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SOLENOID MECHANISM

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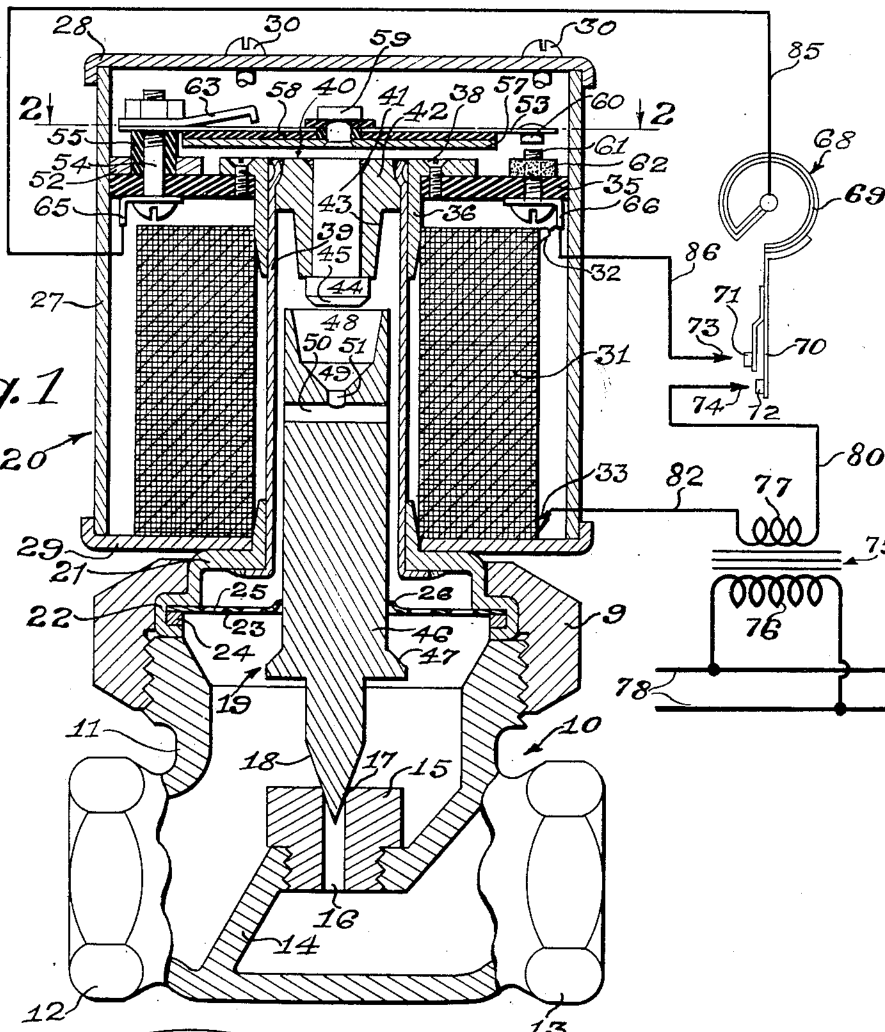

Fig. 1

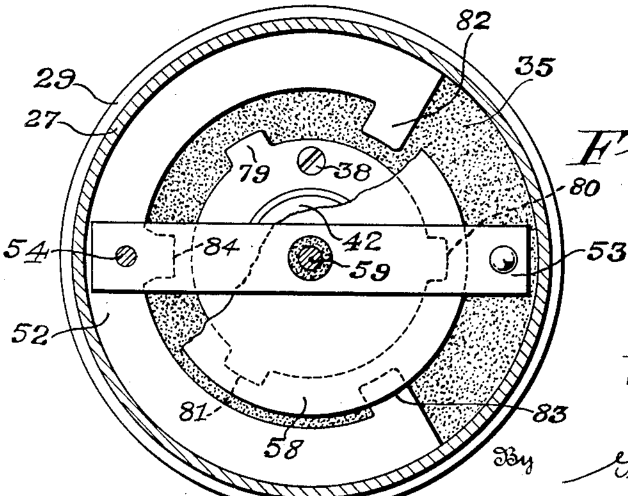

Fig. 2

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SOLENOID MECHANISM

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5 Claims. (Cl. 175—338)

My invention relates to a solenoid mechanism, and more particularly to one designed to operate a valve and to be controlled by a thermostat.

Where a solenoid mechanism is to be controlled by a thermostat, it has been proposed to incorporate with said solenoid mechanism a switch which is moved to closed position upon the solenoid winding being energized and which switch serves to establish a holding circuit for the operation of the solenoid. Where such a mechanism was to be operated by direct current, no particular difficulties were encountered. However, when such a mechanism was to be operated by alternating current it has been almost impossible to operate an associated switch by the action of the solenoid associated with the mechanism due to the excessive vibration in the switch caused by the variation of the flux produced by the alternating current. As a result, it has been necessary to employ a separate relay to establish the holding circuit.

An object of the present invention is to provide a solenoid mechanism designed for operation with alternating current in which a switch is incorporated therewith and is operated by the solenoid and in which vibration of said switch is substantially eliminated.

A further object of this invention is to provide a solenoid mechanism for alternating current operation embodying a switch therewith, in which the solenoid core is contained in one sealed compartment and in which the switch is contained in another such compartment.

A further object of this invention is to provide a solenoid actuated mechanism for alternating current operation having a switch incorporated therewith and actuated by the solenoid in which a single shading means is effective to eliminate vibration of both said core and said switch.

Other objects of the invention will be apparent from the accompanying specification, claims and drawing, in which:

Figure 1 is a sectional view of my mechanism applied to the operation of a valve with a schematic showing of the thermostatic controlling means, and in which

Figure 2 is a section on the line 2—2 of Figure 1, with portions broken away.

Referring to Figure 1 in the drawing, the valve portion of my device is generally indicated by the reference numeral 10. This portion comprises a valve body 11 having inlet and outlet connections 12 and 13. The interior of said valve body is separated by a transverse wall 14 having an aperture therein in which is mounted a plug 15. This plug 15 has an aperture 16 therethrough which is flared at its upper end to provide a valve seat 17. The valve is constituted by the lower end 18 of a core 19 of a solenoid actuating mechanism. The solenoid actuating mechanism is housed in a casing 20. This casing has attached at its lower end an annular member 21 of magnetic material, which is connected to the valve body 11 by a screw thimble connection through the collar 9. The member 21 is provided at its outer extremity with a downwardly directed flange having a recessed portion 22 in which is mounted a spring disc 23 through a retaining ring 24. The spring disc 23 is provided with apertures 25 to make the same more resilient and is provided along its inner portion with an upturned edge 26.

The housing proper comprises a cylindrical member 27 of magnetic material and upper and lower circular plates 28 and 29. Members 27 and 29 are of magnetic material. The housing is retained in position by any suitable fastening means such as studs 30, which are screw-threadedly engaged with the lower plate 29.

Mounted within the casing 20 is a solenoid coil 31. The terminal conductors of said coil are indicated by the reference numerals 32 and 33, respectively.

A disc 35 of insulating material is secured to the casing and serves to separate the switch containing portion of the housing from the rest thereof. Attached to said disc of insulating material is a ring 36 of magnetic material. This ring has its upper edge turned over to form a supporting flange therefor. This flange is provided with three outwardly extending equally spaced projections 79, 80 and 81, as shown in Figure 2. The flange is secured to disc 35 by any suitable fastening means such as rivets 38.

Mounted within the solenoid core is a core-guiding sleeve 39 of suitable non-magnetic material such as brass. This sleeve is fastened at its lower end to an upturned flange of the annular member 21 and at its upper end to the ring 36. The connection at the lower end is made in a fluid tight manner by any suitable means, shown for purposes of illustration, as soldering.

Attached to the sleeve 39 at its upper end is a core stop 40 comprising a center pin member 41 of magnetic material and a surrounding sleeve member 42 of non-magnetic material of relatively high conductivity. Sleeve member 42 is secured to the sleeve 39 in a fluid tight manner such as by soldering and pin 41 is similarly secured to ring 42. Sleeve 42 is provided with a lower conical extremity 43. The pin 41 is provided with a head 44 at its lower end, said head having a conical portion 45 at the lower extremity thereof. It will be seen that the guiding sleeve 39 and the stop 40 form with the casing a fluid-tight compartment within which the core operates.

The core 19 comprises a body portion 46 having a reduced portion 18 at one extremity constituting the valve. At the juncture of the said reduced portion with the main body portion of the core, the core is flared outwardly as at 47 to provide a conical shoulder to cooperate with the upturned edge 26 of spring retainer 23. At its upper end the core is provided with a recess having two conical portions 48 and 49 of different slope. An aperture 50 extends through said core and is connected with the conical recess through a second aperture 51 at right angles therewith. The slope of conical portion 48 corresponds to that of portion 43 of the stop 40 and the slope of conical portion 49 corresponds to that of conical portion 45 of pin 41. The pin 41 serves as the stop proper for the core while the sleeve 42 serves to guide the core into engagement with the stop and is slightly spaced from the core when it is in engagement with pin 41. The apertures 50 and 51 serve to prevent any dashpot action by permitting the ready escape of air in the core recess as the core moves into engagement with the stop 40.

Mounted on the insulating disc 35 is a plate 52 of magnetic material in the form of an incomplete annulus. Referring to Figure 2, this plate is provided with three inwardly extending projections 82, 83 and 84, which are equally spaced from each other and from projections 79, 80 and 81 of sleeve 36. Also mounted on said insulating disc is a switch arm 53 through a bolt 54 and an insulating washer 55. Switch arm 53 is resilient in character and has attached thereto a circular disc 57 of magnetic material. This disc is separated from the switch arm by an insulating washer 58 and is held thereto by any suitable fastening means such as a rivet 59. The switch arm 53 is provided at one end with a contact 60 which is adapted to cooperate with a fixed contact 61 secured to the insulating disc 35 by suitable fastening means 62. Contacts 60 and 61 are so spaced that upon energization of the coil armature 57 will move switch arm 60 downwardly sufficiently to cause engagement of these contacts. Attached to said switch arm through the fastening means 54 is a stop 63 which limits the outward movement of said switch arm. Attached to said lower end of said fastening means 54 is a terminal connection 65 and attached to the lower end of fastening member 62 is a similar terminal member 66. Terminal conductor 32 of the coil 31 is shown as connected to terminal 66 but it will be understood that this is for purposes of illustration only and that said conductor may be connected to any suitable terminal such as one located on the exterior of the casing.

A thermostat 68 comprises a bimetallic element 69 to which is attached a contact arm 70 having contacts 71 and 72 adapted to engage with contacts 73 and 74, respectively. Contacts 72 and 74 are less widely spaced from each other than contacts 71 and 73 so that upon contact arm 70 moving in the direction of contacts 72 and 74, contacts 72 and 74 will be brought into engagement before contacts 71 and 73.

A transformer 75 furnishes low voltage alternating current for the operation of my valve. This transformer comprises a line voltage primary 76 and a low voltage secondary 77. The line voltage primary is connected to line wires 78 which are, in turn, connected to a source of alternating current.

Upon the bimetallic element being subjected to a change in temperature which causes it to move contact arm 70 in the direction of contacts 73 and 74, contacts 72 and 74 will first be brought into engagement. The bringing into engagement of these contacts does not, however, establish an energizing circuit. If the change in temperature continues with the resultant further movement of arm 70 in the direction of, contacts 73 and 74, contacts 71 and 73 will be brought into engagement. Upon such action taking place the following energizing circuit will be established through the solenoid coil 31: From secondary 77, through conductor 80, contacts 74 and 72, contacts 71 and 73, conductor 86, terminal 66, conductor 32, the relay coil, conductor 33 and conductor 82 back to the secondary 77. This energization of the solenoid coil 31 causes a flow of magnetic flux through two different paths. One of these paths comprises the core 19, magnetic ring 36, the air gap between said ring and armature 57, armature 57, the air gap between the armature and plate 52, plate 52, the cylindrical housing member 27 and the lower housing plate 29 back to core 19. The second flux path comprises core 19, the magnetic pin member 41, the air gap between said pin member and armature 57, armature 57, the air gap between the armature and plate 52, plate 52, the cylindrical housing member 27 and lower plate 29 back to core 19. The second flux path is influenced by the presence of ring 42 of conductive non-magnetic material which acts as a shading ring. The result is that the flow of flux through the said second path lags the flow of flux in the first path by substantially 90°. The result will be that both core member 19 and armature 57 are subjected to flux flowing in two different flux paths, the flux of which has a zero value at different times. Thus, the core 19 and the armature 57 will always be subjected to some flux.

Since in an electromagnetic arrangement of this kind, the movable magnetic members tend to assume the position which provides a magnetic path of the lowest possible reluctance, the core 19 will be urged upwardly into engagement with the stop 40 and the armature 57 will be urged downwardly in a direction such as to cause engagement of contacts 60 and 61. Due to the relatively small movement required of the armature 57 to effect engagement of these contacts, such engagement will be made before the solenoid has raised appreciably.

The moving into engagement of contacts 60 and 61 results in the following holding circuit being established: From secondary 77, through conductor 80, contacts 74 and 72, bimetallic element 68, conductor 85, terminal 65, switch arm 53, contacts 60 and 61, terminal 66, conductor 32, solenoid coil 31, conductor 33, conductor 82, back to the secondary 77. It will be noted that this new holding circuit is independent of the engagement of contacts 71 and 73 so that even though contact arm 70 might move slightly to the right causing the separation of contacts 71 and 73, the solenoid would remain energized. Since the holding circuit is established by the engagement of contacts 60 and 61 before the core has raised appreciably, a slight vibration of contact arm 70 is prevented from periodically moving the core valve member slightly off its seat. This is of especial advantage where the valve is employed to control the flow of gas to a burner, since if a slight vibration of contact arm 70 were allowed to raise and drop the core off its seat, puffs of gas would be admitted to the burner, which might lead to an explosion.

Due to the presence of the three projections 79, 80 and 81 of the flange of ring 36 and the three projections 82, 83 and 84 of plate 52 with which the armature is in contact, the armature will be held firmly against the flange of ring 36 and plate 52 at these points. This results in a three-point holding action which insures against vibration of the armature due to an uneven engagement with the ring or plate.

When the core is in its uppermost position, the conical shoulder 47 is in engagement with the upturned portion 26 of the spring disc 23 and is urged downwardly by said spring disc. Thus, upon deenergization of the solenoid, the spring disc 23 serves to insure the return of the core to its lowermost position. In this way there is an assurance that the core will not be held in its uppermost position by reason of any sticking between the pin 44 and the conical recess 49.

Since both the armature and the core are in two different flux paths, the fluxes of which are displaced in phase, the flux acting on these members will never have a zero value. As a result of this, there is not the tendency to chatter which is usually present with solenoid apparatus of this type. This feature coupled with the positive stops for the core and armature insure a quiet operation of the valve and switch.

It will be seen from the foregoing description that I have provided a solenoid mechanism having a switch associated therewith and actuated by the solenoid which is adapted for operation with alternating current without the chattering which hitherto prevented the use of such devices.

While I have shown a specific embodiment of my invention, it will ge understood that this is for purposes of illustration only and that my invention is limited only by the scope of the appended claims.

I claim as my invention:

1. An electromagnetic actuating means designed for operation with alternating current comprising a winding, a movable magnetic core, a stop for said core, an armature adjacent said stop, said armature and said core being moved in the direction of said stop upon energization of said winding, said stop comprising a member of magnetic material surrounded by a ring of conducting non-magnetic material which extends from the upper to the lower surface of said stop and one end of both the said member and the said ring extending in a common plane for cooperation with said armature, the said stop acting to shade a portion of the flux through both said core and said armature to prevent vibration of either said core or said armature.

2. In an actuating mechanism designed for use with alternating current, a solenoid coil, a core of magnetic material movable within said coil, an armature adjacent said coil, and means located adjacent said coil and between said armature and core comprising a shading ring of conductive non-magnetic material and members of magnetic material completely separated by said shading ring, each of said members having a portion closely adjacent to each of said armature and said core, so that the flux flowing through the core, the armature, and said members consists of a shaded and an unshaded component.

3. In an actuating mechanism designed for use with alternating current, a solenoid coil, a core of magnetic material movable within said coil, an armature adjacent one end of said coil, means located within the end of the coil adjacent to said armature comprising concentric spaced members of magnetic material and a shading ring of conductive non-magnetic material surrounding one of said spaced members, said means being located between said armature and said core and said magnetic members being magnetically joined only by said armature and said core so that the flux flowing through both the core and armature consists of a shaded and an unshaded component.

4. In combination, a solenoid actuating mechanism adapted to be operated by alternating current, said solenoid actuating mechanism comprising a solenoid coil, a magnetic core slidably mounted therein, said core being urged downwardly by gravity when said coil is deenergized and being moved upwardly upon energization of said coil, a stop to limit the upward movement of said core, said stop comprising a central pin of magnetic material surrounded by a ring of non-magnetic conducting material, said pin and said ring extending from the upper surface to the lower surface of said stop and having their upper surfaces in a common plane, an armature member adapted to be moved into proximity with the upper end of said stop, said ring serving to subject a portion of the flux flow in both said core and said armature to a shading action to prevent vibration of either said core or said armature.

5. In the combination described comprising, a solenoid coil, a non-magnetic sleeve extending within said coil, a solenoid core within said sleeve for operating a valve, a stop for limiting movement of said core in one direction and to which said sleeve is secured, said stop comprising a member of magnetic material and a surrounding member of non-magnetic conducting material, a shell of magnetic material around said coil, a magnetic member above said coil and extending inwardly from said shell, an inner member of magnetic material spaced from and surrounding said stop and having an outer surface extending within but spaced from the member above said coil to form an air gap therebetween, an armature for operating a switch actuated by said coil and extending over said air gap, said inner member and said stop, a magnetic element beneath said coil and constituting a magnetic path of low reluctance between said shell and said core, the said inner member constituting a path for a portion of the flux through said armature and said core, and the said stop constituting a parallel shaded path for another portion of the flux through said armature and said core.

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