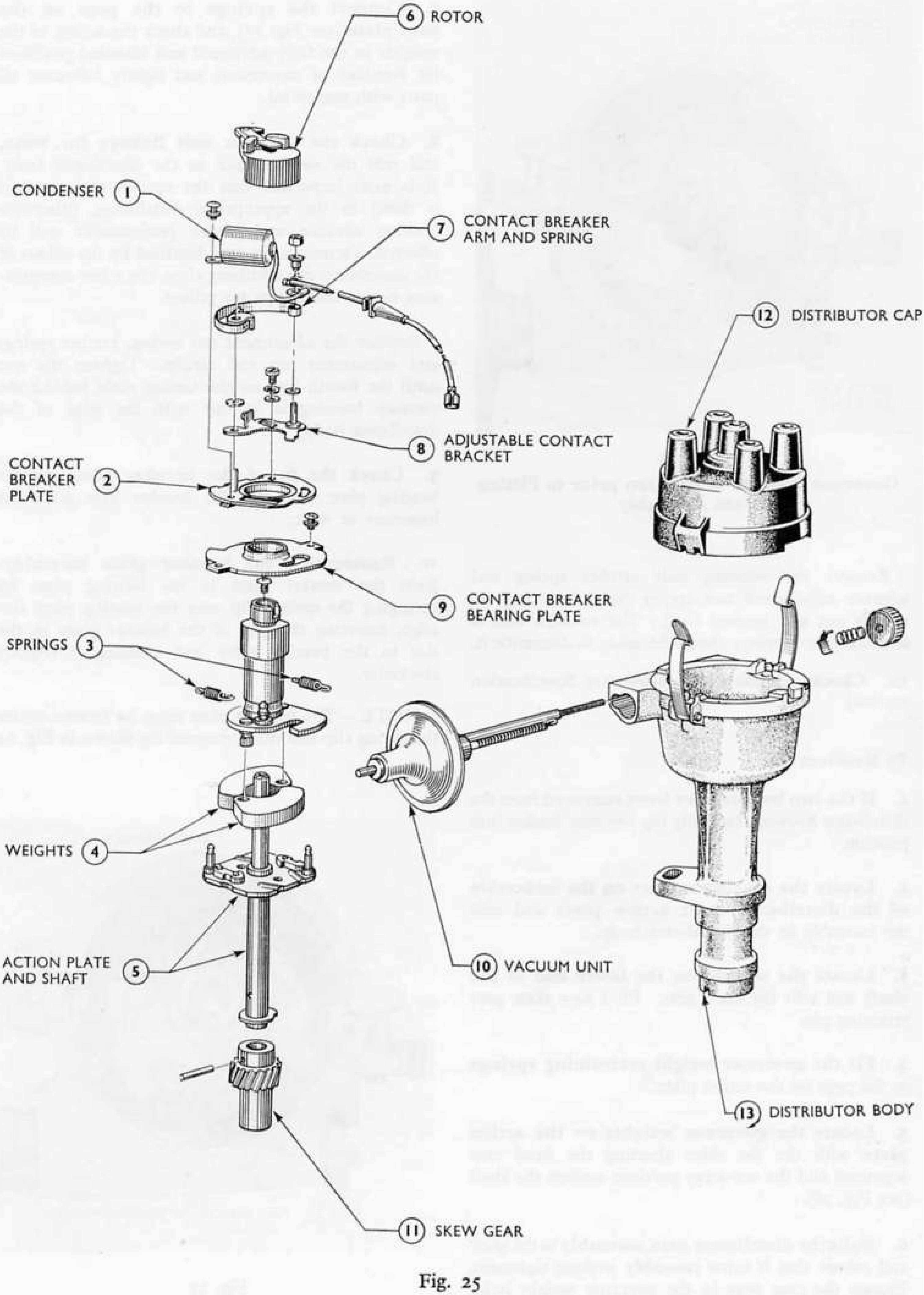


Fig. 25
Distributor—Exploded View

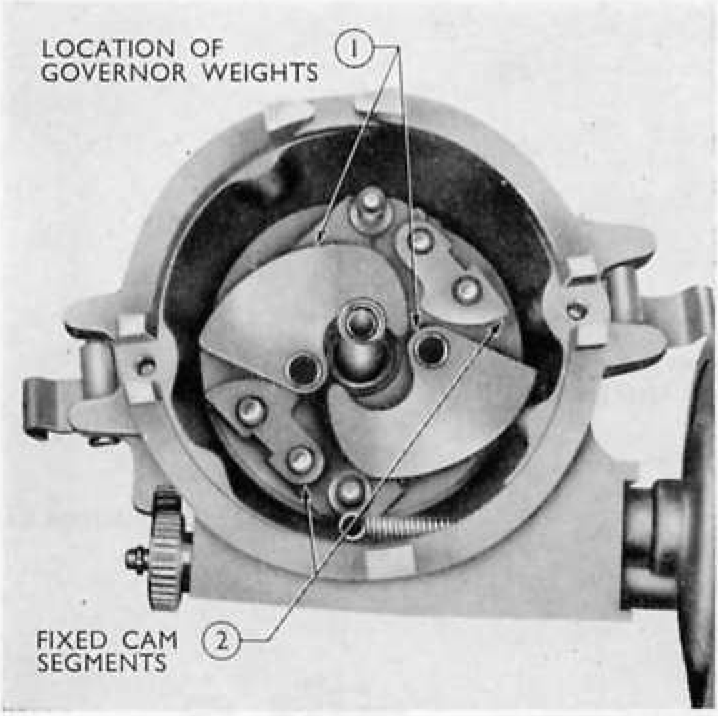


Fig. 26
Governor Weights in Position prior to Fitting Cam Assembly

Remove the vacuum unit ratchet spring and advance adjustment nut spring (take care they do not fly out and become lost). The vacuum unit is sealed and no attempt should be made to dismantle it.

12. Check all parts for wear (see Specification section).

To Reassemble

1. If the two bushes have been removed from the distributor housing, carefully tap two new bushes into position.

2. Locate the spacing washer on the underside of the distributor shaft action plate and refit the assembly in the distributor body.

3. Locate the washer on the lower end of the shaft and refit the skew gear. Fit a new skew gear retaining pin.

4. Fit the governor weight restraining springs to the pegs on the action plate.

5. Locate the governor weights on the action plate with the flat sides abutting the fixed cam segments and the cut-away portions nearest the shaft (see Fig. 26).

6. Refit the distributor cam assembly to the shaft and ensure that it turns smoothly without tightness. Engage the cam pegs in the governor weight holes and refit the securing screw.

7. Connect the springs to the pegs on the cam plate (see Fig. 27), and check the action of the weights in the fully advanced and retarded positions for freedom of movement and lightly lubricate all parts with engine oil.

8. Check the vacuum unit linkage for wear, and refit the vacuum unit to the distributor body. It is most important that the correct vacuum unit is fitted to the appropriate distributor, otherwise ignition advance and engine performance will be affected. Vacuum units are identified by the colour of the distributor cap retaining clips. On a low compression engine these clips are yellow.

Replace the adjustment nut spring, ratchet spring, and adjustment nut and circlip. Tighten the nut until the fourth line on the timing scale behind the vacuum housing is in line with the edge of the distributor body.

9. Check the fit of the breaker plate on the bearing plate and also the breaker arm pivot for looseness or wear.

10. Reassemble the breaker plate assembly. Refit the breaker plate to the bearing plate by springing the spring clip over the bearing plate slot edge, inserting the peg of the breaker plate in the slot in the bearing plate and twisting it slightly clockwise.

NOTE.—The bearing plate must be located under the spring clip and the horizontal lug shown in Fig. 24

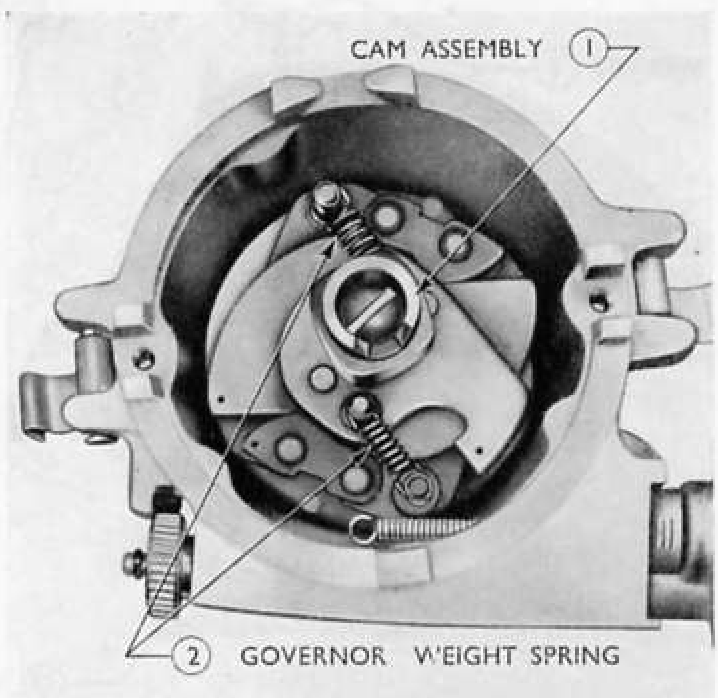
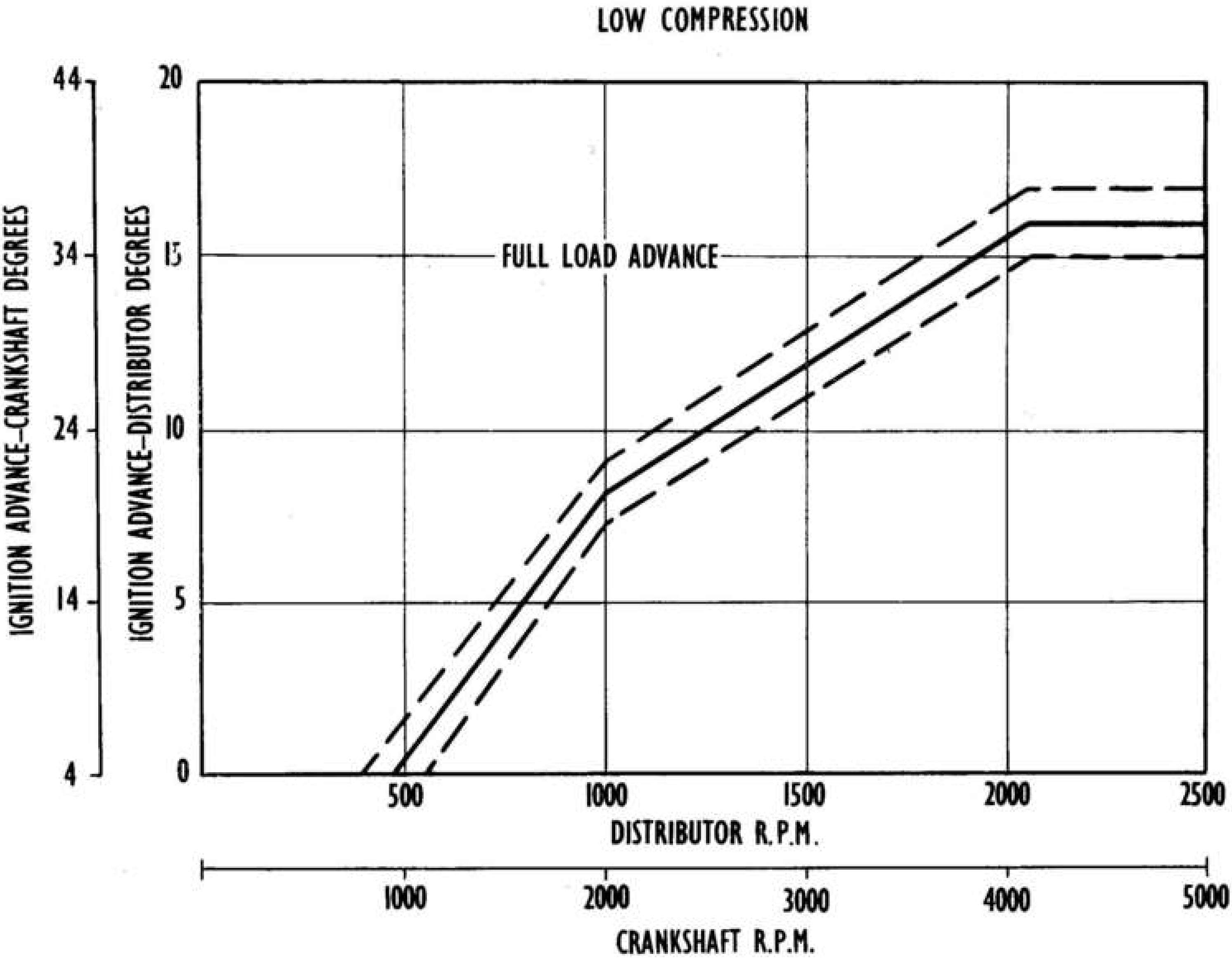


Fig. 27
Cam Assembly in Position



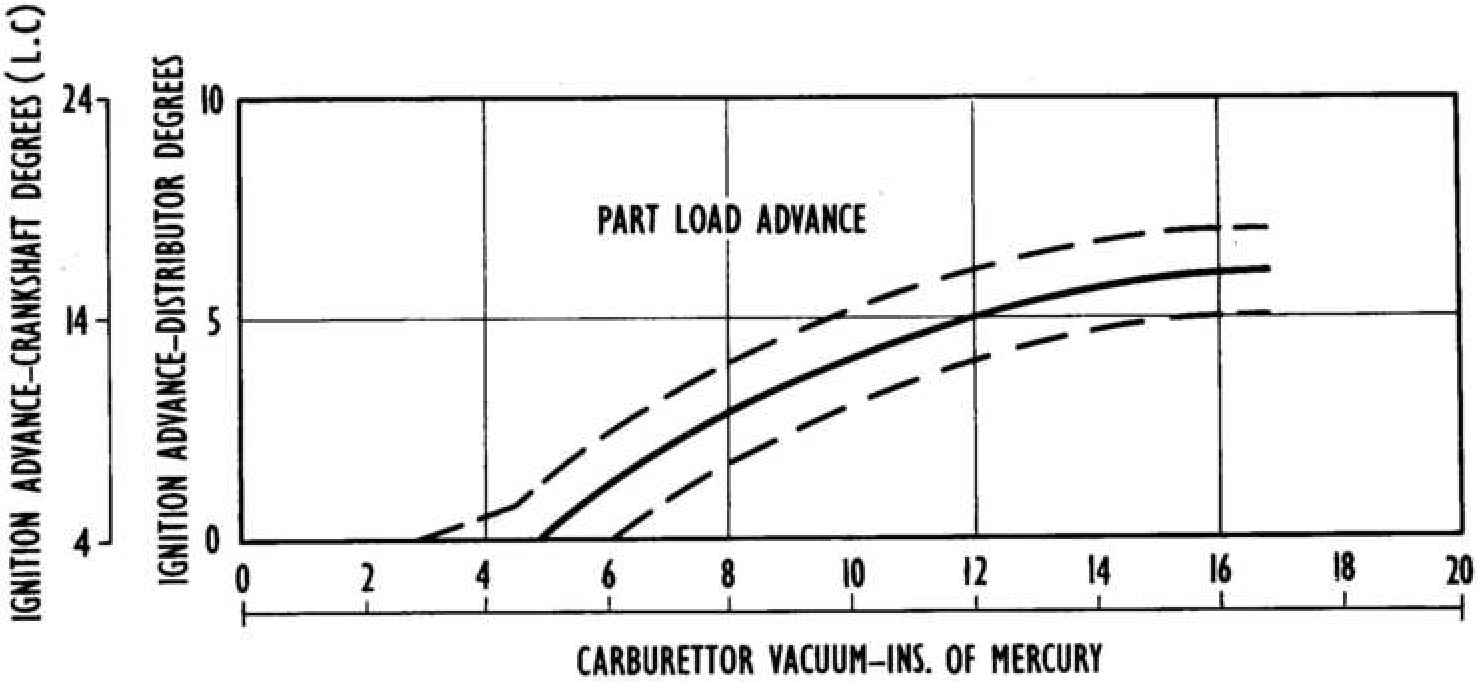


Fig. 28
Mechanical and Vacuum Advance Curves

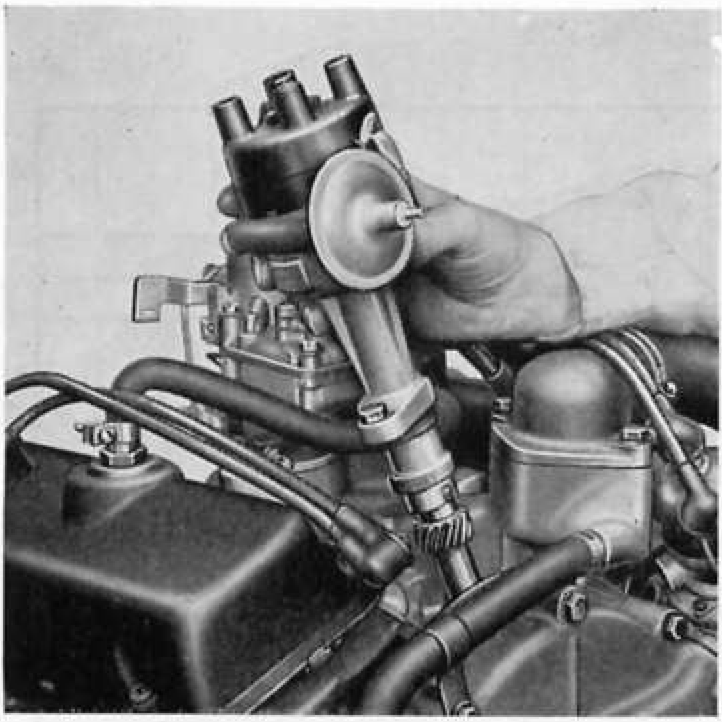


Fig. 29
Locating the Distributor on the Engine

11. **Locate the contact breaker plate assembly in the distributor body,** securing the end of the vacuum unit spring to the post on the breaker plate lug. Secure the plate with two screws and lockwashers to the distributor body, noting that the screw opposite to the vacuum unit retains one end of the contact breaker plate earth wire.

12. **Check the condenser and renew if necessary.** Locate the condenser on the breaker plate and refit the securing screw.

13. **Replace the contact points,** as described on page 16, and initially set the gap to 0.356 to 0.406 mm. (0.014 to 0.016 in.).

Rotate the cam to close the points, then measure the contact breaker arm spring tension by pressing the hook of the scale CP.9501 against the breaker arm, adjacent to the contact point.

The reading should be taken just as the points separate and should be between 510 to 680 gms. (18 to 24 oz.).

14. **Replace the rotor,** locating the tongue in the slot in the distributor cam.

To Replace

1. **Set the engine,** with the upper timing mark on the timing cover in line with the notch in the crankshaft pulley as No. 1 piston comes up on the compression stroke (see Fig. 30).

2. **Line up the recessed end** of the skew gear retaining pin with the groove on the lower part of the distributor body. Position the distributor on the engine so that the vacuum unit faces forward. As the skew gears mesh the rotor arm will rotate until it points towards the H.T. contact in the distributor cap. Verify that this does happen by replacing the cap and noting the position of the rotor arm in relation to No. 1 H.T. contact.

3. **Replace the distributor cap and leads** securing the cap with the two retaining clips.

4. **Reconnect the leads to the spark plug terminals** in the correct firing order (1, 3, 4, 2); noting the direction of rotation of the rotor arm. Connect the high tension lead to the coil and the low tension wire to the coil.

5. **Reconnect the vacuum line to the vacuum housing connector.**

6. **Re-time the ignition** as described below.

IGNITION TIMING

General

(*a*) Prior to adjusting the ignition timing, check the fuel octane rating that is to be used with this engine. Establish that the correct distributor is fitted for this combination of compression ratio and fuel.

(*b*) The static advance of 6° before T.D.C. is "built in" to the engine and when No. 1 cylinder is on the compression stroke and the notch on the crankshaft pulley is midway between the upper and lower timing marks on the timing cover (see Fig. 30) the crankshaft is at the static advance setting and no further adjustment is required at this stage, see operation 5.

(*c*) All reference to degrees (advance or retard) on the distributor are in terms of crankshaft degrees as in 'b' above.

(*d*) If the vehicle is normally operated at a high altitude the distributor settings on the graphs (see Fig. 28) may be **advanced** by 4° (one division on the ignition timing scale).

A. To Adjust the Timing without the use of a Timing Light

1. **If the engine has not been previously set, turn it with No. 1 piston coming up to T.D.C. on the compression stroke** (this can be checked by removing No. 1 spark plug and feeling the pressure developed in the cylinder).

Continue turning the engine until the notch on the crankshaft pulley is midway between the upper and lower timing marks on the timing cover (see Fig. 30).

This will give the initial timing setting of 6° B.T.D.C. (static advance).

2. Check that the fourth line on the ignition timing scale, counting from the vacuum diaphragm housing, is in line with the edge of the distributor body.

At this fourth graduated line the distributor is still at the 6° static advance position. If the octane number of the fuel cuts the horizontal line on the ignition advance graph only correct for high altitudes, see operation 'd' above.

If the octane rating of the fuel falls on the 'slope' of the ignition advance graph **retard** as indicated by the graph (one graduation or division on the distributor is equal to 4°).

Remove the distributor cap.

3. Slacken off the distributor body clamp bolt and move the body until the contact breaker points are just opening when the rotor is adjacent to No. 1 H.T. contact in the distributor cap. Note direction of rotation of arm.

4. Tighten the distributor body clamp bolt and replace the distributor cap.

5. A slight readjustment to the distributor may be necessary and should be carried out on the road in the following manner:—

(*a*) Warm up the engine to normal operating temperature.

(*b*) Accelerate in top gear on wide throttle opening from 32 k.p.h. (20 m.p.h.) to 72 k.p.h. (50 m.p.h.).

(*c*) If heavy pinking occurs, **retard** the ignition (see Fig. 28) until a trace pink can just be heard under these conditions of acceleration.

B. To Adjust the Timing using a Timing Light

1. Complete operations Nos. 1 to 3 inclusive from the previous section, A.

Fig. 30
Correct Engine Timing Position

Octane Number	1662 c.c. L. C. Engine	2000 c.c. L. C. Engine
89	8°	6°
86	4°	4°
80	0°	—2°

Fig. 31
Octane Rating, Compression Ratio and Distributor Setting Chart

2. Replace the distributor cap.

3. Connect the two main leads of the timing light to the battery, using the clips provided. The positive lead clip has a red outer covering and the negative lead clip has a black covering. Connect the third lead, which has a smaller clip, to the L.T. wire from the distributor.

4. Check that the notch on the crankshaft pulley is visible and mark with chalk or paint if necessary.

5. Disconnect the vacuum pipe line and start the engine, allowing it to idle (approx. 550 r.p.m.).

6. Point the timing light at the timing indicator. Check that the upper indicator and the notch on the pulley are in line (see Fig. 30).

If the notch of the pulley is above the indicator, the engine is too far retarded and the distributor body should be turned anti-clockwise slightly to advance the ignition.

Should the notch be below the indicator, the distributor body should be turned clockwise slightly to retard the ignition.

7. Securely tighten the distributor body clamp bolt after the adjustment has been made.

Reconnect the vacuum pipe line.

The operation of the governor weights may be checked by opening and closing the throttle. As the throttle is gradually opened, the notch should move away from the indicator against the direction of engine rotation; and as the throttle is closed the notch will move with the direction of engine rotation.

Any tendency for erratic advance shown by the notch jumping suddenly away from the indicator shows that the governor weights are binding, or that the springs are weak.

NOTE.—As in "A" a slight readjustment to the distributor may be necessary to suit the particular type of fuel in use and this setting should be determined after checking the timing as described in operation 5.

THE AUTOLITE DISTRIBUTOR

(May 1967 onwards)

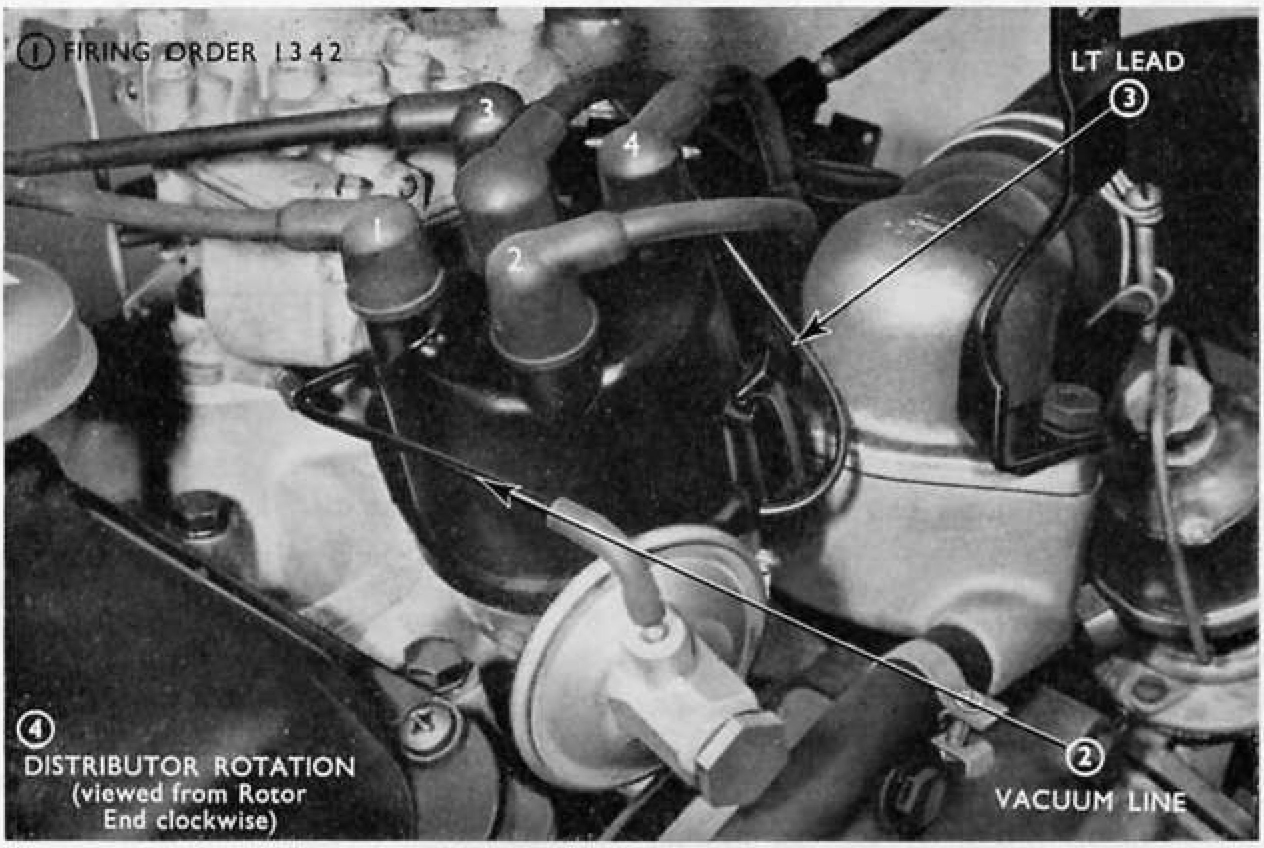


Fig. 32
The Distributor in Situ

A new type of distributor, Part No. C6CH/C8CH-12100-B low compression, (C6CH/C8CH-12100-A high compression) is fitted in production to vehicles manufactured from May 1967 onwards, and is available in both the 1.7 and 2.0 litre engines.

This new distributor is readily identified from its former counterpart by the vacuum advance unit which is mounted on a bracket attached to the distributor body instead of the mounting being cast integrally with the body. There is no advance and retard adjusting screw, and the vacuum line connects to the side of the advance unit housing instead of the end.

The distributor is mounted on the front of the engine between the cylinder heads and is driven by a skew gear from the camshaft. The ignition advance is mechanically controlled, according to engine speed by governor weights within the distributor body, and according to the engine load by a vacuum control acting directly on the contact breaker plate which has a limited arc of movement in relation to the distributor body.

Correction to the spark advance is necessary because of the wide variation in engine speed and load under normal operating conditions. When accelerating or climbing hills, the engine load can be high and the range of spark advance is not necessarily as much as it would be on level ground at an equivalent constant engine speed.

The mechanical advance mechanism consists of two weights pivoted so that they move outwards from the distributor shaft as the engine speed rises. As the weights move outwards they turn the cam relative to the distributor shaft and thus advance the firing point. The weights are restrained by two springs of different tension thus giving a progressive advance action, and the amount the weights move outwards is in direct proportion to the distributor shaft speed.

To maintain a smooth operation throughout the engine speed range the contoured side of the cam plate follows the contours of the weights as they move outwards, and this system has the advantage of reducing the number of moving parts to a minimum.

The maximum advance or radial movement is limited by a stop on the action plate working within a slot in the cam spring plate. Two slots are, in fact, provided so that the cam may be withdrawn, turned 180° and replaced, giving in fact two alternative limits of advance for different applications. It will be seen that these are marked "14R" and "16.5R" adjacent to the slots on either side of the cam base. The number indicating the degree of advance and the letter R right-hand (clockwise) rotation, when viewed from the rotor end.

The distributor is set up in production on the Transit with the stop engaged in the 16.5R position for both high and low compression engines **and on no account must be altered for this vehicle.**

The vacuum advance unit consists of a diaphragm assembly mounted on a bracket attached to the distributor body. The diaphragm is connected to the contact breaker plate by a link and is open to the atmosphere on this side. The other side of the diaphragm has a spring and stop, to control the diaphragm movement, and is connected to the carburettor by a vacuum line. This vacuum line enters the carburettor barrel at a point just above the edge of the throttle plate, and is only sensitive to manifold depression when the throttle plate is opened past the idling position.

The vacuum applied at the diaphragm, combined with the action of the diaphragm spring, gives correct spark advance according to the load placed on the engine. Under part load operation the manifold vacuum is high and the vacuum advance is correspondingly high. At full load there is little or no manifold vacuum and therefore little or no vacuum advance. As the vacuum advance does not operate at idling speed, due to the throttle plate being almost closed, a correctly timed spark is obtained for starting.

Remember that, in practice, the total advance provided by the distributor at a constant engine speed is determined by a combination of both engine speed and manifold depression, according to the engine load.

Lubrication

The cam, weight pivot pins, and cam spindle are lubricated with a suitable high melting point grease. When renewing the contact breaker points assembly, apply a smear of this grease to the cam. Every 8,000 kms. (5,000 miles) remove the rotor and apply a drop or two of engine oil to the felt wick situated within the end of the spindle.

CAUTION: Do not over-lubricate any part of the distributor, otherwise lubricant may reach the breaker contacts, resulting in burning and difficult starting.

CONTACT BREAKER POINT ADJUSTMENT

The contact breaker points should be checked and adjusted every 8,000 kms. (5,000 miles).

Check the condition and alignment (see Fig. 34) of the points and fit a new set if the contacts are worn or burnt. Contacts showing a greyish colour and only slight signs of pitting need not be renewed. Fit a new contact breaker point assembly if the points are badly burnt or excessive metal transfer has occurred. Metal transfer is considered excessive when it equals or exceeds the gap setting of 0.64 mm. (0.025 in.).

Points which have become dirty or contaminated with oil or grease should be cleaned with a stiff brush and carbon tetrachloride.

To Adjust

1. Unclip and detach the distributor cap and remove the rotor arm.

2. Turn the engine so that the heel of the contact breaker arm is on the highest point of the cam.

3. Slacken the two locking screws on the contact breaker bracket and, by means of the vee notch in this component and the adjacent slot in the breaker plate, insert the blade of a screwdriver and adjust the points gap to 0.64 mm. (0.025 in.) (see Fig. 33).

NOTE.—When measuring used points with a feeler gauge, it must be remembered that a pit is usually formed in the face of one point and a corresponding pip on the other. The position of these varies with the capacity of the condenser and has no adverse effect on the functioning of the distributor, as the gap remains practically constant. However, points gap adjustment must be made outside these formations to achieve a correct reading. Under these conditions an oscilloscope or dwell meter should be used to check the points adjustment.

The correct dwell angle is between 38° and 42° at 1,000 rev./min. (crankshaft) with the vacuum pipe disconnected.

Remember that a smaller dwell angle than specified in the test values means too large a breaker point gap, whereas a larger dwell angle means too small a gap.

4. Tighten the screws securing the adjustable contact bracket in position and re-check the gap.

5. Refit the rotor arm squarely on the distributor cam spindle with the slot and lug in line. Press the rotor into position so that the lower face abuts the cam.

6. Check that the high tension leads are securely retained and then refit the distributor cap.

Fig. 33
Adjusting the Contact Breaker Points

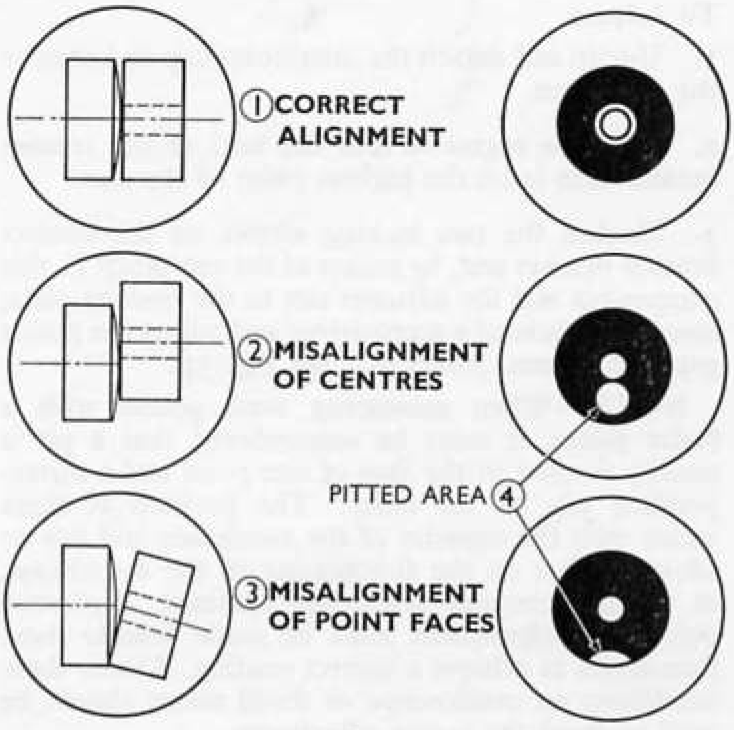


Fig. 34
Contact Breaker Points Alignment

To Remove

1. Unclip and detach the distributor cap and withdraw the rotor arm from the distributor cam spindle.
2. Slacken the terminal screw and detach the primary and condenser leads.
3. Undo the two locking screws and lift out the contact breaker point assembly.

To Replace

1. The contact set is pre-assembled and a new component requires no alignment nor tension check. Position the new set on the breaker plate ensuring that the contact breaker pivot engages with the hole in the breaker plate, and nip (but do not tighten) the locking screws.
2. Assemble the primary and condenser leads to the terminal screw.
3. Adjust the point contact gap to 0.635 mm. (0.025 in.) or to give a dwell angle of 38° to 42° as described previously.

CONDENSER

The condenser is fitted in parallel across the contact breaker points and a short circuit in the condenser will cause ignition failure as the points will no longer interrupt the low tension circuit. In such cases the condenser will have to be renewed.

An open circuit, however, cannot readily be checked without the use of specialised equipment, such as the Diagnosis Test Set. The usual signs of this are excessively burnt contact breaker points and difficult starting.

The capacity of the condenser is 0.21 to 0.25 microfarad.

To Remove

1. Remove the distributor cap and rotor.
2. Slacken the terminal screw and detach the condenser lead.
3. Unscrew the screw retaining the condenser to the breaker plate and remove the condenser.

To Replace

1. Locate the condenser in the hole in the breaker plate and refit the securing screw.
2. Refit the condenser lead to the terminal screw and tighten it securely.
3. Check that there is no possibility of a short circuit between the condenser lead and the breaker plate and refit the rotor and distributor cap.

VACUUM DIAPHRAGM UNIT

To Remove

1. Remove the distributor cap and rotor and disconnect the vacuum line from the vacuum diaphragm.
2. Remove the E-clip retaining the diaphragm pull rod pin to the breaker plate assembly.
3. Remove the two screws that secure the lower breaker plate to the distributor body and lift out the plate assembly.
4. Remove the two diaphragm assembly retaining screws and lift off the diaphragm assembly.
5. Holding the diaphragm by its hexagonal shank in a vice unscrew the 19.0 mm. (¾ in.) plug on the end of the assembly and remove the copper sealing ring. Extract the shim washers, spring and vacuum stop.

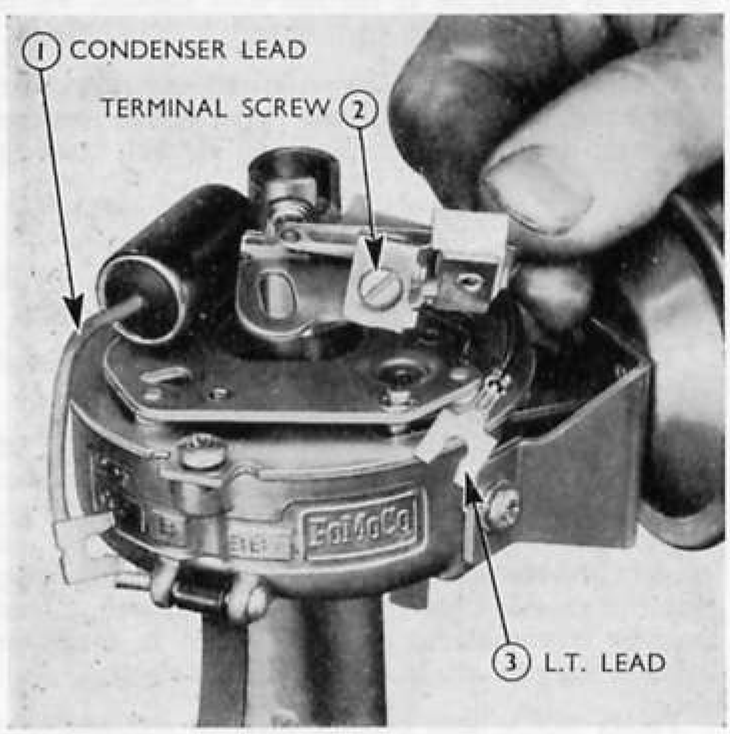


Fig. 35
Replacing the Contact Breaker Points Assembly

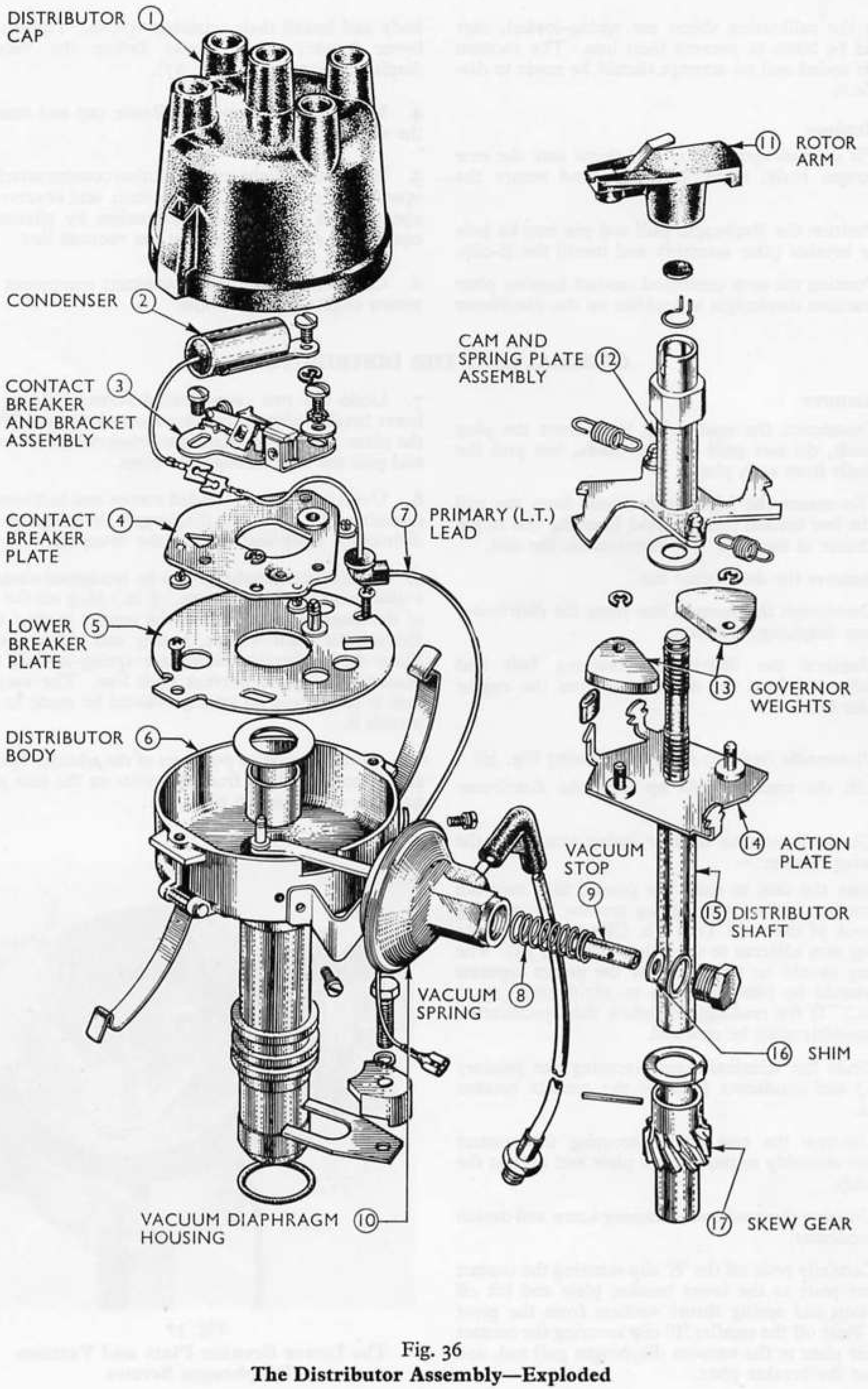


Fig. 36
The Distributor Assembly—Exploded

Since the calibrating shims are spring-loaded, care should be taken to prevent their loss. The vacuum unit is sealed and no attempt should be made to dismantle it.

To Replace

1. Fit original spring, stop and shims into the new diaphragm body, assemble washer and secure the plug.

2. Position the diaphragm pull rod pin into its hole in the breaker plate assembly and install the E-clip.

3. Position the now combined contact breaker plate and vacuum diaphragm assemblies on the distributor body and install their retaining screws. Tighten the lower breaker plate screws before the vacuum diaphragm screws (see Fig. 37).

4. Install the rotor and distributor cap and connect the vacuum line.

5. With timing light and revolution counter attached, operate the engine at 1,000 rev./min. and observe the operation of the vacuum mechanism by alternately connecting and disconnecting the vacuum line.

6. Connect vacuum line, disconnect equipment and return engine setting to idle.

OVERHAULING THE DISTRIBUTOR

To Remove

1. Disconnect the spark plug leads from the plug terminals, **do not pull on the leads,** but pull the terminals from each plug.

2. Disconnect the high tension lead from the coil and the low tension primary lead from the coil to the distributor at the C.B. +ve terminal on the coil.

3. Remove the distributor cap.

4. Disconnect the vacuum line from the distributor vacuum diaphragm housing.

5. Unscrew the distributor retaining bolt and carefully withdraw the distributor from the engine cylinder block.

To Dismantle (refer to exploded drawing Fig. 36)

1. Lift the rotor straight up from the distributor cam.

2. Check the contact breaker spring tension in the following manner:—

Rotate the cam to close the points, then measure the contact breaker arm spring tension by pressing the hook of the scale Tool No. CP.9501 against the breaker arm adjacent to the points (see Fig. 39). The reading should be taken just as the points separate and should be between 481.9 to 567.0 gms. (17 to 21 ozs.). If the readings are below this specification the assembly must be renewed.

3. Undo the terminal screw securing the primary (L.T.) and condenser leads to the contact breaker points.

4. Unscrew the two screws securing the contact breaker assembly to the breaker plate and lift out the assembly.

5. Unscrew the condenser retaining screw and detach the condenser.

6. Carefully prise off the 'E' clip securing the contact breaker plate to the lower breaker plate and lift off the plain and spring thrust washers from the pivot post. Prise off the smaller 'E' clip securing the contact breaker plate to the vacuum diaphragm pull rod, and lift out the breaker plate.

7. Undo the two cross-headed screws holding the lower breaker plate to the distributor body and lift off the plate. Carefully detach the primary lead grommet and pull the lead through the plate.

8. Undo the two pan-headed screws and lockwashers retaining the vacuum diaphragm housing to the distributor body and remove the assembly.

9. Holding the diaphragm by its hexagonal shank in a vice unscrew the 19.0 mm. (¾ in.) plug on the end of the assembly and remove the copper sealing ring. Extract the shim washer, spring and vacuum stop. Since the calibrating shims are spring-loaded, care should be taken to prevent their loss. The vacuum unit is sealed and no attempt should be made to dismantle it.

10. Note the relative positions of the advance springs and disconnect them from the posts on the cam plate and tabs on the action plate.

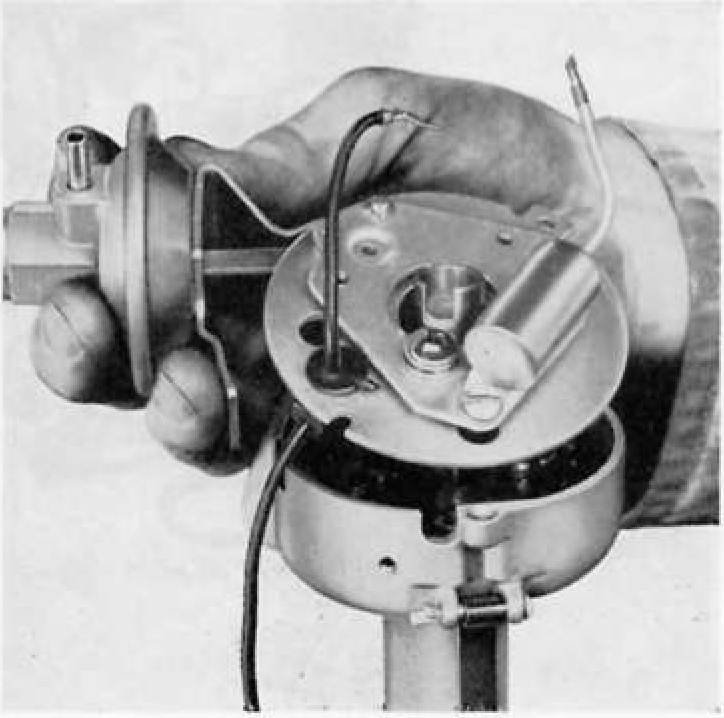


Fig. 37

The Lower Breaker Plate and Vacuum Diaphragm Screws

11. Lift out the felt wick from the counter-bored end of the cam, and extract the wire circlip located within this counterbore around the distributor shaft. Slide off the cam from the distributor shaft.

12. Remove the 'E' clips retaining the governor weights to the action plate.

13. Check all parts for wear, reference should be made to the Specification section, and replace all worn components.

14. If, due to wear, it is necessary to remove the shaft or the thrust washers from the body proceed as follows:—

(*a*) Drift out the 3.18 mm. ($\frac{1}{8}$ in.) roll pin and slide the skew gear, thrust washer, and wave washer from the distributor shaft.

(*b*) Draw out the shaft from the body and remove the washers from beneath the action plate.

To Replace the Skew Gear

When fitting a new skew gear on an old shaft, or a new shaft with the original gear, a new roll pin hole will have to be drilled at right angles to the original roll pin hole and at the same time obtain the correct end-float. This is achieved by assembling the shaft in the body with the correct replacement thrust washers in their top and bottom respective positions, and effecting the desired end-float by temporary shimming, pre-loading the assembled shaft and drilling in the same operation. It will be noted that replacement skew gears are supplied with a pilot drilling for the roll pin hole.

Replacement of gear on original or new shafts

1. Assemble the washers on shaft in their correct sequence beneath the action plate and insert the shaft into the distributor body.

2. Obtain or make a 0.127 mm. (0.005 in.) shim as per illustration.

3. Assemble a new wave washer, thrust washer and the 0.127 mm. (0.005 in.) shim on the distributor shaft (see Fig. 38).

4. When using original shafts, position the new skew gear on the shaft so that the pilot hole is at right angles to the original hole.

5. Using a suitable screw compression clamp, press gear onto shaft until spring washer is compressed and all slack is removed. **Do not over-tighten.**

6. Position the assembly carefully in Vee blocks under a press drill. Drill a 3.18 mm. ($\frac{1}{8}$ in.) hole through gear and shaft using the pilot hole as a guide. When using the original gear with a new shaft, drill the roll pin hole through the gear at right angles to the original hole.

7. Remove drill and install a new roll pin.

8. Release the compression of the clamp and extract the temporary 0.127 mm. (0.005 in.) shim.

To Reassemble

1. Locate the governor weights on the action plate with the flat sides adjacent to the distributor shaft (see Fig. 40).

2. Refit the cam on the distributor shaft with the advance stop on the action plate within the segment slot marked 16.5R.

3. Refit the wire circlip on the distributor shaft within the cam counter-bore and replace the felt oil wick.

4. Reconnect the advance springs to the posts on the cam plate and tabs on the action plate in their original positions (see Fig. 40).

NOTE.—The primary spring tab may be marked with a green paint mark for L.C. The primary spring has a larger coil diameter and a shorter length than the secondary spring.

5. Fit the original spring, stop and shims into the diaphragm body, assemble washer and secure the plug.

6. Insert the primary lead into the lower breaker plate with the breaker terminal connection upwards and locate the lead by pushing the grommet home in the plate.

7. Locate the contact breaker plate over the pivot pin in the lower braker plate, replace the wave washer, plain washer and secure with the 'E' clip.

8. Fit the diaphragm pull rod pin into its hole in the breaker plate assembly and install the E-clip.

9. Position the now combined breaker plate and diaphragm assemblies on the distributor body and install their retaining screws. Tighten the lower breaker plate screws before the vacuum diaphragm screws.

Fig. 38
Setting the Distributor Shaft Pre-Load

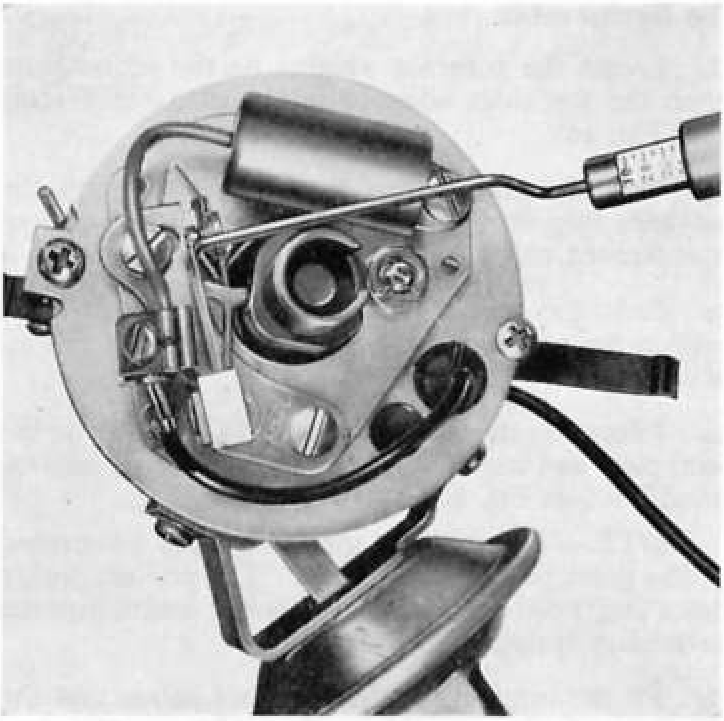


Fig. 39
Checking Contact Breaker Spring Tension

10. Position a new contact breaker and bracket assembly on the breaker plate ensuring that the contact breaker pivot engages with the hole in the breaker plate. Adjust the point contact gap to 0.64 mm. (0.025 in.) as previously outlined within this section.

11. Replace the condenser after checking and re-connect the condenser and primary leads to the terminal screw on the contact breaker.

12. Replace the rotor, locating the tongue in the slot at the top of the distributor cam.

13. Test the distributor and "set-up" if necessary on a "Diagnosis Test Set" or on a suitable tester.

TESTING AND "SETTING-UP" THE DISTRIBUTOR ASSEMBLY

The following instructions indicate the general principles to be followed for testing the distributor on a tester. The method of testing, however, may vary for machines of different manufacture. For specific instructions refer to the equipment manufacturer's handbook.

1. Mount the distributor on the tester, using an adaptor shaft, where necessary, to connect the drive from the machine to the distributor gear. Check that the distributor is free to rotate and that the adaptor shaft has the correct end-float, usually 1.59 mm. ($\frac{1}{16}$ in.).

2. Make the necessary electrical connections and zero the instrument if required.

3. Dwell angle

(*a*) Turn the cylinder selector to the figure corresponding to the number of lobes on the cam of the distributor being tested, in this case four.

(*b*) Turn the test selector switch to the cam angle position and operate the distributor at approximately 1,000 rev./min. (crankshaft).

(*c*) Adjust the distributor breaker point gap to a dwell angle of 42°.

(*d*) Increase the speed up to a maximum of 5,000 rev./min. (crankshaft) and check the dwell reading, which must be between 38° and 42°. If the reading changes more than 3° check for a worn distributor shaft or worn bushings.

4. Mechanical operation

(*a*) Make the necessary connections for the stroboscopic timing light or sparking protractor, refer to equipment manufacturer's handbook.

(*b*) Adjust the speed control to vary the distributor speed between 400 and 5,000 rev./min. (crankshaft). Erratic or thin faint flashes of light preceding the regular flashes as the speed of rotation is increased can be due to weak breaker arm spring tension.

(*c*) Operate the distributor at approximately 2,500 rev./min. (crankshaft).

(*d*) Move the protractor scale with the adjustment control so that the zero degree mark on the scale is opposite one of the neon flashes. The balance of all the flashes should come within plus or minus 1°, evenly around the protractor scale. A larger variation

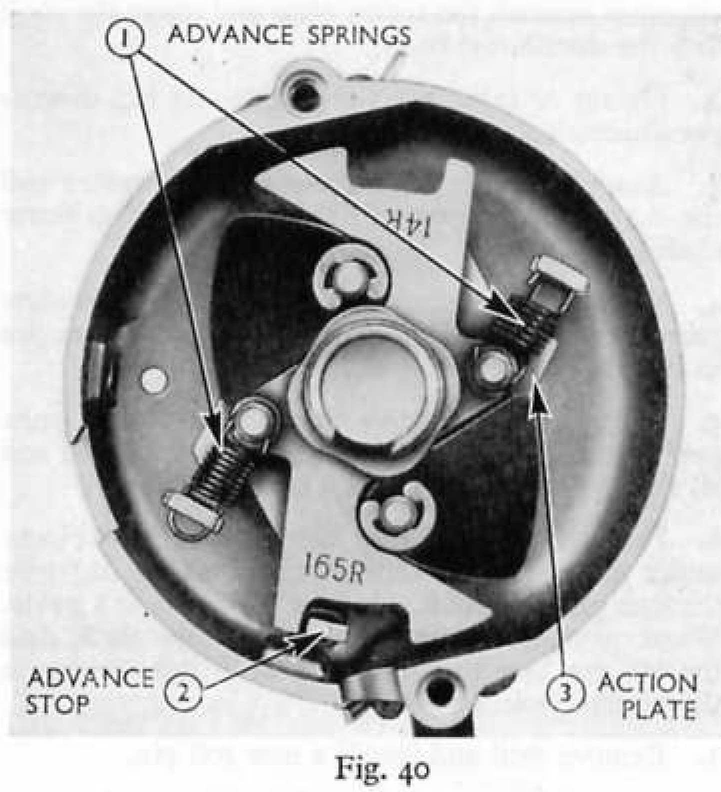


Fig. 40
Assembling the Mechanical Advance Mechanism

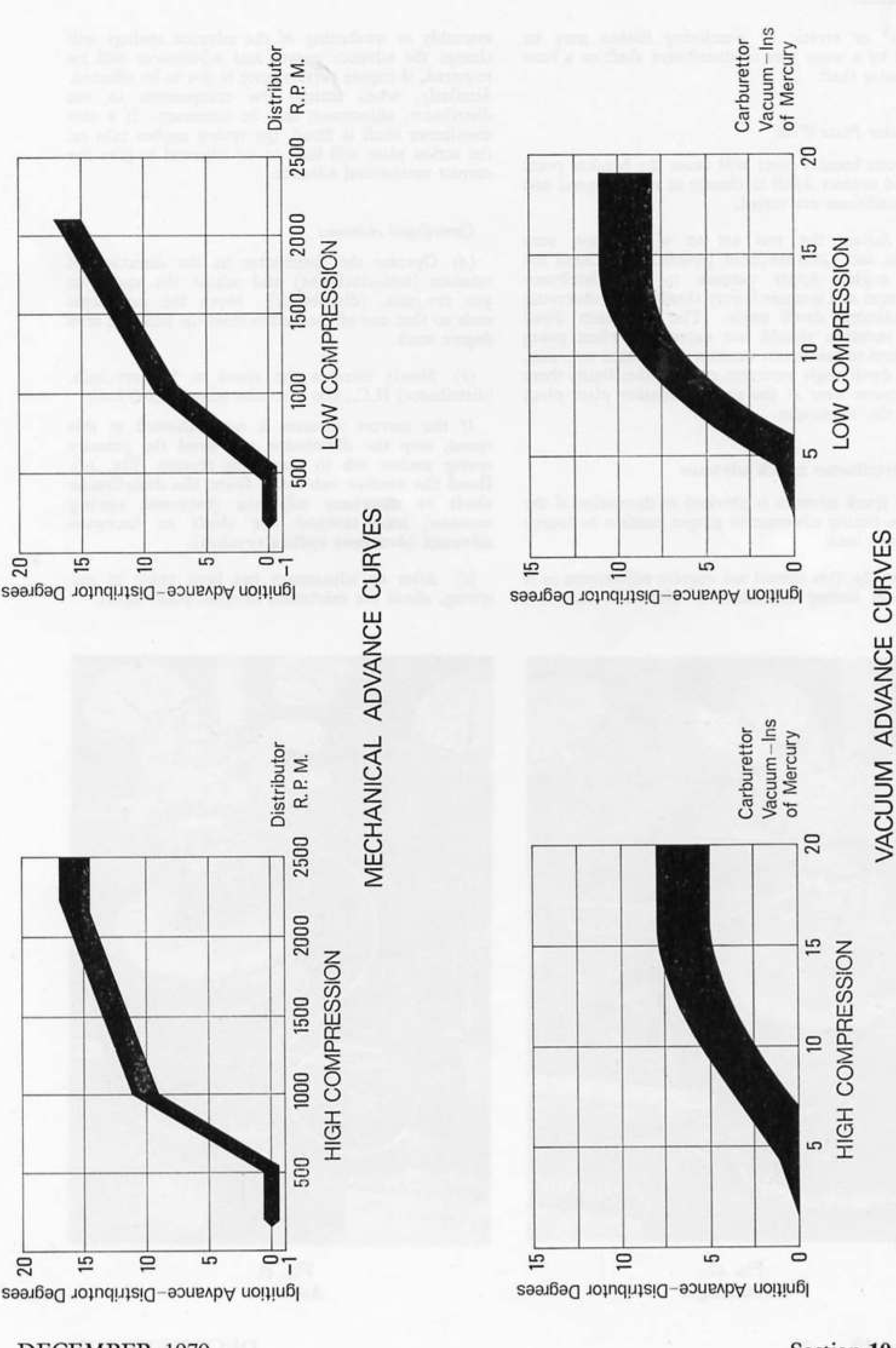


Fig. 41

The Mechanical and Vacuum Advance Curve

than 1° or erratic or wandering flashes may be caused by a worn cam or distributor shaft or a bent distributor shaft.

Breaker Plate Wear

A worn breaker plate will cause the breaker point gap and contact dwell to change as engine speed and load conditions are varied.

(*e*) Adjust the test set to 0° advance, zero vacuum, and 1,000 rev./min. (crankshaft). Check the dwell angle. Apply vacuum to the distributor diaphragm and increase it very slowly while observing the indicated dwell angle. The maximum dwell angle variation should not exceed 6° when going from zero to maximum vacuum at constant rev./min. If the dwell angle variation exceeds this limit, there is excessive wear at the contact breaker plate pivot pin or the diaphragm.

5. Distributor spark advance

The spark advance is checked to determine if the ignition timing advances in proper relation to engine speed and load.

Normally, this should not require adjustment as it is pre-set during manufacture. However, incorrect assembly or weakening of the advance springs will change the advance curves and adjustment will be required, if engine performance is not to be affected. Similarly, when fitting new components in the distributor, adjustment may be necessary. If a new distributor shaft is fitted, the spring anchor tabs on the action plate will have to be adjusted to give the correct mechanical advance.

Centrifugal Advance

(*a*) Operate the distributor in the direction of rotation (anti-clockwise) and adjust the speed to 300 rev./min. (distributor). Move the protractor scale so that one of the flashes lines up with the zero degree mark.

(*b*) Slowly increase the speed to 700 rev./min. (distributor) H.C., 800 rev./min. (distributor) L.C.

If the correct advance is not indicated at this speed, stop the distributor and bend the primary spring anchor tab to change its tension (Fig. 44). **Bend the anchor tab away from the distributor shaft to decrease advance (increase spring tension) and toward the shaft to increase advance (decrease spring tension).**

(*c*) After an adjustment has been made to one spring, check the minimum advance point again.

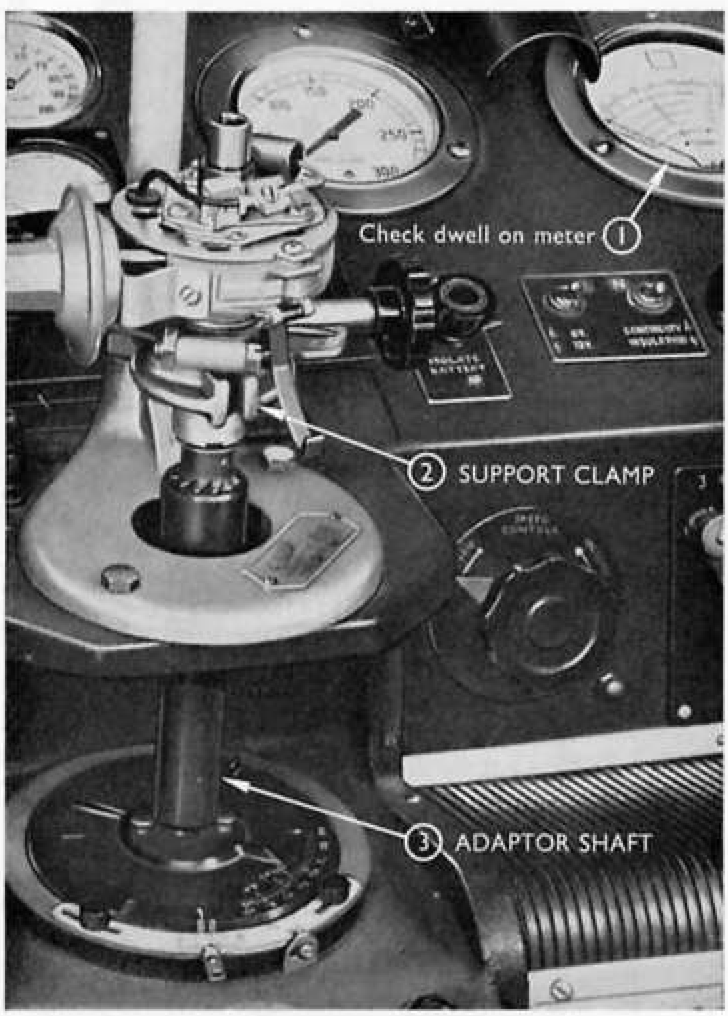


Fig. 42
Dwell Angle

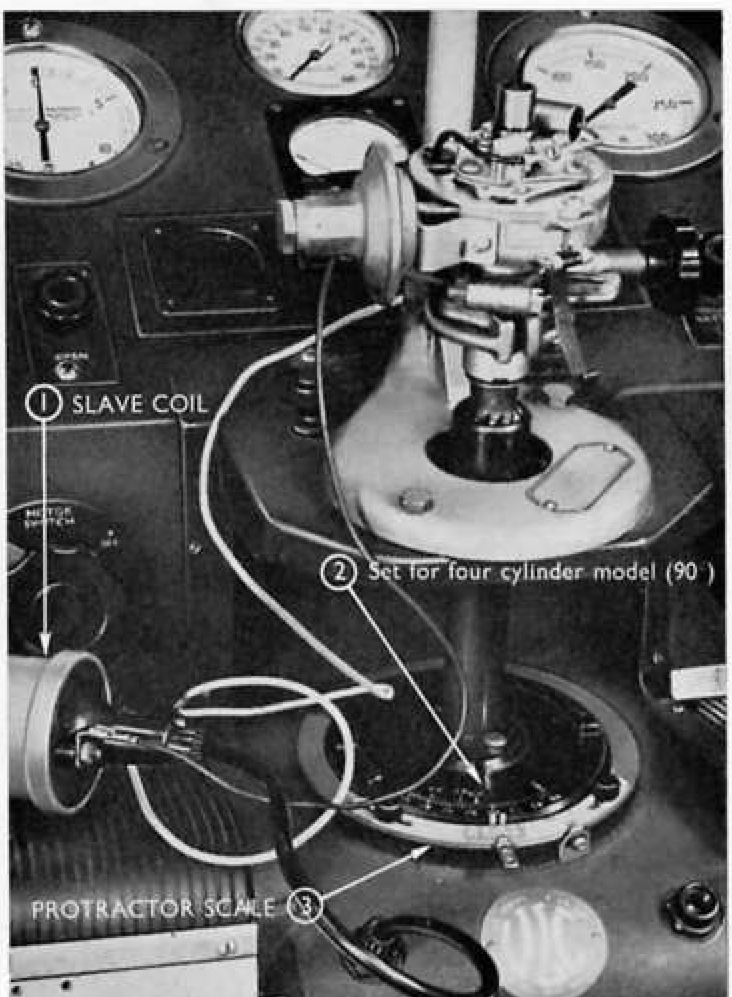


Fig. 43
Advance

(*d*) Operate the distributor at 2,500 rev./min. (distributor). If this advance is not to specifications, stop the distributor and bend the secondary spring anchor tab to give the correct advance.

(*e*) Check the advance at the other speeds tabulated in the Specification section and readjust if necessary. Operate the distributor both up and down the speed range.

Vacuum Advance

(*a*) Connect the test set vacuum line to the fitting on the diaphragm and turn the vacuum supply switch on.

(*b*) Set the test set to 0° advance, zero vacuum, and at 1,000 rev./min. (crankshaft).

(*c*) Check the advance at the vacuum settings tabulated in the Specification section.

(*d*) If the advance is incorrect, change the calibration shims between the vacuum chamber spring and plug (Fig. 45). After installing or removing a shim, position the gasket in place and tighten the plug. **The addition of a shim will decrease advance and the removal of a shim will increase advance.**

(*e*) After one vacuum setting has been adjusted, check the advance at other vacuum settings on the curve. **Do not change the original speed setting when going to a different vacuum setting.** If the other settings are not within limits, it indicates incorrect spring tension, leakage in the vacuum chamber and/or line, or the wrong fibre stop has been installed in the vacuum chamber of the diaphragm housing.

To Replace

1. Set the engine with the upper (inner) timing mark on the timing cover in line with the notch in the crankshaft pulley as No. 1 piston comes up on the compression stroke (see Fig. 46).

2. Point the rotor towards the offside rocker cover in the vicinity of the front rocker cover screw, and insert the distributor into the engine. (It may be necessary to turn the rotor a few degrees clockwise or anti-clockwise for the distributor gear teeth to mesh with those of the cam gear.) Fit the distributor retaining bolt.

3. Connect the primary (L.T.) lead to the coil.

4. Replace the distributor cap and leads securing the cap with the two retaining clips.

5. Reconnect the leads to the spark plug terminals in the correct firing order (1, 3, 4, 2); noting the direction of rotation of the rotor arm. Connect the high tension lead from the coil to the central socket of the distributor cap.

6. Reconnect the vacuum line to the vacuum housing 'push-on' connector.

7. Start engine and adjust the distributor for correct initial advance.

IGNITION TIMING

General

(*a*) Prior to adjusting the ignition timing ascertain the engine compression ratio. This can be readily identified by the letter **"H"** (High Compression 9.1 : 1) or the letter **"L"** (Low Compression 8.0 : 1) stamped on one inlet manifold mounting pad.

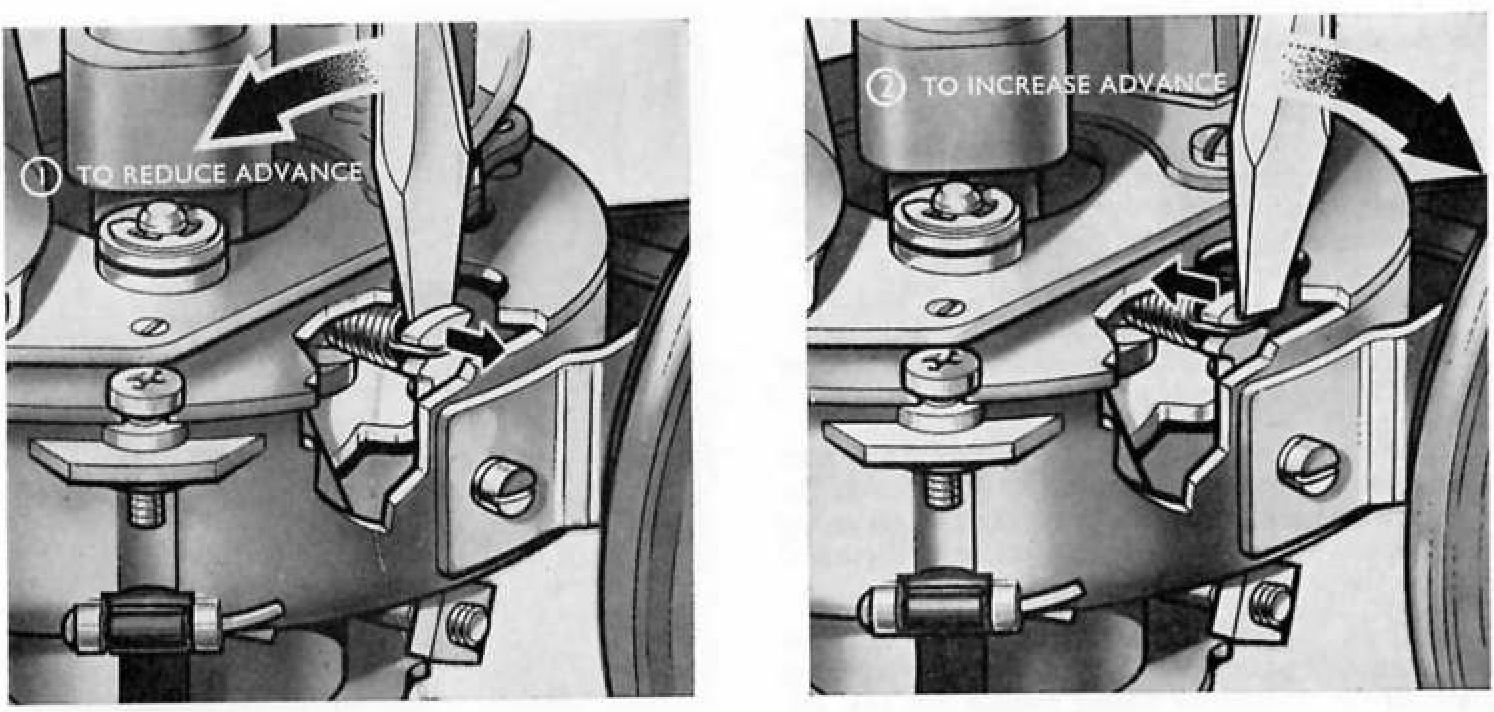


Fig. 44
Adjusting the Mechanical Advance Characteristics

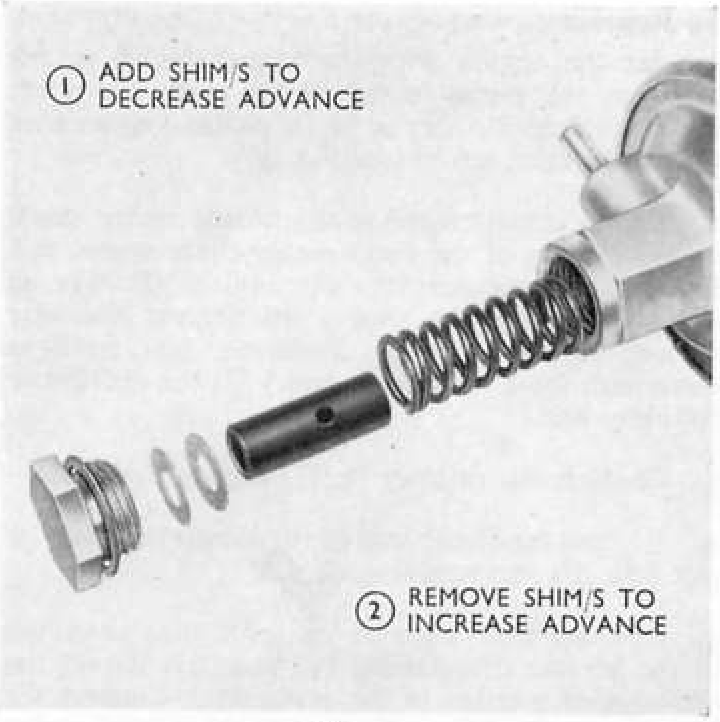


Fig. 45
Adjusting the Vacuum Advance Characteristics

(*b*) Check also the fuel octane rating that is to be used with this engine. Establish that the correct distributor is fitted for this combination of compression ratio and fuel. See page 32.

(*c*) The static advance of 8° H.C. or 6° L.C. before T.D.C. is "built in" to the engine and when No. 1 cylinder is on the compression stroke and the mark on the crankshaft pulley aligns with the appropriate mark on the front cover timing pointer (see Fig. 46) the crankshaft is at the static advance setting and no further adjustment is required at this stage, see operation A5.

(*d*) All reference to degrees (advance or retard) on the distributor are in terms of crankshaft degrees as in 'c'.

(*e*) If the vehicle is normally operated at a high altitude the distributor setting must be **advanced** by 4° for each 609.6 m. (2,000 ft.) above sea level, up to a maximum of 10° from the static setting.

A. To Adjust the Timing without the use of a Timing Light

1. If the engine has not been previously set, turn it with No. 1 piston coming up to T.D.C. on the compression stroke (this can be checked by removing No. 1 spark plug and feeling the pressure developed in the cylinder).

Continue turning the engine until the mark on the crankshaft pulley is in line with the appropriate mark on the front cover timing pointer (see Fig. 46).

This will give the initial timing setting of 6° L.C or 8° H.C. B.T.D.C. (static advance).

2. Remove the distributor cap.

3. Slacken off the distributor body clamp bolt and rotate the body clockwise until the contact breaker points are just opening when the rotor is adjacent to No. 1 H.T. contact in the distributor cap. Note direction of rotation of arm.

4. Tighten the distributor body clamp bolt and replace the distributor cap.

5. A slight readjustment to the distributor may be necessary and should be carried out on the road in the following manner:—

(*a*) Warm up the engine to normal operating temperature.

(*b*) Accelerate in top gear on wide throttle opening from 32 k.p.h. (20 m.p.h.) to 64 k.p.h. (40 m.p.h.).

(*c*) If heavy pinking occurs, **retard** the ignition until a trace pink can just be heard under these conditions of acceleration (see operation B4).

NOTE.—It is not necessary to advance the ignition beyond the static setting (except under high altitude operating conditions previously detailed). Also, there is no need to use a fuel of a higher octane rating (or number) than that specified.

B. To Adjust the Timing using a Timing Light

1. Connect the leads of the timing light, using the clips provided in accordance with the manufacturer's instructions.

2. Check that the mark on the crankshaft pulley is visible and mark with chalk or paint if necessary.

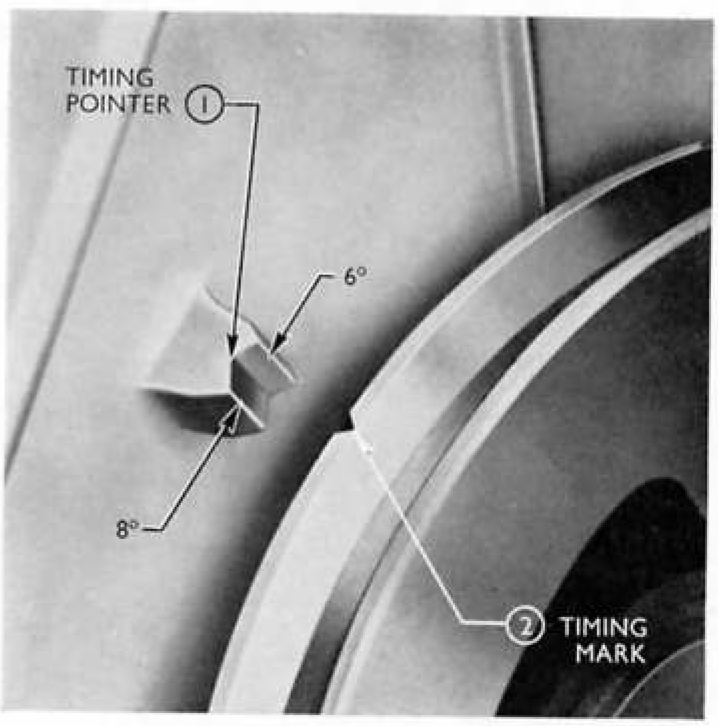


Fig. 46
Engine Positioned for Timing

3. Disconnect the vacuum pipe line and start the engine, allowing it to idle (approx. 600 rev./min.).

4. Point the timing light at the timing pointer. Check that the mark on the crankshaft pulley is adjacent to the appropriate mark on the front cover timing pointer (see Fig. 46).

If the mark of the pulley is above the correct timing mark, the engine is too far advanced. Slacken the distributor body clamp and turn body clockwise slightly to retard the ignition.

Should the mark be below the correct timing mark, the distributor body should be turned anti-clockwise slightly to advance the ignition.

5. Securely tighten the distributor body clamp bolt after the adjustment has been made.

Reconnect the vacuum pipe line.

The operation of the governor weights may be checked by opening and closing the throttle. As the throttle is gradually opened, the mark should move away from the indicator upwards; and as the throttle is closed the notch will move down in line with the indicator.

Any tendency for erratic advance shown by the mark jumping suddenly away from the indicator shows that the governor weights are binding, or that the springs are weak.

NOTE.—As in "A" a slight readjustment to the distributor may be necessary to suit the particular type of fuel in use.

THE LUCAS 11AC ALTERNATOR

(Prior to September 1968)

The alternator is belt-driven from the crankshaft pulley. The mechanical construction of the alternator differs from a generator in that the field rotates (the rotor), and the generating windings are stationary (the stator).

The stator comprises of a 24-slot, 3-phase star-connected output winding on a ring shaped lamination pack, housed between the slip-ring end and drive end brackets. The rotor is of 8-pole construction and carries a slip ring fed field winding. It is supported by a ball bearing in the drive end bracket and a needle roller bearing in the slip ring end bracket.

The brush gear for the field system is mounted on the slip ring end bracket. Two carbon brushes bear against a pair of concentric brass slip rings carried on a moulded disc attached to the end of the rotor.

The slip ring end bracket also carries six silicon diodes connected in a three-phase bridge to rectify the generated alternating current to direct current for use in charging the battery and supplying power to the electrical system.

The diodes and stator windings are cooled by airflow through the alternator induced by the fan at the drive end.

The alternator output is controlled by an electronic voltage regulator unit. In addition a warning light control unit is fitted.

ROUTINE MAINTENANCE

Cleaning

Wipe away any dirt or oil which may collect around the slip ring end cover ventilating apertures.

Belt Adjustment

Inspect the fan belt regularly, for wear and tension. When the belt is pulled and pushed at a point midway between the alternator and fan pulleys, the total movement should not exceed 13 mm. ($\frac{1}{2}$ in.).

Ensure that the alternator pulley is properly aligned with the fan crankshaft and water pump pulleys, otherwise the rotor bearings will be unduly loaded.

Lubrication

The bearings are packed with grease during assembly and do not require attention.

TEST PROCEDURES

In the event of a fault developing in the charging circuit, the following procedure should be followed to locate the cause of the trouble:—

(*a*) Inspect the fan belt for wear and tension.

(*b*) Disconnect the alternator field connections, turn on the ignition and check that battery voltage is being applied to the rotor winding by connecting a voltmeter between the cable ends normally attached to the field terminals. Turn off the ignition.

(*c*) Disconnect the battery earth cable.

(*d*) Disconnect the cables from the alternator output terminal and connect a good quality moving coil ammeter between the output terminal and the disconnected cables.

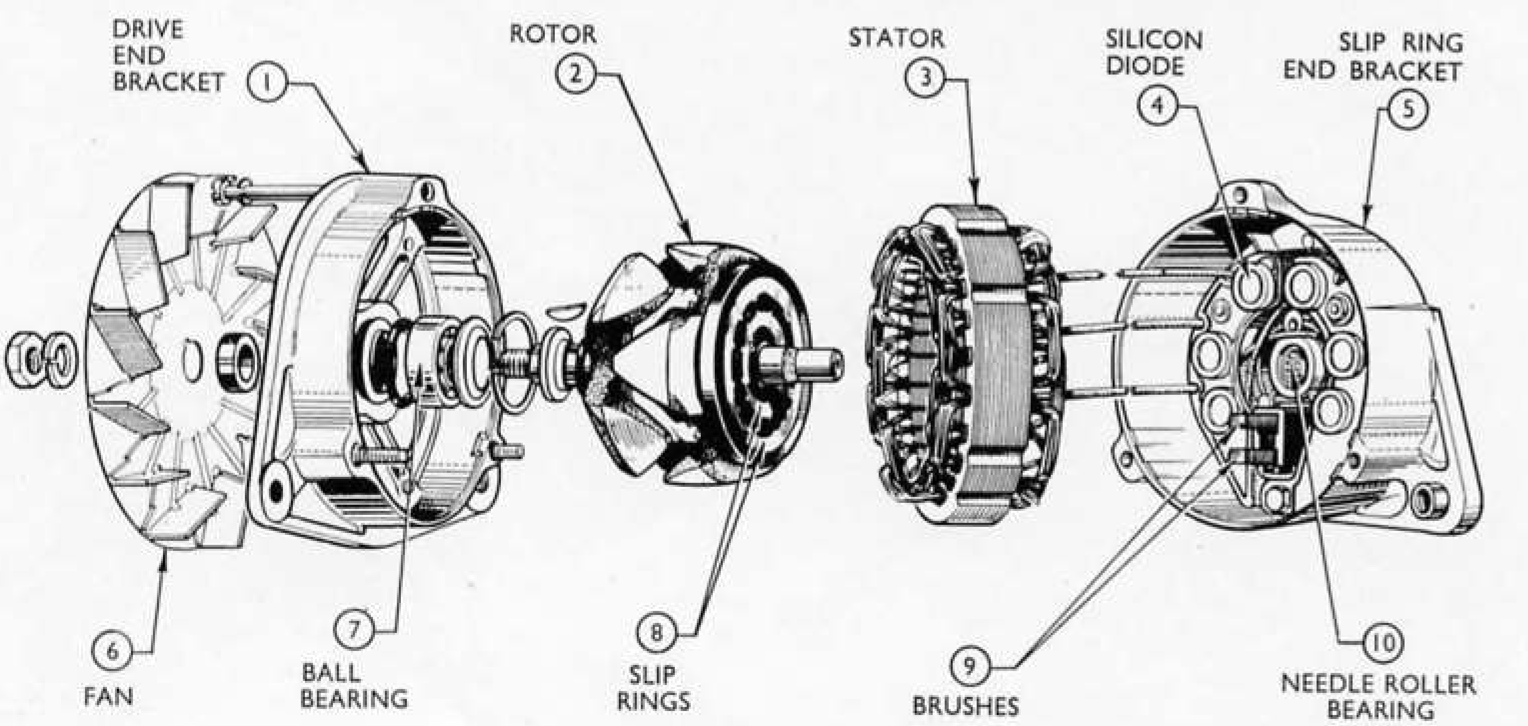


Fig. 47
Alternator — Exploded View

(*e*) Remove the wires from the alternator field terminals and, using a suitable pair of jumper leads, connect these terminals directly to the battery.

For this test polarity matching is unimportant.

(*f*) Reconnect the battery earth lead. Start the engine and slowly open the throttle until the engine speed is approximately 2,200 rev./min. At this speed the reading on the ammeter should be approximately 40 amps.

If a zero reading results, stop the engine and disconnect the cables from the field terminals. Withdraw the two brush box moulding retaining screws and remove the brush gear for examination as described on page 46.

Fit new brush and spring assemblies, if necessary, and re-test the alternator output. If the zero reading persists, the alternator must be removed from the engine and dismantled for detailed inspection (see below).

A low output current reading will indicate either a faulty alternator or poor circuit wiring connections. Check the latter whilst keeping the alternator connected and running as described above; connect a good quality low-range voltmeter between the alternator output terminal and the battery positive terminal and note the voltmeter reading.

Transfer the voltmeter connections to the alternator frame and battery earth terminal and again note the reading.

If either of these readings exceed 0.5 volts there is high resistance in the charging circuit which must be traced and remedied.

If these tests show that there is no undue resistance in the charging circuit, proceed to dismantle the alternator as described below.

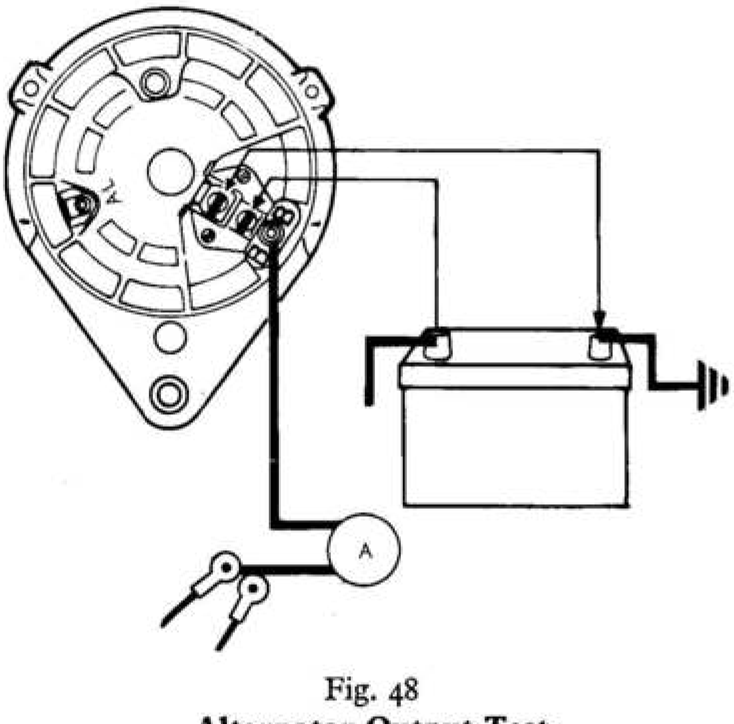


Fig. 48
Alternator Output Test

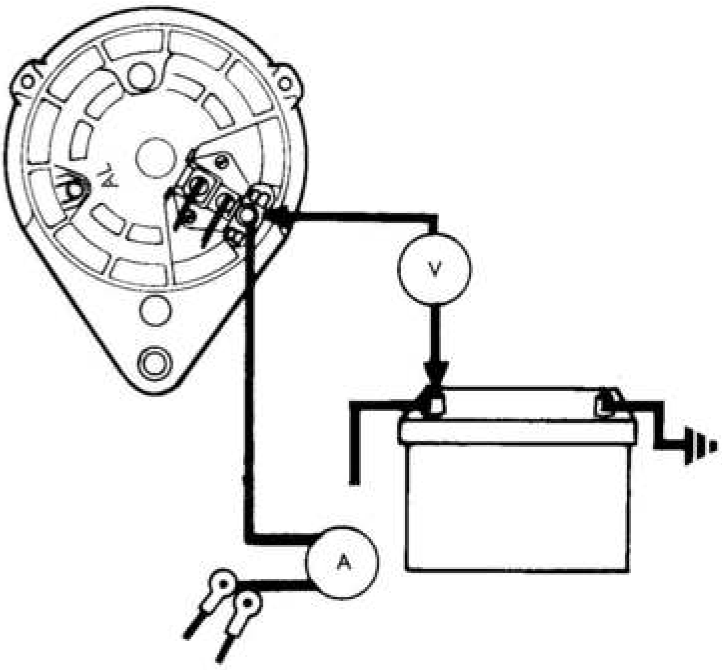


Fig. 49
Charging Circuit Voltage Drop Test Insulated Side

To Remove

1. **Disconnect the battery** and remove the wiring from the alternator.

2. **Remove the alternator adjusting arm bolt,** slacken the alternator mounting bolts and remove the fan belt.

3. **Remove the alternator from the vehicle.**

To Replace

1. **Position the alternator** and fit the mounting bolts.

2. **Refit the fan belt.** Adjust the fan belt tension by moving the alternator. When the tension is correct, refit the adjusting arm bolt and tighten the alternator mounting bolts.

The fan belt tension is correct when the total movement does not exceed 13 mm. ($\frac{1}{2}$ in.) when the belt is pushed and pulled at a point midway between the alternator and fan pulleys.

3. **Connect the wiring** to the alternator and reconnect the battery.

To Dismantle the Alternator

1. **Remove the shaft nut, spring washer, pulley and fan** from the drive end.

2. **Unscrew and withdraw the three 'through' bolts.**

3. **Mark the drive end bracket, lamination pack and slip ring end bracket** so that they may be re-assembled in the correct angular relation to each other.

4. **Withdraw the drive end bracket and rotor** from the stator. The drive end bracket and rotor need

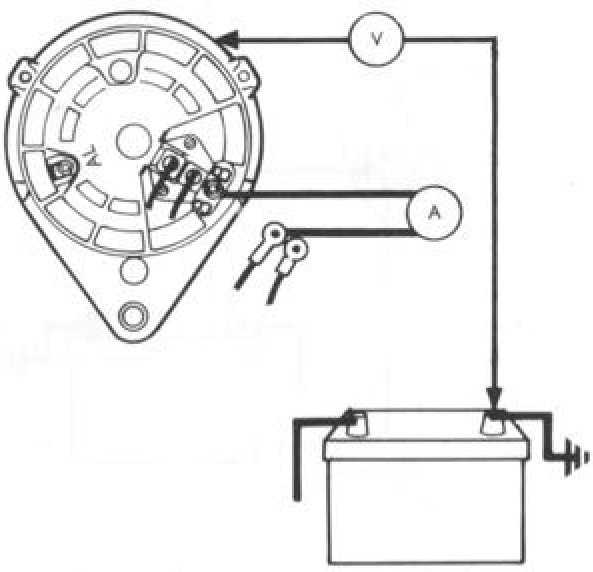


Fig. 50
Charging Circuit Voltage Drop Test Earth Side

not be separated unless the drive end bearing requires examination or the rotor is to be replaced. The rotor can be removed from the drive end bracket by means of a hand press, having first removed the shaft key and bearing collar.

5. **From the slip ring end bracket remove the terminal nuts,** washers, insulating pieces, brush box screws and the 2 B.A. bolt. Take care not to misplace the two washers fitted between the brushbox moulding and the end bracket.

6. **Withdraw the stator** and heat sink assemblies from the slip ring end bracket.

7. **Close up the retaining tongue at the root of each field terminal blade** and withdraw the brush, spring and terminal assemblies from the moulded brush box.

Inspection of Brush Gear

(*a*) Measure brush length. A new brush is 15.9 mm. ($\frac{5}{8}$ in.) long. A fully worn brush is 4 mm. ($\frac{5}{32}$ in.). long and must be replaced at or approaching this length. The new brush is supplied complete with a brush spring and terminal blade and has merely to be pushed in until the tongue registers. To ensure that the terminal is properly retained, carefully lever up the retaining tongue with a small screwdriver blade, so that the tongue makes an angle of about 30° with the terminal blade.

(*b*) Check that the brushes move freely in their holders. If they are at all sluggish, clean the brushes with a petrol-moistened cloth or lightly polish the brush sides on a smooth file. Remove all traces of brush dust before rehousing the brushes in their holders.

NOTE.—The brush which bears on the inner slip ring is always connected to the positive side of the electrical system, since the lower linear speed of the inner ring results in reduced mechanical wear and helps to offset the higher rate of electrical wear peculiar to the positive-connected brush.

Inspection of Slip Rings

The surfaces of the slip rings should be smooth and free from oil or other foreign matter. Clean the surfaces, using a petrol-moistened cloth, or if there is any evidence of burning, very fine glass paper. On no account must emery cloth or similar abrasives be used. No attempt should be made to machine the slip rings, as any eccentricity in the machining may adversely affect the high-speed performance of the alternator.

The small current carried by the rotor winding, and the unbroken surface of the slip rings mean that the likelihood of scored or pitted slip rings is almost negligible.

Rotor

(*a*) Test the rotor winding by connecting either an ohmmeter or a battery and ammeter in series across the two slip rings.

The ohmmeter reading should be 3.8 ohms. If the ammeter was used, the reading should be 3.2 amps.

(*b*) Test for defective insulation between one of the slip rings and one of the rotor poles, using a 110 volt A.C. mains supply and a 15 watt test lamp. If the lamp lights, the coil is earthing and a replacement rotor/slip ring assembly must be fitted.

(*c*) No attempt should be made to machine the rotor poles or to true a distorted shaft.

Stator

(*a*) Unsolder the three stator cables from the heat sink assembly, taking care not to overheat the diodes. Check the continuity of the stator windings by first connecting any two of the three stator cables in series with a 1.5 watt test lamp and a 12 volt battery. Repeat the test, replacing one of the two cables by the third cable. Failure of the test lamp to light on either test indicates that part of the stator winding is open circuit and a replacement stator must be fitted.

(*b*) Test for defective insulation between stator coils and lamination pack with the mains test lamp. Connect the test probes between any one of the three cable ends and the lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

Diodes

Before resoldering the stator cable ends to the diode pins carry out the following test:—

Each diode can be checked by connecting it in series with the 1.5 watt test bulb across a 12 volt battery and then reversing the battery connections.

Current should flow, and the bulb light, in one direction only. Should the bulb light in both tests or not at all, the diode is defective and the heat sink assembly must be replaced.

Diode Heat Sink Replacement

The alternator heat sink assembly consists of two parts, one of positive polarity and the other negative. The positive portion carries three cathode base diodes marked red, and the negative portion three anode diodes marked black. The diodes are not individually replaceable, but for service purposes, are supplied already pressed into the appropriate heat sink portion.

Great care must be taken to avoid overheating the diodes or bending the diode pins. The diode pins should be lightly gripped with a pair of long-nosed pliers (which act as a thermal shunt) and soldering must be carried out as quickly as possible.

After soldering, the connections must be neatly arranged around the heat sinks, to ensure adequate clearance for the rotor and should be tacked down with a suitable adhesive where indicated in Fig. 52. The stator connections must pass through the appropriate notches at the edge of the heat sink.

Bearings

Bearings which are worn to the extent that they allow excessive side movement of the rotor shaft must be renewed.

1. The needle roller bearing in the slip ring end bracket is not serviced separately. Should this bearing require replacing a complete end bracket assembly must be fitted.

2. The drive end ball bearing retaining plate is secured either by screws, rivets or a circlip.

(*a*) Remove the circlip.

(*b*) Press the bearing out of the bracket, noting the order of assembly of the pressure ring and plate (where fitted).

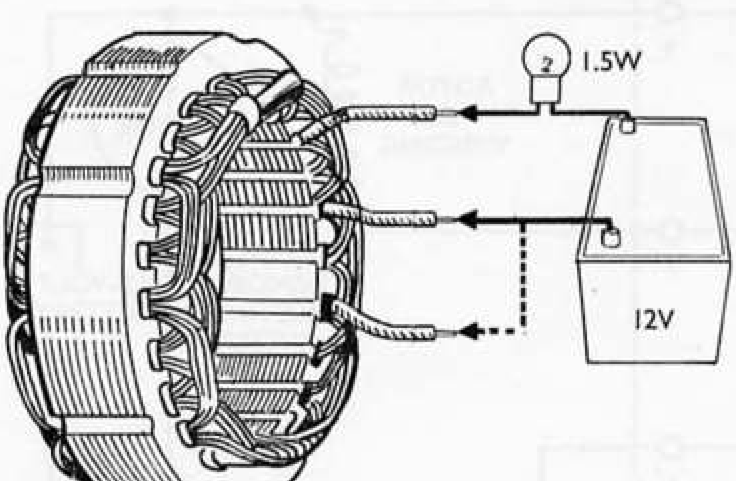


Fig. 51
Stator Winding Continuity Test

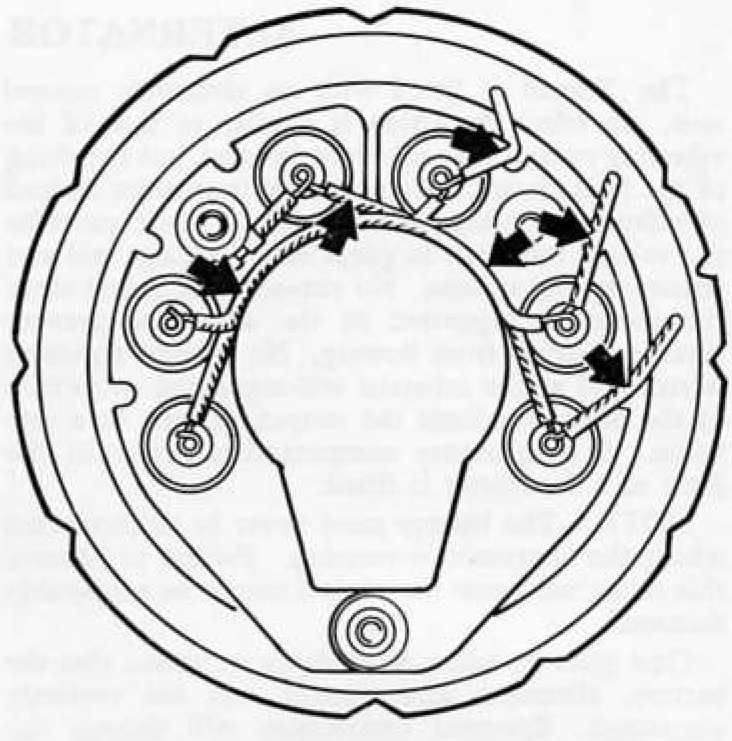


Fig. 52
Heat Sink Cable Securing Points

(*c*) Before fitting the replacement bearing see that it is clean and, if necessary, pack it with a high melting point grease.

(*d*) Locate the bearing in the housing and press it home.

(*e*) Refit the circlip.

To Reassemble the Alternator

1. Fit the brush, spring and terminal assemblies in the moulded brush box. Open out the retaining tongue at the root of each field terminal blade.

2. Replace the stator and heat sink assemblies in the slip ring end bracket.

3. Place the washers over the brush box terminals and replace the brush box in the slip ring end bracket, and secure with the screws and 2 B.A. bolt.

4. Fit the insulating pieces over the terminals and then fit the washers and terminal nuts.

5. Position the drive end bracket and rotor assembly in the slip ring end bracket. Ensure the two end brackets and lamination pack are correctly aligned, using the marks made whilst dismantling.

NOTE.—If the rotor and drive end bracket have been separated, the inner journal of the drive end bracket bearing must be supported by a tube of suitable diameter whilst the rotor is pressed into position. Then refit the key and bearing collar.

6. Replace the three through bolts and tighten to a torque of 0.52 to 0.58 kg.m. (45 to 50 lb. in.).

7. Refit the fan, pulley, spring washer and shaft nut.

ALTERNATOR CONTROL UNIT

The Transit is fitted with an electronic control unit. In effect its action is similar to that of the vibrating contact type of voltage control, but switching of the field circuit is achieved by transistors instead of vibrating contacts, while a Zener diode provides the voltage reference in place of the voltage coil and tension spring system. No cut-out is required since the diodes incorporated in the alternator prevent reverse currents from flowing. No current regulator is required as the inherent self-regulating properties of the alternator limit the output current to a safe value. A temperature compensation device in the form of a thermistor is fitted.

NOTE.—The battery must never be disconnected whilst the alternator is running. Failure to observe this ruling will cause the control unit to be irreparably damaged.

Care must be taken at all times to ensure that the battery, alternator and control unit are correctly connected. Reversed connections will damage the semi-conductor devices used in the alternator and control unit.

No regular maintenance is required, but the moulded cover can be occasionally wiped clean and a check made that the terminal connector is secure.

Checking and Adjusting

Before checking and adjusting the control unit, ensure that the alternator and the charging circuit wiring are in good order. Check also the battery to control unit wiring. To ensure proper working of the control unit, the resistance of this complete circuit must not exceed 0.1 ohms. Any unduly high resistance must be traced and remedied.

Checking

Leave the existing connections to the alternator and control unit undisturbed. Connect a good quality voltmeter between the battery terminals and note the reading with all electrical equipment switched off. If available use a voltmeter of the suppressed-zero type.

Unless an ammeter is fitted to the vehicle, insert one in series with the alternator main output cable.

Switch on an electrical load of approximately 2 amperes, e.g. side and tail lighting.

Start the engine and run at approximately 1650 rev./min. for at least eight minutes. (This will ensure that the system voltage has stabilized.) If the charging current is still greater than 10 amperes, continue to run the engine until this figure is reached. The voltmeter should now give a reading of 13.9 to 14.3 volts.

If the reading is stable but outside these limits the unit can be adjusted to control at the correct voltage.

If, however, the voltmeter reading remains unchanged (at open-circuit battery terminal voltage) or, conversely, increases in an uncontrolled manner, then the control unit is faulty and a replacement unit must be fitted. Component parts are not serviced individually.

Adjusting

Stop the engine and withdraw the control unit mounting screws. Invert the unit and carefully scrape away the sealing compound which conceals the potentiometer adjuster. Check that the voltmeter is still firmly connected between the battery terminals, and that the control unit is earthed. Start the engine and, while running the engine at 1,650 rev./min., turn the potentiometer adjuster slot—clockwise to increase the setting or anti-clockwise to decrease it—until the required setting is obtained. A small movement of the adjuster makes an appreciable difference to the voltage reading.

Recheck the setting by first stopping the engine then starting again and running at 1650 rev./min.

Stop the engine, reconnect the control unit and remove the voltmeter and ammeter.

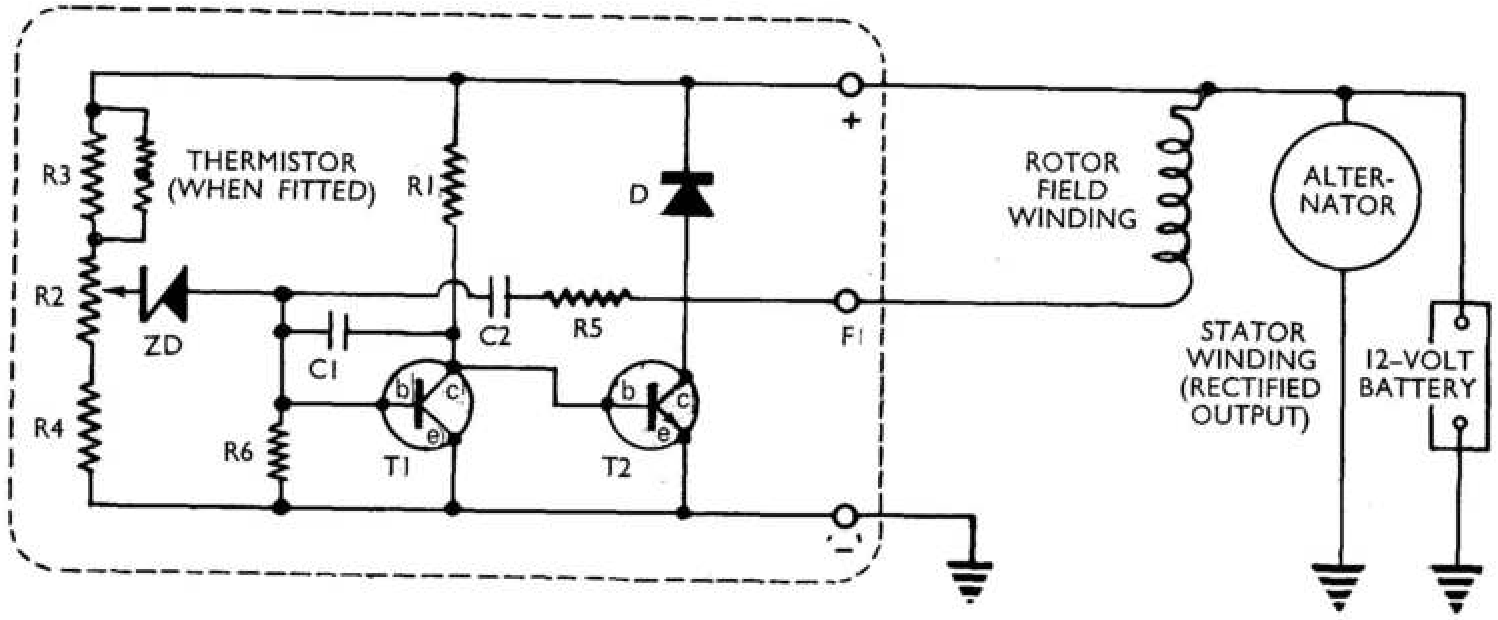


Fig. 53
Control Unit Wiring Diagram

ALTERNATOR WARNING LIGHT CONTROL

Description

The alternator warning light control is a thermally-operated relay for controlling the switching on and off of a facia panel warning light. It is connected, through alternator terminal 'AL', to the centre point of one pair of the six alternator diodes, and to earth. The indication given by the warning light is similar to that provided by the ignition warning light used with generator charging systems. The warning light is illuminated when the alternator is stationary or is being driven very slowly. The light goes out as soon as the alternator voltage begins to rise. If the voltage does not rise for any reason the warning light remains illuminated.

NOTE.—Due to the external similarity of the alternator warning light control unit to the flasher unit, a distinctive green label is applied to the aluminium case of the warning light unit.

Care must be taken to avoid connecting either of these units into a circuit designed for the other.

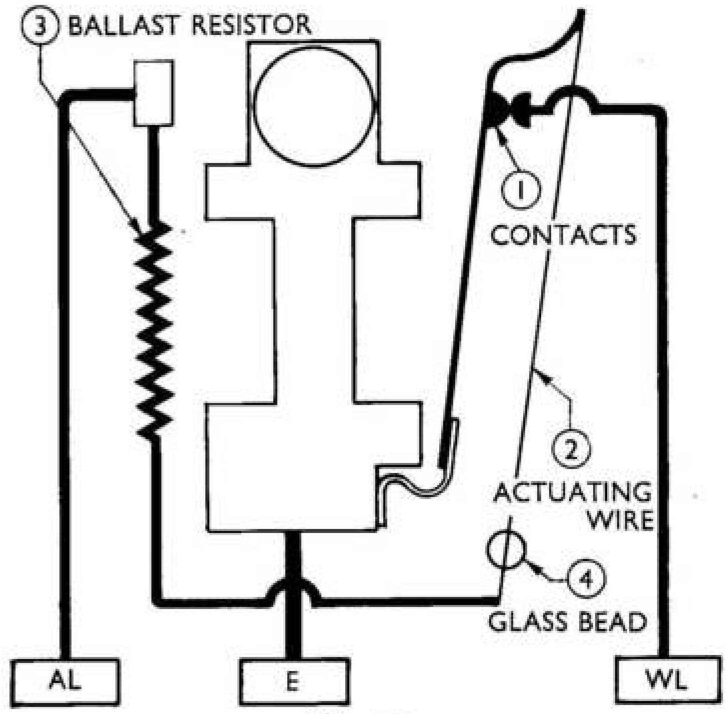


Fig. 54
Theoretical Circuit of Warning Light Control Unit

Operation

The unit consists of a pair of contacts held closed against spring tension by a length of nickel chrome resistance wire. When cold, the wire is in tension: when current flows through the wire, it heats up and lengthens, allowing the contacts to open. The full circuit is shown in Fig. 54.

Servicing

If the warning light unit is shown to be defective by the following tests, it must be replaced:—

NOTE.—A faulty diode in the alternator or an intermittent or open circuit in the alternator-to-battery circuit can cause excessive voltages to be applied to the warning light control. Therefore, to prevent possible damage to the replacement unit, it is important to first measure the voltage between the alternator 'AL' terminal and earth. Run the engine at 1,650 rev./min., when the voltage should be of the order 7 to 7.5 volts, measured on a good quality moving coil voltmeter.

If a higher voltage is indicated, first check all charging circuit connections and then, if necessary, the alternator diodes before fitting a replacement warning light control unit.

11AC ALTERNATOR FAULT DIAGNOSIS

Fault	*Action*
Warning light fails to illuminate when the ignition switch (or equivalent) is turned on	Check the warning light bulb by substitution. Check the warning light control by substitution. Test the continuity of each part of the warning light circuit, i.e. from the alternator to terminal 'AL'; from the ignition switch to terminal 'WL'; and from terminal 'E' to earth.
Warning light fails to go out when the alternator is being driven	Check the warning light control by substitution. Check the continuity of the circuit between the alternator and terminal 'AL' on the warning light control.
Warning light shows intermittent flickering light	Check bulb and circuit connections, and tighten as required. Check warning light control by substitution.

THE LUCAS 15 ACR AND 17 ACR ALTERNATORS

(September 1968 to March 1970)

The Lucas 15 and 17 ACR Alternators are 3 Phase Star Wound Units, giving rated outputs of 28 and 36 amps respectively. A feature of these alternators is the built-in 8 TR voltage regulator which results in a self-contained generating and control unit.

ROUTINE MAINTENANCE

Cleaning

Periodically, clean the outside of the alternator with a petrol-moistened cloth.

Belt Adjustment

Inspect the fan belt regularly, for wear and tension. When the belt is pulled and pushed at a point midway between the alternator and fan pulleys, the total movement should not exceed 13 mm. (½ in.).

Ensure that the alternator pulley is properly aligned with the fan crankshaft and water pump pulleys, otherwise the rotor bearings will be unduly loaded.

Lubrication

The bearings are packed with grease during assembly and do not require attention.

Wiring Connections

Occasionally inspect the connectors to see that they are clean and tight.

Voltage Regulator

This is a sealed unit and does not require any maintenance.

TEST PROCEDURES

Alternator Output Test

(*a*) Check the driving belt for wear and correct tension.

(*b*) Check the connections in the charging circuit.

(*c*) Disconnect the battery earth (—) cable.

(*d*) Remove the two-piece connector from the alternator terminals.

(*e*) Remove the moulded cover, and replace the terminal connectors.

(*f*) Insert a 0–60 scale ammeter in the main (+) cable. (This should be done at the solenoid end of the main cable.)

(*g*) Reconnect the battery earth (—) cable.

(*h*) Using a jumper lead, short together terminals (F) and (—) (Green and Black cables) on the voltage regulator.

(*i*) Switch on all vehicle lighting (headlamps on main beam).

(*j*) Switch on the ignition (auxiliary switch on diesel-engined vehicles) and check that the warning lamp is illuminated. Start the engine and slowly increase speed.

At about 1,500 rev./min. (alternator), the warning light should go out. Increase the engine speed until the alternator is running at 6,000 rev./min. (about half-throttle). If the alternator is satisfactory, the ammeter should indicate the

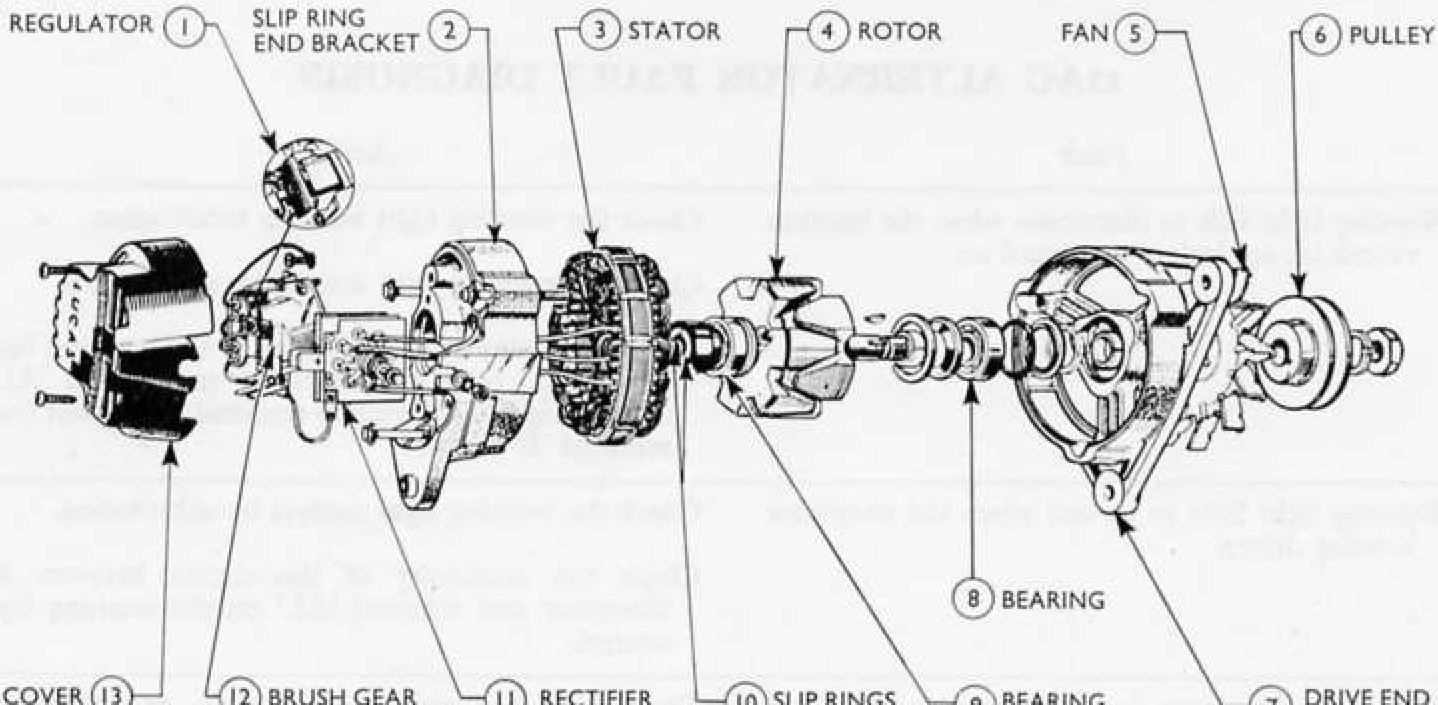


Fig. 55
Alternator — Exploded View

rated output of the machine. 28 Amps (15 ACR) 36 Amps (17 ACR).

NOTE.—The output figures quoted are nominal (hot) values, and may be exceeded if the alternator is tested when cold. To avoid misleading results, the machine should be run for three or four minutes before performing the output test.

If the alternator output is satisfactory, check the voltage regulator setting, see below.

If the alternator output differs appreciably from the specified figure, remove for a detailed bench examination.

The fault-finding chart on page 56 shows how diode failure affects the alternator output. There will also be an increase in the operating temperature and the noise level.

NOTE.—Care should be taken to distinguish between mechanical noises, such as those caused by damaged bearings or loose mounting brackets, and electrical noises caused by short-circuited and open-circuited diodes.

Charging Circuit Voltage Drop Test

A high resistance in the charging circuit (such as a connector which is loose, dirty, or corroded) will affect the alternator output. The following tests should be used to check for a high resistance in the charging circuit. A good quality low-range voltmeter is required, to enable readings to be taken accurately to 0.25 volt. The procedure is as follows:—

(*a*) Connect the voltmeter red lead to the alternator main (+) terminal and the black lead to battery (+) terminal, see Fig. 56.

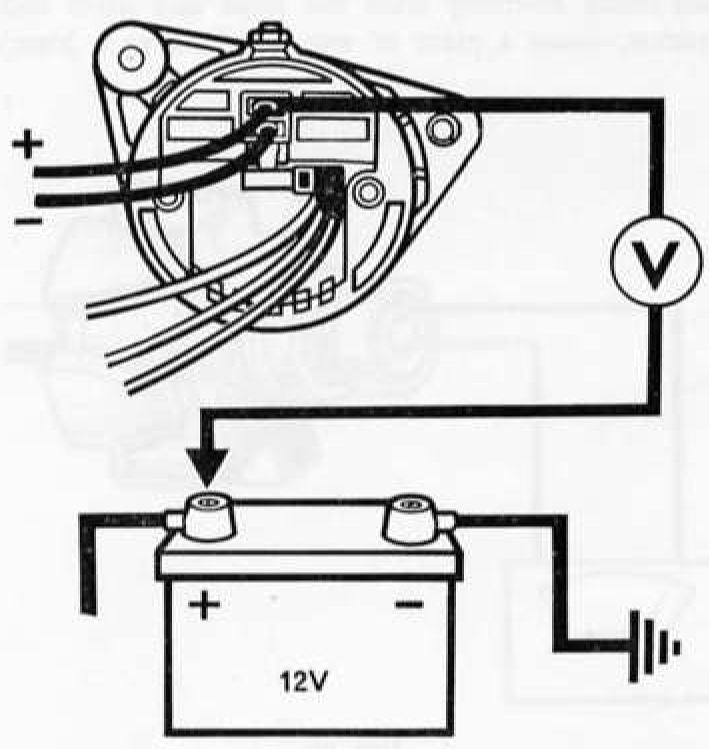


Fig. 56
Charging Circuit Voltage Drop Test (Live Side)

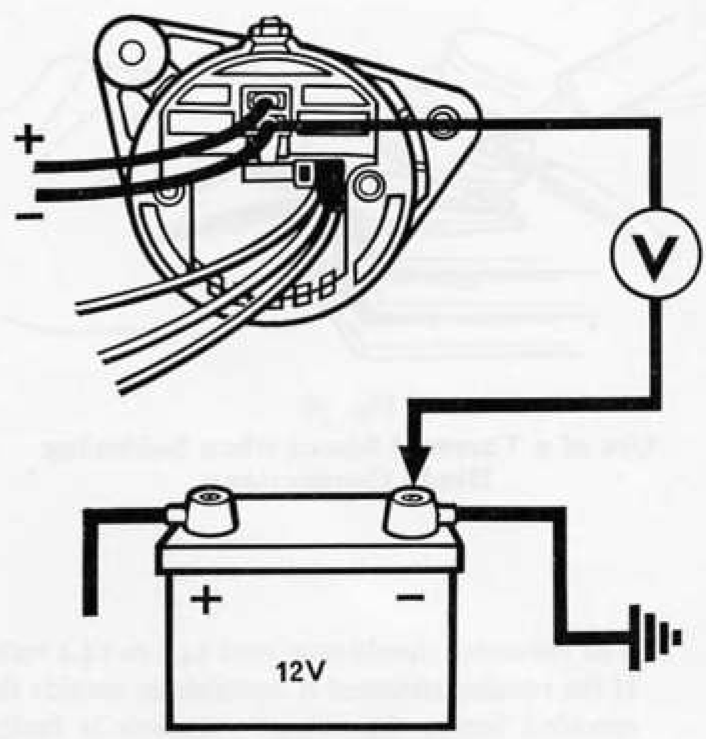


Fig. 57
Charging Circuit Voltage Drop Test (Earth Side)

(*b*) Switch on the headlamps (main beam).

(*c*) Start the engine, and increase the speed until the alternator runs at approximately 6,000 rev./min. Note the voltmeter reading.

(*d*) Transfer the voltmeter connections to the negative (—) terminals of alternator and battery. See Fig. 57 and again note the voltmeter reading. If the reading exceeds 0.5 volt on the positive (live) side, or 0.25 volt on the negative (earth) side, a high resistance in the charging circuit is indicated and this must be traced and rectified.

All cables and connections (including the battery earth cable) should be carefully examined. Rectify any loose, dirty, or corroded connectors.

Checking the Voltage Regulator Setting

Ensure that the wiring and connections in the charging circuit are satisfactory. In particular, the circuit resistance between alternator (—) terminal and battery (—) terminal must not exceed 0.003 ohms. To check the charging circuit the Voltage Drop Test should be performed.

If the battery is discharged, temporarily replace with a similar battery in well-charged state.

(*a*) Connect a good quality voltmeter (a suppressed zero, or extended scale type 12–15 volts) between the main terminals of the battery.

(*b*) Insert an ammeter, scale 0–60 amps, in series with the alternator main output (+) cable at its connection with the starter solenoid.

(*c*) Start the engine and run the alternator at approximately 5,000 rev./min. until the ammeter shows an output current not exceeding 7.5 amps.

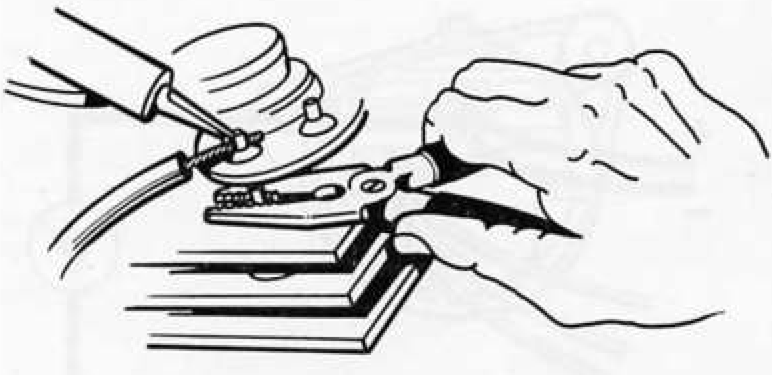


Fig. 58
Use of a Thermal Shunt when Soldering Diode Connections

The voltmeter should now read 14.1 to 14.4 volts. If the reading obtained is unstable or outside the specified limits, the voltage regulator is faulty, and a replacement unit must be fitted. The unit is sealed and is not adjustable.

To Remove

1. Disconnect the battery and remove the wiring from the alternator.

2. Remove the alternator adjusting arm bolt, slacken the alternator mounting bolts and remove the fan belt.

3. Remove the alternator from the vehicle.

To Replace

1. Position the alternator and fit the mounting bolts.

2. Refit the fan belt. Adjust the fan belt tension by moving the alternator. When the tension is correct, refit the adjusting arm bolt and tighten the alternator mounting bolts.

The fan belt tension is correct when the total movement does not exceed 13 mm. (½ in.) when the belt is pushed and pulled at a point midway between the alternator and fan pulleys.

3. Connect the wiring to the alternator and reconnect the battery.

To Dismantle

1. Withdraw the two securing screws and remove the end cover.

2. Disconnect the yellow lead from rectifier terminals.

3. Unscrew the two securing screws for the brush moulding and also the screw which holds the regulator case to the end bracket. Withdraw the brush moulding, complete with the regulator. If required, the regulator can be separated from the brush moulding by removing the top screw which secures the regulator, and also the three screws which secure the regulator yellow, red, and green leads to the brush moulding connectors.

4. Grip the output diode pins in turn with a pair of long-nosed pliers, see Fig. 58. Unsolder the three leads connecting the stator to the diodes. Note the order in which the connections are made.

5. Slacken the rectifier fixing nut sufficiently to allow the assembly to be withdrawn from its moulding.

6. Remove the three alternator through bolts.

7. Separate the slip ring end bracket from the drive end bracket and rotor assembly.

Use of a metal sleeve, having the following dimensions, will assist in this operation.

Length 76.2 mm. (3 ins.)
Outside Diamter 33.52 mm. (1.320 ins.)
Inside Diameter 31.50 mm. (1.240 ins.)

Position the alternator vertically, with the fan underneath. Slide the sleeve over the slip ring moulding, so that it engages with the outer ring of the slip ring end bearing and carefully drive the bearing from its housing.

To get the sleeve to slide smoothly over the slip ring moulding, it may be necessary to file away any surplus solder on the winding terminals.

To simplify separating the slip ring end bracket and stator assembly from the rotor and drive end bracket, insert a piece of wood (to use as a lever)

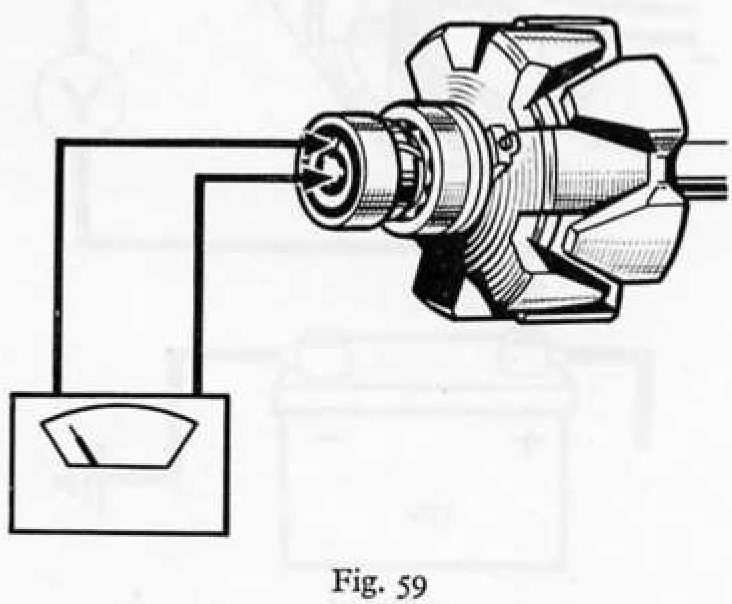


Fig. 59
Measuring Rotor Winding Resistance with an Ohmmeter

between the stator and the drive end bracket. Then, carefully prise the two apart until the clip ring end bearing is clear of its housing.

Inspection of Brush Gear

The length of the brush when new is 12.6 mm. (½ in.). The serviceability of a brush may be estimated by measuring the amount which protrudes beyond the brushbox moulding when the brush is in the free position. Renew if the brush is worn to less than 5 mm. (0.2 in.). Ensure that the special leaf spring is fitted, when the centre brush is replaced.

Check the brush spring pressures, by means of a push-type spring gauge. The brush should be pushed back against the spring, so that the brush face is flush

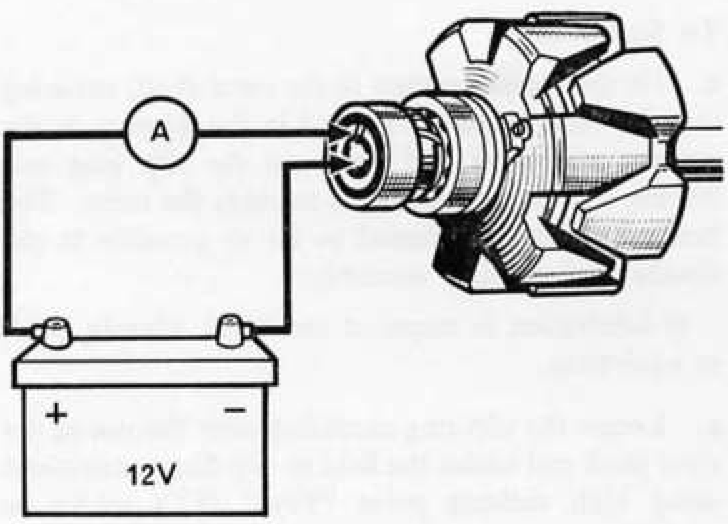


Fig. 60
Measuring Rotor Winding Resistance with a Battery and Ammeter

with the housing. The brush assembly should be replaced, if the reading is appreciably outside the limits 198 to 283 g. (7 to 10 oz.) and the brush is not partially seized. A seized brush should be cleaned with a petrol-moistened cloth or, if necessary, by lightly polishing the brush sides on a smooth file.

Inspection of Slip Rings

The surfaces of the slip ring should be smooth and clean. Remove any contamination with a petrol-moistened cloth. If there is evidence of burning, clean the slip rings with a very fine glass paper. On no account must emery cloth or similar abrasive be used. No attempt must be made to machine (skim) the slip rings, as the high speed performance may be adversely affected.

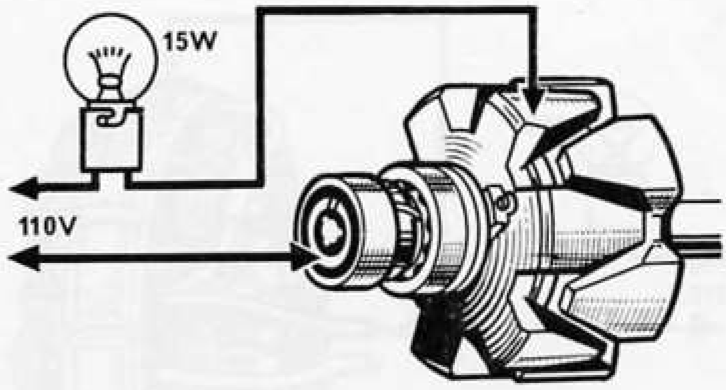


Fig. 61
Rotor Insulation Test

Testing the Rotor

Test the rotor winding by connecting either an Ohmmeter, see Fig. 59, or a 12 volt battery and ammeter, see Fig. 60, between the slip rings. The resistance should be approximately 4.33 ohms (15 ACR), 4.165 (17 ACR) or the value of current approximately 3 amps.

Test for defective insulation between one of the slip rings and the rotor poles, using a 110 volt d.c. mains supply, and a 15 watt test lamp, see Fig. 61. If the lamp lights, the coil is earthed to the rotor core, and a replacement rotor and slip ring assembly must be fitted.

No attempt must be made to machine the rotor poles, or to straighten a distorted shaft.

Stator Tests

Check the continuity of the stator windings by connecting any two of the three stator cables in series with a 12 volt battery and a test lamp of not less than 36 watts, see Fig. 62.

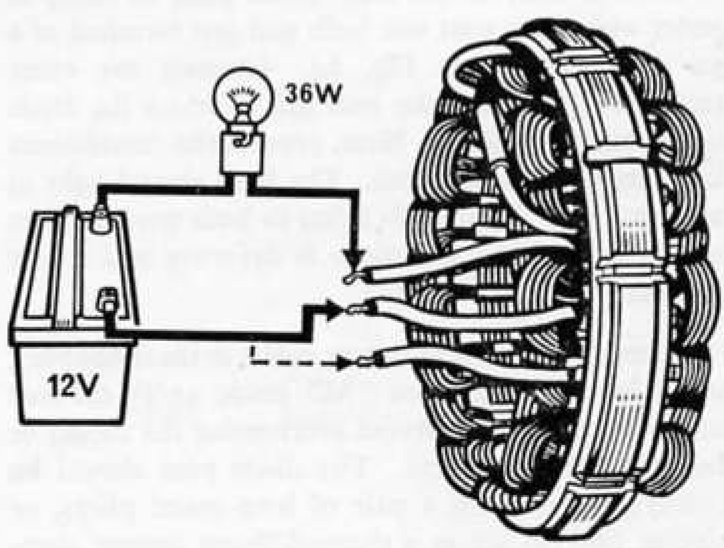


Fig. 62
Stator Winding Continuity Test

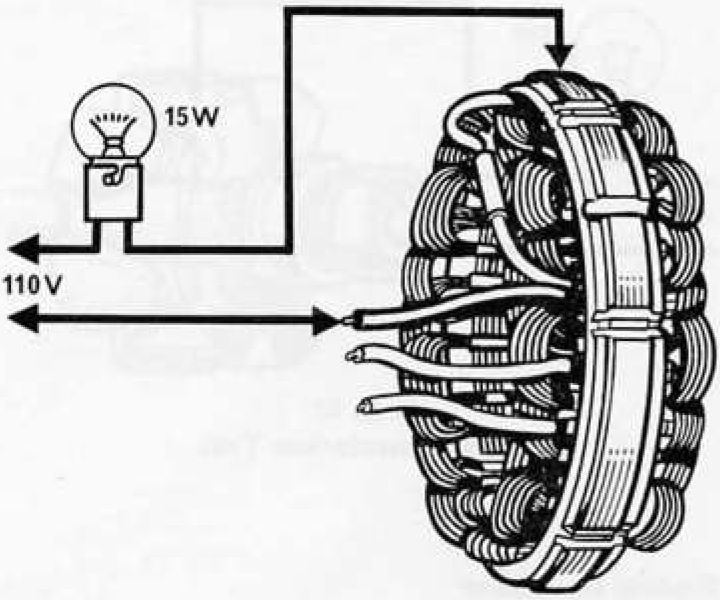


Fig. 63
Stator Winding Insulation Test

Repeat the test, replacing one of the two cables by the third cable. Failure of the test lamp to light on either occasion means that part of the stator winding is open-circuited, and a replacement stator must be fitted.

Test for defective insulation between the stator coils and the lamination pack with the 110 volt d.c. mains supply and a 15 watt test lamp, see Fig. 63. Connect the test probes between any one of the three cable ends and the lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

Diode Tests

If the alternator output test indicates that one or more of the diodes are faulty, the stator winding connections to the rectifier pack must be unsoldered.

Connect each of the nine diode pins, in turn, in series with a 1.5 watt test bulb and one terminal of a 12 volt battery, see Fig. 64. Connect the other terminal to the particular heat sink to which the diode under test is soldered. Next, reverse the connections to diode pin and heat sink. The bulb should light in one test only. If the bulb lights in both tests, or does not light in either, the diode is defective and a new rectifier pack must be fitted.

When re-soldering the stator cables to the diode pins, use a low melting point "M" grade 45/55 tin-lead solder or equivalent. Avoid overheating the diodes or bending the diode pins. The diode pins should be lightly gripped with a pair of long-nosed pliers, or similar tool (to act as a thermal shunt against over-heating) and soldering must be carried out as quickly as possible, see Fig. 58.

Bearings

Bearings which are worn to the extent that they allow excessive side movement of the rotor shaft must be renewed.

If replacement of the drive end bearing is necessary, press the rotor shaft out from the drive end bracket, after having removed the shaft nut, washers, pulley, fan and shaft key.

The drive end bearing assembly can then be withdrawn, after removal of the circlip, see Fig. 55 for details of the bearing assembly.

To remove the slip ring end bearing, first unsolder the field winding connections to the slip ring moulding assembly. The moulding and bearing (and if necessary the grease retainer) may then be withdrawn from the shaft.

To Reassemble

1. Fit the grease retainer to the rotor shaft, ensuring that the rotor leads are located in the grooves in the retainer and shaft and press on the slip ring end bearing with its shielded side towards the rotor. The bearing should be pressed as far as possible in the direction of the field assembly.

If lubrication is required use Shell Alvania 'RA', or equivalent.

2. Locate the slip ring moulding over the slot in the rotor shaft and solder the field to slip ring connections using high melting point "Frys" HT3 solder or equivalent.

3. Locate the seal retainer, seal, bearing and retainer in the drive end bracket and fit the circlip.

4. Fit the spacer and press the rotor shaft into the drive end bracket. Support the inner ring of the

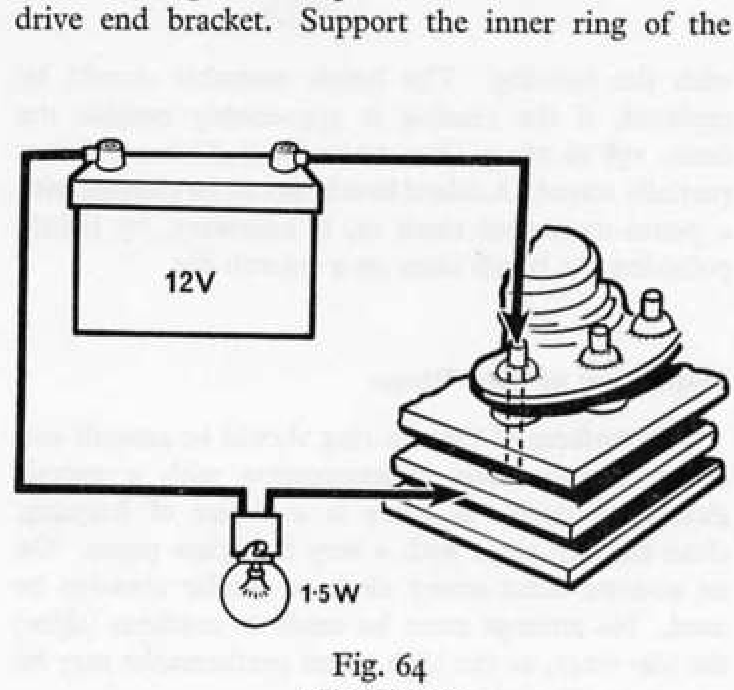


Fig. 64
Diode Test

bearing for this operation and not the drive end bracket.

5. Replace the spacer, key, fan, pulley, washer and nut on the rotor shaft.

6. Locate the stator assembly and the slip ring end bracket on the drive end bracket and rotor assembly and replace the three through bolts, tightening them to a torque of 0.525 to 0.576 kg.m. (45 to 50 lb. in.).

7. Fit the rectifier, locating the step in the rear plate against the slip ring and bracket, and tighten the fixing nut to a torque of 0.420 to 0.460 kg.m. (35 to 40 lb. in.).

8. Resolder the three stator to rectifier leads in the correct order.

9. Position the brushes in their housing, ensuring that the centre brush is fitted with the special leaf spring.

10. Locate the regulator on the brush moulding, fit the regulator top securing screw and secure the yellow, red, and green leads to the brush moulding connectors.

11. Replace the brush moulding and regulator assembly, fit the regulator bottom fixing screw securing the black regulator lead, and fit the two brush moulding screws.

12. Connect the yellow lead to the rectifier.

13. Locate the plastic moulded cover and fit the two securing screws.

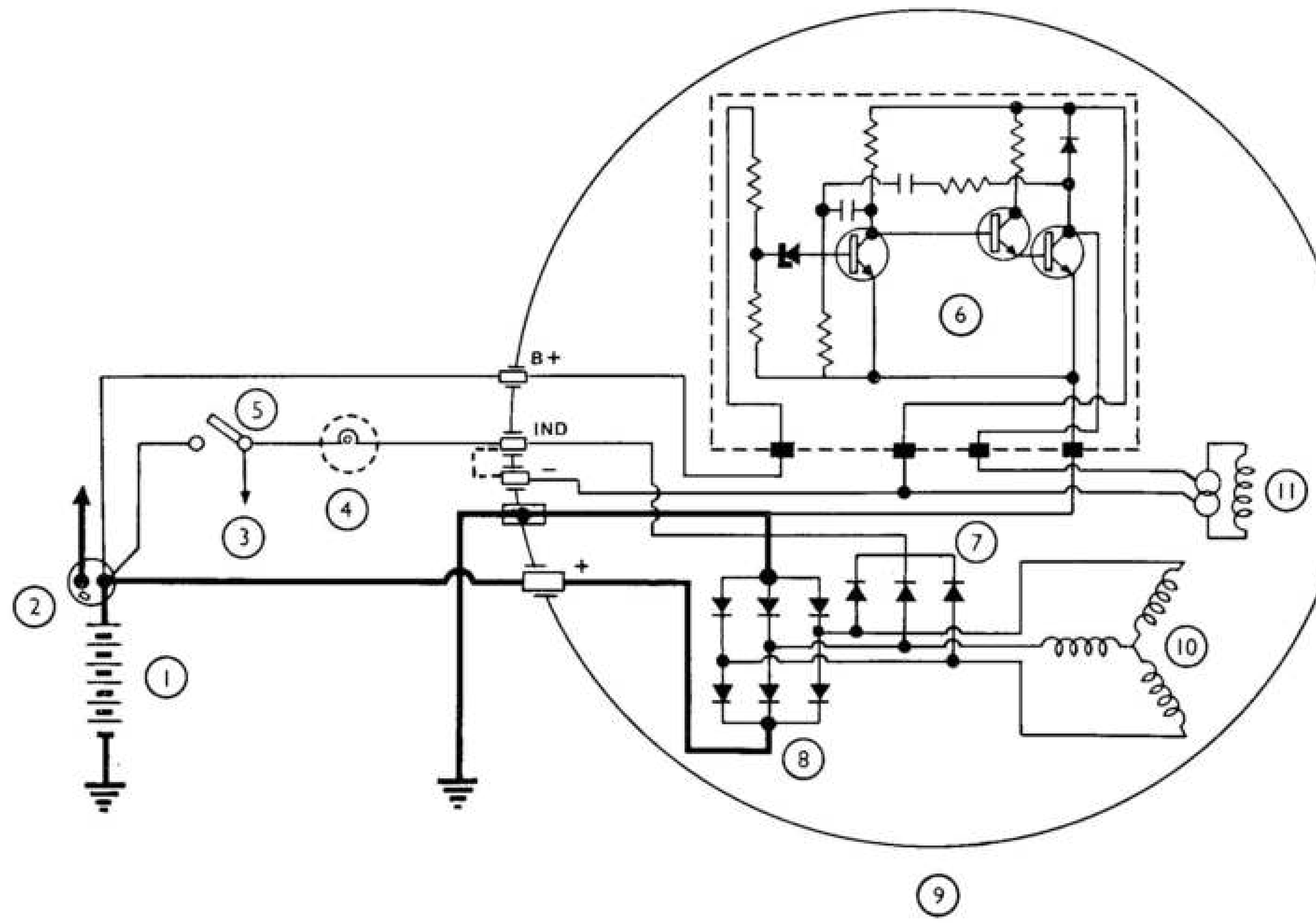


Fig. 65
Charging Circuit

1. Battery
2. Solenoid
3. Ignition loads
4. Charge indicator circuit
5. Ignition switch
6. Regulator
7. Field diodes
8. Output diodes
9. Alternator
10. Stator output windings
11. Fields

15 ACR AND 17 ACR ALTERNATOR FAULT DIAGNOSIS

SYMPTOMS				PROBABLE FAULT
	ALTERNATORS			
WARNING LIGHT	TEMPERATURE	NOISE	OUTPUT	
Normal at standstill. Goes out at cut-in speed. Glows brighter as speed increases.	High	Normal	At 6,000 rev./min. 17 ACR–38 amps. approx. 15 ACR–35 amps. approx.	Output diode open-circuited on supply side.
Light out under all conditions.	High	Excessive	At 6,000 rev./min. 10 amps. approx.	Output diode short-circuited on supply side.
Normal at standstill. Dims at cut-in speed. Gets dimmer or may even be extinguished at higher speeds.	Normal	Excessive	Poor performance at *low speed*. At 6,000 rev./min. 17 ACR–30 amps. approx. 15 ACR–26 amps. approx.	Output diode open-circuited on earth side.
Normal at standstill. Dims at cut-in. Remains dim, or may be extinguished at higher speeds.	Normal	Excessive	Very low at all speeds above cut-in speed. 7 amps. approx.	Output diode short-circuited on each side.
Normal at standstill. Dims at cut-in. Remains dim, or may be extinguished at higher speeds.	Normal	Normal	At 6,000 rev./min. 17 ACR–29 amps. approx. 15 ACR–23 amps. approx.	'Field' diode open-circuited.
Normal at standstill. Dims at cut-in. Remains dim, or may be extinguished at higher speeds.	Normal	Excessive	At 6,000 rev./min. 7 amps. approx.	'Field' diode short-circuited.

THE LUCAS 17 ACR ALTERNATOR

(March 1970 onwards)

A new type of 17-ACR alternator is utilised on all current models of the Transit range. It is a three-phase star wound unit having a built-in 11 TR regulator, which results in a self-contained generating and control unit. The rated output is 36 amps.

Improvements to the internal wiring of the unit have resulted in the elimination of the 'battery sensing' wire (B+) and the separate earth wire (—), used on previous 17-ACR units. The alternator now earths through the casing.

A one-piece connector now connects the remaining two wires to the rear of the alternator (Figs. 67 and 68), these being from the warning light and the starter solenoid.

A relay is now incorporated in the starter switch to solenoid circuit to ensure full voltage reaches the solenoid.

GENERAL PRECAUTIONS

(*a*) NEVER disconnect battery cables from the battery, charging or control circuit, while the engine is running.

(*b*) NEVER "flash" any charging or control cables to earth.

(*c*) NEVER use a high voltage resistance tester ("Megger") for testing alternator circuits.

(*d*) ALWAYS connect a slave battery in parallel, i.e. positive to positive, negative to negative.

(*e*) ALWAYS disconnect the battery earth lead before carrying out any work on the alternator. Note the alternator output lead is live.

(*f*) ALWAYS disconnect the battery leads before connecting a battery charger.

(*g*) ALWAYS disconnect the battery and alternator leads before arc welding on any part of the vehicle.

(*h*) NEVER run an alternator with an open circuit with the rotor fields energised.

(*i*) NEVER use high voltages to test diodes (use 12 volts maximum).

(*j*) NEVER use a lever on the stator or rear housing when adjusting the fan belt.

(*k*) NOTE the polarity of connections to battery, alternator and voltage regulator. Incorrect connections may result in irreparable damage to semi-conductor devices.

ROUTINE MAINTENANCE

(i) **Cleaning**

Periodically, clean the outside of the alternator with paraffin or white spirit moistened cloth.

(ii) **Driving (Fan) Belt**

Occasionally, check that the drive belt is correctly tensioned 12.7 mm. (0.5 in.) total free movement).

If the belt is worn or oily, it should be replaced.

(iii) **Lubrication**

Unnecessary.

(iv) **Cable Terminations**

Occasionally inspect connectors to see that they are clean and tight.

(v) **Voltage Regulator**

Does not require any maintenance.

TESTING THE CHARGING SYSTEM

Alternator Output Test

(i) Check the drive belt for correct tension (12.7 mm. (0.5 in.) total free movement).

(ii) Check all the wiring connections in the charging circuit.

(iii) Remove the connector from the rear of the alternator and switch on the ignition.

Connect a voltmeter between each cable end, in turn, and earth. With the ignition on the voltmeter should read battery voltage. If the reading is incorrect the fault in the wiring must be located and rectified.

(iv) Disconnect the battery earth cable (–) and remove the moulded cover from the rear of the alternator. Refit the cable connector to the alternator.

(v) Insert a 0–60 scale ammeter in the main (+) cable.

(vi) Reconnect the battery earth (–) cable.

Using a "jumper" lead, short together terminals (F) and (–), (Green and Black cables), on the voltage regulator.

(vii) Switch "on" all vehicle lighting (headlamps on main beam).

(viii) Switch "on" the auxiliary switch (ignition) and check that the warning lamp is illuminated.

Start the engine and slowly increase speed.

At about 1,500 rev./min. (alternator) the warning light should go out, increase the engine speed until the alternator is running at 6,000 rev./min. (about half-throttle). If the alternator is satisfactory, the ammeter should indicate the rated output of the machine (36 amp.).

If the alternator output differs appreciably from the specified figure, remove the alternator for a detailed bench examination.

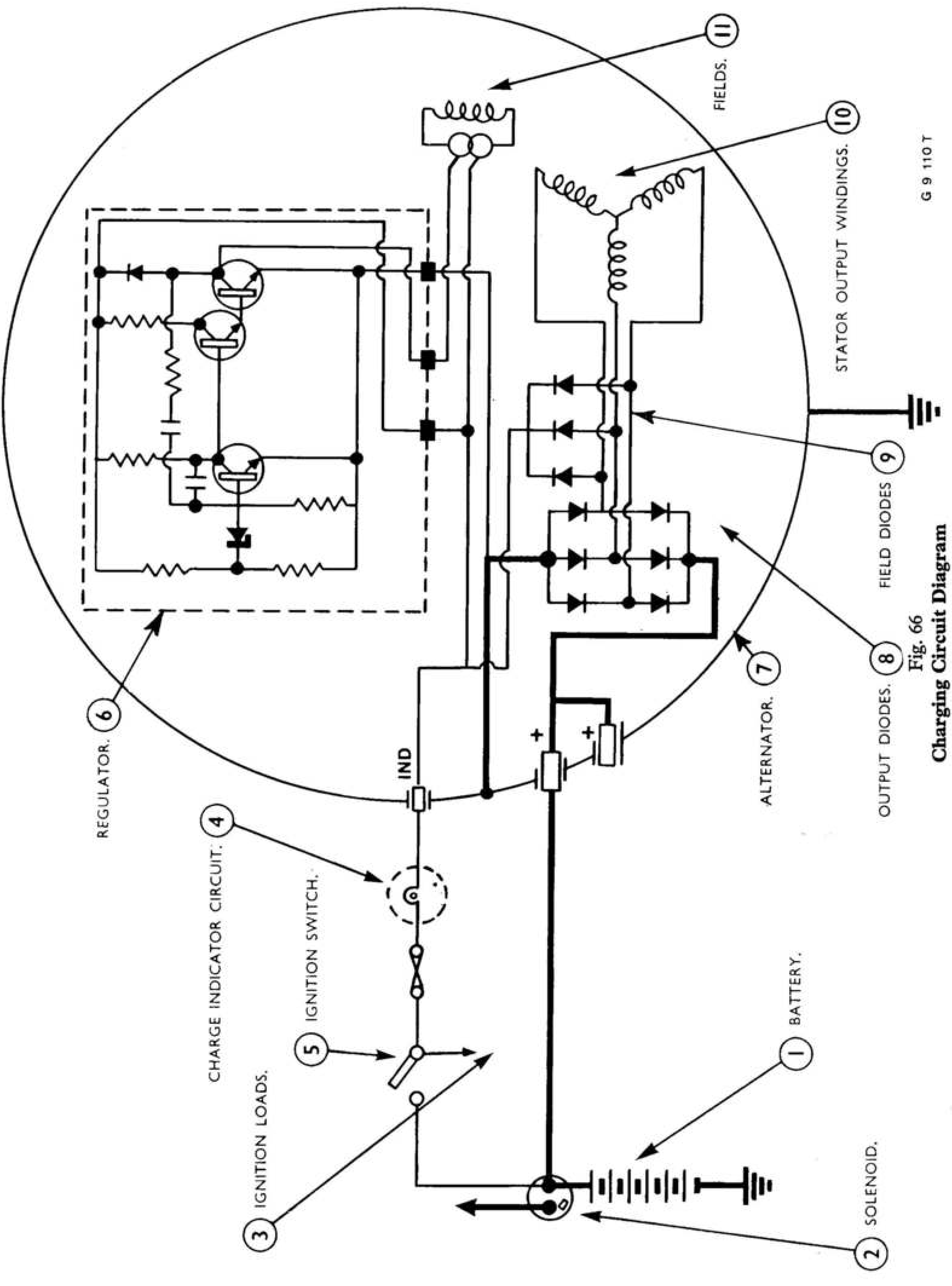


Fig. 66
Charging Circuit Diagram

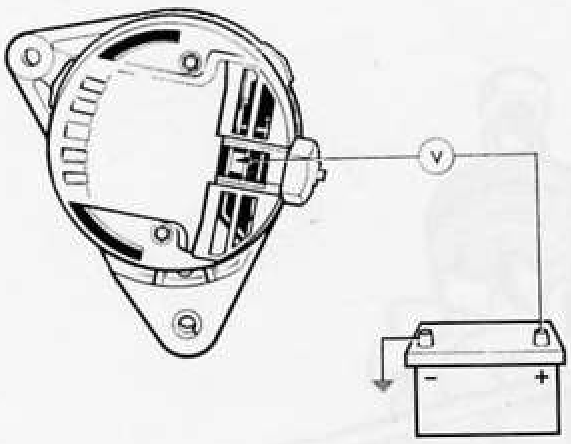


Fig. 67
Volts Drop Test (Live Side)

If the alternator output is satisfactory, check the voltage regulator setting.

NOTE.—The output figures quoted are nominal (hot) values, and may be exceeded if the alternator is tested when cold. To avoid misleading results, the machine should be run for three or four minutes before performing the output test. The diode fault finding chart (see Page 64) shows how diode failure affects the alternator output. There will also be an increase in the operating temperature and the noise level. Care should be taken to distinguish between mechanical noises caused by damaged bearings, loose mounting brackets, etc. and electrical noises caused by short-circuited and open-circuited diodes.

Charging Circuit Volts Drop Test

A high resistance in the charging circuit, such as a connector which is loose, dirty, or corroded, will affect the alternator output. The following tests should be used to check for a high resistance in the charging circuit. A good quality low-range voltmeter is required, to enable readings to be taken accurately to 0.25 volt. The procedure is as follows:

(i) Connect the voltmeter red lead to the alternator main (+) terminal, black lead to battery (+) terminal (see Fig. 67).

(ii) Switch "on" the headlamps (main beam).

(iii) Start the engine, and increase the speed until the alternator runs at approximately 6,000 rev./min. Note the voltmeter reading.

(iv) Transfer the voltmeter connections to the alternator casing (earth) and the negative terminal of the battery (see Fig. 68). Repeat (iii) and again note the voltmeter reading. If the reading exceeds 0.5 volt on the positive (live) side, or 0.25 volt on the negative (earth) side, a high resistance in the charging circuit is indicated.

This must be traced and rectified.

All cables and connections (including the battery earth cable) should be carefully examined. Rectify any loose, dirty, or corroded connectors.

Voltage Regulator Test

Ensure that the wiring and connections in the charging circuit are satisfactory. In particular, the circuit resistance between alternator casing (earth) and battery (−) terminal must not exceed 0.003 ohm. To check the charging circuit the Voltage Drop Test should be carried out.

If the battery is discharged, temporarily replace with a similar battery in a well charged state.

Then proceed as follows:

(i) Connect a good quality voltmeter (a suppressed zero, or extended scale type 12–15 volts) between the main terminals of the battery.

(ii) Insert an ammeter, scale 0–60 amp. in series with the alternator main output (+) cable at its connection with the starter solenoid.

(iii) Start the engine and run the alternator at approximately 5,000 rev./min. until the ammeter shows an output current not exceeding 7.5 amp. The voltmeter should now read 14.1 to 14.4 volts.

If the readings obtained are unstable or outside the specified limits, the voltage regulator is faulty, and a replacement unit must be fitted. The unit is not adjustable and its component parts cannot be serviced individually.

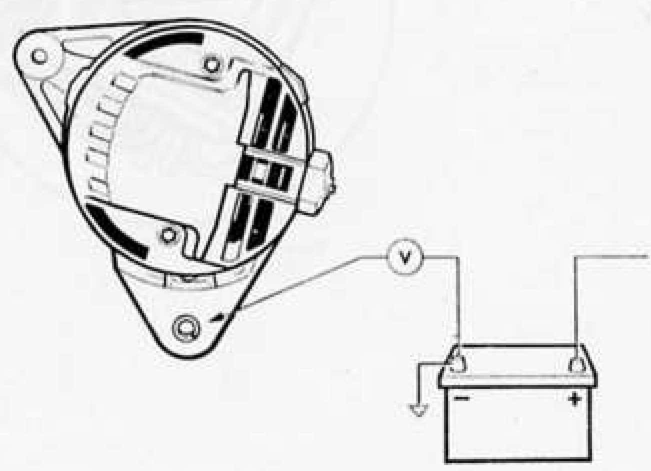


Fig. 68
Volts Drop Test (Earth Side)

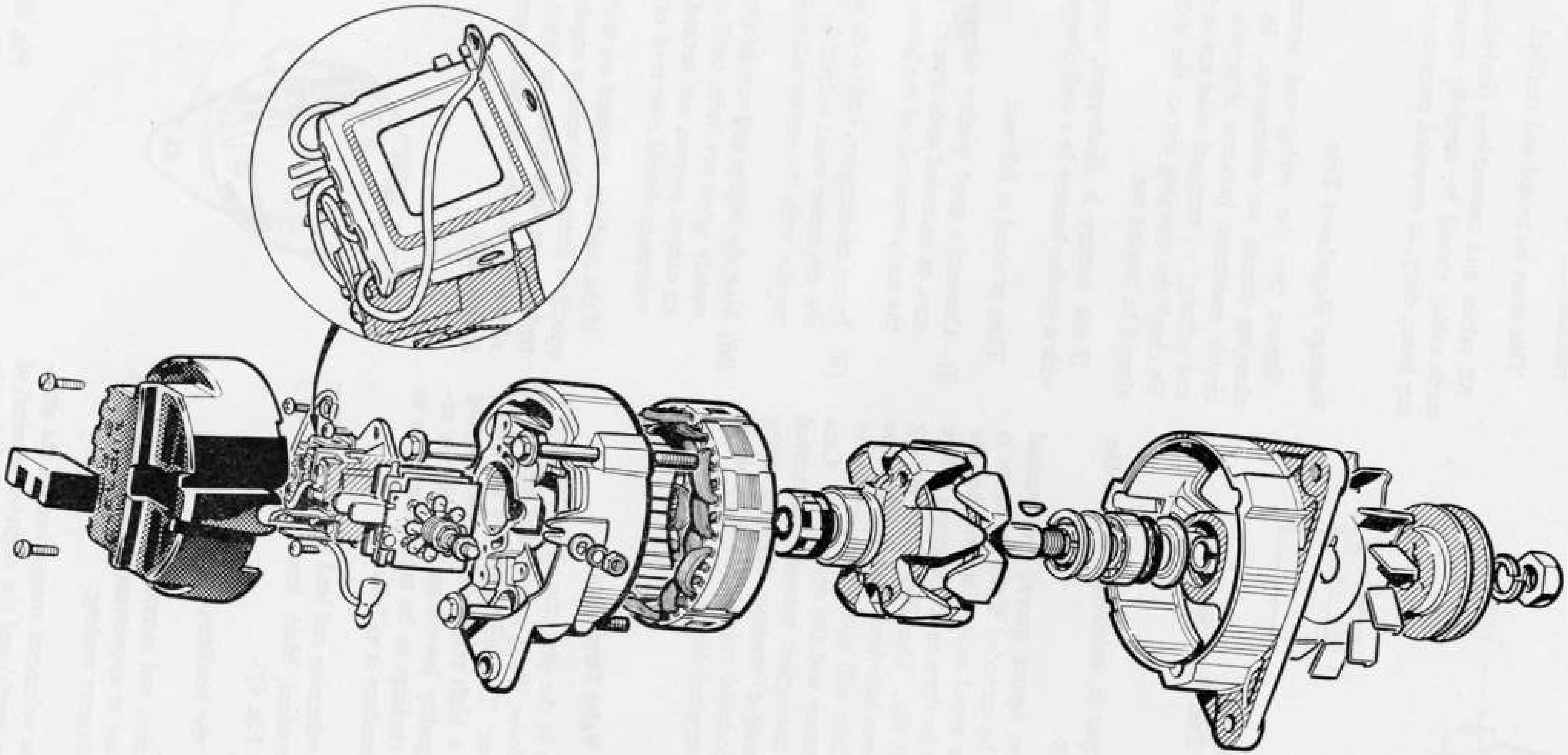


Fig. 69
Alternator — Exploded

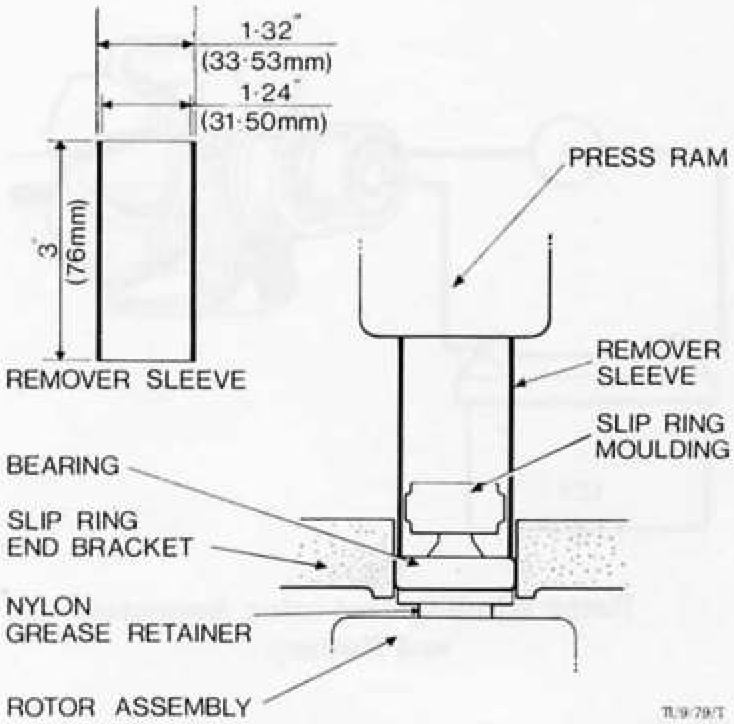


Fig. 70
Remover Sleeve

To Remove the Alternator

1. Disconnect the battery earth wire (–).

2. Disconnect the cable connector from the rear of the alternator.

3. Remove the alternator adjusting arm bolt, slacken the alternator mounting bolts and remove the driving (fan) belt.

4. Remove the mounting bolts and remove the alternator from the vehicle.

To Dismantle

1. Withdraw the two securing screws and remove the alternator end cover.

2. Disconnect the yellow lead from the rectifier terminals.

3. Unscrew the two securing screws for the brush moulding and also the screw which holds the regulator case to the end bracket. Withdraw the brush moulding complete with the regulator. If required, the regulator can be separated from the brush moulding by removing the screws which secure the regulator (top). Also the three screws, which secure the regulator yellow, red and green leads to the brush moulding connectors.

4. Grip the output diode pins in turn with a pair of long-nosed pliers (see Fig. 71). Unsolder the three leads connecting the stator to the diodes. Note the order in which the connections are made (see Diode Tests for re-soldering procedure).

5. Slacken the rectifier fixing nut sufficiently to allow the assembly to be withdrawn from its moulding.

6. Mark end brackets and stator for reassembly. Remove the three through bolts securing the end casings together.

7. Support the slip ring end bracket and press out the rear bearing complete with rotor.

NOTE.—To avoid damaging the slip ring moulding or the end bracket a sleeve with the following dimensions should be used (see Fig. 70).

Length	76.00 mm. (3.00 in.).
Outside Diameter	33.52 mm. (1.32 in.).
Inside Diameter	31.50 mm. (1.24 in.).

Position the sleeve over the slip ring moulding so that it contacts the outer track of the slip ring end bearing. To allow the sleeve to pass freely over the slip ring it may be necessary to file away any surplus solder on the slip ring terminals. Remove the "O" ring.

8. Carefully separate the stator assembly from the end bracket.

9. Remove the nut, washers, pulley, fan and key from the drive end of the rotor.

10. Support the drive bracket and press out the rotor and drive end bearing. Do not lose the spacers located either side of the bearing.

TEST AND INSPECTION

Brush Gear

The length of the brush when new is 12.6 mm. (½ in.). The serviceability of a brush may be estimated by measuring the amount which protrudes beyond the brush-box moulding when the brush is in the free position. Renew if the brush protrusion is less than 5 mm. (0.2 in.). Remove the screws in the rear of the moulding and withdraw the brushes. Ensure that the special leaf spring is fitted, when the centre brush is replaced.

Check the brush spring pressures, by means of a push-type spring gauge. The brush should be pushed back against the spring, so that the brush face is flush with the housing. The brush assembly should be replaced if the reading is appreciably outside the limits 198 to 283 g. (7 to 10 oz.) and the brush is not "partially seized".

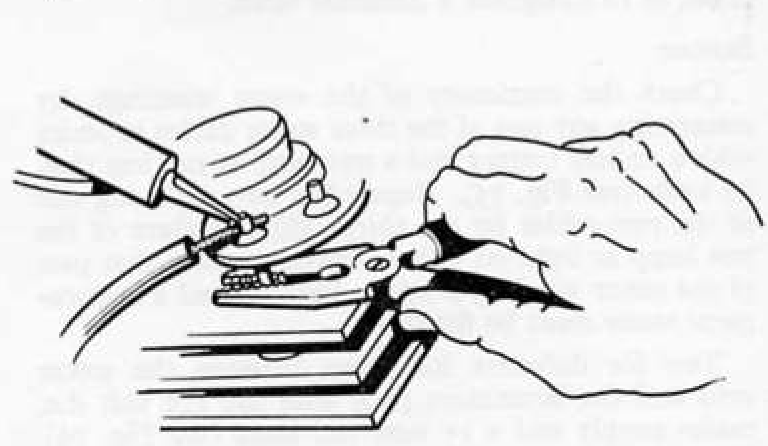


Fig. 71
Use of Pliers as Thermal Shunt

A "seized" brush should be cleaned with a petrol-moistened cloth or, if necessary, by lightly polishing the brush sides on a smooth file.

Slip Rings

The surfaces of the slip ring should be smooth and clean. Remove any contamination with a petrol-moistened cloth. If there is evidence of burning, clean the slip rings with a very fine glass paper. Do not use emery cloth or similar abrasive. No attempt must be made to machine (skim) the slip rings, as the high speed performance may be adversely affected.

Rotor

Test the rotor winding by connecting either an ohmmeter (see Fig. 72) or a 12 volt battery and ammeter (see Fig. 73) between the slip rings. The resistance should be approximately 4.165 ohms or the value of current approximately 3 amp. Test for defective insulation between one of the slip rings and the rotor poles using a 110 volt d.c. mains supply and a 15 watt test lamp (see Fig. 74). If the lamp lights, the coil is earthed to the rotor core, and a replacement rotor/slip ring assembly must be fitted.

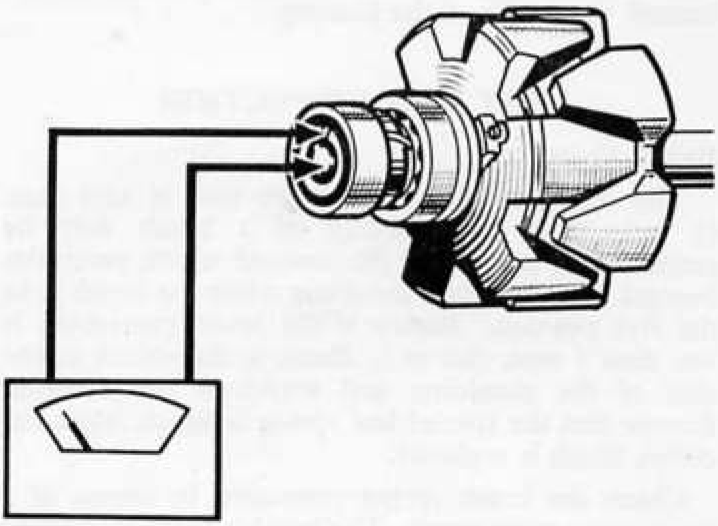


Fig. 72
Rotor Winding Test using Ohmmeter

No attempt must be made to machine the rotor poles, or to straighten a distorted shaft.

Stator

Check the continuity of the stator windings, by connecting any two of the three stator cables in series with a 12 volt battery and a test lamp of not less than 36 watts (see Fig. 75). Repeat the test, replacing one of the two cables by the third cable. Failure of the test lamp to light on either occasion means that part of the stator winding is open-circuited and a replacement stator must be fitted.

Test for defective insulation between the stotor coils and the lamination pack with the 110 volt d.c. mains supply and a 15 watt test lamp (see Fig. 76). Connect the test probes between any one of the three cable ends and the lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

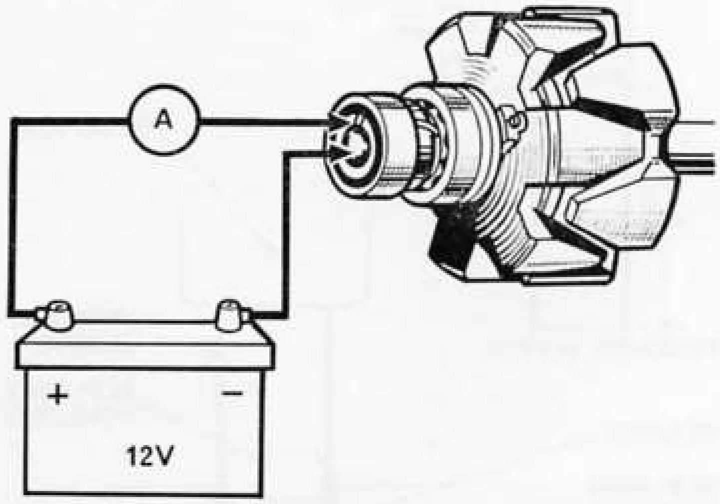


Fig. 73
Rotor Winding Test using Ammeter and Battery

Diodes

Do not attempt to dismantle the rectifier pack.

Connect each of the nine diode pins, in turn, in series with a 1.5 watt test bulb and one terminal of a 12 volt battery (see Fig. 77). Connect the other terminal to the particular heat sink to which the diode under test is soldered. Next, reverse the connections to diode pin and heat sink. The bulb should light in one test only. If the bulb lights in both tests, or does not light in either, the diode is defective and a new rectifier pack must be fitted.

Drive End Bearing

The drive end bearing, grease retainers, "O" ring and the felt seal can be pressed from the end bracket after removal of the circlip. To reassemble, place the felt seal in the bracket followed by a grease retainer, (centre "dish" away from bearing) and the "O" ring. Press in the bearing, position the remaining grease retainer on the bearing (centre dish away from bearing) and insert the circlip.

Slip Ring End Bracket

Unsolder the field windings from the slip ring moulding assembly and withdraw the moulding from the shaft. Press the bearing from the shaft noting that the shielded side faces the slip ring moulding.

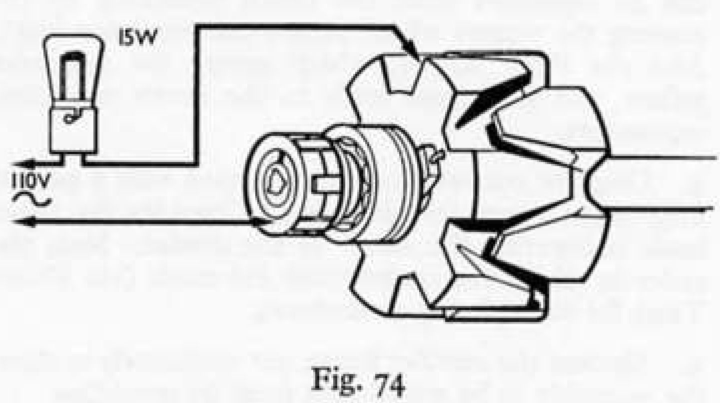


Fig. 74
Insulation Test, Rotor

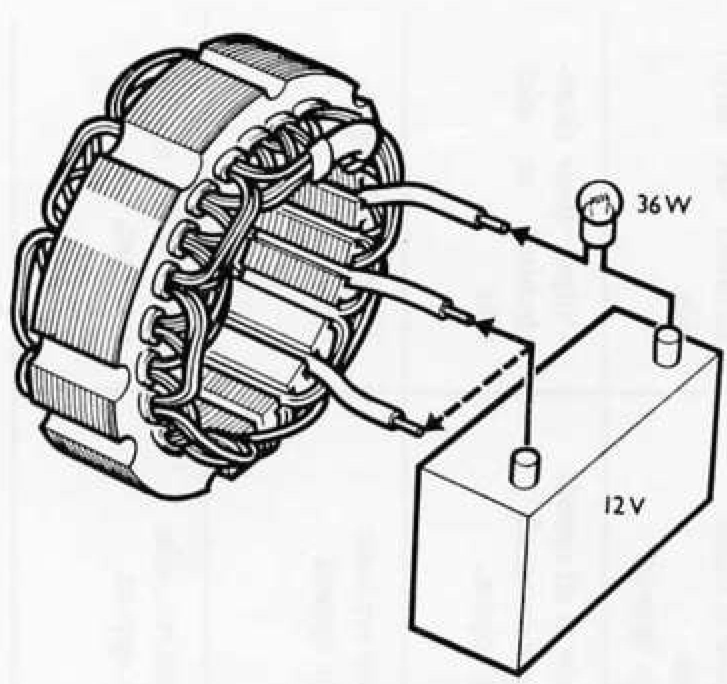


Fig. 75
Stator Winding Continuity Test

Fit the new bearing, and re-engage the slip ring moulding with the slot in the rotor shaft. Finally, remake the field to slip ring connections using a high melting point solder. "Frys" HT3 solder or equivalent.

NOTE.—The correct lubricant for the alternator bearings is Shell "Alvania R.A." or equivalent.

To Reassemble

1. Locate the spacer on the rotor shaft.

Press the rotor shaft into the drive end bearing. Fit the spacer, key, fan, pulley, washers and nut. Tighten the nut to a torque of 8.3 to 11.1 kg.m. (60 to 80 lb. ft.).

2. Fit a new "O" ring to the slip ring and bracket.

Position the stator assembly on the drive end bracket, carefully press the slip ring end bracket over the slip ring end bearing, fit the through bolts and tighten them evenly to a torque of 0.525 to 0.576 kg.m. (45 to 50 lb. in.).

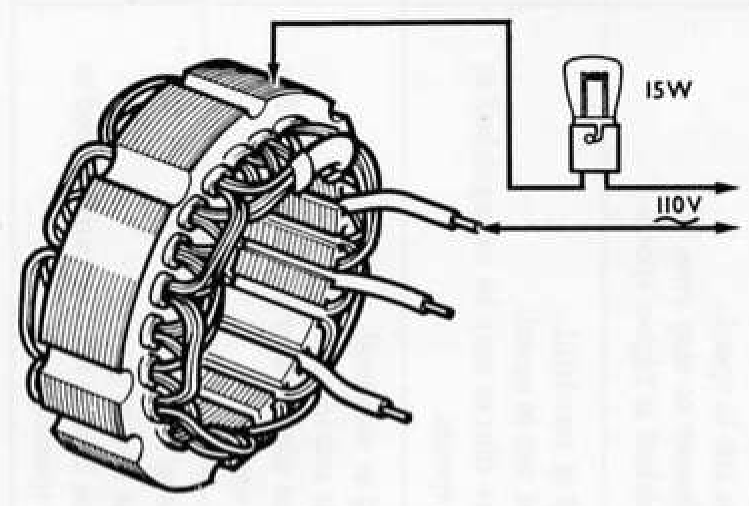


Fig. 76
Insulation Test, Stator

3. Fit the rectifier pack and tighten the nut to 0.42 to 0.46 kg.m. (35 to 40 lb. in.) torque.

When re-soldering the stator cables to the diode pins, use a low melting point solder, "M" grade 45/55 tin-lead solder, or equivalent. Avoid overheating the diodes or bending the diode pins. The diode pins should be lightly gripped with a pair of long-nosed pliers, or similar tool (to act as a thermal shunt against overheating see Fig. 71) and soldering must be carried out as quickly as possible.

4. Fit the regulator to the brush housing and reconnect the wires.

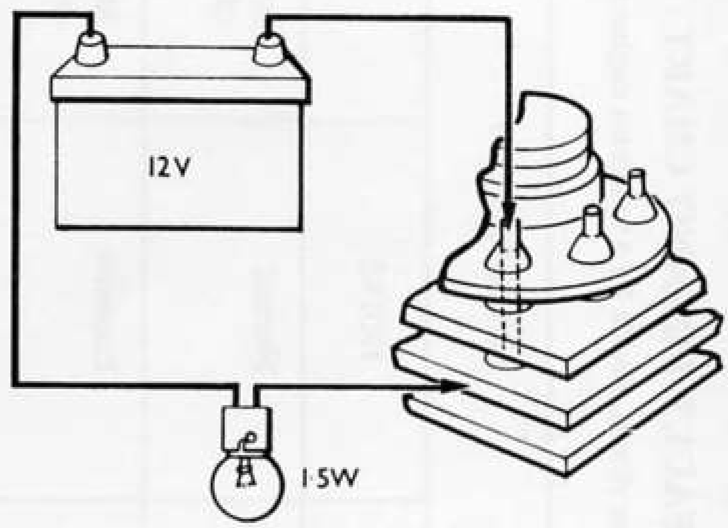


Fig. 77
Diode/Rectifier Pack Test

5. Check the brushes are correctly positioned in their housing (ensure the centre brush is fitted with the special leaf spring) and fit the brush housing to the alternator. Tighten the two screws securely.

6. Connect the yellow lead to the rectifier terminal.

7. Fit the end cover and securing screws.

To Refit

1. Position the alternator on the engine and fit the mounting bolts.

2. Fit the fan and adjust to give 12.7 mm. (0.5 in.) total movement when the belt is pulled and pushed at a point midway between the alternator and water pump pulleys. Tighten the mounting bolts securely.

3. Connect the wiring to the alternator and reconnect the battery.

DIODE FAULT FINDING CHART

(Alternator rev./min. are shown, divide by 2 to obtain engine rev./min.)

SYMPTOMS:

WARNING LIGHT	ALTERNATORS			PROBABLE FAULT
	TEMPERATURE	NOISE	OUTPUT	
Normal at standstill. Goes out at cut-in speed. Glows brighter as speed increases.	High	Normal	At 6,000 rev./min. 38 amp. approx.	Output diode open-circuited on supply side.
Light out under all conditions.	High	Excessive	At 6,000 rev./min. 10 amp. approx.	Output diode short-circuited on supply side.
Normal at standstill. Dims at cut-in speed. Gets dimmer or may even be extinguished at higher speeds.	Normal	Excessive	Poor performance at *Low speed* at 6,000 rev./min. 30 amp. approx.	Output diode open-circuited on earth side.
Normal at standstill. Dims at cut-in speed. Remains dim or may be extinguished at higher speeds.	Normal	Excessive	Very low at all speeds above cut-in speed 7 amp. approx.	Output diode short-circuited on each side.
Normal at standstill. Dims at cut-in speed. Remains dim or may be extinguished at higher speeds.	Normal	Normal	At 6,000 rev./min. 29 amp. approx.	Field diode open-circuited.
Normal at standstill. Dims at cut-in speed. Remains dim or may be extinguished at higher speeds.	Normal	Excessive	At 6,000 rev./min. 7 amp. approx.	Field diode short-circuited.

WIRING DIAGRAMS

(Prior to September 1968)

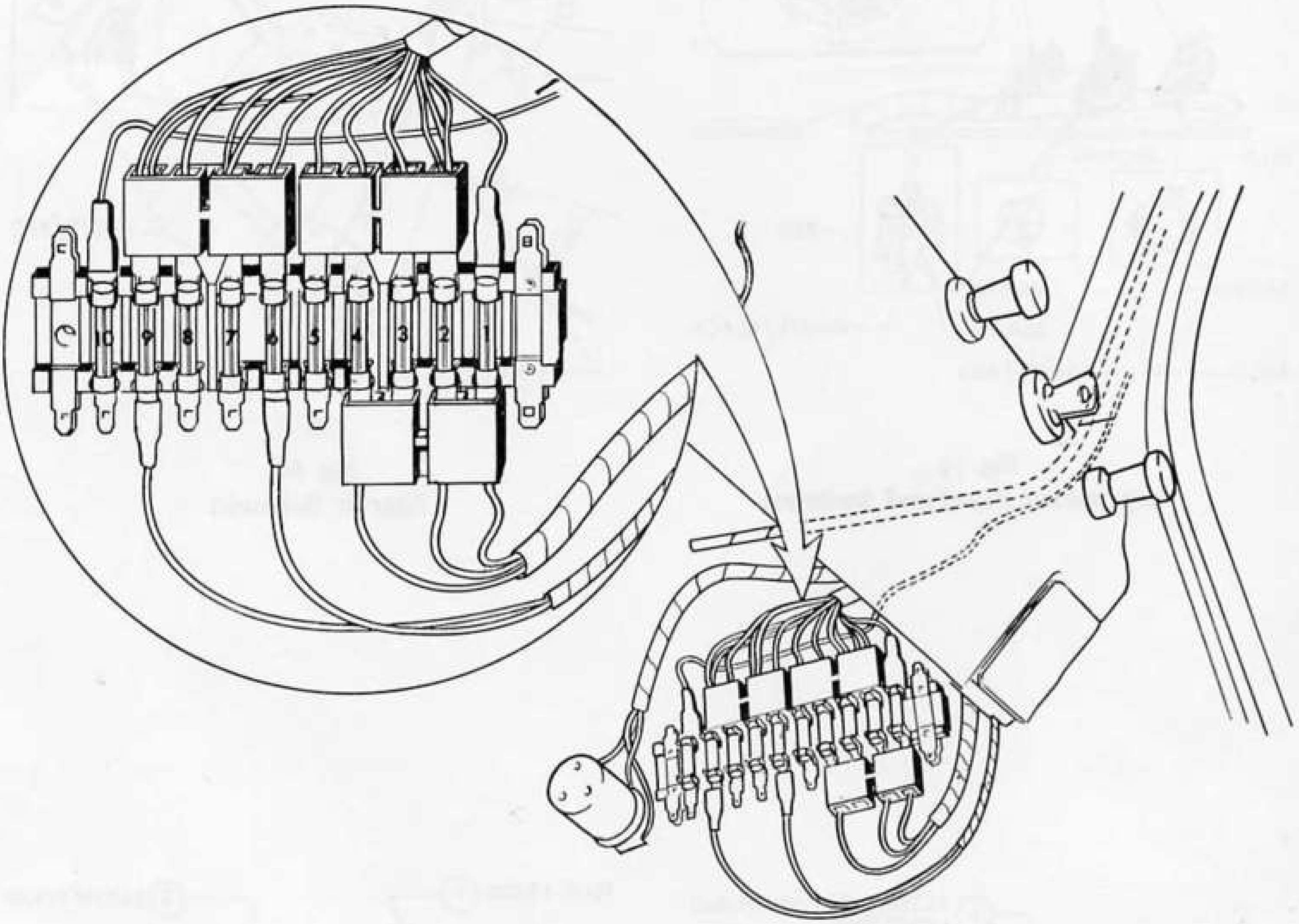


Fig. 78

FUSE BLOCK

Fuse No. 1 10 amp Interior Light

Fuse No. 2 10 amp Instrument Panel Lights, R. H. Side Lights

Fuse No. 3 10 amp L. H. Side Lights

Fuse No. 4 10 amp R. H. Main Beam, Main Beam Warning Light.

Fuse No. 5 10 amp L. H. Main Beam.

Fuse No. 6 10 amp R. H. Dipped Beam.

Fuse No. 7 10 amp L. H. Dipped Beam

Fuse No. 8 10 amp Instrument Panel, Direction Indicator Unit

Fuse No. 9 20 amp Horn, Headlight Flasher Stoplight Switch.

Fuse No. 10 20 amp Alternator Relay, Windscreen Wiper.

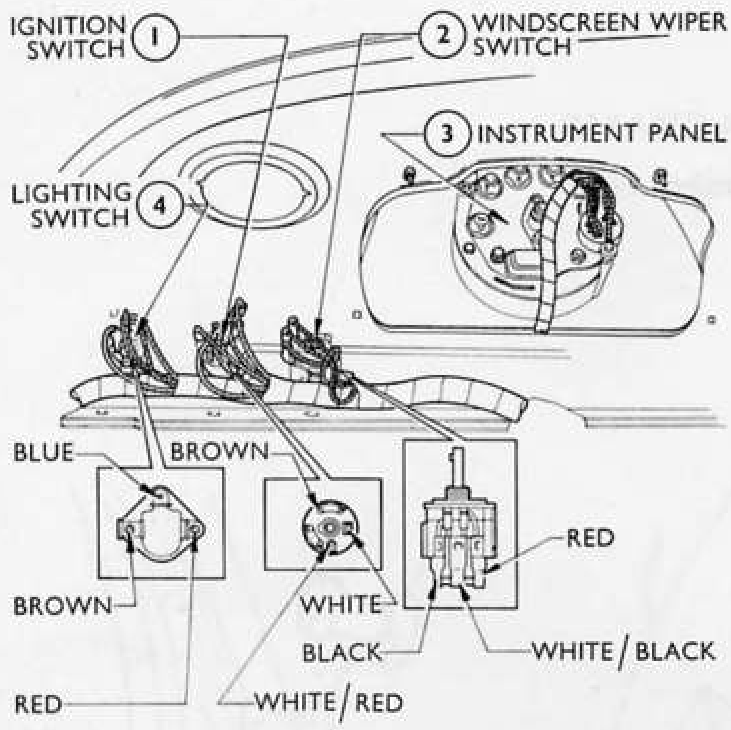


Fig. 79
Instrument Panel and Switches

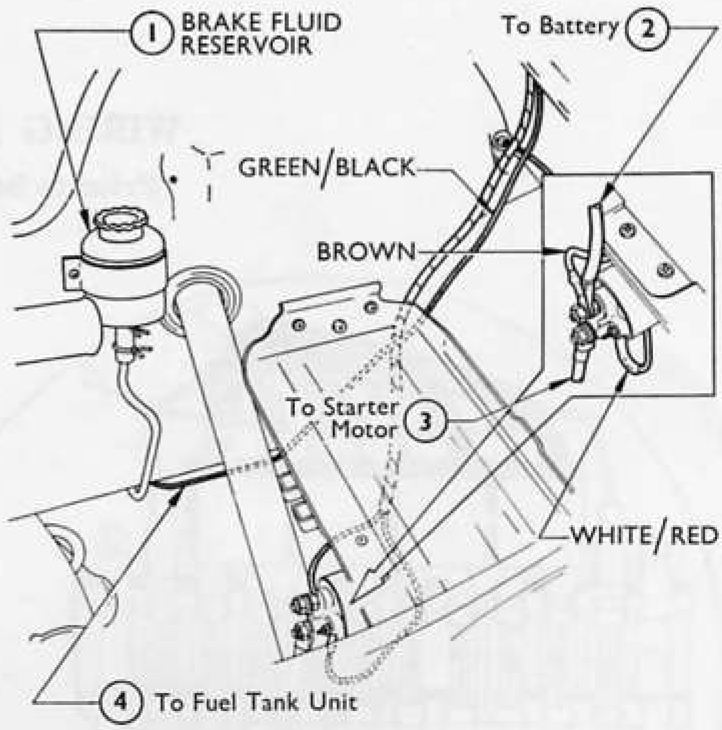


Fig. 80
Starter Solenoid

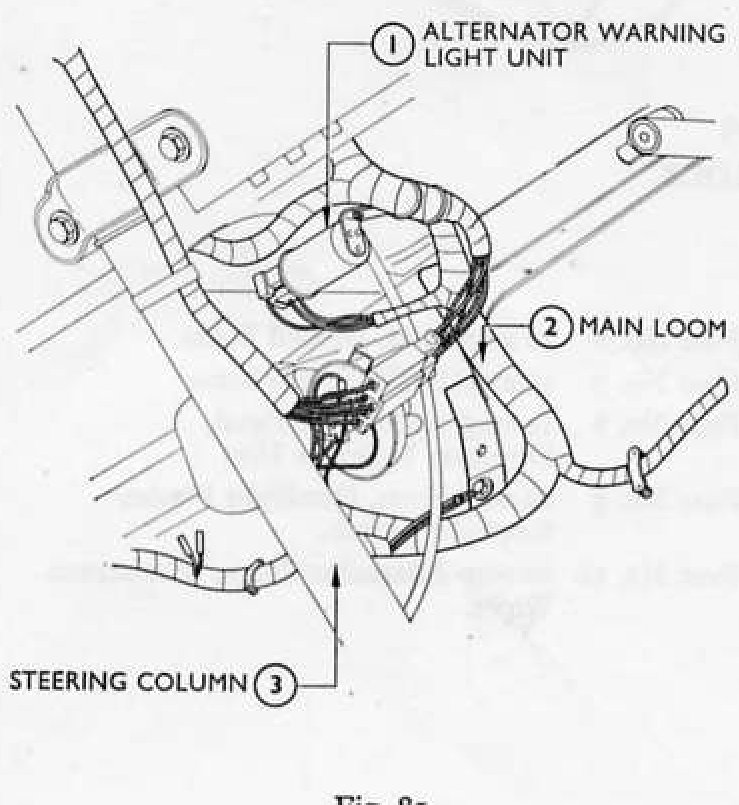


Fig. 81
Alternator Warning Light Unit

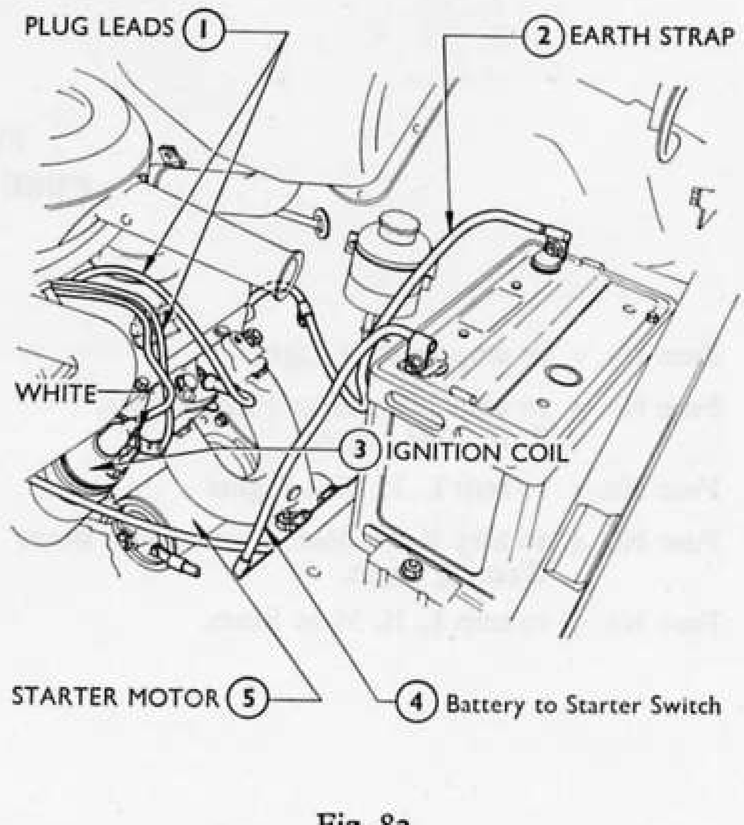
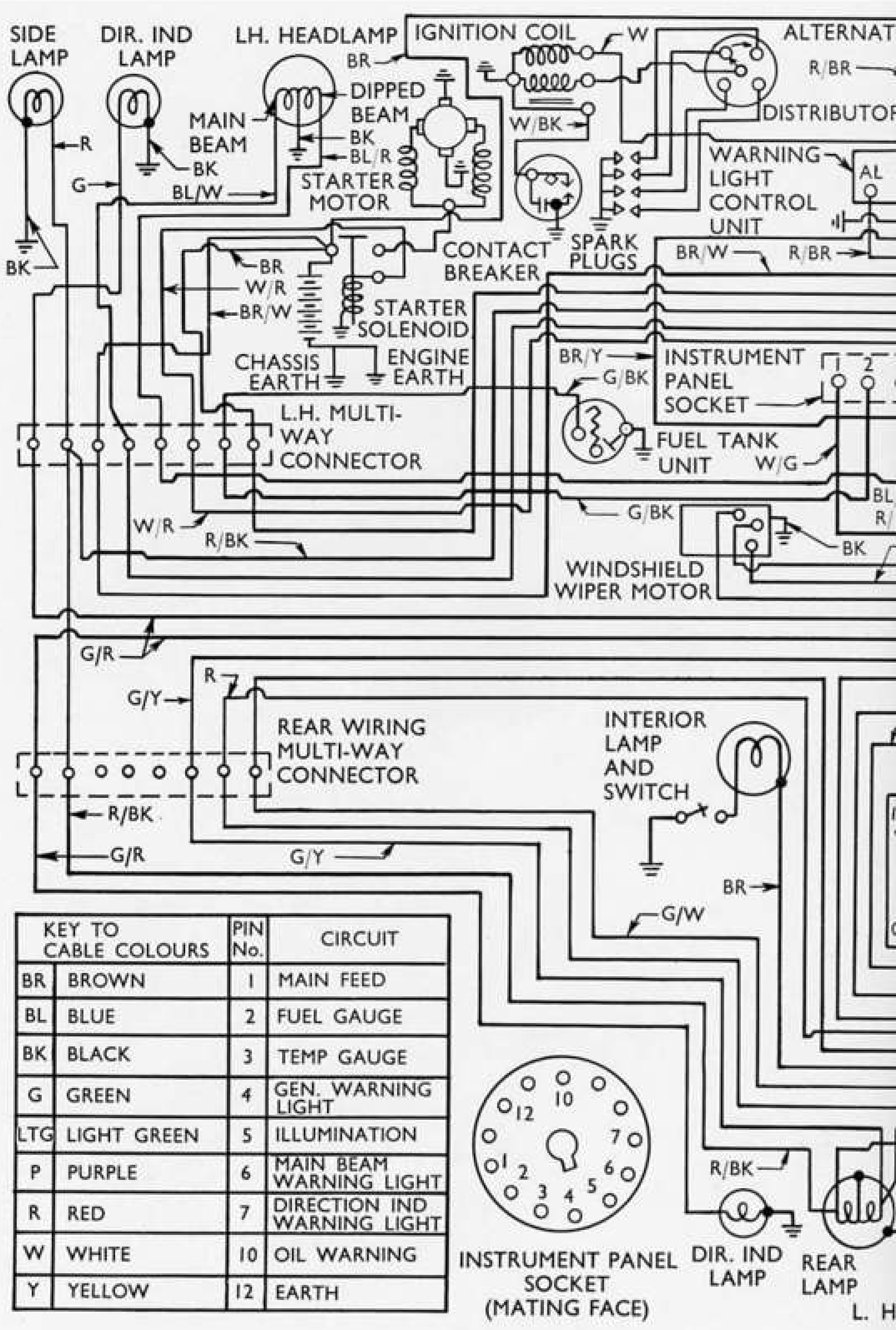


Fig. 82
Engine Compartment



KEY TO CABLE COLOURS		PIN No.	CIRCUIT
BR	BROWN	1	MAIN FEED
BL	BLUE	2	FUEL GAUGE
BK	BLACK	3	TEMP GAUGE
G	GREEN	4	GEN. WARNING LIGHT
LTG	LIGHT GREEN	5	ILLUMINATION
P	PURPLE	6	MAIN BEAM WARNING LIGHT
R	RED	7	DIRECTION IND WARNING LIGHT
W	WHITE	10	OIL WARNING
Y	YELLOW	12	EARTH

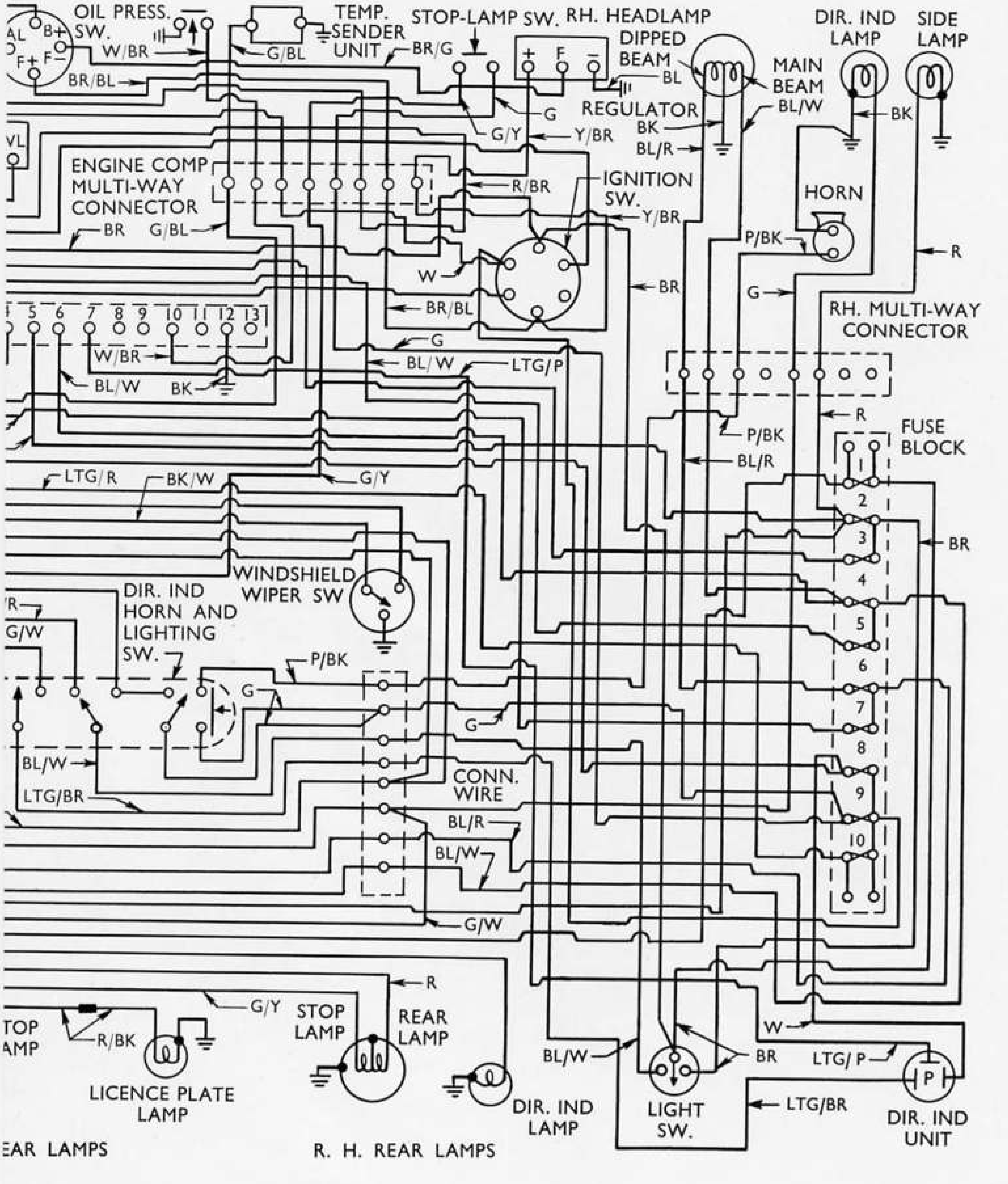
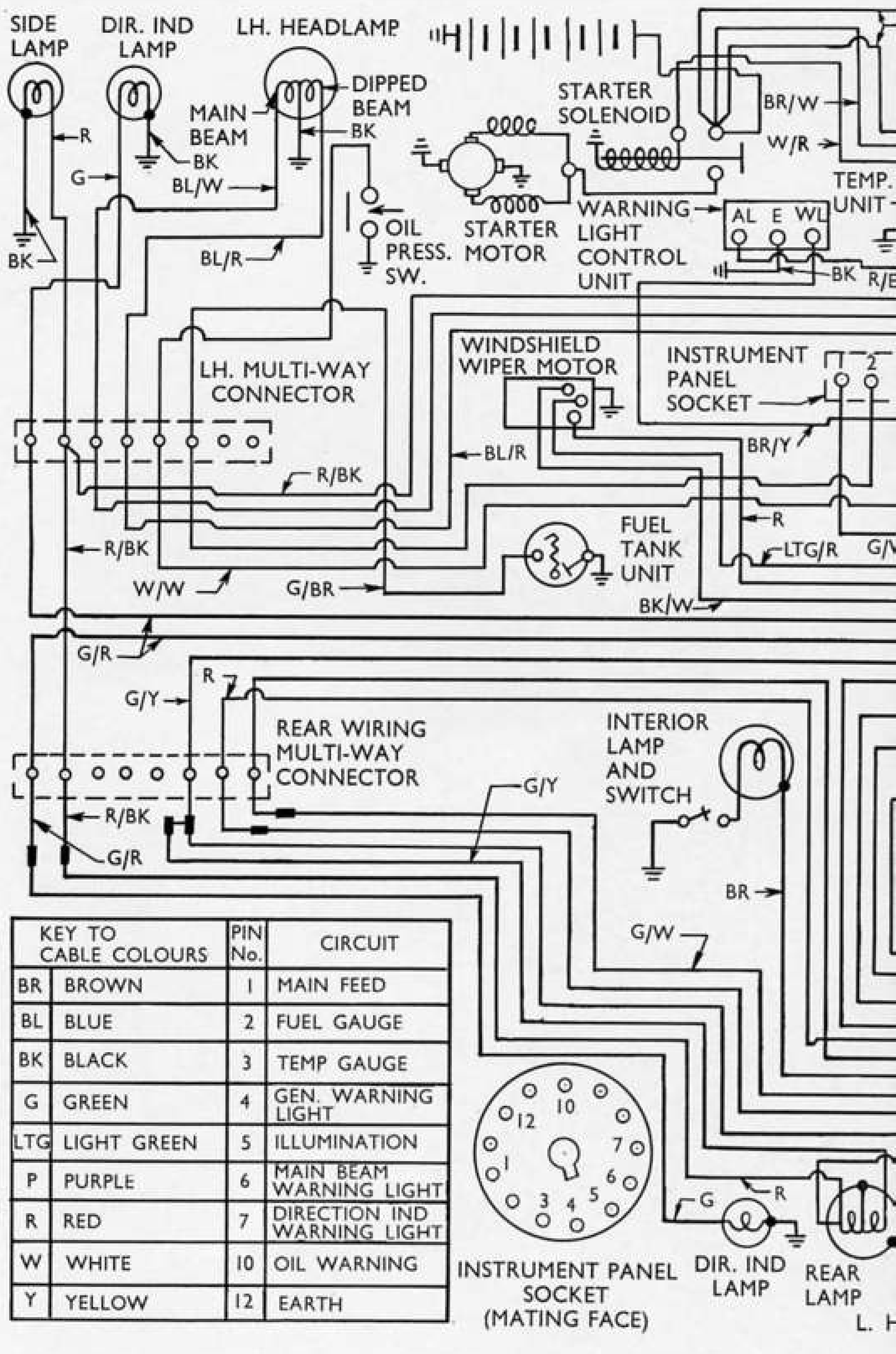


Fig. 83
g Diagram - Petrol



KEY TO CABLE COLOURS		PIN No.	CIRCUIT
BR	BROWN	1	MAIN FEED
BL	BLUE	2	FUEL GAUGE
BK	BLACK	3	TEMP GAUGE
G	GREEN	4	GEN. WARNING LIGHT
LTG	LIGHT GREEN	5	ILLUMINATION
P	PURPLE	6	MAIN BEAM WARNING LIGHT
R	RED	7	DIRECTION IND WARNING LIGHT
W	WHITE	10	OIL WARNING
Y	YELLOW	12	EARTH

Wi

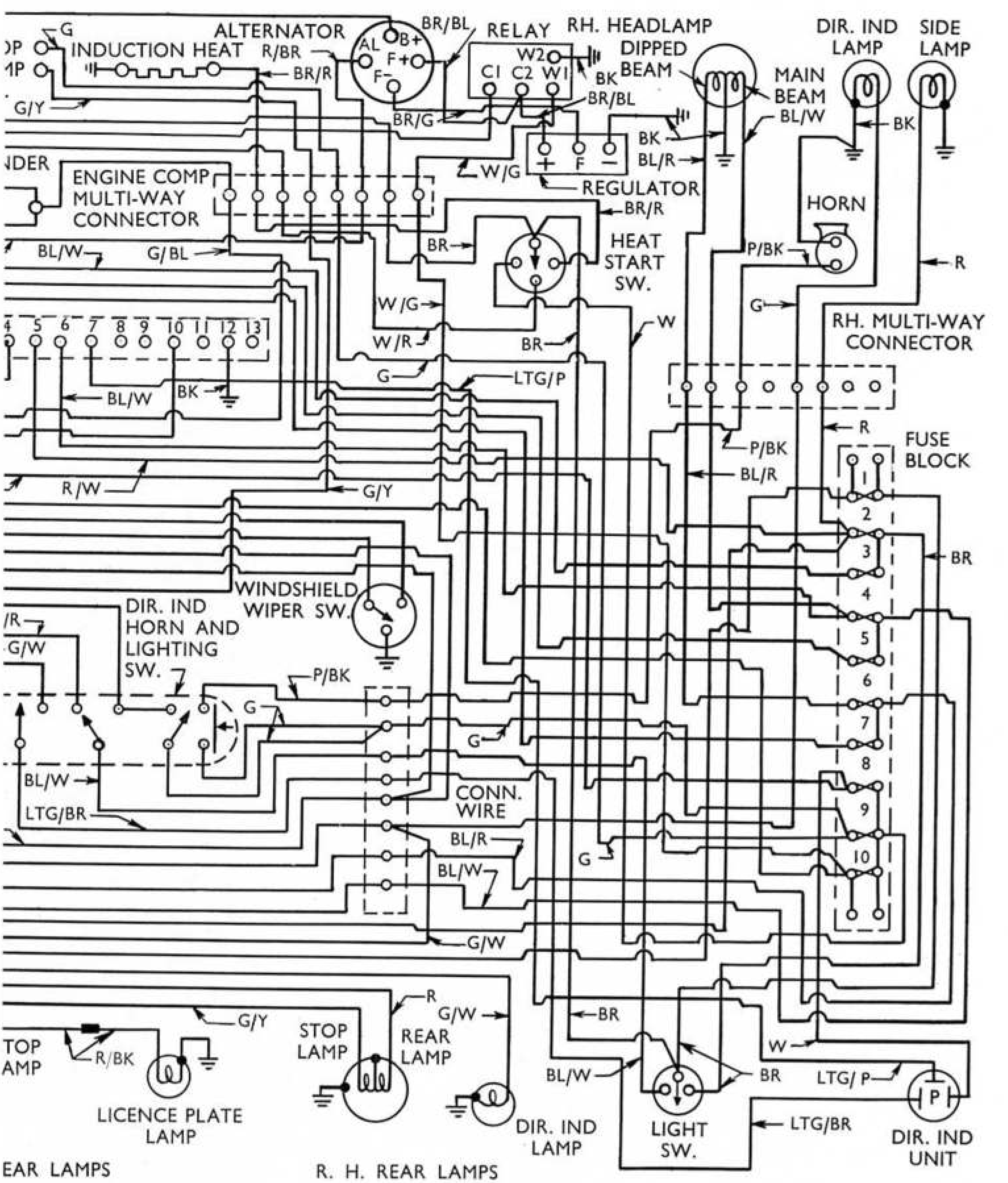


Fig. 84
g Diagram - Diesel

X

WIRING DIAGRAMS

(September 1968 to September 1970)

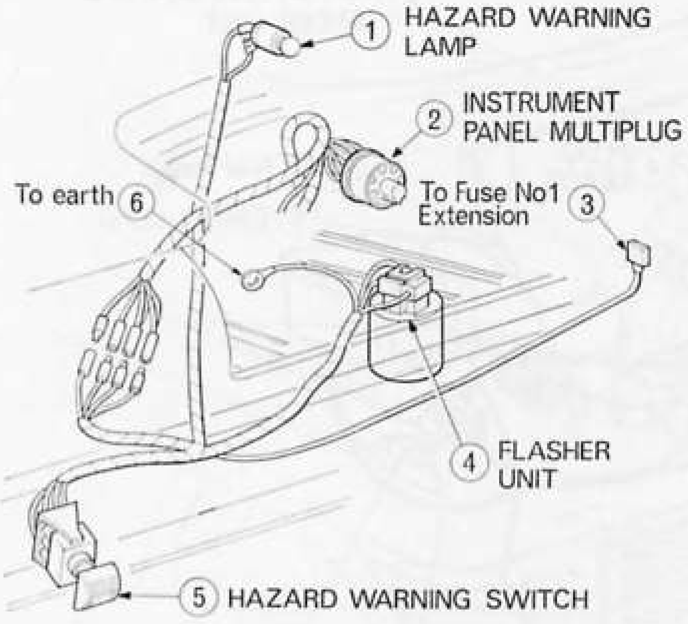


Fig. 85
Hazard Warning

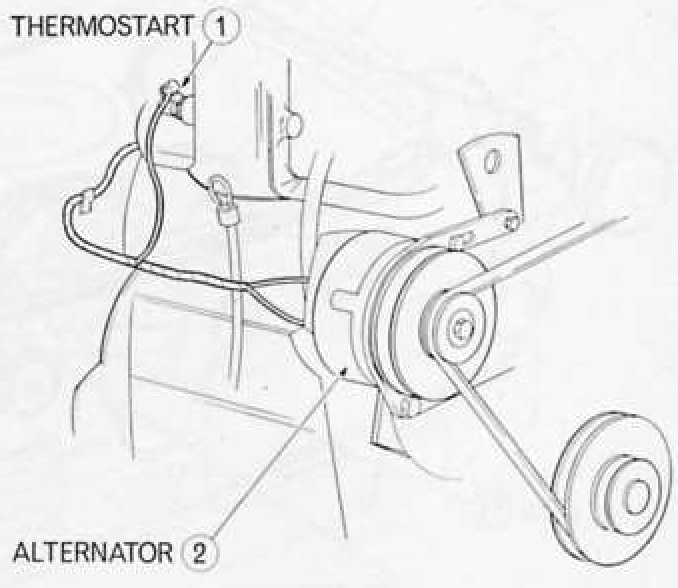


Fig. 86
Thermostart

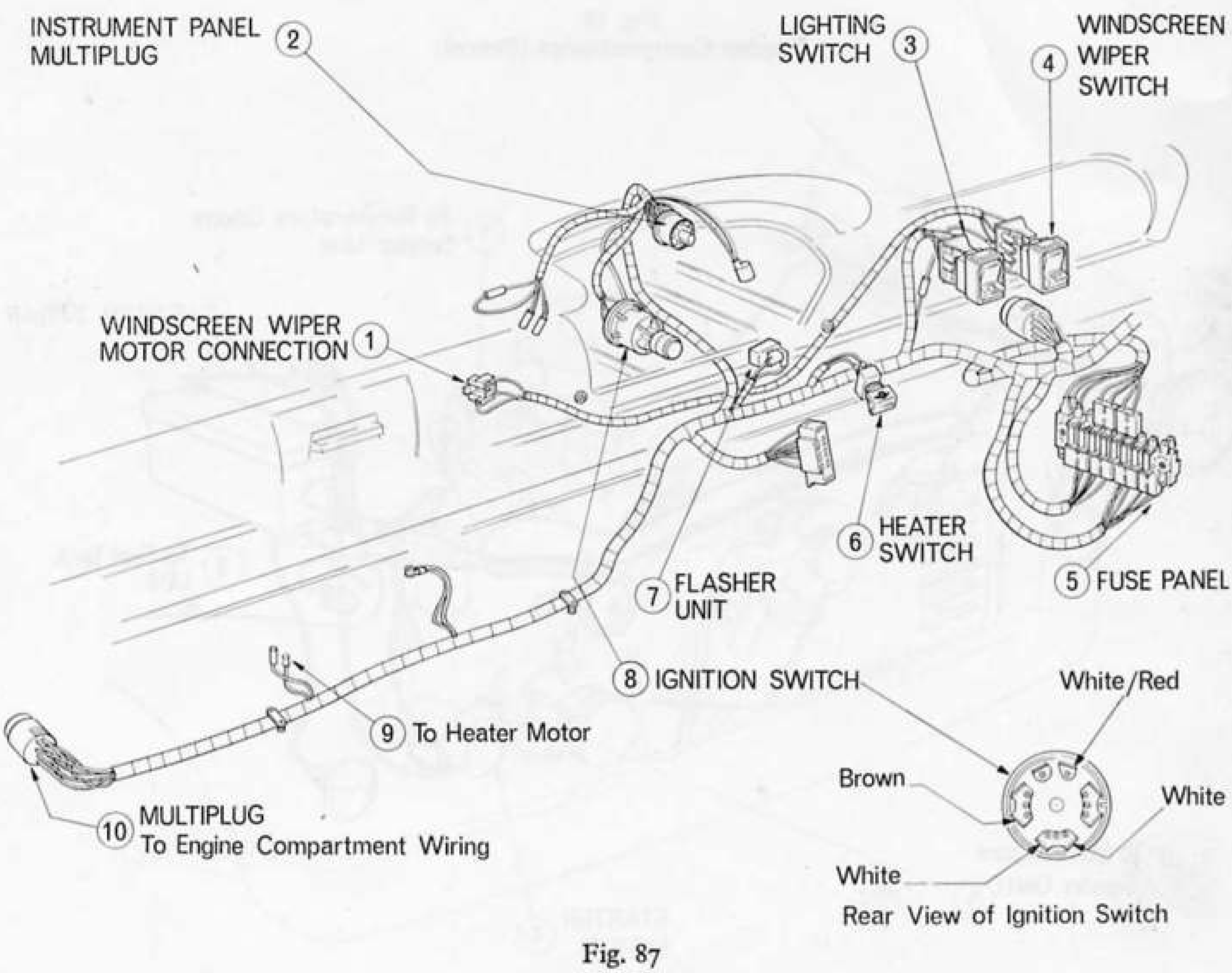


Fig. 87
Dashboard Wiring

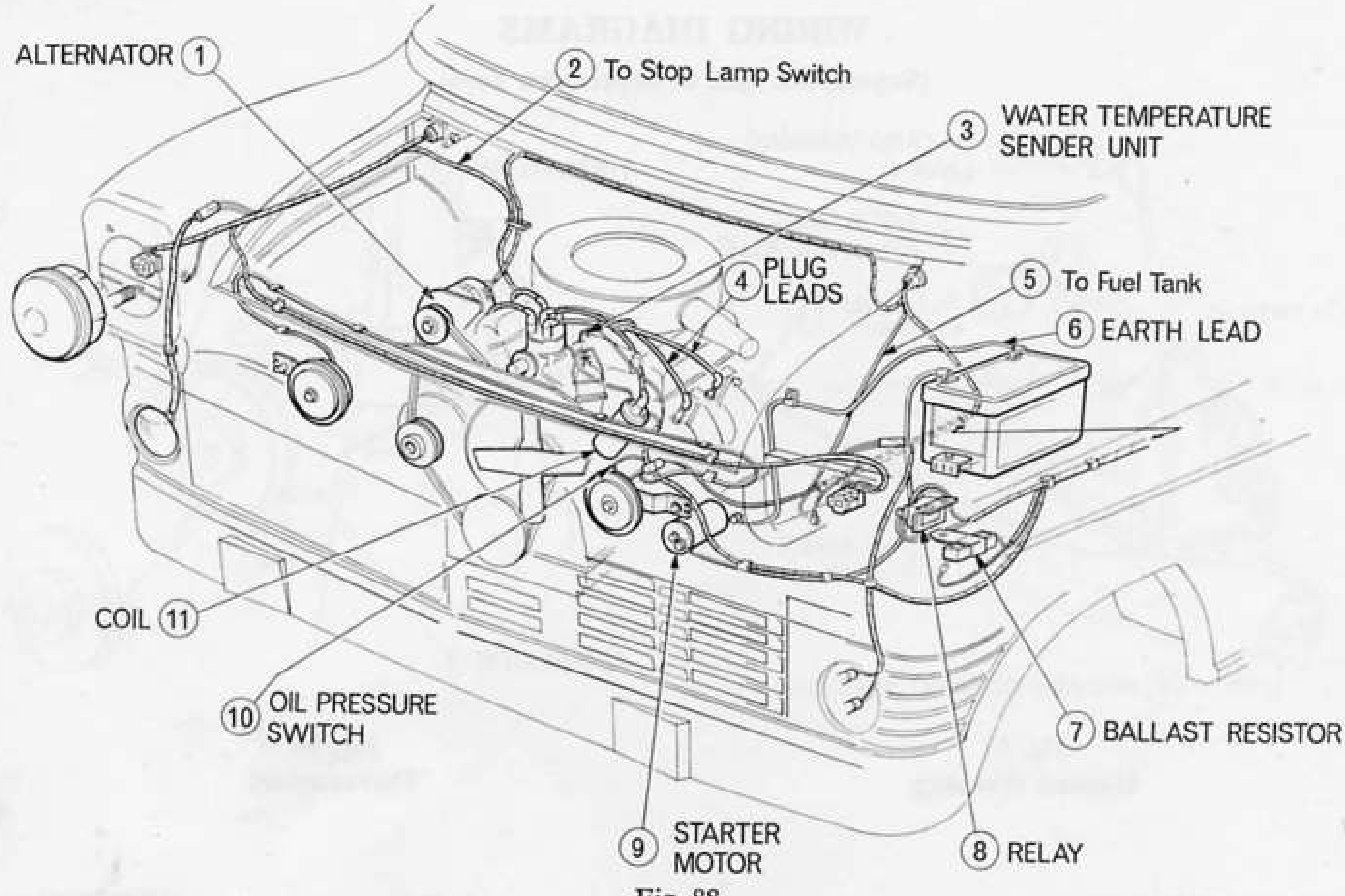


Fig. 88
Engine Compartment (Petrol)

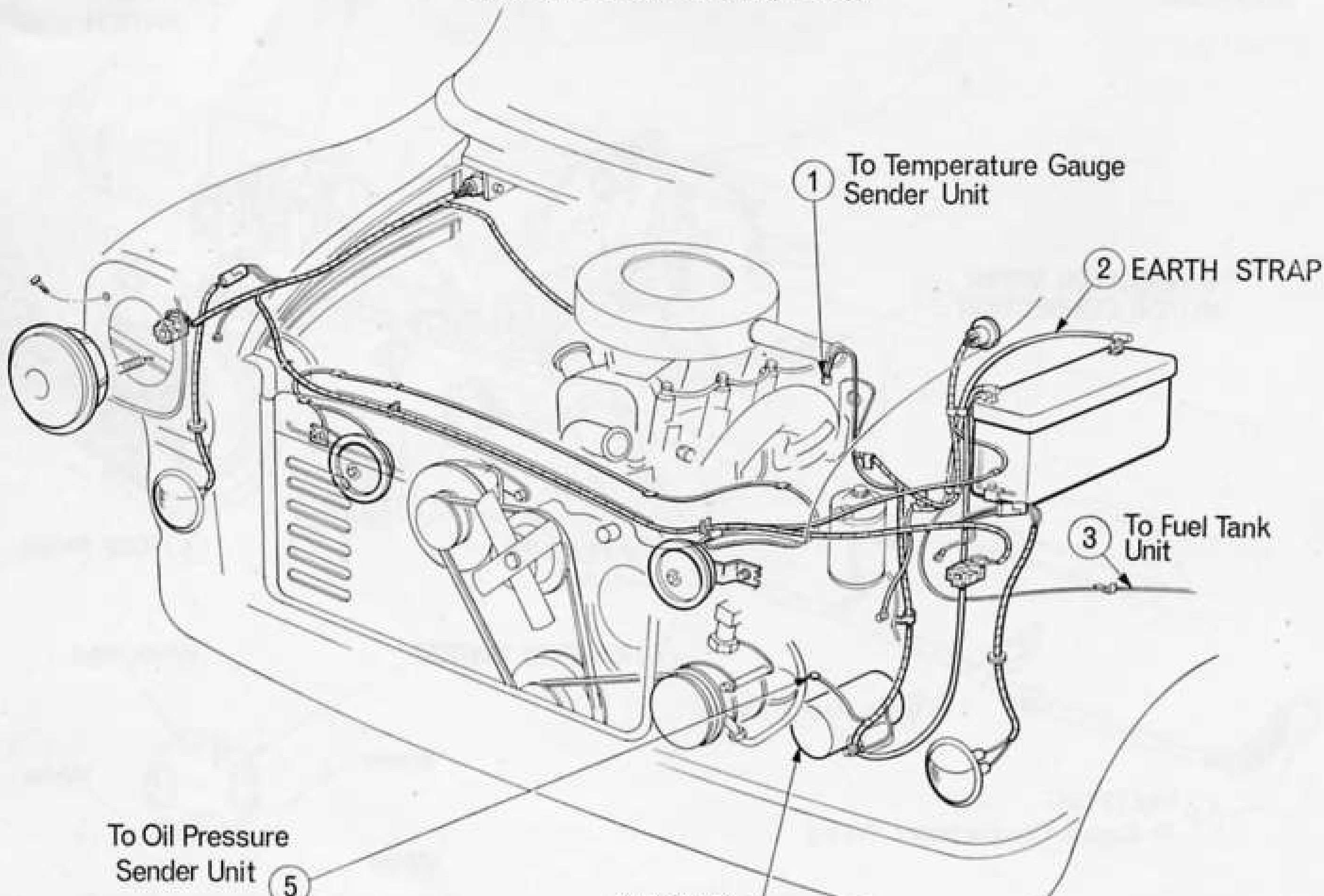


Fig. 89
Engine Compartment (Diesel)

KEY TO WIRING DIAGRAMS — Figures 90, 91 and 92.

1. R/H Side and Flasher Lamp
2. R/H Headlamp
3. Horn
4. L/H Headlamp
5. L/H Side and Flasher Lamp
6. Alternator
7. Distributor
8. Oil Pressure Switch
9. Temperature Sender Unit
10. Starter Motor
11. Ignition Coil
12. Ballast Resistor
13. Starter Solenoid
14. Battery
15. Stop Lamp Switch
16. Lighting Multi-Plug
17. Windshield Wiper Motor
18. Heater Motor
19. Engine Compt. Multi-Plug
20. Fuel Tank Unit
21. Fuse Block
22. Lighting Switch
23. Wiper Switch
24. Hazard Wiring Connection
25. Instrument Wiring Plug
26. Earth
27. Ignition Switch
28. Interior Light
29. Heater Motor Switch
30. Direction Indicator Unit
31. Dipper-Indicator Switch
32. Rear Wiring Multi-Plug
33. R/H Rear Lamp
34. Licence Plate Lamp
35. L/H Rear Lamp
36. Inst. Illum. Vac. Gauge
37. Earth (Accessory)
38. Interior Light Switch
39. Interior Light No. 1
40. Interior Light No. 2
41. Interior Light No. 3
42. Interior Light No. 4
43. Induction Heater Button
44. Induction Heater
45.
46.
47.
48.
49.
50. Side Repeater Flasher Lamp
51. Dual Horn
52. Dual Brake Diff. Valve Switch
53. Auto Trans. Inhibitor Switch
54. Pre-Engage Starter Motor
55. Wiper Motor Switch, Two Speed
56. Wiper Motor, Two Speed
57. Dual Brake Test Switch
58. Dual Brake Warning Ind.
59. Hazard Flasher Indicator
60. Hazard Switch
61. Hazard Flasher Unit
62. Interior Light Switch
63. Interior Light Rear
64. Dipper-Indicator Switch
65. Dip Beam Flasher Relay
66. Ignition Switch Steering Lock

FUSES

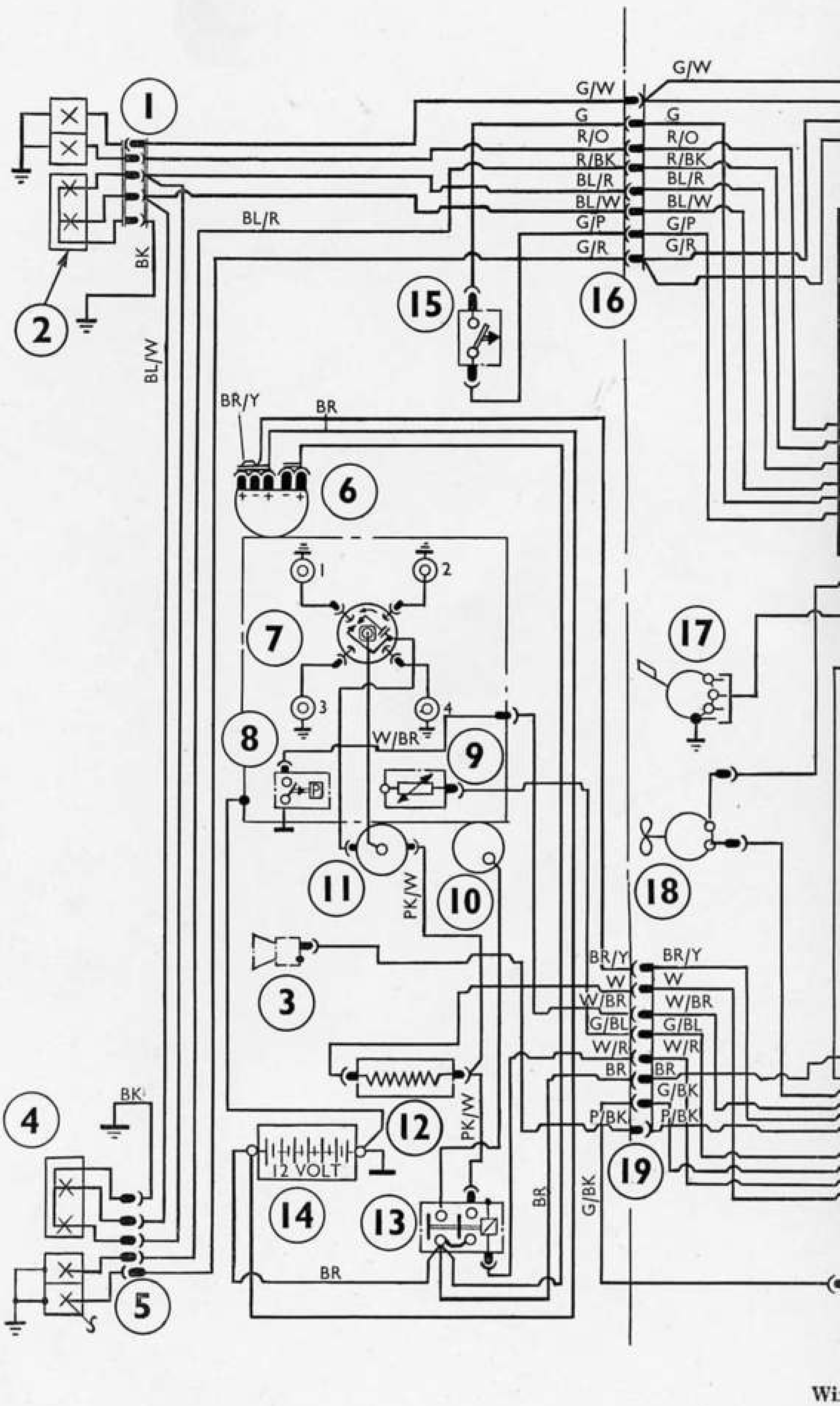
Fuse	1	2	3	4	5	6	7	8
Rating	8	8	8	16	16	16	8	8

INSTRUMENT MULTI CONNECTOR

A Main Feed to Instruments
B Fuel Gauge
C Temperature Gauge
D Alternator Warning Light
E Instrument Panel Lights
F Main Beam Warning Light
G Direction Indicator Warning Light
H Direction Indicator Warning Light
J Oil Pressure Warning Light
K Earth
L Instrument Voltage Stabiliser

CABLE COLOURS

BR – Brown
BL – Blue
BK – Black
G – Green
LTG – Light Green
P – Purple
R – Red
W – White
Y – Yellow


1
2
BK
BL/R
BL/W
G/W
G
R/O
R/BK
BL/R
BL/W
G/P
G/R
15
16
BR/Y
BR
6
7
8
9
W/BR
11
10
PK/W
17
18
3
BR/Y
W
W/BR
G/BL
W/R
BR
G/BK
P/BK
4
BK
12
12 VOLT
14
13
19
5
BR
G/BK

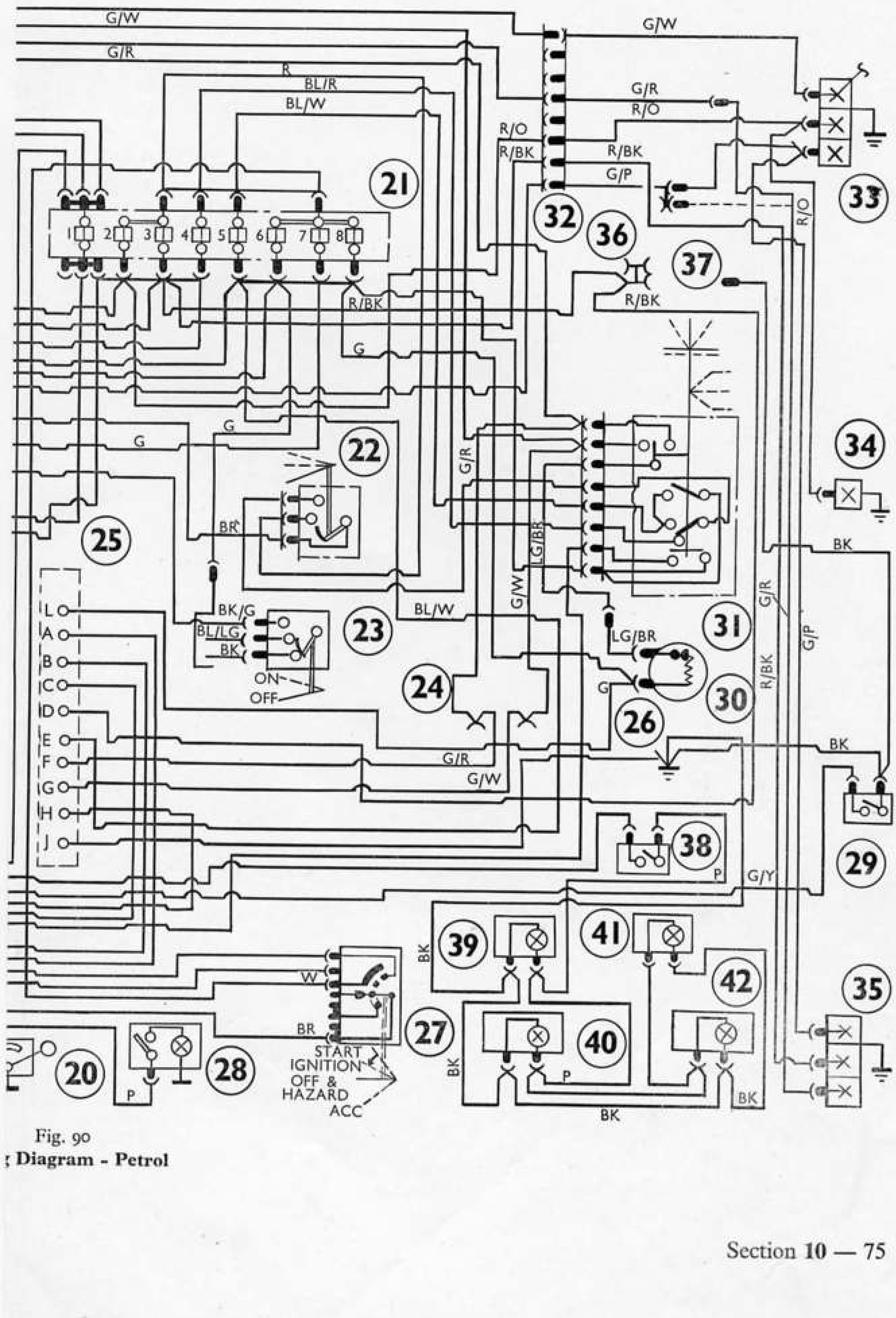
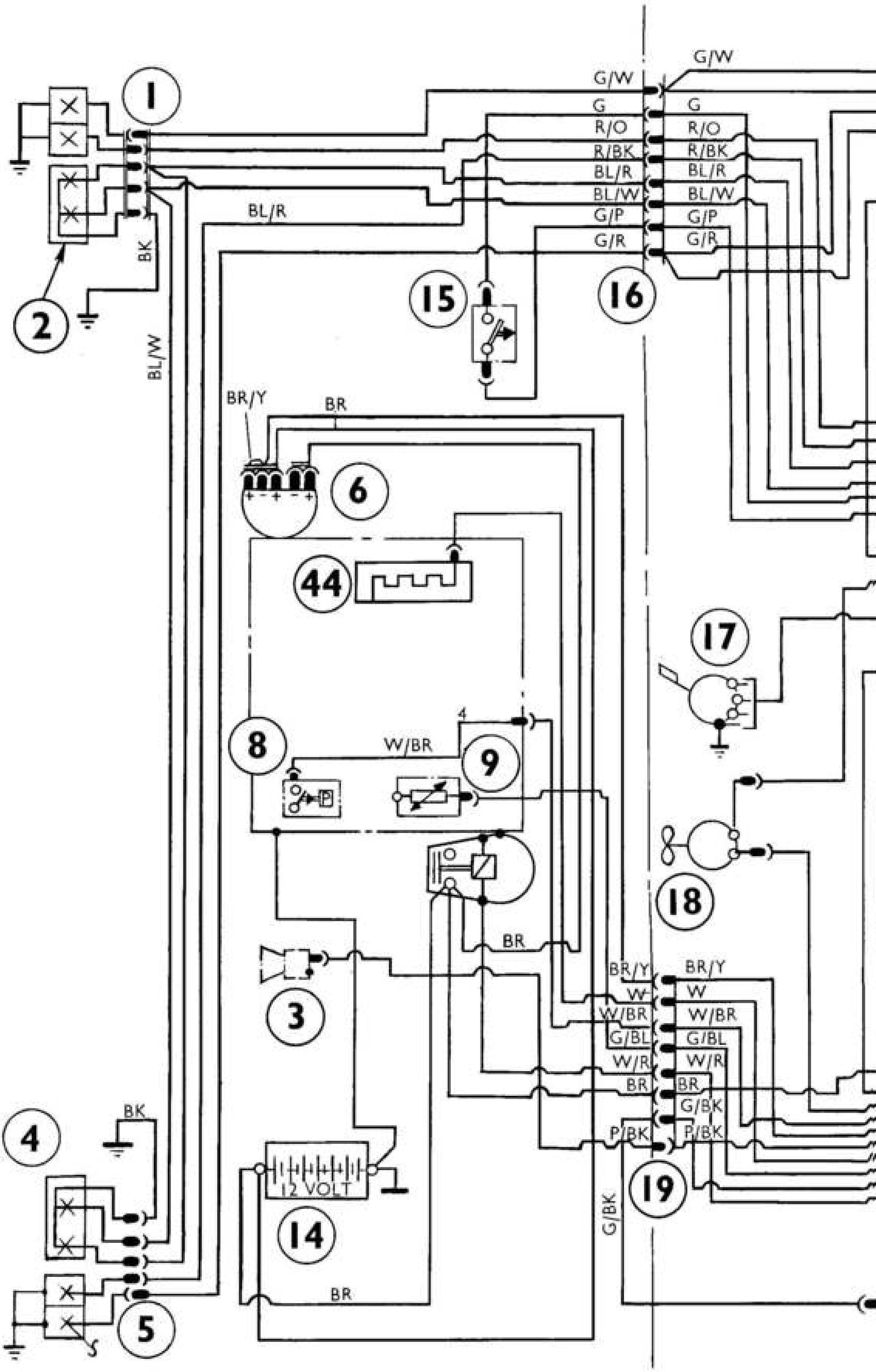


Fig. 90

; Diagram - Petrol


1
2
3
4
5
6
8
9
14
15
16
17
18
19
44
G/W
G
R/O
R/BK
BL/R
BL/W
G/P
G/R
BK
BL/W
BL/R
BR/Y
BR
W/BR
4
W
G/BL
W/R
G/BK
P/BK
12 VOLT

Wi

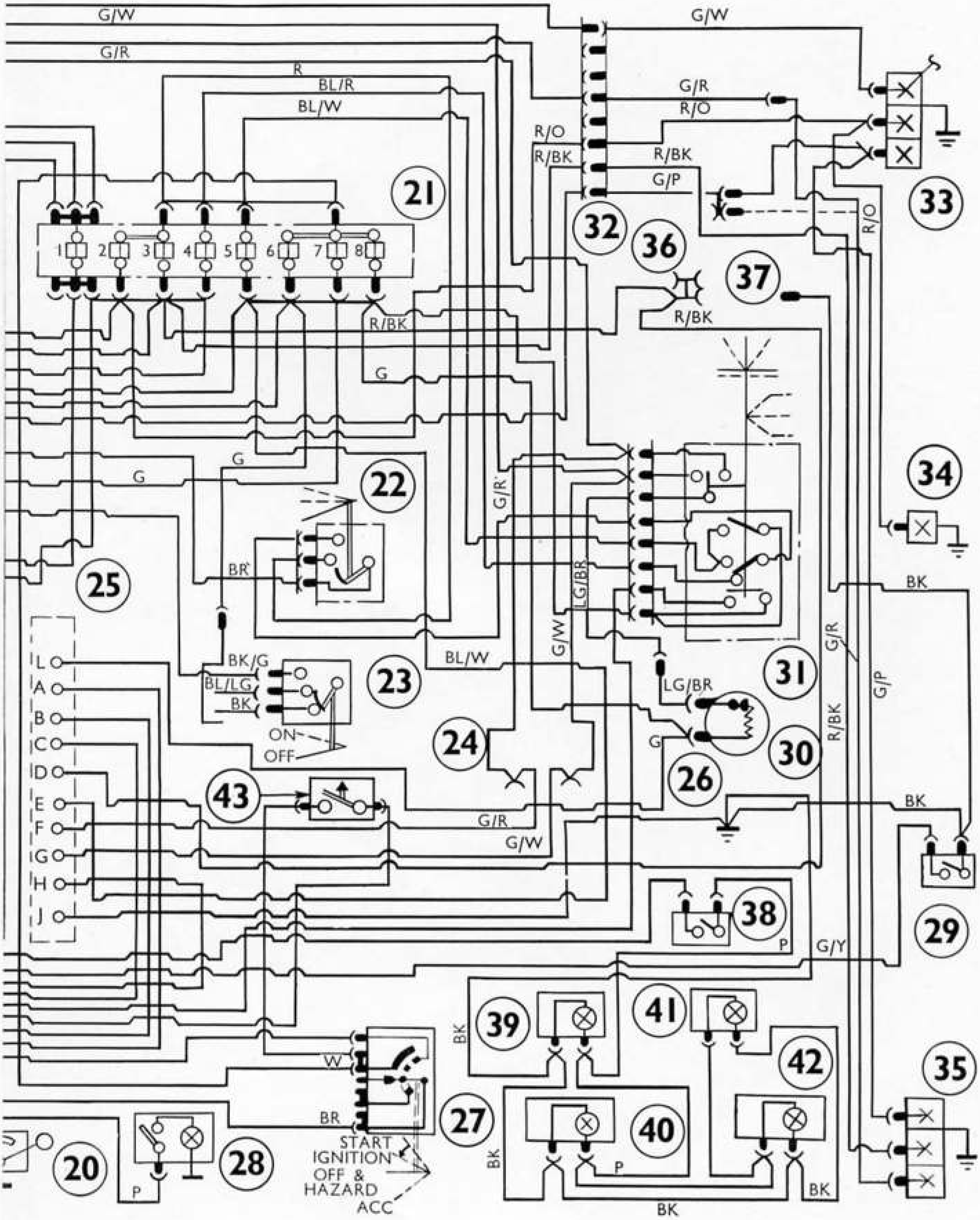
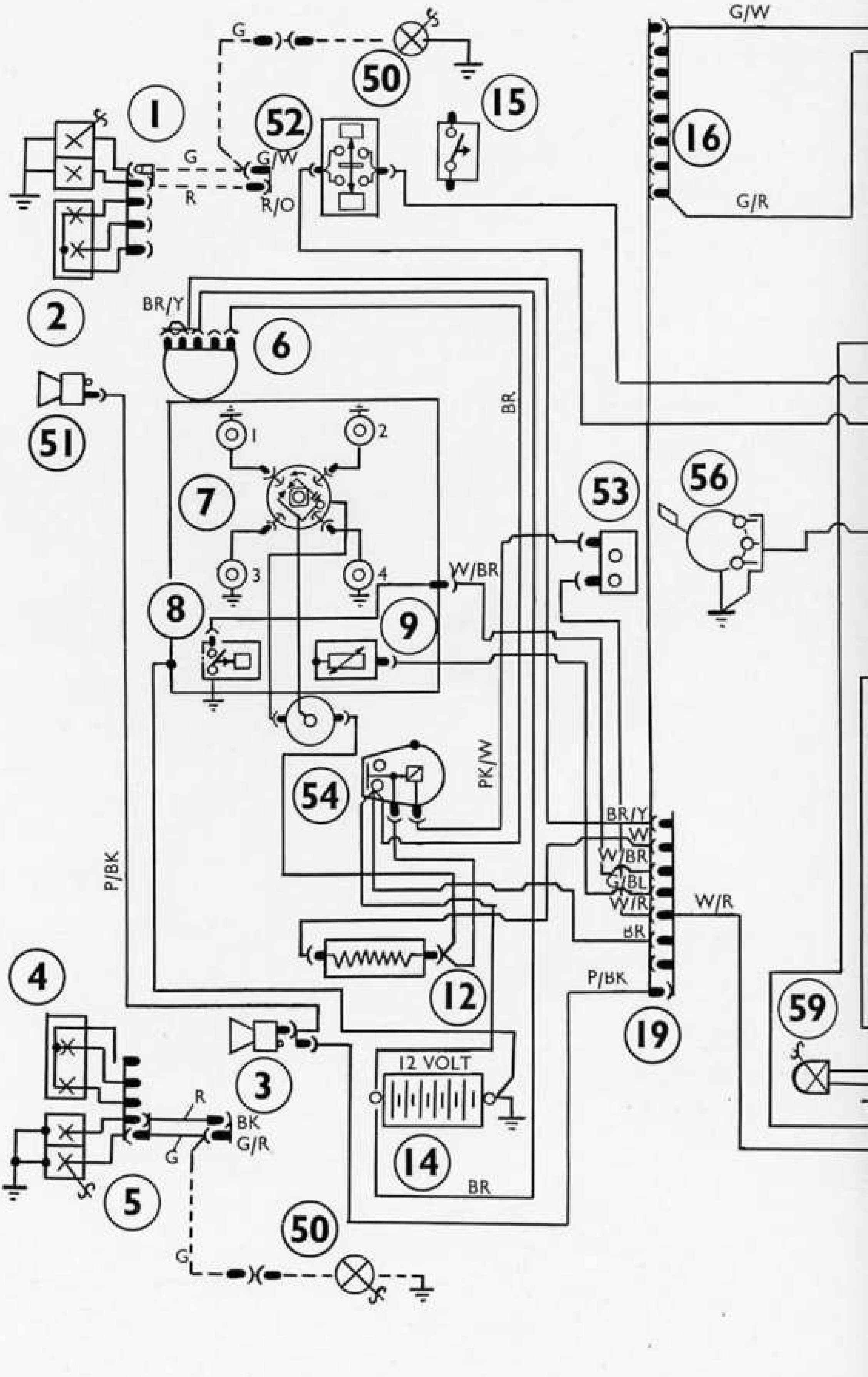


Fig. 91
; Diagram - Diesel



DECEMBER 1970

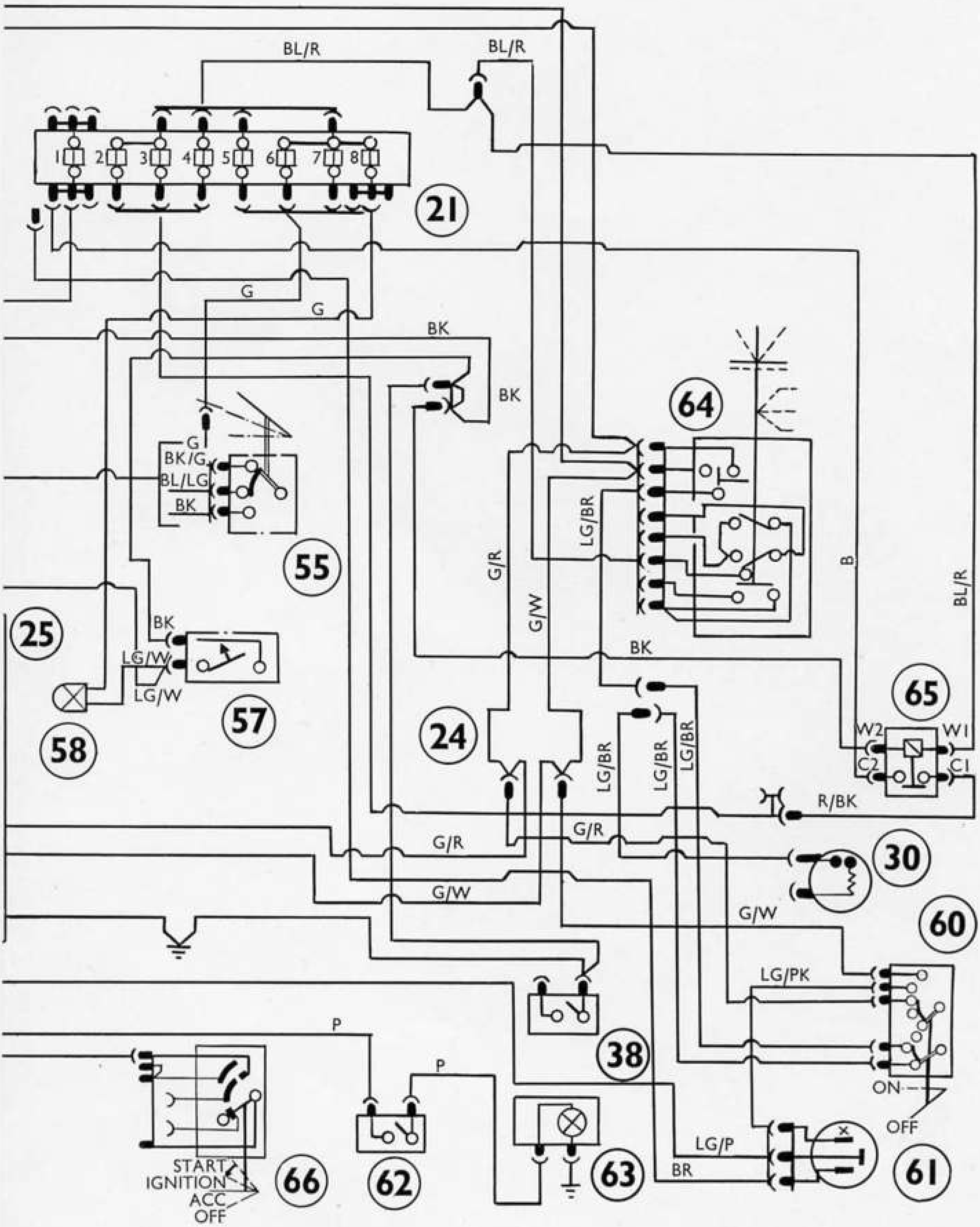


Fig. 92
- Regular Production Options

WIRING DIAGRAMS
(September 1970 onwards)

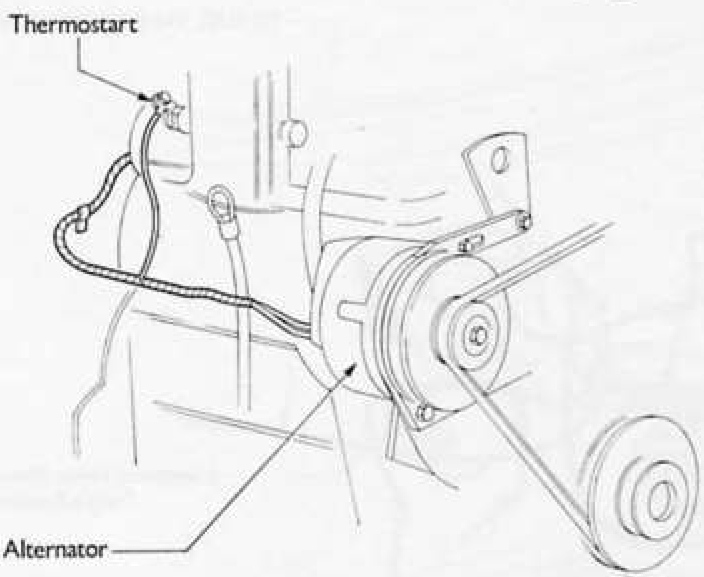


Fig. 93
Thermostart

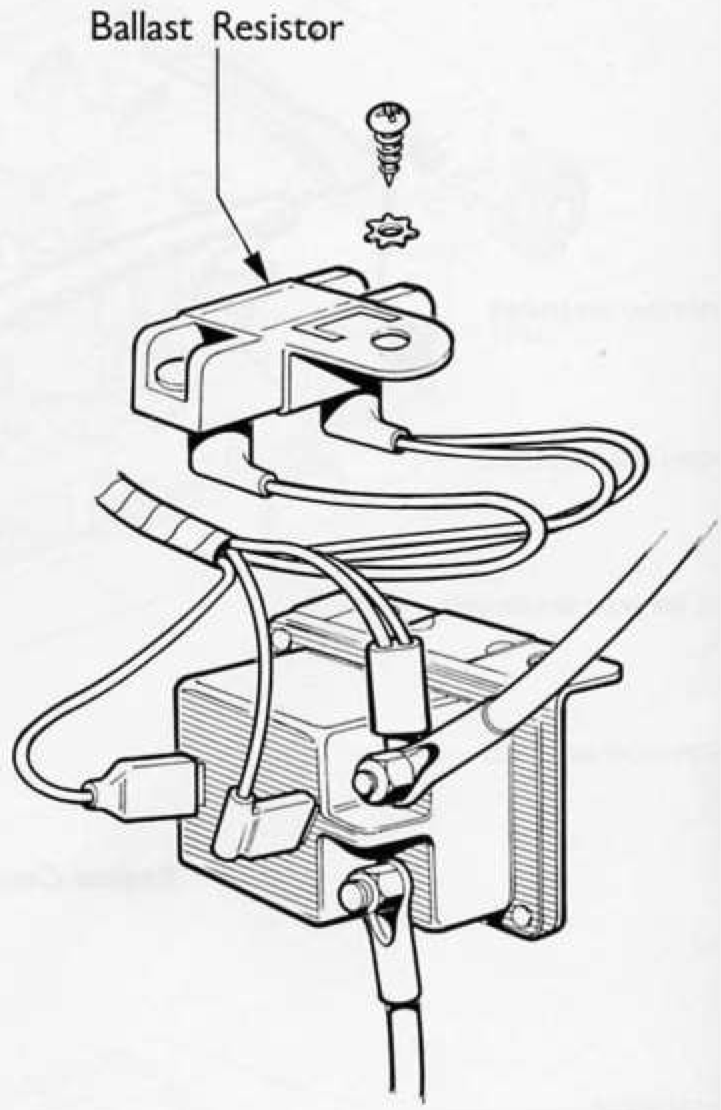


Fig. 94
Ballast Resistor Assembly

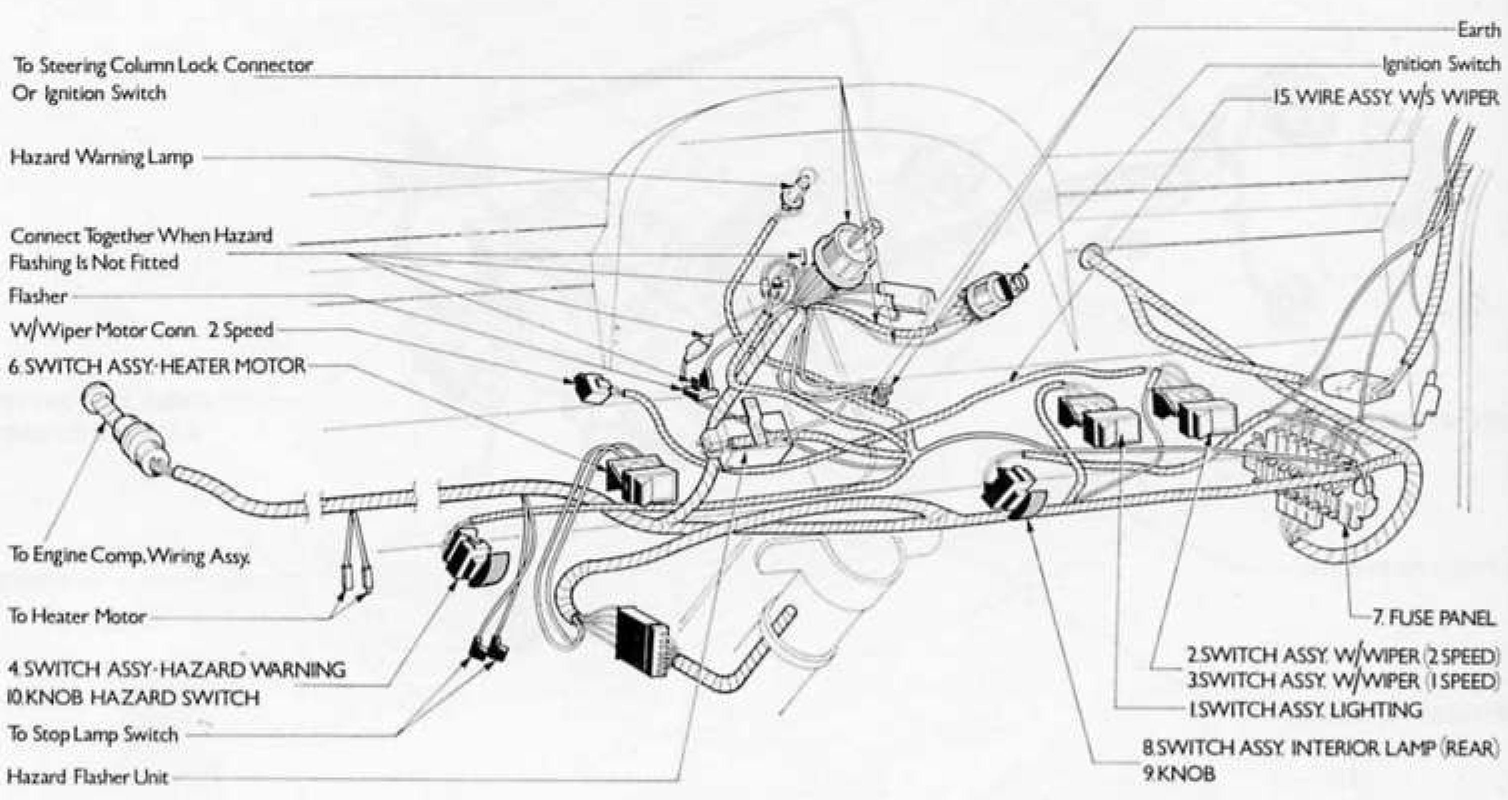


Fig. 95
Dashboard Wiring

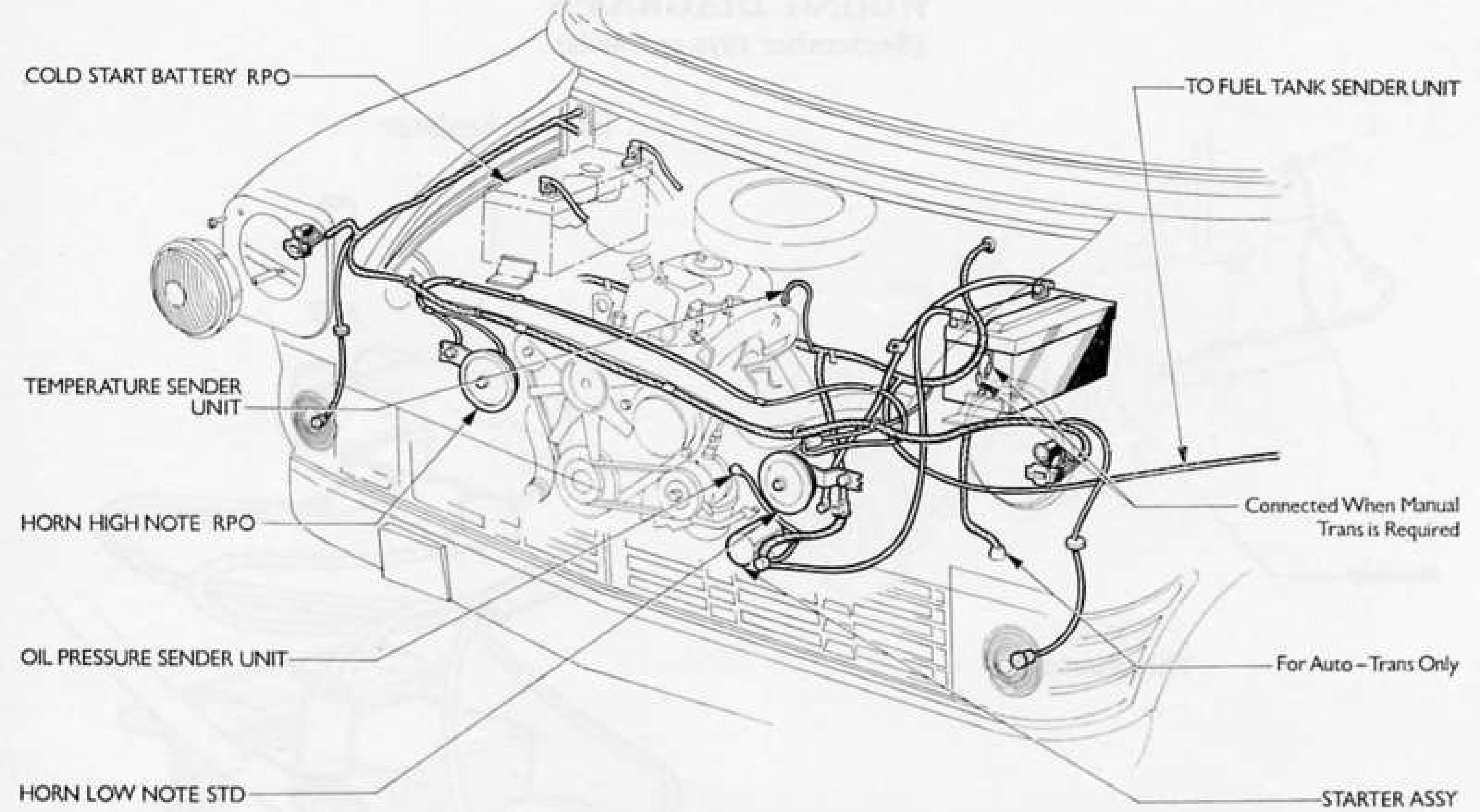


Fig. 96
Engine Compartment (Diesel)

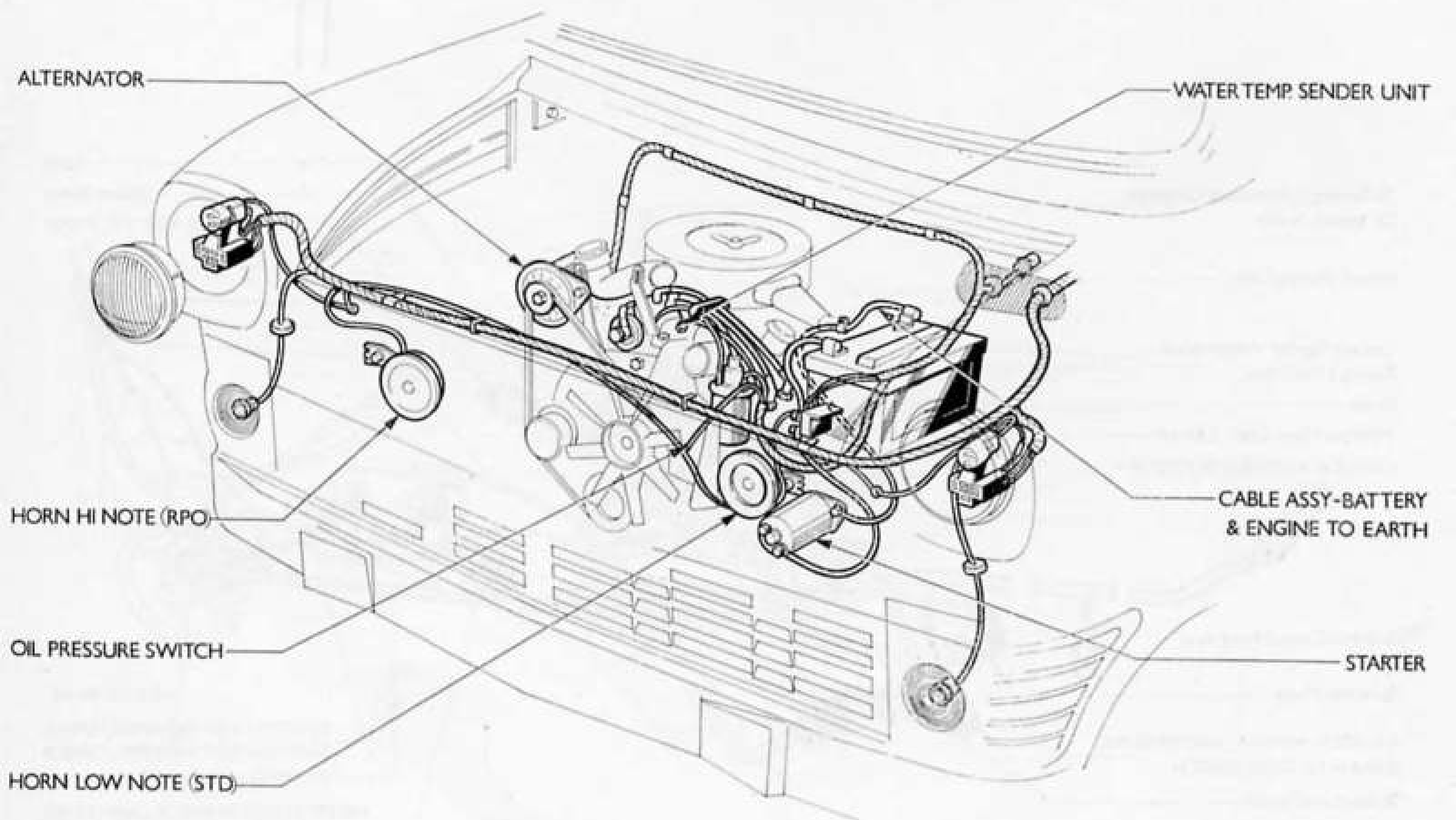


Fig. 97
Engine Compartment (Petrol)

KEY TO WIRING DIAGRAMS (Figs. 98 and 99).

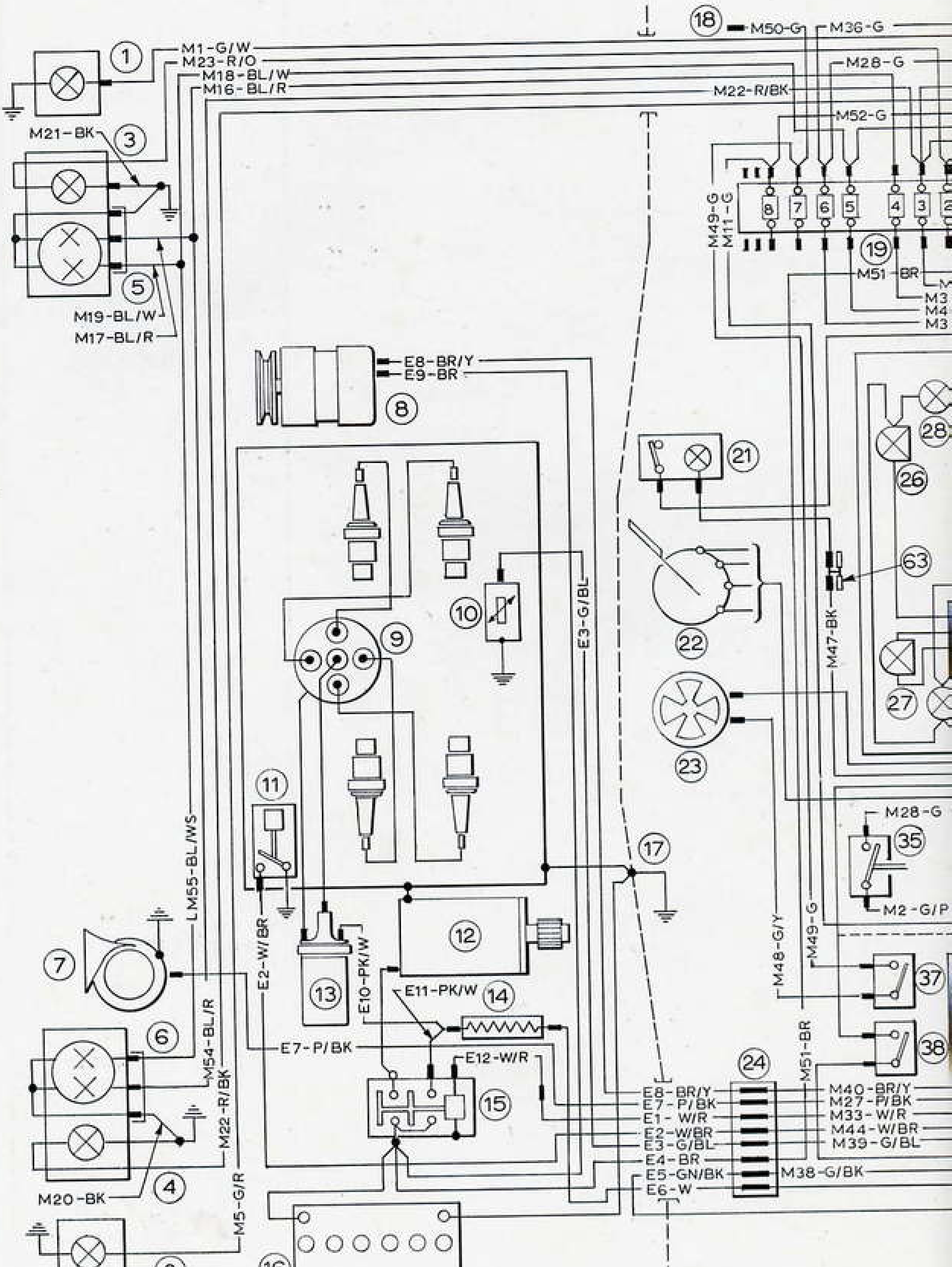
1. R/H Turn Signal Lamp (Front)
2. L/H Turn Signal Lamp (Front)
3. R/H Sidelight
4. L/H Sidelight
5. R/H Headlamp (Main/Dip)
6. L/H Headlamp (Main/Dip)
7. Horn (High)
8. Alternator
9. Distributor
10. Water Temperature Sender
11. Oil Pressure Switch
12. Starter Motor
13. Ignition Coil
14. Ballast Resistor
15. Starter Solenoid
16. Battery
17. Earth (Chassis/Body)
18. Auxiliary Feed
19. Fuse Block
20. Auxiliary Illuminator Feed
21. Interior Lamp
22. Windshield Wiper Motor
23. Heater Motor
24. Main Loom Connector
25. Instrument Cluster
26. Main Beam Warning Light
27. Direction Indicator Warning Light
28. Instrument Illuminator
29. Instrument Connector
30. Alternator Warning Light
31. Oil Pressure Warning Light
32. Fuel Gauge
33. Temperature Gauge
34. Voltage Stabiliser
35. Stop Lamp Switch
36. Instrument Earth
37. Heater Motor Switch
38. Interior Lamp Switch
39. Interior Lamp No. 1
40. Interior Lamp No. 2
41. Interior Lamp Rear
42. Lighting Switch
43. Wiper Switch Feed
44. Windshield Wiper Switch
45. Hazard Connectors
46. Direction Indicator Unit
47. Ignition Switch Connector
48. Steering Lock and Ignition Switch
49. Fuel Gauge Sender Unit
50. Combined D/I Switch Connector
51. Horn Switch
52. Headlamp Flash Switch
53. Headlamp Dip Switch
54. Headlamp Main Beam Switch
55. Direction Indicator Switch
56. R/H Turn Signal Lamp (Rear)
57. L/H Turn Signal Lamp (Rear)
58. R/H Rear Lamp
59. L/H Rear Lamp
60. R/H Stop Lamp
61. L/H Stop Lamp
62. Licence Plate Illuminator
63. Auxiliary Connector
64. Horn (Low)
65. R/H Side Repeater Flasher (Italian requirement)
66. L/H Side Repeater Flasher (Italian requirement)
67. R/H Side Repeater Flasher (Danish requirement)
68. L/H Side Repeater Flasher (Danish requirement)
69. Automatic Transmission Inhibitor Switch
70. Power Wash Motor
71. Fuse Block (Italian requirement)
72. 2-speed A.C. Delco W/Washer and W/Wiper
73. 1-speed A.C. Delco W/Washer and W/Wiper (Parcel Van Only)
74. Dual Brake Differential Valve
75. Vacuum Gauge
76. Foot-switch W/Washer and W/Wiper
77. Power Wash Switch
78. Hazard Warning Light
79. Direction Indicator Unit
80. Hazard Switch
81. Tachograph
82. Fuel Gauge Illuminator
83. Generator Warning Light
84. Temperature Gauge Illuminator
85. 1-speed W/Washer and W/Wiper Switch
86. 2-speed W/Washer and W/Wiper Switch

81. Fuse Unit – Radio – 1·5 amp.

88. Dip Beam Flasher Relay
89. Radio
90. Automatic Transmission Illuminator Dial
91. Dual Brake Warning Indicator
92. Dual Brake Test Switch

CABLE COLOURS

G – Green
R – Red
BL – Blue
BK – Black
W – White
P – Pink
LG – Light Green
O – Orange
BR – Brown



M1-G/W
M23-R/O
M18-BL/W
M16-BL/R
M21-BK
M19-BL/W
M17-BL/R
E8-BR/Y
E9-BR
E3-G/BL
M50-G
M36-G
M28-G
M22-R/BK
M52-G
M49-G
M11-G
M51-BR
M47-BK
M28-G
M2-G/P
M48-G/Y
M49-G
LM55-BL/WS
E2-W/BR
E10-PK/W
E11-PK/W
E7-P/BK
E12-W/R
M54-BL/R
M22-R/BK
M20-BK
M5-G/R
M51-BR
E8-BR/Y
E7-P/BK
E1-W/R
E2-W/BR
E3-G/BL
E4-BR
E5-GN/BK
E6-W
M40-BR/Y
M27-P/BK
M33-W/R
M44-W/BR
M39-G/BL
M38-G/BK

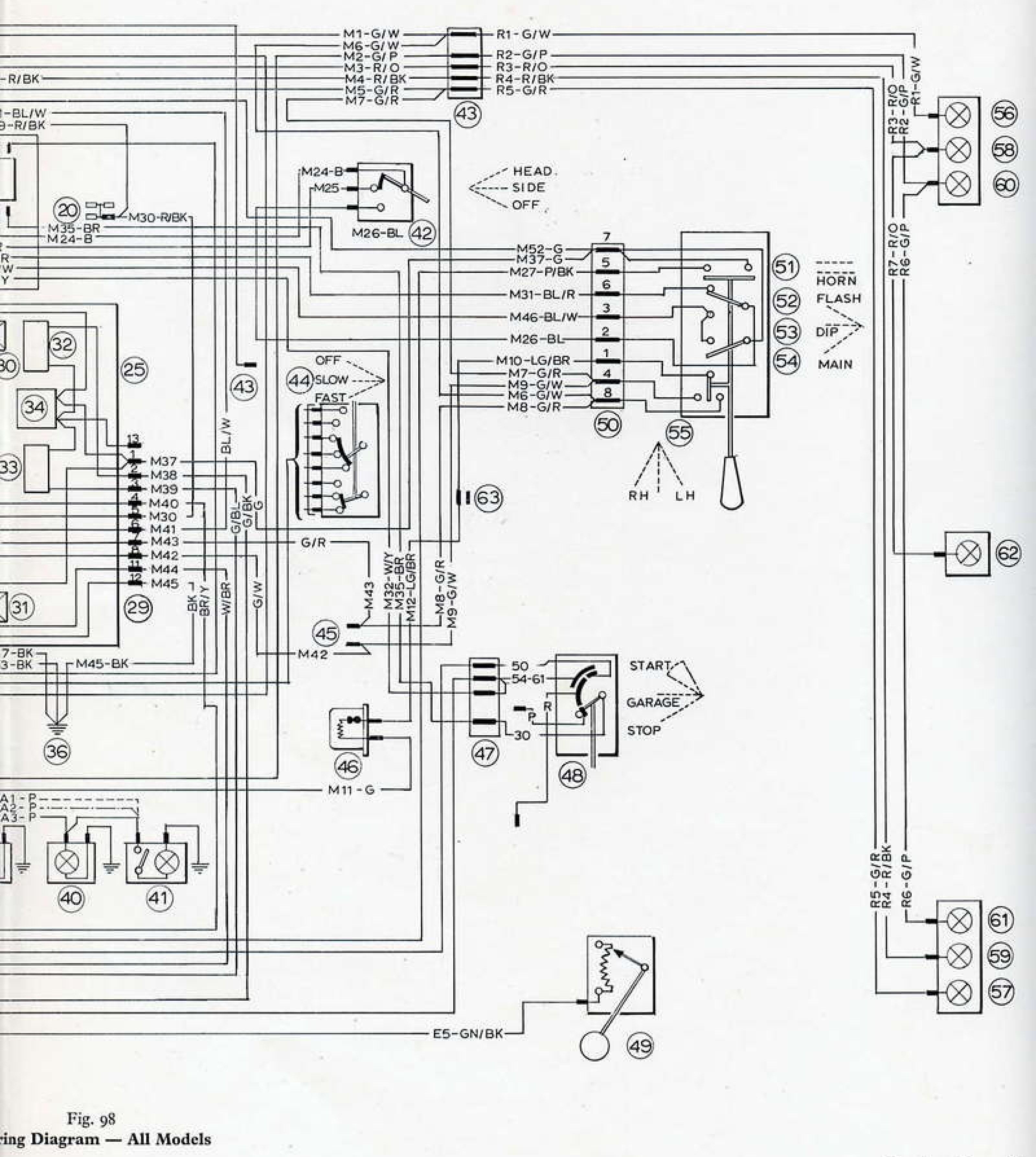
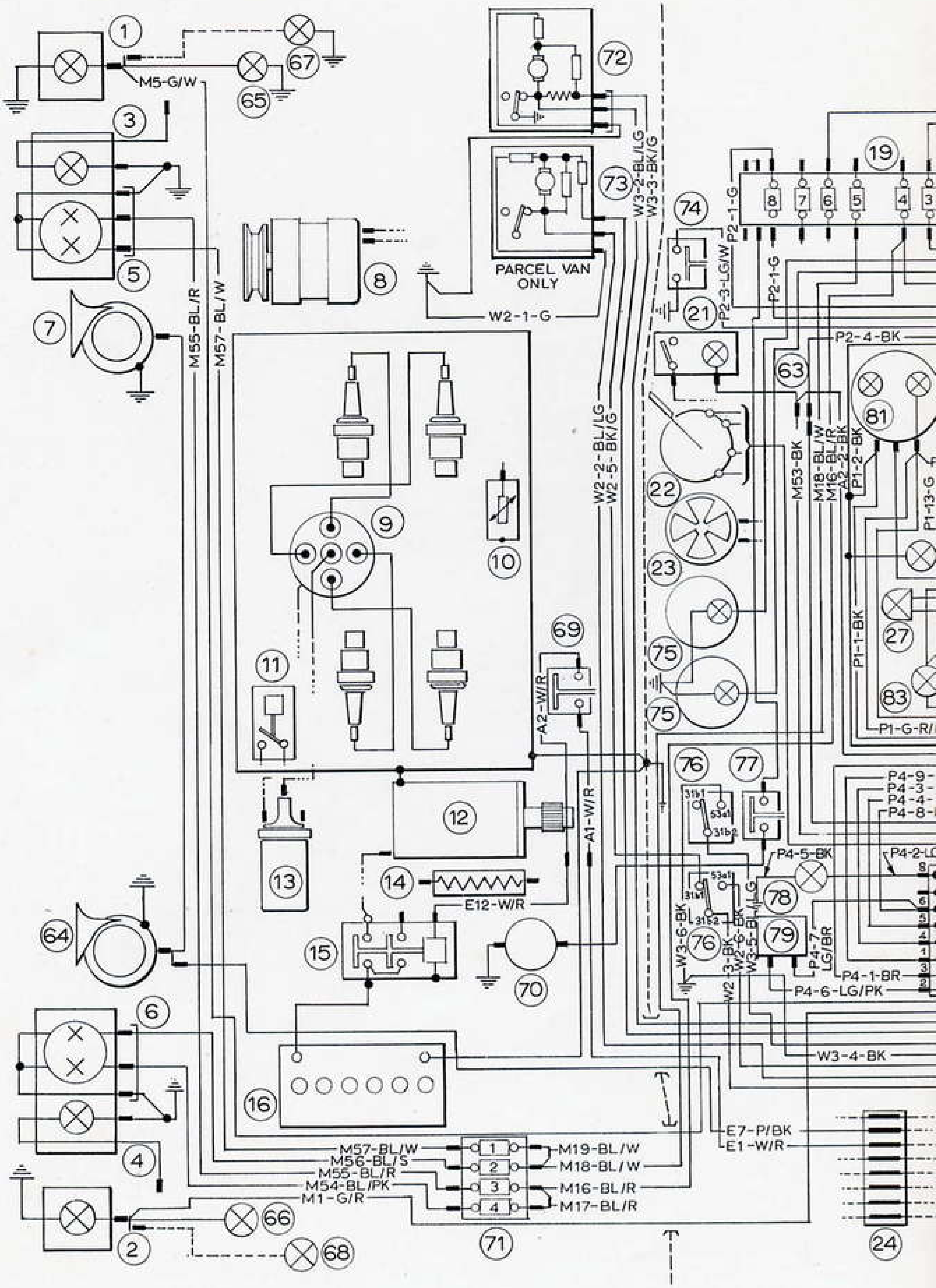


Fig. 98

ring Diagram — All Models


M5-G/W
PARCEL VAN ONLY
W2-1-G
W3-2-BL/LG
W3-3-BK/G
M55-BL/R
M57-BL/W
W2-2-BL/LG
W2-5-BK/G
P2-1-G
P2-3-LG/W
P2-4-BK
M53-BK
M18-BL/W
M16-BL/R
A2-2-BK
P1-2-BK
P1-13-G
P1-1-BK
P1-G-R/
A2-W/R
A1-W/R
E12-W/R
P4-5-BK
P4-1-BR
P4-6-LG/PK
P4-7-LG/BR
W3-6-BK
W3-4-BK
E7-P/BK
E1-W/R
M57-BL/W
M56-BL/S
M55-BL/R
M54-BL/PK
M1-G/R
M19-BL/W
M18-BL/W
M16-BL/R
M17-BL/R

Wiring

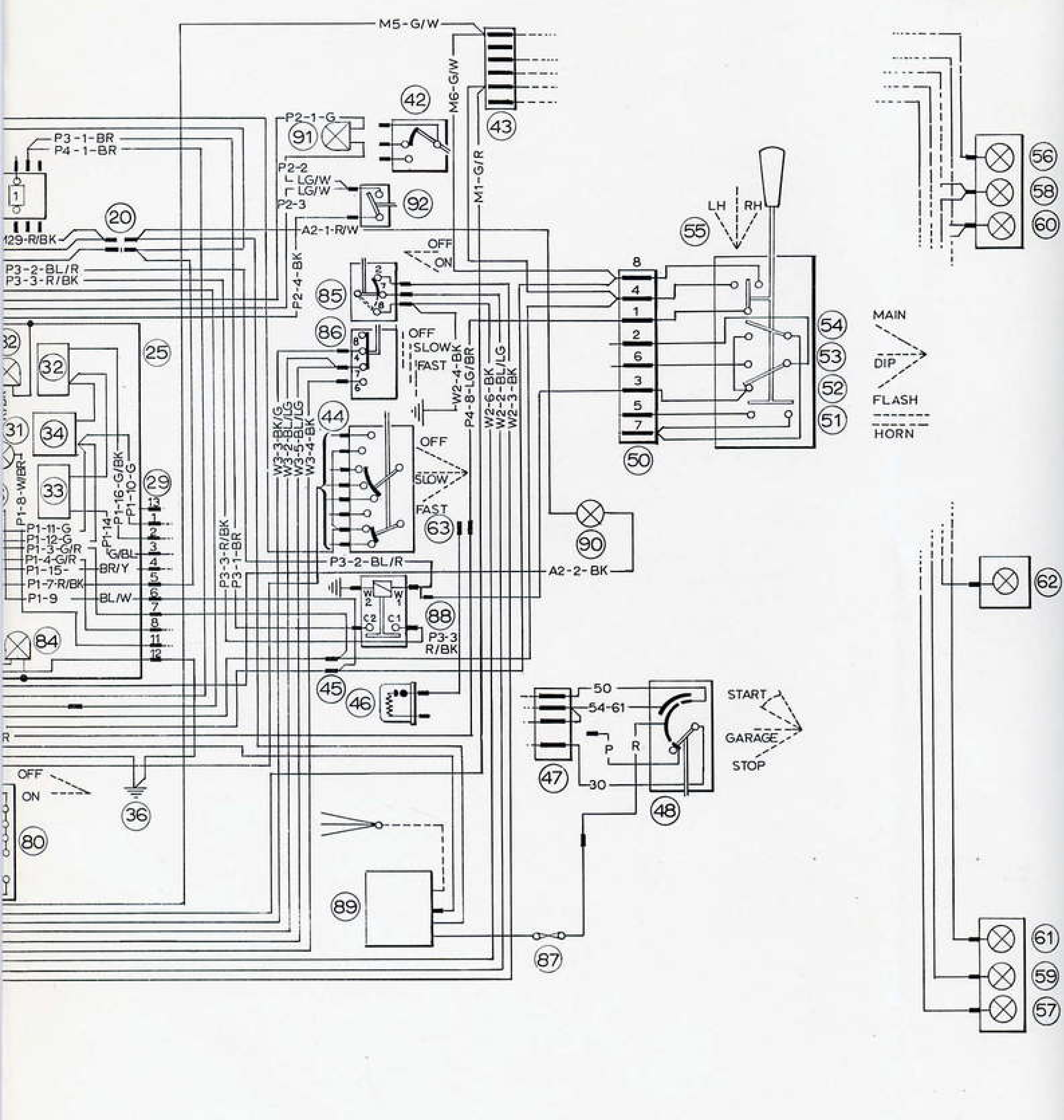


Fig. 99

gram — Regular Production Options

Section 12

BODYWORK

CONTENTS

SUBJECT

DRIVER AND PASSENGER DOOR (Hinged) (All Models)

DOOR TRIM PANEL

An interior trim panel covers the access hole to the door interior mechanisms; it can be detached by removing the window winder handle, the remote control handle and pulling the trim panel away from the door frame.

DOOR INTERIOR HANDLES

The interior lock remote control handle and the window winder handle are each secured by a cross-head screw and shakeproof washer located centrally in the handle boss.

To Remove

1. Unscrew and remove the central crosshead screw and shakeproof washer.

2. Remove the handles and escutcheon plates from their respective control shafts.

To Replace

1. Locate each escutcheon plate and handle on its respective control shaft and secure it with a crosshead screw and shakeproof washer.

THE DOOR EXTERNAL HANDLES

The external driver and passenger door handles incorporate a plunger to release the door lock from the outside. The handle may be removed and adjustment carried out in the following manner:

To Remove

1. Close the window and remove the door interior handles and trim panel (see Door Interior Handles—To Remove and Door Trim Panel).

2. Carefully remove the waterproof plastic sheet secured to the door inner frame.

3. Remove the three crosshead screws and shake-proof washers securing the door lock to the door frame.

4. Remove the two crosshead screws, shakeproof and flat washers securing the door handle to the door. Two holes in the door inner panel provide access to the door handle securing screws.

Ensure that the two rubber gaskets are retained for future use when the door handle is removed.

5. Unhook the short wire control rod and disconnect the long wire control rod from the nylon bush.

6. Remove the door handle by turning the front end until the handle is vertical (see Fig. 1). Twist the handle towards the front of the vehicle and withdraw the handle and wire control rods (see Fig. 2).

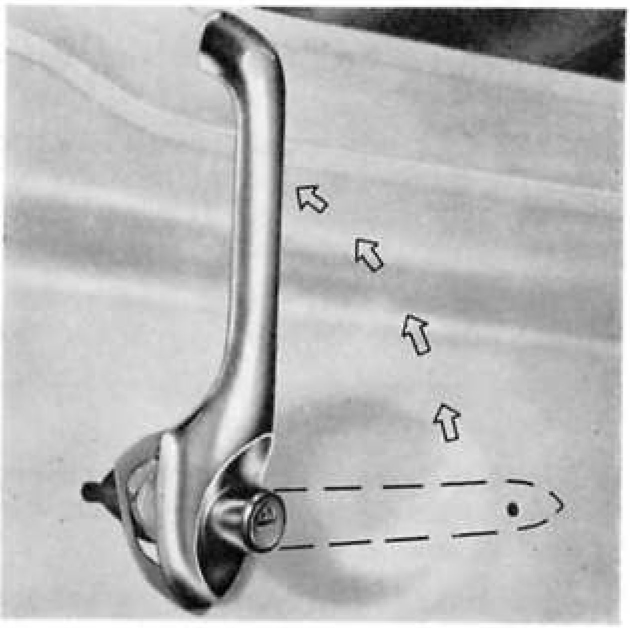


Fig. 1
Removing the Door Handle

Fig. 2
Removing the Door Handle

To Replace

1. With the door handle in the vertical position enter the handle and wire control rods into the door.

2. Rotate the handle until it lines up with the two screw holes in the door outer skin.

3. Reconnect the two wire control rods to the lock mechanism.

4. Replace the two rubber gaskets behind the handle and secure the handle with two crosshead screws, shakeproof and flat washers.

5. Position the door lock and secure it with three crosshead screws and shakeproof washers.

THE DOOR PRIVATE LOCK

An additional control or private lock is fitted to all the exterior doors. Operated by the ignition key, they are located in the centres of the exterior door handles and form the housing for the lock operating plungers (see Fig. 3).

To Remove

1. Remove the door handle (see Door External Handles—To Remove) and detach the two rubber sealing gaskets.

2. Unhook the short wire control rod and disconnect the long wire control rod from the nylon bush.

3. Tap out the split pivot pin locating the plunger crank arm to the door handle and remove the crank arm (see Fig. 4). Ensure that the crank arm return spring does not fly out when the pivot pin is removed.

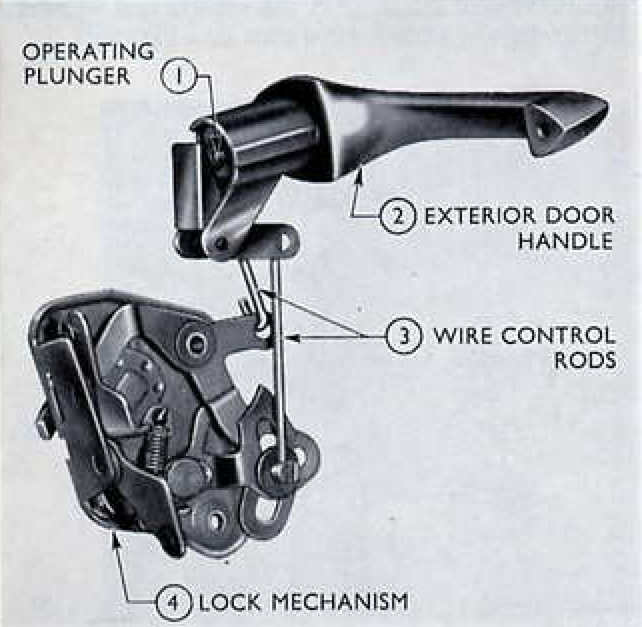


Fig. 3
Door Handle and Lock Mechanism

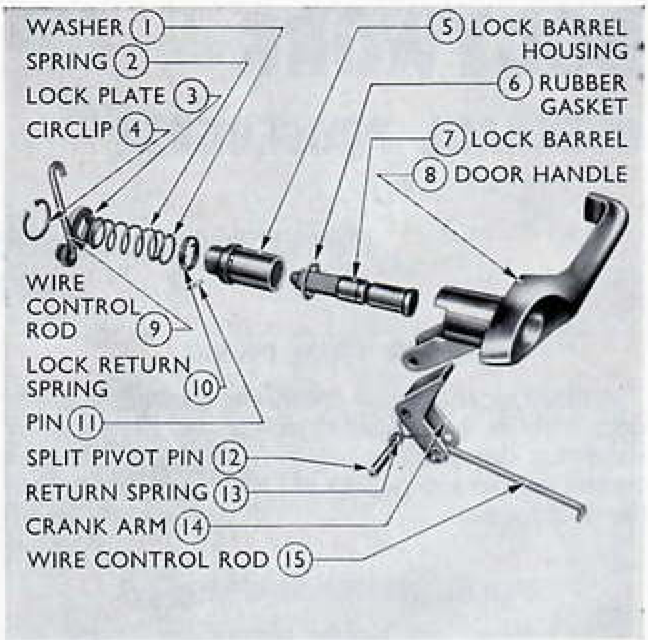


Fig. 4
Door Handle Assembly

4. Remove the circlip locating the lock barrel housing in the door handle and withdraw the lock barrel, lock plate, spring and housing as an assembly (see Fig. 4).

5. Withdraw the steel spacer washers from the lock housing and, using a thin bladed screwdriver, prise the return spring out of the lock barrel and remove the spring (see Fig. 4).

6. Remove the rubber sealing gasket from its groove in the lock housing and drive out the brass pin locating the lock barrel in the housing (see Fig. 4).

7. Withdraw the lock barrel from the housing.

To Replace

1. Slide the lock barrel into the housing and secure it with a brass pin.

2. Replace the rubber gasket in its groove in the lock housing.

3. Slide the return spring into the lock housing and locate the tangs of the spring in the slot provided in the housing and lock barrel. It is important that both tangs are in the same slot.

4. Replace the steel spacer washers on the lock housing and slide the housing into the door handle.

5. Slide the spring and lock plate into the handle and secure them with a circlip.

6. Replace the crank arm and its return spring into position in the door handle and secure them with a split pivot pin.

7. Locate the two wire control rods in their respective positions.

8. Replace the door handle and sealing gaskets (see Door External Handles—To Replace).

THE DOOR LOCKS AND REMOTE CONTROL MECHANISM

The door locks are of a semi-rotary cam type where an external cam, operating in conjunction with a striker plate secured to the door pillar, rotates to give two positions, thus providing a safety catch and a fully closed position.

The remote control operating rod is secured to the remote control mechanism by a spring clip. On early models the operating rod can be detached from the door lock by removing the button, and lowering the remote control mechanism to the bottom of the door after unhooking the rod from the lock mechanism.

On later models the button is not detachable from the operating rod. To remove the rod it must first be unhooked from the lock mechanism and then withdrawn through the door sill.

To Remove

1. Close the window and remove the interior handles, trim panel and plastic sheet (see Door Interior Handles—To Remove and Door Trim Panel).
2. Remove three crosshead screws, spring and cup washers securing the remote control mechanism to the door inner panel (see Fig. 5).
3. Disconnect the remote control operating rod from the door lock mechanism and remove the remote control assembly from the door.
4. Unscrew the door lock interior control knob (see Fig. 5). (Early models only.)
5. Remove the crosshead screw, shakeproof and flat washer securing the lower end of the door rear glass channel, and move the channel to one side.
6. Unscrew and remove the three crosshead screws and shakeproof washers securing the lock mechanism to the door and disconnect the two wire control rods from the lock mechanism (see Fig. 5).
7. Remove the lock mechanism from the door.

To Replace

1. Locate the door lock in the door and reconnect the two wire control rods. Ensure that the interior lock operating rod is correctly positioned through the hole in the top of the door inner panel.
2. Secure the lock with three crosshead screws and shakeproof washers.
3. Position the door glass rear run and secure it at the lower end with a crosshead screw, shakeproof and flat washer.
4. Refit the door lock interior control knob. (Early models only.)
5. Place the remote control mechanism in the door and connect the remote control operating rod to the door lock.
6. Secure the remote control mechanism to the door inner panel with three crosshead screws, spring and cup washers.
7. Replace the plastic sheet, trim panel and interior lock handles (see Door Trim Panel and Door Interior Handles—To Replace).

DOOR ALIGNMENT AND LOCK ADJUSTMENT

The driver's and passenger doors are each hung on two hinges secured to the body hinge pillar and the door inner frame. If necessary, adjustment to the door within the aperture should always be made on the hinges and never on the striker plate. Any adjustments should be carried out in the following sequence:—

1. Carry out a visual examination to determine whether the door will need to be moved within the body aperture.
2. To lift or lower the door, slacken the bolts securing the hinge to the door. Re-locate the door to the desired position and tighten the securing bolts.

STRIKER PLATE ADJUSTMENT

1. Ensure that the rubber weather seal surrounding the lock area is in position.
2. Ensure that the door is correctly aligned in the door aperture.
3. From inside the vehicle, with the door partially open, hold a pencil on the inner surface of the door so that it projects beyond the lock edge just above the striker.
4. Slowly close the door so that the pencil marks a line on the body pillar, ensuring that the pencil does not move relative to the door.
5. Set the top of the striker plate parallel to the pencil line, do not fully tighten the fixing screws.
6. Gently close the door to ease the striker to its correct height. Open the door and check that the striker is still parallel to the pencil line.

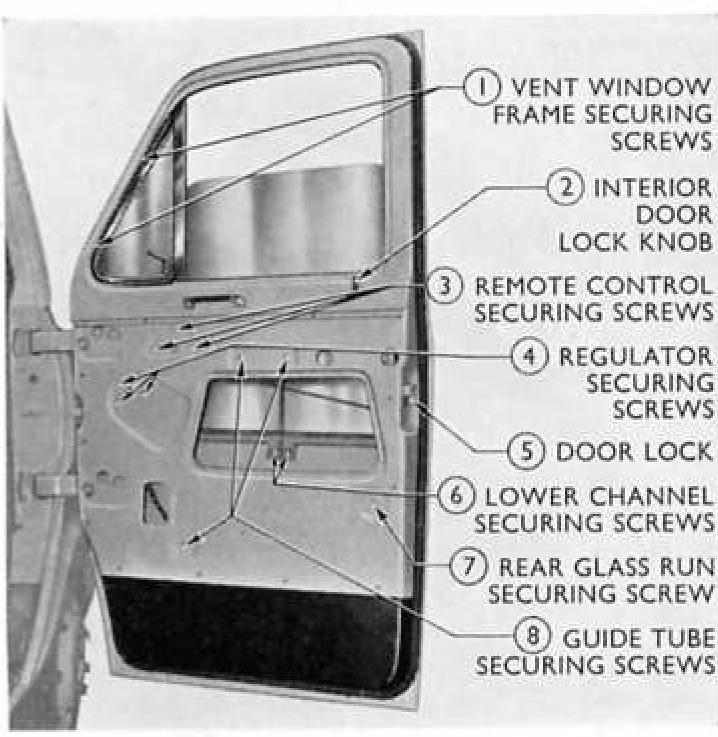


Fig. 5
View of Offside Door

7. Repeat operations 5 and 6 until the lock striker remains parallel to the pencil line. Fully tighten the striker plate fixing screws to 0.97 to 1.24 kg.m. (7 to 9 lb. ft.).

8. Close the door with moderate effort. Two distinct clicks should be heard and the door outer panel should be flush with the outer face of the body pillar. If only one click is heard, move the striker out until door closing gives two clicks and the door panel is flush (ensure that the height and level setting is not disturbed).

THE DOOR VENT WINDOW ASSEMBLY

The door vent window assembly can be removed without removing the door window glass.

To Remove

1. Lower the window and remove the interior handles, trim panel and plastic sheet (see Door Interior Handles—To Remove and Door Trim Panel).

2. Remove the bolt securing the bottom of the vent window dividing channel.

3. Open the vent window fully and remove the two self-tapping screws, securing the vent window outer frame to the door frame (see Fig. 5).

4. Remove the vent window assembly by pulling the top edge towards the rear of the door and withdrawing the assembly through the window aperture (see Fig. 6).

To Dismantle

1. Drill out the two rivets securing the upper pivot hinge.

2. Remove the vent window lower pivot stud clamp bolt and prise off the clamp (see Fig. 6).

3. Remove the vent window and inner frame from the outer frame.

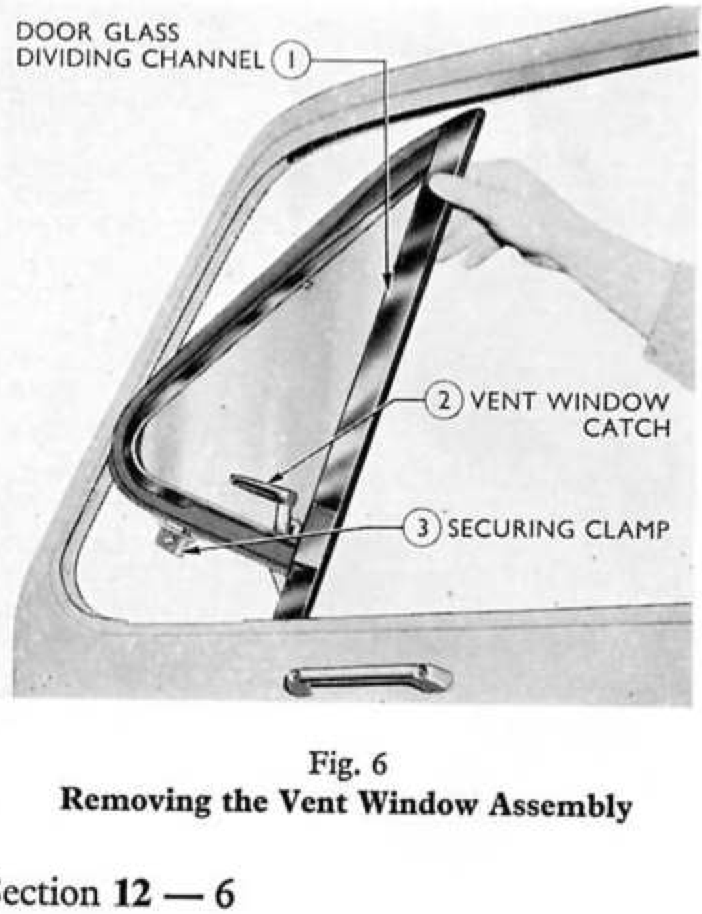


Fig. 6
Removing the Vent Window Assembly

4. The outer frame weatherstrip may then be pulled out from the retaining channel.

To Reassemble

1. Apply soft soap, glycerine or tallow to the rubber weatherstrip and position it in the channel in the outer frame.

2. Refit the glass and inner frame within the outer frame, passing the lower pivot stud through the hole in the bottom of the outer frame.

3. Refit the window upper hinge and retain it with two pop rivets.

4. Replace the lower pivot clamp and bolt.

To Replace

1. Position the vent window assembly in the door frame, ensuring that the door glass is correctly located in the vent window dividing channel.

2. Tap the top of the vent window assembly into position in the door frame and secure it with two self-tapping screws.

3. Secure the lower end of the vent window dividing channel to the door inner panel.

4. Replace the plastic sheet, trim panel and interior handles (see Door Trim Panel and Door Interior Handles—To Replace).

THE DOOR VENT WINDOW GLASS

The door vent window glass may be changed without removing the vent window assembly from the door.

To Remove

1. Open the vent window and at the top rear corner of the frame insert a screwdriver covered with a piece of soft cloth, between the vent window frame and window glass.

2. Gently prise the glass downwards out of the vent window frame to release the top section of the glass.

3. Holding the glass firmly, insert the covered screwdriver between the vent window frame and glass at the bottom rear corner of the frame.

4. Gently prise the bottom of the glass upwards out of the vent window frame and remove the glass and weatherstrip as an assembly.

To Replace

1. If the glass is being replaced due to accident damage, carefully clean any shattered glass which may be present within the window channel.

2. Assuming that the vent window catch pivot shaft has been retained from the shattered glass, carefully clean any fragments of glass which may be present and using a suitable drift, separate the two parts of the pivot shaft.

3. Locate the pivot shaft in the new window glass and slide the securing washer into position over the shaft. Support the outside face of the shaft on a wooden block covered with soft cloth and using a suitable drift carefully tap the securing washer down the shaft, until the shaft is firmly located in the glass.

4. Fit a length of rubber weatherstrip around the glass, with a thin film of adhesive on both sides, ensuring that it is not buckled or twisted. Place the glass and fitted weatherstrip into the vent window inner frame.

5. Carefully push the glass and weatherstrip into the frame so that the lower portion is correctly located with the upper portion of the frame, tilted inwards towards the body.

6. Place a screwdriver covered with a cloth on the top edge of the glass and beneath the upper end of the window frame and carefully prise the frame upwards. At the same time, align the upper section of the glass and when correctly positioned, allow the frame to return to its normal position.

7. Trim off any excess weatherstrip and clean off any surplus adhesive.

THE DOOR VENT WINDOW CATCH

To Remove

NOTE.—Care must be taken when carrying out the following operations to ensure that the vent window glass is not fractured, as the catch is secured to the glass and not the frame.

1. Shut the vent window and using a suitable pin punch, tap out the pin securing the vent window catch to its pivot shaft in the vent window.

2. Withdraw the catch and wave washer from the pivot shaft.

To Replace

1. Locate the wave washer and catch on the vent window pivot shaft and replace the securing pin.

THE DOOR WINDOW GLASS

To Remove

1. Open the window and remove the interior handles, trim panel and plastic sheet (see Door Interior Handles — To Remove and Door Trim Panel).

2. Remove the vent window assembly (see Door Vent Window—To Remove).

3. Remove the inner and outer weatherstrips from the lower edge of the window aperture.

4. Temporarily replace the window winder handle and wind the window up approximately halfway.

5. Support the window glass and remove the two crosshead screws, spring and flat washers securing the door glass lower channel to the window regulator connecting plate (see Fig. 5).

6. Remove the window glass through the window aperture (see Fig. 7).

To Replace

1. Position the window glass in the door through the window aperture.

Fig. 7
Removing the Door Window Glass

2. Secure the door glass window lower channel to the window regulator connecting plate with two crosshead screws, spring and flat washers.

3. Wind the window down and refit the vent window assembly (see Vent Window—To Replace).

4. Replace the inner and outer weatherstrips in the lower edge of the window aperture.

5. Remove the window winder handle and replace the plastic sheet and trim panel (see Door Trim Panel).

6. Replace the interior handles (see Door Interior Handles—To Replace).

THE DOOR WINDOW REGULATOR

The window regulator consists of a remote control mechanism coupled to a spiral flexible cable drive, running in a split guide tube. The reduction gear in the remote control mechanism acts directly on the spirals of the flexible cable. The flexible cable is connected to the door glass lower channel so that when the remote control handle is rotated the cable raises or lowers the window glass.

To Remove

1. Partly open the window and remove the interior handles (see Door Interior Handles—To Remove).

2. Remove the trim panel and plastic sheet (see Door Trim Panel).

3. Support the door window and remove the two crosshead screws, spring and flat washers securing the door window lower channel to the window regulator connecting plate.

4. Lower the window to the bottom of the door and remove the three crosshead screws, spring and flat washers securing the remote control mechanism to the door inner panel (see Fig. 5).

5. Remove the three crosshead screws, spring and flat washers securing the flexible drive guide tube assembly to the door inner panel (see Fig. 5).

6. Remove the bolt securing the bottom of the vent window dividing channel.

7. Lower the window regulator assembly to the bottom of the door, ensuring that the flexible drive guide tube clears the vent window dividing channel.

8. Remove the window regulator assembly through the door access hole.

To Replace

1. Locate the window regulator in position through the door access hole.

2. Replace the bolt securing the bottom of the vent window dividing channel.

3. Replace the three crosshead screws, spring and flat washers securing the flexible drive guide tube assembly to the door inner panel.

4. Replace the three crosshead screws, spring and flat washers securing the remote control mechanism to the door inner panel.

5. Slide the window glass up the door runs until the door glass lower channel lines up with the window regulator connecting plate. Secure the channel to the connecting plate with two crosshead screws, spring and flat washers.

6. Replace the plastic sheet, trim panel and interior handles (see Door Trim Panel and Interior Handles—To Replace).

THE DOOR PULL HANDLE

The door pull handles are located on the top of the door inner panel and are secured by two crosshead screws and spring washers.

THE REAR DOORS

THE DOOR TRIM PANEL (where fitted)

An interior trim panel covers the access hole to the door interior mechanisms, it can be detached by removing the door interior handle and pulling the trim panel away from the door frame.

THE DOOR INTERIOR HANDLE (where fitted)

The door interior handle can be removed by unscrewing a crosshead screw and spring washer located in the centre of the handle boss.

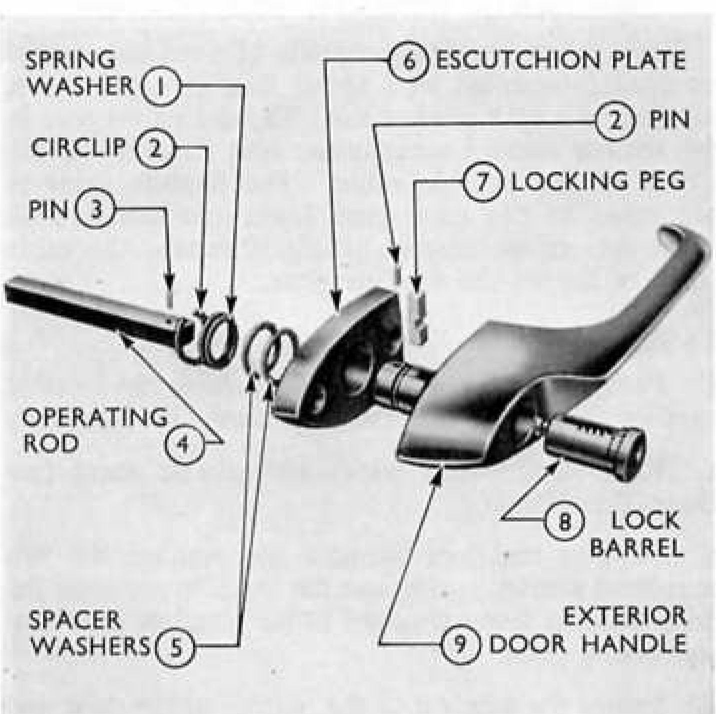


Fig. 8
The Rear Door Handle

THE DOOR EXTERNAL HANDLE

To Remove

1. Where fitted, remove the door interior handle (see Interior Door Handle).

2. Turn the exterior handle into the open position and remove the two crosshead screws securing the handle to the door.

3. Withdraw the handle from the door.

To Replace

1. Engage the door handle spindle into the lock and secure the handle with two crosshead screws.

2. Where fitted, replace the door interior handle and secure it to the exterior handle spindle with a crosshead screw and spring washer.

NOTE.—A change was made in the design of the outside locking handle in May 1967. If it is required to fit a new handle to earlier vehicles, the following modification will be necessary.

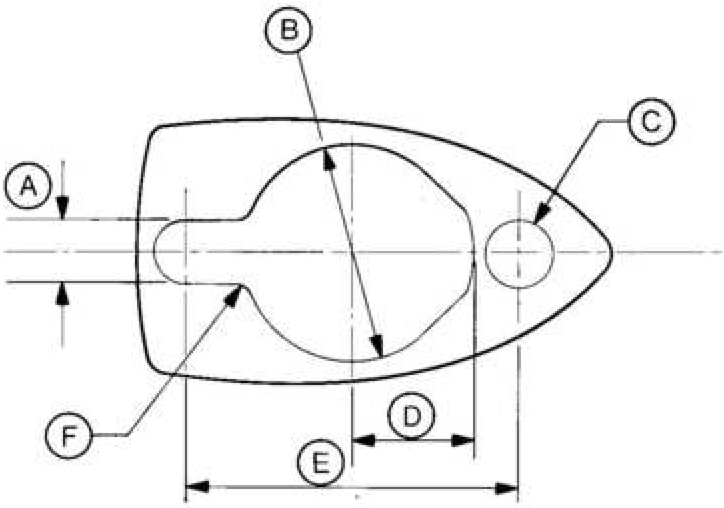
Make up a template as shown in Fig. 9, locate it in position on the door and mark the area to be cut out.

Mask off the surrounding paint area to avoid scratching and, using a rotary drill file, cut the access hole to the new shape. This will involve cutting through the wall of the reinforcing bracket to a depth of 2.54 mm. (0.1 in.).

It may also be necessary to increase the 22.1 mm. (0.87 in.) dia. hole in the reinforcing bracket, to accommodate the increased diameter retaining ring on the handle shaft.

THE DOOR PRIVATE LOCK

An additional control or private lock is fitted to the rear doors. Operated by the ignition key, it is located in the centre of the door exterior handle.



A=7.94 mm. (0.3125 in.) D=17.4 mm. (0.685 in.)
B=31.75 mm. (1.25 in.) dia. E=47.23 mm. (1.860 in.)
C=7.94 mm. (0.3125 in.) dia. F=3.175 mm. (0.125 in.) rad.

Fig. 9

To Dismantle

1. Remove the door exterior handle (see Door Exterior Handle—To Remove).

2. Remove the circlip, spring and spacer washers from the door handle boss and withdraw the escutcheon plate from the handle (see Fig. 8).

3. Tap out the pin securing the square section operating rod and remove the rod.

4. Tap out the pin securing the lock barrel in the door handle and remove the barrel (see Fig. 8).

5. Remove the locking peg from the door handle boss (see Fig. 8).

To Reassemble

1. Replace the locking peg in the slot provided in the door handle boss, ensuring that the slot in the peg faces towards the handle.

2. Slide the lock barrel into the door handle boss, ensuring that the operating pin on the end of the barrel engages in the slot provided in the locking peg.

3. Secure the lock barrel in the handle boss with a pin.

4. Replace the square section operating rod in the handle boss and secure with a pin.

5. Replace the escutcheon plate, spring and spacer washers and secure them with a circlip.

6. Replace the door handle (see Door Exterior Handle—To Replace).

THE DOOR LOCK

To Remove

1. Where fitted, remove the interior handle and escutcheon plate (see Door Interior Handle).

2. Remove the interior trim panel (Bus and Kombi only).

3. Unscrew and remove the three crosshead screws securing the lock assembly to the door inner panel.

4. Unscrew the nylon guide bush located in the bottom edge of the door.

5. Withdraw the lock assembly from the door.

To Replace

1. Locate the lock assembly in the door, ensuring that the top and bottom locking rods are correctly positioned in their respective holes in the door inner frame.

2. Replace the nylon guide bush in the bottom of the door.

3. Secure the lock assembly to the door with three crosshead screws.

4. Replace the interior trim panel (Bus and Kombi only), door handle and escutcheon plate (see Door Interior Handle).

DOOR ALIGNMENT

The rear doors, each hung on two hinges, are secured to the rear body side panel and the door outer frame. If necessary, adjustment to the door within the aperture should always be on the hinges. Any necessary adjustment can be carried out in the following manner:—

1. Carry out a visual examination, to determine whether the door will need to be moved within the body aperture.

2. To lift or lower the door slacken the bolts securing the hinge to the door. Re-locate the door to the desired position and tighten the securing bolts.

DOOR WINDOW GLASS (where fitted)

Removal and fitting procedures for the fixed windows on both the rear doors is identical. In each case the assembly consists of a toughened window glass and a rubber weatherstrip.

To Remove

1. From inside the vehicle, using a lipping tool or screwdriver with all sharp edges removed, force the inner lip of the weatherstrip over the window aperture flange.

2. When approximately two-thirds of the weatherstrip has been treated in this manner, push the glass and weatherstrip out of the door frame as an assembly.

To Replace

1. Fill the groove in the weatherstrip which is to receive the glass with a suitable sealer.

2. Fit the weatherstrip to the glass and insert a cord in the weatherstrip to door groove, so that the cord ends emerge at the bottom centre, allowing a cross-over of approximately 15 cm. (6 in.).

3. Apply a suitable semi-liquid sealer to the rubber to door section of the weatherstrip, if necessary, securing the weatherstrip to the glass with short lengths of masking tape stuck over the rubber and secured to both sides of the glass.

4. From the outside locate the window glass and the weatherstrip assembly centrally in the aperture, ensuring that the two cord ends are hanging loose within the body.

5. Push the assembly up until the groove in the weatherstrip engages the lower transverse lip of the body aperture, and push the window firmly in at the top. From inside the vehicle, pull out the cord, pulling always towards the centre of the glass. Remove any masking tape used to secure the weatherstrip one piece at a time, immediately before the weatherstrip lip is positioned over the aperture flange.

6. On reaching the top centre of the window, start pulling the other end of the cord, repeating the above operations. As the cord is withdrawn, apply pressure to the outside of the window in the immediate area of the cord, to ease the window into position. When the cord has been withdrawn, it may be necessary to work the rubber weatherstrip either side of the glass to obtain even seating of the weatherstrip.

7. Clean off any surplus sealer or lubricant from the glass and weatherstrip.

SIDE LOADING DOOR (Hinged Type)

THE DOOR TRIM PANEL (where fitted)

See Driver and Passenger door (Hinged).

THE DOOR INTERIOR HANDLE (where fitted)

The interior lock remote control handle and escutcheon plate is secured by a crosshead screw and shakeproof washer located centrally in the handle boss.

THE DOOR EXTERNAL HANDLE

See Driver and Passenger door (Hinged).

THE DOOR PULL HANDLE (where fitted)

See Driver and Passenger door (Hinged).

THE DOOR PRIVATE LOCK (where fitted)

See Driver and Passenger door (Hinged).

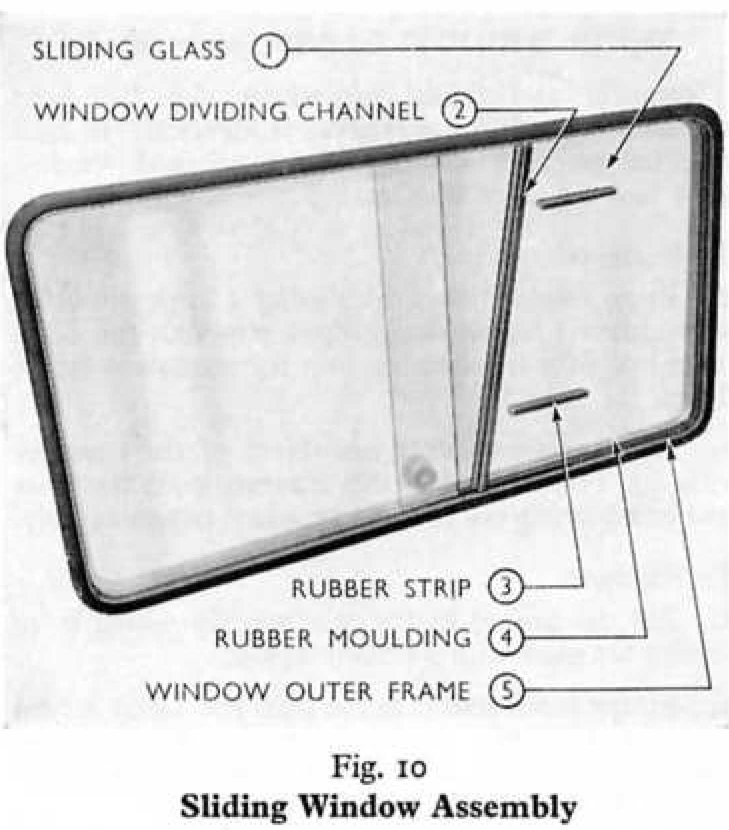


Fig. 10
Sliding Window Assembly

THE DOOR LOCKS AND REMOTE CONTROL MECHANISM

See Driver and Passenger Door (Hinged).

THE DOOR ALIGNMENT AND LOCK ADJUSTMENT

See Driver and Passenger door (Hinged).

FITTING AND ADJUSTING THE STRIKER PLATE

See Driver and Passenger door (Hinged).

THE SLIDING WINDOW (where fitted)

To Remove

1. From inside the vehicle, using a lipping tool or screwdriver with all sharp edges removed, force the inner lip of the sliding window rubber moulding over the window aperture flange.

2. When approximately two-thirds of the moulding has been treated in this manner, from inside the vehicle, push out the sliding window, metal frame and rubber moulding as an assembly.

To Dismantle

1. Pull out two short lengths of rubber strip from the top and bottom inner face of the rubber moulding (see Fig. 10).

2. Using a rubber mallet, gently tap out the window dividing channel (see Fig. 10).

3. Grip the top edge of the outer frame, lift the frame upwards and prise the windows out of their grooves in the frame.

To Reassemble

1. Locate the lower edges of the two windows in their respective grooves in the frame.

2. Grip the top edge of the frame, pull upwards and prise the windows into position.

3. Re-locate the window dividing channel and gently tap into position, using a rubber mallet.

4. Replace the two short lengths of rubber strip in the top and bottom inner face of the frame.

To Replace

1. Apply a suitable semi-liquid sealer to the frame to door groove and insert a cord in the groove so that the cord ends emerge at the bottom centre, allowing a cross-over of approximately 15 cm. (6 in.).

2. From the outside locate the sliding window assembly centrally in the door aperture, ensuring that the cord ends are hanging loose within the body.

3. Push the assembly up until the groove in the weatherstrip engages the lower transverse lip of the door aperture and push the window firmly in at the top. From inside the vehicle pull out the cord, pulling always towards the centre of the glass. Upon reaching the top centre of the window, start pulling out the other end of the cord repeating the above operations. As the cord is withdrawn, apply pressure to the outside of the window in the immediate area of the cord, to ease window into position.

4. Clean off any surplus sealer or lubricant from the glass and weatherstrip.

SIDE WINDOWS, FIXED TYPE (where fitted)

To Remove

1. From the inside of the vehicle, using a lipping tool or a screwdriver with all sharp edges removed, push the inner lip of the weatherstrip under the aperture flange. When approximately two-thirds of the weatherstrip lip has been treated in this manner, apply pressure to the glass from the inside and push out the glass and weatherstrip as an assembly

2. Carefully remove the weatherstrip from the glass.

To Replace

1. Fill the groove which is to receive the glass with a suitable sealer.

2. Fit the weatherstrip to the glass.

3. Fit a length of cord in the weatherstrip groove so that the cord ends emerge at the bottom centre allowing a cross-over of the cord of approximately 15 cm. (6 in.).

4. Apply a suitable sealer to the weatherstrip to door section. If necessary, secure the weatherstrip to the glass with short lengths of masking tape stuck over the weatherstrip and secured to both sides of the glass.

5. From outside offer the assembly to the aperture, top edge first, ensuring that the cord ends are hanging inside the body. Push the assembly firmly from the outside, at the same time pull out the cord, pulling always towards the centre of the glass.

6. Remove any masking tape used to secure the weatherstrip, one piece at a time, immediately before the weatherstrip is positioned over the aperture flange in this location. Upon reaching top centre of the window, start pulling out the other end of the cord, repeating the above operations. It may be necessary to work the weatherstrip either side of the window glass in order to obtain an even seating, for the glass and weatherstrip.

7. Clean off any surplus sealer from the glass and weatherstrip.

THE SIDE WINDOW, HINGED TYPE (where fitted)

The window consists of a window glass and frame pivoting on two rubber inserts secured to the window dividing pillar (see Fig. 11).

To Remove

1. Remove two self-tapping screws securing the window catch to the body.

2. Open the window and place a screwdriver covered with a soft cloth between the window frame and window dividing pillar and carefully prise the frame out of the rubber inserts (see Fig. 11).

3. Remove the window and frame from the vehicle as an assembly.

4. Remove the weatherstrip from the window aperture.

To Replace

1. Apply a suitable semi-liquid sealer to the rubber to body groove of the weatherstrip.

2. Locate the weatherstrip in position around the window flange and press firmly into position.

3. Engage the window frame lugs in the pillar rubber inserts and carefully tap the window assembly into position (see Fig. 11).

4. Position the window catch on the body and secure it with two self-tapping screws.

Fig. 11
Hinged Window and Frame Assembly

DRIVER AND PASSENGER DOOR (Sliding Type)
(All Models)

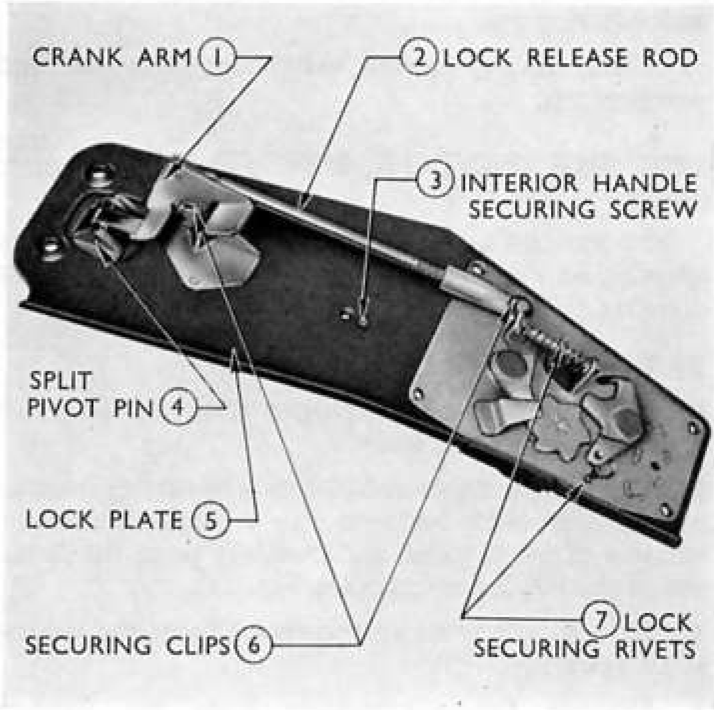


Fig. 12
Sliding Door Lock

THE DOOR EXTERIOR HANDLE

To Remove

1. Remove two crosshead screws and spring washers, four bolts, spring and flat washers securing the lock plate to the door.

2. Remove one crosshead screw and spring washer from the lower end of the door interior handle, remove the interior handle, lock and lock plate as an assembly (see Fig. 12).

3. From inside the door remove three crosshead screws, spring and flat washers securing the door exterior handle and remove the handle.

Ensure that the two rubber gaskets are retained for further use when the door handle is removed.

To Dismantle

1. Remove the circlip from the door handle housing and remove the end plate and spring.

2. Slide the lock barrel, sleeve and adjusting screw out of the door handle housing.

3. Remove the rubber sealing grommet from the lock sleeve.

4. Unscrew and remove the adjusting screw and withdraw the rear section of the lock barrel.

5. Insert the key into the lock and separate the lock barrel and sleeve.

To Reassemble

1. Insert the key in the lock and slide the lock into position in the sleeve.

2. Replace the rear section of the lock and secure with the adjusting screw.

3. Replace the rubber sealing gasket around the lock sleeve.

4. Slide the lock and spring into the door handle housing.

5. Replace the end plate and secure with a circlip.

To Replace

1. Locate the door handle in position, ensuring that the rubber sealing gaskets are correctly located and from the inside of the door secure the handle with three crosshead screws, spring and flat washers.

2. Replace the door interior handle, lock and lock plate as an assembly and secure with one crosshead screw and spring washer in the lower end of the door interior handle.

3. Replace two crosshead screws and spring washers, four bolts, spring and flat washers securing the lock plate to the door.

THE DOOR INTERIOR HANDLE

To Remove

1. Remove two crosshead screws and spring washers, four bolts, spring and flat washers securing the lock plate to the door (see Fig. 12).

2. Remove one crosshead screw and spring washer from the lower end of the door interior handle and remove the interior handle, lock and lock plate as an assembly (see Fig. 12).

3. Remove the clip securing the lock release crank arm to the lock plate (see Fig. 12).

4. Remove the screw from the lower end of the handle and remove the handle from the lock plate (see Fig. 12).

5. Drive out the split pivot pin securing the release lever and return spring to the door handle and withdraw the lever and spring from the handle (see Fig. 12).

To Replace

1. Replace the release lever and return spring in the door handle and secure them with a split pivot pin.

2. Locate the interior handle on the lock plate and secure it with a screw.

3. Replace the lock release crank arm and secure it with a clip.

4. Replace the door interior handle, lock and lock plate in position on the door and secure them with one crosshead screw and spring washer in the lower end of the door interior handle.

5. Replace the two crosshead screws and spring washers, four bolts, spring and flat washers securing the lock plate to the door.

THE DOOR LOCK

To Remove

1. Remove the door interior handle and lock plate (see Door Interior Handle—To Remove).

2. Remove the clips securing the lock interior release rod to the lock mechanism and the crank arm and remove the rod (see Fig. 12).

3. Drill out two pop rivets securing the lock mechanism to the lock plate and remove the lock mechanism (see Fig. 12).

To Replace

1. Locate the lock mechanism on the lock plate and secure it with two pop rivets.

2. Replace the lock interior release rod on the lock mechanism and secure with a clip (see Fig. 12).

3. Replace the door interior handle and lock plate (see Door Interior Handle—To Replace).

THE STRIKER PLATE (FRONT)

To Remove

1. Remove three self-tapping screws securing the striker plate plastic cover to the striker plate mounting bracket and remove the cover.

2. Remove two crosshead screws and spring washers securing the striker plate to the striker plate mounting bracket.

3. Remove the four crosshead screws securing the striker plate mounting bracket to the door front pillar and remove the bracket.

To Replace

1. Locate the striker plate mounting bracket in position on the front pillar and secure it with four crosshead screws.

2. Replace the striker plate on the striker plate mounting bracket and secure it with two crosshead screws and spring washers.

3. Replace the striker plate plastic cover and secure it with three self-tapping screws.

THE STRIKER PLATE (REAR)

To Remove

1. Remove three crosshead screws and spring washers securing the striker plate to the door rear pillar and remove the striker plate.

To Replace

1. Locate the striker plate on the door rear pillar and secure with three crosshead screws.

THE DOOR

To Remove

1. From underneath the door remove four bolts, spring and flat washers securing the two door lower guide brackets.

2. Drill out five pop rivets securing the interior upper draught excluder strip to the upper body framework and remove the strip.

3. Close the door and from the inside of the vehicle slacken the two crosshead screws securing the door front upper guide plate (see Fig. 13).

4. Remove the two screws securing the rear guide tension plate and remove the plate and tension spring (see Fig. 13).

5. Remove the door by lifting upwards and outwards to disengage the door runners from the door upper guide channel.

To Dismantle

1. Remove the two crosshead screws and spacer washers securing the door front upper guide plate and remove the plate (see Fig. 13).

2. Remove two nuts, bolts, spring and spacer washers securing the front upper roller and remove the roller (see Fig. 13).

3. Remove four bolts, spring and flat washers securing the rear upper roller mounting bracket and cover plate and remove the bracket and plate as an assembly (see Fig. 13).

4. Remove one crosshead screw and spring washer securing the cover plate to the rear upper roller mounting bracket and remove the plate (see Fig. 13).

5. Remove two bolts, spring and flat washers securing the rear upper roller to the mounting bracket and remove the roller (see Fig. 13).

6. Drill out five pop rivets securing the lower draught excluder to the door inner panel and remove the draught excluder.

To Reassemble

1. Re-locate the lower draught excluder on the door inner panel and secure it with five pop rivets.

2. Replace the rear upper roller on its mounting bracket and secure it with two bolts, spring and flat washers.

3. Replace the cover plate on the rear upper mounting bracket and secure it with one crosshead screw and spring washer.

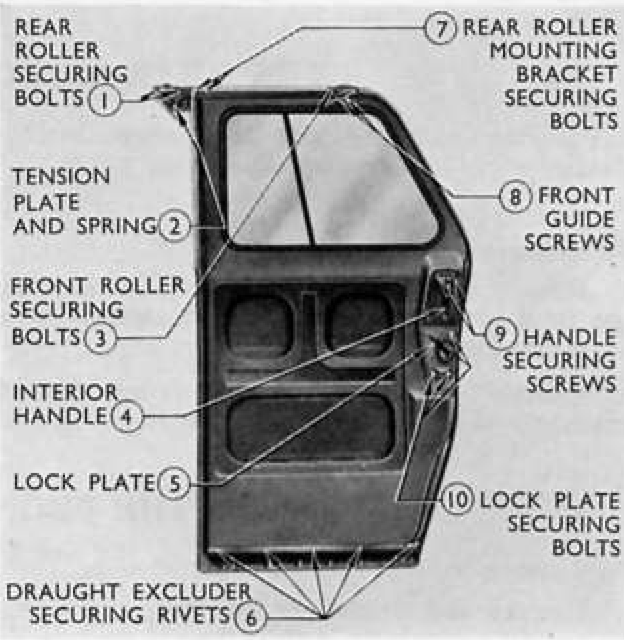


Fig. 13
Sliding Door Off Vehicle

4. Replace the rear upper roller mounting bracket and cover plate and secure them to the door with four bolts, spring and flat washers.

5. Replace the front upper roller on the door frame and secure it with two nuts, bolts, spring and spacer washers.

6. Replace the door front upper guide plate and secure it with two crosshead screws and spacer washers.

To Replace

1. Re-locate the door on the door upper track.

2. Replace the rear guide tension plate and spring and secure it with two screws.

3. Close the door and from the inside, tighten the two crosshead screws securing the door front upper guide plate.

4. Replace the interior upper draught excluder strip and secure it with five pop rivets.

5. Replace the two lower guide brackets on the bottom edge of the door and secure them with four bolts, spring and flat washers.

THE UPPER TRACK

To Remove

1. Remove three nuts and spring washers securing the front end of the upper track to the body.

2. Remove four bolts and spring washers securing the rear end of the upper track and remove the track from the vehicle.

To Replace

1. Locate the upper track in position on the body and secure the rear end with four bolts and spring washers.

2. Secure the front end of the track with three nuts and spring washers.

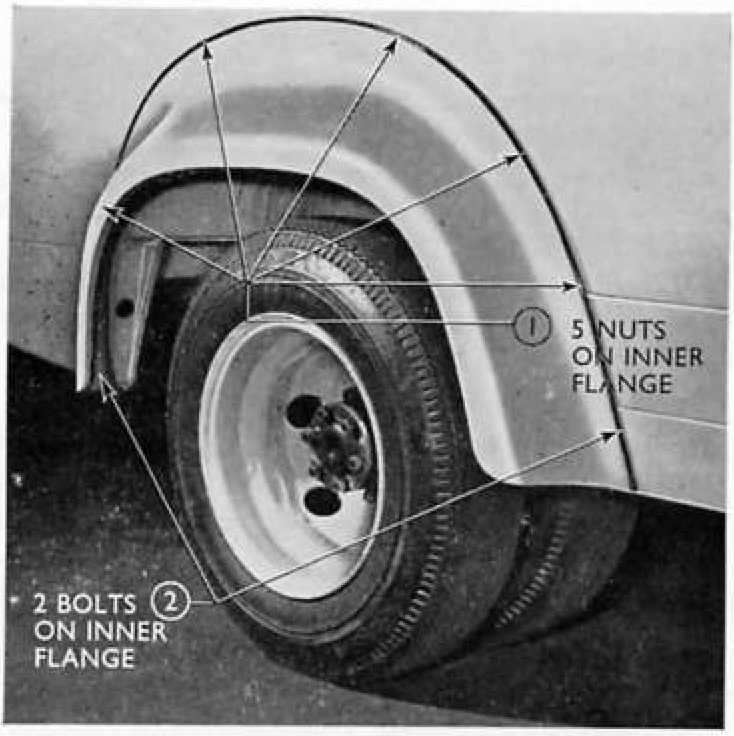


Fig. 14
The Rear Mudguards

THE LOWER TRACK

To Remove

1. Remove six bolts, spring and flat washers securing the lower track to the underbody and remove the track.

To Replace

1. Locate the lower track in position on the underbody and secure it with six bolts, spring and flat washers.

THE RUBBER WEATHERSTRIP

This is a three-piece weatherstrip consisting of a steel and rubber strip and is secured to the rear edge of the door aperture by fifteen pop rivets.

THE REAR MUDGUARDS (where fitted)

The rear mudguard may be removed without disturbing any of the surrounding body panels.

To Remove

1. Remove two bolts, spring and flat washers, one from each lower edge of the mudguard inner flange (see Fig. 14).

2. Remove five nuts, spring and flat washers situated around the mudguard inner panel (see Fig. 14).

3. Pull the mudguard away from the vehicle and remove it and the anti-squeak strip as an assembly.

To Replace

1. Position the anti-squeak strip on the mudguard and locate the mudguard on the vehicle.

2. Replace the two bolts, spring and flat washers securing the lower ends of the mudguard inner flange.

3. Replace the five nuts, spring and flat washers situated around the mudguard inner flange.

THE FRONT BUMPERS

To Remove

1. Unscrew and remove the four nuts, spring and flat washers securing the bumper irons to the vehicle.

2. Remove the bumper and irons from the vehicle as an assembly.

To Replace

1. Locate the bumper and irons in position on the vehicle.

2. Replace the four nuts, spring and flat washers securing the bumper to the vehicle.

THE REAR BUMPERS (where fitted)

To Remove

1. Remove the two nuts, spring and flat washers from each of the two rear bumpers.

2. Remove the bumpers from the vehicle.

To Replace

1. Locate the two rear bumpers on the vehicle.

2. Secure each bumper with two nuts, spring and flat washers.

THE RADIATOR GRILLE PANEL

The radiator grille panel may be removed without disturbing any of the surrounding body panels.

To Remove

1. Remove the four self-tapping bolts from the lower edge of the radiator grille panel (see Fig. 15).

NOTE.—On 125 to 175 diesel engine variants these bolts are replaced by two crosshead screws on the lower grille mounting flange, and are accessible from inside the engine compartment.

2. Remove the pivot bolt securing the bonnet release cable crank arm and disconnect the cable.

Later Models Only

3. Disconnect the wiring loom from the L.H. lamp assemblies.

NOTE.—To disconnect the indicator lamp lead it is necessary to remove the lens and bezel assembly.

4. Remove the loom clips from the radiator grille panel, thread the loom beneath the lock panel and position it aside on the right-hand fender apron. Disconnect the earth location screws at the extreme sides of the grille panel.

5. Pull the horn loom from its locating clips on the upper grille panel, and place to one side. Detach the locating clips.

Early and Later Models

6. Remove the six nuts, spring and flat washers securing the radiator grille panel to the radiator support brackets.

7. Remove the four bolts, spring and flat washers securing the top edge of the radiator grille panel (see Fig. 15).

8. From each side remove two bolts, spring and flat washers securing the radiator grille panel to the front wings (see Fig. 15).

9. From underneath each headlight bezel remove one crosshead screw, spring and flat washer and pull the bezels away from their retaining clips (see Fig. 15).

10. Remove the radiator grille panel from the vehicle.

To Replace

1. Locate the radiator grille panel in position on the front of the vehicle.

2. Replace the two bolts, spring and flat washers securing the grille panel to the front wings.

3. Replace the four bolts, spring and flat washers securing the top edge of the radiator grille panel.

4. Replace the six nuts, spring and flat washers securing the grille panel to the radiator support brackets.

Later Models Only

5. Fit the horn loom retaining clips on the upper grille panel flange, and replace the horn loom.

6. Thread the lighting loom along the top of the grille panel, beneath the lock mounting and reconnect to the L.H. lamp assemblies. Refit the indicator light lens and bezel assembly.

7. Reconnect the earth locating screws at the extreme ends of the grille panel.

Early and Later Models

8. Replace the pivot bolt securing the bonnet release cable crank arm and reconnect the cable.

9. Replace four self-tapping bolts securing the lower edge of the radiator grille panel.

10. Reposition the headlight bezels on their respective retaining clips and secure them with a crosshead screw.

Fig. 15
The Radiator Grille Securing Locations

THE REAR DOOR STEP (where fitted)

To Remove

1. Remove eight nuts, spring and flat washers securing the step support tubes to the underbody.

2. Remove the rear step and support tubes as an assembly.

To Replace

1. Locate the rear step and support tubes in position on the underbody.

2. Secure the step with eight nuts, spring and flat washers.

THE INTERIOR OFFSIDE TRIM PANELS (where fitted)

To Remove

1. Remove the bolts securing the offside seats and remove the seats.

2. Remove the two crosshead screws and cup washers securing the lower edges of the second and third trim panels.

3. Remove the two crosshead screws and cup washers securing the rear edge of the fourth trim panel.

4. Remove the four offside trim panels by pulling the panels away from their securing clips.

To Replace

1. Locate the four trim panels and secure them to the body by pressing the clips into place.

2. Secure the rear edge of the fourth trim panel with two crosshead screws and cup washers.

3. Secure the lower edges of the second and third trim panels with two crosshead screws and cup washers.

4. Replace the four offside seats and secure them to the floor pan with sixteen bolts.

THE INTERIOR NEARSIDE TRIM PANEL (where fitted)

To Remove

1. Remove the bolts securing the nearside seats and remove the seats.

2. Remove the crosshead screw and cup washer securing the front trim panel.

3. Remove the two crosshead screws and cup washers securing the rear trim panel.

4. Remove the two trim panels by pulling them away from their securing clips.

To Replace

1. Locate the trim panels and secure them by pressing the retaining clips into place.

2. Replace the two crosshead screws and cup washers securing the rear trim panel.

3. Replace the two crosshead screws and cup washers securing the front trim panel.

4. Re-locate the seats and secure them to the floorpan.

THE WINDSCREEN

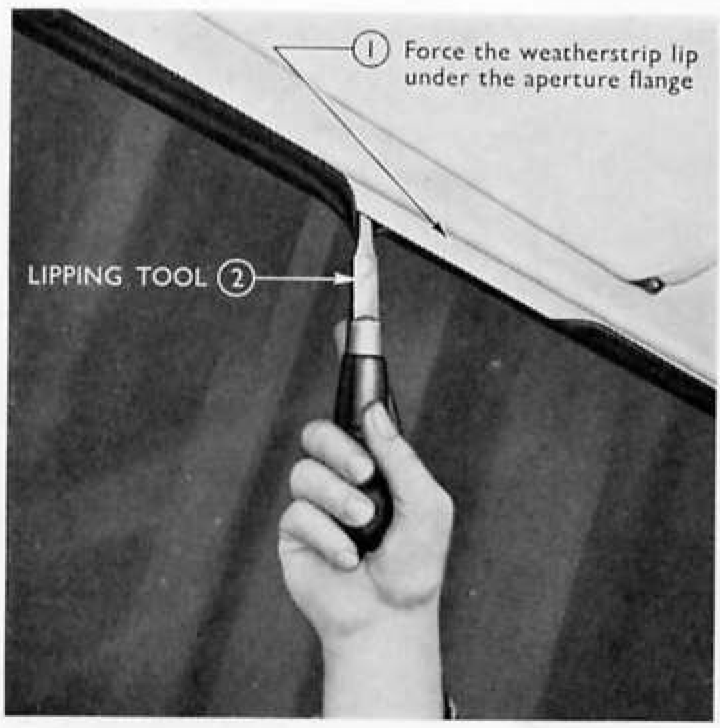


Fig. 16
Removing the Windscreen

The assembly consists of a windscreen glass and weatherstrip. In order that satisfactory sealing against water entry is obtained, it is essential that the correct fitting procedure is adopted.

NOTE 1

Only a suitable permanently flexible sealing material, such as S.R.–51–B manufactured by Expandite Ltd., should be used to seal all fixed windows.

Before removing or refitting windscreen glass, ascertain the type of glass which is being dealt with. Two types are used, "Toughened" or "Laminated", and a close examination of the glass will reveal a distinguishing mark including the words "Toughened" or "Laminated" or 'T' or 'L'. Toughened windscreens have a specially treated zoned area immediately in front of the driver. Since there are different windscreens for Left-Hand and Right-Hand Drive vehicles, the distinguishing mark on the glass incorporates an arrow indicating which side of the windscreen carries the zone.

A rubber mallet can be used to assist in fitting windscreens of toughened glass. but it is essential

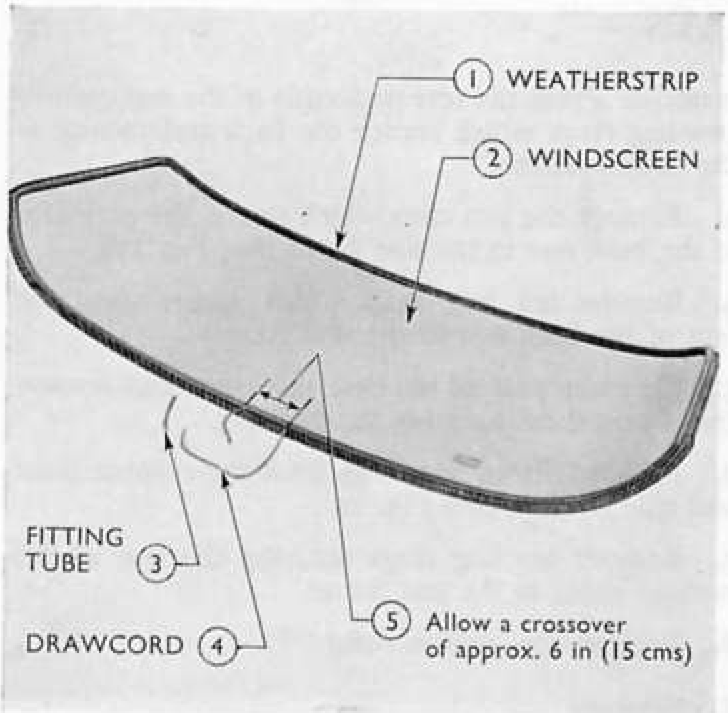


Fig. 17
Fitting the Windscreen Cord

that laminated glass should be treated with extreme care and not subjected to sudden shock or distortion.

To Remove

1. Remove the wiper arms and blades.

2. Using a lipping tool or a screwdriver with all sharp edges removed, from inside the vehicle, force the upper transverse lip of the windscreen weatherstrip under the windscreen aperture flange (see Fig. 16). To accomplish this, it may be necessary to use two or three short flat levers with rounded edges (to avoid damage to the weatherstrip) these may be improvised from lengths of mild steel strip approximately 152 mm. long by 25 mm. wide by 3 mm. thick (6 in. by 1 in. by $\frac{1}{8}$ in.).

Insert the levers behind the upper transverse weatherstrip lip at approximately 5 cm. (2 in.) intervals; when pulled down they will expose the body flange surrounding the windscreen aperture. The weatherstrip then can be forced under this flange until approximately two-thirds of the transverse length has been so treated. From inside the vehicle the glass and weatherstrip can then be pushed out as an assembly.

3. Carefully remove the weatherstrip from the window glass.

To Replace

NOTE 2

If the windscreen glass is being replaced due to accident damage, ensure that the aperture is dimensionally correct and that the aperture flange is free from buckles and protrusions. Carefully clean any shattered glass from the weatherstrip grooves and scrape off any hardened sealer which may be adhering to the weatherstrip or body aperture flange.

1. Fill the groove which is to receive the glass with a suitable sealer (see Note 1).

2. Fit the weatherstrip to the glass.

3. Insert a length of cord into the weatherstrip groove so that the cord ends emerge at the bottom centre, allowing a cross over of approximately 15 cm. (6 in.) (see Fig. 17).

NOTE 3

A short piece of tube, which can be improvised, from a length of petrol feed pipe, can be used to fit the cord. Thread the cord through the tube and insert one end within the weatherstrip groove. Slide the tube along the groove, so feeding the cord into position.

4. Apply suitable sealer to the rubber to body section of the weatherstrip (see Note 1). If necessary secure the weatherstrip to the glass with short lengths of masking tape stuck over the weatherstrip and secured to both sides of the glass.

5. Lubricate the weatherstrip inner lip and the aperture flange with a suitable lubricant such as tallow, glycerine or soft soap.

6. Locate the windscreen and weatherstrip assembly centrally in the aperture, ensuring that the cord ends are hanging loose within the body.

Push the assembly up until the weatherstrip lip engages the lower transverse flange of the body aperture then push the windscreen firmly in at the top.

7. Pull the cord towards the centre of the glass from the inside of the vehicle (see Fig. 18) and remove each piece of masking tape as the weatherstrip is positioned.

As the cord is withdrawn, apply pressure to the outside of the windscreen in the immediate area of the cord to ease the windscreen into position. When the cord has been withdrawn, it may be necessary to work the rubber weatherstrip into position either side of the glass in order to obtain an even seating of the glass and weatherstrip.

8. Clean off any surplus sealer or lubricant from the glass and weatherstrip.

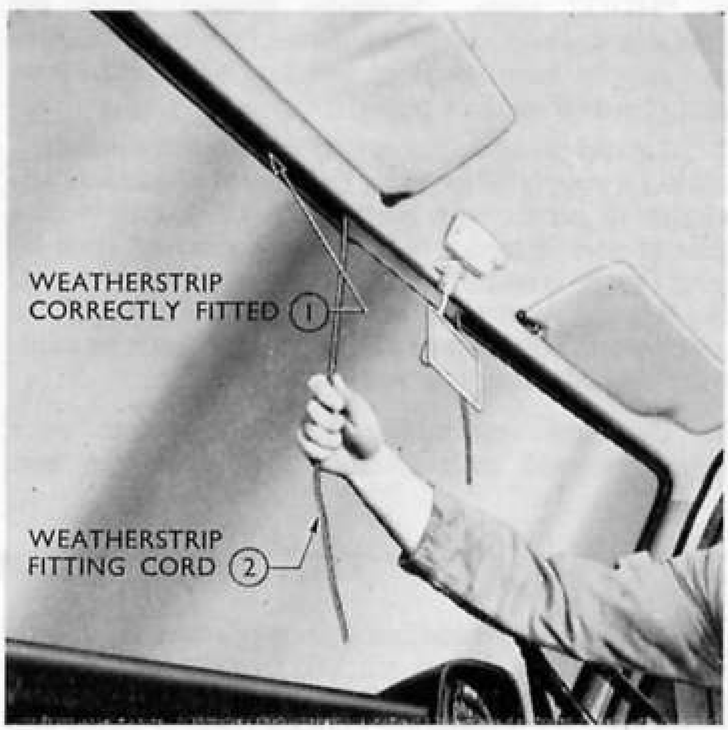


Fig. 18
Fitting the Windscreen

THE SEATS

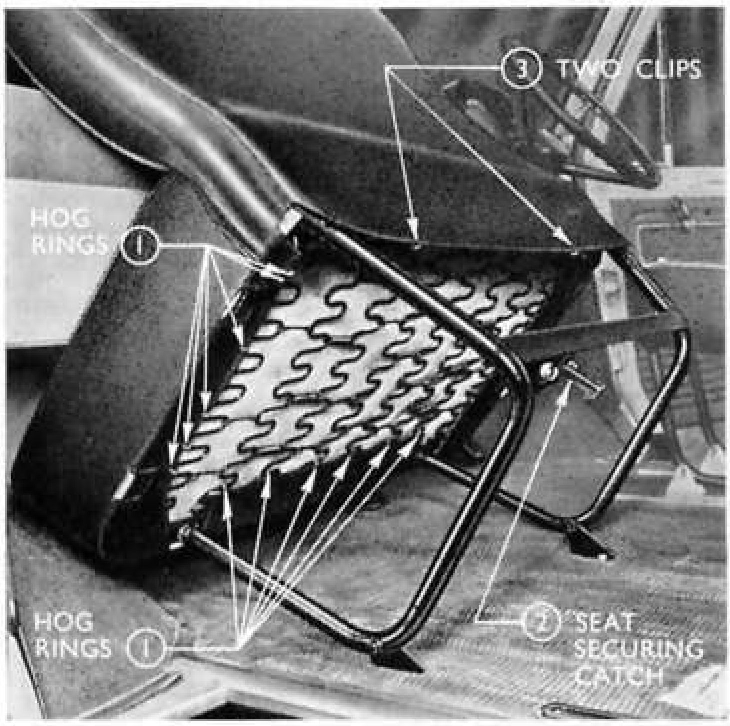


Fig. 19
Seat Cover Securing Clips

As the removal and fitting procedures are similar for all the seats in the range, the only variation being the number of clips and hog rings securing the seat covers to the frames, only one detailed procedure is outlined below.

To Remove

1. Remove the seat from the vehicle.

NOTE 1

The seat covers are secured to the cushion and back rest frame by a number of wire staples known as "HOG" rings. Specially formed pliers are available to close and fasten these clips, but a suitable tool may be improvised by grinding slots in the jaws of a standard type of pliers.

To avoid possible damage to the covering material, should a supply of new hog rings be available it is advisable to cut through each original hog ring with a pair of wire cutters. New hog rings would then be used for the reassembly of the seat cover. However, if the original rings must be retained for further use or wire cutters are not available, each ring must be carefully opened using two pairs of pliers.

2. Place the seat upside down on a clean work bench covered with a cloth to protect the seat material. From the rear underside of the seat remove two hog rings which secure the back rest valance to the cushion frame.

3. Remove the two clips which secure the back face of the back rest to the seat frame (see Fig. 19).

4. Remove ten hog rings which secure the front face of the back rest to the seat frame.

5. Carefully pull off the back rest cover and remove the plastic sheet covering the padding.

6. Remove fifteen hog rings from the cushion front and side borders (see Fig. 19).

7. Remove ten hog rings securing the rear of the cushion cover to the seat frame.

8. Remove the cushion cover.

To Replace

1. Locate the seat cushion cover in position on the seat frame, ensuring that the padding is correctly located and secure the rear edge to the seat frame with ten hog rings.

2. Pull the seat borders down and secure them with eight hog rings, four either side.

3. Pull the material firmly from front to back and secure the front edge of the cover by two hog rings centrally located. Working from the centre, secure the seat cover along the front edge with five more hog rings.

4. Ensure that the back rest padding is correctly located and over the padding place a section of plastic sheeting. Liberally coat the padding corners with liquid soap. Place the back rest cover in position and pull it firmly over the padding.

5. Ensure that the back rest cover is correctly located then tuck the lower edge of the front face of the material behind the seat cushion and secure it to the seat frame with ten hog rings.

6. Secure the back rest cover side valance ends with two hog rings, one either side and the rear face with two clips.

7. Replace the seat.

NOTE 2

If there are any small wrinkles in the material after fitting a new seat cover, they can often be removed by the use of steam iron and a damp cloth on the affected area.

THE FULL HEADLINING (where fitted)

The one-piece headlining is supported by listing wires carried in sleeves stitched to the upper face of the headlining material. Each listing wire locates in a sleeve in the headlining toothed retainer strips and abuts the sound deadener strips secured by adhesive to the underside of the roof panel.

274.3 cm. (108 in.) WHEELBASE (where fitted)

To Remove

1. Remove two self-tapping screws securing the interior rear view mirror.

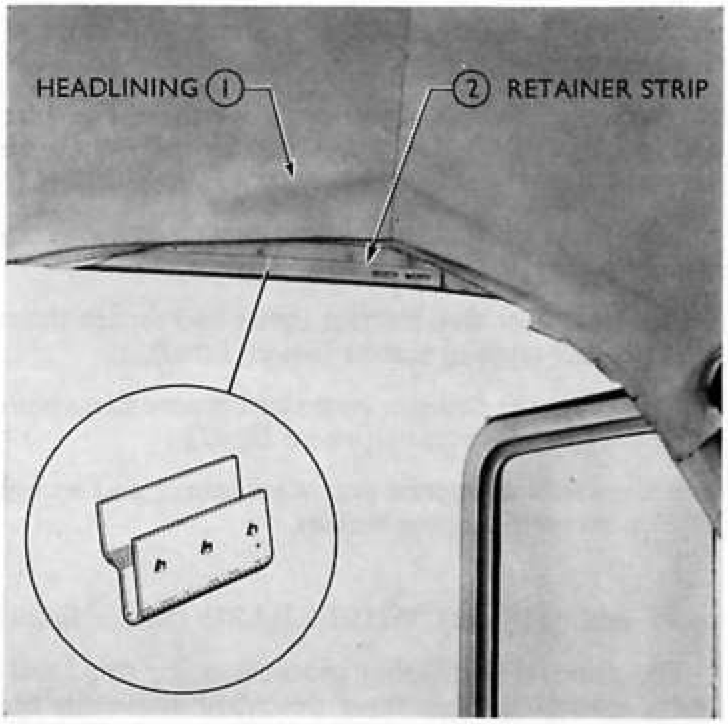


Fig. 20
Headlining Retainer Rail

2. Remove eight self-tapping screws securing the two sun visors (where fitted).

3. Remove ten self-tapping screws securing the five interior lights (where fitted).

4. Remove windscreen and weatherstrip as an assembly (see Windscreen—To Remove).

5. Pull the finish strip away from the door aperture flange and carefully pull the headlining away from the top of the coupe pillars and the windscreen.

6. Insert between the body and the headlining toothed retainer strips, a thin metal blade with all sharp edges removed and gently prise the retainer strips away from the body. (A blunt paint scraper can be used for this operation.) The tool can then be pushed between the retainer strip and body, enabling the headlining to be carefully lifted from the retaining teeth on the back face of the retainer strips (see Fig. 20).

NOTE 1

To avoid damage to the headlining material during this delicate operation, commence to lift the material from the retainer teeth in a location where a sleeve is stitched to the back face. This location can be determined by the stitch join between the panels of the headlining (see Fig. 20) in this manner, detach the headlining along three edges.

The sides and rear edge of the headlining are secured to toothed retainer strips which are spot welded to the upper body framework. The front edge of the headlining is secured by adhesive to the windscreen upper body flange and coupe pillars.

7. The listing wires can then be removed from their sockets in the upper body framework.

8. Remove the headlining and listing wires as an assembly.

To Replace

If the headlining material is to be renewed, ensure that the listing wires are fitted in the correct sleeve. This can be most conveniently carried out by removing the listing wires one at a time from the discarded material and fitting them to the appropriate sleeve of the new. (A generous dusting with powdered chalk will assist in fitting the listing wires to the cotton sleeves.)

The listing wires vary in form and length and are marked with a distinguishing daub of paint. The following list shows the position and colour code of the listing wires, starting from the front of the vehicle.

Position	*Colour*
1	Blue
2	Blue
3	Green
4	Green
5	Yellow
6	Brown
7	Red

NOTE 2

Under cold damp climatic conditions, plastic-covered headlining materials tend to become stiff, making it difficult to obtain a crease and wrinkle-free fitting. To assist in obtaining a satisfactory finish the work should be carried out in a warm 18° to 22°C (65° to 70°F) dry, workshop.

1. Ensure that the listing wires are free to slide within the cotton sleeves and that they are centrally situated, to leave an equal amount of material hanging free at either end. With the material correctly fitted to the listing wires, break the cotton sleeve to allow the ends of the listing wires to protrude with approximately 10 to 15 cm. (4 to 6 in.) of material hanging loose.

2. Locate the first listing wire in its body frame socket, then fit the remaining listing wires in their respective locations.

3. Pull the headlining material from front to back to remove any transverse creases which may exist, and temporarily secure the headlining to the toothed retainer strips with suitable clips or pins. To obtain a crease-free fitting of the material in the corners of the headlining it will be necessary to make short slits from the outside edge of the material. Care must be exercised not to make these slits too long or they will be visible when the headlining is fitted.

4. Liberally coat the top transverse flange of the windscreen aperture flange and coupe pillars with suitable adhesive and temporarily offer the headlining into position on the windscreen and coupe pillars, and thus transfer some of the adhesive to the back face of the material. When both surfaces have thus been primed with adhesive, take down the material and allow a short time to elapse for the adhesive to become tacky.

5. Trim off the surplus material with sharp scissors leaving approximately 5 cm. (2 in.) of material hanging below the retainer strips. Using the tool previously described (a blunt paint scraper) gently push the overhanging material up behind the toothed retainer strips, removing the clips as the operation proceeds. (To avoid possibility of damage to the headlining material this should be commenced at the location where a cotton sleeve is stitched to the back face of the headlining material.) (See Fig. 20). If additional stress is required at any point to remove transverse creases this again should be done by pushing on the headlining material in a position where a cotton sleeve is stitched to the back face of the material.

6. Once the sides and back edges have been secured pull the front edge taut to remove any creases which may exist and secure the front edge of the material to the windscreen upper transverse flange and the coupe pillars. When the headlining is secure, trim off any excess material.

NOTE 3

If there are small wrinkles in the material, after fitting a new plastic-covered headlining, they can often be removed by shrinking the cotton backing in the following manner.

Pierce the material near the wrinkle with a water-filled hypodermic syringe fitted with a fine needle. Whenever possible, insert the needle through a panel joint stitching hole. A small quantity of water can then be ejected on to the upper face of the cotton backing, which will then shrink locally. This shrinkage will usually be sufficient to take out small wrinkles.

7. When the material has been secured along the edges firmly tap the retainer strips to close the locking teeth, using a rubber mallet or hammer and block of wood covered with soft cloth.

8. Refit the finish strip and secure the end under the moulding "pop" rivetted to the door aperture flange.

9. Replace the windscreen and weatherstrip as an assembly (see Windscreen—To Replace).

10. Replace the five interior lights and secure them with ten self-tapping screws (where fitted).

11. Replace the two sun visors and secure them with eight self-tapping screws (where fitted).

12. Replace the interior rear view mirror and secure it with two self-tapping screws.

299.7 cm. (118 in.) WHEELBASE (where fitted)

The removal and fitting procedures for this headlining are identical to those described above for the 274.3 cm. (108 in.) wheelbase (Bus and Kombi), with the exception that there are nine listing wires. The location and colour code on these listing wires is shown below.

Position	*Colour*
1	Blue
2	Green
3	Yellow
4	Yellow
5	Yellow
6	Yellow
7	Brown
8	Red
9	White

PART HEADLINING (where fitted)

This one-piece headlining is supported by two listing wires carried in sleeves stitched to the upper face of the headlining material.

The sides of the headlining are secured to the upper body framework by toothed retainer strips, whilst the front edge is secured by adhesive to the windscreen upper body flange and coupe pillars. The rear edge of the headlining is secured by a steel strip carried in a sleeve in the headlining and screwed to the roof reinforcing panel.

To Remove

1. Remove two self-tapping screws securing the interior rear view mirror.

2. Remove eight self-tapping screws securing the two sun visors (where fitted).

3. Remove the interior lights (where fitted).

4. Remove the windscreen and weatherstrip as an assembly (see Windscreen—To Remove).

5. Pull the finish strip away from the door aperture flange and carefully pull the headlining away from the top of the coupe pillars and the windscreen.

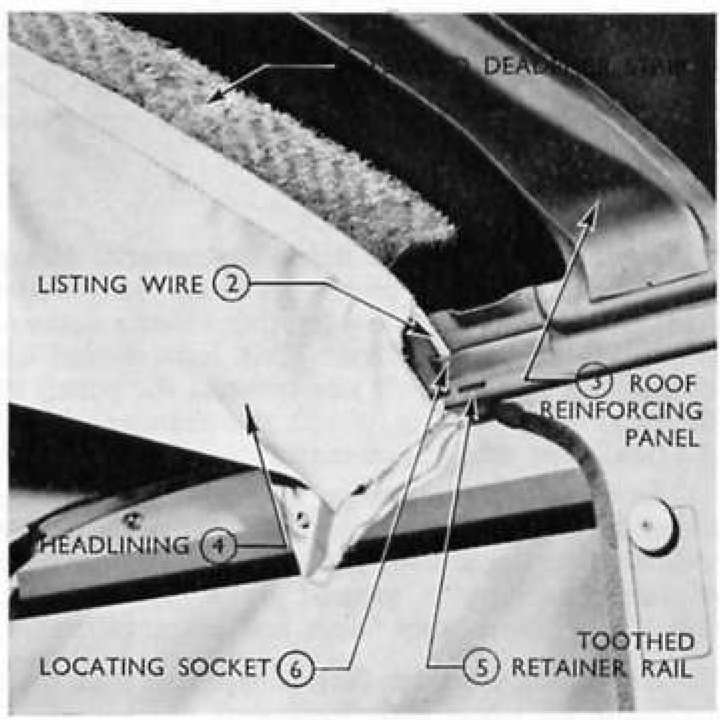


Fig. 21
Part Headlining

6. Unscrew seven self-tapping screws and cup washers securing the rear edge of the headlining to the roof reinforcing panel (see Fig. 21).

7. Insert between the body and the headlining toothed retainer strips, a thin metal blade with all sharp edges removed and gently prise the retainer strips away from the body. (A blunt paint scraper can be used for this operation.) A tool can then be pushed between the retainer strip and body, enabling the headlining to be carefully lifted from the retaining teeth on the back face of the retainer strips.

NOTE 1

To avoid damage to the headlining material during this delicate operation, commence to lift the material from the retainer teeth in a location where a sleeve is stitched to the back face. This location can be determined by the stitch join between the panels of the headlining, in this manner detach the headlining along the sides.

8. The listing wires can then be removed from their sockets in the upper body framework (see Fig. 21).

9. Remove the headlining and listing wires as an assembly.

To Replace

Under cold damp climatic conditions, plastic-covered headlining materials tend to become stiff, making it difficult to obtain a crease and wrinkle-free fitting. To assist in obtaining a satisfactory finish, the work should be carried out in a warm 18° to 22°C (65° to 70°F) dry, workshop.

1. Ensure that the listing wires are free to slide within the cotton sleeves and that they are centrally situated, to leave an equal amount of material hanging free at either end. With the material correctly fitted to the listing wires, break the cotton sleeve to allow the ends of the listing wires to protrude with approximately 10 to 15 cm. (4 to 6 in.) of material hanging loose.

2. Locate the listing wires in their body frame sockets (see Fig. 21).

3. Secure the rear edge of the headlining to the roof reinforcing panel with seven self-tapping screws and cup washers.

4. Pull the headlining material from front to back to remove any transverse creases which may exist, and temporarily secure the headlining to the toothed retainer strips with suitable clips or pins. To obtain a crease-free fitting of the material in the corners of the headlining, it will be necessary to make short slits from the outside edge of the material. Care must be exercised not to make these slits too long or they will be visible when the headlining is fitted.

5. Liberally coat the top transverse flange of the windscreen aperture flange and coupe pillars with suitable adhesive and temporarily offer the headlining into position on the windscreen and coupe pillars, and thus transfer some of the adhesive to the back face of the material. When both surfaces have been primed with adhesive, take down the material and allow a short time to elapse for the adhesive to become tacky.

6. Trim off the surplus material with sharp scissors, leaving approximately 5 cm. (2 in.) of material hanging below the retainer strips. Using the tool previously described (the blunt paint scraper) gently push the overhanging material up behind the toothed retainer strips, removing the clips as the operation proceeds. (To avoid the possibility of damage to the headlining material this should be commenced at the location where a cotton sleeve is stitched to the back face of the headlining material.) If additional stress is required at any point to remove transverse creases, this again should be done by pushing on the headlining material in a position where a cotton sleeve is stitched to the back face.

7. Once the sides and back edges have been secured, pull the front edge taut to remove any creases which may exist and secure the front edge of the material to the windscreen upper transverse flange and the coupe pillars. When the headlining is secure, trim off any excess material.

NOTE 2

If there are any small wrinkles in the material, after fitting a new plastic-covered headlining, they can often be removed by shrinking the cotton backing in the following manner:—

Pierce the material near the wrinkle with a water-filled hypodermic syringe fitted with a fine needle. Whenever possible, insert the needle through a panel joint stitching hole. A small quantity of water can then be ejected onto the upper face of the cotton backing, which will then shrink locally. This shrinkage will usually be sufficient to take out small wrinkles.

8. When the material has been secured along the edges, firmly tap the retainer strips to close the locking teeth, using a rubber mallet or hammer and block of wood covered with a soft cloth.

9. Refit the finish strip and secure the end under the moulding "pop" rivetted to the door aperture flange.

10. Replace the windscreen and weatherstrip as an assembly (see Windscreen—To Replace).

11. Replace the interior lights (where fitted).

12. Replace the two sun visors and secure them with eight self-tapping screws (where fitted).

13. Replace the interior rear view mirror and secure it with two self-tapping screws (where fitted).

BODY AND CHASSIS REPAIR

All Models

The following pages contain dimensional drawings of the various body and chassis versions. These are designed to be of assistance when undertaking repairs to the body or chassis, and should be used in conjunction with suitable stands and a level floor extending the full length of the vehicle (see Note 1). All the bodies are similarly constructed with the chassis members spot welded to the underbody.

An essential first step when checking or repairing extensively damaged vehicles is to ensure correct chassis frame alignment, by carrying out a series of diagonal checks between the various chassis cross-members. The diagonals marked on the plan can be checked by using large callipers or a pair of trammels or, alternatively, by using a plumb bob and line.

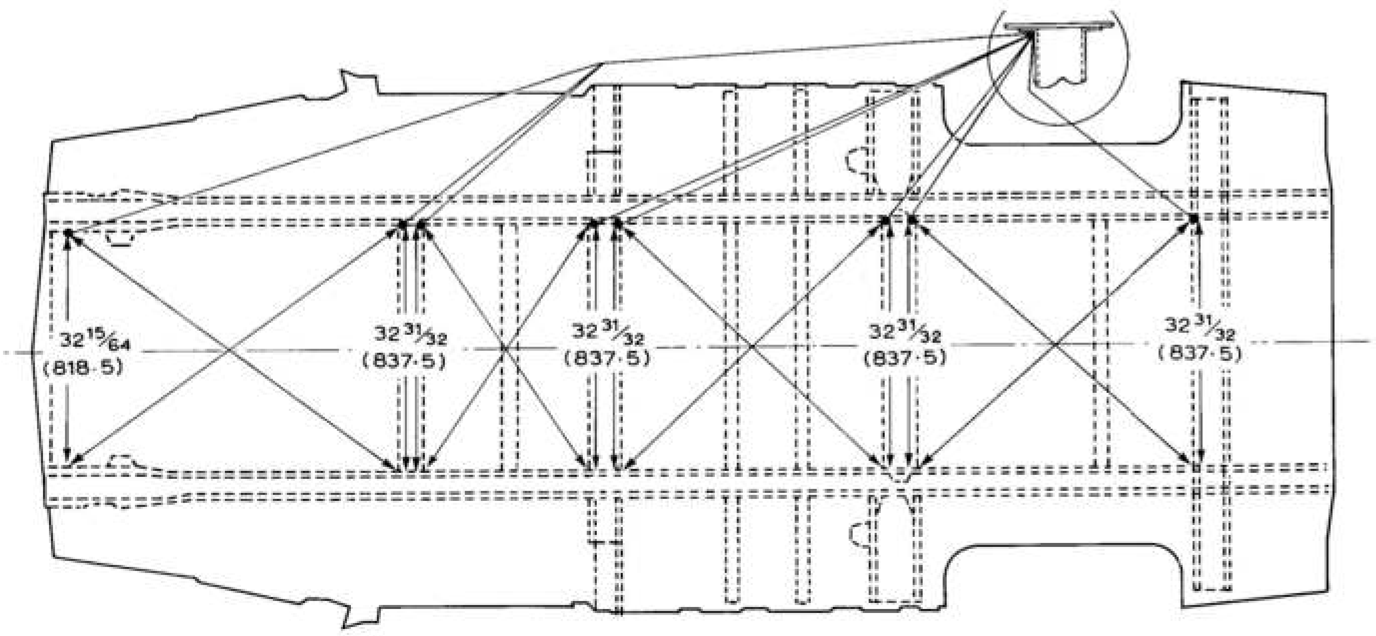
The latter method enables a simple and accurate check to be made. Suspend the plumb bob from the appropriate reference points on the body and carefully mark the floor at each location. Connect these points by a chalk line and draw through the intersecting points of the diagonals. Finally, check the dimensions between the front and rear sidemembers.

NOTE 1:

The vehicle should be supported on four blocks covering the full width of each side member. The blocks should be at least 15.3 cm. (6 in.) long.

The centres of the blocks should be 82.55 cm. (32.5 in.) and 201.9 cm. (79.5 in.) back from the centre line of the front axle on the 75 to 125, and 82.55 cm. (32.5 in.) and 230.1 cm. (90.5 in.) on the 130 to 175.

75 to 125
VAN, BUS and KOMBI



32 15/64
(818·5)
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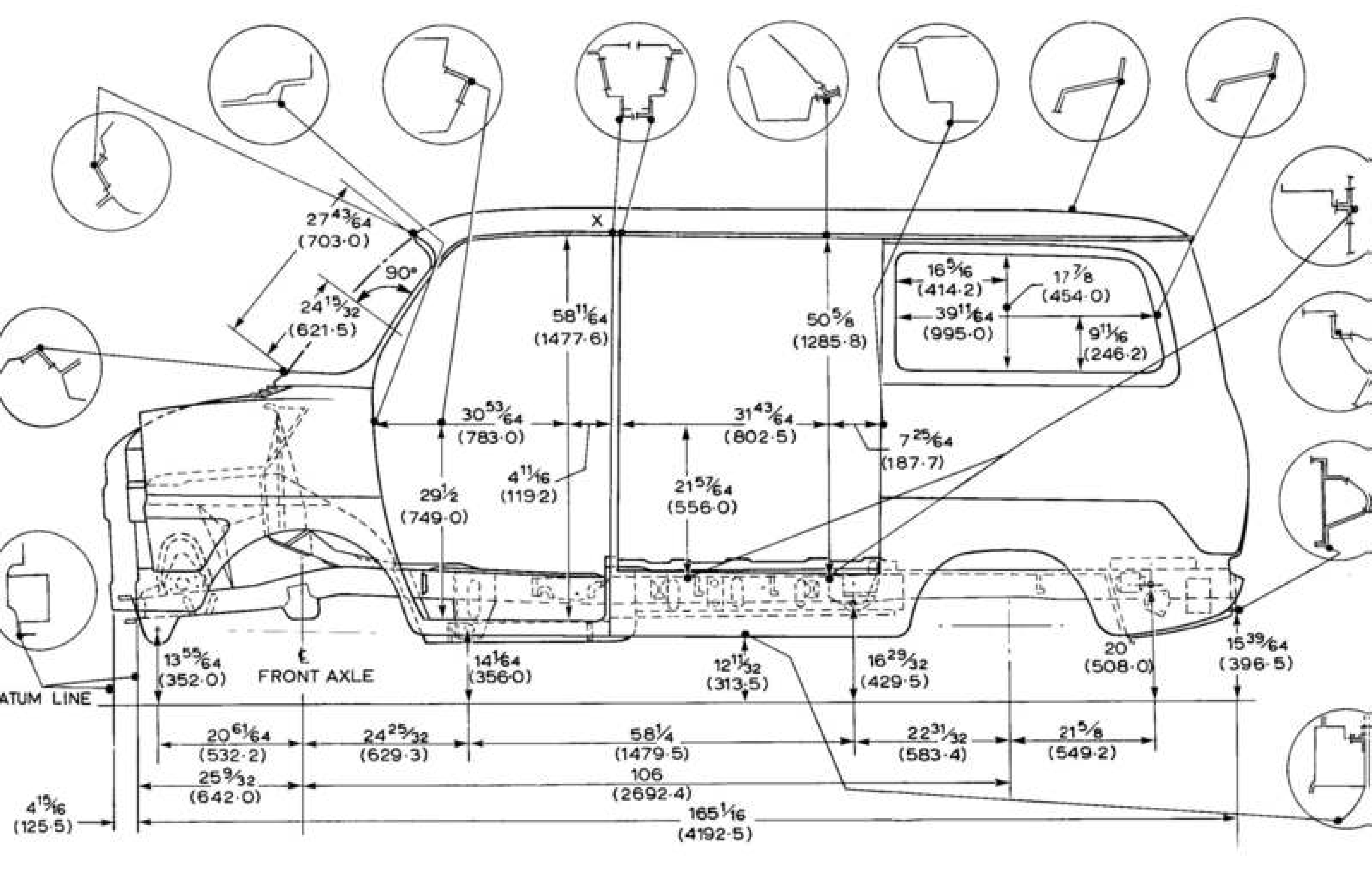

27 43/64
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24 15/32
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9 11/16
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30 53/64
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FRONT AXLE
14 1/64
(356·0)
12 11/32
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16 29/32
(429·5)
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(508·0)
15 39/64
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DATUM LINE
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(532·2)
24 25/32
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(1479·5)
22 31/32
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21 5/8
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106
(2692·4)
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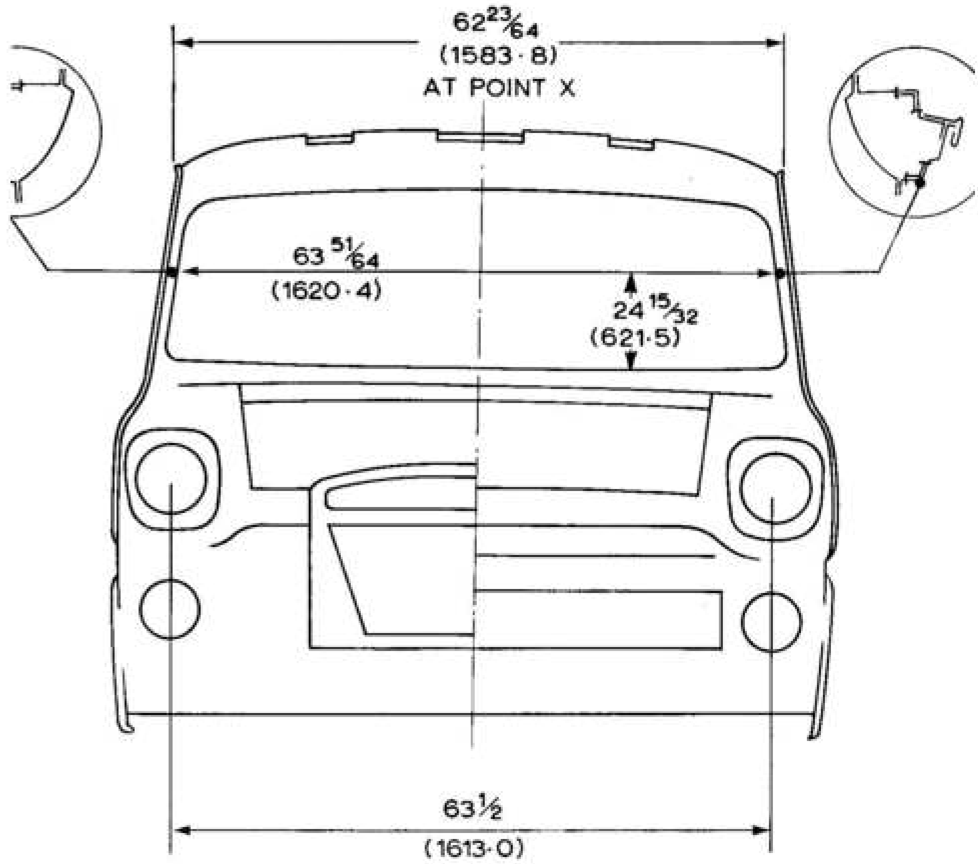
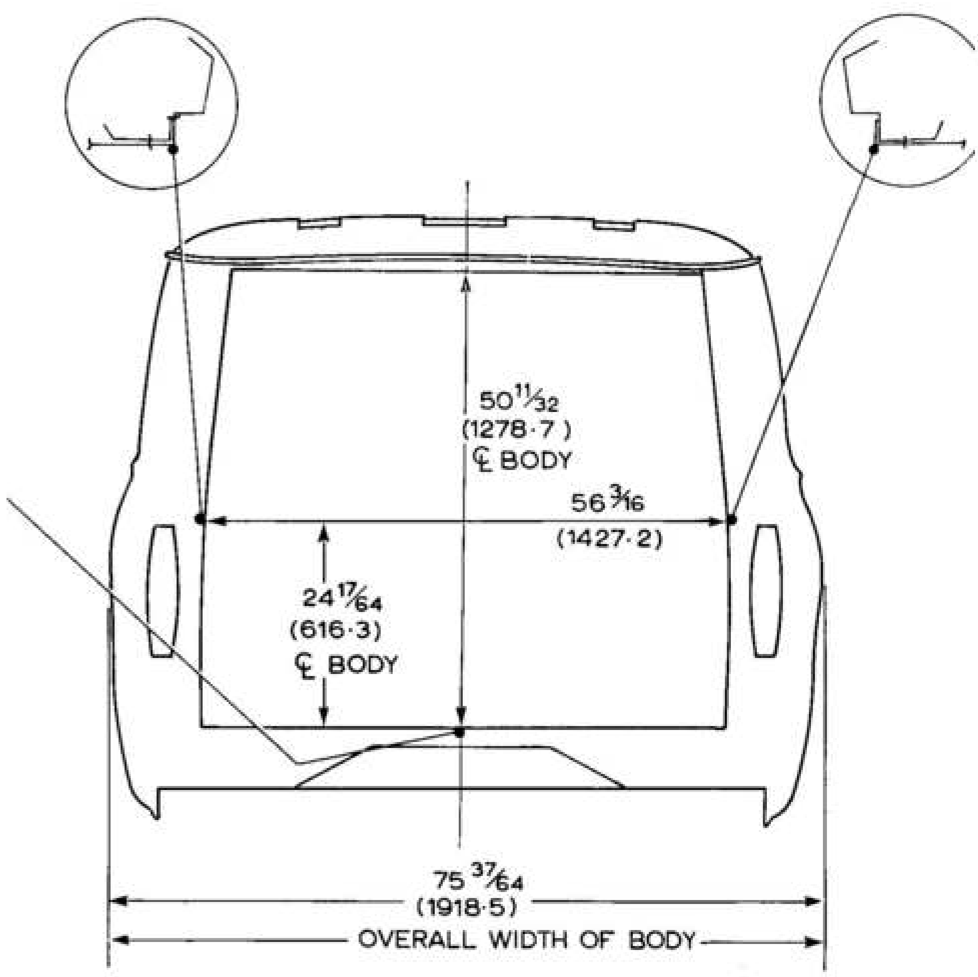
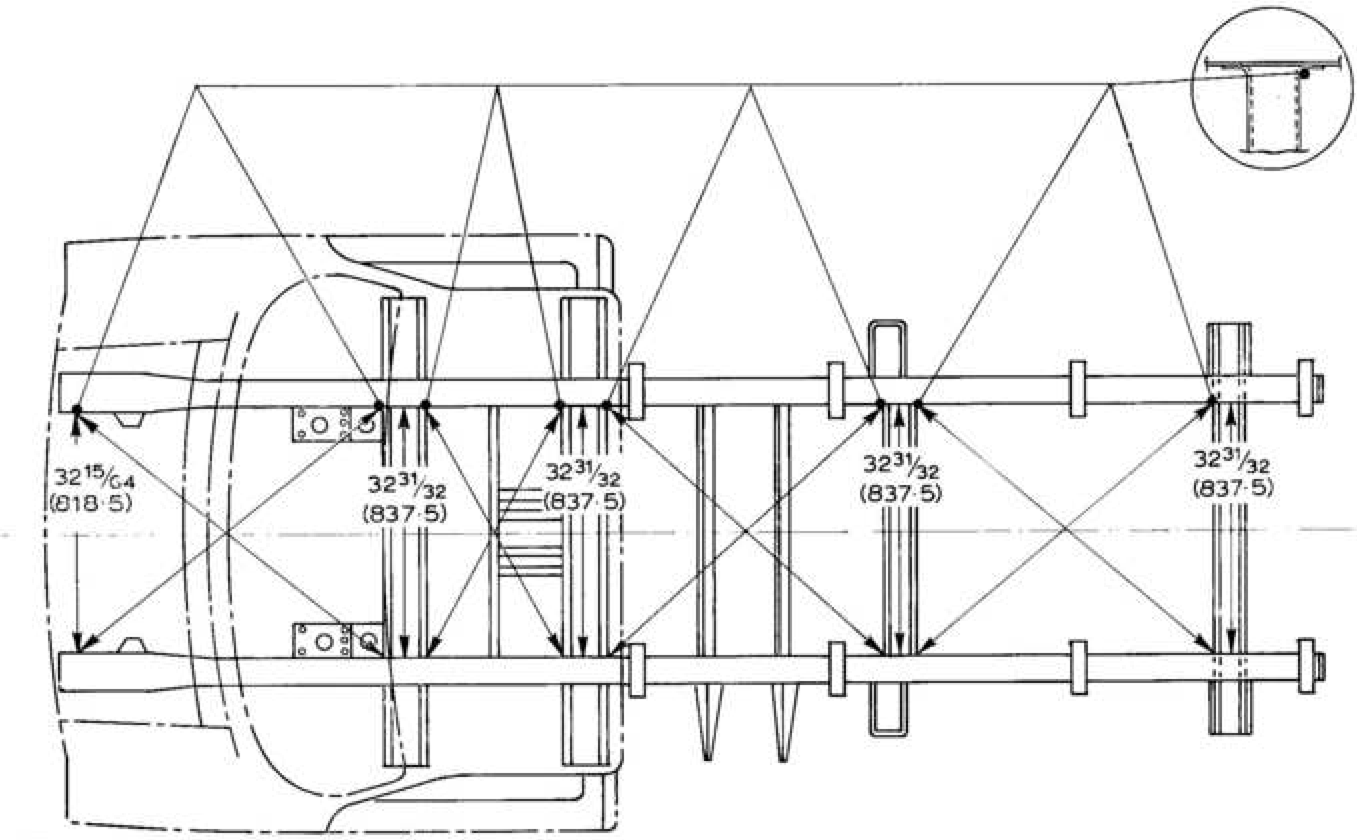
165 1/16
(4192·5)





ALL DIMENSIONS IN INCHES (MILLIMETRES)

75 to 125
CHASSIS CAB



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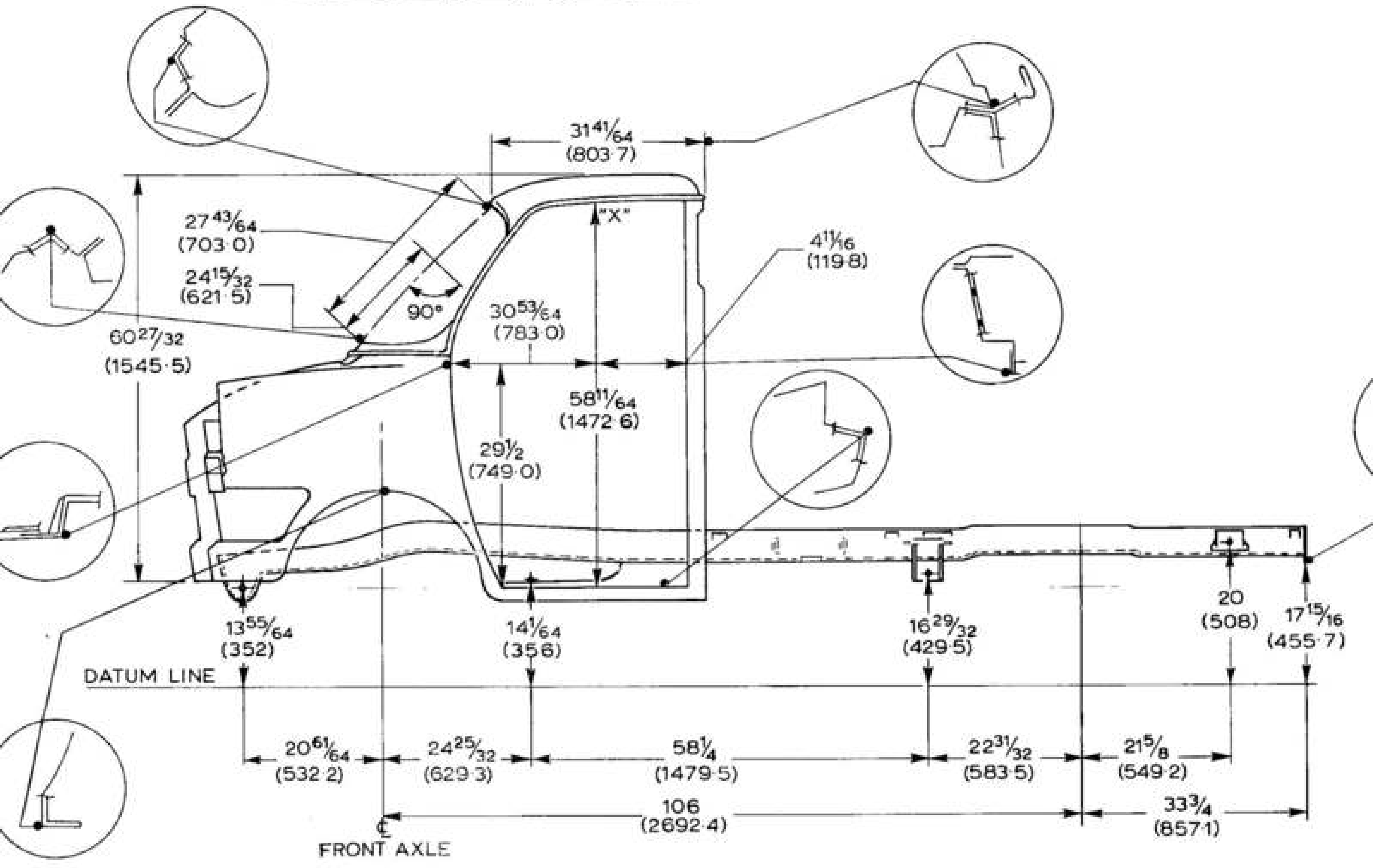

31 41/64
(803·7)
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"X"
90°
4 11/16
(119·8)
30 53/64
(783·0)
60 27/32
(1545·5)
58 11/64
(1472·6)
29 1/2
(749·0)
13 55/64
(352)
14 1/64
(356)
16 29/32
(429·5)
20
(508)
17 15/16
(455·7)
DATUM LINE
20 61/64
(532·2)
24 25/32
(629·3)
58 1/4
(1479·5)
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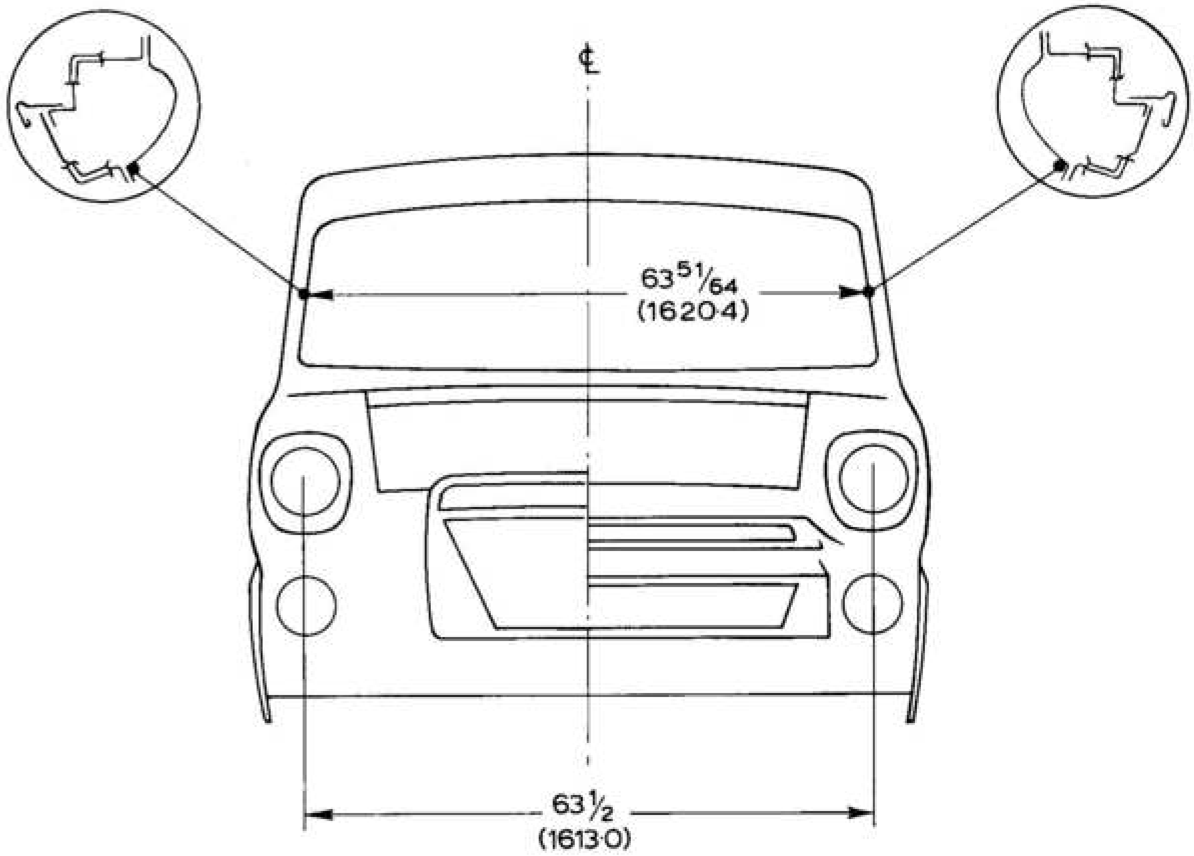
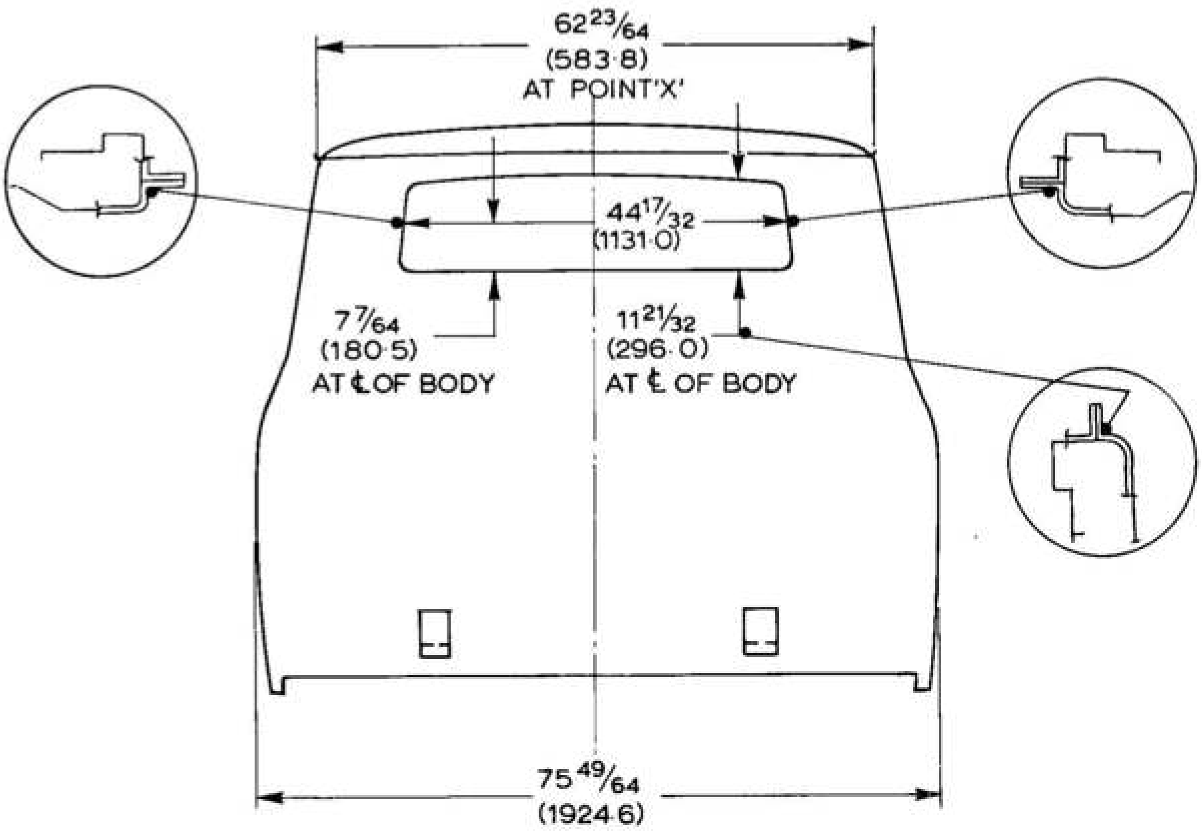
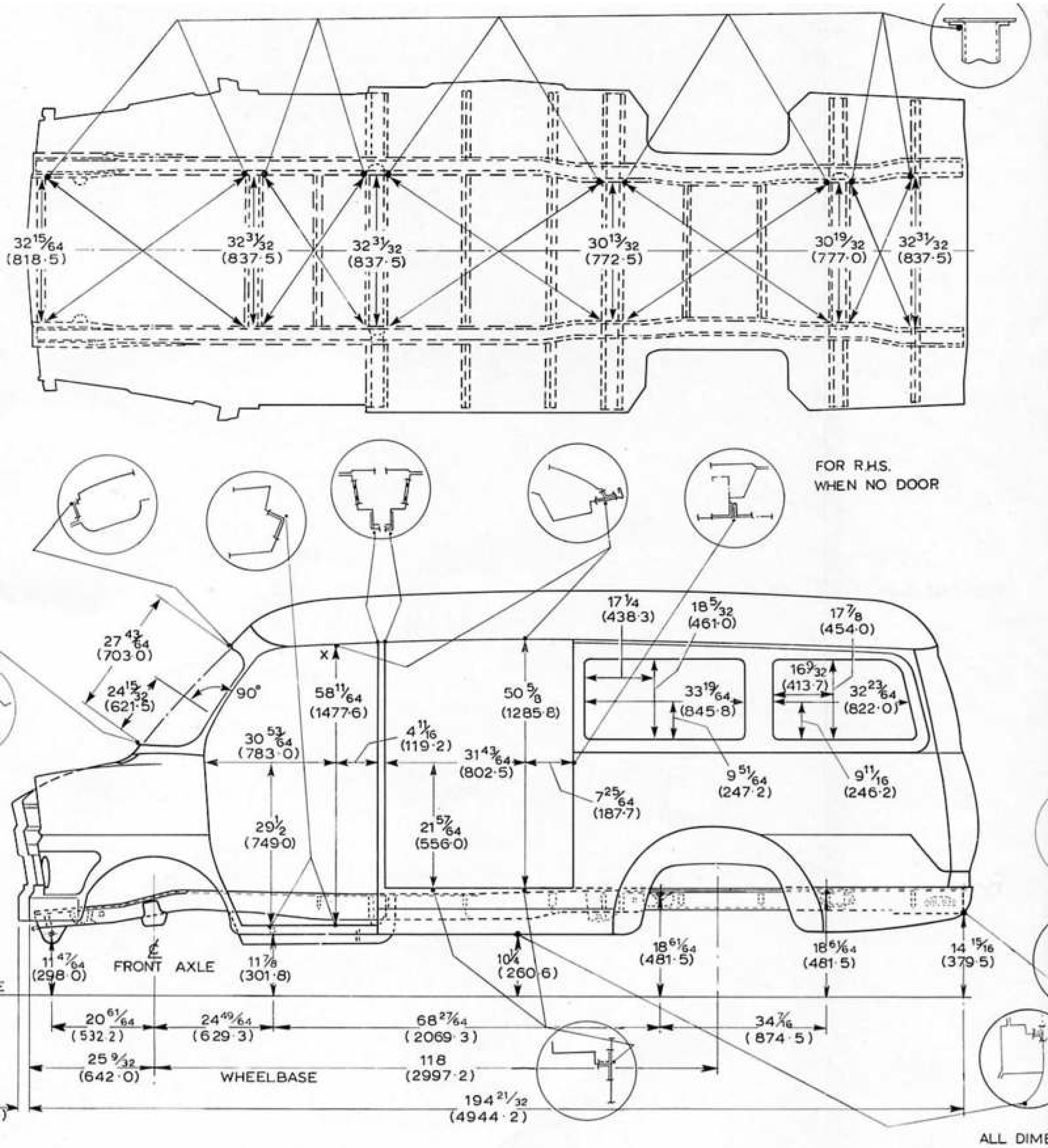
106
(2692·4)
33 3/4
(857·1)
℄
FRONT AXLE





ALL DIMENSIONS IN INCHES (MILLIMETRES)

130 to 175
VAN, BUS and KOMBI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FOR R.H.S. WHEN NO DOOR
27 43/64 (703·0)
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30 53/64 (783·0)
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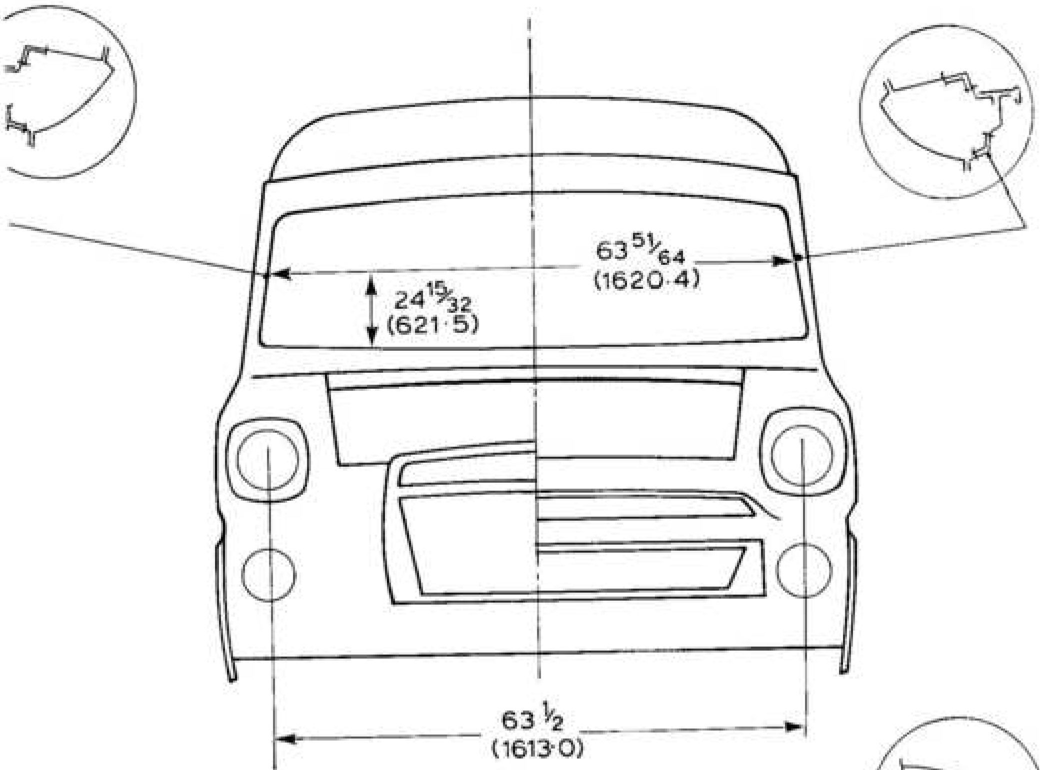
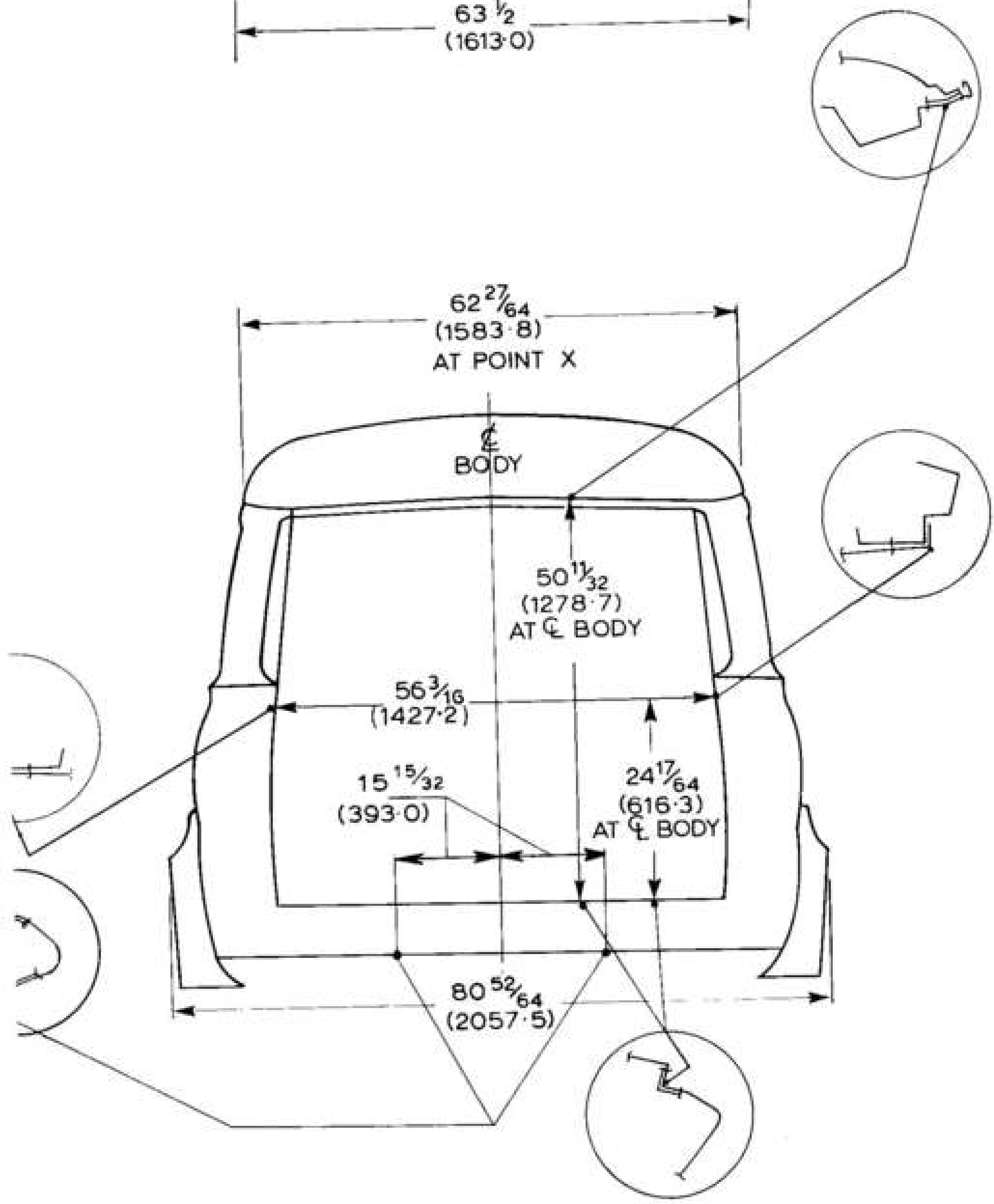
29 1/2 (749·0)
21 57/64 (556·0)
11 47/64 (298·0)
℄ FRONT AXLE
11 7/8 (301·8)
10 1/4 (260·6)
18 61/64 (481·5)
18 61/64 (481·5)
14 15/16 (379·5)
20 61/64 (532·2)
24 49/64 (629·3)
68 27/64 (2069·3)
34 7/16 (874·5)
25 9/32 (642·0)
WHEELBASE
118 (2997·2)
194 21/32 (4944·2)

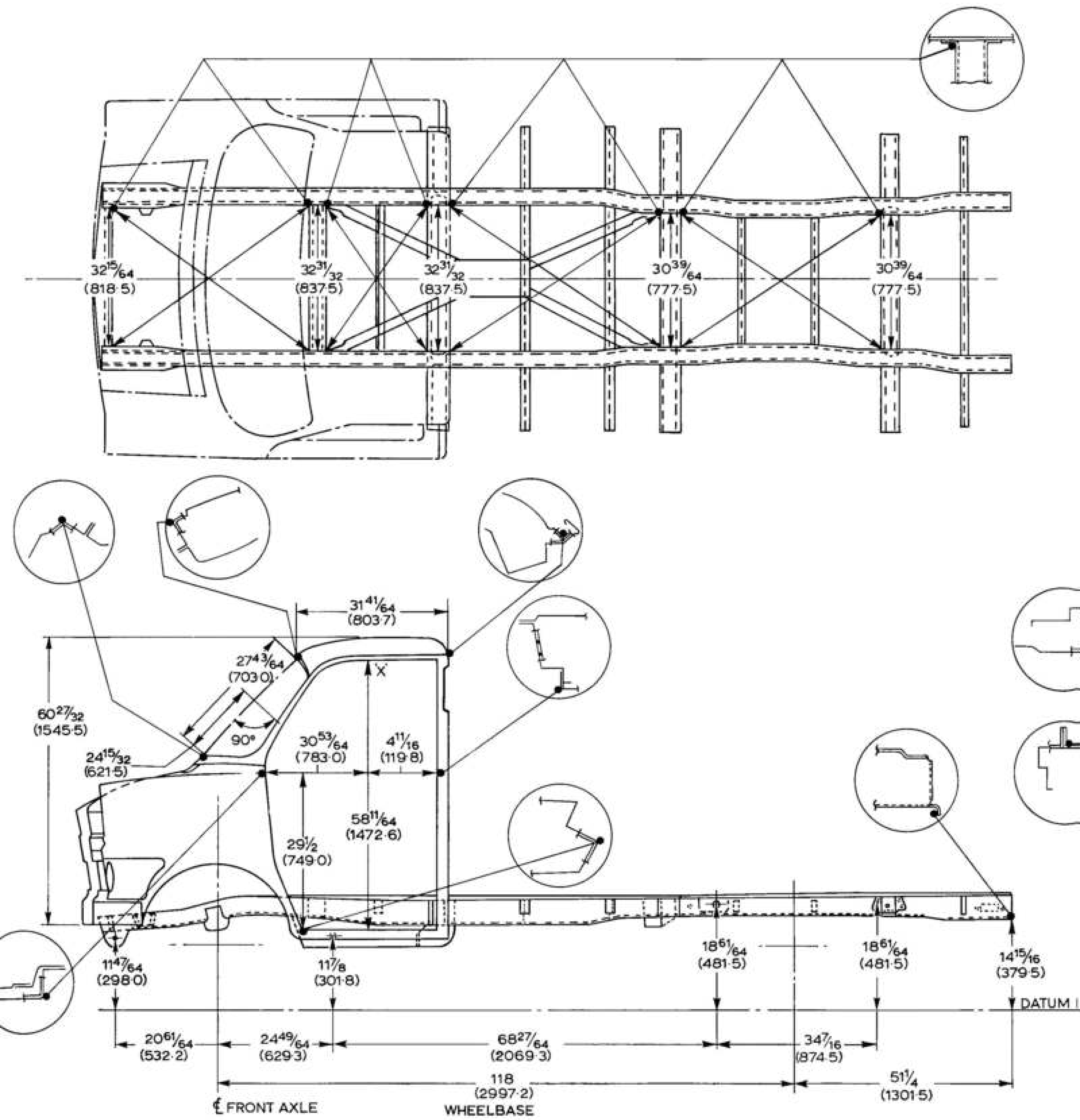
ALL DIME





ONS IN INCHES (MILLIMETRES)

130 to 175
CHASSIS CAB



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(621·5)
30 53/64
(783·0)
4 11/16
(119·8)
58 11/64
(1472·6)
29 1/2
(749·0)
11 47/64
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1 1/8
(301·8)
18 61/64
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(2997·2)
WHEELBASE
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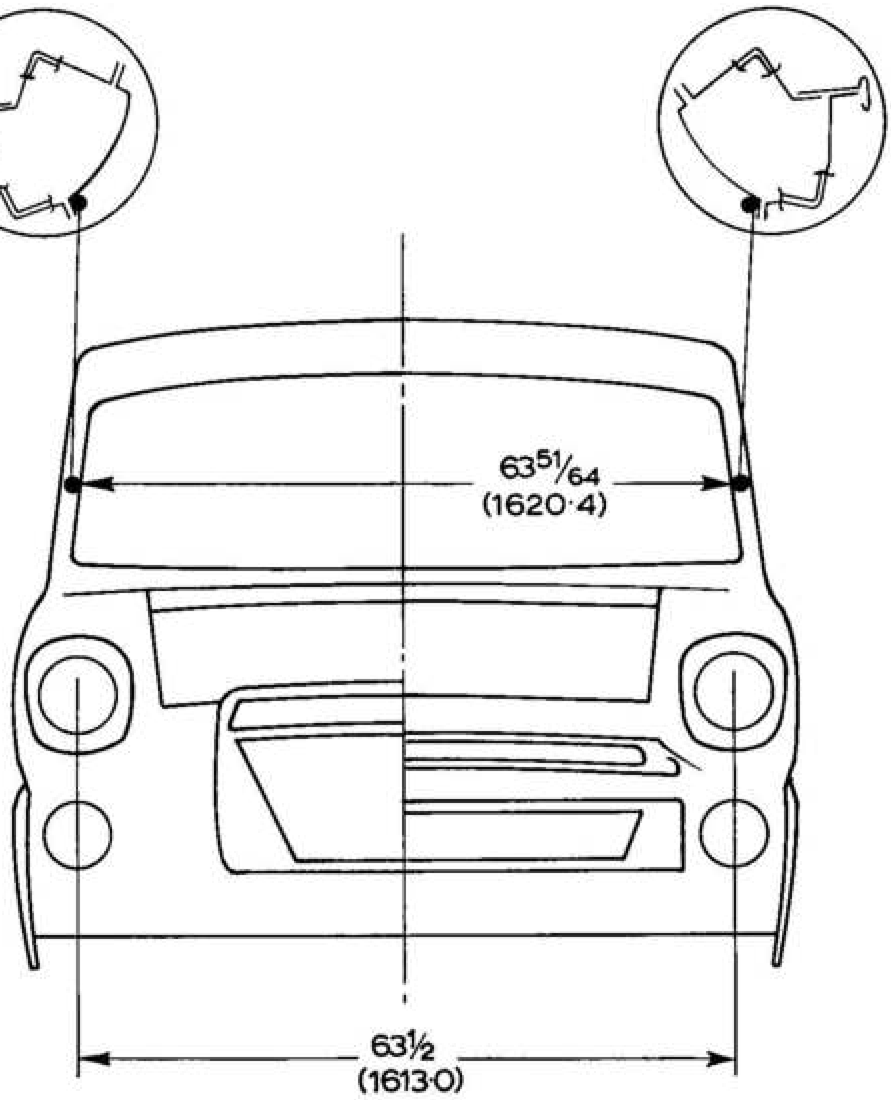
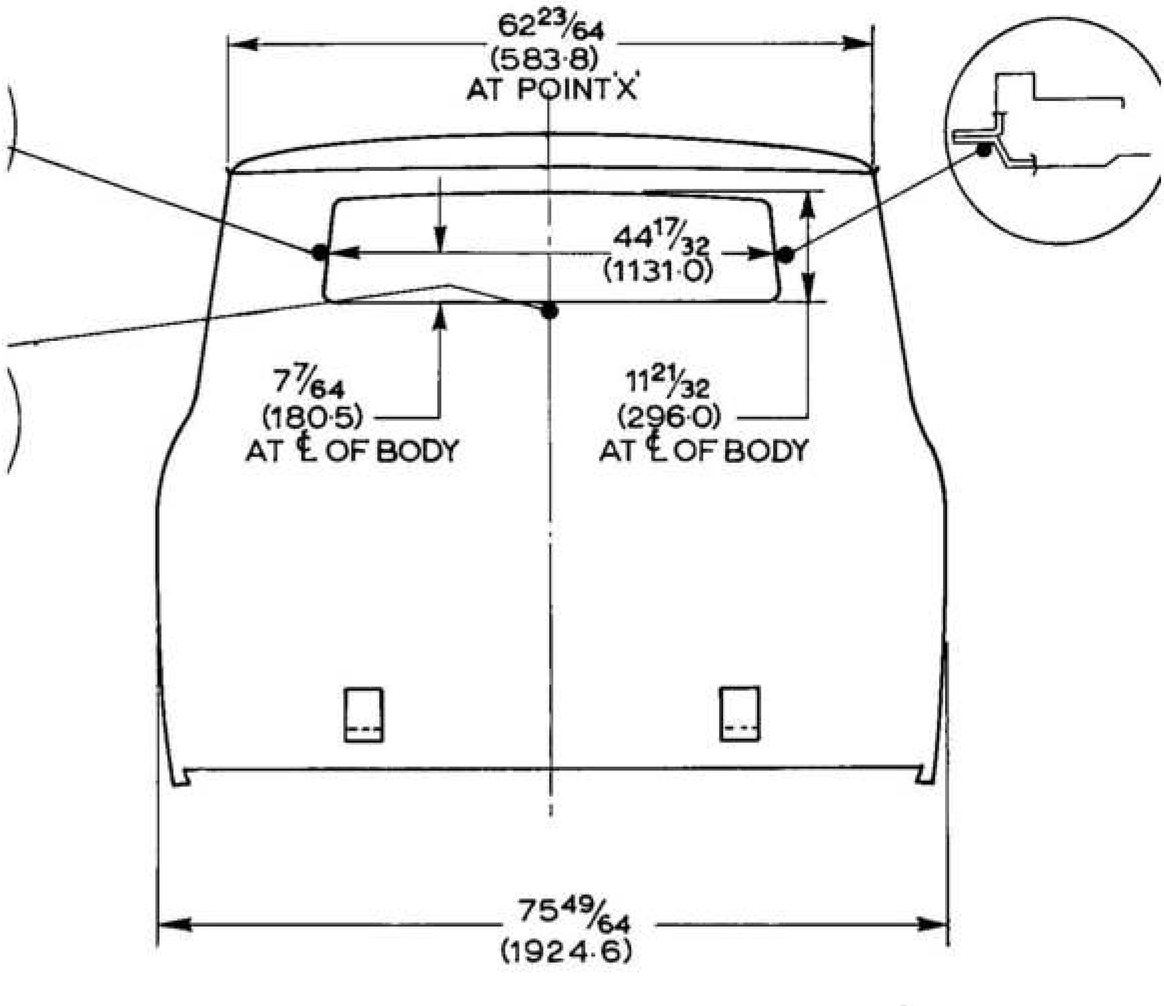
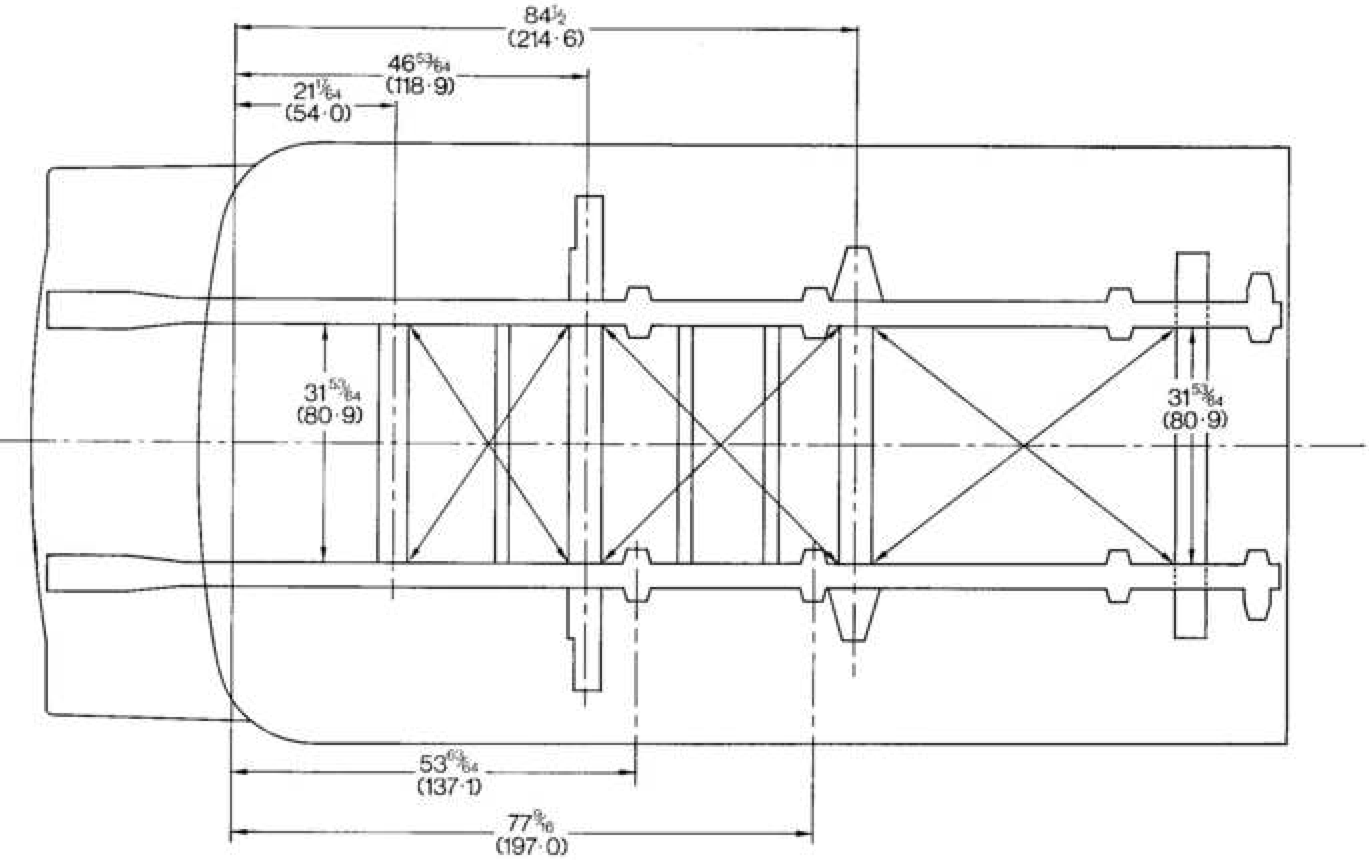
(1301·5)
℄ FRONT AXLE

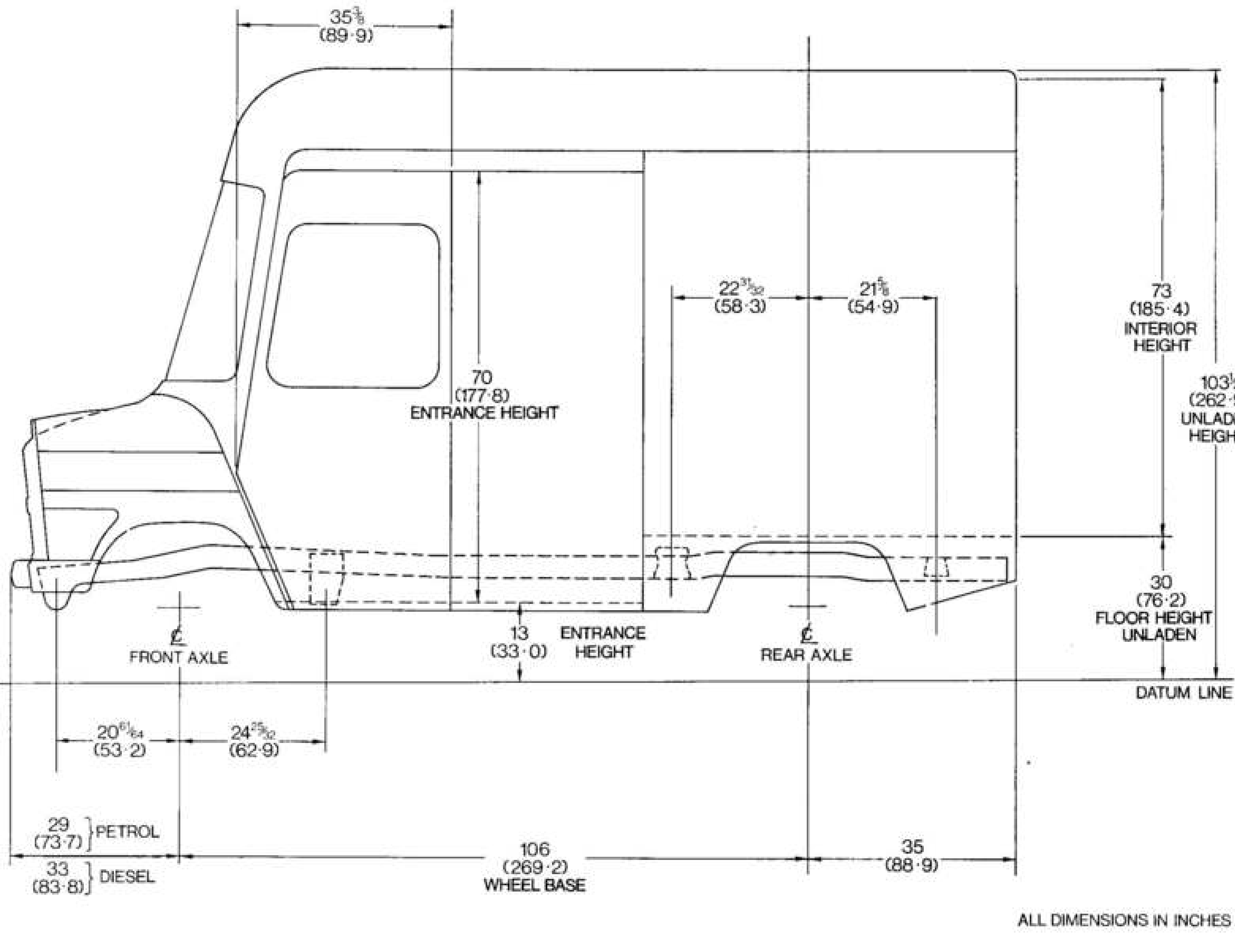




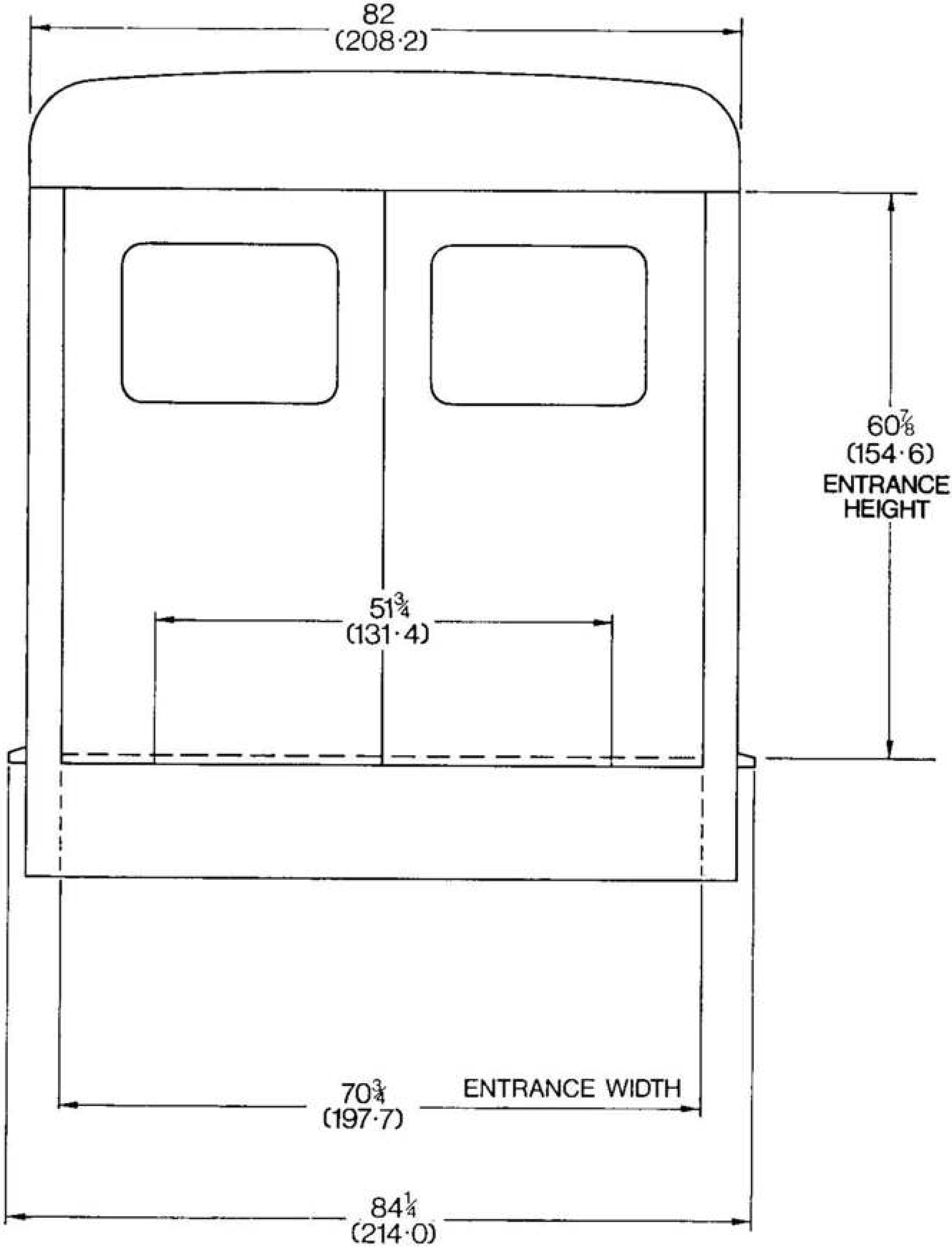
ALL DIMENSIONS IN INCHES (MILLIMETRES)

290 cu. ft.
PARCEL VAN



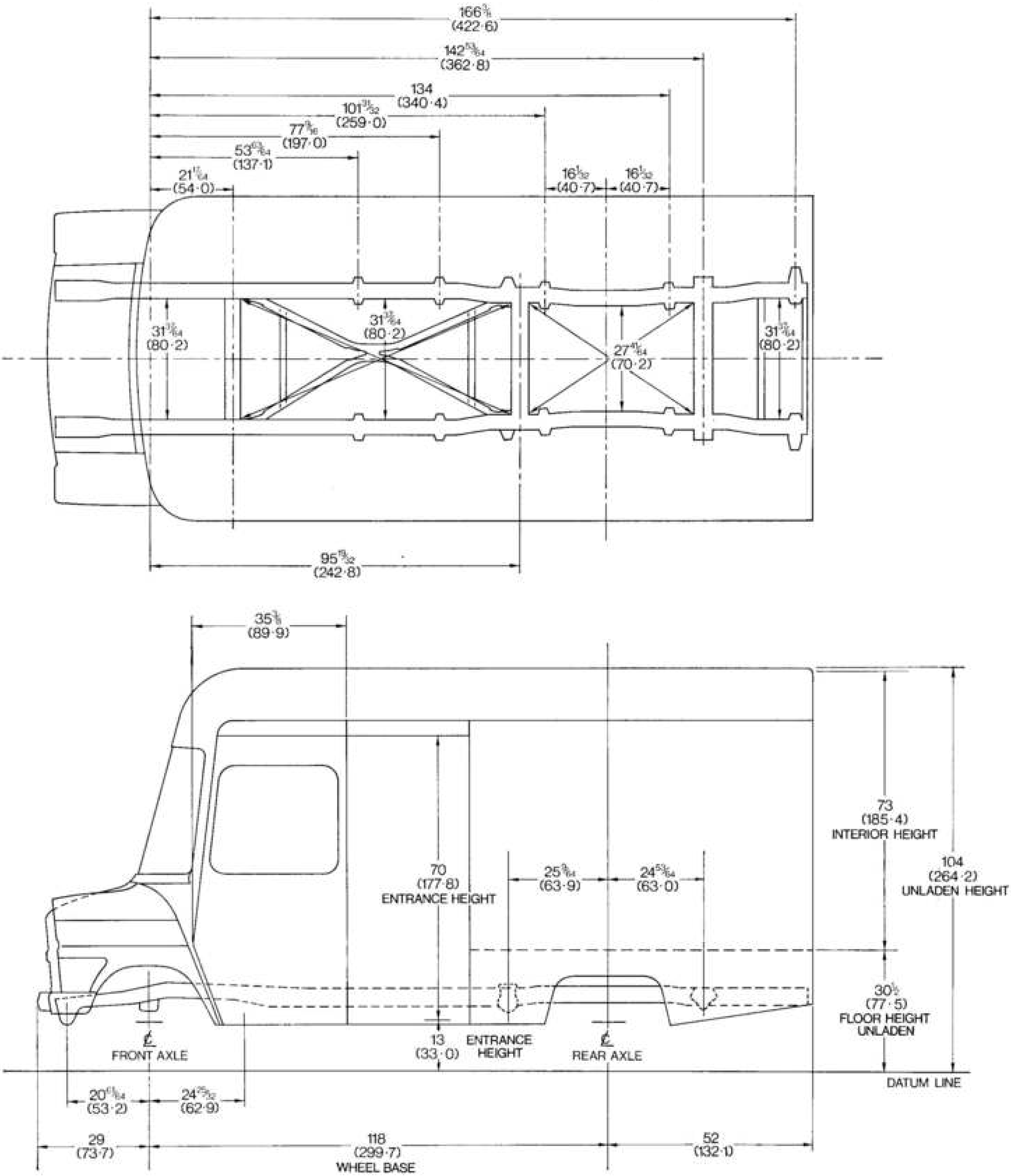


ALL DIMENSIONS IN INCHES (MIL

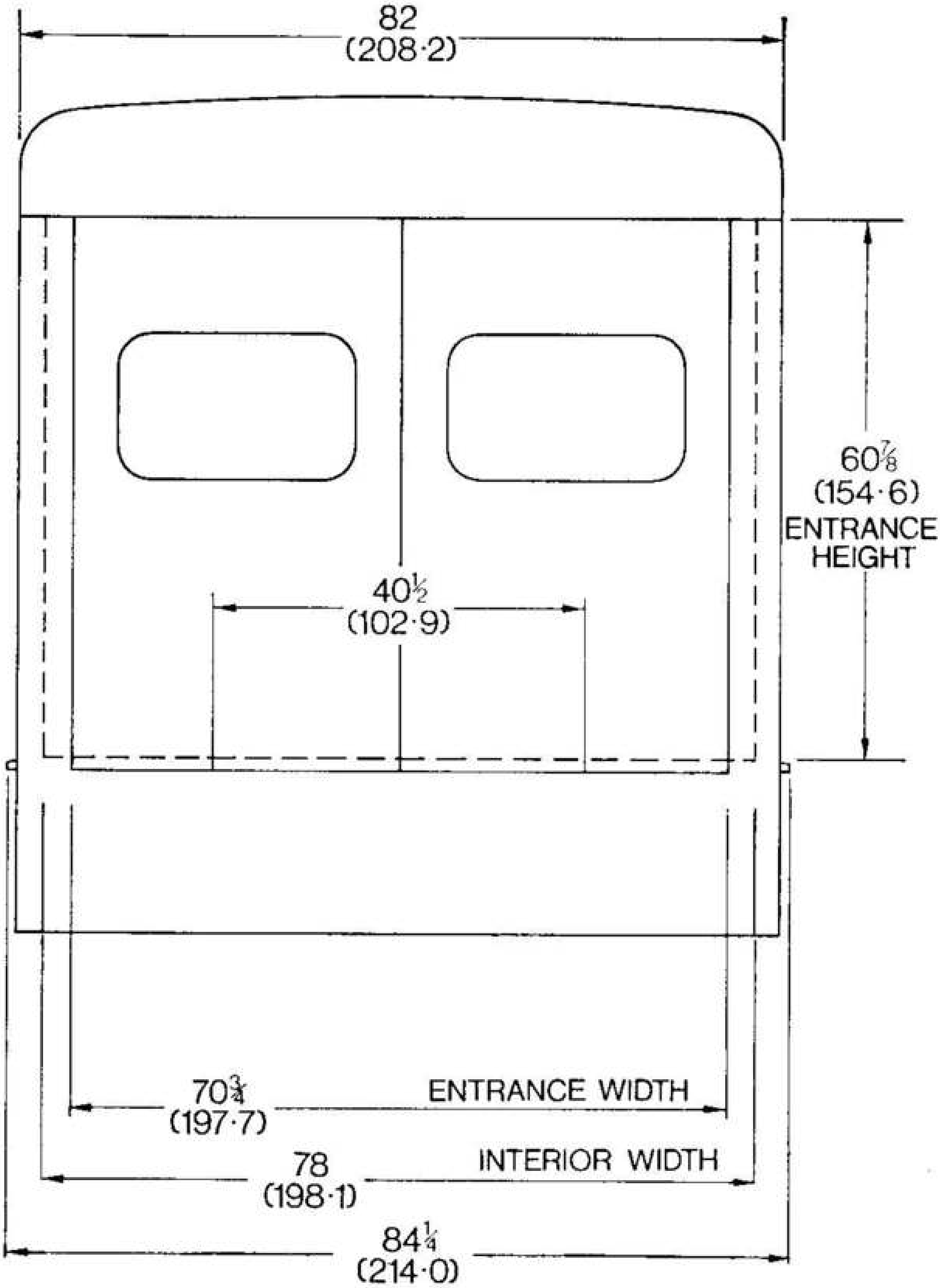

82
(208·2)
60⅞
(154·6)
ENTRANCE
HEIGHT
51¾
(131·4)
70¾
(197·7)
ENTRANCE WIDTH
84¼
(214·0)

TRES)

390 cu. ft.
PARCEL VAN



ALL DIMENSIONS IN INCHES (MILLIM


82
(208·2)
60⅞
(154·6)
ENTRANCE
HEIGHT
40½
(102·9)
70¾
(197·7)
ENTRANCE WIDTH
78
(198·1)
INTERIOR WIDTH
84¼
(214·0)

)

Section 13

SERVICE EQUIPMENT

CONTENTS

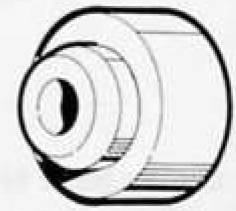
SUBJECT

SPECIAL TOOLS

WHEELS, HUBS AND DRUMS

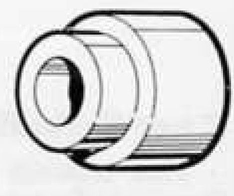
P.1013 Rear Wheel Bearing Grease Seal Replacer

This tool is used with a 550 handle. The lip projecting from the back of the seal locates in the recess in the tool, the front face of the tool abutting the back of the seal, enabling it to be driven into position.



P.1021 Rear Hub Bearing Remover

This tool is used with a 550 handle to assist in easy removal of the hub bearing.

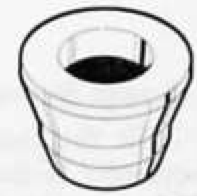


C.1036 Front Hub Grease Seal Replacer

This tool is used with a 550 handle. The lip projecting from the back of the seal locates in the recess in the tool, the front face of the tool abutting the back of the seal, enabling it to be driven into position.

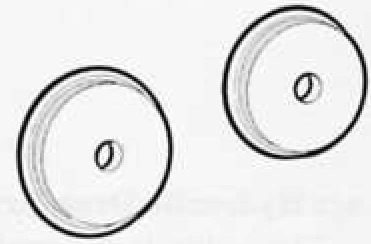
C.1037 Front Hub Bearing Cup Replacer

This tool is used with a 550 handle. The design is such that either the small or large diameter cups may be fitted. Mount the hub on a press and press in the bearing cups.



C.1038 Rear Hub Bearing Cup Replacers

This tool is used with a 550 handle. The tool is made in two sizes, one each for the small and large diameter cups.



3072A Slide Hammer

This tool is used with CP.3072-4A Adaptor and C.4107 Hub Nut Spanner. Unscrew the hub nut, fit the tool to CP.3072-4A and the assembly to the hub which can then be removed.

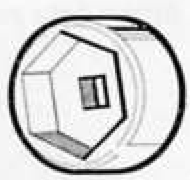
CP.3072-4A Axle Shaft and Hub Remover Adaptor

This tool is used with 3072A Slide Hammer and C.4107 Hub Nut Spanner. The tool fits between the hub and 3072A.

C.4107 Rear Wheel Bearing Nut Socket (75-115)

This tool is specially designed to fit the locating slots on the nut for easy removal.

C.4109 Rear Hub Nut Wrench (125-175)



This tool is in the form of a hexagonal socket with a ½ in. square drive.

BRAKES

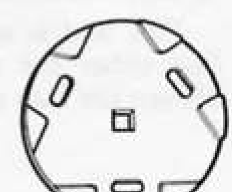
P.2006 Brake Bleeder Tubes

This consists of a set of four clear flexible plastic tubes. One end of a tube is fitted over the bleed nipple of the location being bled, the other end is immersed in a bottle containing brake fluid. When bleeding the brakes, any air bubbling out can be clearly seen through the tube.

P.2012 Brake Line Plugs

This consists of a set of six brass plugs used to seal the open ends of hydraulic lines when dismantling hydraulic brakes.

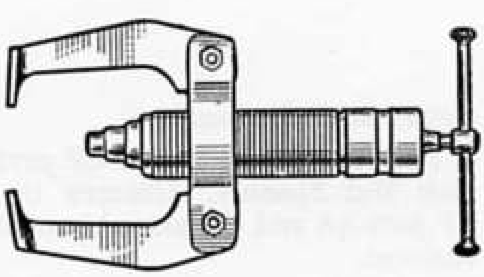
C.2030 Servo Top Cover Remover and Replacer



Fit the tool to the servo mounting studs. Grip the slave cylinder in the vice and separate the shell with the aid of a bar fitted to the square hole in the separator. To replace, clamp the slave cylinder in a vice and locate the two halves of the booster shell together. Press down on the tool and rotate until both halves of the shell are securely locked together.

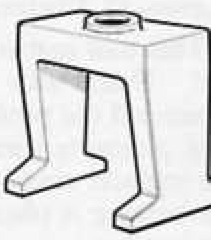
FRONT AXLE AND STEERING

252 Hydraulic Drop Arm Remover



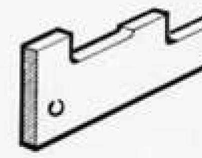
This puller is designed to fit over the drop arm, and the centre screw is screwed in on the steering box shaft until the arm is removed.

C.3065B Anvil



This is used with C.3103 and C.3104. The tool is used to fit new bushes to spindle body assemblies. Position the Stop Collar C.3104/d and the spindle body on the top face of the anvil. The lip on the stop collar, where fitted, must be facing downwards in the anvil.

C.3101 Spindle Body Gauge

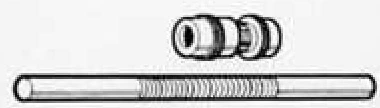


This is a steel gauge used to check the spindle for distortion.

C.3102 Steering Shaft Bearing Plate Nut Wrench

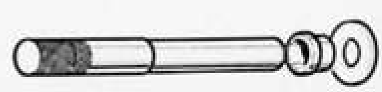
Bend back the tab of the lockwasher and unscrew, with the use of this tool, the lock ring from the worm shaft bearing housing.

C.3103 Spindle Bush Broaching Kit



This tool is used with C.3065B and C.3104. Press the broach through the spindle assembly, preferably using a hydraulic press.

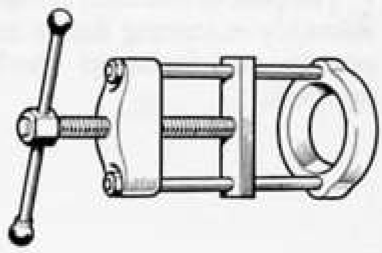
C.3104 Spindle Bush Remover and Replacer



This tool is used with C.3065B and C.3103. The bushes may be pressed out, and in, using the guide bush and a suitable press bed.

REAR AXLE

CP.4000 Hand Press



This tool is used in conjunction with various adaptor sets to remove and replace differential and pinion bearings and related parts.

P.4000-17 Differential Bearing Cone Remover (75-115)

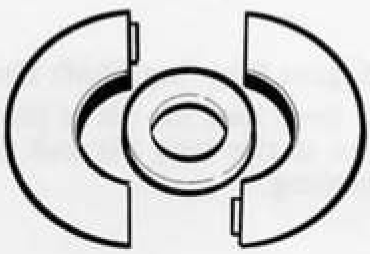
This tool consists of one four-piece split ring adaptor and one thrust block. Used with Main Tool CP.4000. The split adaptors fit around the bearing cone and into the base of the CP.4000 Main Tool. The thrust pad fits into the axle shaft hole and the centre screw of the hand press bears on this whilst withdrawing the bearing cone.

P.4000-18 Pinion Bearing Cone Remover and Replacer

This tool consists of one split ring adaptor and one replacer pad. Used with Main Tool CP.4000. The split adaptors fit around the pinion bearing and are held in place by the base. The pinion is then pressed through the bearing. To replace, the replacer ring is positioned in the split adaptors on the base, the bearing is placed on the ring and the pinion is pressed into the bearing.

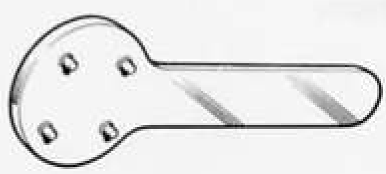
C.4000-36 Pinion Bearing Inner Cone Remover and Replacer (125-175)

This tool consists of one split ring adaptor and one replacer pad. Used with CP.4000 Main Tool. For details of use refer to P.4000-18.



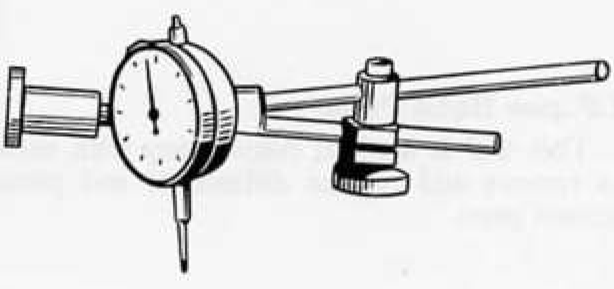
CP.4007 Differential Bearing Adjusting Nut Wrench (75-115)

This tool is a peg style wrench, the pegs of which fit into the differential bearing adjusting nut.



CPT.4008 Crown Wheel and Pinion Backlash Gauge

The post of this tool, CP.4008-1, bolts to one of the differential assembly mounting flange holes and the arm and dial indicator can be positioned to check the crown wheel run-out and backlash.

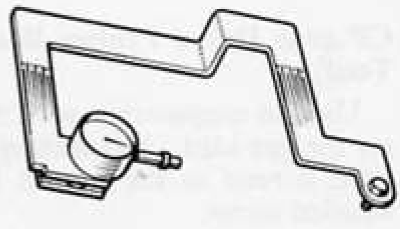


CP.4008-1 Crown Wheel and Pinion Backlash Gauge Adaptor

This tool consists of one mounting post and one locking nut. Used with CPT.4008.

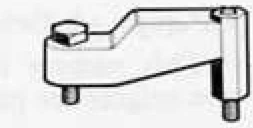
P.4009 Differential Bearing Pre-load Gauge

Secure the tool to the differential bearing cup on one side and then the dial gauge on the opposite side will measure the pre-load.



C.4009-1 Differential Pre-load Gauge Adaptors (125-175)

This tool used with P.4009 measures the pre-load on the 25, 30 and 35 cwt. models.

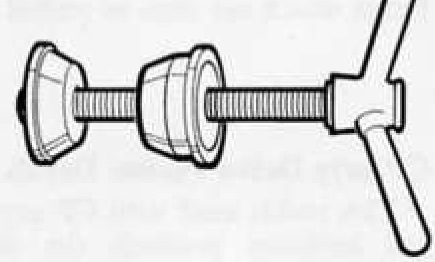


P.4012 Differential Bearing Inner Cone Replacer (75 115)

This tool is used with the 550 handle. The shaft locates in the axle shaft hole whilst the flange abuts the inner track of the bearing cone, enabling the cone to be replaced squarely.

P.4013A Drive Pinion Bearing Cups and Oil Seal Replacer

This tool is used with CP.4013-2 or C.4013-4. Locate the cups. Fit the adaptor to the Replacer and draw into position when the wing nut is turned. By reversing the top pad the oil seal may be replaced.



CP.4013-2 Drive Pinion Bearing Cups and Oil Seal Replacer Adaptor (75-115)

This tool is illustrated with P.4013. The two pads are placed on the outside of the cups which are drawn simultaneously into position.

C.4013-4 Drive Pinion Bearing Cups Replacer Adaptor (125-175)

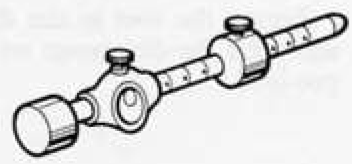
For details of use refer to CP.4013-2.

CP.4015A Drive Pinion Bearing Cups Remover

The spring-loaded legs are placed behind the cup, and the handle struck with a mallet to remove the cup.

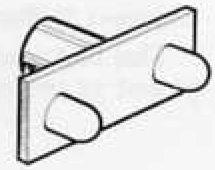
CP.4030 Drive Pinion Bearing Pre-Load Gauge (Main Tool)

Used in conjunction with Adaptor Tool No. CP.4030-3A to set the pre-load. The sliding weight is moved along the beam until it rests at the correct figure where it is locked by the knurled screw.



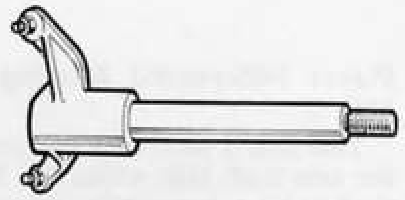
CP.4030-3A Drive Pinion Pre-Load Gauge (Adaptor)

This adaptor is attached to the Main Tool CP.4030, the two spigots are pressed into the drive pinion flange bolt holes.



CP.4046 Differential Carrier Bracket (75-115)

This tool is used with 200A/B Engine Stand, and provides a convenient means of holding the carrier for stripping and rebuilding.

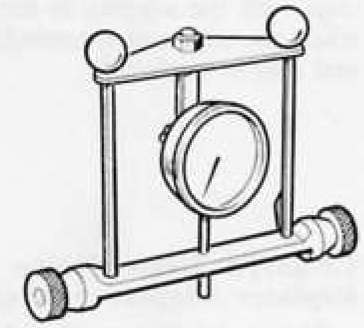


C.4068 Flange Remover

This tool comprises two legs which are used with the 55 Puller. The knurled nuts are removed from the legs which are then passed through two opposed holes in the flange. The knurled nuts are then screwed onto the legs from behind the flange which can then be pulled off.

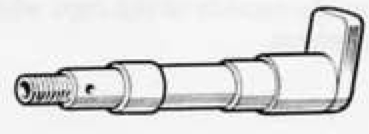
CP.4075 Drive Pinion Depth Gauge

This tool is used with CP.4075-2, CP.4075-3 and C.4075-5, and indicates precisely the thickness of the spacer shim required when reassembling.



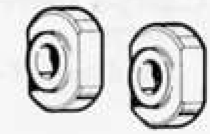
CP.4075-2 Dummy Pinion Adaptor (75-115)

This tool is used with CP.4075. The tool is fitted with the rear pinion bearing cone, and the assembly fitted to the differential carrier. The depth gauge is then fitted and the thickness of shim found.



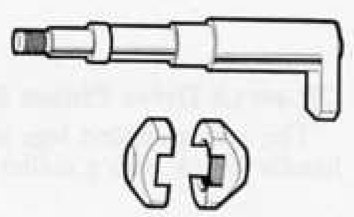
CP.4075-3 Drive Pinion Depth Gauge Adaptor (75-115)

This tool is used with CP.4075 and, together with CP.4075-2, measures the shim thickness required to give the correct pinion depth of mesh in the crown wheel. Add 2.67 mm. (0.105 in.) to the gauge reading to give the thickness of the shim to be fitted between the pinion and the rear bearing cone.



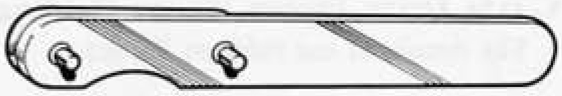
C.4075-5A Drive Pinion Depth Gauge Adaptors (125-175)

This tool consists of one dummy pinion and one split collar. For details of use refer to CP.4075-2 and CP.4075-3.



P.4092 Drive Pinion Flange Wrench (75-115)

This is a special 2-pegged wrench which locates firmly in the flange. Then the drive pinion nut can be removed or replaced.

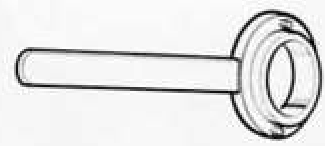


C.4106 Differential Bearing Replacer (125-175)

This is used with the 550 handle. The shaft locates in the axle shaft hole whilst the flange abuts with the bearing, enabling the bearing to be replaced squarely.

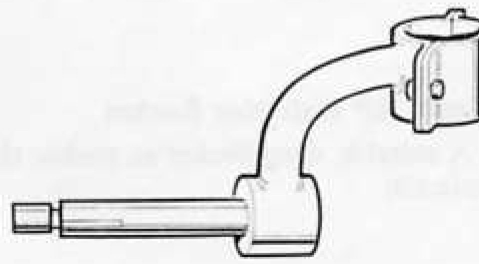
C.4123 Differential Bearing Adjusting Nut Wrench (125-175)

This tool has two pegs which fit the adjusting nut, and is used with P.4009. For adjustment, fit P.4009 and screw in the bearing adjusting nut on the differential side, until a constant cap spread of 0.12 to 0.16 mm. (0.005 to 0.006 in.) is obtained.



C.4110 Axle Holding Bracket (125-175)

This tool is used with the 200A/B Engine Stand and provides a convenient means of holding the carrier for stripping or rebuilding.



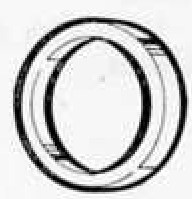
CP.4111A Differential Bearing Cone Remover (125-175)

This tool consists of a thrust block and a puller. These are used to enable easy removal of the bearing cone.

C.4112 Drive Pinion Bearing Pre-load Spacer Selector (125-175)

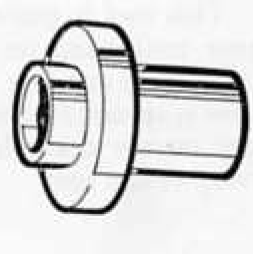
This tool is used with P.4131. The dummy spacer is fitted to the pinion with a ring of soft wire, 2.67 mm. (0.105 in.) diameter, (e.g. solder wire) on its top face. Fit the pinion flange and retaining nut and tighten until only slight end-float can be felt. Fit P.4131, check the running torque. Add this figure to the pre-load, slowly tighten the flange retaining nut until the correct running torque is obtained.

Then dismantle the pinion assembly, the thickness of spacer required is that of the spacer and the flattened wire.



C.4113 Drive Pinion Oil Seal Replacer (125-175)

Locate the oil seal in the axle throat with its lip towards the bearing, and drive into position.

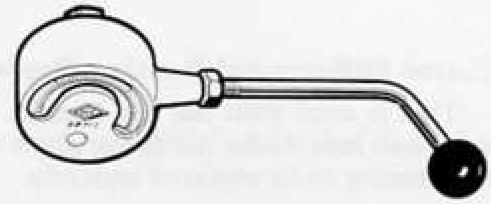


C.4114 Drive Pinion Flange Holding Wrench (125-175)

For details of use refer to P.4092.

P.4131/547D Pinion Bearing Pre-Load Gauge

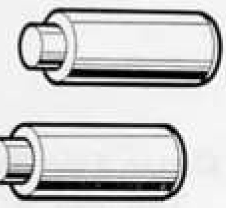
This tool, together with a suitable ½ in. drive socket, is fitted to the pinion nut. The tool is then rotated and while turning an accurate running torque reading is obtained.



SPRINGS AND FRAMES

C.5035 Front and Rear Shackle Bush Remover and Replacer

This tool may be used in conjunction with a driver or in a press.



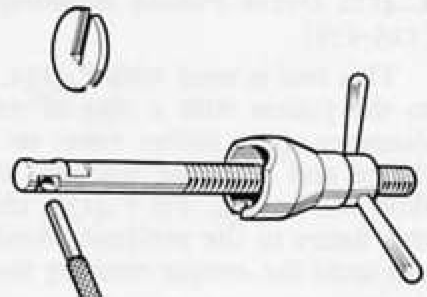
C.5036 'U' Bolt Nut Socket

A suitable deep socket to enable the nuts to be removed or replaced.

ENGINE

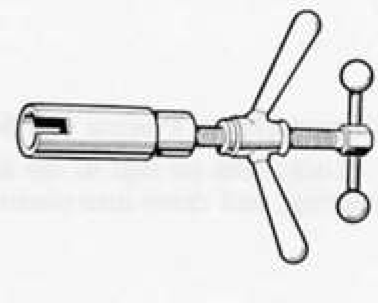
P.6031 Camshaft Bush Remover and Replacer (Main Tool)

Used with CP.6152 Adaptors to remove the balance shaft bushes.



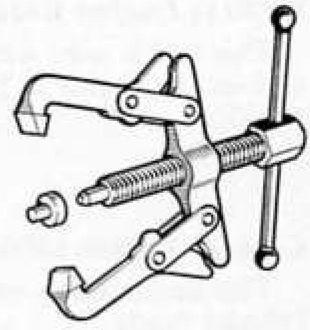
CP.6032B Crankshaft Gear Replacer

This tool is placed over the end of the crankshaft, with the gear positioned on the reduced diameter. The centre screw is screwed into the crankshaft to locate the tool, and then the gear is screwed home using the handles. Take care to align the key on the crankshaft with the keyway on the gear and the body of the tool.



CP.6041 Crankshaft Pulley Remover

A two-legged puller with specially shaped feet to fit closely to the belt groove of the pulley.



STN.6645 Gear Remover Legs

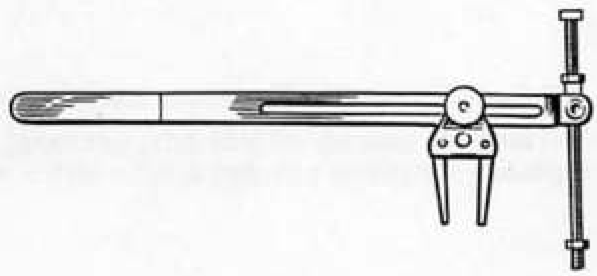
Consists of two legs used with puller CP.6041 to remove the crankshaft and balance shaft gears.

P.6056-015 } P.6056-030 } Valve Guide Reamers

This tool enables the valve guide bore to be reamed oversize after wear in order to fit oversize valve stems.

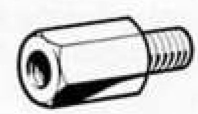
6118B Valve Spring Compressor

One end of this tool screws into CP.6118-1 adaptor. Pivoted at this point is the lever handle along which an adjustable foot can be moved.



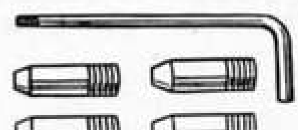
CP.6118-1 Valve Spring Compressor, Adaptor

This tool screws into one of the push rod guide plate holes and the post of 6118B screws into this to give a rigid mounting.



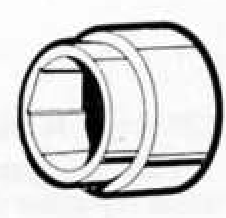
C.6135A Cylinder Head Locating Studs

These short studs screw into four cylinder head bolt holes and locate the cylinder head during reassembly. They are removed after the head has been loosely bolted down with the left-hand threaded extracting tool.



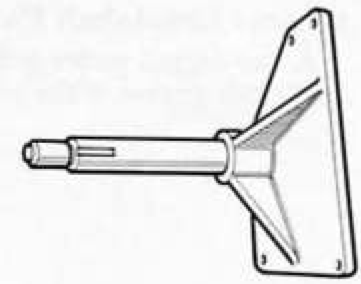
CP.6141 Crankshaft Front Oil Seal Aligner

The inside diameter of this tool is an accurate fit on the crankshaft. The plain section of the outside diameter locates on the accurately moulded section of the front cover oil seal. This holds the seal in its correct relation to the crankshaft whilst the front cover is bolted into position.



CP.6144 Engine Bracket

This tool is used with the 200A or 200B Engine Stand and enables the engine to be mounted for ease of strip-down and rebuild.

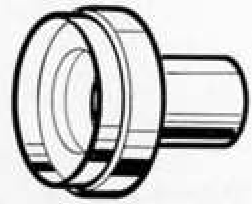


CP.6146 Engine Lifting Eyes

This tool consists of two plates that bolt to the top of the cylinder heads.

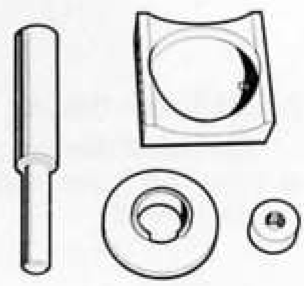
CP.6147 Crankshaft Rear Oil Seal Aligner

This tool is fitted into the rear oil seal in the carrier, the inner recess of the tool fits onto the crankshaft flange and holds the seal in its correct relation to the flange whilst the carrier bolts are tightened.



CP.6148 Rocker Stud Reamers

This tool enables the rocker stud holes to be reamed for oversize rocker studs. Two reamers are supplied 0.076 mm. (0.003 in.) and 0.190 mm. (0.0075 in.) oversize.

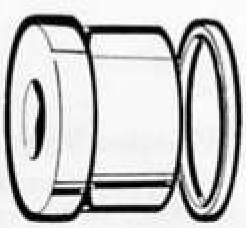


CP.6149 Piston Pin Remover and Replacer

This tool consists of four adaptors used for removing and replacing the piston pin, and is used with a workshop press.

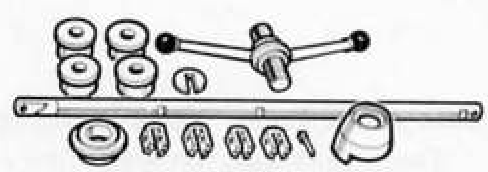
CP.6152 Balance Shaft Bearing Remover and Replacer (Adaptors)

Consists of a set of adaptors used with the 550 Handle for removing the balance shaft bearings or with Tool No. CP.6031 for replacing the bearings.



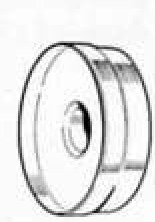
CP.6160 Camshaft Bearing Remover and Replacer

Consists of a main tool and adaptors to allow easy removal and replacement of the camshaft bearings.



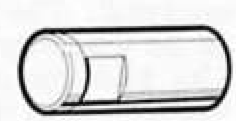
CP.6165 Crankshaft Rear Oil Seal Remover and Replacer

This tool, together with a 550 handle, is used to remove and replace the oil seal in the carrier.



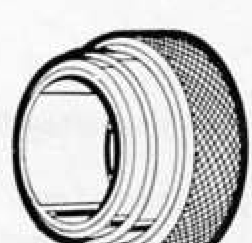
CP.6172A Rocker Stud Replacer

This tool gives the correct protrusion 55.1 mm. (2.17 in.) when replacing the longer rocker stud.



P.6173 Crankshaft Rear Oil Seal Aligner

This tool is a modified version of CP.6147 and can be utilised when replacing the rear oil seal carrier to in-line engines also.

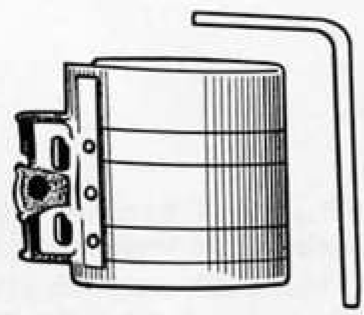


CP.6176 Crankshaft Front Oil Seal Remover and Replacer

The larger diameter side of this tool abuts the outer face of the seal, enabling it to be removed without risk of distorting the housing. For replacement, the smaller diameter side of the tool locates in the seal, the collar abutting the front face, thus avoiding damaging the seal.

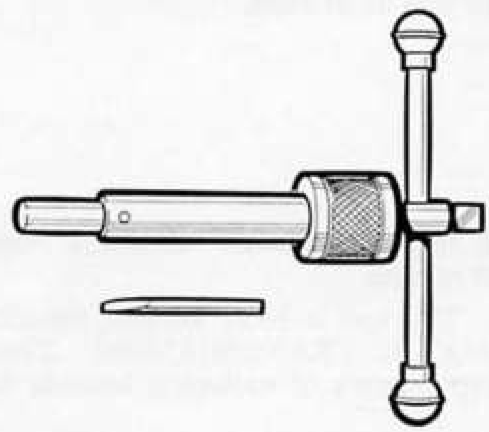
38U3 Piston Ring Compressor

This is a ring of spring steel into which the piston, complete with a set of rings, is placed. The ring is contracted with a key-operated ratchet to compress the piston rings. A lever on the side of the tool releases the ratchet to open it.



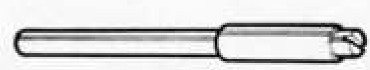
316X Valve Seat Cutter Handle

This tool is used, together with 316-10, 317-27, 317-T-24, FMC.317-P-26, to cut the valve seats in the cylinder heads.



316-10 Valve Seat Cutter Pilot

Used with 316X, FMC-317-24, 317T-24, FMC-317-24, FMC-317P-26, 317-27, FMC-317-27. (Existing Tool.)



317-T-24 15° Valve Seat Narrowing Cutter—Exhaust

FMC-317-24 Valve Seat Cutter—Exhaust

FMC-317-P-26 Valve Seat Narrowing Cutter—Inlet

FMC-317-27 Valve Seat Narrowing Cutter—Exhaust

317-27 Valve Seat Cutter—Inlet

These cutters are a full set for engines fitted to the Transit range.

EXTRA FOR DIESEL ENGINE

335 Connecting Rod Alignment Jig

336 Arbor Tool

This tool is used for checking small end bush alignment.

CT.6120 Piston Protrusion Gauge

This tool is used with P.4008 Gauge Tool to check the piston protrusion.

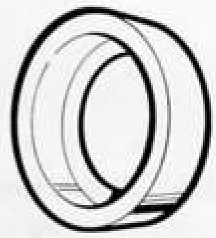
PD.150-5 Cylinder Liner Press Adaptor

This tool is used with a suitable press to remove the cylinder liners.

MANUAL GEARBOX AND CLUTCH

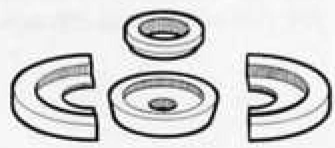
CP.4000-32 Main Drive Gear Bearing Remover

This tool is used with CP.4000 Hand Press to enable the main drive gear bearing to be removed without damage.



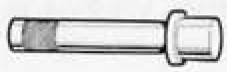
CP.4090-7A Synchro Hub Remover and Replacer and Main Drive Gear Bearing Replacer

This tool is used with 370 Taper Base and a hydraulic press. The tool is placed on the hub or bearing, and is pressed out of or into its location.



P.7040 Extension Housing Bearing Remover and Replacer

This tool is NOT suitable for vehicles fitted with AUTOMATIC TRANSMISSION. The tool may be used for replacement of extension housing bearings.

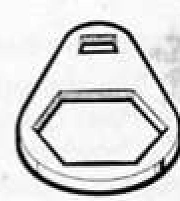


CP.7043 Reverse Idler Shaft Remover

This tool locates over the end of the reverse idler shaft, and is used to remove the mainshaft ball bearing and idler shaft.

CP.7064A Transmission Mainshaft Oil Seal Replacer

The oil seal fits over the boss on the tool and is fully supported and protected during replacement.

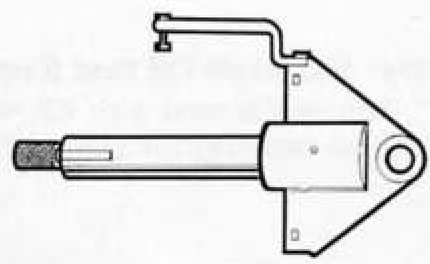


CP.7098 Mainshaft Nut Wrench

This is a specially shaped wrench with a ½ in. square drive. Used in conjunction with a suitable tension wrench, ensures correct torque loading of the mainshaft nut.

C.7109 Dummy Countershaft

The countershaft gear and rollers are assembled on the dummy countershaft. The assembly is then located in the gearbox.

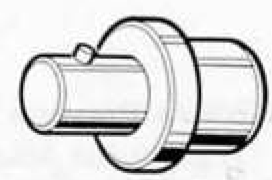


CP.7111 Gearbox Bracket

This tool is used with 200A Engine Stand, and enables the gearbox to be held rigid when stripping or re-assembling. This is suitable for left- or right-hand drive vehicles.

CP.7112A Clutch Plate Locator

This tool considerably simplifies correct alignment of the clutch disc when assembling the clutch to the flywheel. The tool fits through the centre of the plate and locates in the spigot bearing.

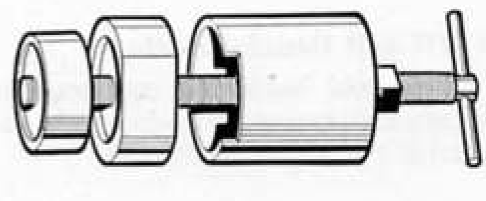


CP.7119 Main Drive Gear Retainer Oil Seal Replacer

This tool is used with 575 Handle, allowing easy and correct fitting of the seal without damage.

CP.7123 Spigot Bearing Replacer

This tool is used with the 550 Handle, and enables the bearing to be replaced squarely and without distortion.

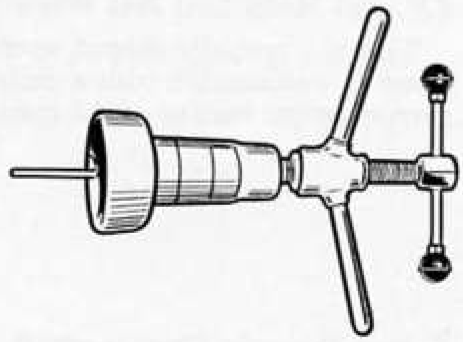


C.7124 Gearbox Insulator Mounting Remover and Replacer

This tool locates onto the gearbox and insulator and, by turning the handle, either presses the insulator in or out.

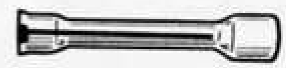
7600 Flywheel Bearing Remover Main Tool

The appropriate collet is contracted and pushed through the flywheel bearing and allowed to expand with the lugs behind the bearing. The main tool screws into the collet to hold it expanded and with the outer casing abutting the flywheel the bearing is pulled out with the centre screw.



CPT.7600-6 Spigot Bearing Remover

The collet is contracted and pushed through the spigot bearing and then expanded. The bearing is then pulled out.

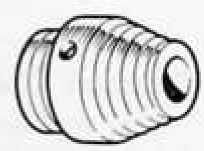


7657 Mainshaft Oil Seal Remover

This tool is used with CP.7657-3A to remove the oil seal without removing the gearbox from the vehicle.

P.7657-3A Mainshaft Oil Seal Remover Adaptor

This tool is used with 7657. The coarse taper thread is turned to bite into the oil seal, which can then be removed easily.



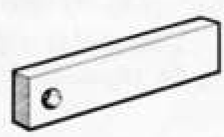
AUTOMATIC TRANSMISSION

CBW.1A Pressure Test Gauge

A gauge and hose used with CBW.38-1 connected to the pressure take-off point on the transmission.

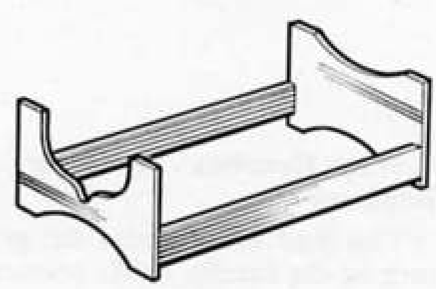
CBW.34 Front Band Spacer Gauge

A small steel gauge used to obtain the correct setting when adjusting the front band.



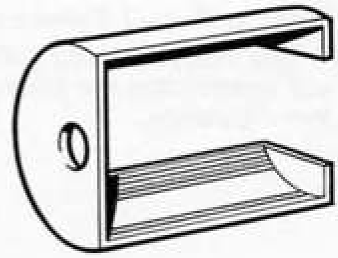
CBW.35B Bench Cradle

This tool holds the complete transmission assembly and allows adjustment, strip-down and re-assembly operations to be carried out without difficulty.



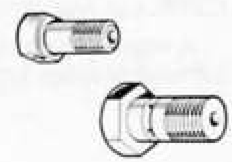
CBW.37A Clutch Spring Compressor

This tool is used with a hydraulic press, and enables the spring to be compressed, facilitating removal of the snap ring.



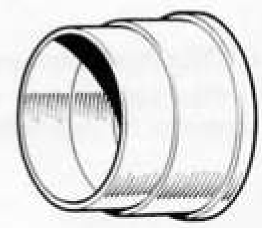
CBW.38A Hydraulic Test Equipment Adaptor

This tool is used with CBW.1A and consists of two adaptors which fit to the transmission assembly and allow all the necessary pressure tests to be carried out.



CBW.41 Rear Clutch Piston Replacer

On the rear clutch the replacer is fitted prior to fitting the piston assembly. This tool will prevent damage and resultant leakage.



CBW.42 Front Clutch Piston Replacer

This tool protects the oil rings during assembly of the piston.

CBW.547A-50 Rear Spring Tension Wrench

CBW.547A-50-2A Rear Servo Adjuster Socket Adaptor

This tool is used with CBW.547A-50. It is a $\frac{5}{16}$ in. bi-square x $\frac{3}{8}$ in. square drive socket used to set the rear band adjustment.

CBW.547A-50-3 Inhibitor Switch Locknut Adaptor

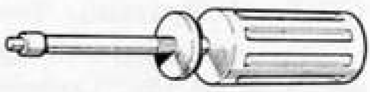
This tool is used with CBW.547A-50. It is a special "U" shaped adaptor used to replace the inhibitor switch when the transmission assembly is in the vehicle.

CBW.547A-50-4 Pressure Take-Off Plug Adaptor

This tool is used with CBW.547A-50 and a suitable extension and ensures that the pressure point plug is replaced without over-tightening.

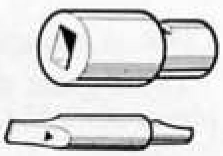
CBW.548 Spintorq Screwdriver

A small pre-set torque screwdriver with a ¼ in. square drive, adjustable from between 0 and 51.8 kg. cm. (0 and 45 lbs. in.).



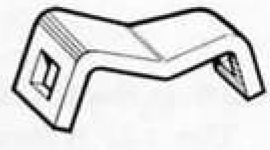
CBW.548-1 Spintorq Screwdriver Adaptor

This tool is used with CBW.548 and allows slotted head screws to be tightened to their correct torque setting.



CBW.548-2A Front Servo Adjuster Adaptor

This tool is used with CBW.548 and CBW.34, and is used when the transmission assembly is fitted to the vehicle.



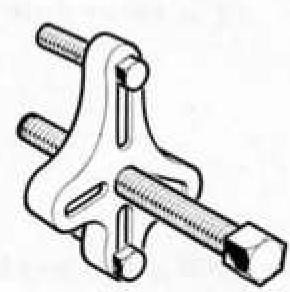
7066J Circlip Pliers 'J' Type Points

This tool is used with 7066 Circlip Pliers for use on 'J' type points fitted on the transmission assembly.

COOLING SYSTEM

C.6156 Water Pump Impeller Remover

This tool is used to remove the water pump pulley of the diesel engines.

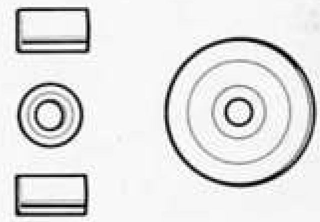


CPT. 8000 Water Pump Overhaul Tool (Main Tool)

This is a hand press used in conjunction with CP. 8010 kit.

CP.8010 Water Pump Overhaul Kit

This tool is a complete kit for the overhaul of the water pump. Full instructions for use are included with the kit.



GENERAL TOOLS

55 Puller

This is a puller body used with C.4068 to remove the differential and gearbox coupling flange.

200B Engine Stand

Using the appropriate mounting bracket, the various engines, gearboxes and differential assemblies in the Ford range can be mounted on this stand to facilitate dismantling and assembly.

370 Base

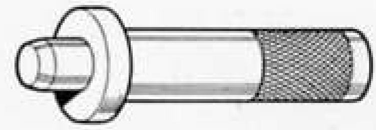
This tool fits on the bed of most workshop presses to take the various split adaptors etc., from the hand presses.

512 Piston Pull Scale

This is a light spring balance with provision for a feeler blade to be attached.

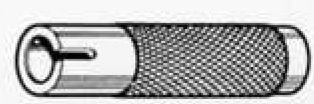
550 Oil Seal Driver Handle

This tool has a spigot at one end, onto which the various oil seal replacers etc., will fit.



575 Light Universal Handle

This tool is a lighter version of 550.



7066 Circlip Pliers

This tool is used for removing and replacing circlips. An adaptor is used for the automatic transmission.

Section 14

SPECIFICATIONS

CONTENTS

SUBJECT

SPECIFICATIONS

GENERAL DATA

WHEELS AND HUBS

Pressed steel wheels. Twin rear wheels on 130 – 175. Front hubs mounted on taper roller bearings. Rear hubs mounted on single bearing on 75 – 115, twin bearings on 125 – 175.

BRAKING SYSTEM

Hydraulically operated internally expanding braking system. Two leading shoes front. One leading, one trailing on 75 – 115. On 130 – 175 a duo-servo is fitted. Both dual line and single line systems are available in boosted and unboosted form, and from December 1970 pendant pedals and a direct servo (where applicable) are fitted.

FRONT AXLE AND STEERING GEAR

Cranked, 'I' section front axle forging. Worm and nut steering box with recirculating ball action. A safety steering column is also available for some territories.

REAR AXLE

Three-quarter floating hypoid on 75 – 115. Fully floating hypoid on 125 – 175. The 125 has basically the LCY axle modified to take single wheels.

FRONT AND REAR SUSPENSION

Longitudinal semi-elliptical leaf springs, telescopic double acting shock absorbers. From December 1970 all front springs are single leaf and all rear springs are minimum leaf.

ENGINE

Petrol. Two versions, 1664 c.c. (101.5 c.i.d.) and 1996 c.c. (121.8 c.i.d.). Both available with high or low compression ratio. Cylinder block and crankcase cast integrally. Detachable cast iron cylinder heads, incorporating push rod operated, stud mounted valve gear. Forged steel, three bearing crankshaft. Aluminium alloy solid skirt pistons.

Diesel. Two versions, 4/99 (prior to May 1966) and 4/108 (from May 1966). Cylinder block and crankcase cast integrally. Wet cylinder liners (4/99), dry cylinder liners (4/108). Detachable cast-iron cylinder head, incorporating push rod operated valve gear. Forged three bearing crankshaft. Aluminium alloy pistons.

GEARBOX AND CLUTCH

Manual or automatic transmission available. Manual gearbox is four-speed with synchromesh on all forward gears. Single dry plate, diaphragm spring type clutch. Mechanically operated clutch release mechanism. Automatic transmission has a torque converter and a hydraulically controlled automatic epicyclic gearbox.

A combined cable and rod clutch release mechanism was fitted across the range from December 1970.

COOLING SYSTEM

Pressurised system, forced circulation type. Centrifugal, belt-driven pump.

FUEL SYSTEM

Petrol. Single-venturi, downdraught carburettor. Mechanical fuel pump.

Diesel. Delay-type pintle nozzle injectors. Distributor type fuel injection pump. Mechanical fuel pump.

ELECTRICAL SYSTEM

Alternator charging system. 12 volt, negative earth battery. Printed circuit dashboard wiring. Wiring circuits fully fused. From December 1970 a new loom was introduced, hazard warning lights became a standard item and the option of a foot-operated wipe/wash switch was included.

WHEELS AND HUBS

WHEELS

Axle Capacity	Type	Model	Details
(Front)			
1,020 kg. (2,250 lb.)	23	75 – 115	35.6 cm. (14 in.) wheels. One-piece drop centre rims. Five-stud fixing.
1,020 kg. (2,250 lb.)	23	125 – 175	35.6 cm. (14 in.) wheels. One-piece drop centre rims. Six-stud fixing.
(Rear)			
1,250 kg. (2,750 lb.)	27 (34 Opt.)	75	35.6 cm. (14 in.) wheels. One-piece drop centre rims. Five-stud fixing. ¾ floating axle shafts.
1,550 kg. (3,400 lb.)	34	90 – 115	
2,360 kg. (5,200 lb.)	52	125 – 175	35.6 cm. (14 in.) wheels. One-piece drop centre rims. Six-stud fixing. Fully floating axle shafts.

WHEEL NUTS

Tightening torque .. .. 7.6 to 9.8 kg.m. (55 to 70 lb. ft.)

TYRES

Model	Tyre	Pressures			
		Front		Rear	
		kg./sq. cm.	lb./sq. in.	kg./sq. cm.	lb./sq. in.
60	6·50 × 14 6PR	2·1	30	2·5	36
60	6·50 × 14 6PRC	2·5	36	3·2	45
60	7·00 × 14 4PR	2·1	30	2·1	30
60	7·00 × 14 6PR	2·1	30	2·5	36
60	165 × R14 Reinforced	2·1	30	3·0	42
60	185 × R14 Reinforced	2·1	30	3·0	42
75	6·50 × 14 6PR	2·1	30	2·5	36
75	6·50 × 14 6PRC	2·5	36	3·2	45
75	7·00 × 14 4PR	2·1	30	2·1	30
75	7·00 × 14 6PR	2·1	30	2·5	36
75	7·00 × 14 6PRC	2·1	30	3·2	45
75	7·50 × 14 4PR	2·1	30	2·1	30
75	165 × R14 6C	2·5	36	3·2	45
75	165 × R14 Reinforced	2·1	30	3·0	42
75	185 × R14 Reinforced	2·1	30	3·0	42
90	7·00 × 14 6PRC	2·1	30	3·2	45
90	7·50 × 14 6PRC	2·1	30	3·2	45
90	7·75 × 14 6PR	1·7	24	2·5	36
90	7·75 × 14 6PRC	1·7	24	3·2	45
90 (Bus)	7·75 × 14 6PRC	1·7	24	2·5	36
90	185 × R14 6C	2·1	30	3·2	45
90	195 × R14 6C	1·7	24	3·2	45
90 (Bus)	195 × R14 6C	1·7	24	2·5	36
90 (Crewbus)	195 × R14 6C	1·7	24	2·1	40
100	7·00 × 14 6PRC	2·1	30	3·2	45
100	7·50 × 14 6PRC	2·1	30	3·2	45
100	7·50 × 14 8PR	2·1	30	3·2	45
100	7·50 × 14 8PRC	2·1	30	3·2	*45
100	7·50 × 14 8PRC			3·8	55
100	7·75 × 14 6PR	1·7	24	2·5	36
100	7·75 × 14 6PRC	1·7	24	2·5	*36
100	7·75 × 14 6PRC			3·2	45
100	185 × R14 6C	2·1	30	3·2	45
100	195 × R14 6C	1·7	24	3·2	45

*Depending on model load application.

Tyres—*continued*

Model	Tyre	Pressures Front kg./sq. cm.	Pressures Front lb./sq. in.	Pressures Rear kg./sq. cm.	Pressures Rear lb./sq. in.
115	7·50 × 14 6PRC	2·1	30	3·2	45
115	7·50 × 14 8PR	2·1	30	3·2	45
115	7·50 × 14 8PRC	2·1	30	3·2	*45
115	7·50 × 14 8PRC			3·8	55
115	7·75 × 14 6PRC	1·7	24	3·2	45
115	195 × R14 6C	1·7	24	3·2	45
125	205 × R14 6C	1·7	24	3·2	45
130	6·50 × 14 4PR	2·1	30	2·1	30
130	6·50 × 14 6PR	2·5	36	2·5	36
130	6·50 × 14 6PRC	2·5	36	2·5	36
130	7·00 × 14 4PR	2·1	30	2·1	30
130	7·00 × 14 6PR	2·1	30	2·1	30
130	165 × R14 6C	2·5	36	2·5	36
130	165 × R14 Reinforced	2·5	36	2·5	36
150	6·50 × 14 6PRC	2·5	36	2·5	36
150	7·00 × 14 4PR	2·1	30	2·1	30
150	7·00 × 14 6PR	2·1	30	2·1	30
150	7·00 × 14 6PRC	2·1	30	2·1	30
150	7·50 × 14 4PR	2·1	30	2·1	30
150	165 × R14 6C	2·5	36	3·0	42
150	165 × R14 Reinforced	2·5	36	3·0	42
150	185 × R14 Reinforced	2·1	30	2·5	36
175	6·50 × 14 6PRC	2·5	36	3·2	45
175	7·00 × 14 6PRC	2·1	30	3·2	45
175	7·50 × 14 6PR	2·1	30	2·5	36
175	7·50 × 14 6PRC	2·1	30	2·5	36
175	185 × R14 6C	2·1	30	3·2	45
175	185 × R14 Reinforced	2·1	30	3·0	42

*Depending on model load application.

BRAKING SYSTEM

TYPE .. .. Hydraulic

FRONT BRAKES	75 – 90	115 – 125
Drum diameter (cm. & in.)	22.86 (9)	25.4 (10)
Lining length (cm. & in.)	21.84 (8.6)	24.38 (9.6)
Lining width (cm. & in.)	6.98 (2.75)	6.98 (2.75)
Lining thickness (mm. & in.)	4.83 (0.19)	4.83 (0.19)
Lining area (sq. cm. & sq. in.)	306 (47.4)	342.0 (52.8)
Wheel cylinder dia. (cm. & in.)	2 at 2.03 (0.8)	2 at 2.03 (0.8)

FRONT BRAKES	130	150 – 175
Drum diameter (cm. & in.)	25.4 (10)	25.4 (10)
Lining length (cm. & in.)	24.38 (9.6)	24.38 (9.6)
Lining width (cm. & in.)	5.71 (2.25)	6.98 (2.75)
Lining thickness (mm. & in.)	4.83 (0.19)	4.83 (0.19)
Lining area (sq. cm. & sq. in.)	278.5 (43.2)	342.0 (52.8)
Wheel cylinder dia. (cm. & in.)	2 at 2.22 (0.875)	2 at 2.22 (0.875)

REAR BRAKES	75 – 90	115	125
Drum diameter (cm. & in.)	22.86 (9)	22.86 (9)	25.4 (10)
Lining length (cm. & in.)	21.84 (8.6)	21.84 (8.6)	21.84 (8.6)
Lining width (cm. & in.)	4.44 (1.75)	4.44 (1.75)	4.44 (1.75)
Lining thickness (mm. & in.)	4.83 (0.19)	4.83 (0.19)	4.83 (0.19)
Lining area (sq. cm. & sq. in.)	197.5 (30.0)	197.5 (30.0)	197.5 (30.0)
Wheel cylinder dia. (cm. & in.)	1 at 1.90 (0.75)	1 at 2.03 (0.8)	1 at 1.59 (0.625)

REAR BRAKES	130	150 – 175
Drum diameter (cm. & in.)	25.4 (10)	25.4 (10)
Lining length—primary (cm. & in.)	24.38 (9.6)	24.38 (9.6)
—secondary (cm. & in.)	27.68 (10.9)	27.68 (10.9)
Lining width (cm. & in.)	5.71 (2.25)	6.98 (2.75)
Lining thickness—primary (mm. & in.)	4.83 (0.19)	4.83 (0.19)
—secondary (mm. & in.)	6.35 (0.25)	6.35 (0.25)
Lining area (sq. cm. & sq. in.)	297.5 (46.1)	364.0 (56.4)
Wheel cylinder dia. (cm. & in.)	1 at 1.59 (0.625)	1 at 1.90 (0.75)

MASTER CYLINDER (Up to December 1970)	75 – 175
Bore diameter (cm. & in.)	1.905 (0.75)
Stroke (cm. & in.)	3.327 (1.31)
Displacement (cu. cm. & cu. in.)	1.475 (0.58)

TANDEM MASTER CYLINDER (Up to December 1970)

Main bore diameter (cm. & in.)	1.905 (0.75)
Pressure differential bore diameter (cm. & in.)	0.950 (0.37)
Stroke (cm. & in.)	3.600 (1.42)

BRAKE FLUID .. ME-3833-E or SM6C-1002-A

SERVO UNIT (Up to December 1970)

Outside diameter (cm. & in.)	17.8 (7.0)
Effective diameter (cm. & in.)	15.25 (6.0)
Slave cylinder diameter (cm. & in.)	2.22 (0.875)
Stroke (cm. & in.)	5.23 (2.06)
Displacement (cu. cm. & cu. in.)	20.31 (1.24)
Reaction plunger diameter (cm. & in.)	0.787 (0.31)
Booster weight (kg. & lb.)	2.97 (6.6)

MASTER CYLINDER (December 1970 onwards)

	Single line boosted	*Single line non-boosted*
Bore (cm. & in.)	2.064 (0.8125)	1.905 (0.75)
Stroke (cm. & in.)	3.30 (1.30)	3.556 (1.40)
Displacement (cu. cm. & cu. in.)	9.98 (0.674)	9.92 (0.608)

	Dual line boosted	*Dual line non-boosted*
Bore (cm. & in.)	2.064 (0.8125)	1.905 (0.75)
Stroke—primary piston (cm. & in.)	1.539 (0.606)	1.70 (0.669)
—secondary piston (cm. & in.)	1.727 (0.680)	1.90 (0.748)
Displacement—primary piston (cu. cm. & cu. in.)	4.62 (0.282)	4.85 (0.312)
—secondary piston (cu. cm. & cu. in.)	5.27 (0.322)	5.41 (0.342)

BOOSTER (December 1970 onwards)

Outside diameter (cm. & in.)	20.44 (8.04)
Effective diameter (cm. & in.)	18.75 (7.39)

TIGHTENING TORQUES

Bridge Pipe Unions	0.76 to 0.97 kg.m. (5.5 to 7 lb. ft.)
Wheel Cylinder Bolts—6.35 mm. ($\frac{1}{4}$ in.) bolt	0.97 to 1.27 kg.m. (7 to 9 lb. ft.)
—7.94 mm. ($\frac{5}{16}$ in.) bolt	1.45 to 1.73 kg.m. (10.5 to 12.5 lb. ft.)

FRONT AXLE AND STEERING

AXLE BEAM

Type	"I" section, cranked
Material	Forged steel
Height at centre	4.97 cm. (1.96 in.)
Width	3.81 cm. (1.50 in.)
Web thickness	0.533 cm. (0.21 in.)
Section modulus at centre	11.7 cm.^{3} (0.713 in.^{3})
Spindle bolt centres at the tops of the bores	148 cm. (58.25 in.)
Spring centres	90 cm. (35.44 in.)
Spindle above spring pad	5.25 cm. (2.07 in.) at wheel centre
Spindle bolt—Diameter	2.06 cm. (0.812 in.)
—Length	15.5 cm. (6.10 in.)
—Bushing length	3.05 cm. (1.20 in.)

STEERING LINKAGE

Castor Angle

Multi-leaf front springs:

	75 - 115 (*Before February* 1967) *Maximum*	75 - 115 (*Before February* 1967) *Minimum*	130 - 175 (*Before 3rd July* 1967) *Maximum*	130 - 175 (*Before 3rd July* 1967) *Minimum*
Van, Bus, Combi	5¾°	3¼°	6°	4°
Chassis cab, Chassis windshield, Chassis cowl	5½°	2¾°	6°	3½°

	75 - 115 (*February* 1967 – *December* 1970) *Maximum*	75 - 115 (*February* 1967 – *December* 1970) *Minimum*	130 - 175 (*July* 1967 – *December* 1970) *Maximum*	130 - 175 (*July* 1967 – *December* 1970) *Minimum*
Van, Bus, Combi	5¼°	2¾°	5½°	3½°
Chassis cab, Chassis windshield, Chassis cowl	5°	2¼°	5½°	3°

Single leaf front springs:

	75 - 125 *Maximum*	75 - 125 *Minimum*	130 - 175 *Maximum*	130 - 175 *Minimum*
Van, Bus, Combi	5¾°	3¼°	6°	4°
Chassis cab, Chassis windshield, Chassis cowl	5½°	2¾°	6°	3½°

Camber angle	0° — 1°
Toe-in	2.38 to 3.97 mm. (0.094 to 0.156 in.) for textile tyres 0.00 to 1.60 mm. (0.00 to 0.063 in.) for radial tyres
King pin inclination	5° ± 10′
Wheel turning angles: Back lock (maximum)	42° 40′
Front lock (maximum)	33°

Turning circles:

	Wheel Circle	*Swept Circle*
75 - 125: 2.79 m. (106 in.) wheelbase	10.36 m. (34.0 ft.)	11.03 m. (36.2 ft.)
130 - 175: 3.0 m. (118 in.) wheelbase	11.36 m. (37.25 ft.)	12.05 m. (39.5 ft.)

STEERING GEAR (Except 9/12 Seat Diesel Bus)

Type	Worm and Nut (Recirculating Ball)
Lubricant	Ford Steering Gear Grease ESW-M-IC-87A
Capacity	0.32 kg. (0.7 lb.)
Ratio	19.88 : 1

Adjustments

Worm shaft pre-load	4.0 to 7.0 kg. cm. (3.5 to 6.0 lb. in.)
Total pre-load (worm shaft pre-load plus mesh load)	45 kg. cm. (39 lb. in.)

STEERING GEAR (9/12 Seat Diesel Bus)

Type	Worm and nut (Recirculating Ball)
Lubricant	Steering gear oil ME-568-C
Capacity	0.42 litre (0.74 pint)
Ratio	20.55 : 1 (at straight ahead position)

Tightening Torques

Side cover bolts	2.07 to 2.49 kg.m. (15 to 18 lb. ft.)
Upper bearing retainer bolts	2.07 to 2.49 kg.m. (15 to 18 lb. ft.)

REAR AXLE

DRIVELINE

75 - 125	Single Piece—106 in. wheelbase
130 - 175	Two Piece—118 in. wheelbase
Centre Bearing	Lubricated for life

REAR AXLE

Type .. Hypoid, Three-quarter Floating (75 – 115). Fully Floating (125 – 175)

Ratios .. 75 (2750 lb. Axle) Type 27

Petrol		*Diesel*	
4.11 : 1	4.44 : 1	4.11 : 1	4.44 : 1
4.62 : 1	5.14 : 1	4.62 : 1	5.14 : 1

Ratios .. 90 (3400 lb. Axle) Type 34

Petrol		*Diesel*	
4.11 : 1	4.44 : 1	4.11 : 1	4.44 : 1
4.62 : 1	5.14 : 1	4.62 : 1	5.14 : 1

Ratios .. 115 (3400 lb. Axle) Type 34

Petrol		*Diesel*	
4.44 : 1	4.62 : 1	4.44 : 1	4.62 : 1
5.14 : 1		5.14 : 1	

Ratios .. 125 (5200 lb. Axle) Type 52

Petrol	*Diesel*
4.625 : 1	4.625 : 1
5.143 : 1	5.143 : 1

Ratios .. 130 (5200 lb. Axle) Type 52

Petrol		*Diesel*	
4.62 : 1	5.14 : 1	5.14 : 1	5.83 : 1
5.83 : 1	6.17 : 1	6.17 : 1	

Ratios .. 150 (5200 lb. Axle) Type 52

Petrol		*Diesel*	
4.62 : 1	5.14 : 1	5.83 : 1	6.17 : 1
5.83 : 1	6.17 : 1		

Ratios .. 175 (5200 lb. Axle) Type 52

Petrol		*Diesel*	
4.62 : 1	5.14 : 1	5.83 : 1	6.17 : 1
5.83 : 1	6.17 : 1		

Ratio	Teeth on Pinion	Teeth on Crown Wheel
4.11 : 1	9	37
4.44 : 1	9	40
4.625 : 1	8	37
5.143 : 1	7	36
5.833 : 1	6	35
6.17 : 1	6	37

LUBRICANT

Grade (2750 & 3400 lb. Axles)	S.A.E. 90 hypoid
(5200 lb. Axle) Initial Fill	EM-2C-29 Stuart hypoid
Top up	S.A.E. 90 hypoid
Capacity (2750 & 3400 lb. Axles)	2.13 litres (4.5 U.S. pints, 3.75 Imp. pints)
(5200 lb. Axle)	1.7 litres (3.0 U.S. pints, 2.50 Imp. pints)

ADJUSTMENTS

75 — 115

Crown wheel and pinion backlash	0.127 to 0.178 mm. (0.005 to 0.007 in.)
Pinion bearing pre-load	0.265 to 0.323 kg.m. (23 to 28 lb. in.)
Differential bearing pre-load (cap spread)	0.127 to 0.178 mm. (0.005 to 0.007 in.)

125 — 175

Crown wheel to pinion backlash	0.12 to 0.22 mm. (0.005 to 0.009 in.)
Differential bearing cap spread	0.16 to 0.22 kg.m. (0.006 to 0.009 in.)
Pinion bearing pre-load	0.14 to 0.17 kg.m. (12 to 15 lb. in.)

TIGHTENING TORQUES

75 — 115

Crown wheel to differential case bolts	6.9 to 7.6 kg.m. (50 to 55 lb. ft.)
Differential carrier to axle housing nuts	3.5 to 4.2 kg.m. (25 to 30 lb. ft.)
Differential bearing locking plate bolts	1.7 to 2.1 kg.m. (12 to 15 lb. ft.)
Differential bearing cap bolts	9.7 to 11.1 kg.m. (70 to 80 lb. ft.)
Driveshafts bolt	3.1 to 3.7 kg.m. (22 to 27 lb. ft.)
Spring clip bolts	7.6 to 9.0 kg.m. (55 to 65 lb. ft.)
Axle hub nut (*minimum*)	18 kg.m. (130 lb. ft.)

125 — 175

Differential backplate bolts	1.8 to 2.3 kg.m. (13 to 17 lb. ft.)
Differential case bolts	3.1 to 3.5 kg.m. (22 to 25 lb. ft.)
Crown wheel to differential case bolts	10 to 14 kg.m. (72 to 101 lb. ft.)
Pinion flange nut	10 to 12 kg.m. (72 to 87 lb. ft.)
Hub to axle shaft nuts	7.0 to 7.6 kg.m. (50 to 55 lb. ft.)
Differential bearing cap bolts	10 to 12 kg.m. (72 to 87 lb. ft.)

Depth of Mesh Shims

Part No.	*Size*	
11—620—564	1.720—1.740 mm.	(0.0677—0.0685 in.)
11—620—565	1.750—1.766 mm.	(0.0689—0.0695 in.)
11—620—566	1.780—1.796 mm.	(0.0701—0.0707 in.)
11—620—567	1.810—1.826 mm.	(0.0713—0.0719 in.)
11—620—568	1.838—1.854 mm.	(0.0724—0.0730 in.)
11—620—569	1.868—1.884 mm.	(0.0736—0.0742 in.)
11—620—570	1.898—1.914 mm.	(0.0748—0.0754 in.)
11—620—571	1.928—1.944 mm.	(0.0760—0.0766 in.)
11—620—572	1.958—1.974 mm.	(0.0772—0.0778 in.)
11—620—573	1.986—2.002 mm.	(0.0783—0.0789 in.)
11—620—574	2.016—2.032 mm.	(0.0795—0.0801 in.)
11—620—575	2.046—2.062 mm.	(0.0807—0.0813 in.)
11—620—576	2.076—2.092 mm.	(0.0819—0.0825 in.)
11—620—577	2.106—2.122 mm.	(0.0831—0.0837 in.)
11—620—578	2.136—2.152 mm.	(0.0843—0.0849 in.)
11—620—579	2.164—2.180 mm.	(0.0854—0.0860 in.)
11—620—580	2.194—2.210 mm.	(0.0866—0.0872 in.)
11—620—581	2.230—2.240 mm.	(0.0878—0.0882 in.)

Pinion Pre-load Spacers

Part No.	*Size*	
11—440—306	10.300—10.310 mm.	(0.4055—0.4059 in.)
11—440—307	10.315—10.325 mm.	(0.4061—0.4065 in.)
11—440—308	10.330—10.340 mm.	(0.4067—0.4071 in.)
11—440—309	10.345—10.355 mm.	(0.4073—0.4077 in.)
11—440—310	10.360—10.370 mm.	(0.4079—0.4083 in.)
11—440—311	10.375—10.385 mm.	(0.4085—0.4089 in.)
11—440—312	10.390—10.400 mm.	(0.4091—0.4095 in.)
11—440—313	10.405—10.415 mm.	(0.4096—0.4100 in.)
11—440—314	10.415—10.425 mm.	(0.4102—0.4106 in.)
11—440—315	10.430—10.440 mm.	(0.4108—0.4112 in.)
11—440—316	10.445—10.455 mm.	(0.4114—0.4118 in.)
11—440—317	10.460—10.470 mm.	(0.4120—0.4124 in.)
11—440—318	10.475—10.485 mm.	(0.4126—0.4130 in.)
11—440—319	10.490—10.500 mm.	(0.4132—0.4136 in.)
11—440—320	10.505—10.515 mm.	(0.4138—0.4142 in.)
11—440—321	10.520—10.530 mm.	(0.4144—0.4148 in.)
11—440—322	10.535—10.545 mm.	(0.4150—0.4154 in.)
11—440—323	10.550—10.560 mm.	(0.4156—0.4160 in.)
11—440—324	10.565—10.575 mm.	(0.4161—0.4165 in.)
11—440—325	10.580—10.590 mm.	(0.4167—0.4171 in.)
11—440—326	10.595—10.605 mm.	(0.4173—0.4177 in.)
11—440—327	10.610—10.620 mm.	(0.4179—0.4183 in.)
11—440—328	10.625—10.635 mm.	(0.4185—0.4189 in.)
11—440—329	10.640—10.650 mm.	(0.4191—0.4195 in.)
11—440—330	10.655—10.665 mm.	(0.4197—0.4201 in.)
11—440—331	10.670—10.680 mm.	(0.4203—0.4207 in.)
11—440—332	10.685—10.695 mm.	(0.4209—0.4213 in.)
11—440—333	10.700—10.710 mm.	(0.4215—0.4219 in.)
11—440—334	10.715—10.725 mm.	(0.4221—0.4225 in.)
11—440—335	10.730—10.740 mm.	(0.4226—0.4230 in.)
11—440—336	10.745—10.755 mm.	(0.4232—0.4236 in.)
11—440—337	10.760—10.770 mm.	(0.4238—0.4242 in.)
11—440—338	10.775—10.785 mm.	(0.4244—0.4248 in.)
11—440—339	10.790—10.800 mm.	(0.4250—0.4254 in.)
11—440—340	10.805—10.815 mm.	(0.4256—0.4260 in.)
11—440—341	10.825—10.835 mm.	(0.4262—0.4266 in.)
11—440—342	10.840—10.850 mm.	(0.4268—0.4272 in.)
11—440—343	10.855—10.865 mm.	(0.4274—0.4278 in.)
11—440—344	10.870—10.880 mm.	(0.4280—0.4284 in.)
11—440—345	10.885—10.895 mm.	(0.4285—0.4289 in.)
11—440—346	10.900—10.910 mm.	(0.4291—0.4295 in.)
11—440—347	10.915—10.925 mm.	(0.4297—0.4301 in.)
11—440—348	10.930—10.940 mm.	(0.4303—0.4307 in.)
11—440—349	10.945—10.955 mm.	(0.4309—0.4313 in.)
11—440—350	10.960—10.970 mm.	(0.4314—0.4319 in.)
11—440—351	10.975—10.985 mm.	(0.4321—0.4325 in.)
11—440—352	10.990—11.000 mm.	(0.4327—0.4331 in.)
11—440—353	11.000—11.010 mm.	(0.4333—0.4337 in.)
11—440—354	11.015—11.025 mm.	(0.4339—0.4343 in.)
11—440—355	11.030—11.040 mm.	(0.4345—0.4349 in.)
11—440—356	11.045—11.055 mm.	(0.4351—0.4355 in.)
11—440—357	11.060—11.070 mm.	(0.4357—0.4361 in.)
11—440—358	11.075—11.085 mm.	(0.4363—0.4367 in.)
11—440—359	11.090—11.100 mm.	(0.4368—0.4372 in.)
11—440—360	11.105—11.115 mm.	(0.4374—0.4378 in.)
11—440—361	11.120—11.130 mm.	(0.4380—0.4384 in.)
11—440—362	11.135—11.145 mm.	(0.4386—0.4390 in.)
11—440—363	11.150—11.160 mm.	(0.4392—0.4396 in.)
11—440—364	11.165—11.175 mm.	(0.4398—0.4402 in.)
11—440—365	11.180—11.190 mm.	(0.4404—0.4408 in.)

FRONT AND REAR SUSPENSION

Until December 1970 — Except Parcel Van

FRONT SPRINGS (Multi-leaf) .. **75 to 175** .. Semi-elliptic, mounted on rubber-bushed shackles and pins.

	Petrol Engines	Diesel Engines
No. of Leaves	3	3 and one spacer
Deflection rate (unclamped)	36.0 kg. cm. (200 lb. in.)	36.0 kg. cm. (200 lb. in.)
Width	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)
Length	120.015 cm. (47.25 in.)	120.015 cm. (47.25 in.)
Thickness	3 at 0.828 cm. (0.326 in.)	3 at 0.828 cm. (0.326 in.) spacer at 0.813 cm. (0.32 in.)

FRONT SPRINGS (Single-leaf) .. **75 to 175** .. Semi-elliptic, mounted on rubber-bushed shackles and pins.

No. of leaves	1 (plus spacer with diesel engines)
Deflection rate (unclamped)	36.0 kg. cm. (200 lb. in.)
Width	5.99 cm. (2.36 in.)
Length	120.015 cm. (47.25 in.)
Thickness	Tapered

REAR SPRINGS .. **75 to 115** .. Semi-elliptic, mounted on rubber-bushed shackles and pins.

	75	90	115
No. of leaves	5 (Single Rate)	5 (Progressive Rate)	6 (Progressive Rate)
Deflection rate (unclamped)	30.0 kg. cm. (168 lb. in.)	50.0 kg. cm. (280 lb. in.)	71.0 kg. cm. (395 lb. in.)
Width	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)
Length	116.84 cm. (46 in.)	116.84 cm. (46 in.)	116.84 cm. (46 in.)
Thickness	5 at 0.64 cm. (0.252 in.)	4 at 0.571 cm. (0.225 in.) 1 at 1.196 cm. (0.471 in.)	4 at 0.559 cm. (0.220 in.) 2 at 1.170 cm. (0.461 in.)

REAR SPRINGS .. **130 to 175** .. Semi-elliptic, mounted on a rubber-bushed front pin and a rear slipper bracket. Progressive rate of deflection.

	130	150	175
No. of leaves	7 (Progressive Rate)	7 (Progressive Rate)	7 (Progressive Rate)
Deflection rate (unclamped)	90.55 kg. cm. (507 lb. in.)	106.3 kg. cm. (595 lb. in.)	123.6 kg. cm. (692 lb. in.)
Width	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)
Length	141.0 cm. (55.5 in.)	141.0 cm. (55.5 in.)	141.0 cm. (55.5 in.)
Thickness	5 at 0.635 cm. (0.250 in.) 2 at 1.331 cm. (0.524 in.)	5 at 0.648 cm. (0.255 in.) 2 at 1.496 cm. (0.598 in.)	5 at 0.658 cm. (0.259 in.) 2 at 1.582 cm. (0.623 in.)

Parcel Van

FRONT SPRINGS (Multi-leaf) .. **130 and 175** .. Semi-elliptic, mounted on rubber-bushed shackles and pins.

	Petrol Engines	Diesel Engines
No. of leaves	3	3 and one spacer
Deflection rate (unclamped)	59.0 kg. cm. (330 lb. in.)	59.0 kg. cm. (330 lb. in.)
Width	5.99 cm. (2.36 in.)	5.99 cm. (2.36 in.)
Length	120.015 cm. (47.25 in.)	120.015 cm. (47.25 in.)
Thickness	3 at 0.965 cm. (0.38 in.)	3 at 0.965 cm. (0.38 in.) spacer at 0.800 cm. (0.315 in.)

REAR SPRINGS .. **130** .. .. Semi-elliptic, mounted on rubber-bushed shackles and pins.

	Petrol and Diesel Engines
No. of leaves	6 (Progressive Rate)
Deflection Rate (unclamped)	103.24 kg. cm. (580 lb. in.)

Width ..	.. ..	5.99 cm. (2.36 in.)
Length ..	.. ..	116.84 cm. (46.00 in.)
Thickness	.. ..	4 at 0.559 cm. (0.22 in.) 2 at 1.496 cm. (0.589 in.)

REAR SPRINGS .. 175 .. Semi-elliptic, mounted on a rubber-bushed front pin and a rear slipper bracket.

Petrol and Diesel Engines

No. of leaves ..	..	8 (Progressive Rate)
Deflection rate (unclamped)	..	173.55 kg. cm. (975 lb. in.)
Width ..	.. ..	5.99 cm. (2.36 in.)
Length ..	.. ..	127.0 cm. (50.0 in.)
Thickness	.. ..	5 at 0.708 cm. (0.314 in.) 3 at 1.582 cm. (0.623 in.)

From December 1970

FRONT SPRINGS .. 75 to 175 Single leaf, semi-elliptic, mounted on rubber-bushed shackles and pins.

No. of leaves ..	..	1
Width ..	.. ..	6.8 cm. (2.67 in.)
Length ..	.. ..	120.02 cm. (47.25 in.)
Basic Part No.	..	70VB–5310

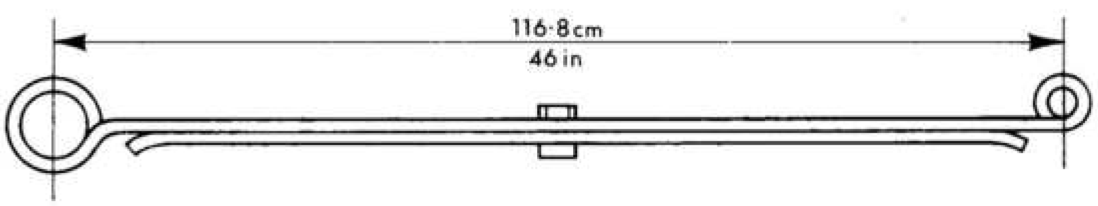
For full list of Part Numbers and their application, see Parts Catalogue.

REAR SPRINGS .. 75 to 125 (LCX) .. Minimum leaf, semi-elliptic, mounted on rubber-bushed shackles and pins.

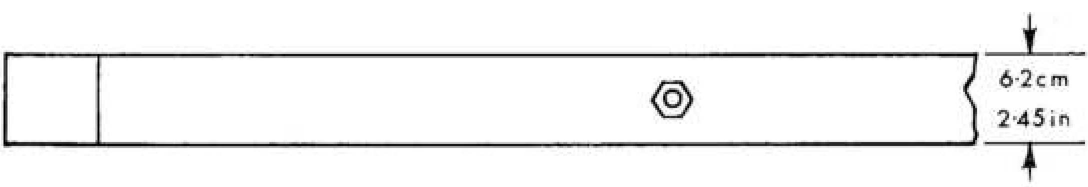
No. of leaves ..	..	2 or 3
Width ..	.. ..	6.2 cm. (2.45 in.)
Length ..	.. ..	116.8 cm. (46 in.)

REAR SPRINGS .. 130 to 175 (LCY) .. Minimum leaf, semi-elliptic, mounted on rubber-bushed front pin and a rear slipper bracket.

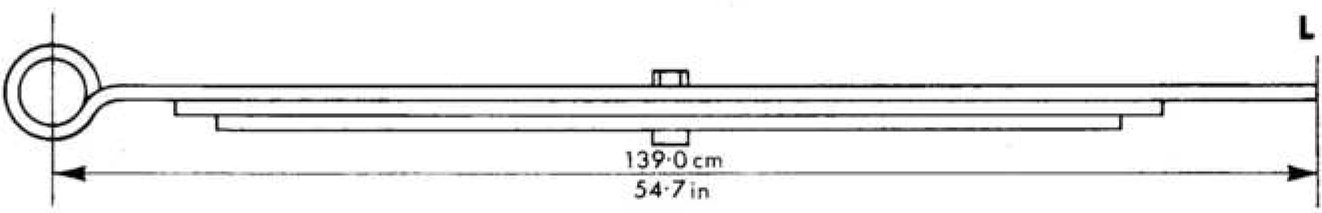
No. of leaves ..	..	3
Width ..	.. ..	6.2 cm. (2.45 in.)
Length ..	.. ..	139.0 cm. (54.7 in.)



LCX



LCY



Basic Part No.	..	70VB–5560

For full list of Part Numbers and their application, see Parts Catalogue.

ENGINE

PETROL

	1.7 *Litre*		2.0 *Litre*	
Type	4 cylinder 60° Vee O.H.V.			
Bore	93.67 mm. (3.6878 in.)		93.67 mm. (3.6878 in.)	
Stroke	60.35 mm. (2.376 in.)		72.42 mm. (2.851 in.)	
Cubic Capacity ..	1663 c.c. (101.5 C.I.D.)		1996 c.c. (121.8 C.I.D.)	
Compression ratio ..	8 : 1	9.1 : 1	8 : 1	8.9 : 1
Brake horse power ..	73 at 4750 rev./min.	81.5 at 4750 rev./min.	85.5 at 4750 rev./min.	93 at 4750 rev./min.
Torque	91 lb. ft. at 3000 rev./min.	99.5 lb. ft. at 3000 rev./min.	114 lb. ft. at 2750 rev./min.	123.5 lb. ft. at 2750 rev./min.
Firing order	1, 3, 4, 2			
Cylinder numbering	1 & 2 Right-hand Bank, 3 & 4 Left-hand Bank			
Location of No. 1 cylinder	Right-hand bank next to radiator			
Engine weight (less clutch)	144 kg. (318 lbs.)		145 kg. (320 lbs.)	

CAMSHAFT

Camshaft drive .. .. Gear

	Prior to Feb. 1968	*Feb.* 1968 *onwards*
Cam lift—Intake	6.47 mm. (0.25465 in.)	6.48 mm. (0.25498 in.)
—Exhaust	6.62 mm. (0.26065 in.)	6.63 mm. (0.26098 in.)

No. of bearings	3
Bearing diameter—Front	47.64 to 47.66 mm. (1.8757 to 1.8763 in.)
—Intermediate	46.10 to 46.13 mm. (1.8153 to 1.8163 in.)
—Rear	44.58 to 44.6 mm. (1.7553 to 1.7563 in.)
Bearing length—Front	21.3 mm. (0.84 in.)
—Intermediate	26.9 mm. (1.06 in.)
—Rear	21.3 mm. (0.84 in.)
Bearing clearance	0.066 to 0.02 mm. (0.0026 to 0.0008 in.)
Type of bearing	Steel backed babbit
Shaft diameter	24.4 mm. (0.96 in.)
Journal diameter—Front	47.59 to 47.61 mm. (1.8735 to 1.8745 in.)
—Intermediate	46.07 to 46.09 mm. (1.8137 to 1.8145 in.)
—Rear	44.54 to 44.56 mm. (1.7537 to 1.7545 in.)
End float	0.076 to 0.178 mm. (0.003 to 0.007 in.)
Backlash—Crankshaft to camshaft gear	0.05 to 0.10 mm. (0.002 to 0.004 in.)

CRANKSHAFT

No. of main bearings	3
Main journal diameter—blue	63.515 to 63.536 mm. (2.5006 to 2.5014 in.)
Main journal diameter—red	63.526 to 63.535 mm. (2.5010 to 2.5014 in.)
Journal length—Front	24.13 to 25.4 mm. (0.95 to 1.00 in.)
—Intermediate	26.89 to 26.95 mm. (1.059 to 1.061 in.)
—Rear	26.92 to 27.68 mm. (1.06 to 1.09 in.)
Main journal fillet radius—centre and oil slinger double radius of	1.78 and 2.03 mm. (0.07 and 0.08 in.)
—Front and rear	2.032 to 2.388 mm. (0.080 to 0.094 in.)
Crankpin diameter	60.36 to 60.34 mm. (2.3764 to 2.3756 in.)
Crankpin length	21.29 to 21.39 mm. (0.838 to 0.842 in.)
Crankpin journal fillet radius	2.032 to 2.388 mm. (0.080 to 0.094 in.)
Oversize thrust washers available	0.064 mm. (0.0025 in.), 0.127 mm. (0.005 in.) 0.191 mm. (0.0075 in.), 0.254 mm. (0.010 in.)
End float	0.076 to 0.279 mm. (0.003 to 0.011 in.)

CONNECTING ROD

Length	143.281 to 143.332 mm. (5.641 to 5.643 in.)
Piston pin fit in rod	0.0203 to 0.0381 mm. (0.0008 to 0.0015 in.) interference
End float on shaft	0.102 to 0.254 mm. (0.004 to 0.010 in.)
Big end bearings	Steel back aluminium/tin or copper/lead liners
Big end bore	64.033 to 64.046 mm. (2.5210 to 2.5215 in.)
Bearing liner wall thickness	1.826 to 1.835 mm. (0.0719 to 0.07225 in.)
Undersize bearings available	0.25 mm. (0.010 in.), 0.51 mm. (0.020 in.) 0.76 mm. (0.030 in.), 1.02 mm. (0.040 in.) on I.D.
Small end diameter	23.769 to 23.779 mm. (0.9358 to 0.9362 in.)

PISTONS

Type	Cut-away skirt with combustion chamber in crown
Material	Aluminium alloy tin plated
Weight—1.7 litre	608.0 to 612.0 grams
—2 litre	563.0 to 567.0 grams
Number of rings	Two compression, one oil control
Width of ring grooves—Compression rings	2.032 to 2.057 mm. (0.080 to 0.081 in.)
—Oil control ring	4.787 to 4.762 mm. (0.1885 to 0.1875 in.)
Piston pin bore diameter	Graded
Grade—Red	23.810 to 23.813 mm. (0.9374 to 0.9375 in.)
—Yellow	23.813 to 23.815 mm. (0.9375 to 0.9376 in.)
Blue	23.815 to 23.818 mm. (0.9376 to 0.9377 in.)
Piston pin bore offset	1.59 mm. (0.06 in.) towards thrust face
Piston clearance in cylinder bore	0.0356 to 0.0508 mm. (0.0014 to 0.0020 in.)
Piston pull	4.08 to 5.89 kg. (9 to 13 lb.) pull on 0.0508 mm. (0.002 in.) feeler blade, 12.7 mm. (0.5 in.) wide
Piston diameter	93.642 to 93.659 mm. (3.6867 to 3.6870 in.) Measured at right angles to, and level with, piston bore pin
Oversize pistons available	0.0635 mm. (0.0025 in.) 0.381 mm. (0.015 in.), 0.762 mm. (0.030 in.) 1.14 mm. (0.045 in.), 1.52 mm. (0.060 in.)

PISTON PINS

Type	Semi-floating, pressed into connecting rod
Material	Machined seamless steel tubing
Length	74.42 to 74.93 mm. (2.93 to 2.95 in.)
Outside diameter	23.793 to 23.806 mm. (0.9370 to 0.9373 in.)
Clearance in piston	0.0076 to 0.0127 mm. (0.0003 to 0.0005 in.) selective

PISTON RINGS

Upper Compression Ring

Material	Cast iron and chrome plated
Type	Barrel face
Radial thickness	4.24 to 3.98 mm. (0.167 to 0.157 in.)
Width	1.956 to 1.981 mm. (0.077 to 0.078 in.)
Ring to groove clearance	0.0508 to 0.1016 mm. (0.002 to 0.004 in.)
Ring gap	0.254 to 0.508 mm. (0.010 to 0.020 in.)

Lower Compression Ring

Material	Cast iron
Type	Externally stepped on the lower face
Radial thickness	4.14 to 4.67 mm. (0.163 to 0.184 in.)
Width	1.956 to 1.981 mm. (0.077 to 0.078 in.)
Ring to groove clearance	0.0508 to 0.1016 mm. (0.002 to 0.004 in.)
Ring gap	0.254 to 0.508 mm. (0.010 to 0.020 in.)

Oil Control Ring

Material	Cast iron
Type	"Micro-land" scraper with slotted channel
Radial thickness	3.81 to 4.06 mm. (0.150 to 0.160 in.)
Width	4.711 to 4.73 mm. (0.1855 to 0.1865 in.)
Ring to groove clearance	0.0254 to 0.0762 mm. (0.001 to 0.003 in.)
Ring gap	0.254 to 0.381 mm. (0.010 to 0.015 in.)
Oversize rings available	0.0635 mm. (0.0025 in.), 0.381 mm. (0.015 in.), 0.762 mm. (0.030 in.), 1.14 mm. (0.045 in.), 1.52 mm. (0.060 in.)

CYLINDER BLOCK

Type	Cylinder cast integral with top half of crankcase
Material	Ford cast iron alloy
Water jackets	Full length
Angle of Vee	60°
Nominal cylinder bore diameter	93.67 mm. (3.6878 in.)
Cylinder liners available	Std. and 0.51 mm. (0.020 in.) o/s on O.D.
Bore for cylinder liners	97.320 to 97.345 mm. (3.8315 to 3.8325 in.) Std. 97.828 to 97.854 mm. (3.8515 to 3.8525 in.) oversize
Bore for main bearing liners—Red	67.701 to 67.711 mm. (2.6654 to 2.6658 in.)
—Blue	67.711 to 67.721 mm. (2.6658 to 2.6662 in.)

CYLINDER HEAD

Type	Cast iron with vertical valves. Separate inlet and exhaust ports
Bolt size	$\frac{1}{2}$ in.—13 UNC$\times 3\frac{11}{16}$ in. long
Valve guides	Machined directly in the head but guide bushes are available
Bore for guide bushes	11.133 to 11.153 mm. (0.4383 to 0.4391 in.)
Valve guide inside diameter	7.912 to 7.938 mm. (0.3115 to 0.3125 in.)
Valve seat angle	44° 30′ to 45° inlet and exhaust
Valve seat width—Inlet	1.397 mm. (0.055 in.)
—Exhaust	1.930 mm. (0.076 in.)

Valve Seat Inserts

Insert	*Valve*	*I.D. of Recess in Head*	*Depth of Recess in Head*
Standard	Inlet Exhaust	41.656/41.668 mm. (1.6400/1.6405 in.) 37.846/37.859 mm. (1.4900/1.4095 in.)	8.23/8.28 mm. (0.324/0.326 in.)
0.254 mm. (0.010 in.) o/s dia std. depth	Inlet Exhaust	41.910/41.923 mm. (1.6500/1.6505 in.) 38.100/38.113 mm. (1.5000/1.5005 in.)	8.23/8.28 mm. (0.324/0.326 in.)
0.254 mm. (0.010 in.) o/s dia. and depth	Inlet Exhaust	41.910/41.923 mm. (1.6500/1.6505 in.) 38.100/38.113 mm. (1.5000/1.5005 in.)	8.48/8.53 mm. (0.334/0.336 in.)
0.508 mm. (0.020 in.) o/s dia. std. depth	Inlet Exhaust	42.164/42.177 mm. (1.6600/1.6605 in.) 38.354/38.367 mm. (1.5100/1.5105 in.)	8.23/8.28 mm. (0.324/0.326 in.)
0.508 mm. (0.020 in.) o/s dia. and depth	Inlet Exhaust	42.164/42.177 mm. (1.6600/1.6605 in.) 38.354/38.367 mm. (1.5100/1.5105 in.)	8.74/8.79 mm. (0.344/0.346 in.)

Bore for rocker stud (std.)	9.360 to 9.385 mm. (0.3685 to 0.3695 in.)

VALVES

Valve stem diameter—Inlet	7.861 to 7.887 mm. (0.3095 to 0.3105 in.)
—Exhaust	7.838 to 7.864 mm. (0.3086 to 0.3096 in.)
Valve stem to guide clearance—Inlet	0.025 to 0.076 mm. (0.001 to 0.003 in.)
—Exhaust	0.048 to 0.099 mm. (0.0019 to 0.0039 in.)
Oversize stems available	0.076 mm. (0.003 in.), 0.381 mm. (0.015 in.), 0.76 mm. (0.030 in.)
Valve head diameter—Inlet	40.44 to 40.69 mm. (1.592 to 1.602 in.)
—Exhaust	36.27 to 36.52 mm. (1.428 to 1.438 in.)
Valve face angle	45° to 45° 15′
Valve face run-out	0.025 mm. (0.001 in.) T.I.R.

VALVE SPRINGS

Free length	51.51 mm. (2.028 in.)
Diameter	33.63 to 34.24 mm. (1.324 to 1.348 in.)
Total number of coils	6.75
Wire diameter	4.24 to 4.29 mm. (0.167 to 0.169 in.)
Load at 40.64 mm. (1.60 in.) length (valve closed)	27.10 to 31.64 kg. (59.75 to 69.75 lb.)
Load at 31.06 mm. (1.223 in.) length (valve open)	58.97 to 65.32 kg. (130 to 144 lb.)

VALVE TIMING AND CLEARANCES

Nominal valve timing: Valve clearances 0.457 mm. (0.018 in.) inlet and 0.66 mm. (0.026 in.) exhaust

	Prior to Feb. 1968	*Feb.* 1968 *onward*
Inlet opens	20° B.T.D.C.	20° B.T.D.C.
Inlet closes	56° A.B.D.C.	64° A.B.D.C.
Exhausts opens	62° B.B.D.C.	70° B.B.D.C.
Exhaust closes	14° A.T.D.C.	14° A.T.D.C.
Valve lift—Inlet	9.296 mm. (0.366 in.)	8.56 mm. (0.335 in.)
—Exhaust	9.296 mm. (0.366 in.)	8.56 mm. (0.335 in.)
Valve clearance (set dynamically [engine running] at normal operating temperature)—Inlet	0.25 mm. (0.010 in.)	0.25 mm. (0.010 in.)
—Exhaust	0.46 mm. (0.018 in.)	0.46 mm. (0.018 in.)

ENGINE DIMENSIONS

Length	518.16 mm. (20.4 in.)
Overall width (alternator in maximum adjustment position)	690.88 mm. (27.2 in.)
Height (less air cleaner)	660.40 mm. (26.0 in.)

FLYWHEEL

Run-out clutch face (T.I.R. max.)	0.18 mm. (0.007 in.) at 107.9 mm. (4.25 in.) radius
No. of teeth on ring gear	121
Flywheel retention	Dowel and bolts
Ring gear retention	Shrunk into position

BALANCE SHAFT

End-float	0.254 to 0.381 mm. (0.010 to 0.015 in.)
Bearing clearance	0.046 to 0.084 mm. (0.0018 to 0.0033 in.)
Backlash—crankshaft to balance shaft gear	0.05 to 0.10 mm. (0.002 to 0.004 in.)

LUBRICATION

System	Pressure feed
Pressure feed bearings	Mains, big ends, camshaft and balance shaft
Metered feed	Rocker gear
Timing gear lubrication	Controlled spray
Oil pump	Eccentric bi-rotor or sliding vane types

Eccentric Bi-Rotor Type Pump

Inner and outer rotor clearance	0.152 mm. (0.006 in.) maximum
Outer rotor and housing clearance	0.254 mm. (0.010 in.) maximum
	After Oct. 1968 0.381 mm. (0.015 in.) maximum
Inner and outer rotor end-float	0.127 mm. (0.005 in.) maximum
Capacity	4.425 litres (12 U.S. galls., 10 Imp. galls.)/min. at 2,500 rev./min.

Sliding Vane Type Pump

Rotor to pump body clearance	0.127 mm. (0.005 in.) maximum
Vane clearance in rotor	0.127 mm. (0.005 in.) maximum
Rotor and vane end-float	0.127 mm. (0.005 in.) maximum
Vane to body clearance	0.279 mm. (0.011 in.) maximum
Capacity	4.425 litres (12 U.S. galls., 10 Imp. galls.)/min. at 2,500 rev./min.
Oil pressure	3.15 to 3.61 kp./sq. cm. (45 to 50 lb./sq. in.)
Oil filter type	External full flow pressure relief type
Sump capacity	4.54 litres (9.6 U.S. pints, 8 Imp. pints)
Oil filter capacity	0.85 litres (1.8 U.S. pints, 1.5 Imp. pints)

	Temperature Range			
SAE Viscosity No.	Use Below	Use Above	Max. High	Min. Low
5W-20 and 5W-30	—23.3°C (—10°F)	—	0°C (+32°F)	—
10W-30	—	General Use	+32.2°C (+90°F)	—23.3°C (—10°F)
10W-40	—	General Use	—	—23.3°C (—10°F)
10W-50	—	General Use	—	—23.3°C (—10°F)
20W-40 and 20W-50	—	+32.2°C (+90°F)	— —	0°C +32°F)
10W	—12.2°C (+10°F)	—23.3°C (—10°F)	—	—
10W-20	0°C (+32°F)	—12.2°C (+10°F)	—	—
30	+32.2°C (+90°F)	0°C (+32°F)	—	—
40	—	+32.2°C (+90°F)	—	—

4/99 DIESEL ENGINE

Bore	76.2 mm. (3 in.)
Stroke	88.9 mm. (3.5 in.)
Number of cylinders	4
Capacity	1,621 c.c. (99 cu. in.)
Compression ratio	20 : 1
Firing order	1, 3, 4, 2
Maximum b.h.p.	42 at 3,600 rev./min.
Maximum torque	10.09 kg.m. (73 lb. ft.) at 2,250 rev./min.
Valve clearance (hot)	0.25 mm. (0.010 in.)
Valve seat and face angle	45
Cam lift	6.6 mm. (0.26 in.)
Sump capacity	4.9 litres (10.3 U.S. pints, 8.6 pints)
Filter capacity	1.1 litres (2.4 U.S. pints, 2.0 pints)
Oil pressure	2.8123 kg. sq. cm. (40 lb. sq. in.)
Injection pressure	130 atmospheres

TIGHTENING TORQUES

Cylinder head nuts	5.25 to 5.81 kg.m. (38 to 42 lb. ft.)
Connecting rod bolts	5.0 to 5.2 kg.m. (36 to 38 lb. ft.)
Main bearing bolts	10.9 to 11.75 kg.m. (79 to 85 lb. ft.)
Flywheel bolts	7.6 to 8.3 kg.m. (55 to 60 lb. ft.)
Idler gear set-screws	4.56 to 4.98 kg.m. (33 to 36 lb. ft.)
Crankshaft pulley retaining bolt	19.35 to 20.73 kg.m. (140 to 150 lb. ft.)
Injector securing nuts	1.38 to 1.66 kg.m. (10 to 12 lb. ft.)
Rocker shaft pedestal nuts	1.66 to 2.08 kg.m. (12 to 15 lb. ft.)

CYLINDER BLOCK

Total height of cylinder block between top and bottom faces	252.37 to 252.45 mm. (9.936 to 9.939 in.)
Cylinder bore diameter	76.20 to 76.23 mm. (3.000 to 3.001 in.)
Main bearing parent bore diameter	60.833 to 60.846 mm. (2.3950 to 2.3955 in.)
Camshaft bore diameter No. 1	45.568 to 45.696 mm. (1.794 to 1.7955 in.)
Camshaft bore diameter No. 2	44.314 to 45.390 mm. (1.784 to 1.787 in.)
Camshaft bore diameter No. 3	45.110 to 45.161 mm. (1.776 to 1.778 in.)
Tappet bore diameter	14.275 to 14.307 mm. (0.562 to 0.56325 in.)
Cylinder liner protrusion	—0.025 to +0.076 mm. (—0.001 to +0.003 in.)

PISTONS, PINS AND RINGS

Height of piston crown above cylinder block at T.D.C.	0.216 to 0.305 mm. (0.085 to 0.012 in.)
Piston pin diameter	23.811 to 23.816 mm. (0.9375 to 0.9377 in.)
Top compression ring groove width	2.03 to 2.06 mm. (0.0801 to 0.0811 in.)
Top compression ring width	1.96 to 1.974 mm. (0.0871 to 0.0781 in.)
2nd and 3rd compression ring groove width	1.638 to 1.664 mm. (0.0645 to 0.0655 in.)
2nd and 3rd compression ring width	1.562 to 1.587 mm. (0.0615 to 0.0625 in.)
Oil control ring groove width	4.826 to 4.851 mm. (0.190 to 0.191 in.)
Oil control ring width	4.737 to 4.762 mm. (0.1865 to 0.1875 in.)
Top compression ring gap	0.305 to 0.432 mm. (0.012 to 0.017 in.)
2nd and 3rd compression ring gap	0.229 to 0.381 mm. (0.009 to 0.015 in.)
Oil control ring gap	0.229 to 0.381 mm. (0.009 to 0.015 in.)

CONNECTING ROD

Big end bore	54.508 to 54.521 mm. (2.146 to 2.1465 in.)
Big end bearing liner bore (std.)	50.838 to 50.863 mm. (2.0015 to 2.0025 in.)
Small end bush bore (ream bushes to suit individual piston pins)	23.828 to 23.844 mm. (0.9382 to 0.93875 in.)

CRANKSHAFT

Main journal diameter (std.)	57.099 to 57.112 mm. (2.248 to 2.2485 in.)
Main journal diameter 0.254 mm. (0.010 in.) U/S	56.845 to 56.858 mm. (2.238 to 2.2385 in.)
Main journal diameter 0.508 mm. (0.020 in.) U/S	56.591 to 65.604 mm. (2.228 to 2.2285 in.)
Main journal diameter 0.762 mm. (0.030 in.) U/S	56.337 to 56.350 mm. (2.218 to 2.2185 in.)
Front main journal width	49.592 to 50.393 mm. (1.39125 to 1.43125 in.)
Centre main journal width	37.968 to 38.202 mm. (1.496 to 1.504 in.)
Rear main journal width	38.075 to 38.125 mm. (1.499 to 1.501 in.) After re-grinding 38.506 mm. (1.516 in.) max.
Main journal fillet radius	3.175 to 3.572 mm. ($\frac{1}{8}$ to $\frac{9}{64}$ in.)
Crankpin diameter (std.)	50.787 to 50.80 mm. (1.9995 to 2.000 in.)
Crankpin diameter 0.254 mm. (0.010 in.) U/S	50.533 to 50.546 mm. (1.9895 to 1.990 in.)
Crankpin diameter 0.508 mm. (0.020 in.) U/S	50.279 to 50.292 mm. (1.9795 to 1.980 in.)
Crankpin diameter 0.762 mm. (0.030 in.) U/S	50.025 to 50.038 mm. (1.9695 to 1.970 in.)
Crankpin width	30.162 to 30.213 mm. (1.1875 to 1.1895 in.) After re-grinding 30.594 mm. (1.2045 in.) max.
Crankpin fillet radius	3.97 to 4.37 mm. ($\frac{5}{32}$ to $\frac{11}{64}$ in.)
Crankshaft end-float	0.051 to 0.36 mm. (0.002 to 0.014 in.)
Standard thrust washer thickness	2.311 to 2.362 mm. (0.091 to 0.093 in.)
Oversize thrust washer thickness	2.502 to 2.553 mm. (0.0985 to 0.1005 in.)

CAMSHAFT AND TIMING GEARS

Front journal diameter	45.49 to 45.52 mm. (1.791 to 1.792 in.)
Centre journal diameter	45.24 to 45.26 mm. (1.781 to 1.782 in.)
Rear journal diameter	44.03 to 45.06 mm. (1.773 to 1.774 in.)
Cam lift	6.60 to 6.76 mm. (0.260 to 0.266 in.)
Timing gear backlash between crankshaft, idler and camshaft gears	0.038 to 0.076 mm. (0.0015 to 0.003 in.)

VALVES AND GUIDES

Inlet valve stem diameter	7.924 to 7.950 mm. (0.312 to 0.313 in.)
Exhaust valve stem diameter	7.912 to 7.937 mm. (0.3115 to 0.3125 in.)
Inlet valve head clearance below cylinder head face	0.711 to 1.22 mm. (0.028 to 0.048 in.)
Exhaust valve head clearance below cylinder head face	0.523 to 1.22 mm. (0.021 to 0.048 in.)
Valve guide bore diameter	7.976 to 8.012 mm. (0.314 to 0.3155 in.)

ROCKER SHAFT

Rocker bush bore diameter	15.862 to 15.894 mm. (0.6245 to 0.62575 in.)
Rocker shaft diameter	15.805 to 15.843 mm. (0.62225 to 0.62375 in.)

TAPPETS

Tappet shank diameter	14.224 to 14.249 mm. (0.560 to 0.561 in.)

FLYWHEEL

Run-out at 101.6 mm. (4 in.) radius on clutch face	0.102 mm. (0.004 in.) T.I.R. max.
Run-out periphery	0.305 mm. (0.012 in.) T.I.R. max.

OIL PUMP

Housing (diameter of pocket)	40.72 to 40.74 mm. (1.603 to 1.604 in.)
Housing (depth of pocket)	34.92 to 34.95 mm. (1.375 to 1.376 in.)
Housing (bore diameter for shaft)	12.70 to 12.73 mm. (0.500 to 0.501 in.)
Shaft diameter	12.656 to 12.664 mm. (0.4983 to 0.4986 in.)
Driving gear to housing	0.787 to 1.194 mm. (0.031 to 0.047 in.)

4/108 DIESEL ENGINE

Bore	79.375 mm. (3.125 in.)
Stroke	88.9 mm. (3.5 in.)
Number of cylinders	4
Capacity	1760 c.c. (107.4 cu. in.)
Compression ratio	22 : 1
Firing order	1, 3, 4, 2
Maximum b.h.p.	52 at 4,000 rev./min.
Maximum torque	10.92 kg.m. (79 lb. ft.)
Valve clearance (hot)	0.25 mm. (0.010 in.)
Valve seat and face angle	45°
Cam lift	6.6 mm. (0.26 in.)
Sump capacity	5.0 litres (10.5 U.S. pints, 8.75 Imp. pints)
Filter capacity	1.02 litres (2.16 U.S. pints, 1.8 Imp. pints)
Oil pressure (nominal)	2.8123 kg./sq. cm. (40 lb./sq. in.)
Injection pressure	Setting 150 atmospheres Working 135 atmospheres

TIGHTENING TORQUES

Cylinder head nuts	7.6 to 8.3 kg.m. (55 to 60 lb. ft.)
Connecting rod bolts	5.0 to 5.2 kg.m. (36 to 38 lb. ft.)
Main bearing bolts	10.9 to 11.75 kg.m. (79 to 85 lb. ft.)
Flywheel bolts	7.6 to 8.3 kg.m. (55 to 60 lb. ft.)
Idler gear set-screws	4.56 to 4.98 kg.m. (33 to 36 lb. ft.)
Crankshaft pulley retaining bolt	19.35 to 20.73 kg.m. (104 to 105 lb. ft.)
Injector securing nuts	1.38 to 1.66 kg.m. (10 to 12 lb. ft.)
Rocker shaft pedestal nuts	1.66 to 2.08 kg.m. (12 to 15 lb. ft.)

CYLINDER BLOCK

Total height of cylinder block between top and bottom faces	252.374 to 252.451 mm. (9.936 to 9.939 in.)
Parent bore diameter for cylinder liner (cast iron)	82.525 to 82.550 mm. (3.249 to 3.250 in.)
Main bearing parent bore diameter	60.833 to 60.846 mm. (2.3950 to 2.3955 in.)
Camshaft bore diameter No. 1	45.568 to 45.606 mm. (1.794 to 1.7955 in.)
Camshaft bore diameter No. 2	44.314 to 45.390 mm. (1.784 to 1.787 in.)
Camshaft bore diameter No. 3	45.110 to 45.161 mm. (1.776 to 1.778 in.)
Tappet bore diameter	14.275 to 14.307 mm. (0.562 to 0.56325 in.)
Fuel pump drive hub bearing bore diameter	46.037 to 46.078 mm. (1.8125 to 1.8141 in.)

CYLINDER LINER (Cast Iron)

Type	Dry—interference fit
Interference fit of liner	0.076 to 0.127 mm. (0.003 to 0.005 in.)
Inside diameter of liner after finish boring and honing	79.375 to 79.400 mm. (3.125 to 3.126 in.)
Height of liner in relation to cylinder block top face	0.584 to 0.686 mm. (0.023 to 0.027 in.) ABOVE
Overall length of liner	164.973 to 165.227 mm. (6.495 to 6.505 in.)

PISTONS

Type	Flat topped
Overall height (skirt to crown)	79.934 to 80.010 mm. (3.147 to 3.150 in.)
Centre line of gudgeon pin to piston skirt	29.388 mm. (1.157 in.)
Piston to bore clearance (cold)	0.127 to 0.152 mm. (0.005 to 0.006 in.)
Piston height in relation to cylinder block top face	0.051 to 0.152 mm. (0.002 to 0.006 in.) ABOVE
Bore diameter for gudgeon pin	26.989 to 26.994 mm. (1.06255 to 1.06275 in.)
Compression ring groove width—top	2.807 to 2.832 mm. (0.1105 to 0.1115 in.)
Compression ring groove width—second	1.638 to 1.664 mm. (0.0645 to 0.0655 in.)
Compression ring groove width—third	1.638 to 1.664 mm. (0.0645 to 0.0655 in.)
Oil control ring groove width—Fourth	3.200 to 3.225 mm. (0.126 to 0.127 in.)
Oil control ring groove width—Fifth	4.826 to 4.851 mm. (0.190 to 0.191 in.)

Note: There is a 0.762 mm. (0.030 in.) × 3.759 to 3.861 mm. (0.140 to 0.152 in.) Steel insert fitted into the top groove and located immediately above the top compression ring.

PISTON RINGS

Top—compression	Parallel faced
Second and third—compression	Internally stepped
Fourth—oil control	Laminated segment
Fifth—oil control	Slotted groove
Top compression ring width	1.958 to 1.984 mm. (0.0771 to 0.0781 in.)
Ring clearance in groove	0.061 to 0.112 mm. (0.0024 to 0.0044 in.)
Second and third compression ring width	1.562 to 1.587 mm. (0.0615 to 0.0625 in.)
Ring clearance in groove	0.051 to 0.102 mm. (0.002 to 0.004 in.)
Fifth scraper ring width	4.737 to 4.762 mm. (0.1865 to 0.1875 in.)
Ring clearance in groove	0.063 to 0.114 mm. (0.0025 to 0.0045 in.)
Ring gap—top compression	0.229 to 0.381 mm. (0.009 to 0.015 in.)
Ring gap—second and third compression	0.229 to 0.356 mm. (0.009 to 0.014 in.)
Ring gap—fourth scraper	0.305 to 0.432 mm. (0.012 to 0.017 in.)
Ring gap—fifth scraper	0.229 to 0.356 mm. (0.009 to 0.014 in.)

GUDGEON PIN

Type	Fully floating
Outside diameter of gudgeon pin	26.987 to 26.993 mm. (1.0625 to 1.0627 in.)
Length of gudgeon pin	67.894 to 68.250 mm. (2.673 to 2.687 in.)
Fit in piston boss	Transition

SMALL END BUSH

Type	Steel backed, lead-bronze lined
Length of small end bush	23.749 to 24.257 mm. (0.940 to 0.950 in.)
Outside diameter of small end bush	31.013 to 31.039 mm. (1.221 to 1.2225 in.)
Inside diameter before reaming	26.657 to 26.784 mm. (1.0495 to 1.0545 in.)
Inside diameter after reaming	27.005 to 27.019 mm. (1.0632 to 1.06375 in.)
Clearance between small end bush and gudgeon pin	0.0127 to 0.0318 mm. (0.0005 to 0.00125 in.)

CONNECTING ROD

Type	'H' section
Cap location to connecting rod	Serrations, offset 45° to the horizontal
Big end parent bore diameter	54.508 to 54.521 mm. (2.146 to 2.1465 in.)
Small end parent bore diameter	30.956 to 30.982 mm. (1.21875 to 1.21975 in.)
Length from centre line of big end to centre line of small end	157.912 to 157.963 mm. (6.217 to 6.219 in.)
Big end set-screw	0.375 in. (⅜ in.) U.N.F.

CRANKSHAFT

Overall length	536.575 mm. (21.125 in.)
Main journal diameter Nos. 1 and 2	57.099 to 57.112 mm. (2.248 to 2.2485 in.)
Main journal diameter No. 3	57.086 to 57.099 mm. (2.2475 to 2.248 in.)
Main journal length No. 1	35.719 mm. (1.40625 in.)
Main journal length No. 2	37.998 to 38.202 mm. (1.496 to 1.504 in.)
Main journal length No. 3	38.075 to 38.151 mm. (1.499 to 1.502 in.)
Main journal fillet radii	3.175 to 3.581 mm. (0.125 to 0.141 in.)
Crankpin diameters	50.787 to 50.800 mm. (1.9995 to 2.000 in.)

Crankpin lengths	30.162 to 30.213 mm. (1.1875 to 1.1895 in.)
Crankpin fillet radii	3.969 to 4.366 mm. (0.15625 to 0.17187 in.)
Surface finish—all journals	0.2 to 0.4 micron (8 to 16 micro-in.)
Main journal and crankpin regrind undersizes	0.25, 0.51, 0.76 mm. (0.010, 0.020, 0.030 in.)
Oil seal helix diameter	56.153 to 56.178 mm. (2.21075 to 2.21175 in.)
Oil seal helix width	1.270 to 2.032 mm. (0.050 to 0.080 in.)
Oil seal helix depth	0.102 to 0.203 mm. (0.004 to 0.008 in.)
Flange diameter	101.562 to 101.587 mm. (3.9985 to 3.9995 in.)
Flange width	12.700 mm. (0.500 in.)
Spigot bearing recess depth	22.225 mm. (0.875 in.)
Spigot bearing recess bore	31.750 mm. (1.250 in.)
Crankshaft end-float	0.0508 to 0.381 mm. (0.002 to 0.016 in.)

CRANKSHAFT THRUST WASHERS

Type	Steel backed—Lead-bronze faced
Position in engine	Rear main bearing
Thrust washer thickness (std.)	2.261 to 2.311 mm. (0.089 to 0.091 in.)
Thrust washer thickness (o/s)	2.451 to 2.553 mm. (0.0965 to 0.1005 in.)
Thrust washer outside diameter	82.423 to 82.677 mm. (3.245 to 3.255 in.)
Thrust washer inside diameter	65.786 to 66.040 mm. (2.590 to 2.600 in.)

MAIN BEARINGS

Type	Pre-finished, steel backed, aluminium-tin lined
Shell width	31.623 to 31.877 mm. (1.245 to 1.255 in.)
Outside diameter of main bearing	60.846 mm. (2.3955 in.)
Inside diameter of main bearing	57.163 to 57.188 mm. (2.2505 to 2.2515 in.)
Running clearance—Nos. 1 and 2	0.051 to 0.089 mm. (0.002 to 0.0035 in.)
Running clearance—No. 3	0.038 to 0.102 mm. (0.0015 to 0.004 in.)

CONNECTING ROD BEARINGS

Type	Pre-finished, steel backed, aluminium-tin lined
Shell width	22.098 to 22.352 mm. (0.870 to 0.880 in.)
Outside diameter of connecting rod bearing	54.521 mm. (2.1465 in.)
Inside diameter of connecting rod bearing	50.838 to 50.863 mm. (2.0015 to 2.0025 in.)
Running clearance	0.038 to 0.076 mm. (0.0015 to 0.003 in.)

CAMSHAFT

No. 1 journal length	34.214 to 34.315 mm. (1.347 to 1.351 in.)
No. 1 journal diameter	45.491 to 45.517 mm. (1.791 to 1.792 in.)
No. 2 cylinder block camshaft bore diameter	45.568 to 45.606 mm. (1.794 to 1.7955 in.)
No. 1 journal running clearance	0.051 to 0.114 mm. (0.002 to 0.0045 in.)
No. 2 journal length	31.750 mm. (1.250 in.)
No. 2 journal diameter	45.237 to 45.263 mm. (1.781 to 1.782 in.)
No. 2 cylinder block camshaft bore diameter	45.314 to 45.390 mm. (1.784 to 1.787 in.)
No. 2 journal running clearance	0.051 to 0.152 mm. (0.002 to 0.006 in.)
No. 3 journal length	25.400 mm. (1.000 in.)
No. 3 journal diameter	45.034 to 45.060 mm. (1.773 to 1.774 in.)
No. 3 cylinder block camshaft bore diameter	45.110 to 45.161 mm. (1.776 to 1.778 in.)
No. 3 journal running clearance	0.051 to 0.127 mm. (0.002 to 0.005 in.)
Cam lift	6.766 mm. (0.266 in.)
Oilways for rocker shaft lubrication	No. 2 journal

CAMSHAFT THRUST PLATES

Type	180° oil impregnated sintered iron
Thrust plate outside diameter	64.897 to 64.948 mm. (2.555 to 2.557 in.)
Cylinder block recess diameter for thrust plate	64.986 to 65.240 mm. (2.5585 to 2.5685 in.)
Clearance fit of thrust plate in recess	0.038 to 0.348 mm. (0.0015 to 0.0135 in.)
Thrust plate inside diameter	38.100 mm. (1.500 in.)
Thrust plate thickness	4.060 to 4.115 mm. (0.160 to 0.162 in.)
Cylinder block recess depth for thrust plate	4.009 to 4.166 mm. (0.158 to 0.164 in.)
Thrust plate height in relation to cylinder block face	0.102 mm. (0.004 in.) above or below
Camshaft end-float	0.076 to 0.228 mm. (0.003 to 0.009 in.)

CYLINDER HEAD

Overall length of cylinder head	508.000 mm. (20.000 in.)
Overall depth of cylinder head	66.472 to 66.878 mm. (2.617 to 2.633 in.)
Pressure for water leakage test	1.4 kg./cm.² (20 lb./in.²)
Valve seat angle	45°
Bore in cylinder head for guide	12.687 to 12.713 mm. (0.4995 to 0.5005 in.)
Bore in cylinder head for combustion chamber inserts	31.750 to 31.801 mm. (1.250 to 1.252 in.)
Depth of bore in cylinder head for combustion chamber inserts	9.474 to 9.550 mm. (0.373 to 0.376 in.)

COMBUSTION CHAMBER INSERTS

Outside diameter of insert	31.699 to 31.724 mm. (1.248 to 1.249 in.)
Length of insert	9.499 to 9.525 mm. (0.374 to 0.375 in.)
Height of insert in relation to cylinder head face	0.051 mm. (0.002 in.) above or below
Clearance fit of insert in cylinder head bore	0.025 to 0.102 mm. (0.001 to 0.004 in.)
Method of location in cylinder head	By cylinder block face and expansion washer

VALVE GUIDES (Inlet)

Inside diameter	7.988 to 8.014 mm. (0.3145 to 0.3155 in.)
Outside diameter	12.744 to 12.757 mm. (0.50125 to 0.50175 in.)
Interference fit of guide in cylinder head bore	0.019 to 0.057 mm. (0.00075 to 0.00225 in.)
Overall length of guide	54.102 mm. (2.130 in.)
Guide protrusion above top face of cylinder head	20.320 to 20.701 mm. (0.800 to 0.815 in.)

VALVE GUIDES (Exhaust)

Inside diameter	7.988 to 8.014 mm. (0.3145 to 0.3155 in.)
Outside diameter	12.744 to 12.757 mm. (0.50125 to 0.50175 in.)
Interference fit of guide in cylinder head bore	0.019 to 0.057 mm. (0.00075 to 0.00225 in.)
Depth of counterbore	9.650 mm. (0.380 in.)
Overall length of guide	61.980 mm. (2.440 in.)
Guide protrusion above top face of cylinder head	20.320 to 20.701 mm. (0.800 to 0.815 in.)

VALVES (Inlet)

Valve stem diameter	7.925 to 7.950 mm. (0.312 to 0.313 in.)
Clearance fit of valve stem in guide	0.038 to 0.089 mm. (0.0015 to 0.0035 in.)
Valve head diameter	35.814 to 35.916 mm. (1.410 to 1.414 in.)
Valve face angle	45°
Valve head depth below cylinder head face	0.711 mm. (0.028 in.) minimum 0.991 mm. (0.039 in.) maximum
Overall length of valve	116.637 to 117.043 mm. (4.592 to 4.608 in.)
Sealing arrangement	Rubber oil seal

VALVES (Exhaust)

Valve stem diameter	7.912 to 7.937 mm. (0.3115 to 0.3125 in.)
Clearance fit of valve stem in guide	0.051 to 0.102 mm. (0.002 to 0.004 in.)
Valve head diameter	30.251 to 30.353 mm. (1.191 to 1.195 in.)
Valve face angle	45°
Valve head depth below cylinder head face	0.53 mm. (0.021 in.) minimum 0.813 mm. (0.032 in.) maximum
Overall length of valve	116.840 to 117.246 mm. (4.600 to 4.616 in.)
Sealing arrangement	None fitted to exhaust valve

INNER VALVE SPRINGS

Fitted length	38.862 mm. (1.530 in.)
Load at fitted length	13.0 kg. ± 0.91 kg. (28.6 lb. ± 2 lb.)
Fitted position	Damper coil to cylinder head

OUTER VALVE SPRINGS

Fitted length	45.212 mm. (1.780 in.)
Load at fitted length	25.4 kg. ± 1.27 kg. (56.0 lb. ± 2.8 lb.)
Fitted position	Damper coil to cylinder head

ROCKER LEVERS

Length between centre line of adjusting screw and centre line of rocker shaft	26.467 to 26.873 mm. (1.042 to 1.058 in.)
Length between centre line of rocker lever pad and centre line of rocker shaft	39.802 to 40.208 mm. (1.567 to 1.583 in.)
Inside diameter of rocker lever bore	18.237 to 18.275 mm. (0.7180 to 0.7195 in.)
Outside diameter of rocker lever bush	18.275 to 18.243 mm. (0.7195 to 0.71825 in.)
Transition fit of bush in rocker lever	0.038 to 0.032 mm. (0.0015 to 0.00125 in.)
Finished inside diameter of rocker lever bush	15.862 to 15.894 mm. (0.6245 to 0.62575 in.)
Clearance of rocker lever bush on rocker shaft	0.019 to 0.089 mm. (0.00075 to 0.0035 in.)

VALVE CLEARANCES

Clearance between valve stem tip and rocker lever	0.25 mm. (0.010 in.) hot 0.30 mm. (0.012 in.) cold

ROCKER SHAFT

Overall length of shaft	369.887 mm. (14.5625 in.)
Outside diameter of shaft	15.805 to 15.843 mm. (0.62225 to 0.62375 in.)
Lubrication	Oil feed from cylinder head through central passage to individual rocker levers

PUSH RODS

Overall length	216.12 to 217.01 mm. (8.5085 to 8.5435 in.)
Outside diameter	6.350 mm. (0.250 in.)

TAPPETS

Overall length	57.150 mm. (2.250 in.)
Outside diameter of tappet shank	14.224 to 14.249 mm. (0.560 to 0.561 in.)
Cylinder block tappet bore diameter	14.275 to 14.307 mm. (0.562 to 0.56325 in.)
Tappet running clearance in cylinder block bore	0.025 to 0.082 mm. (0.001 to 0.00325 in.)
Outside diameter of tappet foot	38.075 to 38.125 mm. (1.245 to 1.255 in.)

TIMING GEARS

CAMSHAFT GEAR

Number of teeth	48
Inside diameter of gear boss	44.450 to 44.476 mm. (1.750 to 1.751 in.)
Outside diameter of camshaft hub	44.430 to 44.458 mm. (1.7496 to 1.7503 in.)
Transition fit of gear on hub	0.008 to 0.036 mm. (0.0003 to 0.0014 in.)

FUEL PUMP GEAR

Number of teeth	48
Inside diameter of cylinder block bore for fuel pump drive hub bearing	46.037 to 46.078 mm. (1.8125 to 1.8141 in.)
Outside diameter of fuel pump drive hub bearing	46.088 to 46.106 mm. (1.8145 to 1.8152 in.)
Interference fit of drive hub bearing in cylinder block bore	0.010 to 0.069 mm. (0.0004 to 0.0027 in.)
Inside diameter of fuel pump drive hub bearing	33.35 to 33.41 mm. (1.313 to 1.314 in.)
Outside diameter of fuel pump gear drive hub	33.274 to 33.299 mm. (1.310 to 1.311 in.)
Running clearance of drive hub in bearing	0.051 to 0.102 mm. (0.002 to 0.004 in.)
Drive hub end-float	0.127 to 0.203 mm. (0.005 to 0.008 in.)

IDLER GEAR AND HUB

Number of teeth	57
Inside diameter of gear boss	43.655 to 43.680 mm. (1.7187 to 1.7197 in.)
Inside diameter of gear boss with bush fitted	39.682 to 39.708 mm. (1.5627 to 1.5633 in.)
Outside diameter of gear hub	39.654 to 39.668 mm. (1.5612 to 1.5619 in.)
Running clearance of gear on hub	0.0203 to 0.0533 mm. (0.0008 to 0.0021 in.)
Idler gear width	33.287 to 33.363 mm. (1.3105 to 1.3135 in.)
Hub width	33.439 to 33.490 mm. (1.3165 to 1.3185 in.)
Idler gear end-float	0.076 to 0.203 mm. (0.003 to 0.008 in.)

CRANKSHAFT GEAR

Number of teeth	24
Inside diameter of gear	31.750 to 31.780 mm. (1.250 to 1.2512 in.)
Crankshaft diameter for gear	31.750 to 31.765 mm. (1.250 to 1.2506 in.)
Transition fit of gear on crankshaft	0.015 to 0.030 mm. (0.0006 to 0.0012 in.)

TIMING GEAR BACKLASH

Clearance between crankshaft/idler and camshaft/idler gears
0.038 to 0.064 mm. (0.0015 to 0.0025 in.)

LUBRICATION SYSTEM

Lubricating oil pressure .. .. 2.1 to 4.2 kg./cm.² (30 to 60 lb./in.²) at normal working speed and temperature

SUMP

Dipstick position	Camshaft side of engine opposite No. 2 cylinder
Strainer location	End of suction pipe to lubricating oil pump
Capacity	5.0 litres (10.5 U.S. pints, 8.75 Imp. pints)

LUBRICATING OIL PUMP

Type	Rotor type
Number of lobes—inner rotor	4
No. of lobes—outer rotor	5
Method of drive	By spiral gears from the camshaft

PUMP CLEARANCES

Inner rotor to outer rotor	0.152 mm. (0.006 in.) maximum
Outer rotor to pump body	0.140 to 0.254 mm. (0.0055 to 0.010 in.)
Top of rotor to surface of pump body	0.025 to 0.127 mm. (0.001 to 0.005 in.)
Inside diameter of bore for pump shaft	12.700 to 12.725 mm. (0.500 to 0.501 in.)
Outside diameter of pump shaft	12.655 to 12.664 mm. (0.4983 to 0.4986 in.)
Running clearance of shaft in bore	0.036 to 0.069 mm. (0.0014 to 0.0027 in.)
Lubricating oil pump drive gear backlash	0.394 to 0.483 mm. (0.0155 to 0.019 in.)

LUBRICATING OIL PUMP

Minimum delivery rate at 800 pump rev./min. 2.81 kgf./cm.² (40 lbf./in.²)
9.1 litre/min. (2.4 U.S. gall./min. or 2.0 Imp. gall./min.)

LUBRICATING OIL PUMP DRIVE GEAR

Number of teeth	12
Inside diameter of gear bore	12.611 to 12.624 mm. (0.4965 to 0.4970 in.)
Outside diameter of oil pump drive shaft	12.655 to 12.664 mm. (0.4983 to 0.4986 in.)
Interference fit of gear on shaft	0.033 to 0.053 mm. (0.0013 to 0.0021 in.)

RELIEF VALVE

Type	Spring loaded plunger
Pressure setting	3.5 to 4.6 kg./cm.² (50 to 65 lb./in.²)
Length of plunger	13.99 to 14.15 mm. (0.551 to 0.557 in.)
Outside diameter of plunger	14.19 to 14.21 mm. (0.5585 to 0.5595 in.)
Inside diameter of valve housing bore	14.24 to 14.29 mm. (0.5605 to 0.5625 in.)
Clearance of plunger in bore	0.025 to 0.102 mm. (0.001 to 0.004 in.)
Outside diameter of spring	9.881 to 10.287 mm. (0.389 to 0.405 in.)
Spring—free length	39.688 mm. (1.5625 in.)
Spring—solid length	20.63 mm. (0.812 in.)

LUBRICATING OIL FILTER

Type	Full flow
Element type	Paper
By-pass valve setting	Opens between 0.91 to 1.2 kg./cm.² (13 to 17 lb./in.²) pressure differential
Type of valve	Spring loaded ball

GEARBOX

MANUAL GEARBOX

RATIOS

First	4.412 : 1
Second	2.353 : 1
Third	1.505 : 1
Fourth	1 : 1
Reverse	4.667 : 1

MAIN DRIVE GEAR

Number of teeth	17
I.D. gear end	30.712 to 30.729 mm. (1.2091 to 1.2098 in.)
Main shaft pilot end diameter (Prior to April 1966)	21.154 to 21.166 mm. (0.8329 to 0.8334 in.)
Main shaft pilot end diameter (After April 1966)	14.978 to 14.989 mm. (0.5897 to 0.5901 in.)

COUNTERSHAFT GEAR

Number of teeth	35 26 21 15 Reverse 14
End-float	0.203 to 0.508 mm. (0.008 to 0.020 in.)
Bore diameter (for rollers)	25.7114 to 25.7366 mm. (1.01225 to 1.01325 in.)
Rear thrust washer, thickness	1.549 to 1.600 mm. (0.061 to 0.063 in.)
Front thrust washer, thickness	2.362 to 2.431 mm. (0.093 to 0.095 in.)
Number of rollers	44
Countershaft diameter	19.325 to 19.338 mm. (0.7610 to 0.7615 in.)

FIRST GEAR

End-float	0.254 to 0.432 mm. (0.010 to 0.017 in.)
Internal diameter (Prior to April 1966)	39.429 to 39.446 mm. (1.5523 to 1.5530 in.)
Internal diameter (After April 1966)	37.643 to 37.668 mm. (1.482 to 1.483 in.)
Number of teeth	30

FIRST GEAR BUSH (Prior to April 1966 only)

Internal diameter	32.009 to 32.034 mm. (1.2602 to 1.2612 in.)
External diameter	39.370 to 39.383 mm. (1.5500 to 1.5505 in.)

SECOND GEAR

End-float	0.127 to 0.229 mm. (0.005 to 0.009 in.)
Internal diameter (Prior to April 1966)	39.421 to 39.446 mm. (1.552 to 1.553 in.)
Internal diameter (After April 1966)	45.008 to 45.034 mm. (1.772 to 1.773 in.)
Number of teeth	24

THIRD GEAR

End-float	0.127 to 0.406 mm. (0.005 to 0.016 in.)
Internal diameter	39.421 to 39.446 mm. (1.552 to 1.553 in.)
Number of teeth	19

REVERSE MAINSHAFT GEAR
(First and Second Gear Synchroniser Sleeve)

Number of teeth	34

REVERSE IDLER GEAR

Internal diameter	19.050 to 19.070 mm. (0.7500 to 0.7508 in.)
Shaft diameter	18.961 to 18.973 mm. (0.7465 to 0.7470 in.)
Number of teeth	17

LUBRICANT

Grade	S.A.E. 80 E.P.
Capacity	2.6 litres (5.4 U.S. pints, 4.5 Imp. pints)
Additive	4 oz. (Part No. ESET-M996C-1004-A)

TORQUE FIGURES

Extension housing to transmission case	5.5 to 6.2 kg.m. (40 to 45 lb. ft.)
Transmission drive flange retaining nut (where fitted)	5.5 to 6.9 kg.m. (40 to 50 lb. ft.)
Drive flange insert	4.8 to 5.5 kg.m. (35 to 45 lb. ft.)
Selector housing to transmission case bolts	1.7 to 2.1 kg.m. (12 to 15 lb. ft.)
Main drive gear bearing retainer to transmission case bolts	1.7 to 2.1 kg.m. (12 to 15 lb. ft.)
Clutch housing to transmission case bolts	5.5 to 6.2 kg.m. (40 to 45 lb. ft.)

CLUTCH

Type	Single dry plate, diaphragm spring
Actuation	Mechanical
Clutch disc lining outside diameter	21.59 cm. (8.50 in.)
Pressure plate diameter	21.59 cm. (8.50 in.)

TIGHTENING TORQUES

Pressure plate to flywheel bolts	1.6 to 2.0 kg.m. (12 to 15 lb. ft.)

AUTOMATIC GEARBOX

GEAR RATIOS

First	2.393 : 1
Second	1.450 : 1
Third	1.000 : 1
Reverse	2.094 : 1
Lubricant	M-2C-33F
Capacity (including Converter)	6.39 litres (13.5 U.S. pints, 11¼ pints)
Gear train end-float	0.254 to 0.762 mm. (0.010 to 0.030 in.)

TORQUE FIGURES

Transmission case to converter housing	1.1 to 1.4 kg.m. (8 to 10 lb. ft.)
Extension housing to transmission case	1.1 to 1.4 kg.m. (8 to 10 lb. ft.)
Gearbox sump	1.1 to 1.4 kg.m. (8 to 10 lb. ft.)
Front servo to transmission case	1.1 to 1.4 kg.m. (8 to 10 lb. ft.)
Rear servo to transmission case	1.4 to 1.8 kg.m. (10 to 13 lb. ft.)
Pump adaptor to front pump housing (set-screw)	0.3 to 0.4 kg.m. (24 to 36 lb. in.)
($\frac{5}{16}$ in. bolt)	2.4 to 3.1 kg.m. (17 to 22 lb. ft.)
Pump adaptor to transmission case	1.1 to 1.2 kg.m. (8 to 8.5 lb. ft.)
Rear adaptor to transmission case (¼ in. bolt)	0.55 to 0.7 kg.m. (4 to 5 lb. ft.)
(set-screw)	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Centre support to transmission case	1.4 to 1.8 kg.m. (10 to 13 lb. ft.)
Outer lever to manual valve shaft	0.83 to 0.97 kg.m. (6 to 7 lb. ft.)
Pressure point (use sealer)	0.55 to 0.7 kg.m. (4 to 5 lb. ft.)
Gearbox drain plug	1.4 to 1.9 kg.m. (10 to 14 lb. ft.)
Oil tube collector to lower body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Governor line plate to lower body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Lower body end plate to lower body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Upper body front or rear end plate to upper body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Upper body to lower body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Valve bodies assembly to transmission case	0.55 to 0.7 kg.m. (4 to 5 lb. ft.)
Front pump strainer to lower body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Downshift valve cam bracket to valve body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Governor body to sleeve	0.55 to 0.7 kg.m. (4 to 5 lb. ft.)
Governor cover plate to governor body	0.24 to 0.35 kg.m. (20 to 30 lb. in.)
Front servo lever adjusting screw locknut	2.1 to 2.8 kg.m. (15 to 20 lb. ft.)
Rear servo adjusting screw locknut	3.5 to 4.14 kg.m. (25 to 30 lb. ft.)
Starter inhibitor switch locknut	0.55 to 0.83 kg.m. (4 to 6 lb. ft.)
Downshift valve control cable adaptor to case	1.1 to 1.24 kg.m. (8 to 9 lb. ft.)
Filler tube connector adaptor to case	1.4 to 4.1 kg.m. (10 to 30 lb. ft.)
Filler tube to connector sleeve nut	2.34 to 2.5 kg.m. (17 to 18 lb. ft.)
Stone guards to converter housing	0.19 to 0.22 kg.m. (1.4 to 1.6 lb. ft.)
Drive plate to torque converter	3.5 to 4.14 kg.m. (25 to 30 lb. ft.)
Transmission drive flange retaining nut	6.3 to 7.7 kg.m. (45 to 55 lb. ft.)

COOLING SYSTEM

COOLANT CAPACITY

Petrol	7.1 litres (15 U.S. pints, 12.5 pints)
Petrol (with heater)	8.1 litres (17.1 U.S. pints, 14.25 pints)
Diesel	6.5 litres (13.8 U.S. pints, 11.5 pints)
Diesel (with heater)	7.7 litres (16.2 U.S. pints, 13.5 pints)

THERMOSTAT

Petrol

Type	Wax capsule
Opening temperature	85 to 88° C. (185 to 190° F.)
Fully open at	100° C. (212° F.)

Diesel

Type	Wax capsule
Opening temperature	79.5 to 83.5° C. (175 to 182° F.)
Fully open at	93.5 to 96° C. (200 to 205° F.)

PRESSURE CAP

Operates at	0.49 kg./cm.^{2} (7 lb./in.^{2}) Diesel 0.91 kg./cm.^{2} (13 lb./in.^{2}) Petrol

WATER PUMP

Type	Centrifugal—belt driven from crankshaft pulley

Petrol

Outside diameter of shaft for pulley	12.725 to 12.738 mm. (0.5010 to 0.5015 in.)
Inside diameter of pulley bore	12.675 to 12.7 mm. (0.499 to 0.500 in.)
Interference fit of pulley on shaft	0.025 to 0.0630 mm. (0.0010 to 0.0025 in.)
Outside diameter of shaft for impeller	12.725 to 12.738 mm. (0.5010 to 0.5015 in.)
Inside diameter of impeller bore	12.687 to 12.713 mm. (0.4995 to 0.5005 in.)
Interference fit of impel'er on shaft	0.0127 to 0.0508 mm. (0.0005 to 0.002 in.)
Outside diameter of impeller	60.452 mm. (2.38 in.)
Impeller to body clearance	0.508 to 1.016 mm. (0.020 to 0.040 in.)
Seal type	Alumina ceramic faced rubber
Outside diameter of seal	33.528 to 33.452 mm. (1.320 to 1.3170 in.)
Inside diameter of pump housing for seal	33.274 to 33.350 mm. (1.310 to 1.313 in.)
Interference fit of seal in pump housing	25.502 to 25.654 mm. (1.004 to 1.010 in.)
Outside diameter of slinger	13.03 to 13.31 mm. (0.513 to 0.524 in.)
Inside diameter of slinger	12.624 to 12.7 mm. (0.497 to 0.500 in.)
Interference fit of slinger on shaft	0.114 to 0.025 mm. (0.0045 to 0.001 in.)
Inside diameter of seat	12.065 to 12.319 mm. (0.475 to 0.485 in.)
Interference fit of seat on slinger	0.711 to 1.245 mm. (0.028 to 0.049 in.)

Diesel

Outside diameter of shaft for pulley	14.099 to 15.006 mm. (0.5905 to 0.5908 in.)
Inside diameter of pulley bore	14.935 to 14.961 mm. (0.588 to 0.598 in.)
Interference fit of pulley on shaft	0.038 to 0.071 mm. (0.0015 to 0.0028 in.)
Outside diameter of shaft for impeller	12.649 to 12.675 mm. (0.498 to 0.499 in.)
Inside diameter of impeller bore	12.624 to 12.636 mm. (0.497 to 0.4975 in.)
Interference fit of impeller on shaft	0.013 to 0.051 mm. (0.0005 to 0.002 in.)
Outside diameter of impeller	78.588 to 79.375 mm. (3.094 to 3.125 in.)
Impeller to body clearance	0.127 to 0.635 mm. (0.005 to 0.025 in.)
Water pump seal	Synthetic rubber—Carbon faced
Water pump insert	Ceramic faced
Outside diameter of insert	41.250 to 41.263 mm. (1.624 to 1.6245 in.)
Inside diameter of insert bore in water pump housing	41.275 to 41.300 mm. (1.625 to 1.626 in.)

ANTI-FREEZE TABLE

PETROL CAPACITY 7.1 LITRES (15 U.S. PINTS, 12.5 PINTS)

Volume of ESE-M97B18C Anti-freeze in Water	*Coolant remains fluid down to the following temperatures*	*Anti-freeze Quantity Required*	
		With Heater	*Without Heater*
10%	— 4°C (+25°F)	0.9 litres (1.5 pints)	0.7 litres (1.25 pints)
15%	— 7°C (+20°F)	1.1 litres (2.0 pints)	1.0 litres (1.75 pints)
20%	— 9°C (+15°F)	1.7 litres (3.0 pints)	1.4 litres (2.50 pints)
25%	—13°C (+ 9°F)	2.0 litres (3.5 pints)	1.7 litres (3.00 pints)
30%	—16°C (+ 3°F)	2.3 litres (4.0 pints)	2.1 litres (3.75 pints)
40%	—25°C (—13°F)	3.1 litres (5.5 pints)	2.8 litres (5.00 pints)
50%	—37°C (—34°F)	4.0 litres (7.0 pints)	3.6 litres (6.25 pints)

DIESEL CAPACITY 6.5 LITRES (13.8 U.S. PINTS, 11.5 PINTS)

Volume of ESE-M97B18C Anti-freeze in Water	*Coolant remains fluid down to the following temperatures*	*Anti-freeze Quantity Required*	
		With Heater	*Without Heater*
10%	— 4°C (+25°F)	0.9 litres (1.5 pints)	0.7 litres (1.25 pints)
15%	— 7°C (+20°F)	1.1 litres (2.0 pints)	1.0 litres (1.75 pints)
20%	— 9°C (+15°F)	1.6 litres (2.75 pints)	1.3 litres (2.25 pints)
25%	—13°C (+ 9°F)	1.8 litres (3.25 pints)	1.6 litres (2.75 pints)
30%	—16°C (+ 3°F)	2.3 litres (4.0 pints)	2.0 litres (3.50 pints)
40%	—25°C (—13°F)	3.1 litres (5.5 pints)	2.6 litres (4.50 pints)
50%	—37°C (—34°F)	3.8 litres (6.75 pints)	3.3 litres (5.75 pints)

FUEL SYSTEM

PETROL

CARBURETTOR (Prior to May 1967)

Type .. .. Zenith 36 IV Downdraught

	1700 c.c.	2000 c.c.
Venturi diameter	28 mm. (1.11 in.)	29 mm. (1.14 in.)
Main jet	92	102
Slow running jet	55	55
Compensating jet	112	120
Fuel enrichment jet	110	80
Accelerator pump jet	55	55
Part throttle air bleed	2.6	2.6

Alternative jets for use at various altitudes:

MAIN JETS	1700 c.c.	2000 c.c.
0 to 610 m. (zero to 2,000 ft.)	107	102
610 to 1830 m. (2,000 to 6,000 ft.)	105	100
1930 to 3050 m. (6,000 to 10,000 ft.)	100	97

COMPENSATING JETS	1700 c.c.	2000 c.c.
0 to 610 m. (zero to 2,000 ft.)	92	120
610 to 1830 m. (2,000 to 6,000 ft.)	90	117
1830 to 3050 m. (6,000 to 10,000 ft.)	92	117

CARBURETTOR (May 1967 to September 1968)

Type .. .. Ford Single Venturi downdraught with manual or automatic choke, and accelerator pump

	1700 c.c.	2000 c.c.
Manual choke	C7EH-9510-A	C7EH-9510-B
Automatic choke	C6CH-9510-A	C7EH-9510-E
Throttle barrel diameter	36 mm. (1.42 in.)	36 mm. (1.42 in.)
Venturi diameter	28 mm. (1.10 in.)	30 mm. (1.18 in.)
Main jet	140	150
Idling speed	580 to 620 r.p.m.	
Fast idle speed—manual choke	750 to 850 r.p.m.	
—automatic choke	2000 to 2200 r.p.m.	1800 to 2000 r.p.m.
Fast idle setting—manual choke	No. 64 drill 0.9 mm. (0.035 in.)	
—automatic choke	3.8 to 4.3 mm. (0.15 to 0.17 in.)	
Choke plate pull-down—manual choke	2.8 mm. (0.110 in.)	4.0 mm. (0.150 in.)
—automatic choke	4.2 mm. (0.165 in.)	3.4 mm. (0.135 in.)
Accelerator pump stroke	4.5 mm. (0.175 in.)	3.4 mm. (0.135 in.)
Float setting—inverted from casting	28.5 to 29.0 mm. (1.12 to 1.14 in.)	
—upright from casting	35.0 to 35.5 mm. (1.38 to 1.40 in.)	

Alternative main jets for use at various altitudes:

0 to 915 m. (zero to 3,000 ft.)	140	—
915 to 2,135 m. (3,000 ft to 7,000 ft.)	137	—
2,135 to 3,050 m. (7,000 ft. to 10,000 ft.)	132	—
0 to 2,135 m. (zero to 7,000 ft.)	—	150
2,135 to 3,050 m. (7,000 ft. to 10,000 ft.)	—	145

CARBURETTOR (September 1968 onwards)

Type .. Ford Single Venturi downdraught with manual or automatic choke, and accelerator pump

	1700 c.c.	2000 c.c.
Manual choke	C8EH-9510-A	C8EH-9510-B
Automatic choke	C8CH-9510-B	C8EH-9510-C
Throttle barrel diameter	36 mm. (1.42 in.)	36 mm. (1.42 in.)
Venturi diameter	28 mm. (1.10 in.)	30 mm. (1.18 in.)
Main jet	140	150
Idling speed	580 to 620 r.p.m.	
Fast idle speed—manual choke	750 to 850 r.p.m.	
—automatic choke	2000 to 2200 r.p.m.	1800 to 2000 r.p.m.
Fast idle setting—manual choke	No. 64 drill 0.9 mm. (0.035 in.)	
Choke plate pull-down—manual choke	0.100 to 0.120 in.	0.140 to 0.160 in.
—automatic choke	0.155 to 0.175 in.	0.125 to 0.145 in.
Accelerator pump stroke	0.170 to 0.180 in.	0.130 to 0.140 in.
Float setting—inverted from casting	30.75 to 31.24 mm. (1.21 to 1.23 in.)	
—upright from casting	35.81 to 36.32 mm. (1.41 to 1.43 in.)	

CARBURETTOR (Exhaust Emission)	1700 c.c.	2000 c.c.
Manual choke	712W-9510-KA	712W-9510-DA
Throttle barrel diameter	36 mm.	36 mm.
Venturi	28 mm.	28 mm.
Main jet	1.57 mm.	1.65 mm.
Idle speed	700 r.p.m.	700 r.p.m.
Fast idle speed	1600 to 1800 r.p.m.	1550 to 1750 r.p.m.
Fast idle setting	1.20 mm.	1.20 mm.
Pull down	0.140 to 0.160 in.	0.140 to 0.160 in.
Accelerator pump	0.140 to 0.150 in.	0.140 to 0.150 in.
Float setting—inverted	1.21 to 1.23 in.	1.21 to 1.23 in.
—upright	1.41 to 1.43 in.	1.41 to 1.43 in.

FUEL TANK

Capacity— 75—125	42.1 litres (11.1 U.S. gall., 9.25 gall.)
—130—175	68.1 litres (18.0 U.S. gall., 15.0 gall.)

FUEL PUMP

Type	Mechanical
Delivery pressure	0.07 to 0.175 kg./sq. cm. (1 to 2.5 lb./sq. in.)
Inlet depression	21.6 cm. mercury (8.5 in.)
Static pressure (i.e. no flow condition)	0.25 to 0.35 kg./sq. cm. (3.5 to 5.0 lb./sq. in.)

DIESEL

FUEL INJECTION PUMP

Type	Distributor	
Rotation	Clockwise from drive end	
Pumping element plunger diameter	5 mm. (4/99) 6 mm. (4/108)	
Governor type	Hydraulic	
Maximum speed full load	3,800 r.p.m. (4/99) 4175 r.p.m. (4/108)	
Maximum speed no load	4,100 r.p.m. (4/99) 4480 r.p.m. (4/108)	
Idling speed	625 r.p.m.	
Governor spring rate	0.357 kg./mm.	4/99 ONLY
Governor spring free length	18.8 mm. ± 0.5 mm.	4/99 ONLY
Total number of coils	7	4/99 ONLY
Idling spring rate	1.04 kg./mm.	4/99 ONLY
Idling spring free length	8.5 mm.	4/99 ONLY
Regulating valve spring rate	0.453 kg./mm.	4/99 ONLY
Regulating valve spring free length	12.5 mm. ± 0.5 mm.	4/99 ONLY
Advance mechanism	Combined light load and speed advance	4/99 ONLY
Light load advance	4° to 4½°	4/99 ONLY
Total advance	5½° to 6¼°	4/99 ONLY
Inner advance spring rate	0.05 kg./mm.	4/99 ONLY
Inner advance spring free length	24 mm.	4/99 ONLY
Outer advance spring rate	0.88 kg/mm.	4/99 ONLY
Outer advance spring free length	27 mm.	4/99 ONLY

Tightening Torques:

Advance ball stud	345.6 kg. cm. (300 lb. in.)
Drive plate bolts	184.3 kg. cm. (160 lb. in.)
Drive plate bolts (using Tool No. CA.57)	144.0 kg. cm. (125 lb. in.)
Advance mechanism banjo bolt	403.2 kg. cm. (350 lb. in.)
Advance mechanism securing nut	126.7 kg. cm. (110 lb. in.)
Hydraulic head locking screws	195.8 kg. cm. (170 lb. in.)
Transfer pump rotor	74.9 kg. cm. (65 lb. in.)
End plate bolts	51.8 kg. cm. (45 lb. in.)
Fuel inlet connection	414.7 kg. cm. (360 lb. in.)

SUBSTITUTE FUEL OIL

Amoco (U.K.) Limited	
Castrol Limited	H.111/60
Alexander Duckham and Company Limited	
Esso Petroleum Company Limited	T.S.D. 81.5
Mobil Oil Company Limited	
Petrofina (Great Britain) Limited	
Regent Oil Company Limited	
Shell Mex& B.P. Limited	Shell "Fusus" Oil "A" Shell D.T. 11.

FUEL INJECTOR

Type	Pintle
Opening pressure	130 atmospheres (4/99) 150 atmospheres (4/108)
Spray cone angle	12° (symmetrical about injector centre line)
Needle seat leakage	No seepage or leaking should occur with pressure maintained at 110 atmospheres
Back leak test	Time, for pressure to drop from 100 to 75 atmospheres (4/99), 120 to 100 atmospheres (4/108), not less than 6 sec.
Securing nut torque	1.93 kg.m. (14 lb. ft.)

FUEL LIFT PUMP

Type	Diaphragm, with hand primer. Operated by push rod from engine camshaft
Delivery pressure	0.422 to 0.703 kg./sq. cm. (6 to 10 lb./sq. in.)
Inlet depression	21.59 cm. of Hg. (8½ in. of Mercury)
Diaphragm spring test length and pressure	5.433 kg. ± 56.7 grm. at 11.98 mm. (12 lb. ± 2 oz. at 0.468 in.)
Free length	28 mm. approx. (1⅛ in.)

FUEL FILTERS

Primary	Sediment bowl and gauze screen
Secondary	Replaceable paper element

FUEL TANK

Capacity— 75—125	42.1 litres (11.1 U.S. gall., 9.25 Imp. gall.)
130—175	68.1 litres (18.0 U.S. gall., 15.0 Imp. gall.)

THERMOSTART

Current consumption (maximum)	12.9 amps at 11.5 volts
Reservoir capacity	25 c.c.
Flow rate	4.3 to 4.9 c.c. per min. at 21°C (70°F)

AIR CLEANER

Type	Oil bath
Oil capacity	132 c.c. (0.3 U.S. pint, ¼ Imp. pint)
Oil grade	As for engine

ELECTRICAL SYSTEM

BATTERY

Type	Lead acid
Voltage	12
Terminal earthed	Negative
Capacity—Standard	38 A/H
—Optional	57 A/H
Plates per cell—Standard	9
—Optional	13
Specific gravity—charged	1.275 to 1.290
Low limit while discharging at 20 hr. rate	1.105
Electrolyte capacity—Standard	2.5 litres (5.4 U.S. pints, 4.5 Imp. pints)
—Optional	3.6 litres (7.7 U.S. pints, 6.4 Imp. pints)

ALTERNATOR (Prior to September 1968)

Type	Lucas 11 A.C.
Nominal voltage	12
Nominal D.C. output	43 amps
Resistance of field coil at 20°C (68°F)	3.8 ohms
Stator phases	3
Stator connection	star
No. of rotor poles	8
No. of field coils	1

Slip-ring brushes:

Length new	15.9 mm. (0.625 in.)
Replace at	4.0 mm. (0.156 in.)

Brush spring tests:

Load at 19.9 mm. (25/32 in.)	113 to 142 gm. (4 to 5 oz.)
Load at 10.3 mm. (13/32 in.)	212 to 241 gm. (7.5 to 8.5 oz.)

Tightening torques:

Brushbox screws	0.115 kg.m. (10 lb. in.)
Diode heat sink fixings	0.288 kg.m. (25 lb. in.)
Alternator through bolts	0.518 to 0.576 kg.m. (45 to 50 lb. in.)

ALTERNATOR (**September 1968 onwards**)

	Petrol	*Diesel*
Type	Lucas 15 ACR.	Lucas 17 ACR.
Nominal voltage	12	12
Nominal D.C. output	28 amps.	36 amps.
Resistance of field coil at 20°C (68°F)	4.33 ohms.	4.165 ohms.
Stator phases	3	3
Stator connection	Star	Star
No. of rotor poles	12	12
No. of field coils	1	1
Slip-ring brushes:		
Length new	12.6 mm. (0.50 in.)	12.6 mm. (0.50 in.)
Replace at	5.0 mm. (0.20 in.)	5.0 mm. (0.20 in.)
Brush spring test:		
Load with brush pushed back flush with the housing	198 to 283 g. (7 to 10 oz.)	198 to 283 g. (7 to 10 oz.)

Tightening Torques:

Diode heat sink fixing	0.404 to 0.450 kg.m. (35 to 40 lb. in.)
Alternator through bolts	0.518 to 0.576 kg.m. (45 to 50 lb. in.)

STARTER MOTOR (**Inertia**)

Type		12 volt, 4-pole
Number of brushes		4 (2 earthed)
Ampere draw	zero r.p.m.	340 amps at 7.4 volts
	1,000 r.p.m.	245 amps at 8.7 volts
Lock torque		0.84 kg.m. (6.4 lb. ft.)
Number of teeth on ring gear		121
Number of teeth on pinion		9
Gear ratio		13.44 : 1

Commutator end bearing bush:

Length	1.257 to 1.283 cm. (0.495 to 0.505 in.)
Inside diameter (assembled in end plate)	1.269 to 1.271 cm. (0.4995 to 0.5005 in.)
Outside diameter	1.584 to 1.586 cm. (0.6235 to 0.6245 in.)

Drive end bearing bush:

Length	1.7492 to 1.8262 cm. (0.68875 to 0.71875 in.)
Inside diameter (assembled in end plate)	1.9042 to 1.9063 cm. (0.7495 to 0.7505 in.)
Outside diameter	2.062 to 2.064 cm. (0.812 to 0.813 in.)

STARTER MOTOR (**Pre-engaged with Parallel Solenoid**)

Ampere draw (pinion locked)	430
Ampere draw (normal cranking)	260
Teeth on pinion	9
Teeth on ring gear	121
Gear ratio	13.4 : 1
Lock torque	2.21 kg.m. (16.5 lb. ft.)
Minimum brush length	7.5 mm. (0.3 in.)
Brush spring pressure	0.91 kg. (32 oz.)

STARTER MOTOR (Pre-engaged with Moving Pole Shoe Solenoid)

Ampere draw (pinion locked)	460
Ampere draw (normal cranking)	250
Teeth on pinion	9
Teeth on ring gear	121
Gear ratio	13.4 : 1
Lock torque	1.24 kg.m. (9 lb. ft.)
Minimum brush length	6.4 mm. (0.25 in.)
Brush spring pressure	1.15 kg. (40 oz.)

COIL

Type	12 v., oil filled, high performance
Current consumption	Standstill, 3.9 amp. 2,000 r.p.m., 1.4 amp.

PLUGS

Type	Autolite AG22
Gap	0.59 to 0.70 mm. (0.023 to 0.028 in.)

DISTRIBUTOR (Lucas)

Type	Single pair contact breaker point
Drive	Skew gear from camshaft
Ignition advance	Centrifugal and vacuum controlled
Static advance (initial)	6° before T.D.C. (on upper timing mark)

Automatic advance (no vacuum):

Starts	950 r.p.m. (crankshaft) low compression
Ends	4,100 r.p.m. (crankshaft) low compression
Breaker arm spring tension	510.3 to 680.36 gms. (18 to 24 oz.)
Condenser capacity	0.18 to 0.22 microfarad
Contact breaker points gap	0.356 to 0.406 mm. (0.014 to 0.016 in.)
Dwell angle	60° + 3°

Distributor shaft:

Diameter	12.432 to 12.450 mm. (0.4895 to 0.490 in.)
End-float (at max. wear limit)	0.127 mm. (0.005 in.)
End-float (on initial assembly or when fitting new washer)	0.000 to 0.038 mm. (0.000 to 0.0015 in.)

Advance characteristics (Low Compression):

Mechanical		*Vacuum*	
Distributor Speed rev./min.	*Degrees Advance (Distributor)*	*Vacuum cm. of Hg. (in. of Hg.)*	*Degrees Advance (Distributor)*
2,500	15°—17°	50.8 (20)	5°—7°
2,050	15°—17°	35.6 (14)	4½°—6½°
1,500	11°—13°	25.4 (10)	3°—5°
1,000	7°—9°	20.3 (8)	2°—4°
800	4°—6°	15.2 (6)	1¼°—2½°
600	1°—3°	10.2 (4)	No advance
400	No advance		

TRANSIT

DISTRIBUTOR (Autolite)

Type	Single pair contact breaker point
Automatic advance	Mechanically and vacuum controlled
Drive	Skew gear from camshaft
Rotation	Clockwise from rotor end
Shaft end-float	0.012 to 0.190 mm. (0.0005 to 0.0075 in.)

Identification:

Low compression (C6CH-12100-B)	Green paint mark on vacuum plug
High compression (C6CH-12100-A)	Red paint mark on vacuum plug
Static advance (initial)	6° L.C. before T.D.C. 4° H.C. with 94 octane petrol 8° H.C. with 97 octane petrol
Breaker arm spring tension	481.9 to 567.0 gms. (17 to 21 oz.)
Condenser capacity	0.21 to 0.25 microfarad
Contact breaker points gap	0.64 mm. (0.025 in.)
Dwell angle	38° to 42°
Firing order	1, 3, 4, 2

Advance characteristics (Low Compression):

Mechanical		*Vacuum*	
Distributor Speed rev./min.	*Degrees Advance (Distributor)*	*Vacuum cm. of Hg. (in. of Hg.)*	*Degrees Advance (Distributor)*
700	2° to 4°	17.8 (7)	1½° to 5°
900	5° to 7½°	22.9 (9)	4½° to 7½°
1,200	9° to 11°	27.9 (11)	7° to 10°
2,000	14½° to 16½°	33.0 (13) and up	8° to 11°

Advance characteristics (High Compression):

Mechanical		*Vacuum*	
Distributor Speed rev./min.	*Degrees Advance (Distributor)*	*Vacuum cm. of Hg. (in. of Hg.)*	*Degrees Advance (Distributor)*
600	½° to 2½°	20.3 (8)	1° to 2°
900	7° to 9°	27.9 (11)	3° to 6°
1,200	10° to 12°	40.6 (16) and up	5° to 8°
2,100	14° to 16°	—	—

LIGHT BULBS

Description	*Quantity*	*Wattage*
Sealed beam units	2	60/45
Side lights	2	5
Front direction indicator	2	21
Rear direction indicator	2	21
Rear and stop light	2	5/21
Rear number plate light	1	6
Interior light	1	6
Instrument panel lights and warning lights	6	2.2

Section 15

SERVICE SCHEDULE

Diesel Engines: Under all operating conditions whether the vehicle is used for short or long journeys, the oil and filter MUST be changed every 2,000 miles. If these instructions are not adhered to, high oil contamination, condensation and sludge formation will result, with consequential damage to the engine.

First 1,000 km. (600 miles) Service.

Check engine oil level.

Check coolant level.

Check windscreen washer reservoir.

Check brake fluid level.

Check battery electrolyte level.

Check tyre pressures and condition.

Tighten cylinder head bolts to correct torque.

Tighten inlet and exhaust manifold bolts to correct torque.

Adjust valve clearances.

Check carburettor idling and mixture setting.

Check torque of exhaust manifold to downpipe bolts.

Check torque of sump bolts.

Check clutch adjustment.

Inspect brake hoses.

Check for oil or water leaks.

Check operation of lights.

Adjust steering box.

Adjust front wheel bearings.

Torque "U" bolts.

Adjust toe-in.

Road test or roller test with brake function test.

Diesel as above plus:—

Change engine oil and filter.

Check injector pump idling and max. no-load speed.

First 5,000 km. (3,000 miles) and every subsequent 10,000 km. (6,000 miles). (Standard Service).

Check and, if necessary, top up coolant level.

Check and, if necessary, top up brake fluid reservoirs.

Check and, if necessary, top up windshield washer reservoir.

Change engine oil and renew filter element.

Clean sparking plugs and set gaps – replace if required.

Examine distributor points, check and adjust dwell angle, clean distributor cap, coil and H.T. leads, lubricate distributor and check ignition timing.

Check carburettor idling/mixture setting – adjust as required.

Clean crankcase emission valve and oil filler cap.

Check and adjust valve clearances.

Check drive belts for tension and wear.

Check battery charge, clean and grease connections and top up.

Inspect radiator and heater hoses for leaks or deterioration.

Check and lubricate accelerator linkage or cable – adjust if required.

Change manual transmission oil. (First 5,000 km. (3,000 miles) only.)

Check engine for oil or water leaks.

Check transmission oil level and top up if required.

Check rear axle oil level and top up if required.

Check torque of spring "U" bolts.

Adjust front wheel bearings.

Check brake linings for wear.

Adjust brakes.

Inspect brake system for leaks and hoses chafing.

Check exhaust system for damage or leaks and external condition.

Check suspension and steering linkages for wear.

Adjust steering box (at first 5,000 km. (3,000 miles) and 25,000 km. (15,000 miles) and thereafter every 30,000 km. (18,000 miles).

* Grease spindle pins.

Grease prop. shaft sliding joint (130, 150 and 175 models only).

Check toe-in.

Clean air cleaner element.

Cheque torque of inlet manifold bolts.

Check condition of steering and ball joint covers.

Check clutch adjustment.

Check operation of all controls, instruments and lights.

Lubricate door locks, lock cylinders, bonnet safety catch pivot, door striker wedges, door check straps, hinges, sliding door and all oil can points.

Lubricate handbrake linkage – adjust if required.

Check seat belts for security and wear.

Check tyre pressures, and condition.

Lubricate multi leaf springs (except when anti-squeak strip is fitted).

Lubricate sliding step.

Road test or roller test with brake function and check operation of automatic transmission.

First 25,000 km. (15,000 miles) and every subsequent 30,000 km. (18,000 miles). (Major Service).

As 10,000 km. (6,000 miles) plus:—

Clean, repack and adjust front and rear wheel bearings (rear wheel bearings on 130, 150 and 175 models only).

Change air cleaner element (petrol only).

Adjust steering box.

* A Molybdenum Disulphide Lithium base grease should be used.

NOTE:

These are recommended intervals only. Vehicles operating under arduous conditions may need more frequent attention to certain components.

Arduous conditions would include:
Constant Stop-Start work.
Off-road or poor road surfaces.
Hilly country.

Components which could need additional attention include:

Front and rear brake bands on automatic transmission.

Brakes.

Air cleaner.

Steering components.