The present invention relates to hydraulic valves and more particularly to pilot-operated valves.

The object of the present invention is to provide a pilot operated valve which is simple and inexpensive in construction and reliable in operation. The invention is particularly concerned with self-contained units such as are used in thermostatic water controls for automotive vehicles wherein a considerable valve movement is required upon relatively slight changes in temperature.

With the foregoing and other objects in view as will hereinafter appear, the present invention comprises the pilot valve hereinafter described and particularly defined in the claims.

The accompanying drawings Fig. 1 is an elevation of the preferred form of valve shown as mounted in a water conduit, and Fig. 2 is a sectional elevation showing the construction of the valve.

The illustrated embodiment of the invention comprises a frame 4 adapted to be placed in a water conduit illustrated diagrammatically at 6 as, for example, in the jacket of an internal combustion engine. The flow of water is from left to right as indicated by the arrows. The main flow is through a valve 8 arranged to close against a seat 10 which is suitably supported in the conduit 6. The frame 4 is provided with openings 12 to accommodate the main flow when the valve 8 is open.

As shown in Fig. 2, the valve member 8 is of bell shaped form and is provided with a flat base portion 14 and a cylindrical portion 16.

The flange 16 is supported on the frame by a rubber seal member 18 suitably secured to the flange by a suitable clamp, shown here as a snap ring 20. The seal member has an inner fold that extends along the flange, a middle fold extending forwardly therefrom, and an outer fold which is secured between the frame and an internal metallic ring 24. It will be seen, therefore, that the valve 8 is free to move axially and that the rubber seal will accommodate itself to the position of the valve.

The pilot member comprises a thermostatic element shown as a bellows 26 mounted at the left end of the frame. The bellows is completely filled with liquid or wax and carries a pilot valve member 28 adapted to seat against a dome shaped member 30 which forms a closure for the left end of the frame and is secured to the frame, preferably by the same rivets which secure the metal ring 24 and the seal member thereto. A bowed leaf spring 32 is secured to the dome 30 and is connected at its mid-portion to the stem 34 on which the pilot valve member 28 is mounted. This spring acting in a direction to close the pilot valve as the liquid or wax contracts within the bellows.

As shown in Fig. 2, the stem 34 extends through the center of the main valve 8. A compression spring 36 preferably bears between the end of the stem and the center of the valve, acting in a direction tending to hold the main valve closed.

It will be noted that the opening through the main valve is somewhat larger than the outer diameter of the stem 34, whereby a small passage 38 between the stem and the valve is left for a purpose to be described later.

In operation the valve 8 is normally maintained closed when the water temperature is low. At this time the forces are nearly balanced since the water pressure supplied through the openings 12 acts on the valve 8 and the base 14 and seal member 18. The effective projected area of the base and seal is preferably slightly larger than the projected area of the valve seat 10, whereby a small resultant closing force is normally applied, regardless of the spring 36. For this reason, the spring 36 may be omitted, if desired.

When the water comes up to temperature, the thermostat 26 expands and opens the pilot valve 28, thereby admitting water under pressure to the rear of the valve base 14. This unbalances the forces on the main valve and causes it to open, to which end the seal member 18 unfolds in a manner to accommodate the valve motion. When the water cools down, the thermostat 26 contracts and closes the pilot valve. At this time the passage 38 allows the pressure to be relieved in the back of the base 14 so that the water cannot be trapped in said space in a manner to prevent closing of the main valve. The pressures on the surfaces 6 and 14 then become balanced again, and the main valve closes. Although the passage 38 allows some leakage of water through the pilot valve 28 when it is open, the flow is so small that it does not materially reduce the pressure in back of the base 14, and hence does not prevent the main valve from remaining open when the pilot valve is open.

Having thus described the invention, I claim:

1. A hydraulic valve comprising a frame having a main valve seat, a main valve member having a base portion, a flexible seal secured between said base portion and the frame to accommodate axial movements of the main valve member, a pilot valve coaxial with the main valve, and having a stem passing through the main valve, a closure member for the frame having a seat for the pilot valve, a spring tending to close the pilot valve, and a spring surrounding the stem and tending to close the main valve, the main valve member having a leakage opening to relieve the pressure in the rear of said base when the pilot valve closes.

2. A hydraulic valve comprising a frame having a main valve seat, a main valve member having a base portion, the frame having openings to apply substantially simultaneously a force tending to open the main valve member and a force to one face of the base portion tending to close the main valve member, a flexible seal secured between said base portion and the frame to accommodate axial movements of the main valve member, a pilot valve coaxial with the main valve, and having a stem passing through the main valve, a closure member for the frame having a seat for the pilot valve, said closure member excluding inlet pressure from the other face of said base portion except through the pilot valve, a spring tending to close the pilot valve, and a spring surrounding the stem and tending to close the main valve, the main valve member having a leakage opening to relieve the pressure on said other face of the base portion when the pilot valve closes, the total effective area of the base and seal being slightly larger than the effective area of the main valve seat.

3. A hydraulic valve comprising a frame disposed in a fluid channel and having a main valve seat near one end and a closure on the inlet side of the main valve seat near the other end, said closure having a pilot valve seat coaxial with the main valve seat, a main valve member having a base portion, a flexible seal secured between said base portion and the frame to form an axially expansible chamber with said closure forming one wall...
thereof, the main valve member having a leakage opening from said chamber to the outlet side of the main valve, the frame having openings to inlet pressure to apply substantially simultaneously a force tending to open the main valve member and an external force to the base portion tending to collapse the chamber and to close the main valve member, a pilot valve cooperating with the pilot valve seat and having a stem passing through the main valve, a spring tending to close the pilot valve, and a spring surrounding the stem and bearing at one end upon the main valve member and at the other end upon the stem, the total effective area of the base and seal being slightly larger than the effective area of the main valve seat.

5. A hydraulic valve comprising a frame disposed in a fluid channel and having a main valve seat near one end and a closure on the inlet side of the main valve seat near the other end, said closure having a pilot valve seat coaxial with the main valve seat, a main valve member having a base portion, a flexible seal secured between said base portion and the frame to form an axially expansible chamber with said closure forming one wall thereof, the main valve member having a leakage opening from said chamber to the outlet side of the main valve, the frame having openings to inlet pressure to apply substantially simultaneously a force tending to open the main valve member and an external force to the base portion tending to collapse the chamber and to close the main valve member, a pilot valve cooperating with the pilot valve seat, opening in the same direction as the main valve, and having a stem passing through the main valve, a spring tending to close the pilot valve, and a spring surrounding the stem and tending to close the main valve, the total effective area of the base and seal being slightly larger than the effective area of the main valve seat.

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