Aug. 28, 1962 T. J. SULLIVAN 3,051,432

TWO-STAGE HYDROMOTOR-OPERATED VALVE

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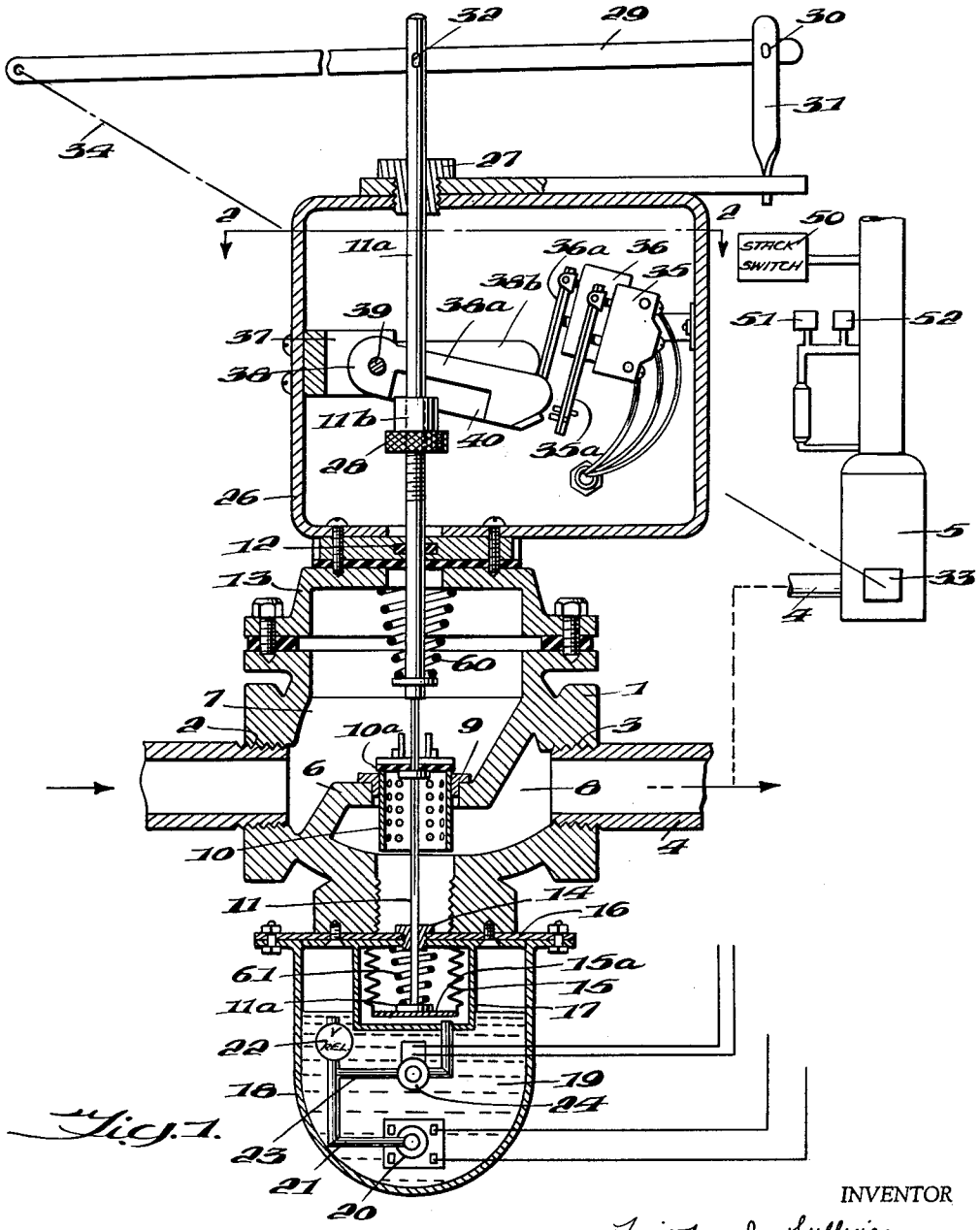


Fig. 1.

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Fig. 2.

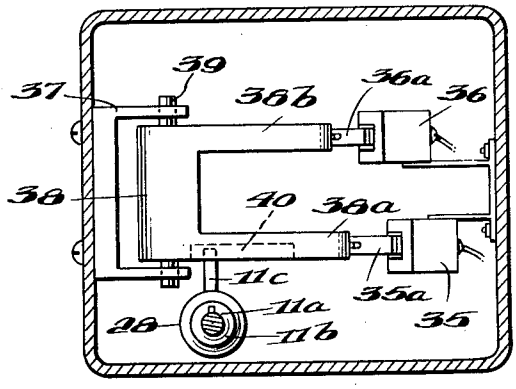
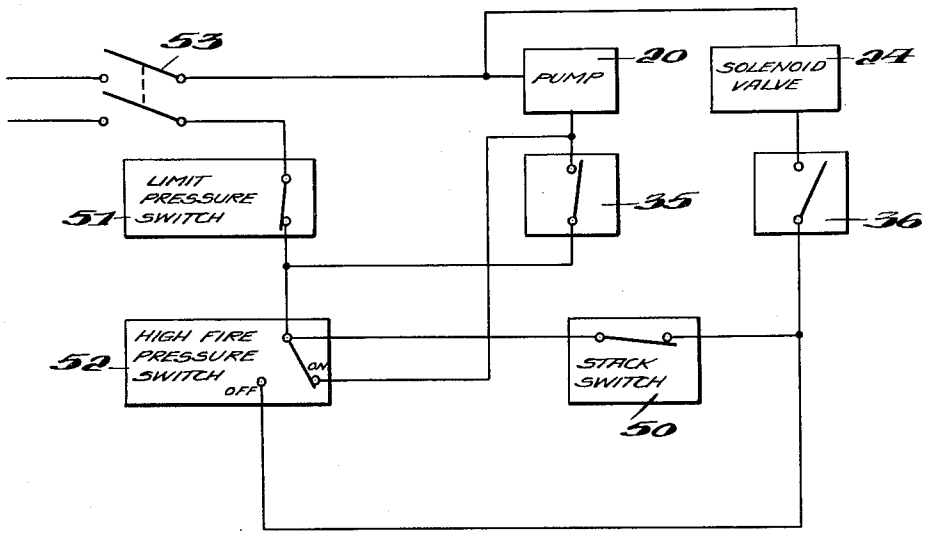


Fig. 3.



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TWO-STAGE HYDROMOTOR-OPERATED VALVE

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This invention relates generally to a hydromotor-operated fluid valve, and more particularly to a two-stage hydromotor-operated valve apparatus which may be automatically positioned and maintained at a first partially-open condition and at a second fully-open condition.

Two-stage valves adapted for connection in the fuel line to the burner of a boiler furnace are, of course, well-known in the prior art. In my prior U.S. Patents #2,333,-212 and #2,825,510 I have disclosed embodiments of two-stage valve devices using a pair of diaphragm controllers, and in my pending U.S. patent applications Serial Number 691,362 filed December 21, 1957, now Patent No. 2,973,-935, and Serial Number 843,461 filed September 30, 1959 (now abandoned) I have disclosed embodiments of two-stage devices utilizing a single diaphragm controller. In boiler furnace or heating systems utilizing such two-stage valves, the valve is connected in series in the fluid fuel line and is initially opened from a closed position to a partially-open low-fire position until the chimney of the furnace has been heated sufficiently to create a draft therethrough, whereupon the valve is then fully opened to a high fire position to permit maximum flow of fuel to the burners of the furnace. As the demand of the load fluctuates, the valve is automatically changed from its high-fire position to its low-fire position.

The primary object of the present invention is to provide a fluid control valve which is operated by hydromotor operating means.

A further object of my invention is to provide a fluid control valve which is operated by means of a hydromotor operator and which includes solenoid valve means in the fluid circuit of the hydromotor for maintaining the valve member at a predetermined degree of opening.

Still another object of my invention is to provide a fluid control valve which is operated by hydromotor means, said hydromotor means including in the fluid circuit thereof a solenoid valve controller operable as a function of the degree of opening of the valve member relative to its seat to positively lock the valve member in a given position.

A more specific object of my invention is to provide a two-stage fluid valve operable by hydromotor means including in the fluid circuit thereof a solenoid valve which is actuated when the valve member is raised from its closed position or lowered from its fully open position to a low-fire partially open condition to temporarily lock the valve member in its low-fire position.

Other objects and advantages of my invention will become apparent from a study of the following specification when considered in conjunction with the accompanying drawings in which:

FIG. 1 is a vertical sectional view of the two-stage hydromotor operated valve in its closed position;

FIG. 2 is a horizontal sectional view taken along line 2—2 of FIG. 1; and

FIG. 3 is an electrical wiring diagram of the valve connected in a boiler furnace system.

Referring first more particularly to FIG. 1, the valve body **1** has an inlet opening **2** and an outlet opening **3** connected in series in the gas supply conduit **4** leading to the burner unit of the boiler furnace **5**. The valve body **1** has a transverse wall **6** therein defining an inlet chamber **7** and an outlet chamber **8**, which wall **6** contains an opening in which is mounted the valve seat **9**. Slidably

mounted within the valve seat opening is the perforated valve sleeve **10** having a resilient washer **10***a* adapted to be seated upon the valve seat **9** when the valve is in the closed position to prevent flow of the fluid fuel from the valve inlet chamber **7** to the outlet chamber **8**. The valve sleeve **10** is carried on a valve stem **11** which slidably extends through an opening in the upper portion of the valve body bonnet **13**, said opening being sealed by the fluid seal **12**. At its lower end, the valve stem **11** slidably extends through seal **14** mounted in the valve body bottom plate **16** and terminates in an enlarged portion **11***a* within the flexible bellows **15** adjacent the rigid bottom portion **15***a* thereof.

The bellows **15** is mounted within the fluid tight seal to the horizontal plate **16**. Surrounding the pressure chamber **17** and secured to the plate **16** is the housing **18** which contains a quantity of fluid **19**, such as oil, therein. Submerged within the fluid **19** is the electrically-driven pump **20** having a pressure outlet line **21** provided with a pressure relief valve **22**. A branch line **23** extends from the pressure line **21** and has an electrically-operated solenoid valve **24** connected in series therewith. Solenoid valve **24** is open in its normally de-energized state and is closed in its energized state. The branch line **23** terminates within the pressure chamber housing **17** so that when the solenoid valve **24** is open, fluid under pressure may be pumped by pump **20** through lines **21** and **23** into the pressure chamber housing **17** to compress the flexible bellows **15** and cause upward movement of the valve stem **11** and raising of the valve sleeve **10** from its seat **9** as will be described in greater detail below. Spring **60** provided on the valve stem normally biases the valve stem **11** and sleeve **10** downwardly to seat the washer **10***a* upon the seat **9**.

To the upper end of the valve bonnet **13** is secured the switch housing **26** having a guide bearing **27** in the upper wall thereof through which the upper portion **11***a* of valve stem **11** slidably extends. Adjusting nut **28** is threadedly mounted on the valve stem portion **11***a* and will be displaced longitudinally of the valve stem by rotation relative thereto. The adjusting nut supports the sleeve **11***b* which is keyed to the valve stem and is freely displaceable longitudinally of the valve stem.

At one end the furnace air doors operating arm **29** is pivotally connected to the fixed pivot **30** secured to the switch housing by the rigid bracket **31**, and intermediate its ends the arm **29** is pivotally connected to the upper extremity of the valve stem extension **11***a* by the pivot **32**. At its other end the arm **29** is connected to the furnace air doors **33** by the chain **34**. Thus upward movement of the valve stem **11** will result in opening of the furnace air doors **33** and downward movement of the valve stem will cause closing of the doors.

Secured to one wall of the switch housing **26** are the microswitches **35**, **36** having switch actuators **35***a*, **36***a*, respectively. Secured to the opposite wall of the switch housing is the bracket **37** to which is pivotally connected the switch operator **38** by means of shaft **39**. The switch operator has two rigid arms **38***a*, **38***b* terminating adjacent the switch actuators **35***a*, **36***a*, respectively, as shown in FIGS. 1 and 2. The switch operator arm **38***a* has a recess **40** therein into which extends the radial pin **11***c* of the valve stem sleeve **11***b*. It will now be apparent that upward movement of valve stem **11** causes pin **11***c* to engage the horizontal wall of recess **40** to pivot the operator **38** in the counter-clockwise (upward) direction relative to the pivot shaft **39**. The contacts of switch **35** are normally closed and the contacts of switch **36** are normally open. The switch actuators **35***a* and **36***b* are operated by the extremities of arms **38***a* and **38***b* during pivotal movement of the operator **38** as will be explained below.

The operation of the two-stage hydromotor valve may

now be described with reference to the circuit diagram of FIG. 3, the physical locations of the temperature responsive stack switch **50** and the pressure-responsive limit and high-fire switches having been illustrated diagrammatically in FIG. 1.

When the hydromotor valve is in the closed position of FIG. 1 and the line switch **53** is closed, current will flow to pump **20** through the normally-closed contacts of the limit pressure switch **51** and through the normally closed contacts of switch **35**. Upon energization, pump **20** will pump fluid **19** through conduits **21** and **23** and through the normally open solenoid valve **24** into the pressure chamber housing **17**. As the fluid pressure in housing **17** builds up, flexible bellows **15** will be compressed and valve stem **11** will be moved upwardly to partially raise valve sleeve **10** from its seat **8**. Fuel will then be fed at a relatively low rate to the burners of boiler furnace **5** through the valve body **1** and the conduit **4**.

As the valve stem **11** moves upwardly to the low-fire partially-open position, operator **38** is pivoted upwardly by radial pin **11***c* until switch **36** is operated by contact of the extremity of arm **38***b* with the actuator **36***a* so that the contacts of switch **36** are closed. Solenoid valve **24** will then be energized by current flowing through the line containing the stack switch **50** and the solenoid valve will be actuated to its closed position. Thus no more fluid **19** may be pumped through conduit **23** into the pressure chamber housing **17** and the valve stem **11** will be maintained at its low fire position. In a similar manner, the contacts of switch **35** will be caused to open due to the cooperation between arm **38***a* and actuator **35***a*. The contacts of switch **35** are maintained open during both low and high fire positions of the valve stem **11**. The pump **20**, of course, will continue to operate (due to the jumper connection through the high-fire switch **52**) and the pressure fluid therefrom will pass through conduit **21** and pressure relief valve **22** for recirculation.

After the chimney has been heated sufficiently to create the desired draft therethrough, stack switch **50** will be opened and the solenoid valve **24** will be de-energized to open the passage through branch line **23** so that more fluid will be pumped into the pressure chamber housing **17**. The bellows **15** will then be further compressed and valve stem **11** will be raised to fully lift valve sleeve **10** to its high fire position. The fuel fluid will then flow at a relatively high rate through conduit **4** to the burners of furnace **5**. The upward travel of the valve stem **11** and the degree of complete opening of the valve is limited by the compression of springs **60** and **61** mounted upon the valve stem. At the high fire position, the contact pressure applied by arm **38***b* to actuator **36***a* is reduced to cause the contacts of switch **36** to be opened.

After the high fire demand has been satisfied, the high-fire pressure switch is operated to the "off" position and the pump **20** becomes de-energized to discontinue the flow of fluid into pressure chamber **17**. Fluid will then flow out of chamber **17** through branch conduit **23** until the valve stem **11** (and the valve sleeve **10***a* secured thereto) fall under the biasing force of spring **60** to the low fire position. At this point, however, the arm **38***b* will again engage switch **36** to close the contacts thereof to energize the solenoid valve **24** and prevent further outflow from the pressure chamber housing **17** and consequently the valve stem **11** will be positively maintained at its low fire position. Upon reactivation of the high-fire pressure switch upon demand for more heat, pump **20** will again be energized (by current flowing through the high-fire pressure switch) and solenoid valve **24** will be de-energized to permit pumping of additional fluid into housing **17** whereby the valve stem **11** will again be raised to its high-fire position. Thus it is apparent that the contacts of switch **36** are closed by arm **38***b* only when the valve stem **11** is at the low-fire position, and the contacts of switch **36** are open in both the closed and high fire positions of valve **10**. The contacts of switch **35** are maintained open by the arm **38***a* once the valve stem **11** has been initially raised from the valve-closed position.

Upon operation of the limit pressure switch **51** with the valve stem **11** (and the valve sleeve **10** carried thereon) in either the low or high-fire positions, both the pump **20** and the solenoid valve **24** will be de-energized with the result that fluid will flow out of pressure chamber housing **17** and valve stem **11** will drop to its fully closed position to seat valve sleeve washer **10***a* upon its seat.

It should be mentioned that the low-fire degree of partial opening of the valve member relative to its seat may be adjusted as desired by means of the adjusting nut **28**. Rotation of the adjusting nut **28** in one direction will cause raising of sleeve **11***b* and pin **11***c* relative to the valve stem **11**, and rotation of the adjusting nut **28** in the opposite direction will cause lowering of pin **11***c*, whereby the point of cooperation between operator arm **38***b* with actuator **36***a*—and consequently the degree of opening of the valve at low-fire—may be determined.

The use of the perforated sleeve **10** in place of the common V-port sleeve or regular valve seat should be noted. Due to the use of the perforated sleeve—which may be made of steel, brass or other suitable material—equal additional increments of fuel gas will enter the sleeve for each quarter inch lift of the valve member from its seat. In the valves of the prior art using V-ports the valve will not progressively open in equal increments but rather will open more on the last half inch of movement than on the first half inch of movement.

Although a two-stage valve has been illustrated and described, it is apparent that the principles of the instant invention are equally applicable to simple throttling valves and other types of fluid control valves.

While in accordance with the patent statutes I have illustrated and described the best form and embodiment of my invention now known to me, it will be apparent to those skilled in the art that other changes and modifications may be made in the apparatus described without deviating from the invention set forth in the following claims:

I claim:

1. In combination with a valve body having an inlet chamber and an outlet chamber divided by a transverse wall provided with an opening containing a valve seat, and a valve member in said valve body adapted to be seated upon said seated opening to close the same; the invention which consists of hydromotor means for raising said valve member from its seat comprising a pressure chamber housing connected to said valve body, a flexible bellows in said pressure chamber housing, said valve member having an extension adjacent said bellows for engagement thereby, means including a conduit for introducing fluid under pressure into said pressure chamber housing to distort said belolws in a direction to raise said valve member relative to its seat, an electrically-actuated solenoid control valve means in said conduit for interrupting the flow of fluid in either direction through said conduit, said combination further including means biasing said valve member to a closed position on its seat and for biasing said bellows to urge fluid out of said pressure chamber housing through said conduit, and means responsive to the position of said valve member relative to its seat for actuating said solenoid valve to close the same when the valve member is positioned at a predetermined position relative to its seat.

2. Apparatus as defined in claim 1 wherein said means for actuating said solenoid valve includes a switch connected to said valve body, electrical means connecting said switch to said solenoid valve, and means operable by said valve member for operating said switch when the valve member is positioned at said predetermined position relative to its seat.

3. Apparatus as defined in claim 2 and further includ-

ing means for adjusting the point of operation of said switch by said switch operating means whereby the predetermined partially-open position of the valve member relative to its seat may be set as desired.

4. Apparatus as defined in claim 1 wherein said means for introducing fluid under pressure into said pressure chamber housing includes an electro-mechanical pump connected to said conduit.

5. Apparatus as defined in claim 4 and further including a relief valve connected in said conduit intermediate said pump and said control valve for relieveing the fluid pressure in said conduit when said pump is operative and said control valve is closed.

6. Apparatus as defined in claim 5 wherein said pump is submerged in a receptacle containing the fluid and the relief valve discharges the fluid into said receptacle for recirculation.

7. Apparatus as defined in claim 4 and further including switch means for discontinuing the operation of said pump.

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