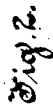


SOLENOID OPERATED VALVE AND THE LIKE.

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BY

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SOLENOID-OPERATED VALVE AND THE LIKE

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Specification of Letters Patent.

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Application filed October 23, 1916. Serial No. 127,221.

To all whom it may concern:

Be it known that I, ARTHUR SIMON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Solenoid-Operated Valves and the like, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

This invention relates to improvements in solenoid operated valves and is particularly applicable to valves used for high pressures and operable by direct current solenoids.

Such valves are commonly provided in lieu of stuffing boxes with tubular extensions from their casings inclosing the plungers of their operating solenoids, and the present invention has among its objects to provide an improved lamp switch for valves of this type.

As is understood, a valve of the type mentioned requires of its operating solenoid a materially greater pull for unseating than for continued movement, whereas as is also understood, the pull of a D. C. solenoid varies inversely with the square of its travel, and the present invention has for a further object to provide for unseating of such a valve toward the end of the stroke of the plunger of its operating solenoid thereby enabling the use of a smaller solenoid than heretofore required.

Various other objects and advantages of the invention will hereinafter appear.

A solenoid operated valve embodying the invention is illustrated in the accompanying drawing, and the same will now be described, it being understood that the invention is susceptible of various modifications.

In the drawing,

Figure 1 is a vertical sectional view through the valve and solenoid, certain parts however being shown in elevation; and,

Fig. 2 is a side elevation of Fig. 1.

The valve illustrated is of the usual type comprising a casing 1 having therein a valve seat 2, a reciprocable piston 3 having a valve 4 to fit said seat and a non-magnetic tubular extension 5 from said casing concentric with the guide of piston 3.

The operating solenoid includes a winding 6 mounted upon the tube 5 and inclosed in

a magnetic frame 7, a plunger 8 reciprocally mounted in said tube, a non-magnetic plug 9 sealing said tube and having a magnetic end facing 10 and core 11 and an auxiliary plunger 12 reciprocally mounted in said non-magnetic plug. The plunger 8 is operatively connected to the valve piston, as hereinafter described, while the auxiliary plunger 12 comprises the actuating member of a lamp switch operable to reduce the current supplied to the solenoid following actuation of the valve by plunger 8.

The lamp switch comprises yielding contacts 14 and 15 of a well known type mounted upon an insulating panel 16 fixed to one side of the solenoid frame 7 and a cooperating contact 17 to bridge the former contacts. The contact 17 comprises a conducting tube mounted upon and insulated from a rod 18 carried by and between two bell crank levers 19. The levers 19 are fulcrumed upon a spindle 20 carried by and between upstanding lugs 21 on the solenoid frame and said levers are provided with weights 22 biasing the same in a direction to engage contact 17 with contacts 14 and 15. As will be understood, these contacts are employed to short-circuit a series resistance for the solenoid winding and to include said resistance in circuit upon disengagement. As stated, the auxiliary plunger of the solenoid constitutes the actuating means for the lamp switch, said plunger having a stem 12^a threaded through a block 23 pivotally connected to and between the levers 19. The weights 22 of the levers overbalance the auxiliary plunger, thus normally holding the latter in a spaced relation with the magnetic core of the plug 9, the spacing of said elements being variable at will by adjustment of the auxiliary plunger relative to the levers 19 through the medium of the threaded stem 12^a. The auxiliary plunger 12, the magnetic core 11 and the main plunger 8 are all in axial alinement and the auxiliary plunger when elevated, as shown, is subjected only to the stray magnetic flux of the solenoid. Accordingly, when the plunger 8 is in the position shown, comparatively few magnetic lines of force will pass to the auxiliary plunger, while during movement of the plunger toward the plug 9 the magnetic flux of the solenoid is so curtailed by self induction as to insure against any material pull upon the

auxiliary plunger. On the other hand, when the plunger 8 is arrested by the plug the magnetic flux of the solenoid will rise to its maximum, saturating the core 11 thereby causing sufficient magnetic lines of force to pass to and through the auxiliary plunger to attract the same toward the core 11 which under the conditions noted will constitute in reality an extension of the plunger 8. Such attraction of the auxiliary plunger will serve to actuate the lamp switch to disengage the contact 17 from its cooperating contacts thereby inserting the protecting resistance for the solenoid winding. In practice, it is preferable to arrest the auxiliary plunger prior to contact with the core 9 and to this end the levers 19 are provided with lugs 24 coöperable with stops 25 provided on the solenoid frame.

As will now be apparent, the adjustment of the auxiliary plunger to vary the air gap between the same and the core 11 provides for regulation of the sensitiveness of the lamp switch which is preferably so regulated as to insure arrest of the plunger prior to actuation of said switch. Also, as will now be apparent, insurance against operation of the lamp switch until arrest of the plunger 8 enables utilization of substantially the maximum pull of the solenoid for valve actuation and the operating connection between the solenoid plunger and valve piston to be described enables utilization of such pull for unseating of the valve.

This connection comprises a plunger 26 slidably fitting a socket portion 3^a of the valve piston, said socket portion containing a helical spring 27 interposed between the plunger and internal shoulders 3^b of the piston and said plunger having a stem 26^a threaded into the end of the solenoid plunger 8. The arrangement is such that with the valve 4 seated, as shown, elevation of the solenoid plunger will effect compression of the spring 27 to bias the valve away from its seat. Moreover, the arrangement is such that if the valve refuses to respond to the bias of the spring, continued movement of the solenoid plunger will cause the plunger 26 to abut the internal shoulders 3^b of the valve piston, thereby establishing a positive connection between said piston and solenoid plunger, the parts being so proportioned as to first permit the solenoid plunger to move into close proximity with the stop plug 9. In other words, the connecting means provides for a delay in the establishment of the positive connection until the pull of the solenoid nearly approximates its maximum value. Thus the final movement of the solenoid plunger may be utilized to unseat the valve while the energy stored in the spring may be utilized to continue the movement of the valve to full open position.

The connecting means accordingly enables utilization of the smallest solenoid which will exert the requisite pull under substantially maximum pull conditions while the lamp switch enables utilization of the smallest solenoids capable of exerting the requisite pull subject to immediate reduction in the current supplied thereto. Moreover, the very simple lamp switch which requires no special construction of the solenoid frame for magnetic shunts, etc., is positive and reliable in operation and subject to expeditious and fine adjustment for attaining maximum efficiency of the solenoid employed.

What I claim as new and desire to secure by Letters Patent is:

1. The combination with an inclosed device having a reciprocable member, the inclosure thereof including a sealed non-magnetic tubular extension having a magnetic plug in the outer end thereof, of a solenoid having coaxially arranged plungers one being reciprocably mounted within said extension and attractable toward said plug and the other being mounted externally of said extension and arranged to be attracted toward said plug upon substantial completion of the stroke of said former plunger, means connecting said former plunger and the reciprocable member of said device whereby the latter part of the stroke of said plunger is available for initiation of the movement of said member and a protective device for said solenoid operable by said latter plunger.
2. The combination with a device to be operated, of an operating solenoid therefor, an operative connection between said device and the plunger of said solenoid providing for initiation of the movement of said device during the latter part of the stroke of said plunger, said connection including means adapted to store energy prior to initiation of the movement of said device and to effect continued movement of said device upon initiation of movement thereof and a protective device for said solenoid operable thereby but only after a substantially full stroke of said plunger.
3. The combination with a device to be operated, of an operating solenoid therefor, an energy storing connection between said device and the plunger of said solenoid to bias the former upon attraction of the latter and to store energy upon failure of said device to respond to such bias, said connection providing for transmission of the pull of said plunger directly to said device during the latter part of the movement of said plunger and a protective device for said solenoid operable thereby but only upon substantial completion of the stroke of said plunger.
4. The combination with an inclosed valve, the inclosure thereof having a sealed tubular extension, of a solenoid having a plunger reciprocably mounted within said extension, an energy storing connection between said

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valve and said plunger whereby said valve may be unseated by said plunger during the latter part of its stroke and continued in movement by the energy stored in said connection and a protective device for said solenoid magnetically operable thereby but only after substantial completion of the stroke of said plunger.

5. The combination with an inclosed valve, the inclosure thereof having a sealed non-magnetic tubular extension provided with a magnetic plug in the outer end thereof, of an operating solenoid having a plunger reciprocally mounted in said tubular extension and operatively connected to said valve, said solenoid also having in axial alinement with said plunger an auxiliary plunger external of said tubular extension and a protective switch for said solenoid connected to and operable by said auxiliary plunger, said switch normally holding said plunger in a position relative to the magnetic field of said solenoid to insure against its attraction until after predetermined movement of said valve operating plunger.

6. The combination with an inclosed valve, the inclosure thereof having a tubular extension, of an operating solenoid having a plunger reciprocally mounted in said tubular extension and connected to said valve, said solenoid also having an auxiliary plunger in axial alinement with the former plunger and an interposed non-magnetic tube sealing said tubular extension and provided with a magnetic core symmetrical with respect to the axes of said plungers and a protective switch for said solenoid operatively connected to said auxiliary plunger and normally holding the same in a position with respect to the magnetic field of said solenoid to insure

against its attraction until after attraction of said valve actuating plunger.

7. The combination with a tube, of a solenoid winding mounted thereon, a main plunger for said solenoid winding reciprocally mounted within said tube, an auxiliary plunger external to said tube and alined axially with said main plunger, a non-magnetic plug interposed between said plungers and sealing said tube, said plug having a magnetic core symmetrical with respect to the axes of said plungers and a protective switch for said solenoid having an operative connection with said auxiliary plunger, said switch biasing said auxiliary plunger to a position whereby its attraction is dependent upon prior attraction of said main plunger and saturation of said core, said auxiliary plunger being adjustable with respect to said switch for variation of its normal position.

8. The combination with a device to be operated, of an operating solenoid therefor, the pull required for operation of said device varying conversely with the pull exerted by said solenoid upon corresponding movements thereof and an operative connection between said device and the plunger of said solenoid providing for initiation of the movement of said device during the latter part of the stroke of said plunger, said connection including means adapted to store energy prior to initiation of the movement of said device and to effect continued movement of said device upon initiation of movement thereof.

In witness whereof, I have hereunto subscribed my name.

ARTHUR SIMON.