SECTION M

THE BRAKING SYSTEM

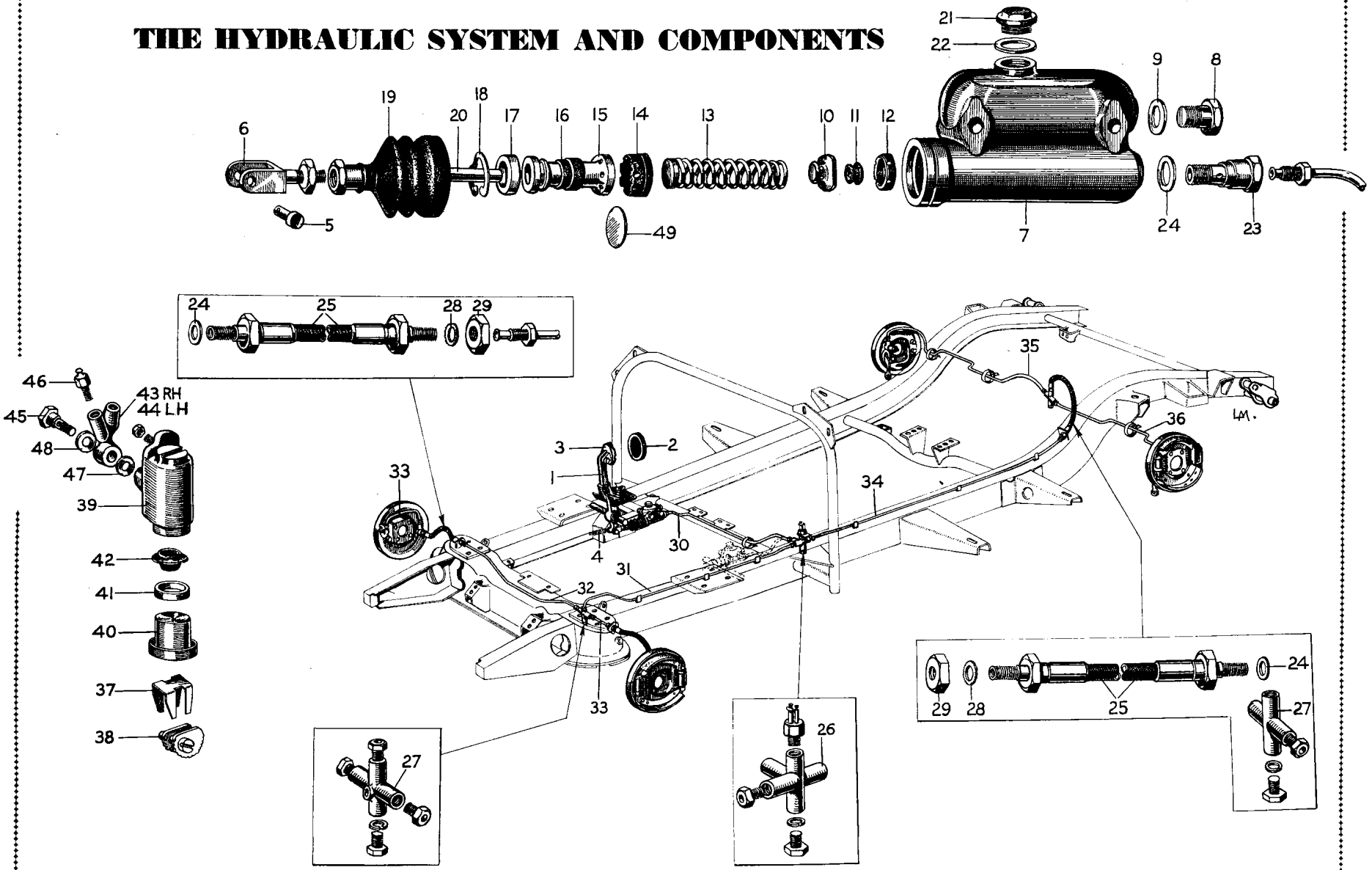
GENERAL DESCRIPTION

The Lockheed hydraulic brake operating equipment comprises a combined fluid supply tank and master cylinder in which the hydraulic pressure is generated, and wheel cylinders which operate the brake-shoes.

Steel pipe lines, unions and flexible hoses convey the hydraulic pressure from the master cylinder to each wheel cylinder.

Each brake-shoe on the front wheels has a separate wheel cylinder, thus providing two leading shoes. On the rear wheels a single wheel cylinder, operated both hydraulically and mechanically, floats on the brake plate and operates the two shoes, giving one leading and one trailing shoe in either direction of rotation to provide adequate braking in reverse.

THE HYDRAULIC SYSTEM AND COMPONENTS



KEY TO THE HYDRAULIC SYSTEM AND COMPONENTS

No.	Description
1.	Brake pedal and bush.
2.	Pad—rubber—brake pedal.
3.	Pad—brake pedal.
4.	Return spring—brake pedal.
5.	Pin—brake pedal.
6.	Fork end—master cylinder.
7.	Master cylinder and tank assembly.
8.	Drain plug.
9.	Gasket—drain plug.
10.	Valve assembly.
11.	Cup—valve.
12.	Washer—valve.
13.	Spring (with retainer)—piston return.
14.	Cup—piston.
15.	Piston—master cylinder.
16.	Cup—piston secondary.
17.	Stop—piston.
18.	Circlip—stop.
19.	Boot—master cylinder.
20.	Push-rod—master cylinder.
21.	Filler plug assembly.
22.	Gasket—filler plug.
23.	Adaptor—master cylinder.
24.	Gasket—master cylinder.
25.	Hose assembly.
26.	Four-way piece.
27.	Three-way piece.
28.	Lock washer.
29.	Locknut—hose.
30.	Pipe (master cylinder to 4-way).
31.	Pipe (4-way to 3-way).
32.	Pipe (front 3-way to R/H front hose pipe).
33.	Pipe (front 3-way to front hose).
34.	Pipe (4-way to rear hose).
35.	Pipe (axle hose bracket to R/H rear).
36.	Pipe (axle hose bracket to L/H rear).
37.	Mask—shoe adjuster.
38.	Adjuster—brake-shoe.
39.	Body with studs and abutment.
40.	Piston and dust cover assembly.
41.	Cup—piston.
42.	Cup—filler.
43.	Banjo connection—forward R/H.
44.	Banjo connection—forward L/H.
45.	Bolt—connection.
46.	Bleeder screw.
47.	Gasket—banjo bolt—small.
48.	Gasket—banjo bolt—large.
49.	Washer.

MAINTENANCE

Periodically examine the quantity of brake fluid in the master cylinder. It should never be less than half full or closer than ½ in. (13 mm.) from the bottom of the filler neck. The necessity for frequent topping up is an indication of over-filling or a leak in the system, which should at once be traced and rectified.

Adjust the brake-shoes to compensate for wear of the linings. The need for this is shown by the pedal going down almost to the floorboards before solid resistance is felt. For brake-shoe adjustments see Section M.2.

Adjustment of the brake-shoes in the manner indicated also adjusts the hand brake automatically and no separate adjustment is required or permitted.

THE MASTER CYLINDER

The master cylinder is mounted on the driver's side of the car underneath the gearbox cover.

Within the cylinder is a piston, backed by a rubber cup, normally held in the "off" position by a piston return spring. Immediately in front of the cup, when it is in the "off" position, is a compensating orifice connecting the cylinder with the fluid supply. This port allows free compensation for any expansion or contraction of the fluid, thus ensuring that the system is constantly filled ; it also serves as a release for additional fluid drawn into the system during brake applications. Pressure is applied to the piston by means of the push-rod attached to the brake pedal. The push-rod is adjustable and should have a slight clearance when the system is at rest to allow the piston to return fully against its stop. Without this clearance the main cup will cover the by-pass port, causing pressure to build up within the system, and produce binding of the brakes on all wheels. The reduced skirt of the piston forms an annular space which is filled with fluid from the supply tank via the feed hole. Leakage of fluid from the open end of the cylinder is prevented by the secondary cup fitted to the flange end of the piston. On releasing the brake pedal, after application, the piston is returned quickly to its stop by the return spring, thus creating a vacuum in the cylinder ; this vacuum causes the main cup to collapse and pass fluid through the small holes in the piston head from the annular space formed by the piston skirt. This additional fluid finds its way back to the reserve supply under the action of the brake return springs, when the system finally comes to rest, through the outlet valve and compensating orifice. If the compensating orifice is covered by the piston cup when the system is at rest, pressure will build up as a result of the brake application. The combination inlet and outlet check valve in the head of the cylinder is provided to allow the passage of fluid under pressure from the master piston into the pipe lines, and control its return into the cylinder, so that a small pressure of approximately 8 lb. per square inch (·56 kg./cm.^{2}) is maintained in the pipe lines to ensure that the cups of the wheel cylinders are kept expanded ; it also prevents fluid pumped out from the cylinder "when bleeding" from returning to

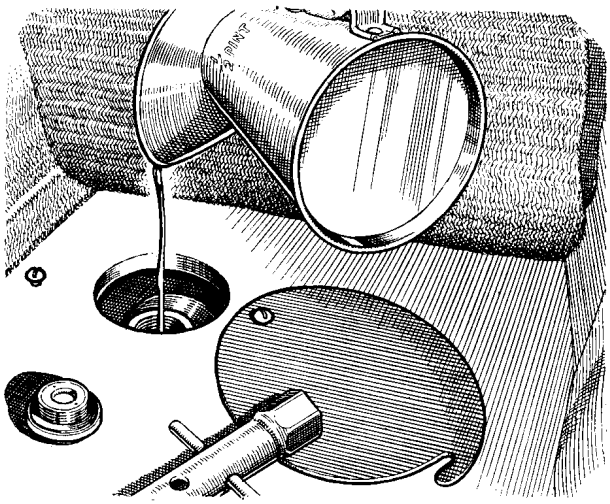


Fig. M.1.
Replenishment of the system is accomplished through the aperture in the floorboard closed by a pivoting metal cover.

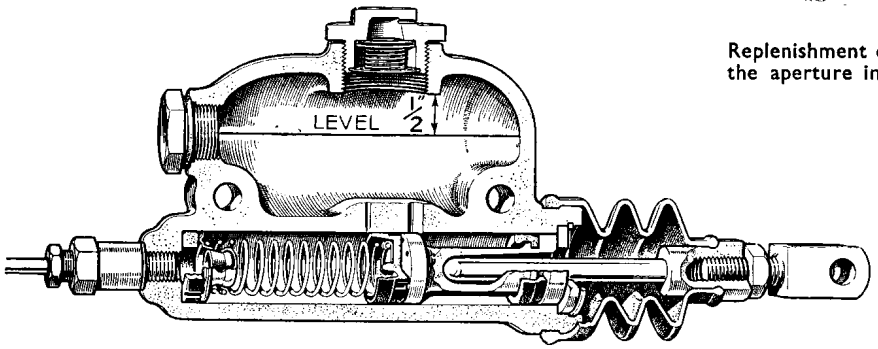


Fig. M.2.
The master cylinder in section, showing the correct fluid level and the disposition of the components.

the cylinder, thus ensuring a fresh charge being delivered at each stroke of the pedal.

Section M.1

ADJUSTMENT OF THE BRAKE PEDAL

The correct amount of free movement between the master cylinder push-rod and piston is set during erection of the vehicle, and should never need alteration.

In the event of the adjustment having been disturbed, adjust the effective length of the rod connecting the cylinder to the pedal until the pedal pad can be depressed approximately ½ in. (13 mm.) before the piston begins to move. The clearance can be felt if the pedal is depressed by hand.

Note.—*Before making any alteration it is important to ensure that neither the floorboard nor the floor carpet obstructs the pedal and that the piston has not stuck in the cylinder bore. In either case a false impression will be given, even though the adjustment is correct.*

Remove the front hub cap and road wheel and rotate the brake-drum until both adjustment screws are visible through the holes provided in the face of the brake-drum. With a screwdriver turn both screws as far as they will go in a clockwise direction until the drum is locked solid, then turn them anti-clockwise

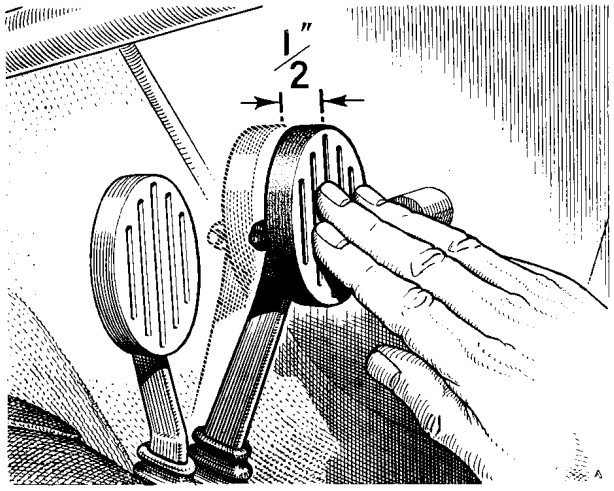


Fig. M.3.
There must be ½ in. (13 mm.) of free movement at the brake pedal pad.

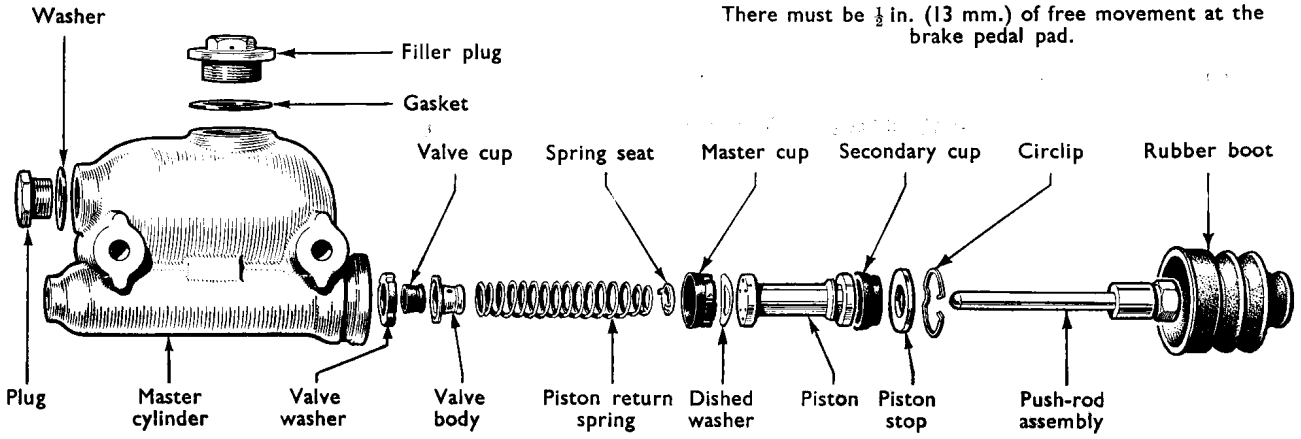


Fig. M.4.
The component parts of the master cylinder.
Later models have a thin dished copper washer between the end of the piston and the master cup which must be fitted with its concave face against the master cup and its convex face against the piston head as shown. (See also Fig. M.14.) If this washer is found to be missing when dismantling, a washer must be procured and fitted on reassembling. This is imperative.

Section M.2

BRAKE-SHOE ADJUSTMENTS

When lining wear has reached a point where the pedal travels to within 1 in. (25 mm.) of the floorboards before the brakes come into action, it is necessary to adjust the brake-shoes.

The front brakes

Jack up the wheel on which it is desired to set the brake.

one notch only. The brake-drum should then be free to rotate without the shoes rubbing, and the adjustment on this wheel is complete. The brake-shoes on the other front wheel must be adjusted by the same method.

The rear brakes

The procedure is similar to that detailed for the front brakes except that there is only one adjuster, and this controls both shoes and the hand-brake operation.

Section M.3

TO BLEED THE SYSTEM
(Expel Air)

Bleeding the system is not a routine maintenance job, and should only be necessary when some portion of the hydraulic equipment has been disconnected or the fluid drained off.

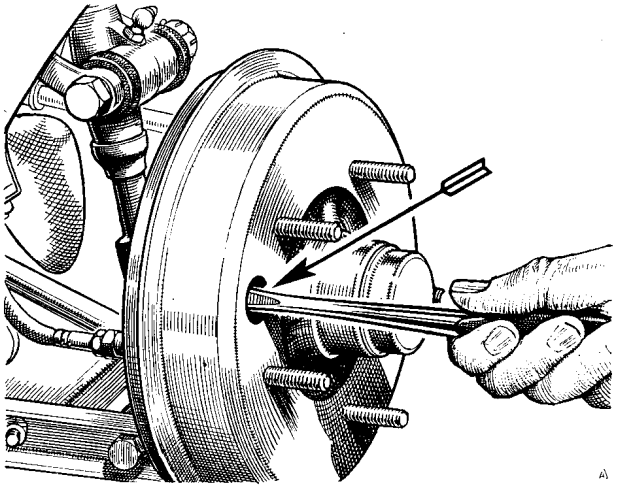


Fig. M.5.
Two holes are provided in the brake-drums to enable both the front brake-shoe adjusters to be reached easily with a screwdriver.

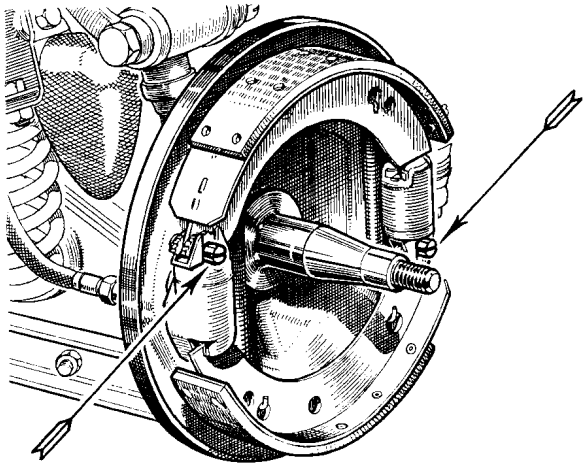


Fig. M.6.
The front brake-drum removed to show the two "Micram" adjusters for the shoes.

Fill the master cylinder with Lockheed Genuine Brake Fluid and keep it at least half-full throughout the operation, otherwise air will be drawn into the system, necessitating a fresh start.

Attach the bleeder tube to the wheel cylinder bleeder screw and allow the free end of the tube to be submerged in a small quantity of fluid in a clean glass jar.

Open the bleeder screw one full turn.

Depress the brake pedal quickly, and allow it to return without assistance. Repeat this pumping action with a slight pause before each depression of the pedal.

Watch the flow of fluid into the glass jar, and when air bubbles cease to appear, hold the pedal firmly against the floorboards while the bleeder screw is securely tightened.

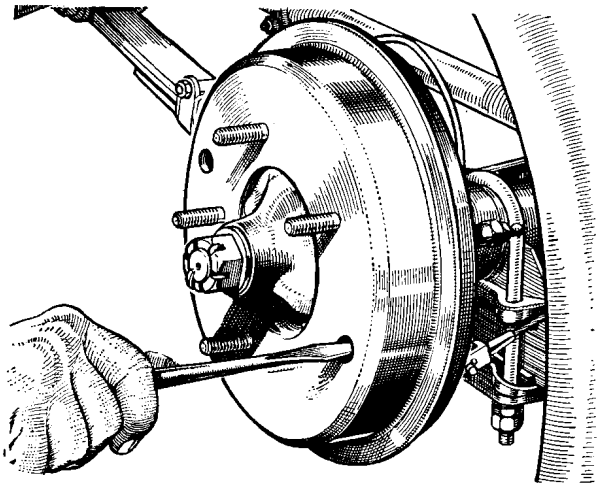


Fig. M.7.
The rear brake-shoes have only one adjuster which adjusts both shoes simultaneously.

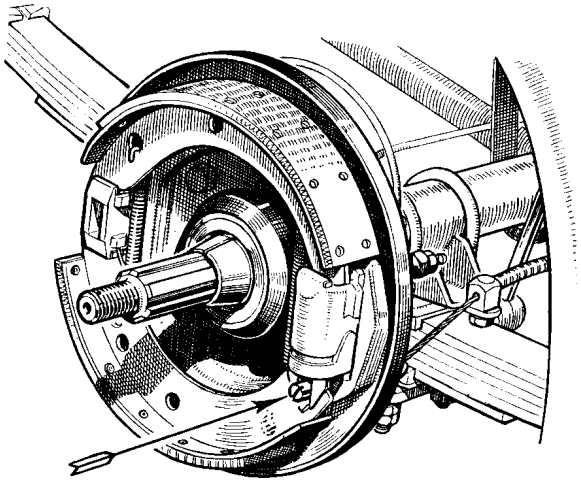


Fig. M.8.
The single "Micram" adjuster of the rear brakes. This adjusts the hand brake mechanism at the same time.

Repeat the operation on each wheel.

Note.—*Clean fluid bled from the system must be allowed to stand until it is clear of air bubbles before using it again. Dirty fluid should be discarded.*

Section M.4

REMOVAL OF THE MASTER CYLINDER

Remove the floorboard and disconnect the $\frac{3}{16}$ in. union nut connecting the pipe line to the master cylinder.

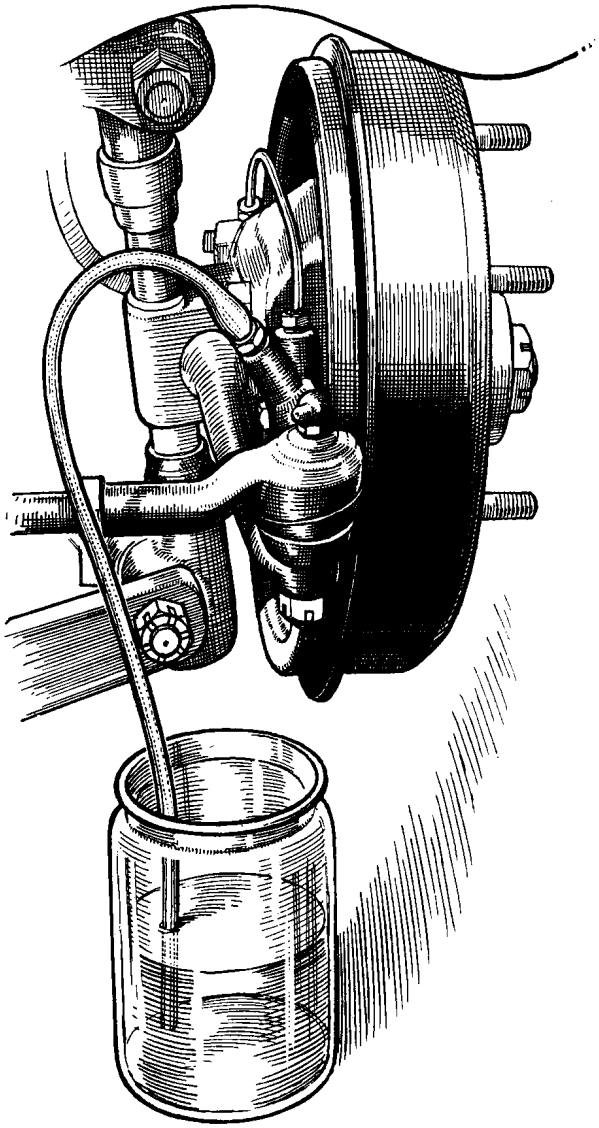


Fig. M.9.
The special bleeding tube in use in conjunction with a glass jar to clear the system of air.

Remove the $\frac{5}{16}$ in. nuts and spring washers from the two bolts passing through the master cylinder and securing it to the frame member. Withdraw the bolts.

Disconnect the brake pedal return spring from the frame.

Lift out the brake pedal complete with push-rod, rubber boot and pedal return spring.

The master cylinder complete with main supply pipe is now easily removed.

Section M.5

DISMANTLING THE MASTER CYLINDER

Remove the filler cap and drain the Lockheed hydraulic brake fluid from the master cylinder. Remove the main feed pipe, union and copper washers.

Push the piston down the cylinder bore and remove the retaining circlip.

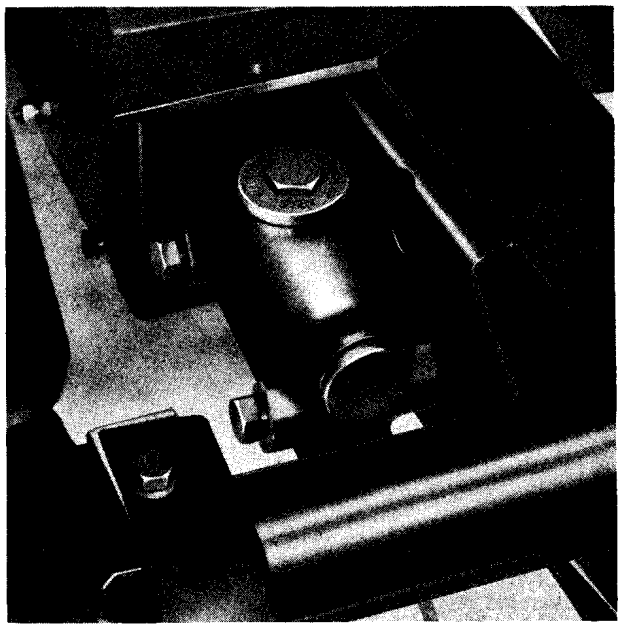


Fig. M.10.
Access to the master cylinder for removal is obtained by removing the floorboard.

Remove the remaining internal parts, i.e. the piston, piston master cup, return spring, valve cup assembly and valve seating washer.

To remove the secondary cup from the piston, carefully stretch it over the end flange, using the fingers only.

Section M.6

ASSEMBLING THE MASTER CYLINDER

Clean all parts thoroughly, using Lockheed Genuine Brake Fluid for all rubber components. All traces of fuel, kerosene or trichlorethylene used for cleaning the metal parts must be removed before assembly.

Examine all the rubber parts for damage or distortion. It is usually advisable to renew the rubbers when rebuilding the cylinder.

Dip all the internal parts in brake fluid and assemble them wet.

Stretch the secondary cup over the end flange of the piston with the lip of the cup facing towards the opposite end of the piston. When the cup is in its groove, work it round gently with the fingers to make sure it is correctly seated.

Fit the valve washer, valve cup and body onto the return spring and insert the spring valve first into the cylinder. See that the spring retainer is in position.

Insert the master cup, lip first, taking care not to damage or turn back the lip, and press it down onto the spring retainer. Place the dished washer in place on the end of the master cup with its concave face in contact with the cup. It is imperative that this washer should be fitted in all cases.

Insert the piston, taking care not to damage or turn back the lip of the secondary cup.

Push the piston down the bore slightly, and insert the retaining circlip in the groove in the cylinder bore.

Test the master cylinder by filling the tank and by pushing the piston down the bore and allowing it to return ; after one or two applications fluid should flow from the outlet.

Section M.7

REPLACING THE MASTER CYLINDER

The replacement procedure is the reverse of the removal instructions given in Section M.4 with the following additions :—

Replace the main feed pipe in its correct position and fully tighten the union before replacing the master cylinder in its housing.

Check the shoe adjustment as detailed in Section M.2.

Connect the fluid pipes and bleed the system as in Section M.3.

Check the system for leaks with the brakes fully applied. Renew the copper washers on the two-way outlet connection if necessary.

Section M.8

BRAKE ASSEMBLY

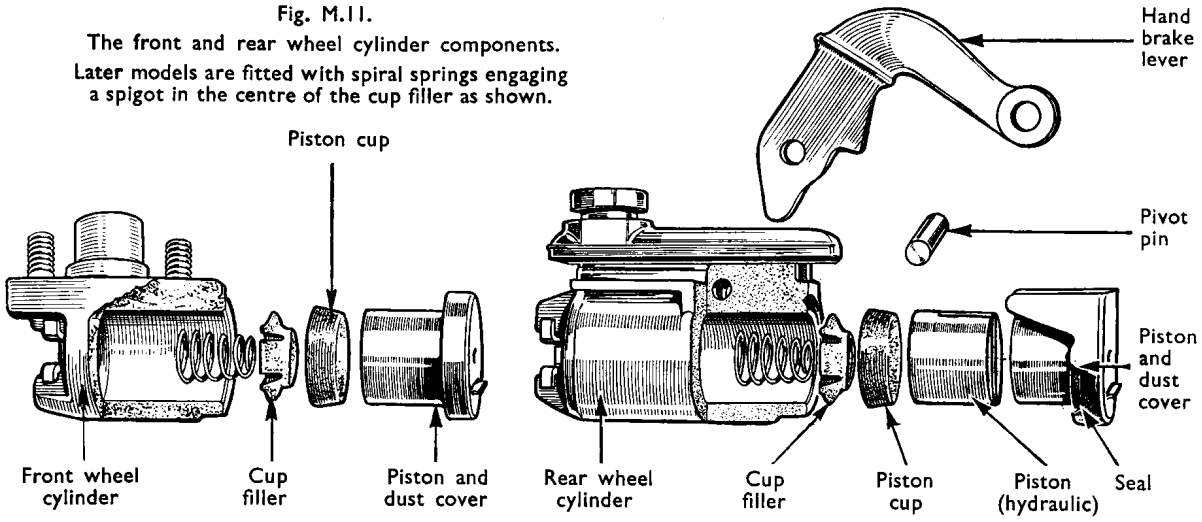
Two leading shoes are incorporated in the front wheel braking system and take the greater percentage of the braking load. The rear brakes are of the leading and trailing shoe type, giving the advantage of equal braking action when the brakes are used in reverse.

All the shoes have a floating anchorage, each front shoe utilising the closed end of the other shoe actuating cylinder as its abutment. The two rear shoes share one common abutment stop.

The hand brake lever operates the rear brakes mechanically through a linkage operating on the piston of the rear wheel cylinder which is made in two halves. The outer half of the piston applies the leading shoes when actuated by a lever pivoted in the cylinder body. The trailing shoe is applied by the movement of the cylinder body which slides on the brake plate as a result of the reaction of the mechanically operated lever on the pivot.

When operated hydraulically the inner half of the piston is forced outwards, carrying with it the outer half, thus applying the leading shoe, and the trailing shoe is applied by the floating cylinder body as a result of the reaction of the fluid pressure on the body.

Fig. M.11.
The front and rear wheel cylinder components.
Later models are fitted with spiral springs engaging a spigot in the centre of the cup filler as shown.



Section M.9

REMOVAL OF THE WHEEL CYLINDER

Front

Raise the front of the car and remove the hub cap and road wheel. Remove the brake-drum and hub assembly as detailed in Section K.12.

Draw the brake-shoes apart until the assembly can be lifted from the wheel cylinders and brake plate.

Release the flexible hose as detailed in Section M.13.

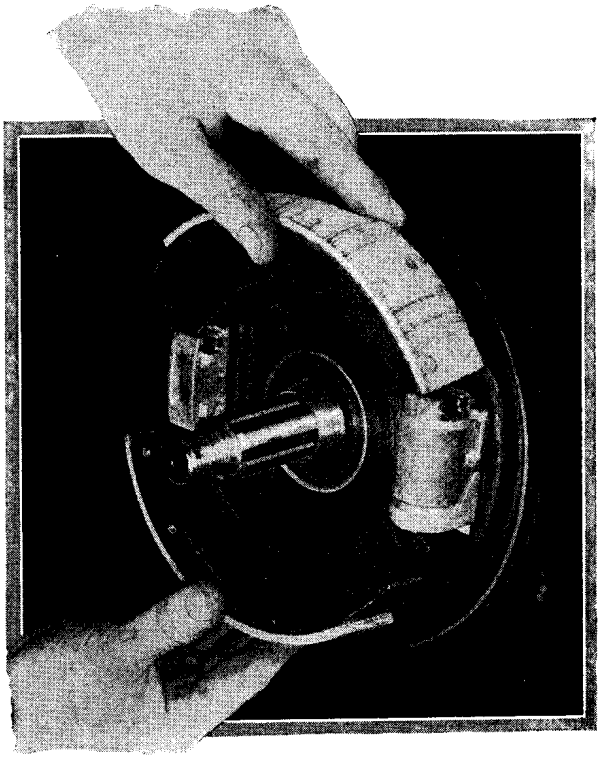


Fig. M.12.
Removing the rear brake-shoes from the brake plate after releasing the return spring.

Remove the flexible hose union bolt from the wheel cylinder, observing that the copper washers on either side of the banjo union are of different sizes and that the small washer is next to the cylinder.

Remove the two $\frac{1}{4}$ in. nuts and spring washers securing the wheel cylinder to the brake plate and remove the cylinder.

The other cylinder is removed after extracting the $\frac{5}{16}$ in. banjo union bolt and the two bolts securing the cylinder to the brake plate.

Rear

Raise the rear of the car and remove the hub cap and road wheel. Remove the brake-drum and hub assembly as detailed in Section H.1.

Draw the brake-shoes apart until the assembly can be lifted from the brake plate.

Release the metal feed pipe from the wheel cylinder by undoing the $\frac{3}{16}$ in. union nut. Remove the $\frac{5}{16}$ in. adaptor securing the bleed screw banjo union to the wheel cylinder, observing that the large copper washer is fitted away from the cylinder.

Remove the clevis pin from the hand brake cable yoke and disconnect the cable from the wheel cylinder lever. Remove the rubber boot and withdraw the lower half of the piston from the wheel cylinder. Extract the wheel cylinder from the brake plate.

Section M.10

DISMANTLING THE WHEEL CYLINDER

Rear cylinders

Tap out the hand brake lever pivot pin and withdraw the lever. Withdraw the upper half of the piston, the rubber cup and the bakelite filler. In later models the centre of the filler has a spigot which engages a spiral spring.

Front cylinders

Withdraw the piston, the rubber cup and cup filler. Here again later models are fitted with a spiral spring engaging the filler.

Section M.11

ASSEMBLING THE WHEEL CYLINDER

Clean all parts thoroughly, using only Lockheed hydraulic brake fluid for the rubber components. All traces of petrol (gasoline), paraffin (kerosene) or trichlorethylene used for cleaning the metal parts must be completely removed before assembly.

Examine the rubber cups for damage, wear, or distortion. Dip all parts in brake fluid and assemble wet. Place the spiral spring with its small end engaging the spigot of the bakelite filler, on which it should be a push fit.

Insert the cup filler, shallow side and spring first (this is important), and the rubber cup concave side first.

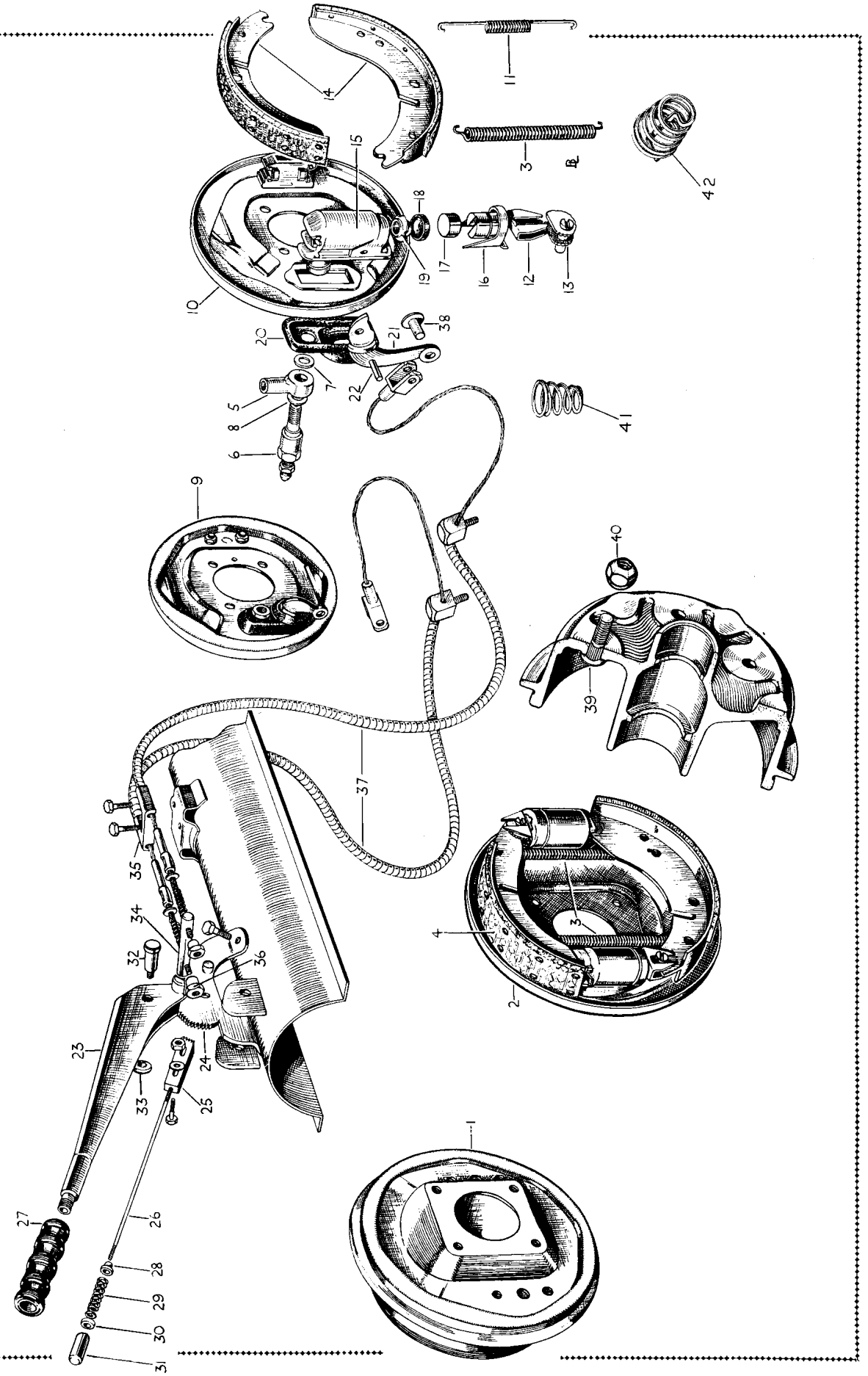
Replace the piston, and in the case of the rear cylinders, insert the hand brake lever and its pivot pin.

Section M.12

REPLACEMENT OF THE WHEEL CYLINDER

The procedure for replacing the wheel cylinder is a reversal of the sequence of operations given in Section M.9 but attention must be given to the important points noted on page M.12.

THE HAND BRAKE AND BRAKE-SHOE COMPONENTS



KEY TO THE HAND BRAKE AND BRAKE-SHOE COMPONENTS

No.	Description
1.	Brake gear (front axle) back plate assembly—R/H.
2.	Brake gear (front axle) back plate assembly—L/H.
3.	Spring—shoe pull-off.
4.	Front brake-shoe—lined complete.
5.	Banjo connections.
6.	Bolt—connection.
7.	Gasket—banjo bolt—small.
8.	Gasket—banjo bolt—large.
9.	Brake gear (rear axle) back plate assembly—R/H.
10.	Brake gear (rear axle) back plate assembly—L/H.
11.	Spring—shoe tension.
12.	Mask—shoe adjuster.
13.	Adjuster—brake-shoe.
14.	Rear brake-shoe—lined complete.
15.	Body and abutment strip.
16.	Piston and dust cover.
17.	Piston (hydraulic).
18.	Cup—piston.
19.	Cup—filler.
20.	Boot—wheel cylinder.
21.	Hand brake lever.
22.	Pivot pin—hand brake lever.
23.	Lever assembly.
24.	Ratchet assembly
25.	Hand brake pawl.
26.	Pawl rod—hand brake.
27.	Hand grip.
28.	Bush for rod.
29.	Spring—lever knob.
30.	Washer—spring.
31.	Knob—pawl rod.
32.	Fulcrum pin.
33.	Washer—fulcrum pin.
34.	Trunnion—hand brake.
35.	Twin cable abutment.
36.	Adjuster nut—brake cable.
37.	Cable—hand brake.
38.	Clevis pin.
39.	Wheel stud.
40.	Nut—wheel stud.
41.	Spring—wheel cylinder piston.
42.	Spring—brake-shoe steady.

Front

The front brake wheel cylinders are interchangeable but the link pipe banjo unions must be fitted to them so that the flexible hose is connected to the forward cylinder and the bleed screw to the rear cylinder. The link pipe must pass above the brake plate.

The brake-shoes are interchangeable but the recessed ends must engage the "Micram" shoe adjusters and the brake-shoe pull-off springs must be fitted between the shoes and the brake plate.

Rear

The wheel cylinder must be fitted on the forward side of the axle casing with the bleed screw vertical.

The brake-shoes are interchangeable but the recessed end of the lower or leading shoe must engage the "Micram" shoe adjuster. The other shoe should also be fitted with its recessed end against the wheel cylinder.

The light brake-shoe pull-off spring must be fitted away from the wheel cylinder, and both springs are fitted between the shoes and the brake plate.

Section M.13

REMOVAL OF THE FLEXIBLE HOSE

Do not attempt to release the flexible hose by turning either end with a spanner. It should be removed as follows :—

Front

Unscrew the metal pipe line union nut (1) (Fig. M.13) from its connection to the hose.

Remove the locknut (2) securing the flexible hose union to the chassis and unscrew the hose from the wheel cylinder.

The union on the master cylinder side also incorporates the stop-lamp switch. Disconnect the two wires from their terminals and with a $\frac{5}{16}$ in. spanner undo the nut to release the switch and the two copper washers fitted either side of the two-way union.

Section M.14

REMOVAL AND REPLACEMENT OF THE BRAKE-SHOES

Remove the rear brake-drum and hub as detailed in Section H.1. Instructions for removing the front brake-drum and hub are given in Section K.12.

Draw the brake-shoes apart until they can be removed from the brake plate.

Important.—When replacing the shoes the pull-off springs must be between the shoes and the brake plate.

The brake-shoes are interchangeable but the recessed end must engage the "Micram" shoe adjuster on the wheel cylinder.

In the case of the rear brakes, the light pull-off spring is fitted away from the wheel cylinder. The recessed end of the upper or trailing shoe is fitted against the brake-shoe stop on the brake plate.

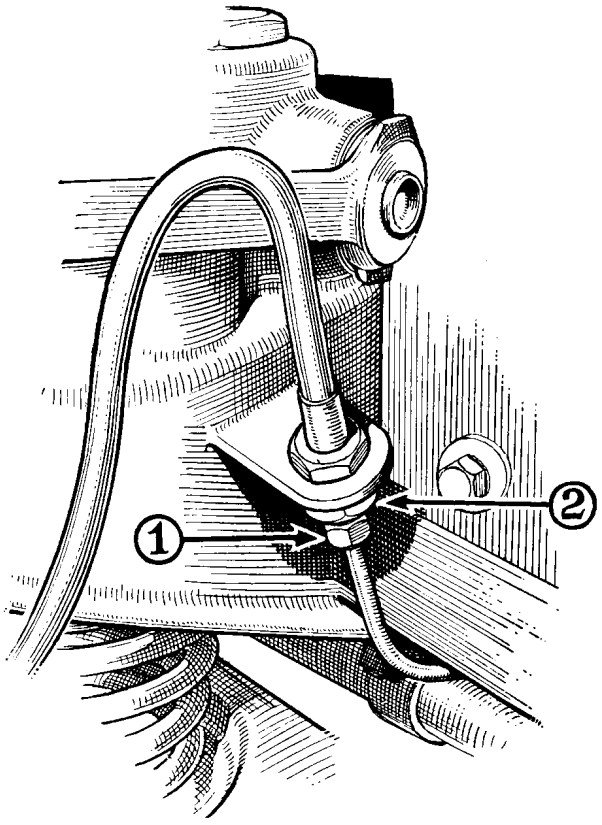


Fig. M.13

When uncoupling the flexible hoses the union nut (1) must first be undone and then the hexagon retaining nut (2). On no account must the other hexagon attached to the hose be turned.

Section M.15

RELINING THE BRAKE-SHOES

Owing to the need for the brake linings to be finished so that they are perfectly concentric with the brake-drums, to obtain the best results, relining of the brake-shoes is not satisfactory without special precautions.

If replacement of the brake-shoes and linings is necessary on account of excessive wear or other cause, it is most important that the material used for the lining is as specified by The M.G. Car Company Ltd. Any variations from this will give an unequal and unsatisfactory braking performance.

After riveting the new brake linings to the brake-shoes it is essential that any high spots should be removed before replacement on the back plate assembly.

When new shoes and linings are fitted it must be appreciated that considerable adjustment has to be made to the foot brake mechanism, and it is necessary to return the " Micram " adjusters to their fully anti-clockwise position before attempting to refit the brake-drums over the new linings. The hand brake must also be in the fully released position.

Important.—Do not use any substitute for Genuine Brake Fluid, as a substitute will seriously affect the working of the system. In extremely cold conditions use Wagner No. 21 Fluid.

Do not allow grease, paint, oil or brake fluid to come in contact with the brake linings.

Do not clean the rubber parts with any fluid other than Lockheed hydraulic brake fluid. All traces of petrol (gasoline), paraffin (kerosene), etc., used for cleaning metal parts must be removed before reassembly.

Do not reline the brake-shoes with different types of linings, as this is bound to cause unequal braking.

Do not allow the fluid in the master cylinder and supply tank assembly to fall below the half-full mark. When full the fluid should be level with the bottom of the filler neck, with the brakes in the " off " position.

Section M.16

THE BRAKE FLUID

The only correct fluid for replenishment of the hydraulic brake system is Lockheed Genuine Brake Fluid.

In cases of difficulty in obtaining Lockheed Genuine Brake Fluid use must be made of a fluid conforming to S.A.E. specification 70.R2.

In cases of extreme cold consistently below 0° Fahrenheit or —18° Centigrade, Wagner No. 21 Fluid should be used either for topping up or refilling the system.

Section M.17

THE HAND BRAKE

The hand brake is of the quick-release type, the ratchet knob being depressed after the lever has been pulled up. A slight upward pull on the lever will allow it to move to the " off " position without depressing the ratchet knob.

It operates the rear brakes by means of cables, and no adjustment is necessary, as adjustment of the hydraulic brake automatically adjusts the hand brake. **If the two brass nuts on the lever are moved the whole braking system will be upset.**

Sufficient movement is allowed at the lever to deal with full wear at the linings.

If the wheel cylinder operating cables have been disconnected, they should be readjusted after re-assembly in the following manner :—

Return the hand brake pull lever to the fully released position.

Remove the split pin and clevis pin retaining the brake cable to each wheel cylinder lever.

Adjust the brake-shoes as in Section M.2.

Screw up the cable adjusting nuts by equal amounts until the cable clevis pins will fall into position in the cable forks without moving the wheel cylinder lever. Replace the split pins.

Section M.18

REAR BRAKE PIPES

Cases have been reported where the rear brake pipes lying along the axle rub against the rear axle strap, or, in the case of Mk. II competition cars, against the shock absorber arms. The pipes are adequately clipped, and care should be taken to see that the pipe is set to give at least 1 in. (2·5 cm.) clearance at these points.

Section M.19

BRAKING IRREGULARITIES AND THEIR CAUSES

Pedal travel excessive (requires pumping)

(*a*) Brake-shoes require adjusting.
(*b*) Leak at one or more joints.
(*c*) Master cylinder cup worn.

Pedal feels springy

(*a*) System requires bleeding.
(*b*) Linings not " bedded in."
(*c*) Master cylinder fixing loose.
(*d*) Master cylinder cup worn.

Brakes inefficient

(*a*) Shoes not correctly adjusted.
(*b*) Linings not " bedded in."
(*c*) Linings greasy.
(*d*) Linings wrong quality.
(*e*) Drums badly scored.
(*f*) Linings badly worn.
(*g*) Wrongly fitted cup fillers.

Brakes drag

(*a*) Shoes incorrectly adjusted.
(*b*) Shoe springs weak or broken.
(*c*) Pedal spring weak or broken.
(*d*) Hand brake mechanism seized.
(*e*) Wheel cylinder piston seized.
(*f*) Locked pipe line.
(*g*) Filler cap vent choked.

Brakes remain on

(*a*) Shoes over-adjusted.
(*b*) Hand brake over-adjusted.
(*c*) No free movement on pedal.
(*d*) Compensator port in master cylinder covered by swollen rubber cup, or incorrect adjustment of push-rod.
(e) Swollen wheel cylinder cups.
(*f*) Choked flexible hose.

Unbalanced braking

(*a*) Greasy linings.
(*b*) Distorted drums.
(*c*) Tyres unevenly inflated.
(*d*) Brake plate loose on the axle.
(e) Worn steering connections.
(*f*) Worn suspension linkage.
(*g*) Different types or grades of lining fitted.

Brakes grab

(*a*) Shoes require adjusting.
(*b*) Drums distorted.
(*c*) Greasy linings.
(*d*) Broken or loose road spring.
(e) Scored drums.
(*f*) Worn suspension linkage.

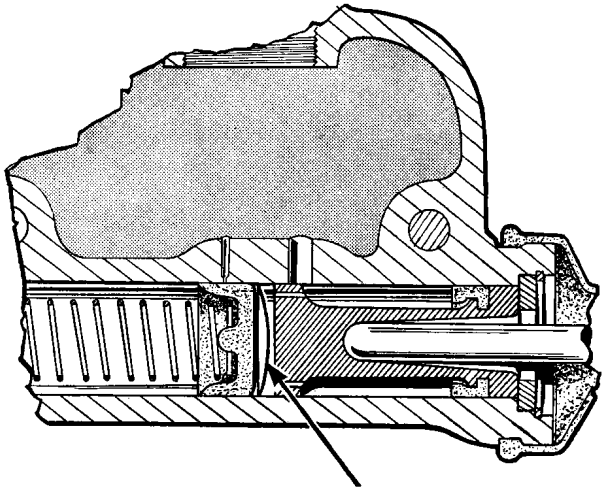


Fig. M.14.

The correct method of fitting the thin dished washer between the piston head and the master cup of the master cylinder. **It is imperative to make sure that the washer is in position and correctly fitted in all master cylinder assemblies.**