

Oct. 3, 1950

A. E. SPINASSE ET AL

2,524,334

CONTROL CIRCUIT FOR ELECTROMAGNETS

Filed Nov. 28, 1944

3 Sheets-Sheet 1

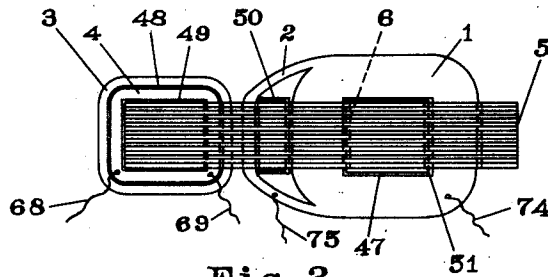


Fig. 2.

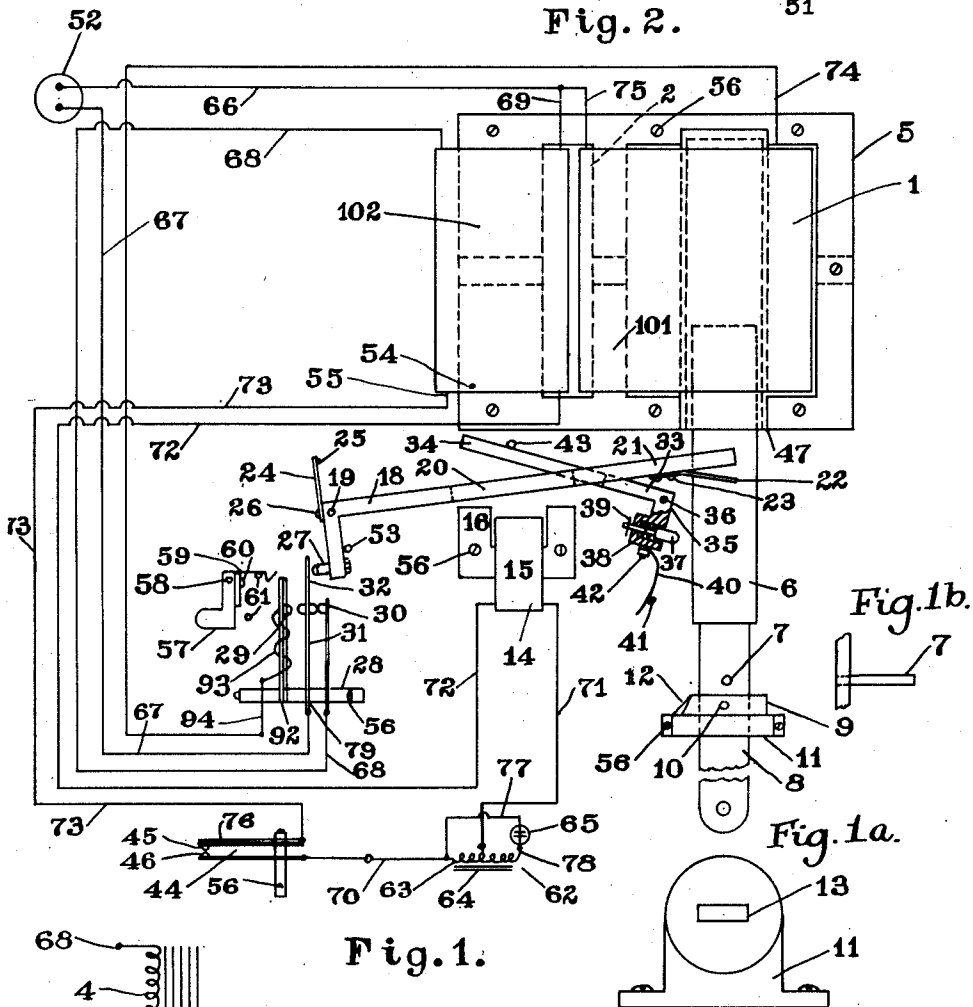


Fig. 1.

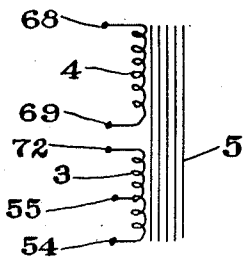


Fig. 8.

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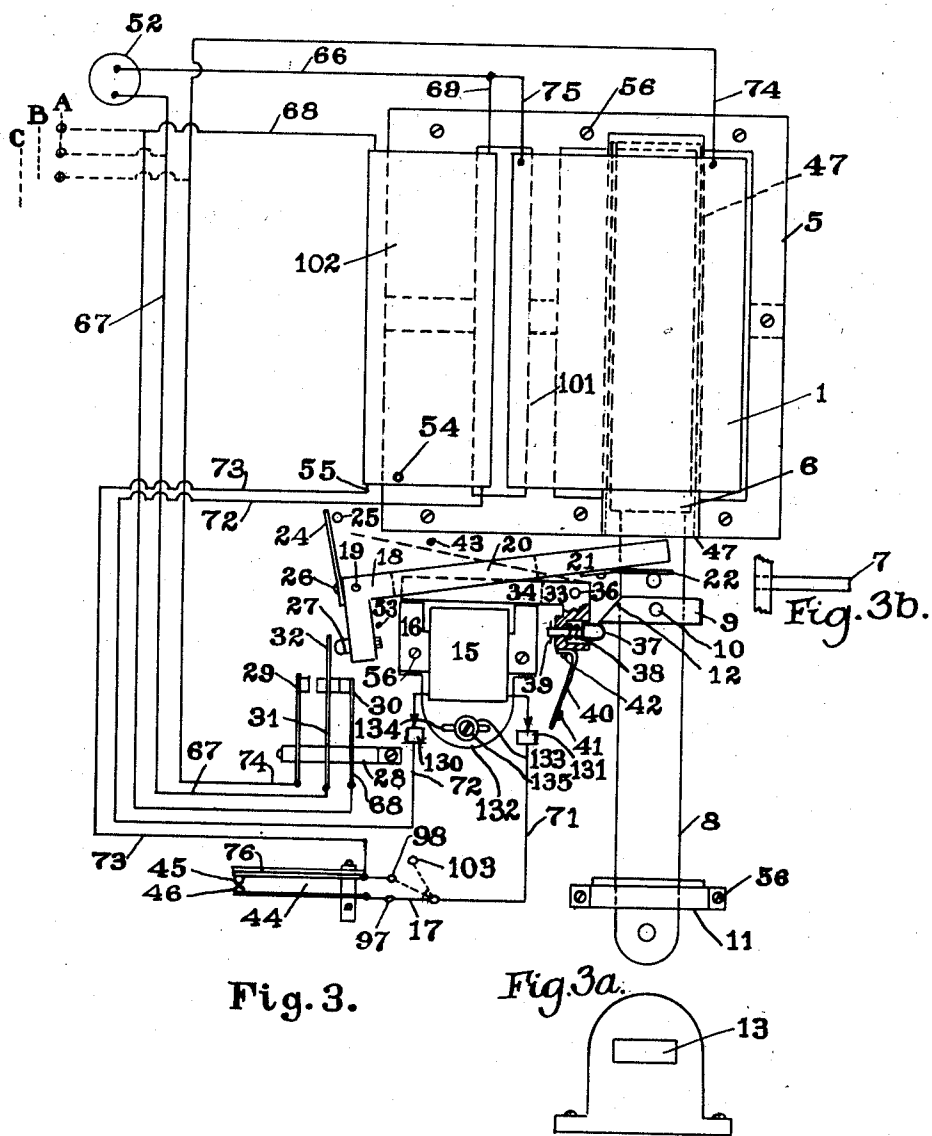
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3 Sheets-Sheet 2



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CONTROL CIRCUIT FOR ELECTROMAGNETS

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3 Sheets-Sheet 3

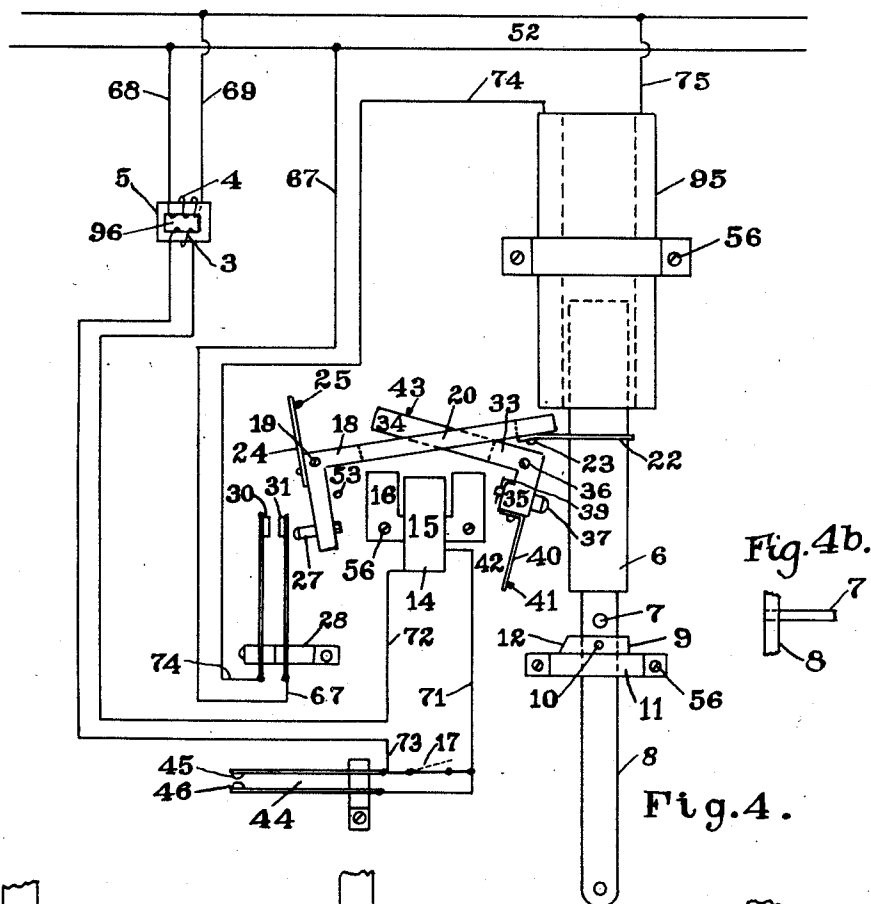


Fig. 4b.

Fig. 4.

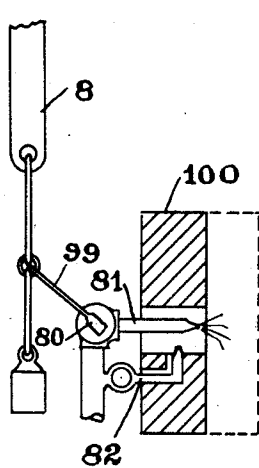


Fig. 5.

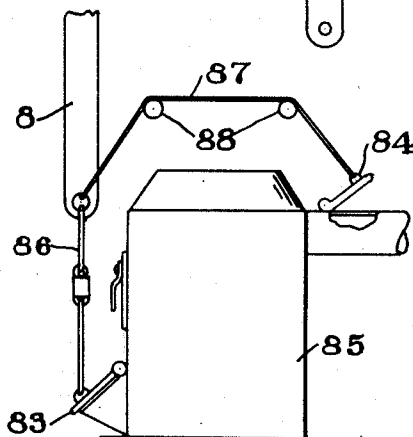


Fig. 6.

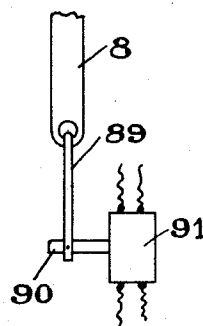


Fig. 7.

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UNITED STATES PATENT OFFICE

2,524,334

CONTROL CIRCUIT FOR ELECTROMAGNETS

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Application November 28, 1944, Serial No. 565,552

3 Claims. (Cl. 175-335)

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This invention relates to electrically actuated solenoid devices for the control of dampers, check valves, and control valves used in supplying liquid or gaseous fuel to temperature control systems, and while the invention is illustrated in connection with systems of the above type, its use is by no means so limited.

The main object of the invention is to provide a solenoid actuated device capable of exerting a high actuating effort but capable of exercising a holding action with a greatly reduced, and minimum consumption of current.

Another object of the invention is to assure positive operation of a transformer solenoid device by use of an electromagnetic device embodying mechanical holding means effective when the solenoid is de-energized but rendered ineffective by power restoration.

Another object of this invention is to assure the positive latching movement and action of the electro-magnetic mechanical holding device and magnetically controlled switch contacts in the event of partial loss of power in the electromagnet due to temporary low voltage at the source of power by applying an appreciably greater electrical current to the coil of the electro-magnet during the period of time the plunger of said solenoid is in movement from an inoperative energized position to an operative de-energized position.

A further object of the invention is to provide a device employing an exceptionally small but powerful solenoid coil having auxiliary holding means effective when the coil is de-energized, so as to require energization of the coil for short intervals only so as to prevent overheating of the coil.

Other objects of this invention are the low initial cost, compactness and flexibility in the utilization of the device.

Further objects of this invention will be apparent from the following specification taken in connection with the drawings wherein like symbols refer to like or corresponding parts throughout the several views in which:

Figure 1 is a front vertical view illustrating a form of the invention.

Figure 1a is a plan view of the plunger support shown in Fig. 1.

Figure 1b is a side view of the switch armature supporting pin.

Figure 2 is a top plan view in part of Fig. 1.

Figure 3 is a front view in part of a modified form of the device in an operative position.

Figure 3a is a plan view of the plunger sup-

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port shown in Fig. 3. Figure 3b is a side view of the armature supporting pin.

Figure 4 is a view of a modified form of the invention.

Figure 4b is a side view of the armature supporting pin shown in Figure 4.

Figures 5, 6 and 7 show various applications of the solenoid device.

Figure 8 is a schematic view of a modification which may be used with the device.

Referring to the drawings and more particularly to Figures 1 and 2, character 1 designates a solenoid coil, 4 a transformer primary winding, and 3 a secondary transformer winding. 5 is essentially a single unit laminated iron core having leg portions 101 and 102, and adapted to receive said primary and secondary windings, also the solenoid coil within which a plunger 6 operates. Portion 2 of solenoid coil 1 is shown as overlapping portion 101 of said iron core and another portion 102 of the same core being adapted to receive the said transformer windings 3 and 4. 56 are mounting screws for said iron core. Conductor 74 of solenoid coil 1 leads to an electric switch 28. Conductor 67 of the same circuit leads to a source of power 52 by way of conductor 66 and conductor 69 of primary winding 4. The iron core portion 102 also has the secondary winding 3 including conductors 73 from said secondary winding 3 to thermostat switch 44, conductor 70 from said switch to signal device 62, conductor 71 to electro-magnet coil 14 and from said coil, conductor 72 leading to said secondary winding 3 which is adapted to periodically energize the electro-magnet 14, and signal device 62, by the action of the thermostat switch 44. The electro-magnet 14 includes a coil 15, and an iron core 16 assembled as shown and supported by screws 56.

As shown in Figure 2, 47 is a suitable non-magnetic plunger tube, 48, 49 and 50 are suitable insulating materials and 51 indicates a clearance between the plunger 6 and tube 47. Winding 2 is a continuation of the solenoid coil winding 1, the same being so placed and arranged as to encircle both plunger 6 and a suitable portion of iron core 5. 4 is the transformer primary winding having connections 68 and 69. Nos. 66 to 75 inclusive represent conductors.

Extension 8 of solenoid plunger 6 is provided with a switch armature supporting pin 7, a support 9 and support pin 10 therefor including a resting support 11 with bearing opening 13, said support 9 being held in position by screws 56. The electromagnet switch has an L shaped arm

18 pivoted at 19 for coaction with switch 28 and magnet 14, said arm 18 having a non-magnetic portion 21 and magnetic portion 20, the former having an offset spring 22 adapted to be engaged by supporting pin 7 in the upward movement of plunger 6. 23 are mounting screws for said spring. The L shaped portion of said arm 18 is further provided with spring 24 and spring stop support 25 including mounting screws 26. This portion of arm 18 is also provided with a switch operating member 27, made of a suitable insulating material such as fiber, or the like. This switch operating member 27 is preferably threaded and is adjustable for controlling the operation of the different contacts of switch 28 which thus regulates or determines the time of energization and de-energization of the solenoid coil 6 in accordance with the elevation of the rising plunger therein. This is important for reducing or even eliminating plunger pounding against any part of the iron core and for adjusting and securing smooth engaging action between the switch armature supporting pin 7, spring 22, the latching pin 37 and inclined surface 12 of the support member 9 herein described. The structure of the solenoid is, therefore, such that the switch operating member may be adjusted for de-energizing the coil at desired points in advance of the ultimate stopping operative position of the moving solenoid plunger. This not only permits stopping the plunger at desired predetermined positions but smoother action of the coacting parts is also secured. 33 designates an electromagnet holding device including a magnetic arm portion 34, a non-magnetic L shaped portion 35 pivoted at 36, and latching and holding pin 37 adapted to engage armature support 9, the latching pin spring 38, latching pin key 39, and holding armature return spring 40 adapted to reduce friction and wear between members 37 and 9. 42 is a mounting screw for spring 40, 41 is a limit stop for said spring, and 43 is a limit stop for portion 34 of arm 33.

Electric switch 28 as shown in Figures 1 and 3 consists of one closed and one open circuit, three spring blade contacts, two position type, including primary winding spring blade contact 30, contacts 30 and 31 shown in a closed position, and center common contact 31 and solenoid coil contacts 29 and 31 shown in an open position. Spring blade contact member 31 has an extension 32 which is adapted to be periodically engaged by the switch operating member 27.

44 is a thermostatic electric switch including a temperature sensitive bimetal element 76 on which is mounted a contact 45 adapted to engage and thereafter disengage contact 46.

An electric power saving and safety device may be used in connection with switch 28 or otherwise in the circuit of the solenoid coil for limiting the time period in which winding 1 and 2 may remain energized, said device comprising a bimetallic spring blade member 92 upon which is wound a resistance wire 93, one end of which is connected to member 92 and the other terminal thereof to member 94. Either the spring blade member 92 or resistance wire 93, or both, are covered with suitable heat resisting and electrical insulating material such as is known in the art.

Holding and releasing lever 57 made of a suitable insulating material such as fiber, is pivoted at 58 and carries a spring blade hook member 59 supported by screws 60 adapted to engage and thereafter disengage the upper end of bimetallic

member 92. The tilting movement of member 57 is limited by stops 61.

In the event that the windings 1 and 2 should remain energized beyond a predetermined period of time, the resistance wire 93 will become heated and in turn also will impart some of its heat to the bimetallic spring blade 92 causing the same to warp so that the upper portion thereof will engage the spring blade hook member 59, at the same time moving contact 29 from contact 31 thereby opening the power circuit of solenoid windings 1 and 2.

When pressure is applied to end of member 57, member 59 is caused to disengage member 92, thus releasing said member 92.

62 is a signalling device including auto-transformer winding 63, iron core 64 and neon lamp 65, said signal device being adapted to indicate when contacts 45 and 46 of the thermostat switch 44 are in contact. It will be noted that the device 62 is energized when contacts 45 and 46 are engaged and said indicator is de-energized when said contacts are disengaged. Conductors 77 and 78 energize the neon lamp indicator 65. When so desired, one or both signalling device 62 and power saving safety device members may be omitted without affecting the proper operation of said transformer solenoid device, providing, of course, the opening of the circuit caused by the removal of said device is re-established by means of a suitable conductor.

In Figure 8, a fractional part view of Figure 1 is shown, wherein member 4 is the transformer primary winding of said transformer solenoid device and 3 is the secondary winding. For normal operation, secondary current is obtained from points 72 and 55 of said secondary 3. To obtain additional secondary voltage, points 72 and 54 of secondary 3 may be used to compensate for voltage drop incurred in instances where it is necessary to locate thermostat switch 44 an excessive distance from said transformer solenoid device.

For clarity, Figure 3 shows a slightly modified form of the device illustrated in Figure 1 in an operative position. In this figure the signal device 62 and the power saving and safety device shown in Figure 1 are omitted. A means for adjusting the position of the pole pieces of electro-magnet 15 is also shown wherein the electro-magnet is mounted on a plate 132 having a slot 134 through which a screw or bolt 135 passes to a main support 129, the slot being larger than that of the cross section of the bolt so that, by means of a washer 133 and said screw or bolt, the magnet may be adjusted to desired position on said support with the pole pieces of the magnet in positive contact with the magnetic arm portion 34 of holding armature 33, including the magnetic arm portion 20 of switch arm 18. 130 and 131 represent rectifiers which may be used in circuit leads 71 and 72 of the electro-magnet 15.

When desired a manual switch may be provided as shown by lines in Figure 3, said switch including extension leads to lines 67, 68 and 74. Different positions of contact bars are indicated by vertical dotted lines wherein position (A) transformer primary and secondary windings are energized; in position (B) transformer primary, secondary and solenoid coil are energized, and in position (C) solenoid coil is energized, the primary winding is de-energized and the secondary winding is further energized as heretofore described, thus substantially duplicating, by said hand switch, the action of the electro-magneti-

cally operated switch 28. In such case switch 28 and arm 18 may be omitted while retaining proper conductors in the circuits of the device. In this manner the operation and control of the solenoid coil and electro-magnet including the operation and control of the holding member 33 may be had through the manipulation of said manual switch.

A three point switch 17 shown in Figure 3 may be provided, wherein when contact 97 is made thermostat 44 controls the electro-magnet 15, when contact 98 is made thermostat 44 is idle but the electro-magnet may be manually controlled by said switch 17 between contact point 98 and idle point 103.

In Figure 4 is shown a modified form of the invention wherein the improved holding member 33 and support 9 of plunger extension 10 are used in connection with a separate solenoid coil 95 and a separate step down transformer 96 is used to energize a coil 14 of an electro-magnet 15 by the action of thermostat switch 44 by means of lead wires 71, 72 and 73. Electric switch 28 is adapted to energize coil 95 by means of a separate circuit comprising leads 67, 75 and 74. When contacts 45 and 46 of the thermostat switch 44 are closed, thereby energizing the electro-magnet 15, switch arm 18 is attracted toward and to electro-magnet 15, the holding member 33 due to its greater mass follows the action of switch arm 18 also moving to its operative position on magnet 15, this action of switch arm 18 causing contact operating member 27 to close contacts 30 and 31 of switch 28 thereby energizing coil 95, causing solenoid plunger 6 to be moved to an operative position and thereafter held in its operative position by the action of plunger support member 9 engaging the top of latching pin 37 of holding member 33 as shown in Figure 3, and at the same time pin 7 engages spring 22 raising switch arm 18 which in turn causes member 27 to retract and contacts 30 and 31 to open, thus de-energizing coil 95. Plunger 6 continues to be maintained in its operative position by support member 9.

When contacts 45 and 46 of thermostat switch 44 separate, magnet 15 is de-energized, releasing members 18 and 33 to the position shown in Figure 4 causing plunger 6 to return to its inoperative position, contacts 30 and 31 remaining open by the action of spring 24 of member 18.

Figures 5, 6 and 7 illustrate examples of possible combination features and various applications of the invention. For example, in Figure 5, solenoid plunger extension 8 is shown connected to arm 99 of feed valve 80 adapted to supply liquid or gaseous fuel from a source, through a nozzle 81, into a heating furnace 82. In Figure 6 plunger extension 8 is shown connected by suitable means to operate a damper 83 and check 84 of heating furnace 85. In the position shown plunger extension 8 is in an off position with damper 83 closed and check 84 opened by means of cable 86 and 87 and pulley members 88. In Figure 7, plunger extension 8 is shown with a link 89 and arm 90 arranged to operate an enclosed electric switch or rheostat 91.

In the operation of the present invention as shown, in Figure 1 solenoid plunger 6, and electro-magnet holding armature 33 are shown in a "standby" or inoperative position. In electric switch 28, contacts 30 and 31 are shown in an "on" position. Contacts 45 and 46 of the sensitive temperature switch 44 are shown in an "off" position. Conductors 67 and 68 are shown con-

nected to a source of suitable electric power 52. By means of contacts 31 and 30 and conductors 66, 67, 68 and 69, transformer winding 4, core 5 and secondary winding 3 are energized. The control switch 44 which is in the form of a room rheostat includes a bimetallic element 76 to which is secured a contact 45 adapted to engage a fixed contact 46. Upon a fall of temperature bimetallic element 76 moves contact 45 into a position engaging contact 46.

As heretofore pointed out, the secondary winding 3 is energized and upon the instant that contacts 45 and 46 are engaged, switch arm 18 is attracted against the force of spring 24 to the iron core 16 causing contact 31, by action of contact operating member 27 engaging extension member 32, to move toward and engage contact 29 before disengaging contact 30, thus energizing solenoid coils 1 and 2 shown in Figure 2. Coil 2 is adapted to energize iron core portion 101 and is also a continuation of coil 1. When contacts 30 and 31 are disengaged, primary winding 4 is de-energized.

Portion 2 of the solenoid coil 1 is also a transformer primary winding designed to have a much greater number of ampere turns than primary winding 4 for the purpose of greater excitation of the iron core 5, thus secondary winding 3 will deliver a much higher voltage to electro-magnet coil 14 to assure the proper operation of holding member 33, by overcoming the resistance of spring 40. Holding member 33 will thus engage electro-magnet pole piece 16 while at the same time plunger 6 is moving upward.

By the action of inclined surface 12 of plunger support 9, latch pin 37 is forced against the action of latch pin spring 38, plunger 6 continuing in an upward movement thus permitting pin 7 on plunger extension 8 to engage spring 22 and compressing same, toward and against switch arm extension 21, thereby moving switch arm 18 upward and away from iron core 16 of the electro-magnet 15. While switch arm member 18 is being forced to disengage member 16 of electro-magnet 15, contact 31 engages contact 30 re-energizing primary winding 4 while at the same time disengaging contact 29 de-energizing solenoid coil and thus causing plunger 6 to be latched up by latch pin 37 and plunger support member 9. Molding and releasing member 33 and latch pin 37 are by now in an operative supporting position thus maintaining plunger 6, while de-energized in an operative position. The transformer solenoid device is now in an operative position.

With a rise in temperature, thermostat contacts 45 and 46 are by the action of the bimetallic element 76 caused to disengage, and by reason of the electro-magnet 16 becoming de-energized permitting member 33 to return to its former position, thereby releasing plunger 6 which is now free to return to its former inoperative position.

The saving of electric power of this invention will be apparent. While said alternating current transformer solenoid is in an inoperative position when plunger 6 is down, the power consumption is for example one watt. While the plunger 6 is being lifted to its operative position, the power is increased to say namely solenoid coil 550 watts and the electro-magnet 60 watts, totalling 610 watts. However, due to the almost instantaneous movement of the plunger, this increased consumption of current occurs only for a fraction of a second. When plunger 6 is moved to an op-

erative position, coils 1 and 2 of the solenoid are no longer energized, the plunger being maintained in its operative position by holding member 33 as shown in Figure 3. Primary winding 2, secondary winding 3, and electro-magnet 15 are now energized and require only a small amount of current to hold the plunger holding member 33 in its operative position, for example only 12 watts or less.

It is to be understood that the power consumption of the said transformer-solenoid device may be varied so as to be adaptable to any modifications for which it may be designed to operate, all within the ratio of power saving above described. The ratio of power saving also progressively increases proportionately with the increase of the size of the solenoid device. The power of the coils 1 and 2 may be materially increased without substantially increasing the size and power consumption of the transformer device which serves to supply current to operate the above named electro-magnet.

Since solenoid coil member 1 is energized for only a sufficient period of time to actuate plunger 6 from an inoperative position to an operative position, said coil member may be designed to have a much greater lifting power without overheating, plunger 6 being thereafter maintained in its operative position within the de-energized coil by suitable means other than the coil and, therefore, said solenoid device may be constructed extremely small and very powerful.

In some instances the solenoid coil and electro-magnet may also be operated by direct current; member 52 also denoting a suitable source of power which may be a storage battery, a generator, a rectifier or the like corresponding to the nature of the power to be employed.

It is obvious that various other changes and modifications may be made in the details of construction, position and/or the arrangement of parts or design of the above described embodiments of this invention without departing from the spirit thereof. Such changes and modifications being restricted only by the scope of the following or appended claims.

What we claim as our invention is:

1. A transformer solenoid device comprising an iron core having three parallel legs comprising a middle leg and two outside legs, primary and secondary windings mounted on one of the outside legs in inductive relation to each other, a solenoid mounted between the middle leg and the other outside leg, and having a portion in flux threading relation with said primary and secondary windings, a plunger movable in said solenoid, means for energizing said primary winding and solenoid, electromagnetic switching means connected to said secondary winding for causing energization of said solenoid to draw said plunger into said solenoid, and then to de-energize said primary winding, means actuated by said plunger when lifted, for re-energizing said primary winding and then de-energizing said solenoid, and mechanical holding means for retaining said plunger in said solenoid when the solenoid is de-energized.

2. A solenoid operated device comprising an iron core having first, second and third legs, a primary winding and a secondary winding on the first of said legs, a solenoid winding between the second and third of said legs, and having a portion in flux threading relation with said primary and secondary windings, a plunger for said solenoid, means for energizing said primary winding and said solenoid winding, a switch for controlling both said primary and said solenoid, an electro-magnet in circuit with said secondary winding, a pivoted member controlled by said electromagnet for actuating said switch for closing the circuit of the solenoid winding and then opening the circuit of the primary winding, means actuated by said plunger when lifted, for re-energizing said primary winding and then de-energizing said solenoid winding, latch means controlled by said electromagnet for mechanically holding said plunger in said solenoid winding when the solenoid winding is de-energized, and thermal means in circuit with said electromagnet for controlling said electromagnet.

3. A solenoid operated protective device comprising an iron core having at least three legs, a solenoid winding disposed between two of said legs and having a portion embracing one of said legs, primary and secondary transformer windings carried by one of said legs adjacent to the leg carrying said portion of said solenoid winding, a plunger for said solenoid, a source of current connected to said primary winding and said solenoid winding, electromagnetic switching means in circuit with said secondary winding for causing energization of said solenoid winding to lift said plunger and to subsequently break said primary circuit, means actuated by said plunger when lifted, for re-energizing said primary winding and then de-energizing said solenoid winding, and latch means operated by said plunger and retained by said electromagnet for holding said plunger in said solenoid winding when the winding is de-energized.

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