Sept. 3, 1940. O. H. BANKER 2,213,195

VALVE ACTUATING MECHANISM

Filed May 13, 1938

Fig. 1.

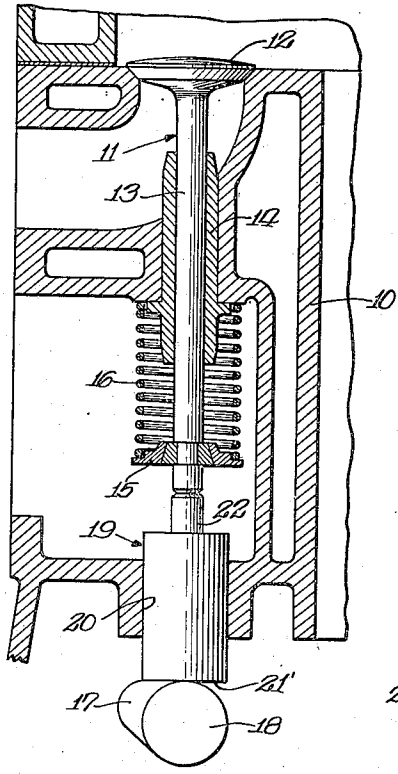



Fig. 2.

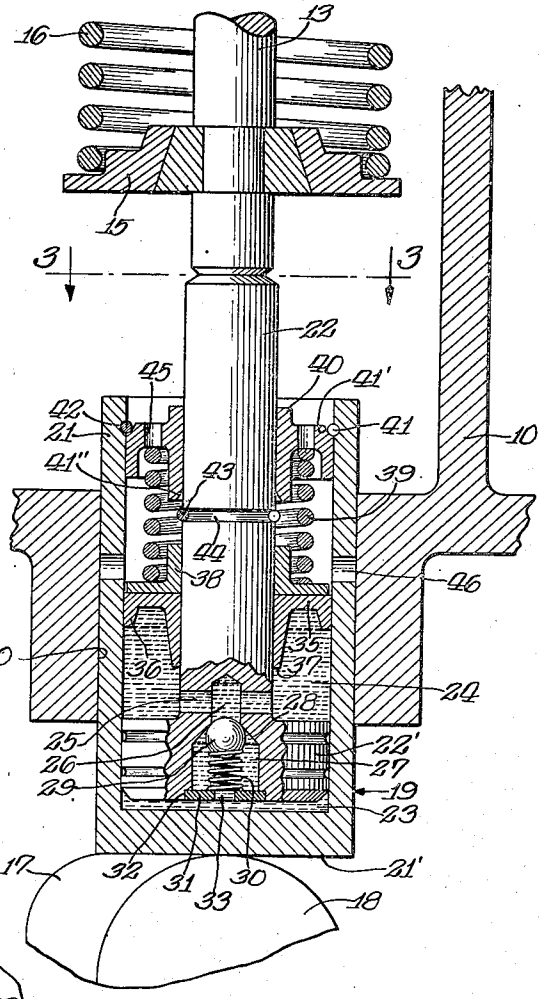
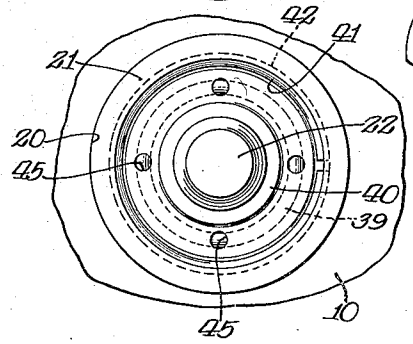



Fig. 3.




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## VALVE ACTUATING MECHANISM

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13 Claims. (Cl. 123—90)

The invention relates generally to a valve actuating mechanism for an internal combustion engine and more particularly to a valve lifter or silencer for eliminating clearance in the actuating mechanism.

The general object of the invention is to provide a selft-contained valve lifter of new and improved construction.

Another object is to provide a self-contained, hydraulic valve actuating device comprising two telescopically engaged members, one for engagement with the valve stem of a valve actuating mechanism and the other for engagement with the valve actuating cam, together with hydraulic means of novel construction for maintaining said members extended and in engagement with said valve stem and cam and for transmitting the force for opening the valve.

Another object is to provide a device of this character of a new and improved construction rendering the mechanism extremely quiet under all operating conditions, economical to manufacture, efficient, durable, and easy to install either initially or as a replacement for noisy, worn or obsolete mechanism.

A further object is to provide a self-contained hydraulic type of valve lifter device, in which all churning of the liquid is eliminated, and means is provided to avoid excessive build-up of pressure due to the expansion caused by a rise in temperature.

A more particular object is to provide a self-contained hydraulic valve lifter comprising a cylinder and a piston separating the cylinder into a head-end chamber and a reserve chamber, with means carried on the device for maintaining the fluid in the reserve chamber under sufficient pressure to extend the piston and cylinder parts of the device into constant engagement with the valve stem and valve cam of the valve actuating mechanism.

Other objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a view partly in section of a valve actuating mechanism for an internal combustion engine embodying features of the invention.

Fig. 2 is a fragmentary view partly in longitudinal central section through the preferred form of the invention shown in Fig. 1.

Fig. 3 is a fragmentary plan view taken along line 3—3 of Fig. 2.

While the invention is disclosed in the drawing and will hereinafter be described as embodied in a preferred form, it is not intended that the invention be limited to the specific embodiment disclosed. It is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as defined in the appended claims.

Referring to the drawing, and particularly to Fig. 1, 10 represents the cylinder block of an internal combustion engine and 11 represents a valve having a valve head 12 controlling a port opening into a cylinder of the engine. The valve is mounted in the usual manner with its stem 13 projecting slidably through a sleeve bushing 14 secured in the cylinder block 10. At the end remote from the valve head, the valve stem carries a washer 15 between which and the cylinder block 10 a compression spring 16 is interposed to urge the valve toward seated position. The valve is opened against the action of the spring 16 at proper intervals by means of a cam 17 formed on a cam shaft 18 and acting through a valve lifter generally designated 19. The valve lifter is guided for longitudinal reciprocatory movement in a bore 20 formed in a portion of the cylinder block 10.

The invention is directed more particularly to the valve lifter or actuating device generally designated 19, this device being of a self-contained by embodying a liquid as a cushioning means. Generally, the valve lifter comprises two telescopically engaged parts or members, one in the form of a cylinder 21, the lower and closed end 21' of which is maintained in contact with the valve actuating cam 17. The cylinder 21 has a cylindrical exterior surface also so that this member can be slidably mounted in the bore 20 of the cylinder block. The other member is in the form of a rod or plunger 22 which is maintained in contact with the valve stem. The rod member 22 has a piston 22' formed on its lower end which is slidable in the cylinder 21 and divides the cylinder into a first or head end chamber 23 below the piston, and a second or reserve chamber 24 above the piston. These chambers are interconnected by means of a passageway through the piston formed by radially extending ports 25 and an axial port 26, the axial port having an enlarged portion 27 with a beveled end 28 forming a seat for a ball check valve 29. This check valve is maintained in engagement with the seat by a coiled spring 30, one end of which engages the check valve and the other end of which abuts an apertured washer 31 pressed into a recess 32 in the lower end of the piston and expanded therein. The check valve is so arranged

as to permit rapid and substantially free flow of liquid from the reserve chamber through the passage, which includes an aperture 33 in the washer, to the head end chamber, the fit of the piston in the cylinder being such as to permit slow leakage of fluid past the piston from the head end chamber back to the reserve chamber.

In order to maintain the two parts of the device extended so as to eliminate clearance between the cylinder 21 and the cam 17 and between the upper end of the rod 22 and the valve stem 13, the invention provides means for maintaining the liquid in the reserve chamber under pressure. As illustrated in Fig. 2, an annular member or second piston 35 surrounds the rod 22 and has a rim 36 with a sliding fit in the cylinder 21 and has a hub 37 with a sliding fit on the rod so as to form an upper wall for the reserve chamber 24. This member is preferably formed of a material which is not affected by the liquid in the device (usually oil) and is backed by an annular metal collar 38 positioned against the upper surface thereof. However, the sealing member is sufficiently resilient and flexible so that the pressure of the fluid may act against the inner surfaces of the hub 37 and rim 36 and press these parts into contact with the rod 22 and cylinder 21, respectively, to provide a good seal between these parts and prevent loss of liquid. The member 35, and the liquid as well, are selected to withstand the high temperatures encountered. A commercial product called "Neoprene", made from coal and having some of the characteristics of rubber, has been found satisfactory as a material for the member 35. A very low viscosity oil or a liquid commonly known as "brake fluid" because of its use in hydraulic brakes may be used for the liquid.

The secondary piston thus formed is forced downwardly by means of a coiled spring 39 positioned intermediate the collar 38 and an apertured closure 40 for the open end of the cylinder. The closure 40 is preferably retained against movement outwardly of the cylinder by means of a split wire ring 41 positioned in an annular recess 42 of semi-circular cross-section in the wall of the cylinder. The adjacent annular surface 41' on the head 40 is beveled as shown so that the action of the spring 39 tending to move the closure outwardly causes the beveled surface 41' to cam or expand the locking ring into the recess 41. This permits of the use of an inexpensive plain wire ring in place of the usual spring type. Similarly, a split wire ring 43 is secured in an annular recess 44 of semi-circular cross-section in the rod 21 so as to limit the outward movement of the piston in the cylinder when the device is removed from its position between the valve stem and valve cam, as shown in Figs. 10 and 12. Here again, the head 40 is provided with an annular beveled or cam surface 41'' which functions to contract the locking ring and retain it in the recess 44.

In assembling the form of the invention illustrated, a suitable liquid is placed in the cylinder and the piston 22' and annular member 35 are installed in a way which does not trap any air below the member 35. When the valve lifter is installed in an engine, as illustrated in Fig. 1, liquid under pressure in the reserve chamber is forced past the check valve and into the head end chamber until the two parts of the device are extended sufficiently to take up all clearance in the mechanism. During the operation of the engine, any leakage past the piston during the valve lifting strokes, or due to expansion of the liquid and parts with a rise in temperature, is immediately replaced in the head end chamber during the return strokes because of the pressure maintained on the liquid in the reserve chamber. Actually, this pressure need only be sufficiently great so that the total pressure acting on the lower end of the piston is sufficient to overcome the pressure of atmosphere on the outer end of the piston rod.

In a valve mechanism of the type illustrated, a valve spring such as 16 (Fig. 1) is generally selected very carefully as to strength so as to insure proper operation of the valve. In providing a valve lifter, such as 19, for incorporation in the valve actuating mechanism, it is highly desirable that the action of the valve lifter does not neutralize too large a portion of the pressure exerted by the spring 16 in maintaining the valve 12 in its closed position. Thus, if a spring were used in such a manner as to act directly between the cylinder 21 and the rod 22 to extend the parts into engagement with the valve cam and valve stem, respectively, such a spring must necessarily be relatively light and, as a result, would be somewhat fragile and subject to frequent breakage in view of the high speeds and vibration encountered when the engine is in operation. In the invention as illustrated, a relatively heavy spring 39 is utilized so as to obtain satisfactory operation and long life, and yet the upward pressure exerted by the rod 22 on the valve stem, while the valve 12 is seated, is relatively light due to the arrangement of the parts. The pressure of the spring 39 is exerted upon the liquid in the reserve reservoir through the annular member 35, and during the closing movement of the valve 12 the pressure in the head end chamber 23 is equal to the pressure in the reserve chamber 24. Since the liquid in the reserve chamber 24 acts to move the piston 22' downwardly and the liquid in the head end chamber 23 acts to move the piston upwardly, the resultant force tending to move the piston upwardly is equivalent to that exerted by the liquid acting on an area equal to the cross-sectional area of the rod 22. The rod area may be so selected that the upward pressure on the rod is but a fraction of the total pressure exerted by the spring 39.

It will be readily apparent that by providing the reserve chamber with a movable wall which is constantly forced in a direction to compress the liquid in the reserve chamber, as well as the head end chamber and the connecting passage, is completely filled with liquid under pressure. This effectively excludes air from the device and thus prevents the churning of the liquid which might otherwise be encountered if the piston and cylinder were forced apart by means of a spring, so that the liquid from the reserve chamber would pass into the head end chamber because of the resulting suction. By maintaining the entire body of fluid under pressure, the formation of gas or vapor is also prevented. Should the pressure of the liquid tend to increase due to expansion as the parts rise in temperature when the engine is in operation, an unusually high back pressure is avoided by providing the reserve chamber with a yieldable wall.

Preferably, the end wall 21' of the cylinder 21 has a flat inner surface and the adjacent end of the piston 22' is also flat and of large area. In the event the liquid in the device is for any reason dissipated or none is placed therein, these contacting surfaces of the piston and cylinder end

are of sufficient area to withstand the shocks of continued operation of the engine, even in the absence of the usual cushioning effect of the liquid. With the construction shown herein, it is possible to leave an extremely small amount of clearance between the piston 22' and the closed end of the cylinder. This holds the piston to a short travel even in the event the liquid is lost or inadvertently left out, insuring proper opening and closing of the valve. Continued operation of the engine is thereby assured. Furthermore, the head end of the piston is free from springs and other mechanisms, so that there are no fragile parts in the head end of the cylinder which would be crushed in the absence of liquid in the device.

Openings 45 are preferably provided in the closure 40 and drain openings 46 are provided in the sidewall of the cylinder 21 so that any oil or other liquid which may leak from other parts of the engine into the upper portion of the cylinder cannot remain and build up a presssure which will destroy the normal effect of the coiled spring 39. Oil passing out through the openings 46 serve to lubricate the outer surface of the cylinder and the bore 20.

The invention provides an extremely compact device which is able to function continuously even though the liquid normally contained therein is absent. By maintaining the liquid in the reserve chamber under pressure, it is possible to utilize the liquid itself as a means for extending the parts. When a spring such as 39 is used for producing the pressure in the reserve chamber, a larger and stronger spring may be used than would be possible if the spring acted directly to extend the parts.

I claim as my invention:

1. A valve actuating device comprising, in combination, a cylinder closed at the head end and having an apertured head at the other, a piston slidable in said cylinder and having a rod extending through said aperture, a flexible annular member between said rod and the wall of the cylinder and cooperating therewith to form a reserve chamber outside of the piston, said cylinder being completely filled with liquid between said flexible member and the closed end of the cylinder, a check valve device permitting rapid flow of liquid from the reserve chamber to the head end of the cylinder, and resilient means acting against said flexible member to maintain the liquid in the reserve chamber under pressure sufficient to move the piston outwardly in the cylinder.

2. A valve actuating device comprising, in combination, a cylinder closed at the head end and having an apertured head at the other, a piston slidable in said cylinder and having a rod extending through said aperture, an annular member between said rod and the wall of the cylinder and cooperating therewith to form a reserve chamber outside of the piston, said cylinder being completely filled with liquid between said annular member and the closed end of the cylinder, means permitting flow of liquid from the reserve chamber to the head end of the cylinder, and means carried on the cylinder and acting against said annular member to maintain the liquid in the reserve chamber under pressure sufficient to move the piston outwardly in the cylinder.

3. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a rod projecting from the open end thereof, a check valve device carried on said piston permitting liquid to flow freely from a reserve chamber on the outside of the piston to the head end of the cylinder and preventing reverse flow, an annular member mounted on said rod and forming one wall for the reserve chamber, an apertured closure for the open end of said cylinder through which the rod projects, and a coiled spring intermediate said annular member and closure effective to depress the annular member and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder.

4. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a rod projecting from the open end thereof, a check valve device carried on said piston permitting liquid to flow freely from a reserve chamber on the outside of the piston to the head end of the cylinder and preventing reverse flow, an annular member slidably mounted on said rod and forming one wall for the reserve chamber, and a spring effective to press said annular member and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder.

5. In a valve operating mechanism, in combination, two telescopically engaged members, hydraulic resisting means between said members cooperating therewith to permit the slow contraction and rapid extension of the same and including a first chamber filled with liquid, a second expansible chamber completely filled with liquid into which liquid from said first chamber leaks slowly and a check valve permitting rapid return of liquid from the second chamber to the first to extend said telescopic members, and means including a resilient device acting to contract said second chamber for exerting pressure on the liquid therein so as to force it past said check valve and into said first chamber and cause the extension of said members.

6. In a valve operating mechanism, in combination, two telescopically engaged members, hydraulic resisting means between said members cooperating therewith to permit the slow contraction and rapid extension of the same and including a first chamber filled with liquid, a second expansible chamber completely filled with liquid into which liquid from said first chamber leaks slowly and a check valve permitting rapid return of liquid from the second chamber to the first to extend said telescopic members, and means associating with said second chamber for exerting pressure on the liquid therein so as to force it past said check valve and into said first chamber and cause the extension of said members.

7. In a valve operating mechanism, in combination, two telescopically engaged members, hydraulic resisting means between said members cooperating therewith to permit the slow contraction and rapid extension of the same and including a first chamber filled with liquid, a second expansible chamber completely filled with liquid into which liquid from said first chamber leaks slowly and means permitting relatively rapid return of liquid from the second chamber to the first to extend said telescopic members, and means including a resilient device carried on one of said members for exerting pressure on

the liquid in said second chamber so as to force it past said check valve and into said first chamber and cause the extension of said members.

8. A valve actuating device comprising, in combination, a cylinder, a piston rod, a piston on the inner end of said rod dividing said cylinder into two chambers completely filled with liquid, said piston permitting slow leakage of liquid from the first chamber into the second, a check valve device permitting rapid return of liquid from the second chamber to the first to force the piston outwardly of the cylinder, and means carried on the cylinder for maintaining the liquid in said second chamber under pressure.

9. A valve actuating device comprising, in combination, a cylinder, a piston rod, a piston on the inner end of said rod dividing said cylinder into two chambers completely filled with liquid, said piston permitting slow leakage of liquid from the first chamber into the second, means permitting rapid return of liquid from the second chamber to the first to force the piston outwardly of the cylinder, and means carried on the cylinder for maintaining the liquid in said second chamber under pressure sufficient to force liquid into the first chamber and move the piston outwardly in the cylinder.

10. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a rod projecting from the open end thereof, means permitting liquid to flow freely from a reserve chamber on the outside of the piston to the head end of the cylinder and preventing reverse flow, an annular member surrounding said rod and forming one wall for the reserve chamber which is completely filled with liquid so as to exclude air, an apertured closure for the open end of said cylinder through which the rod projects, a coiled spring intermediate said annular member and closure effective to depress the annular member and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder, and means for retaining said closure in said cylinder comprising an annular recess in the cylinder, a split wire ring positioned partly in said recess and a beveled annular surface on said closure engaging said ring and acting under the force of said spring to expand the ring against the cylinder.

11. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a rod projecting from the open end thereof, means permitting liquid to flow freely from a reserve chamber on the outside of the piston to the head end of the cylinder and preventing reverse flow, an annular member surrounding said rod and forming one wall for the reserve chamber which is completely filled with liquid, an apertured closure for the open end of said cylinder through which the rod projects, a coiled spring intermediate said annular member and closure effective to depress the annular member and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder, and means for limiting the outward movement of the rod through said closure when the device is removed from an engine comprising an annular recess in said rod within the closure, a split wire ring in said recess and an annular beveled surface on said closure arranged to engage said ring when the rod moves outwardly.

12. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a rod projecting from the open end thereof, means permitting liquid to flow freely from a reserve chamber on the outside of the piston to the head end of the cylinder and preventing reverse flow, an annular member surrounding said rod and forming one wall for the reserve chamber which is completely filled with liquid, an apertured closure for the open end of said cylinder through which the rod projects, a coiled spring intermediate said annular member and closure effective to depress the annular member and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder, means for retaining said closure in said cylinder comprising an annular recess in the cylinder, a split wire ring positioned partly in said recess and a beveled annular surface on said closure engaging said ring and acting under the force of said spring to expand the ring against the cylinder, and means for limiting the outward movement of the rod through said closure when the device is removed from an engine comprising an annular recess in said rod within the closure, a split wire ring in said recess and an annular beveled surface on said closure arranged to engage said ring when the rod moves outwardly.

13. A valve actuating device comprising, in combination, a member forming a cylinder, a piston in said cylinder having a part projecting in the cylinder and from the open end thereof, a check valve device carried on said piston permitting liquid to flow freely from a reserve chamber on one side of the piston to the head end of the cylinder on the other side of the piston and preventing reverse flow, a member slidably mounted on the projecting part of the piston and forming one wall for the reserve chamber, and a spring supported within the cylinder and effective to press said member in a direction to contract the reserve chamber and maintain the liquid in the reserve chamber under pressure sufficient to force liquid into the head end of the cylinder and move the piston outwardly in the cylinder.

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