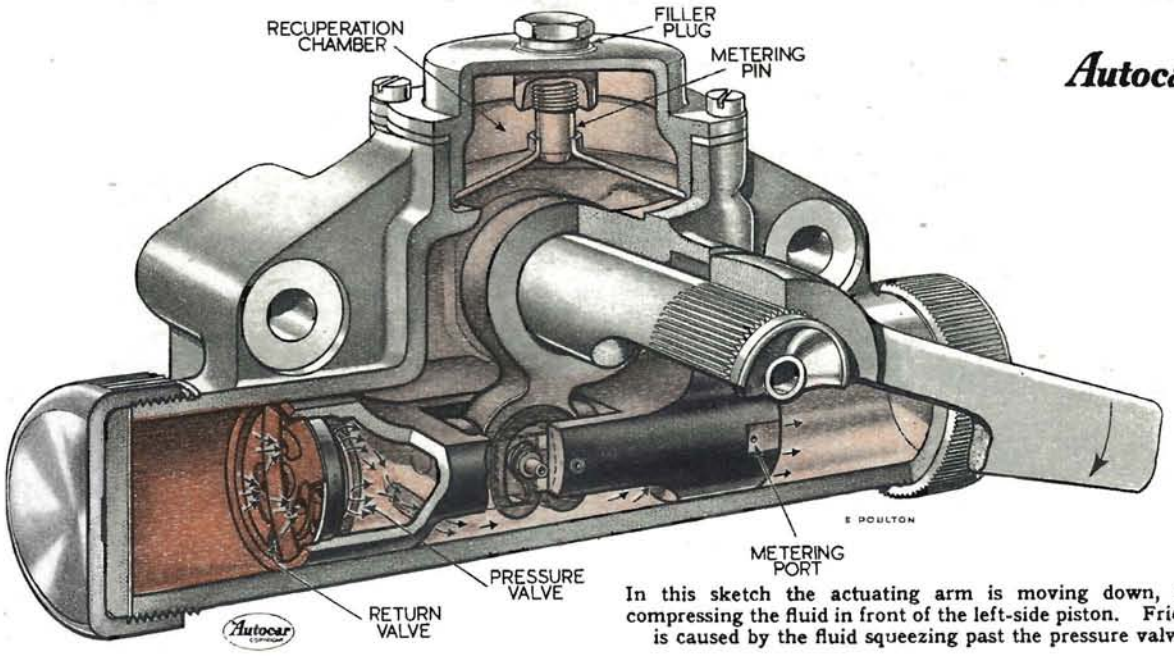


In this sketch the actuating arm is moving down, thus compressing the fluid in front of the left-side piston. Friction is caused by the fluid squeezing past the pressure valve.

The New Luvax-Girling Hydrauli

Minimising Adjustment, Replenishment and Maintenance by the Car Owner

TENS of thousands of cars have been fitted in the past with Luvax piston-type hydraulic shock absorbers, or dampers, as they should more correctly be called, and in the future many more hundreds of thousands will be equipped with a new and improved variety of this necessary component of modern suspension.

Recently the control of the design and manufacture of Luvax hydraulic dampers has passed into the hands of Girling, Ltd., and a new factory in South Wales is being specially equipped for the accurate manufacture of the new type, although the administration will remain in the Luvax-Girling headquarters in Birmingham. Considerable research work has resulted not only in an improved design, but also in methods of manufacture which will ensure precision workmanship and thus a high standard of accuracy of setting for continuous performance.

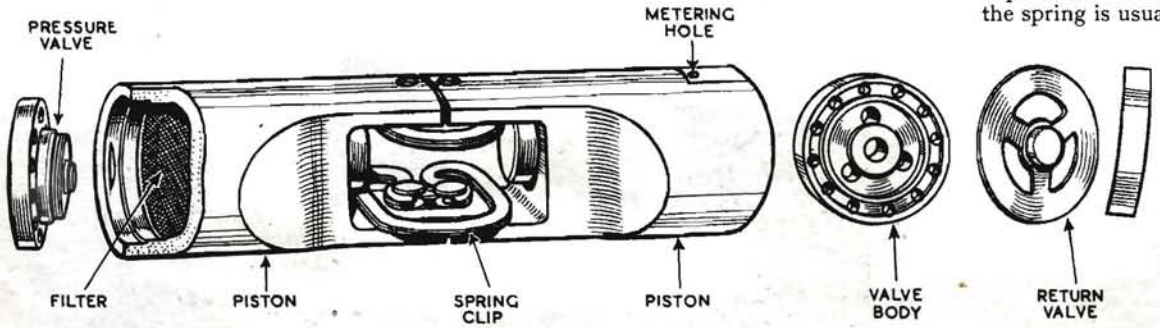
It may be worth while to outline briefly the reasons why car suspension systems need to have so-called shock absorbers, or dampers. As everybody knows, the main body of the car is insulated from the road wheels by the interpolation of flexible springs of one form or another. The idea is that when the wheels rise up over an obstacle or drop into a hollow, large or small according to the nature of the surface traversed, the main body of the car shall be undisturbed, as the movement of the wheels is accommodated by the springs. The absolute ideal would be reached if the main body of the car could be made to float serenely along in truly horizontal position quite irrespective of any dancing movement the wheels might make.

It is usual to classify the whole of the main body of the car which rests on the springs as the "sprung" weight, and the wheels with all on them and including the attachment formed by axles, or other means, as "unsprung weight." The ideal would be reached if the ratio of sprung weight to unsprung weight was infinity; or in other words if the unsprung weight was nothing and the sprung weight everything. Unfortunately that absolute ideal can never be attained, because the wheels and whatever attaches them to the car must have some strength and therefore weight.

Unfortunately this weight has a way of increasing itself as car evolution goes forward; it has to include stout steel wheels with their heavy rims, adequate hub bearings, large brake drums and so on. Hence the unsprung weight is apt to be considerable.

When a wheel rises over an obstacle the whole of the unsprung weight of it and its nearby components is given a kick upwards. As the unsprung weight is then given a momentum it tends to continue the movement and so compress the adjacent road spring farther than need be. The function of a road spring is to give way to this movement gently, while resisting it. The sharp upward kick of the wheel is thus translated into a slow push upwards by the spring upon the main body of the car. If the spring were made of a single blade unfettered in any way, as soon as it had finished absorbing the upward blow it would commence to return the blow downwards with almost undiminished force. Thereafter the spring would vibrate again and again until the energy was expended. To deal with this effect the spring is usually made with a number of blades, which, when deflected, rub against one another and produce friction. This friction damps down not only the subsequent vibration, but the initial movement as well.

From this it is easy to see the function of the so-called



Twin-piston assembly of the new Luvax-Girling damper. On the left is the pressure valve formed of spring discs bearing upon a hemispherical lip seating, which is self-clearing. On the right is a perforated disc return valve, held closed by a light blade spring.

shock absorber, or damper, as it should be termed. It imposes an additional brake upon the movements of the spring to which it is applied. It absorbs some of the energy, which it transforms into heat. It can be designed to produce whatever resistance is needed, and it can be made to operate at any desired rate of action or of increase. It can be made to operate in one direction of spring movement or in both directions, above or below the static loading position of the spring. It has other values, for it can assist in the location of the axle or other attachment of the wheels to the car, and it can be used to locate the axle against torsional movements introduced by the application of brakes. It is also possible to cross-couple dampers so as to make both sides operate together in order to control tendencies of the car to roll.

c Damper

With these points borne in mind it is easy to see why shock absorbers of all types have in various cases given a certain amount of trouble to car owners. In the first place the component is always at work when the car is travelling; in the second, as car evolution has proceeded the tendency has been to try to obtain softer riding, and this entails allowing for an increased extent of oscillatory movement for the springs, whence an increased burden is put upon the dampers. Possibly there has been a tendency to ask the "boy damper" to do the work of a "man-size" damper, with the idea of keeping down first cost. These are points to which car designers are paying special attention for the future.

Fluid Friction

From this point we can proceed to examine the new edition of the Luvax-Girling piston-type hydraulic damper. The basic principle is that of using fluid friction, by means of compressing the fluid and forcing it to flow through small restrictive orifices, which produce resistance. If reference be made to the various illustrations it will be seen that the damper consists of a horizontal cast-iron main body of cylindrical shape, with a vertical chamber above the middle. The cylindrical part is bored out and ground to a fine finish and contains two horizontally opposed pistons, the heads of which face outwards. Each cylinder end is closed in by a screwed cap containing a shallow distance piece and a thin fibre sealing washer. The outside of the cap is serrated and during the process of assembly a serrated ring spanner is mechanically operated to screw on the cap sufficiently tightly to compress the washer to an adequate degree in order to make what is in effect a permanent pressure-tight joint.

The pistons are of the "slipper" type; that is to say, the skirts are cut away except at the sides, in order to leave room for the assembly of the rockers. Mounted laterally at a point above the cylinder bore in the rigid wall of the chamber is a rocker shaft, which has a main bearing on one side and a tail bearing on the other side of the chamber. Attached to this shaft on splines is the rocker itself, having its hardened lower end shaped into a circular form. Within the body of each piston is a hardened steel pad. Strong U-shaped springs clip the inner ends of the pistons towards one another and ensure a chatter-proof contact between the foot of the rocker and the pad of each piston. The spring pressure automatically takes up wear.

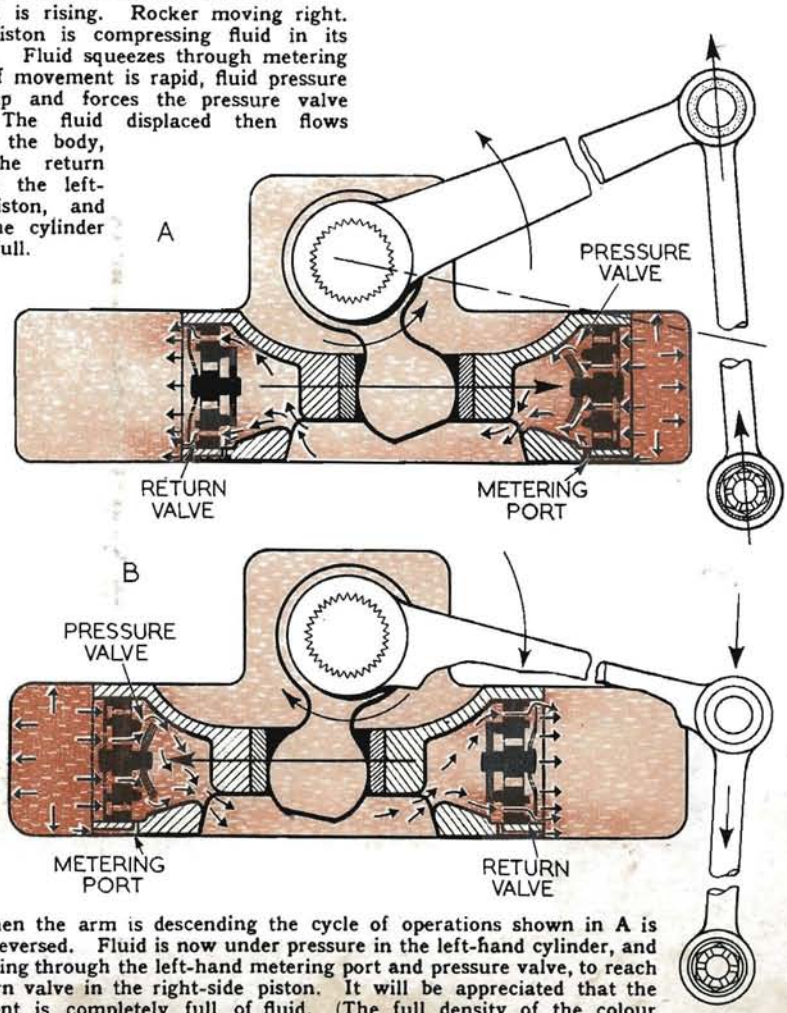
Where the operational end of the rocker shaft projects from the main bearing there is a specially shaped recess into which a thick rubber washer is inserted under pressure. This washer makes a gripping contact within its housing and on the rocker shaft, thereby providing a permanent oil seal. When the shaft rocks the rubber washer twists torsionally without moving, as do the rubber bushes on road springs, with which all car owners are familiar. The outer end of the rocker shaft is splined and carries the actuation arm, which is coupled to the car axle by a link with torsional rubber cushion bearings. It will be seen, therefore, that when the actuation arm is rocked upwards or downwards from the central position the rocker pushes one piston outwards, and pulls the other inwards through the agency of the twin U springs which couple the pistons together. So much for the purely mechanical construction of the device.

Constant Viscosity

As regards the hydraulic system, the whole body of the damper is filled with a special Luvax-Girling fluid, a thin oil which has an almost constant viscosity at all normal working temperatures, and which is obtainable at garages and service stations. This fluid completely fills the working chambers of the two cylinders and the recuperation chamber provided by the space between the pistons and around the rocker. If the pistons had solid heads it would be almost impossible to move

HOW THE DAMPER WORKS

(A) Arm is rising. Rocker moving right. Right piston is compressing fluid in its cylinder. Fluid squeezes through metering port. If movement is rapid, fluid pressure builds up and forces the pressure valve open. The fluid displaced then flows through the body, opens the return valve in the left-hand piston, and keeps the cylinder full.



(B) When the arm is descending the cycle of operations shown in A is exactly reversed. Fluid is now under pressure in the left-hand cylinder, and is squeezing through the left-hand metering port and pressure valve, to reach the return valve in the right-side piston. It will be appreciated that the instrument is completely full of fluid. (The full density of the colour representing the fluid indicates the pressure build-up on the damping stroke.)

the rocker by reason of the relative incompressibility of oil, which could escape from the cylinders into the rocker chambers only by squeezing through the narrow working clearance between the pistons and the cylinder walls. However, means are provided whereby the fluid can pass through. The first item is that a flat is cut for a short distance on the outer circumference of each piston head, and a fine port is drilled from this point to behind the piston crown. In this port is placed a metering pin, of a size suited to the work which the individual damper is to perform. When a piston is moving outwards the fluid thereby put under pressure in the working chamber is forced through the metering port and into the recuperation chamber, thus providing the needed frictional resistance.

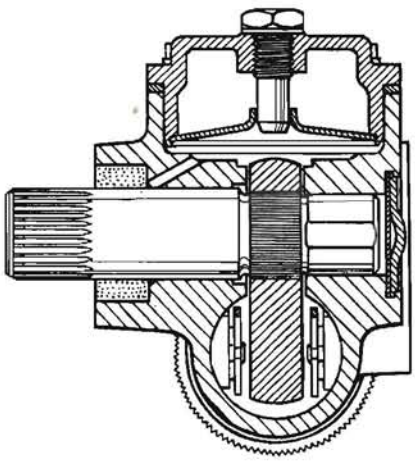
If this port were the only one the range of work which the damper could handle would be limited, and also a cavitation would be formed in the working chamber of whichever piston was moving inwards. Hence a system of valves is also essential. The crown of each piston is formed by a stout partition which is hardened and pressed into place. The partition has a series of ports around its centre, and at the back of it is a valve seat formed with a face of hemispherical cross section. On this seat rests a disc-type pressure valve built up of spring steel laminations. These are located by a central rivet, which puts a predetermined pressure on the centre of the discs and causes the outer circumference to form a line contact upon the curved face of the seating.

Self-cleaning Valve

When the fluid is forced under high pressure through the ports by the action of the damper this simple valve opens sufficiently to allow a restricted flow. The line contact and the shape of the seat ensure that the pressure valve is self cleaning. Fine particles of foreign matter, if such should be present as the result of wear, cannot find a permanent lodgement and so cause the valve to leak. It will be appreciated from the foregoing that the primary action of the damper has two phases:—In phase 1, when the car spring movement is slow, the restraining friction in the damper is caused by the passage of fluid through the metering port in the piston. In phase 2, when the spring movement is rapid, an excessive resistance is prevented from building up by the opening of the pressure valve.

There is also a second or return valve in each piston crown. On the outer face of the partition plate is a seating for a disc valve, and a ring of return ports. The valve is formed in the shape of a disc with arms running towards the centre, where there is a central locating pin. A spring blade is anchored at its extremities in the head of the piston, and at its centre bears upon the head of the return valve locating pin, thus holding the valve shut. Normally the return valve remains closed, and when pressure is built up by the movement of the piston outwards into the working chamber the valve is held even more firmly upon its seat. When, however, the piston is moving inwards on its return stroke and the pressure in the working chamber is reduced, the return valve automatically opens and allows the fluid to flow freely back from the recuperation chamber, and into the working chamber, thus filling the last-mentioned ready for the next stroke.

Because the damper has two pistons in two working chambers it is double acting; that is to say, frictional fluid resistance is caused whether the car spring is compressed by a wheel passing over an obstacle on the road surface, or is expanding downwards as a wheel drops into a hollow. The rate and degree of the fluid resistance can be set the same both ways, or can be arranged differentially; for instance, to be greater on the downward movement than on the upward movement of the spring. These degrees of damping are



Transverse section through the Luvax-Girling damper, showing the sealed spigot bearing and the rubber bush-sealed main bearing.

settled when this type of Luvax-Girling damper is assembled in the factory, and cannot be changed without stripping the damper.

It may be helpful to grasping the principle completely if an outline is given of a complete cycle of operation. With the illustration of the damper in section in front of one, suppose that the compression of a road spring is causing the rocker arm to move anti-clockwise, thus moving the twin pistons towards the right. This causes the right-hand piston to compress the fluid on the right-hand-side working chamber. If the movement is slow the fluid is forced through the metering port into the recuperation chamber. If the movement is fast the pressure valve in the piston crown opens and allows the fluid to escape in greater volume back to the recuperation chamber. In each case fluid frictional damping is caused.

As the left-hand piston is coupled to the right-hand one by the twin U springs, the left piston also moves to the right. This action opens the return valve in that piston and allows fluid to flow from the recuperation chamber and keep the left-hand working chamber full. When the car spring is returning to its normal position the rocker will move clockwise, and the pistons will travel towards the left. This causes compression in the left-hand working chamber, with a damping flow of fluid back to the recuperation chamber. The right-hand piston is following towards the left, and so its return valve opens and allows fluid to return and replenish the right-hand working chamber.

Additional Recuperating Chamber

A new feature of the Luvax-Girling damper is a recuperating chamber above and additional to that provided by the main body of the instrument. This is formed by a deep cap which is spigoted into the body and hermetically sealed by a gasket and four holding down studs. At the base of this cap is a dished disc, having its centre lipped to form a metered socket for a filler plug in the cover. The boss for the plug is continued downwards to a certain distance so as to ensure that fluid cannot be filled above a particular level, above which a cushion of air is formed in a compensation space. Fluid from this chamber percolates past the metering end of the filler plug and keeps the main body full. If expansion resulting from heat takes place fluid can rise back into the recuperating chamber past the metering pin, and the air in the compensation space is compressed.

Restrictor Action

This arrangement has a further purpose. A moment's consideration and a glance at the illustrations should make it plain that if the whole body of the damper was plumb full of fluid, and sealed up, a high-speed movement to one side would force the fluid to flow through the pressure valve on one piston, straight across, and through the return valve on the opposite piston in order to make good the cavitation on that side. On the other hand if the fluid were open to the air this quick return would not take place. The purpose, therefore, of the metering pin in the disc at the base of the recuperation and air chamber is to introduce a restriction which gives the same effect as a sealed chamber full of fluid. At the same time the fluid in the recuperation chamber can percolate past the metering pin in order to keep the body always full.