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LOCKHEED HYDRAULIC BRAKE COMPANY LTD.

SERVICE MANUAL

FOR LOCKHEED HYDRAULIC BRAKING SYSTEM AND CLUTCH OPERATING SYSTEM

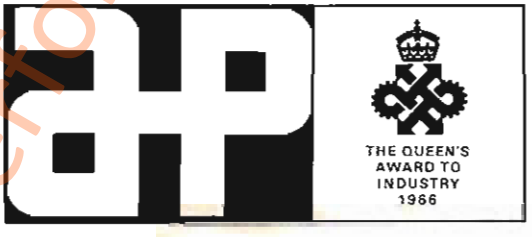
AS FITTED TO THE MORRIS "MINI-MINOR" AND AUSTIN MINI

One of the Automotive Products Group

SERVICE MANUAL

CONTENTS

			Page
SECTION 1.	DESCRIPTION AND OPERATION	.....	1
SECTION 2.	ROUTINE ATTENTION	.....	5
SECTION 3.	BRAKE ADJUSTMENT	.....	7
SECTION 4.	OVERHAUL INSTRUCTIONS	.....	9
SECTION 5.	BLEEDING AND FLUSHING	.....	19
SECTION 6.	FAULT FINDING	.....	23



SECTION I

DESCRIPTION AND OPERATION

SECTION 1 DESCRIPTION AND OPERATION

DESCRIPTION OF BRAKING SYSTEM

The braking system (refer to Fig. 1) comprises four leading and trailing shoe brake assemblies which are operated by fluid pressure generated in a master cylinder. Each brake assembly comprises two brake shoes, a wheel cylinder and an adjuster ; the rear brakes also incorporate the handbrake operating linkage. The master cylinder is connected to the brake assemblies by means of metal tubing and flexible rubber hoses ; a pressure regulating valve is incorporated in the line to the rear brakes.

When normal brake applications are made the master cylinder pressure is applied direct to, and shared equally by, all four brake assemblies ; the normal front-to-rear braking ratio in such instances is ensured by the front wheel cylinders having larger-diameter pistons than those at the rear.

When heavy brake applications are made, the incorporation of the pressure regulating valve ensures that, under normal conditions of adhesion between tyres and road, maximum braking effort is performed without risk of the rear wheels locking. This is due to the fact that, when the master cylinder pressure has reached a certain figure, the pressure regulating valve prevents further pressure from passing to the rear brakes ; any additional pressure then generated in the master cylinder is applied only to the front brakes, so compensating for the transfer of weight to the front end of the vehicle.

The brake shoes are free to float within slots in the wheel cylinder body and adjuster tappets, and are therefore able automatically to centralise themselves in relation to the brake drums when the brakes are applied.

OPERATION OF BRAKING SYSTEM

From the very simplified diagram (Fig. 2) it wil be seen that the master cylinder, pipeline and wheel cylinders form one vessel which is filled with Lockheed Hydraulic Brake Fluid.

The master cylinder has a single piston, whilst each wheel cylinder has two, all pistons being provided with rubber seals to maintain pressure and prevent loss of fluid.

When the brake pedal is depressed, the master cylinder piston applies a force to the fluid which, being incompressible, is displaced through the pipes and thrusts the wheel cylinder pistons apart until the brake shoes contact the drums. One shoe of each brake assembly will be applied in the same sense of rotation as the drum and is termed the " leading shoe," the other is applied in the opposite sense of rotation and is termed " trailing."

When the pressure on the brake pedal is released, the brake shoe pull-off springs cause the brake shoes to move away from the drums, and the wheel cylinder pistons are thrust back to the "off" position ; whilst this is occurring, fluid is displaced back to the master cylinder ready for the next brake application.

DESCRIPTION OF CLUTCH SYSTEM

The clutch operating system is shown on Fig. 1 and comprises a master cylinder which is connected to a clutch slave cylinder by means of a metal pipe and a flexible rubber hose ; the slave cylinder is mechanically connected to the clutch throw-out mechanism.

The master cylinder is somewhat similar to that used for the braking system and, when the clutch pedal is depressed, it displaces a column of fluid which moves the slave cylinder piston so as to disengage the clutch.

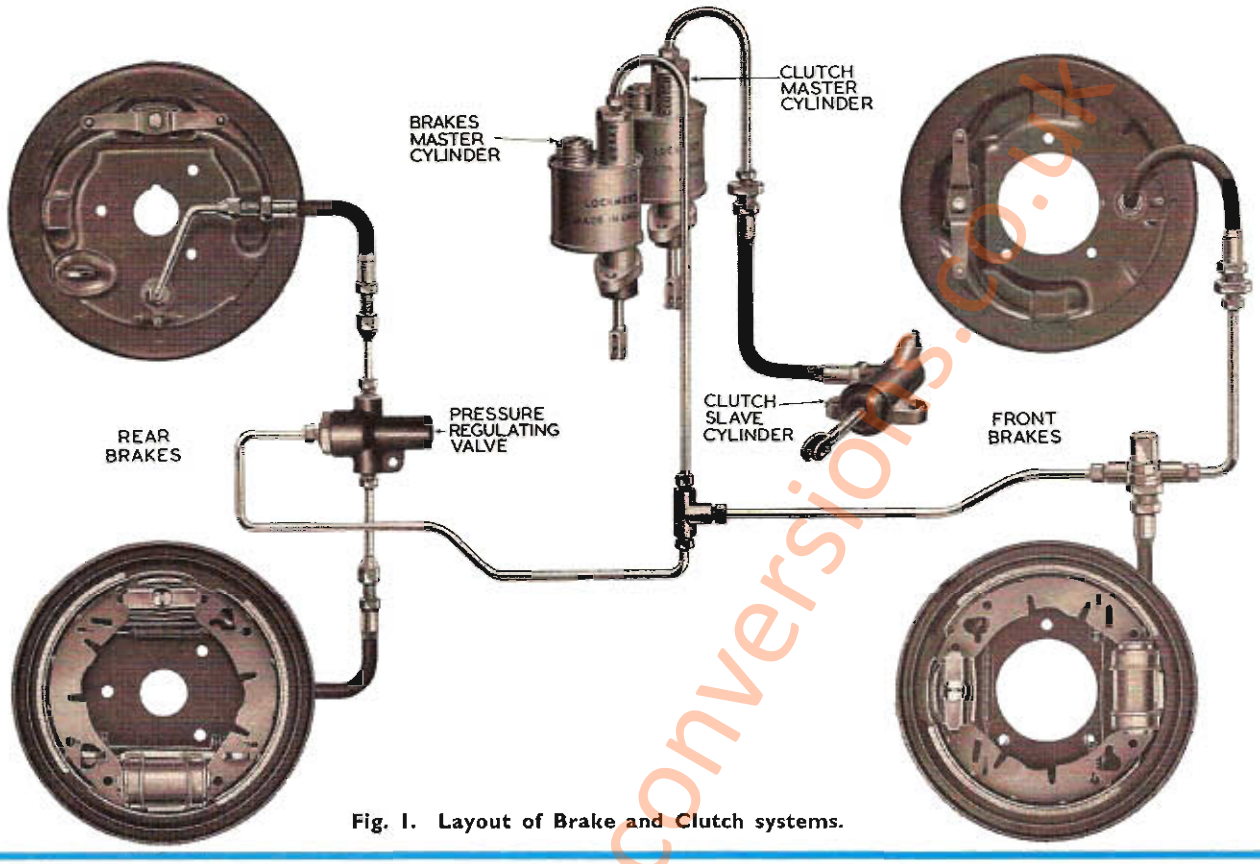


Fig. 1. Layout of Brake and Clutch systems.

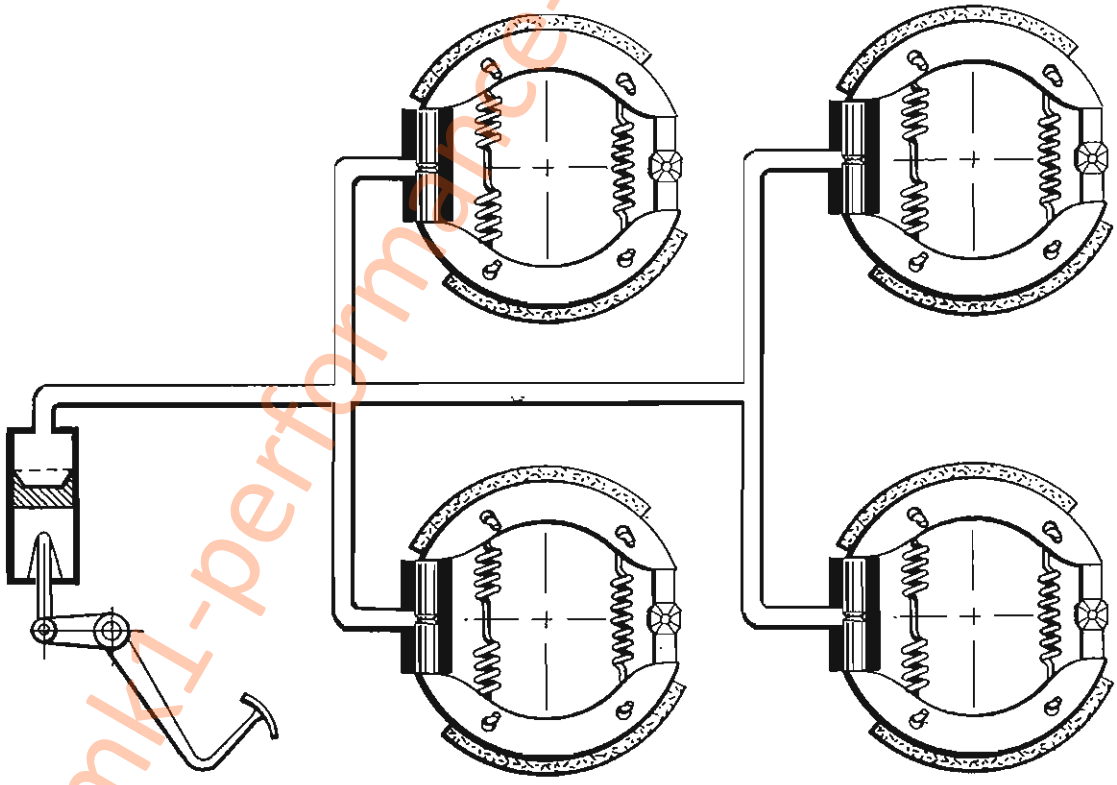


Fig. 2. Simplified diagrammatic Layout of Brake system.

SECTION 2

ROUTINE ATTENTION

SECTION 2 ROUTINE ATTENTION

(1) The fluid level in the master cylinders should be checked every 1,000 miles or once a month (whichever occurs first) and replenished if necessary. Prior to unscrewing the filler cap, clean the area around it to prevent dirt entering when it is removed. The correct fluid level is to the bottom of the filler cap orifice. Great care should be taken not to spill any brake fluid on the bodywork of the car as this fluid is injurious to paint. Refit the filler cap, together with its seal, and securely tighten. USE ONLY GENUINE LOCKHEED SUPER HEAVY DUTY BRAKE FLUID WHEN TOPPING UP.

The addition of fluid should be required only at extremely long intervals, and a considerable fall in the fluid level would indicate an external leak at some point in the system which should be traced and rectified immediately. To check for leakage, apply firm pressure in turn to the brake pedal and the clutch pedal whilst an assistant examines the hydraulic units, pipes, hoses and fittings.

(2) Ensure that the air vents in the filler caps of the master cylinders are not choked; blockage of these would cause the brakes to drag and the clutch to slip.

(3) The brake shoes should be adjusted when the free travel of the brake pedal is excessive (this is the movement of the pedal before the brakes become effective).

(4) Every 5,000 miles examine brake linings and renew if worn to less than a third of their original thickness. Check brake drums for excessive wear and ensure that linings are not contaminated by lubricating oil or grease. Whilst doing this, also check for wheel cylinder and master cylinder leakage.

(5) All rubber hoses are to be inspected every 10,000 miles for any signs of leakage, chafing or general deterioration. If there is any doubt, renew the hoses. In any case, it is recommended that hoses are renewed every three years or 40,000 miles. When checking hoses, also inspect metal pipes for corrosion chafing or looseness.

(6) At intervals not exceeding three years or 40,000 miles, or at each third change of a brake lining, whichever occurs first, renew all rubber cups and seals throughout the system.

(7) At intervals not exceeding eighteen months or twenty four thousand miles, which ever occurs first, the fluid should be completely drained from the system and refilled with new Lockheed hydraulic brake fluid.

This operation must be carried out under strictly controlled conditions, i.e. great care must be taken to see that any containers or dispensers used for filling the braking system are completely free of water.

Brake fluid absorbs water from the atmosphere and it is, therefore, essential that fluid is only exposed to atmosphere during the time it takes to fill the system.

It is also most important that extreme care is taken to see that dirt or dust of any kind is prevented from entering the system during the filling operation.

USE OF THE GENUINE LOCKHEED BRAKE FLUID

The special fluid used in Lockheed brakes is one of the most important factors in the correct operation of the hydraulic systems, for no equipment will give satisfaction with incorrect fluid. When topping up or overhauling the systems use only the genuine Lockheed Super Heavy Duty Brake Fluid for it lengthens the life of all internal parts, acts as an efficient lubricant and operates satisfactorily under all extremes of temperature throughout the world. **The use of any other fluid nullifies all guarantees.**

SECTION 3

BRAKE ADJUSTMENT

SECTION 3 BRAKE ADJUSTMENT

ADJUSTING THE FRONT BRAKES
(Refer to Fig. 3)

Apply the handbrake and jack up the wheel to be dealt with until clear of the ground. Apply a spanner to the adjuster spindle and turn in a clockwise direction until the brake shoes are in contact with the drum. **Do not strain the adjuster.** Slacken off the adjuster spindle by one flat to permit the drum to be revolved freely. To ensure that the adjustment is as close as possible, now spin the wheel in the forward direction and apply the brake hard whilst the wheel is still spinning, this will centralise the shoes; then repeat the adjustment procedure.

Adjust the opposite front brake in the same way.

ADJUSTING THE REAR BRAKES

Place chocks in front of the front wheels (to prevent the car from rolling), ensure that the handbrake is fully released, then jack up the wheel to be dealt with. Proceed as detailed for the front brakes. The adjuster spindle for each rear brake is situated at the top of the backplate.

Adjust the opposite rear brake in the same way.

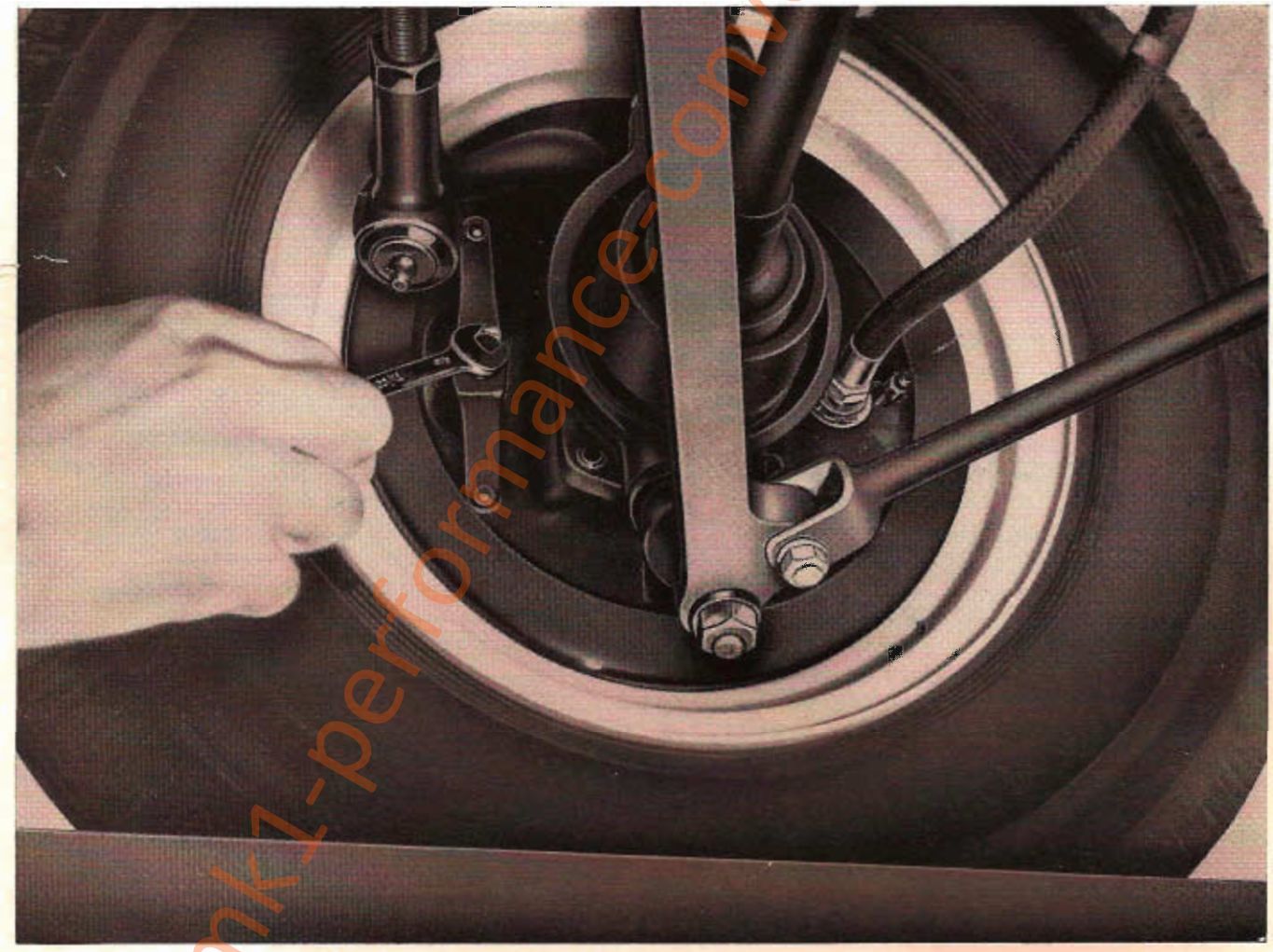


Fig. 3. Adjusting Front Brakes.

Note: In the instance of the Rear Brakes, the adjuster is at the top of backplate.

SECTION 4

OVERHAUL INSTRUCTIONS

INDEX

	Page
GENERAL	10
MASTER CYLINDERS	10
FRONT BRAKE ASSEMBLIES	12
REAR BRAKE ASSEMBLIES	16
PRESSURE REGULATING VALVE	16
CLUTCH SLAVE CYLINDER	18
REMOVING AND RE-FITTING A FLEXIBLE HOSE	18

SECTION 4 OVERHAUL INSTRUCTIONS

GENERAL

Should it be found necessary to dismantle the brake or clutch systems, the operation must be carried out under conditions of scrupulous cleanliness.

Clean off the dirt and grease before removing any units. Do not swill a unit in petrol, paraffin or trichlorethylene, after removal from the vehicle, because these solvents will ruin rubber parts and, on dismantling, will give a misleading impression of their original condition.

Dismantle units on a bench covered with a sheet of clean paper. Do not handle internal parts with dirty hands, particularly rubber parts.

After dismantling, place all metal parts in a tray of clean brake fluid to soak, afterwards, dry off with a clean lint-free cloth and lay out in order on a sheet of clean paper. To ensure unfailing reliability we would recommend that all rubber parts be replaced with new ones, these being readily available in the form of Repair Kits containing all the rubber components required for each particular unit.

The main bodies of units may be swilled in industrial methylated spirit or Lockheed Super Heavy Duty Brake Fluid, but if spirit is used all traces must be dried out before assembly.

In the case of the master cylinders, make sure that the by-pass port is clear by probing with a piece of fine wire. A Primus Stove 'pricker' is ideal for this. The brakes will drag or the clutch will slip if the by-pass port is clogged because pressure will build up in the system. The port is deliberately drilled first with a $\frac{1}{8}$" drill halfway and then completed with a 0.028" hole which is pierce-peened from within the bore.

All internal parts should be dipped in clean Lockheed Super Heavy Duty Brake Fluid and assembled wet; when assembling rubber parts use the fingers only.

Stores departments should exercise special care in handling spare parts to ensure that no damage is caused which would affect their correct functioning. Rubber parts should be stored in a cool, dark place well removed from any fumes.

Caution :—At no time must oil or grease be allowed to contact the brake shoe linings.

RE-LINING THE BRAKE SHOES

When re-lined brake shoes are being used, the same make and quality of lining specified by the vehicle manufacturer (or an approved alternative) must be used throughout, otherwise uneven braking will result. To enable this to be accomplished in the easiest possible manner advantage should be taken of our **exchange brake shoe scheme,** particulars of which are obtainable from Lockheed stockists.

MASTER CYLINDERS

The brake and clutch master cylinders are very similar externally and are shown on Fig. 4; however, the internal parts differ in that, whilst the brake cylinder incorporates a check valve, the clutch cylinder does not. The cylinders may be identified, one from the other, by the word "BRAKE" or "CLUTCH" etched on the cylinder barrel (or the letters 'B' or 'C').

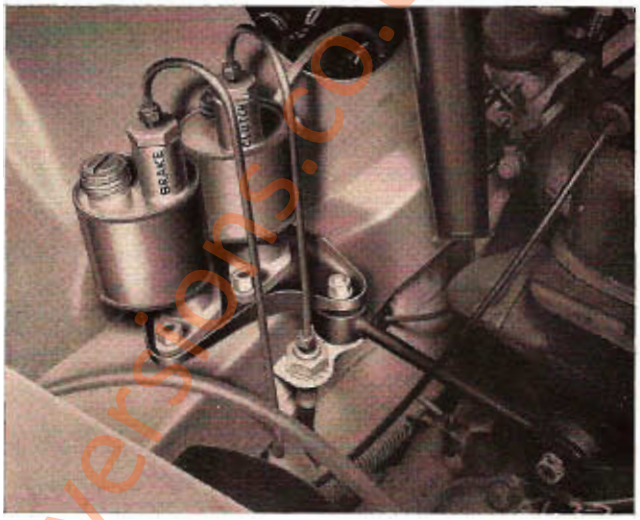


Fig. 4. Installation of Master Cylinders on vehicle.

Description (Refer to Fig. 5)

A piston (8) is contained within the barrel, and has a rubber main cup (10) spring loaded against its inner end; between the cup and the piston a thin washer (9) is interposed to prevent the cup from being drawn into the small feed holes drilled around the piston head. The outer end of the piston carries a rubber secondary cup (7) and is formed with a depression to receive the spherical end of a push rod (6) which carries a piston stop and is retained by a circlip (5). A small sleeve is also carried on the push rod and this supports the small end of a rubber boot (4) and acts as a guide for the push rod; the large end of the boot stretches around the neck of the barrel, and its purpose is to prevent the intrusion of dirt and moisture into the cylinder.

In the instance of the brake master cylinder, the piston return spring (12) also loads a check-valve assembly (13) against the end face of the bore, this valve comprising a rubber body which accommodates a metal insert drilled with a number of holes; these holes are sealed in one direction by a flap on the rubber body.

Note : Early master cylinders have a screwed plug and gasket fitted at this end of the bore. This should not be disturbed.

Principle of Operation (Refer to Fig. 6)

Depressing the brake pedal or clutch pedal causes the push rod of the appropriate master cylinder to move through the small sleeve which supports it and to thrust the piston along the bore of the barrel. Fluid is thus displaced from the master cylinder to the wheel cylinders in the brake assemblies or to the clutch slave cylinder. In the instance of the brake master cylinder, the fluid passes via the holes in the check valve insert (the flap of the rubber valve body is held away from these holes whilst this is happening).

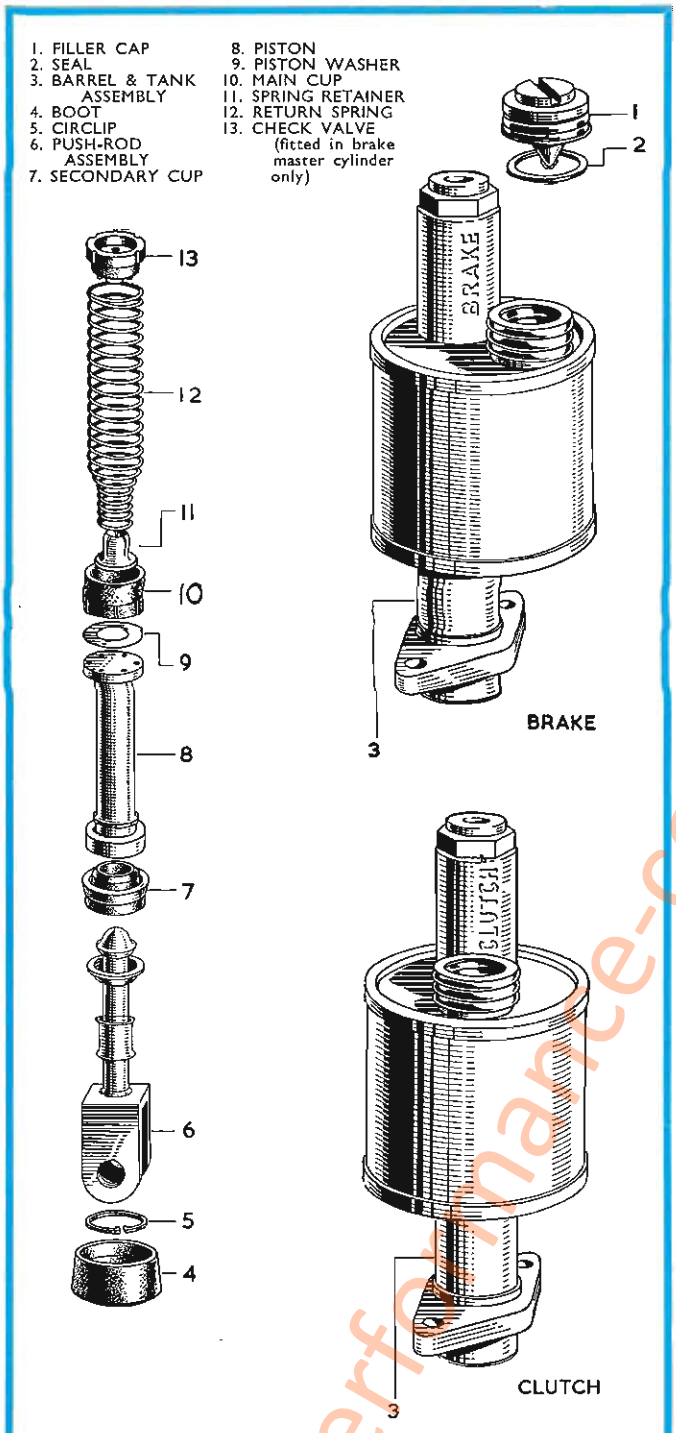


Fig. 5. Exploded view of Master Cylinders.

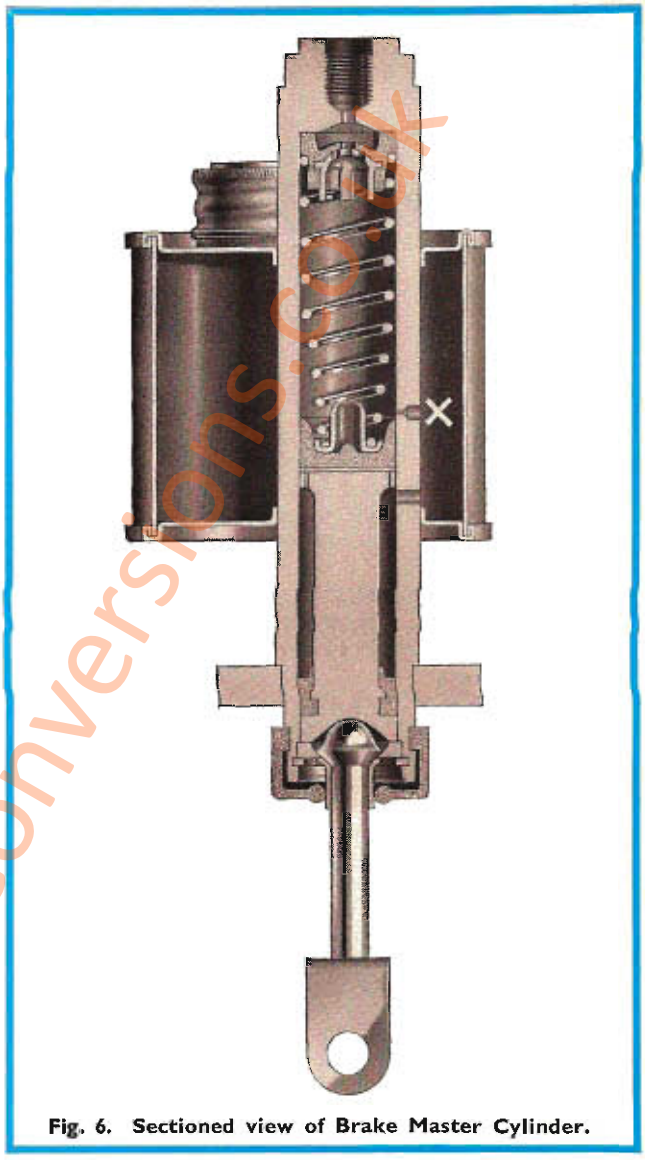


Fig. 6. Sectioned view of Brake Master Cylinder.

Upon removal of the load from the pedal, the return spring thrusts the piston back against its stop faster than fluid is able to return from the brake wheel cylinders or from the clutch slave cylinder; this creates a depression in the master cylinder which draws the edge of the main cup away from the head of the piston and allows fluid from the tank to flow through the feed holes thus uncovered to make up the temporary deficiency.

Meanwhile, fluid is displaced back from the system to the master cylinder, being under load from the brake shoe pull off springs or from the clutch thrust springs. In the instance of the brake master cylinder, this return fluid lifts the complete check valve assembly away from the end of the bore whilst this is happening.

When the piston is fully back against its stop, the main cup uncovers a small by-pass port "X" in the barrel, and this allows the release of excess fluid to the tank, thus permitting the pull-off springs to return the brake shoes to the fully "off" position or the clutch thrust springs to push the piston of the clutch slave cylinder back to its original position. The by-pass port also compensates for contraction or expansion of the fluid, due to changes in temperature, allowing fluid to flow into or escape from the system. Should this port become blocked, any excess fluid would be unable to escape and the brakes would consequently drag or the clutch would slip.

In the instance of the brake master cylinder, when the brakes are fully "off" the check valve once more resumes its seat at the end of the bore; the purpose of this valve is to prevent the re-entry into the master cylinder of fluid pumped into the line when "bleeding" the

system; this ensures a fresh charge of fluid at each stroke of the brake pedal and a complete purge of air from the system.

The omission of the check valve in the clutch master cylinder prevents pressure building up in the clutch system when the clutch is engaged, thus preventing the slave cylinder piston causing a slipping clutch. A different method of "bleeding" is used with the clutch system in order to prevent the re-entry of fluid into the master cylinder when this operation is being carried out. (Refer to Section 5).

Removing the Master Cylinders from the Vehicle

The cylinders may be identified, one from the other by the word "BRAKE" or "CLUTCH" etched on the cylinder barrel, or the letters 'B' or 'C'.

Brush away any dirt from the pipe connection, disconnect the pipe from the cylinder (by unscrewing the tube nut), and plug the end of the pipe to prevent the entry of dirt and/or the loss of fluid.

Remove the clevis pin which connects the fork-end of the push rod to the linkage. Unscrew the fixing bolts, detach the master cylinder from the vehicle, remove the filler cap and drain off the fluid.

Dismantling (Refer to Fig. 5)

Detach the rubber boot (4) from the end of the barrel, and move the boot along the push rod.

Depress the piston to relieve the spring load from the circlip (5), remove the circlip and the push rod, and withdraw the piston (8), the piston washer (9), the main cup (10), the spring and the check valve (13), (this latter part is not fitted in the clutch master cylinder). The screwed plug should not normally need to be removed from the end of earlier type master cylinders.

Remove the secondary cup (7) by stretching it over the end of the piston.

Assembly (Refer to Fig. 5)

Using the fingers only, stretch the secondary cup (7) on to the piston, with the small end towards the head (*i.e.* drilled end) and with the groove engaging the ridge; gently work round the cup, with the fingers, to ensure correct bedding.

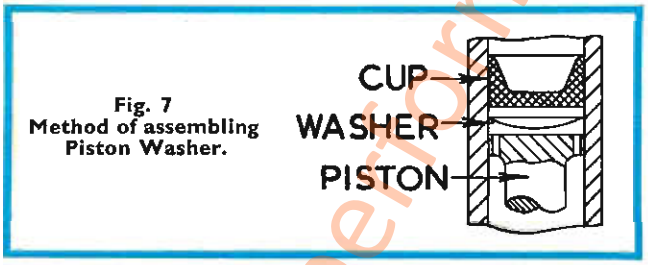


Fig. 7
Method of assembling Piston Washer.

Locate the spring retainer (11) in the small end of the spring and, in the instance of the brake master cylinder, fit the check valve assembly (13) at the large end of the spring so that it locates within the coils.

Hold the barrel and tank assembly (3) with the outlet connection uppermost, and insert the spring and its associated parts into the bore (in the instance of the brake master cylinder, the check-valve assembly is to be nearer to the outlet connection). Reverse the barrel and tank assembly and insert the main cup (10) into the bore, with the lip leading (take care not to turn back or buckle the lip of the cup).

Insert the piston washer (9) so that the curved edge is towards the cup (as on Fig. 7).

Insert the piston (8) into the bore, with the drilled head innermost.

If previously removed, stretch the small end of the boot (4) on to the small sleeve on the push rod, with the open end of the boot towards the spherical end of the push rod.

Offer up the push rod to the barrel, push the piston down the bore and locate the piston stop within the mouth of the bore (the piston stop is in the form of a washer loosely located on the push rod). Secure the piston stop by fitting the circlip (5) at the end of the bore, **it is most important that the circlip be fitted correctly in its groove.**

Stretch the large end of the boot on to the end of the barrel, engaging it with the groove.

Re-fitting the Master Cylinders to the Vehicle

Secure the master cylinder to the vehicle, by means of the two bolts, and fit the clevis pin to attach the fork-end of the push rod to the appropriate pedal linkage (the master cylinders are identifiable, one from the other by the words "BRAKE" or "CLUTCH" etched on the cylinder barrel, or the letters 'B' or 'C').

Fill the supply tank as indicated under ROUTINE ATTENTION (Section 2); re-fit the filler cap (1) together with its seal (2) and securely tighten.

Test the master cylinder by pumping the pedal several times, and allowing it to return unassisted; after one or two applications fluid should flow from the outlet connection.

Unplug the pipe and connect it to the master cylinder by screwing home the tube nut.

Check for leakage by applying a firm pressure to the pedal and, whilst maintaining the pressure, inspect the "line" and connections.

FRONT BRAKE ASSEMBLIES

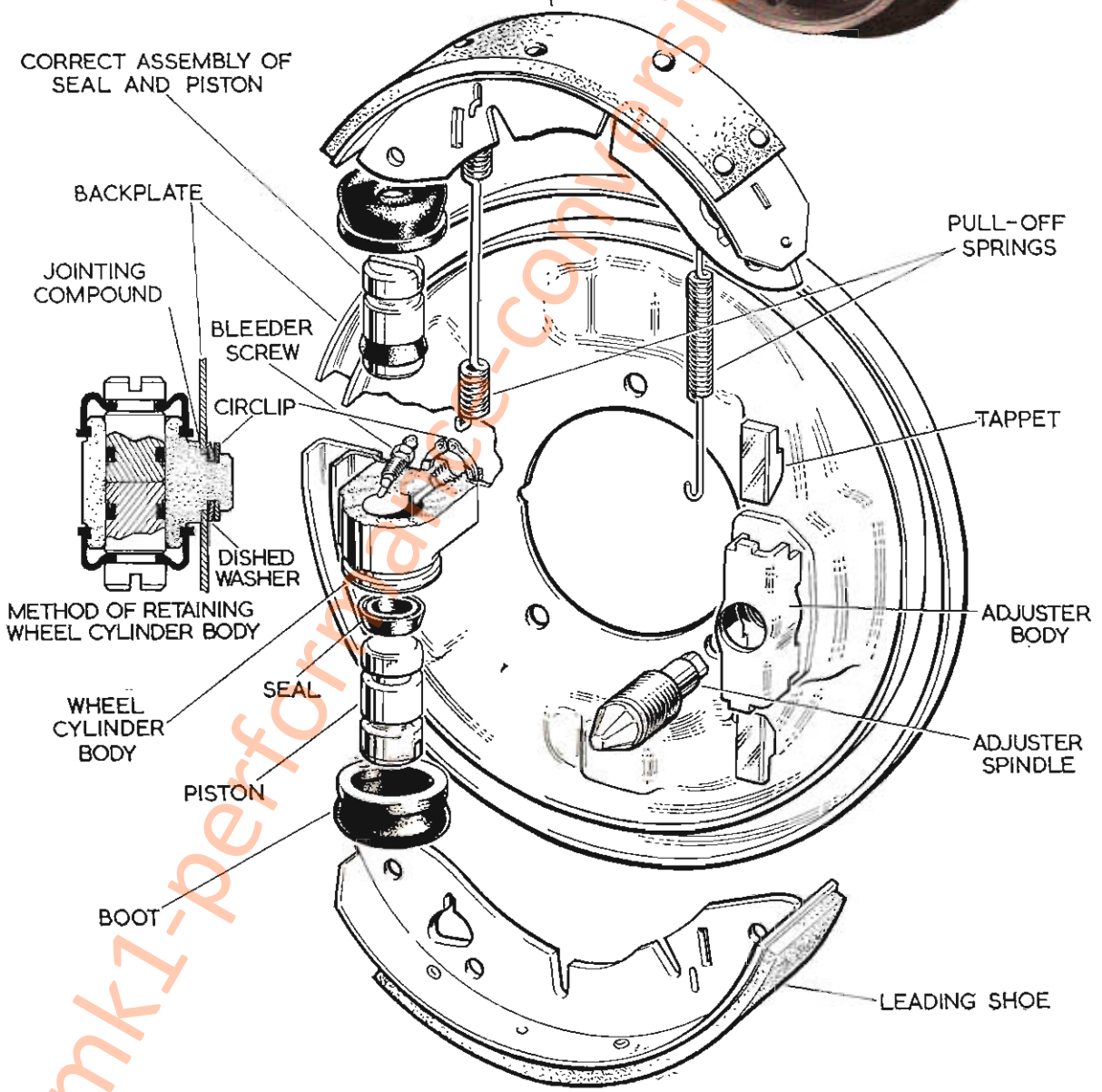
Description (Refer to Fig. 8)

The front brake assemblies are of leading and trailing shoe design and each consists of a backplate upon which is mounted a wheel cylinder, an adjuster and two brake shoes. The inner end of the brake drum is enlarged and has a groove running around it, a flange on the backplate locates within this groove and so prevents dirt and moisture from entering the assembly.

The wheel cylinder body is secured by means of a dished washer and a circlip, and contains two opposed pistons each of which carries a rubber seal of tapered cross-section to prevent fluid leakage. Two threaded connections in the body receive respectively a bleeder screw and a flexible rubber hose which is connected to the pipe line from the brake master cylinder.

The adjuster body is riveted to the backplate and has two tappets, the inner faces of which are inclined; an adjuster spindle is threaded into the body between the tappets, the inner end of this part being wedge-shaped and formed with four flat surfaces. The outer end of the spindle is supported by a bracket riveted to the backplate and is "squared off" to receive a spanner by means of which the spindle is turned when adjusting the brakes.

Fig. 8.
Front Brake Assembly
(Left hand assembly shewn)



Slots in the wheel cylinder pistons and the adjuster tappets provide locations for the brake shoes which are held in position by means of two pull-off springs. The webs of the shoes have slots in their inner faces so as to provide a degree of flexibility for the shoes; the purpose of this being to avoid brake squeal.

When the brake pedal is depressed, fluid pressure from the master cylinder thrusts the wheel cylinder pistons outwards until the linings riveted to the brake shoes are in contact with the drums. One of the shoes is applied in the same sense of rotation as the drum and, upon making contact, drum rotation exerts a force in the same direction as the wheel cylinder piston operating the shoe; in this way the effort on the piston is augmented, causing the shoe to give increased braking effort. The shoe to which the foregoing applies is termed "leading". In the instance of the opposite shoe, the drum drag opposes the piston thrust and somewhat reduces the efficiency of the shoe; this shoe is termed "trailing". Leading and trailing shoe characteristics are obtained with the vehicle moving either forward or in reverse.

Upon releasing the load on the pedal, the pull-off springs return the brake shoes to the "off" position, thus thrusting the wheel cylinder pistons back into the body and displacing fluid back to the master cylinder ready for the next brake application.

When the shoes are full "off", a running clearance exists between them and the drum; this clearance should be kept to a minimum by periodic adjustment (to compensate for lining wear) otherwise the pedal travel required before the shoes contact the drum will become progressively greater until eventually no braking will be available.

Brake adjustment is effected by turning the adjuster spindle in a clockwise direction, this screws the spindle further into the adjuster body causing its wedge-shaped head to thrust the tappets, and consequently the shoes, nearer to the drum. Refer to Section 3 for the adjustment procedure.

Dismantling the Front Brakes (Refer to Fig. 8)

Apply the handbrake and jack up the wheel to be dealt with until clear of the ground. Disconnect the flexible hose as detailed on page 18 and plug the end of the metal pipe to prevent loss of fluid and entry of dirt. Turn the adjuster spindle anti-clockwise as far as possible and then remove the wheel and brake drum.

Pull one of the brake shoes against the load of the pull-off springs, and disengage the shoe from the springs; the other shoe will now fall away.

Ease the two rubber boots away from the ends of the wheel cylinder body, pull out the two pistons and remove from them the boots and the rubber seals.

Caution: When removing the rubber seals, use a blunt-nosed tool to avoid scoring the grooves.

If only the rubber parts in the wheel cylinder are to be renewed, there is no need to remove the wheel cylinder body from the backplate; however, if it is considered necessary to do so, remove the bleeder screw, the dished washer and the circlip, the body may then be withdrawn. If the body is left in position ensure that the jointing compound between it and the backplate is forming an efficient seal against the entry of moisture.

Extract the two tappets from the adjuster body, and unscrew the adjuster spindle, the body cannot be removed.

Caution: At no time must oil or grease be allowed in contact with the brake shoe linings. If contamination of this nature occurs, new re-lined shoes must be fitted.

Assembling the Front Brakes (Refer to Fig. 8)

Obtain a small quantity of Lanolin for the purpose of lubricating the adjuster tappets and spindle; in addition, if it was previously found necessary to remove the wheel cylinder body, a small quantity of "Bostik 252" Jointing Compound will be required to ensure a water-tight joint between the body and the backplate.

If the wheel cylinder body was previously removed, smear with the jointing compound the flat face of the body and the surface of the backplate against which this fits. Fit the dished washer to the spigot of the body, as shown on illustration, and secure the body with the circlip.

Ease a rubber seal into the larger groove on each of the pistons, so that the greater diameter of the seal is pointing away from the slot in the piston (as shown on the illustration). Stretch the small end of each rubber boot into the smaller groove on the pistons. Insert the pistons into the wheel cylinder body and stretch the large end of the boots into the grooves on the body.

Lightly smear with the Lanolin the adjuster tappets and the adjuster spindle. Screw the spindle fully into the adjuster body, and insert the tappets so that their inclined faces rest against the head of the spindle.

It will be seen that the brake shoe linings are shorter than the platforms to which they are attached; the end at which the greater portion of platform is exposed is known as the "toe" whilst the other end is termed the "heel". The lining is displaced in the direction of forward rotation of the wheel.

Caution: At no time must oil or grease be allowed in contact with the brake shoe linings.

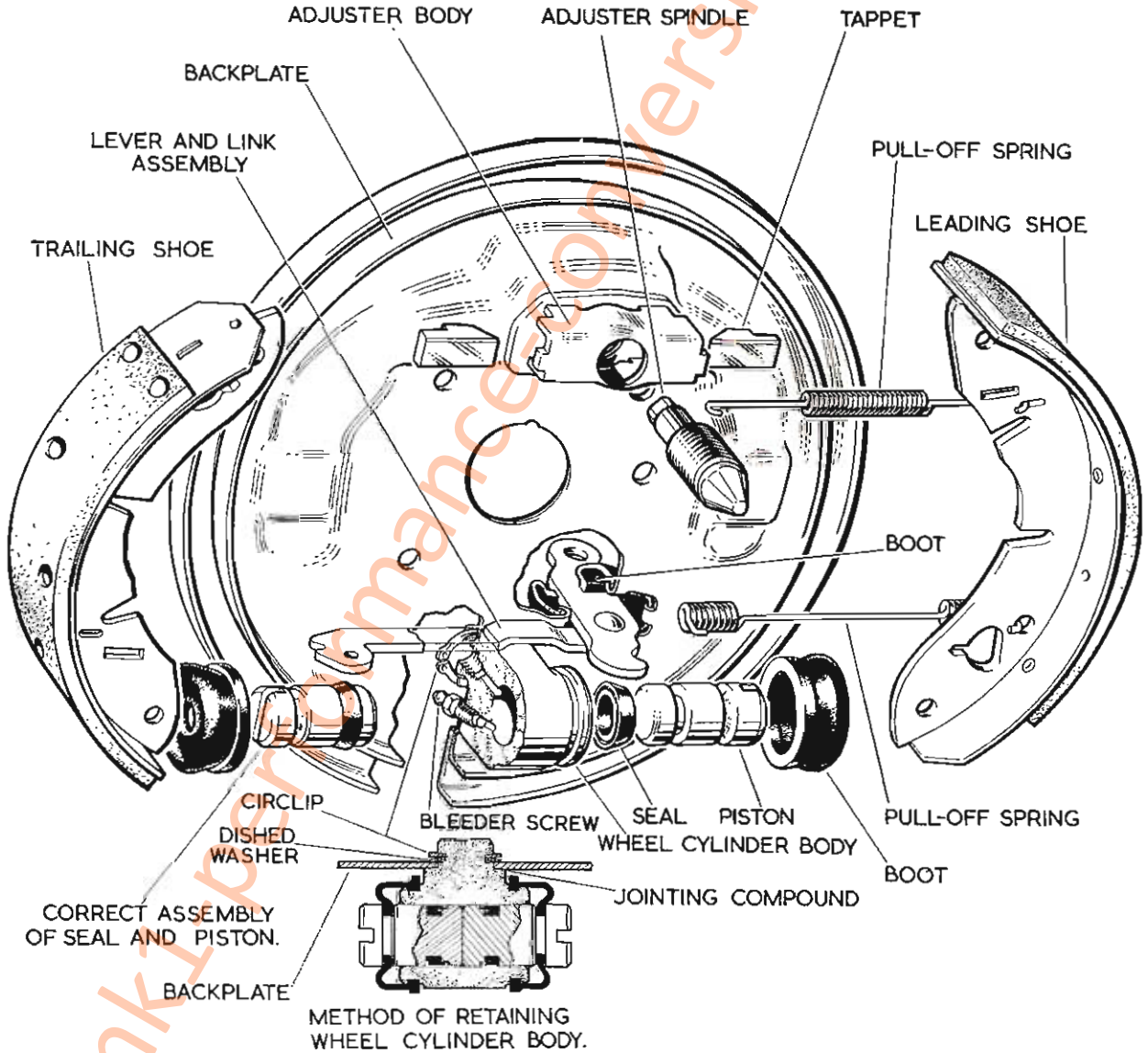
Offer up the trailing shoe to the backplate, so that the heel and toe engage respectively the slots in the wheel cylinder piston and the adjuster tappet. Hook the pull-off springs into the appropriate holes in the shoe (the coils of the springs are to be on the underside of the shoe).

Offer up the leading shoe so that its toe and heel are the opposite way to those of the trailing shoe; engage the pull-off springs with the appropriate holes, and pull the shoe into position with the ends engaging the slots in piston and tappet.

Screw the bleeder screw into the wheel cylinder, and connect up the flexible hose as detailed on page 18 after unplugging the metal pipe.

Fit the brake drum and the road wheel, "bleed" the system and adjust the brakes.

Fig. 9
Rear Brake Assembly
(Left hand assembly shewn)



Re-fitting the Pressure Regulating Valve to the Vehicle

Secure the unit by means of the fixing bolt. Unplug the pipes and connect up to the unit by screwing home the tube nuts ; the pipe from the master cylinder must be coupled to the connection at the end of the valve. "Bleed" the system as detailed in Section 5.

CLUTCH SLAVE CYLINDER (Refer to Fig. 12)

Description

The clutch slave cylinder comprises a body (8) housing a piston (5) against the inner face of which a rubber cup (3) is urged by a spring loaded cup filler (2) ; these parts are retained in the body by a circlip (6). A rubber boot (7) fits on to the end of the body to prevent the entry of dirt or moisture and, when the slave cylinder is mounted on the vehicle, a push rod passes through this ; the push rod being connected to the clutch throw-out mechanism.

The body is provided with two threaded connections, one of which receives the pipe from the clutch master cylinder whilst the other is fitted with a bleeder screw.

Removing and dismantling Clutch Slave Cylinder

To remove from the vehicle, disconnect the pipe and plug the end of it to prevent loss of fluid and entry of dirt, detach the rubber boot from the body and remove the fixing bolts. Leave the push rod on the vehicle ; if the rubber boot does not require to be renewed it may be left on the push rod.

Remove the circlip (6) from the bore. Apply a **low** air pressure at the open connection to expel the piston and the other parts ; remove the bleeder screw (4).

Assembling and re-fitting Slave Cylinder

Smear the internal parts and the bore of the body (8) with Lockheed Rubberlube. Locate the spring (1) in the cup filler (2), and insert the cup filler into the body, with the spring leading. Insert the rubber cup (3) into the body, lip leading, taking care not to turn back or buckle the lip ; follow up with the piston (5), flat face leading. Fit the circlip (6) into its groove at the mouth of the bore, pay particular attention to ensure correct location of the circlip.

Liberally treat the inside of the rubber boot (7) with Lockheed Rubberlube and, if previously removed, stretch the boot on to the body. Fit the bleeder screw (4) into the appropriate connection. Offer up the complete assembly to the vehicle, with the push rod passing through the boot ; if the boot was previously left on the push rod, stretch the large end into position on the body. Secure the slave cylinder by fitting the two fixing bolts.

Unplug the pipe and connect it to the cylinder by screwing in the tube nut. Bleed the system as described in Section 5.

REMOVING AND RE-FITTING A FLEXIBLE HOSE (Refer to Fig. 13)

In some cases the cause of faulty brakes or clutch may be traced to a choked flexible hose. Do not attempt to clear the obstruction by any means except air pressure, otherwise the hose may be damaged. If the obstruction cannot be cleared the hose must be replaced by a new one.

To remove the flexible hose, adopt the following procedure :—Unscrew the tube nut 'B' from the hose union 'A', then unscrew the nut 'C' and withdraw the hose from the bracket. Disconnect the hose at the other end.

When re-fitting brake hoses ensure that there is no risk of fouling due to the steering lock of the front wheels or oscillating movement of the suspension.

Screw the hose into the appropriate hydraulic unit, using a new gasket.

Before passing the hose union 'A' through the bracket **ensure the hose is not twisted or kinked ;** when the union is in position, hold it with a spanner to prevent the hose from turning whilst fitting the nut 'C' and the shakeproof washer. Connect up the metal pipe, by screwing home the tube nut 'B'.

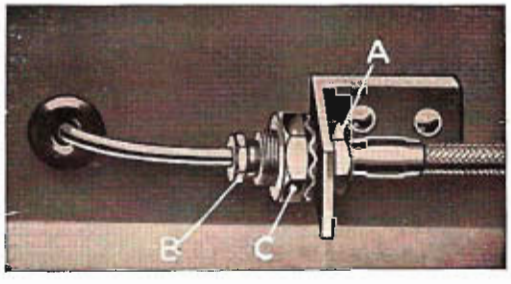


Fig. 13. Hose Junction

SECTION 5

BLEEDING AND FLUSHING

SECTION 5 BLEEDING AND FLUSHING

BLEEDING THE SYSTEMS

"Bleeding"—or expelling air—is not a routine operation and should be necessary only when some portion of the hydraulic equipment has been disconnected or when fluid has been drained off.

(1) **Bleeding the Braking System**
(Refer to Figs. 14 & 15)

(*a*) Fill the master cylinder tank with clean Lockheed Super Heavy Duty Brake Fluid to Spec. S.A.E. 70R3 and keep at least half full throughout the operation; otherwise air may be drawn in, necessitating a fresh start.

(*b*) Attach a rubber tube to the bleeder screw in one of the wheel cylinders and allow the free end to be submerged in a little brake fluid in a clean glass jar. Slacken the bleeder screw one complete turn.

(*c*) Depress the brake pedal slowly, allowing it to return unassisted, repeating this pumping action with a slight pause between each operation. Watch the flow of fluid in the jar and, when all air bubbles cease to appear, hold the pedal down firmly and securely tighten the bleeder screw.

(*d*) Repeat at all wheel cylinders. On completion of the "bleeding" procedure, replenish the master cylinder tank as indicated in Section 2.

Note: We do not recommend re-use of fluid bled from the system.

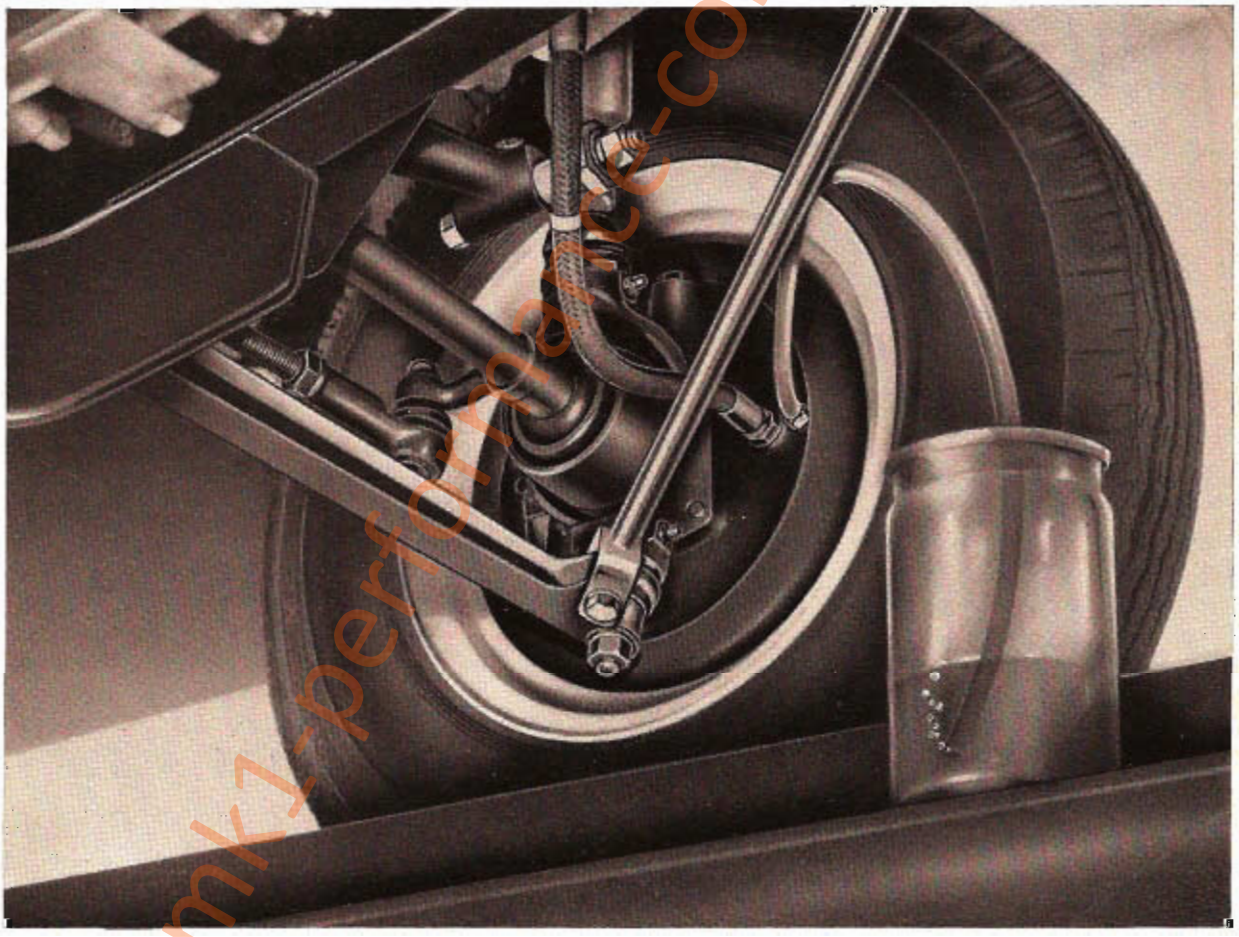


Fig. 14. "Bleeding" Front Brakes.

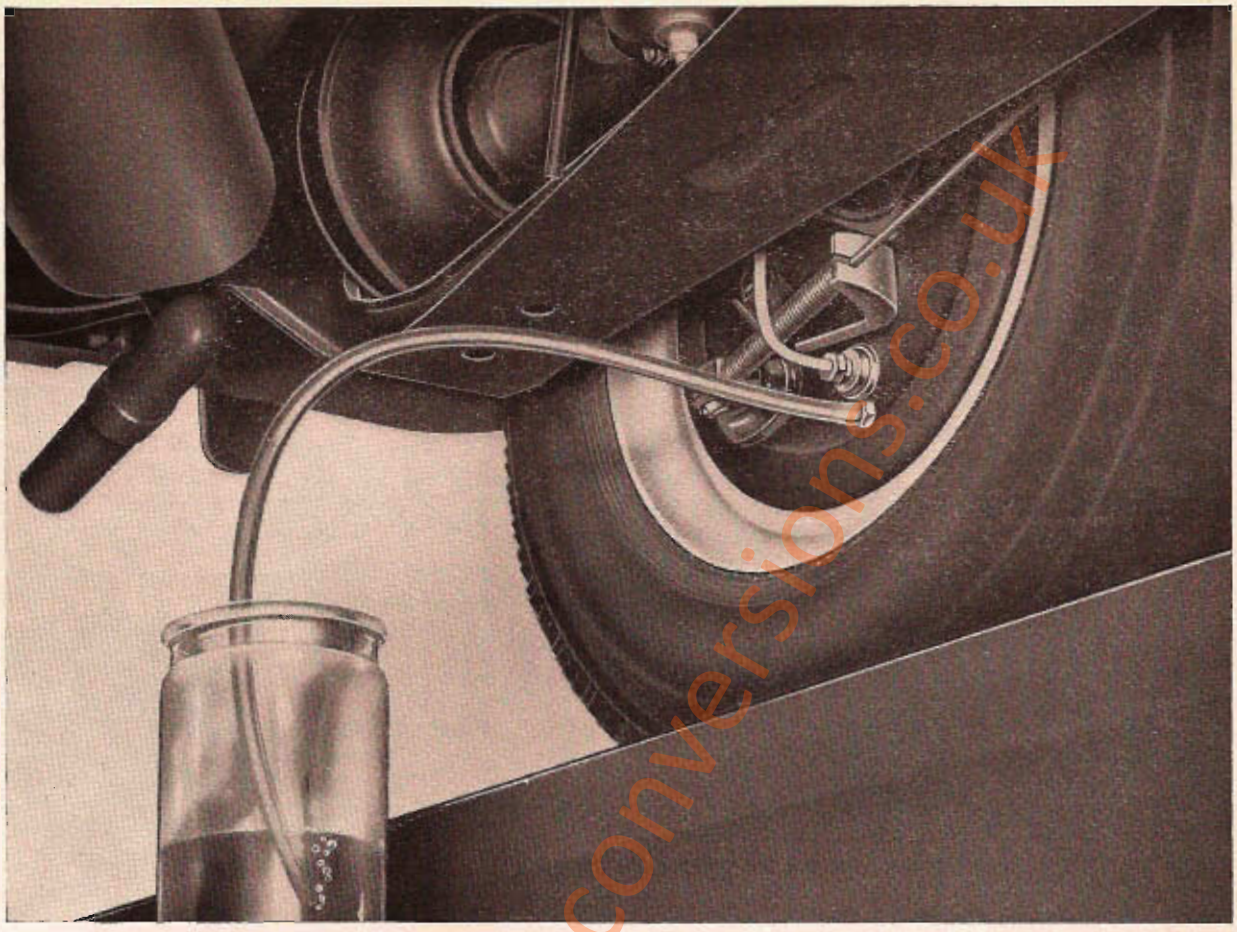


Fig. 15. "Bleeding" Rear Brakes.

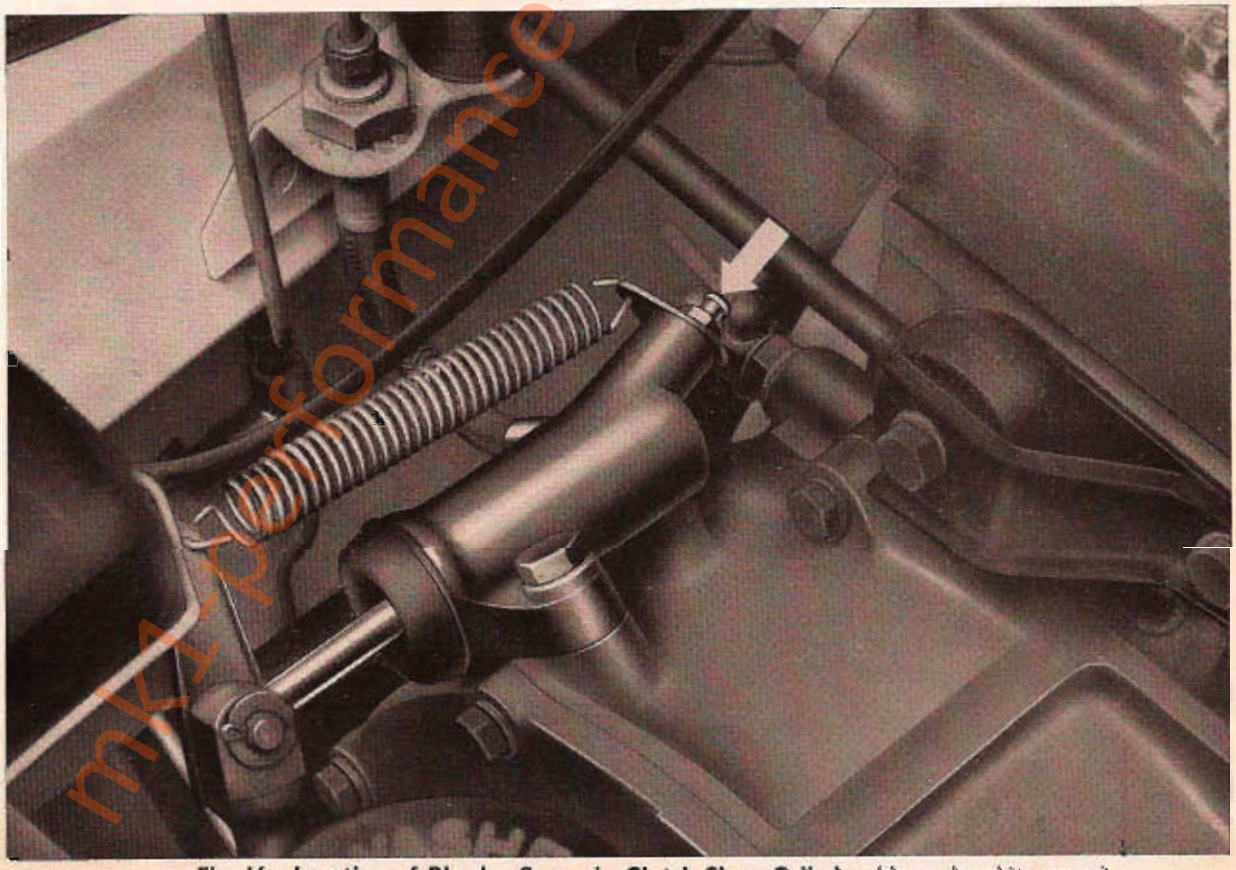


Fig. 16. Location of Bleeder Screw in Clutch Slave Cylinder (shewn by white arrow).

(2) **Bleeding the Clutch System** (Refer to Fig. 16)

(*a*) Fill the master cylinder tank with clean Lockheed Super Heavy Duty Brake Fluid and keep at least half full throughout the operation; otherwise air may be drawn in, necessitating a fresh start.

(*b*) Attach a rubber tube to the bleeder screw in the slave cylinder (indicated by an arrow on the illustration) and allow the free end to be submerged in a little brake fluid in a clean glass jar. Slacken the bleeder screw one complete turn.

(*c*) Depress the clutch pedal slowly, and tighten the bleeder screw before the pedal reaches the end of its stroke; repeat this action with a slight pause between each operation. Watch the flow of fluid in the jar and, when all air bubbles cease to appear, hold the pedal down firmly and securely tighten the bleeder screw.

(*d*) On completion of the "bleeding" procedure, replenish the master cylinder tank as indicated in Section 2.

Note: We do not recommend re-use of brake fluid which has been bled from the system.

FLUSHING THE SYSTEMS

Should the fluid in the systems become thick or "gummy" after long service, or after a vehicle has been laid up for some time, the system should be drained off, flushed and re-filled. It is recommended that this be carried out at least once every eighteen months. The system should also be flushed if it has become contaminated by the use of spurious fluid.

(1) **Flushing the Braking System**

(*a*) Pump all fluid out of the system through the bleeder screw of each wheel cylinder in turn. Connect one end of a rubber tube to the bleeder screw, allowing the other end to fall into a container; slacken the bleeder screw one complete turn and pump the brake pedal by depressing it quickly and allowing to return without assistance. Repeat, with a pause between each operation, until no more fluid is expelled. Discard all fluid extracted from the system.

(*b*) Fill the master cylinder tank with Lockheed Super Heavy Duty Brake Fluid and flush the system as described in sub paragraph (*a*) until the fluid runs clean.

(*c*) Keep the tank replenished with Lockheed Super Heavy Duty Brake Fluid.

(*d*) Top up the tank with clean Lockheed Super Heavy Duty Brake Fluid.

Note: If the system has become contaminated by the use of mineral oil, etc., the above process may not prove effective. In such an instance it is recommended that the various hydraulic units, including the pipe line, be dismantled and thoroughly cleaned and that all rubber parts, including flexible hoses, be renewed. The contaminated fluid should be destroyed immediately.

(2) **Flushing the Clutch System**

The method of flushing the clutch system is identical to that described for the brake system, except that the bleeder screw on the clutch slave cylinder should be closed at the end of each downward stroke of the clutch pedal.

SECTION 6 FAULT FINDING

BRAKING SYSTEM

1. **Pedal travel excessive** (Requires pumping)
   - (*a*) Brake shoes require adjusting, or re-lined brake shoes require to be fitted (if adjustment is already at maximum).
   - (*b*) Master cylinder requires replenishing with brake fluid.
   - (*c*) Leakage past main cup in master cylinder.
   - (*d*) Leakage from a hydraulic unit.

2. **Pedal feels springy**
   - (*a*) Linings not "bedded in".
   - (*b*) Brake drums weak or cracked.
   - (*c*) Master cylinder loose on mounting bracket.

3. **Pedal feels spongy**
   - (*a*) Leakage past main cup in master cylinder.
   - (*b*) Master cylinder secondary cup worn (air bubbles rise in tank).
   - (*c*) Leak at one or more points in system.
   - (*d*) Brakes not properly bled.

4. **Brakes inefficient**
   - (*a*) Linings not "bedded-in".
   - (*b*) Linings greasy.
   - (*c*) Linings incorrect type.
   - (*d*) Pressure regulating valve faulty (would affect operation of rear brakes only).

5. **Brakes drag**
   - (*a*) Shoes over-adjusted.
   - (*b*) Shoe pull-off springs weak or broken.
   - (*c*) Handbrake linkage seized or over-adjusted.
   - (*d*) Wheel cylinder piston seized.
   - (*e*) Supply tank overfilled.
   - (*f*) Air vent in master cylinder filler cap blocked.
   - (*g*) Master cylinder by-pass port blocked.
   - (*h*) Pressure regulating valve fails to release (would affect operation of rear brakes only).

6. **Brakes remain on**
   - (*a*) Shoes over-adjusted.
   - (*b*) Handbrake linkage seized or over-adjusted.
   - (*c*) Swollen rubber cups in master cylinder or wheel cylinders, caused by contamination with mineral oil or spurious fluid. The system will need to be flushed and re-filled as indicated on page 22.

7. **Unbalanced braking**
   - (*a*) Greasy linings.
   - (*b*) Distorted drums.
   - (*c*) Tyres unevenly inflated.
   - (*d*) Brake backplate loose on stub axle.
   - (*e*) Worn steering connections.
   - (*f*) Different grades of linings fitted.
   - (*g*) Faulty pressure regulating valve (would affect front/rear braking ratio).

CLUTCH SYSTEM

1. **Clutch slips**
   - (*a*) Seized piston in clutch slave cylinder.
   - (*b*) Insufficient clearance between master cylinder piston and push-rod.
   - (*c*) By-pass port blocked in master cylinder.

2. **Clutch drags or fails to release**
   - (*a*) System needs "bleeding".
   - (*b*) Bad external leak between clutch master cylinder and slave cylinder.
   - (*c*) Leakage past main cup in master cylinder.

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