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GIRLING

VACUUM SERVO UNITS

Providing
Power assistance to
Hydraulic Braking Systems

APPLYING POWER ASSISTANCE TO BRAKING SYSTEMS

A driver can apply the same force to the brake pedal whether he, or she, is in a bubble car or a family saloon, in a sports car or a heavy limousine, and one of the problems of brake design is to equate the limited strength of the driver with the tremendous braking forces that sometimes are involved.

The Girling Vacuum Servo Unit provides some of the answers to this problem. It takes otherwise wasted power from the engine and uses it to boost the hydraulic pressure in the brake system in an exact and controlled manner.

In brake systems which have been designed to take full advantage of the extra power available the Unit forms part of the equipment originally fitted to the car. A unit called the Powerstop has been designed with the same basic principles for fitting into brake systems not equipped originally with a servo unit. This provides the opportunity for any car owner to have the luxury of ample power at the brake pedal.

This booklet describes the principle by which the Girling Vacuum Servo Unit operates, provides instructions for dismantling and assembly and also includes a simple guide for testing and diagnosing faults.

GIRLING VACUUM SERVO UNITS

The unit is installed in the hydraulic system between the master cylinder and the wheel cylinders, with the outlet pipe from the master cylinder connected to the Servo hydraulic inlet and the Servo hydraulic outlet connected to the wheel cylinders. The force required to augment the driver's effort is obtained by admitting atmospheric pressure to a vacuum cylinder containing a piston.

The pressure difference thus obtained across the vacuum piston produces a thrust load which is used to increase the hydraulic pressure available at the wheel cylinders.

In the Girling Servo Unit, and the "Powerstop", the piston in the vacuum cylinder is normally subjected to vacuum on both sides and this principle is known as "Suspended Vacuum" system.

This method induces a more rapid response than the "direct" or "non-suspended" vacuum type of cylinder, in which the piston is normally subjected to atmospheric pressure on both sides and the vacuum is introduced to one side when a pressure difference is required.

HOW IT WORKS When air is admitted to the vacuum cylinder by the control valve, the piston drives the piston rod and plunger down the hydraulic cylinder, providing a considerable increase in pressure of fluid to the wheel cylinders.

The control valve operated by the fluid from the master cylinder exercises a precise control over the pressure increase and the brakes are operated exactly in proportion to the effort applied to the pedal.

Illustration 1 shows diagrammatically the unit in the "at rest" position with no pressure in the hydraulic system. The valve is open to the vacuum tank or inlet manifold and the vacuum on both sides of the piston is equal.

When the foot pedal is applied, hydraulic pressure is exerted throughout the whole system and equally on both ends of the composite valve control piston. As one end of the piston is larger than the other, an equal pressure per square inch on both ends causes a proportionately greater thrust to be exerted on the large end and the piston moves (to the left as drawn), and the "T"-shaped lever opens the valve to the atmosphere. The air admitted to the right-hand end of the vacuum cylinder drives the piston to the left and the piston rod first seals the centre hole in the output piston and, continuing the movement, applies pressure on the fluid proceeding to the wheel cylinders and to the small end of the valve-control piston. See diagram 2.

This movement of the output piston continues until the thrust on the small end of the plunger, by the high fluid pressure, overcomes the thrust by the low pressure fluid on the large end. The valve control piston is thus moved back, closing the air valve. At this point both valves are closed as diagram 3 and the brakes are being held on. If the foot pedal is released the fluid pressure is reduced at the large end of the control piston, which moves to the right, the valve rocker opens the vacuum valve, air is drawn out of the cylinder, the vacuum piston returns and with it the output piston, relieving the pressure to the wheel cylinders as diagram 4. The piston rod is withdrawn from the output piston, allowing flow of fluid between supply tank and wheel cylinders.

If the force on the pedal is increased after arriving at the position shown on diagram 3, the valve gear operates to give additional assistance from the vacuum piston until the thrust on each end of the control piston is balanced or until the limit of available vacuum is reached. Conversely, if the foot pedal force is reduced the valve gear operates to reduce the pressure at the brake cylinders until again a state of balance of the control piston is reached.

The difference in area between the two opposed ends of the control piston determines the proportion of assistance provided by the unit. If, for example, the large end is twice the area of the small end, the hydraulic pressure output is built up to twice that of the input from the master cylinder before the control piston moves back to close the air valve. Such a unit therefore would have an output of twice the pressure of the input, throughout the range of the unit.

In this way, the pressure in the wheel cylinders varies in proportion to the effort at the pedal and full and precise control of the brakes is always at the command of the driver.

Some units have an output of $2\frac{3}{4}$ to 1, some have an output ratio of 2 to 1 and others have an output ratio of $1\frac{1}{2}$ to 1.

Between the engine inlet manifold and the vacuum reserve tank or, if a tank is not fitted, between the manifold and the servo unit, is a non-return valve, Fig. 5. This valve prevents the entry of air and petrol vapour into the tank or servo unit.

In the end cover of the Powerstop is fitted a piston return stop, Fig. 6, which determines the gap between the output piston and piston rod when fully returned. The gap governs the flow of fluid through the unit when at rest and the smoothness of the application of power.

The position of the stop is set and locked during final test and should not be disturbed in service.

A design modification renders unnecessary the external piston stop and units being manufactured at the present time do not incorporate this feature.

ATMOSPHERE

VACUUM

FLUID

LOW PRESSURE FLUID

HIGH PRESSURE FLUID

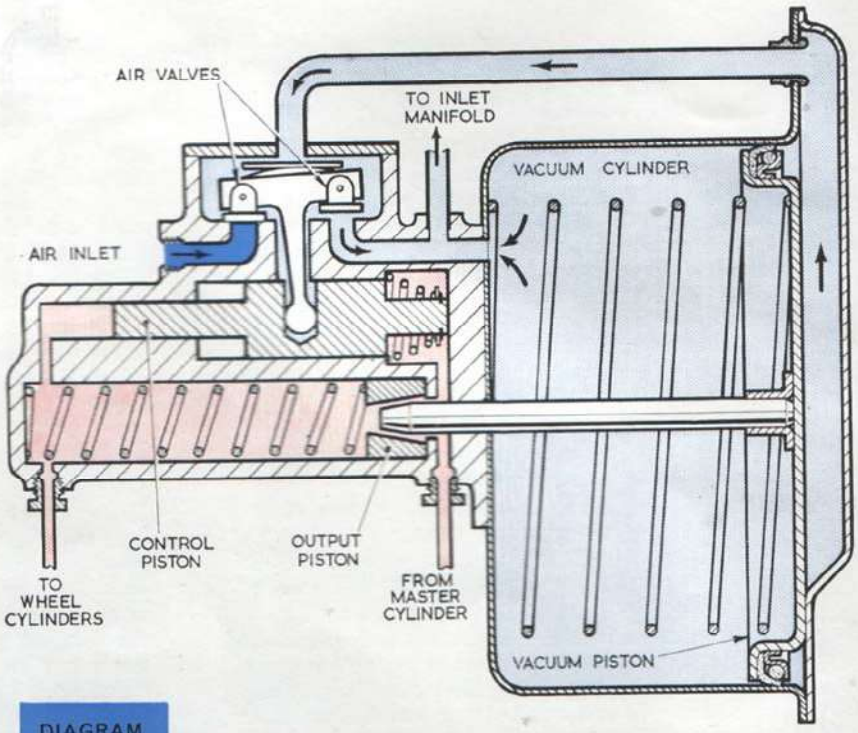
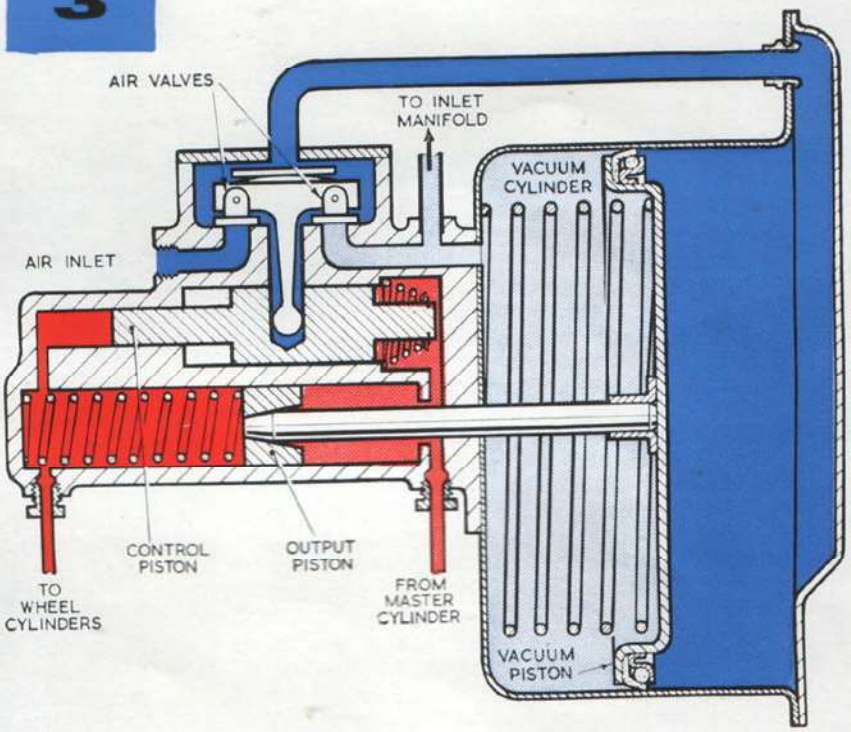


DIAGRAM 1

DIAGRAM 3



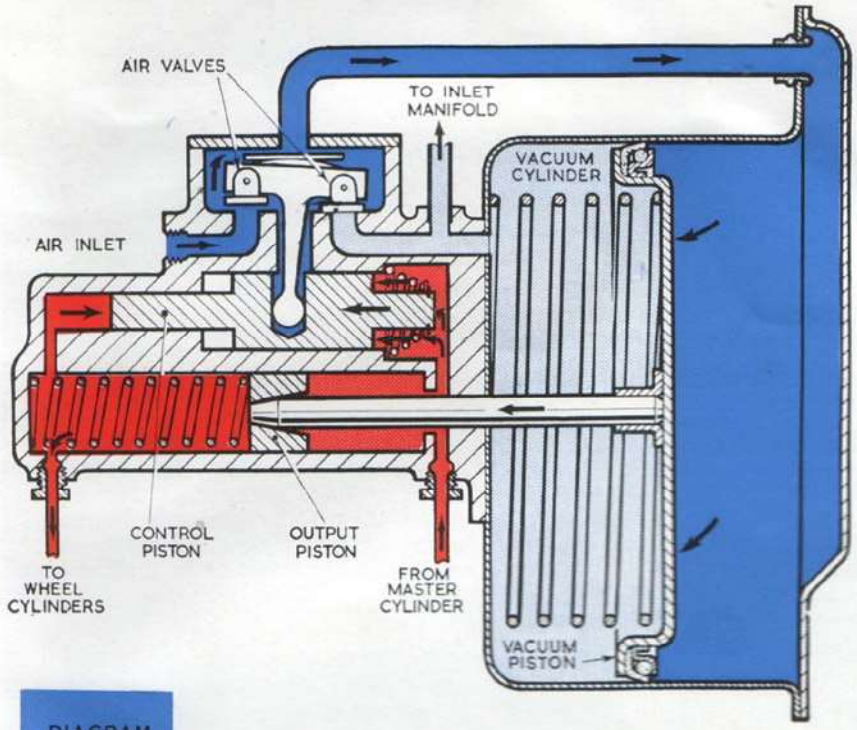


DIAGRAM **2**

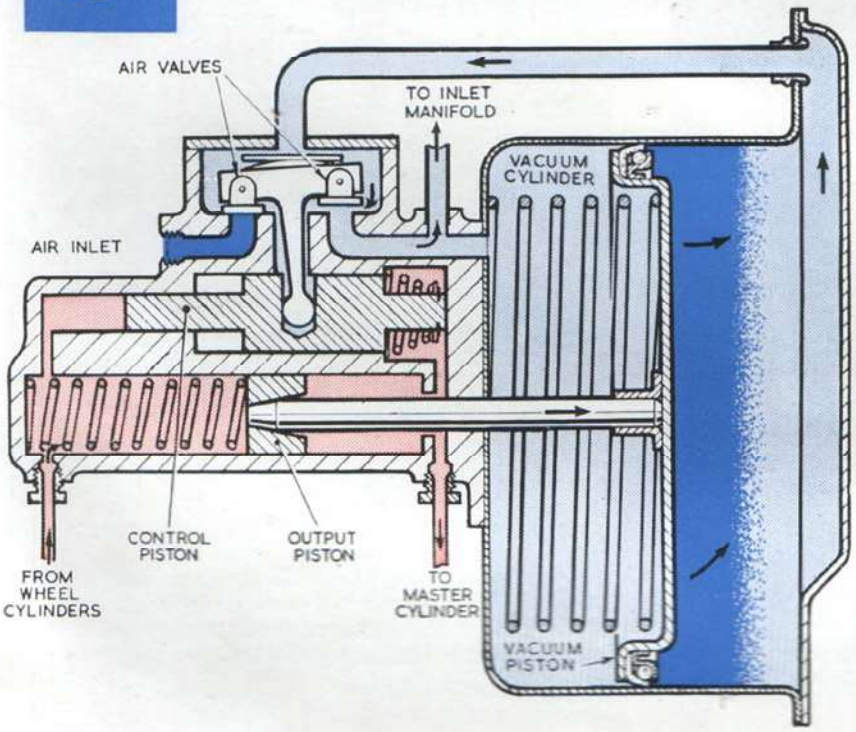


DIAGRAM **4**

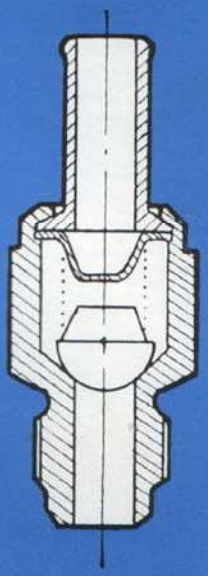


FIG. 5

FIG. 6

SERVICING

All seals and the vacuum hose should be changed at 40,000 miles or three years if this mileage has not been achieved. Whenever possible the servo unit should be returned to Girling for replacement, but if this is not possible the replacing of all seals as contained in the service kit should provide a satisfactory unit providing **the internal working surfaces are in good condition.**

There should be no sign of corrosion, pitting, scoring or steps on piston rod, pistons or bores and the surfaces should be smooth to the touch.

When dismantling, absolute cleanliness is essential. Wash the hands and lay out a clean sheet of paper on which to work and place the parts. Take care of all highly finished working surfaces on pistons, rods and bores. Clean hydraulic parts with Girling Cleaning Fluid, Alcohol or Castrol Girling Brake and Clutch Fluid (Crimson) and do not allow any other fluid, oil, or grease to touch them. Special care should be exercised when removing and fitting the circlip in the hydraulic output cylinder and when assembling the vacuum cylinder to the body. Particular attention is directed to the remarks in the sections concerned.

FIG. 7

The unit may be considered in five parts:-

1. The Air Filter.
2. The Vacuum Cylinder which supplies the force to operate the output cylinder.
3. The Valve Chest which houses the valves, controlling the movement of air to and from the vacuum cylinder.
4. The valve control piston occupying the upper bore of the body.
5. The hydraulic output cylinder from which the pressure is applied to the brakes.

THE AIR FILTER. **Fig. 7**

The element, of moulded cellular construction, should be changed whenever replacement brake shoes are fitted and on the occasion when the servo unit is overhauled.

The current type of filter is shown inset.