J. H. CAMPBELL.

ELECTROMAGNETIC VALVE.

APPLICATION FILED NOV. 1, 1918.

1,382,412. Patented June 21, 1921.

Fig. 1.

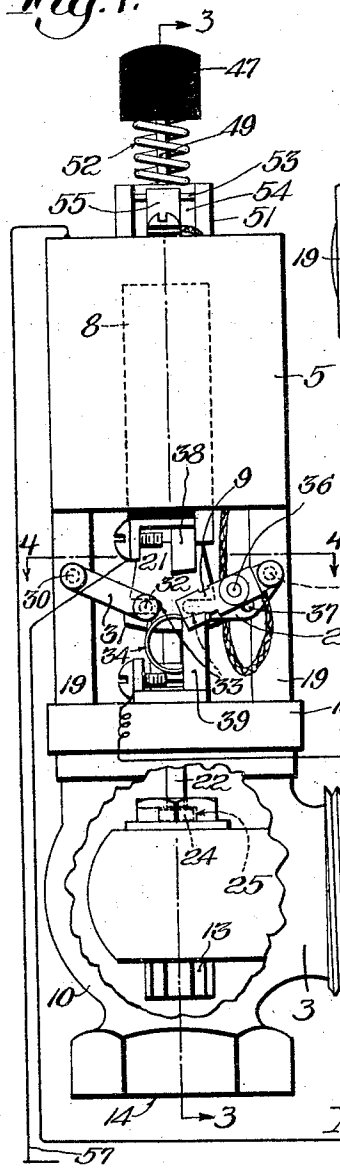


Fig. 4.

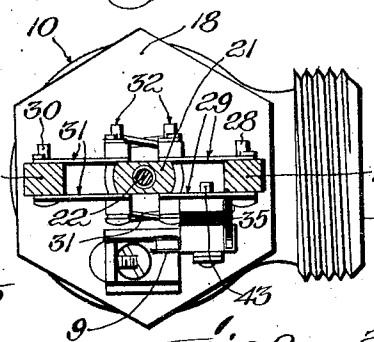


Fig. 2.

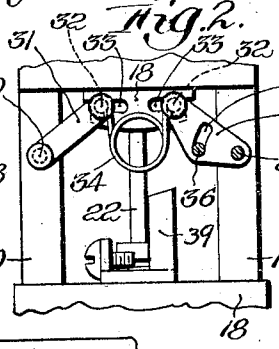
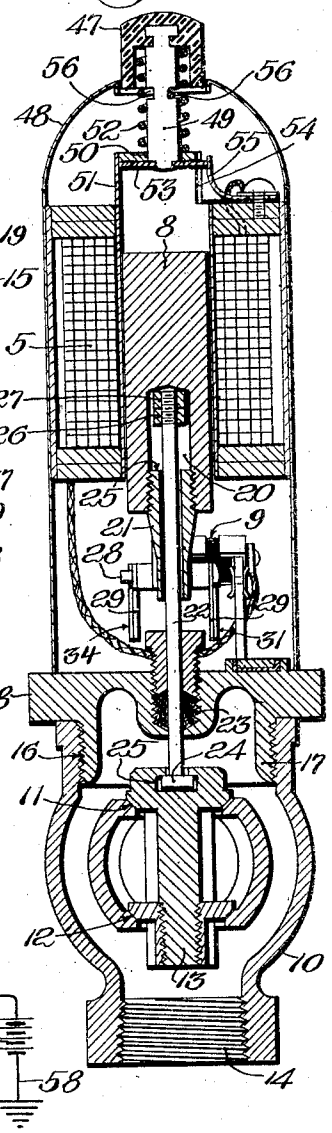
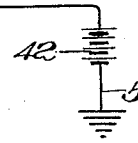
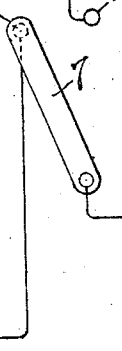


Fig. 3.







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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC VALVE.

1,382,412. Specification of Letters Patent. Patented June 21, 1921.

Application filed November 1, 1918. Serial No. 260,745.

To all whom it may concern:

Be it known that I, JAMES H. CAMPBELL, a citizen of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Electromagnetic Valves; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to electromagnetically operated valves. The invention is particularly useful wherever it is desirable to employ a positively acting automatic valve which is adapted to be controlled from a point remote from the valve.

The principal objects of this invention are; to provide an electro-magnetically actuated valve of simple and durable construction, contrived and arranged to consume electric current only momentarily and therefore adapted to use with widely different, including relatively heavy currents, either direct or alternating; to provide for opening and closing the valve by a hammer-blow struck in line with either movement of the valve itself; to provide for automatic control of the duration of the actuating current independently of the motion of the valve to be operated; and to provide a mechanism of this kind which is capable of assemblage in compact compass as an article of sale and use, adapted to be installed by any steam fitter, or electrician's workman without requiring the exercise of any high degree of electrical or mechanical skill, and capable also of preserving indefinitely its capacity for quick and certain action without demanding skilled inspection.

While the broad principles on which my invention operates are already known to and exemplified in the literature of the art to which it belongs, there has not—so far as I am informed—been any embodiment of these principles in an instrument possessed of features and characteristics of the nature above indicated, and therefore adapted practically to such uses as I have pointed out.

To this end I have invented an electromagnetically operated valve in which the actuating factor, an electro-magnet or solenoid, with its armature, is reduced to the simplest minimum of working parts, in which friction-producing bearings are eliminated, leaving the gland or stuffing-box of the actuated valve as practically the sole representative of frictional factors.

The various features of the invention will be readily understood from a description of the preferred embodiment thereof, illustrated in the accompanying drawings, in which:—

Figure 1 is a view in side elevation, showing the valve in closed position, certain portions of the valve being removed or broken away to disclose parts of the actuating mechanism; Fig. 2 is a fragmentary view of the valve, in side elevation, the parts being shown in the positions they occupy when the valve is open, and certain parts being removed to illustrate the construction of the others more clearly; Fig. 3 is a vertical sectional view of the valve, taken on the line 3—3 of Fig. 1; and Fig. 4 is a cross-sectional view, taken substantially on the line 4—4 of Fig. 1.

In the construction shown, the valve and its actuating mechanism is carried by a valve body 10 which may be of standard construction, having an inlet 14, an outlet 15, and a screw-threaded opening 16 at the top for receiving the threaded tubular extension 17 of a bonnet 18 which closes the opening 16. The valve body 10 is provided with the usual seats 11 and 12 for a balanced valve 13, this form of valve being preferably employed since it permits the use of actuating means of comparatively small size and power.

The means for opening and closing the valve comprises an electro-magnet, and an armature that is mounted for movement, preferably rectilinear, through and beyond its neutral position, in opposite directions, upon successive energizations of the magnet. It also includes means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction, to permit its movement to continue beyond said position. The movement of the armature may, therefore, be transmitted to the valve to move the latter in opposite directions, through simple and effective connections, while the electric current is utilized but an instant in either opening or closing the valve. In order to secure the full advantage of this construction, the armature is preferably mounted to move in the direction of move-

ment of the valve and also substantially in line therewith, and is directly connected with the valve by a rod which causes the valve to move with the armature during the movement of the latter beyond neutral position in either direction. The magnet is preferably in the form of a solenoid 5 which is supported above the bonnet 18 by standards 19 with its central opening substantially in line with the valve 13. The solenoid 5 is open at its lower and upper ends so that its armature 8, which is mounted to move freely through the solenoid, may move, in either direction, beyond its neutral position in the magnetic field.

The connections between the valve 13 and the armature of the solenoid 5 comprise a rod 22, which extends through a stuffing-box 23 in the bonnet 18, and through a thimble 21 which is threaded into the mouth of an axial recess 20 in the armature. The rod 22 has a head 24 at its lower end which is retained in a socket 25 in the valve, while at its upper end the rod is provided with nuts 26 and 27 which play in the recess 20 permitting sufficient lost motion to insure that no movement will be transmitted to the rod until after the armature has substantially reached neutral position. When the lost motion has been taken up on the upward movement of the armature, the thimble 21 strikes the nut 26 with a hammer blow due to the momentum of the armature and on the downward movement the top of the rod 22 is struck a similar blow by the portion of the armature at the inner end of the recess 20. The rod is then moved suddenly and with a great deal of force and consequently the valve is opened or closed, as the case may be, effectively and quickly. Furthermore, on the upward movement of the armature, the hammer blow insures the starting of the valve in case it should be corroded or frozen to its seat, or in case the rod 22 should bind or stick in the stuffing-box, while on the downward movement of the armature, it supplies the necessary closing force to insure the proper adjustment of the valve to its seat. The rod 22 fits loosely in the socket 25, and in the thimble 21, to permit the armature and the valve to adjust themselves to the magnet and the valve seat, respectively, in case the stuffing-box is slightly out of alinement.

The solenoid 5 is adapted, by means of two terminals 38 and 39, to be connected with the wires X and Y of two circuits, one or the other of which may be closed to energize the solenoid, through a suitable switch 7, which is arranged to engage contacts 40 and 41 in said circuits and which may be located at any remote point from which it is desired to control the valve. The terminal 38 is secured to the outside of the solenoid and the terminal 39 is secured to the valve-body, each being insulated from the part to which it is secured and adapted to be engaged by a knife-blade switch 9 which is connected with the winding of the solenoid. The switch 9 is secured to a block 35, of insulating material, which is pivoted upon a pin 28 extending through one of the standards 19. The two solenoid circuits may include a single battery 42 which is connected with the switch 7, and the circuits may be completed by means of a wire 57, connected with the solenoid, and a wire 58, connected with the battery 42, each of said wires being suitably grounded or otherwise electrically connected.

The means for deënergizing the solenoid comprises the switch 9 described above. In order that the switch 9 may be actuated automatically to effect the deënergization of the solenoid, said switch is connected to be moved by the armature 8. To this end a link 29 is pivoted on the pin 28, alongside the switch 9, and is operatively connected with said switch by a pin 36 which projects from the switch-block 35 and extends into an arcuate slot 37 in the link, the sides of the slot being concentric with the pivot-pin 28. At its inner end, the link 29 is connected with the thimble 21, by a pin 32 which projects from the link through a slot 33 extending transversely in the side of the thimble adjacent said link. The arrangement of the link 29 and of the slot 37 are such that the movements of the armature are transmitted to the switch so as to effect the deënergization of the solenoid as the armature reaches its neutral position when moving in either direction. In order to prevent waste of current if, for any reason, the valve should fail to be moved by the armature, the arrangement is such that the switch 9 is shifted to break the solenoid circuit just before the lost motion between the rod 22 and the armature is taken up. The solenoid being deënergized, the momentum of the armature carries it beyond its neutral position, leaving it protruding from the opposite end of the solenoid from which it protruded before the solenoid was energized and consequently in position to be moved in the opposite direction by the succeeding energization of the solenoid. The armature is somewhat shorter than the recess through the solenoid so that when the armature is retracted with one end flush with the end of the solenoid, it has to move a short distance before it begins to protrude beyond the opposite end of the solenoid. With this construction, the armature is influenced only slightly by the solenoid while it is moving entirely within the latter, and the hysteresis of the iron in the solenoid is overcome before any appreciable retarding influence is exerted thereby upon the armature.

Means is provided for assisting the move-

ments of the armature after it has passed beyond its neutral position in the magnetic field, when moving in either direction, and for retaining it at either limit of its movement. In the construction shown, two springs 34 of the so-called "grasshopper" type are employed for this purpose, the springs being arranged on opposite sides of the thimble 21 and one end of each of said springs being connected with the pin 32 which is carried by the link 29, while the opposite ends of the springs are connected with a similar pin 32 which projects from a link 31, the link 31 being pivoted at 30 on the opposite standard 19 and its pin 32 extending through a transverse slot 33 in the corresponding side of the thimble. With this construction, the springs 34 are compressed somewhat during the movements of the links 29 and 31 toward dead center, in either direction, and after the links have passed dead center the expansion of the springs assists the continued movement of the armature. In order to better support the pin 32 the links 29 and 31 are preferably made in pairs, the individual members of each pair being arranged on opposite sides of the standards 19. By reason of the pin and slot connections hereinbefore described between the thimble 21 and each pair of links 29 and 31, the springs 34 will not exert any lateral pressure upon the armature and the latter will be free to center itself in the solenoid.

In order to obtain the fullest measure of permanent automatic operativeness, the valve and its associated parts should be mounted, as shown in the drawings, in a vertical position. The solenoid armature makes a loose fit in the interior of the coil-case, the engagement between the armature and the valve stem is also loose, and the bearings of the links 29 and 31 are all easy, so that no lubrication is necessary anywhere; the only point where friction is likely to develop is in the stuffing-box through which the valve stem passes. The vertical position of the valve stem and armature reduces all drag of moving upon stationary parts to a minimum.

The downward movement of the armature, the valve and the parts connected therewith, is accelerated by their weight, whereas the weight of these parts tends to retard their upward movement. In order to equalize the upward and downward movements of the armature, provision has been made for causing the springs 34 to assist the upward movement more than the downward movement. To this end the pivots 28 and 30 are so arranged that the links 29 and 31 pass dead center on their upward movement approximately at the same time the armature reaches its neutral position and the solenoid is deenergized, while on their downward movement these links do not pass dead center until after the armature reaches its neutral position. Consequently the assisting force of the springs is exerted sooner and acts through a greater portion of the stroke of the armature when the latter is moving upwardly, and any retarding influence due to the weight of the armature and connected parts is offset by the action of the spring.

The operation of the parts thus far described is as follows: When the valve is closed, the armature is in its lowermost position, protruding below the field of the solenoid, and the switches 7 and 9 occupy the positions indicated in Fig. 1. By shifting the switch 7 from the contact 40 to the contact 41 the solenoid may be energized to lift the armature. As the armature reaches neutral position, the lower end of the slot 37 in the link 29 engages the pin 36 in the switch-block 35, swinging the switch 9 upwardly and thus deënergizing the solenoid. The momentum of the armature, assisted by the springs 34, then continues the upward movement of the armature and when the lost motion between the armature and the rod 22 has been taken up the valve will be suddenly opened. The action of the spring 34 will then prevent the armature from returning under the influence of gravity and thus serve to hold the valve in its wide open position. When the valve is open, the links 29 and 31 occupy the positions indicated in Fig. 2 and the switch 9 is connected with the terminal 38. By shifting the switch 7 from the contact 41 to the contact 40, the solenoid may be again energized, but this time the armature will be moved downwardly. As the armature reaches neutral position, the slotted link 29 is actuated to shift the switch 9 from the terminal 38 to the terminal 39, deënergizing the solenoid and thus permitting gravity and the momentum of the armature, assisted by the springs 34, to continue the downward movement of the armature and close the valve. The springs 34 will then serve to hold the valve closed. It will be observed that the solenoid is only momentarily energized to effect either the opening or the closing of the valve and that consequently the consumption of current is minimized.

In order to enable the valve to be closed at the valve as well as from a more or less remote point, means is provided for mechanically forcing the armature downward and locking it in its lowermost position. This means comprises a push-button 47 protruding through an opening in the top of a dome-shaped casing 48 (Fig. 3) which incloses the solenoid and the valve actuating mechanism. The flat stem 49 of the push-button 47 extends through a slot 50 in the closed upper end of a tube 51 which guides the armature in the solenoid, and secured to the lower end of the stem is a disk 53 which is adapted to move vertically within the tube

51. The push-button is pressed upwardly by a spring 52 which surrounds the stem 49 between the push-button and the closed end of the tube 51. The disk 53 is normally permitted by means of a lateral slot 54 in the tube 51 to engage a spring contact-finger 55 which is insulated from the outside of the solenoid and connected with the winding thereof. Electrical connection between the disk 53 and the wire 57 is made through the metallic parts of the solenoid and valve body. When the push-button 47 is depressed, its stem 49 mechanically forces the armature 8 downwardly and closes the valve. The disk 53 is thus moved out of engagement with the contact-finger 55, breaking the connection between the solenoid and the wire 57 so that the shifting of the switch 9, upon the downward movement of the armature, will not cause a flow of current through the solenoid and exhaust the battery. In order that the push-button may be locked in depressed position to hold the valve closed, the stem 49 is provided with notches 56 on its opposite longitudinal edges which may be brought into engagement with the sides of the slot 50, in the closed upper end of the tube 51, by a twist of the push-button. When the push-button is unlocked and released, the spring 52 will return it to normal position, with the disk 53 in contact with the finger 55, thus restoring the electrical connections between the solenoid and the battery.

The invention is not limited to the details of construction and operation herein described and illustrated except in so far as specified in the appended claims since it will be clear to those skilled in the art that various changes may be made in the structural details and that the invention may be embodied in other forms of valves without departing from the spirit of the claims.

Having now described the invention, what is claimed is:

1. An electro-magnetic valve comprising a valve, an electro-magnet, and an armature, the valve and armature mounted for vertical movement in the same line, the armature movable in said line beyond its neutral position in the magnetic field in opposite directions, direct connections for opening and closing the valve by said opposite movements of the armature, and means for deenergizing the magnet as the armature reaches its neutral position when moving in either direction.

2. An electro-magnetic valve comprising a valve, an electro-magnet, an armature mounted for rectilinear movement in opposite directions beyond its neutral position in the magnetic field, connections for opening the valve by the movement of the armature in one direction and closing the valve by the movement of the armature in the opposite direction, and means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction.

3. An electro-magnetic valve comprising a valve, an electro-magnet, an armature mounted for movement in the line of movement of the valve beyond its neutral position in the magnetic field in opposite directions, connections for opening and closing the valve by opposite movements of the armature, and means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction.

4. An electro-magnetic valve comprising a valve, a solenoid open at both ends, an armature mounted within the solenoid for movement beyond its neutral position in both directions, connections for opening and closing the valve by opposite movements of the armature, and means for deënergizing the solenoid as the armature reaches its neutral position when moving in either direction.

5. An electro-magnetic valve comprising a valve, a solenoid having its central opening in line with the valve, an armature mounted for movement through the solenoid beyond its neutral position in both directions, a connection for moving the valve with the armature during its movement in each direction, and means for deënergizing the solenoid as the armature reaches its neutral position when moving in either direction.

6. An electro-magnetic valve comprising a valve, a solenoid having a central recess open at both ends, an armature shorter than the solenoid mounted within the recess for movement beyond its neutral position in both directions, connections for opening and closing the valve by opposite movements of the armature, and means for deënergizing the solenoid as the armature reaches its neutral position when moving in either direction.

7. An electro-magnetic valve comprising a valve, a solenoid having a vertical central opening in line with the valve, an armature loosely mounted for movement through the solenoid beyond its neutral position in both directions, a direct connection for moving the valve with the armature during the movement of the latter in each direction, and means for deënergizing the solenoid as the armature reaches its neutral position when moving in either direction.

8. An electro-magnetic valve comprising a valve, an electro-magnet, an armature mounted for movement beyond its neutral position in the magnetic field in opposite directions, connections for opening and closing the valve by opposite movements of the armature, means for deënergizing the magnet as the armature reaches its neutral posi-

tion when moving in either direction, and means for assisting the movement of the armature in one direction more than in the opposite direction.

9. An electro-magnetic valve comprising a valve, a solenoid having a vertical central opening in line with the valve, an armature loosely fitting and mounted for movement through the solenoid beyond its neutral position in both directions, a valve stem, lost-motion connection between the valve stem and the armature, proportioned to engage as the armature reaches its neutral position when moving in either direction, and means for deënergizing the solenoid as the armature reaches said neutral position when moving in either direction.

10. An electro-magnetic valve comprising a valve body, a valve therein, an electro-magnet mounted thereon, an armature mounted for movement beyond its neutral position in the magnetic field in opposite directions, connections for opening and closing the valve by opposite movements of the armature, means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction, a link pivoted at one end on the valve body and at the opposite end thereof connected to move with the armature, and a spring adapted to swing the link so as to assist the movement of the armature beyond its neutral position in either direction.

11. An electro-magnetic valve comprising a valve body, a valve therein, an electro-magnet mounted thereon, an armature mounted for movement beyond its neutral position in the magnetic field in opposite directions, connections for opening and closing the valve by opposite movements of the armature, means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction, links connected at their inner ends to move with the armature and pivoted on the valve body at opposite sides of the armature in such positions that they will be moved toward and beyond dead center by the movements of the armature in either direction, and a compression spring having its opposite ends secured to said links, the spring being adapted to expand after the links pass dead center to assist the continued movement of the armature.

12. An electro-magnetic valve comprising a valve, an electro-magnet, an armature mounted for movement beyond its neutral position in the magnetic field in opposite directions, means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction, and connections for opening and closing the valve by opposite movements of the armature having provision for lost motion which is taken up as the armature reaches its neutral position in either direction.

13. An electro-magnetic valve having therein a valve to be operated, an electric circuit including electro-magnetic means for operating the valve, and an armature therefor movable in line with and for a part of its stroke independently of the movable element of the valve, and means operating independently of motion of the valve to automatically control the duration of energization of said electro-magnetic means.

14. An electro-magnetic actuating device comprising a support, an electro-magnet mounted thereon, an armature mounted for movement beyond its neutral position in the magnetic field in opposite directions and adapted to be connected with the part to be actuated, means for deënergizing the magnet as the armature reaches its neutral position when moving in either direction, a link pivoted at one end on the support and at its opposite end connected to move with the armature, and a spring adapted to swing the link so as to assist the movement of the armature beyond neutral position in either direction.

15. An electro-magnetic actuating device comprising a support, a solenoid open at both ends and mounted on said support, an armature mounted within the solenoid for movement beyond its neutral position in both directions and adapted to be connected with the part to be actuated, terminals for connecting the wires of two circuits, a switch operated by the armature as it reaches neutral position when moving in either direction to break connections between one circuit terminal and the solenoid winding and to make connections between said winding and the other circuit terminal, a link pivoted at one end on the support and at its opposite end connected to move with the armature, and a spring adapted to swing the link so as to assist the movement of the armature beyond its neutral position in either direction.

16. A valve operated by a solenoid having, in combination, a valve body provided with a passage extending therethrough, a valve for closing said passage, a solenoid, operative connections between the armature of the solenoid and the valve, a movable contact member for completing the solenoid circuit, a push-button connected with said contact member and adapted to be depressed to break the solenoid circuit and to mechanically move the armature to close the valve, a spring tending to raise said push-button, and means for locking the push-button in its depressed position to hold the valve closed and to keep the solenoid circuit open.

17. An electro-magnetic valve having therein a valve to be operated, an electric circuit including electro-magnetic means for operating the valve, and an armature therefor movable in line with and for a part of its stroke independently of the movable ele-

ment of the valve, and means actuated by the armature during its independent movement for opening said circuit.

18. An electro-magnetic valve having therein a valve stem and an armature movable in the same direction as the stem, interfitting parts carried by said stem and said armature adapted for contact, when the valve stem is respectively in open or closed position, upon passage of the armature past a neutral point, an electro-magnet in a normally closed circuit for moving the armature, and means controlled by the armature for opening the actuating circuit, including the electro-magnet at passage of the armature past said neutral point.

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