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W. A. RAY

2,675,508

ELECTROMAGNETICALLY CONTROLLED OPERATOR

Original Filed Aug. 20, 1945

2 Sheets-Sheet 1

Fig. 1

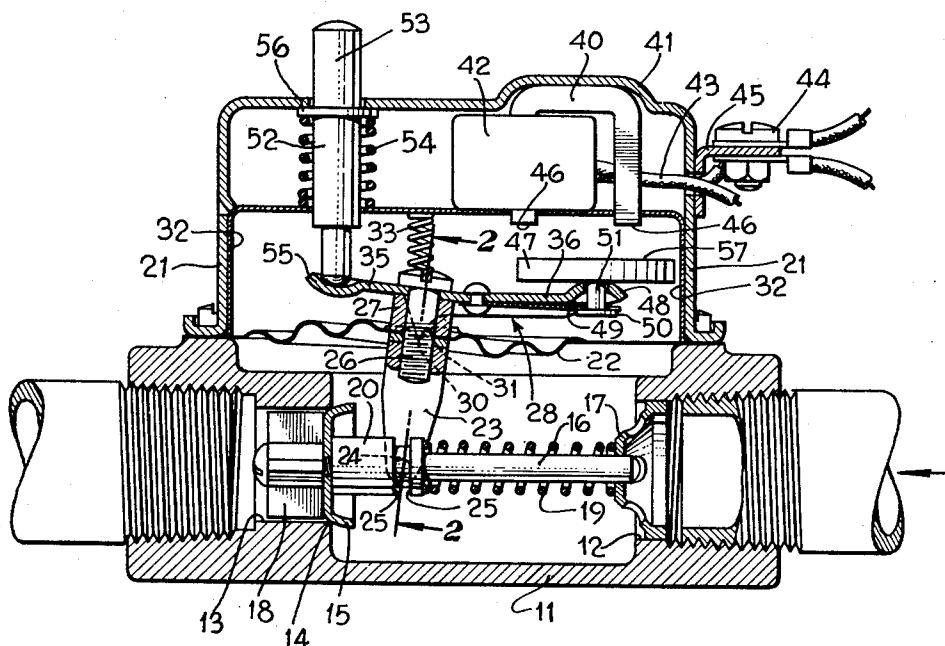
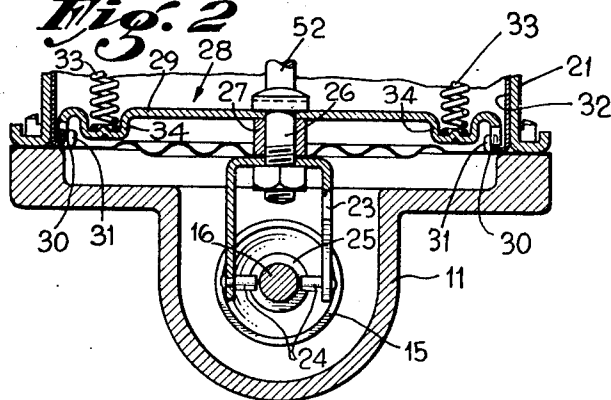


Fig. 2



Inventor:

WILLIAM A. RAY,

By

John Flann

Attorney.

April 13, 1954

W. A. RAY

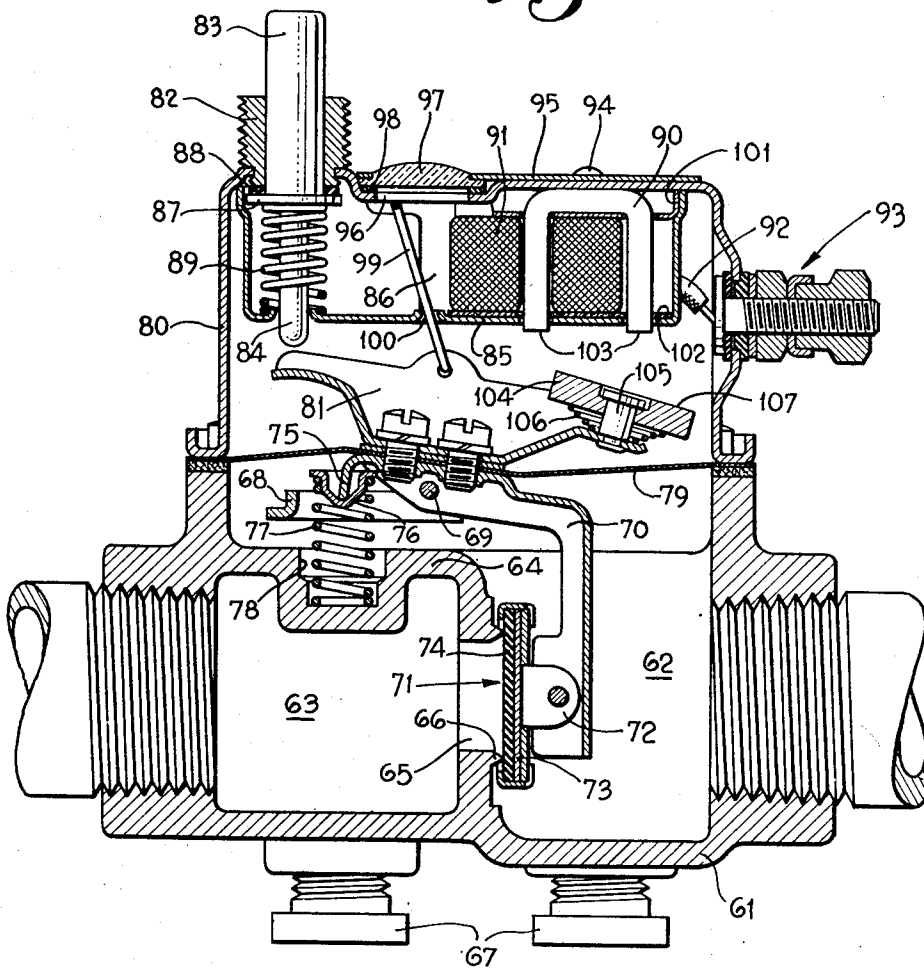
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Fig. 3



Inventor:

WILLIAM A. RAY,

John Flann

Attorney.

UNITED STATES PATENT OFFICE

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ELECTROMAGNETICALLY CONTROLLED OPERATOR

William A. Ray, North Hollywood, Calif., assignor to General Controls Co., a corporation

Continuation of application Serial No. 611,597, August 20, 1945. This application January 19, 1953, Serial No. 331,850

5 Claims. (Cl. 317-175)

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This invention relates to electromagnetically controlled devices of the type wherein an electromagnet is employed for retaining an armature in attracted position after it is first brought to that position by mechanical means; the electromagnet being so designed that it is incapable of attracting the armature through space. The present application is a continuation of an application, Serial No. 611,597, filed August 20, 1945.

Devices of the character described have their chief utility in connection with "safety" control systems wherein energization of the electromagnet is so controlled by means responsive to a condition, which is a prerequisite to safe operation of the system, that in the event of cessation of the condition the armature is released and thereby effects such control of the system that the same is rendered inoperative; it then being necessary to manually "reset" the armature after the cause of the trouble has been corrected.

Typical of such a system is one wherein the armature is connected to a valve for controlling supply of fuel to a main burner and is normally retained in a valve-opening attracted position due to the current generated by a thermoelectric device subjected to the flame of a pilot burner for the main burner. Especially since the amount of power produced by such a thermoelectric generating device is relatively minute, it is obviously desirable that the armature should hold in and drop out (in the event of extinguishment of the pilot flame) at predetermined respective values of the energizing current; however, in previous devices of this character these respective current values have been found to vary considerably in successive operations of the same device. It is, therefore, an object of this invention to prevent such erratic action, and I have found that this object can be accomplished by sliding together the cooperating surfaces of the armature and the core of the electromagnet so that the degree of intimacy of contact between these surfaces is substantially the same each time the armature is reset.

I have further discovered that by plating one or both of the cooperating surfaces of the armature and core with a thin layer of hard non-magnetic metal, such as chromium, not only are the surfaces protected from wear, but also that, due to the non-magnetic barrier between it and the core, the armature is released each time the holding current is reduced to substantially the same value.

For full understanding of the invention and further appreciation of its objects and advan-

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tages, reference is to be had to the following detailed description and accompanying drawing, and to the appended claims.

In the drawing:

5 Figure 1 is a longitudinal sectional view of a valve embodying the invention;

Figure 2 is a fragmentary transverse section taken along the line 2-2 of Fig. 1; and

10 Figure 3 is a longitudinal sectional view of a modified form of valve embodying the invention.

Referring first to Figs. 1 and 2 of the drawing, the numeral 11 indicates a valve casing having axially aligned inlet and outlet openings 12 and 13, respectively. Cooperable with a seat 14 formed at the inner end of the outlet opening is a closure member 15 mounted on a rod 16, which rod is guided at its right-hand end in an apertured cup-shaped washer 17 pressed in the inlet opening 12. The left-hand end of rod 16 is guided by 15 a vaned member 18 secured thereto and freely slidable in the outlet opening 13. A spring 19, compressed between an enlarged portion 20 of the rod and the washer 17, urges the closure member toward its seat. Covering an opening in the 20 upper wall of the casing and secured thereto is a housing 21. Interposed at its margin between the flanged lower portion of this housing and the surface of the casing surrounding the opening is a corrugated metallic diaphragm 22. Extending from the underside of the diaphragm is a U-shaped closure-operating member 23, in the lower portions of the side arms of which are pins 24, 25 freely received in an annular recess 25 formed in the enlarged portion 20 of the rod 16. The member 23 is secured to the diaphragm by a bolt 26 which extends through an opening concentric of the corrugated portion thereof. Also secured to the diaphragm by the bolt 26, with a bushing 27 therebetween, is a cross-shaped lever 28. The 30 arms 29 of this lever are provided at their downwardly-turned outer ends with knife-edged portions 30 which bear in V-shaped notches cut in upwardly-turned lug portions 31 formed on the lower end of a sub-housing 32, which sub-housing fits snugly within the main housing 21. The lever 28 is thus pivoted substantially in the general plane of the diaphragm 22, and is held in that position by the force of a pair of springs 33 compressed between the arms 29 (Fig. 2) and the upper wall of the sub-housing 32. The pivots of the lever also being on a line which intersects the longitudinal axis of member 23 at the diaphragm, no appreciable amount of fluid is displaced in the flexing of the diaphragm as the lever is rocked, and for the same reason, the fluid pressure below

the diaphragm has no tendency to rock, or impede rocking of, the lever. So that the springs 33 will not produce a toggle action when the lever is rocked, the arms 29 are provided with depressed portions 34 for receiving the springs so that their lower ends are substantially in the axis of rotation of the lever. The cross-shaped lever 28 has an additional pair of arms 35-36 which extend at right-angles to the arms 29.

Mounted in the upper part of the housing 21 is an electromagnet comprising a U-shaped core 40, the upper end of which is received in a recess 41 formed in the top wall of the housing. Surrounding one of the side arms of the U-shaped core is a coil 42, the leads 43 of which extend through an opening in the side wall of the housing and are connected to terminals 44, insulatingly mounted in a bracket 45 secured to the housing. The side arms of the core extend through openings in the top wall of the sub-housing, and the electromagnet is maintained in position by its coil. Cooperable with the pole faces 46 of the core is an armature 47 which is rockably mounted on an up-set end portion 48 of the arm 36, the armature being resiliently held to the arm by a leaf spring 49 compressed against the inner surface of the head 50 of a pin secured to the armature. This rockable mounting of the armature permits accurate alignment of its upper surface 51 with the pole faces 46 when these surfaces are brought together.

Reciprocable in aligned openings formed in the top walls of housing 21 and sub-housing 32 is a rod 52, the outer end portion 53 of which forms a manually operable push-button. Compressed between a shoulder 56 formed on rod 52 and the upper wall of the sub-housing 32 is a spring 54 which urges the rod upwardly, its movement in this direction being limited by the shoulder 56. The rounded lower end of rod 52 engages a cupped portion 55 of lever arm 35, downward movement of push-button 53 serving to rock the lever about its pivots so that the closure member 15 is moved into open position and the surface 51 of armature 47 is simultaneously brought into engagement with the pole faces 46 of the core. If, when this occurs, the core 40 is sufficiently energized by passage of current through coil 42, upon release of push-button 53, since the armature is then magnetically held in engagement with the pole faces, the closure member is retained in open position against the bias of spring 19. If the current through coil 42 is interrupted or sufficiently weakened, the armature is released from the core and the valve closes.

Inasmuch as the lever 28 is pivoted on an axis remote from the plane of the core pole-faces 46, after the armature is brought into engagement with the core continued pressure on the push-button 53 effects a slight relative sliding movement of the surfaces 46 and 51, due to the inherent yieldability of the lever-arm 36, so that they are intimately interengaged; uniform cooperation of the core and armature thus being ensured each time the armature is reset.

This sliding movement is effected because the force urging the armature 47 against the core 40 has a direction oblique to the interengaging surfaces. This force has a component parallel to the interengaging surfaces. Since the lever 36 can yield, continued pressure on button 53 inevitably causes the sliding movement.

One or both of the cooperating surfaces 46 and 51 is preferably plated with a thin layer (0.0001-0.0002 inch thick) of chromium. Due, presum-

ably, to the non-magnetic barrier between the magnetic members formed by this layer, I have found that after each resetting of the armature its release occurs when the electromagnet-current is reduced to substantially the same value. In previous devices of this character it is well known that the drop-out value of the current may at times vary more than 100%. Further, since the chromium layer is very hard and substantially non-corrosive, the surface wear is reduced to a minimum.

Referring now to the modified embodiment of the invention shown in Fig. 3, the numeral 61 indicates a valve casing having inlet and outlet chambers 62 and 63, respectively, separated by a partition 64 the vertical portion of which is provided with a valve port 65 having around its inlet end an annular valve seat 66. In the bottom wall of the casing are openings, shown closed by a pair of plugs 67, which can serve as pilot tapplings when the valve is employed for controlling supply of gaseous fuel to main and pilot burners. Above the top wall of partition 64, and joined integrally to the front and back walls of the casing, is a U-shaped bracket 68 between the side arms of which is pivoted, on a pin 69, a channelled right-angled lever 70 to the dependent vertical portion of which is connected a closure member 71 cooperable with the seat 66; the closure member being rockably mounted on the lever by means of an ear 72 turned up from a metal plate 73 which forms a backing for the resilient seat-engaging disk 74. The left-hand extremity of the horizontal portion of lever 70 is formed to provide a dependent finger 75 which bears in a cup 76 provided in the upper end of a compression spring 77 which serves to bias the lever in a clockwise direction; the lower end of the spring being received in a recess 78 formed in a thickened portion of the top wall of partition 64.

Covering the open top of casing 61 is a diaphragm 79, of flexible material such as leather or thin metal, which is clamped at its margin between the casing and the flanged mouth of a cup-shaped housing 80 secured to the casing. Forming within housing 80 an extension of lever 70 is a channelled arm 81 which is secured by screws to the horizontal portion of the lever with diaphragm 79 therebetween; the connection between these parts being fluid-tight. Reciprocable in a bushing 82, sealingly secured in an opening through the top wall of housing 80, is a push-button 83 having a stem 84 engageable with the left-hand end of the arm 81. The bushing 82 is preferably externally threaded, as shown, for the attachment of a protective cap, or for the connection of means for remotely operating the push-button. The stem 84 extends freely through an opening in the bottom wall of a relatively-narrow rectangular receptacle 85 which is secured in position by a sheet-metal member 86 spot-welded to the top wall of housing 80 and having ears (not shown) which cooperate with slots in the side walls of the receptacle. When the push-button 83 is in its retracted position, as shown, the clearance-opening around it is sealed by cooperation of its enlargement 87 and soft washer 88 with the undersurface of bushing 82; the push-button being biased to this position by a compression spring 89 encircling the stem 84.

Within the right-hand end of receptacle 85 is an electromagnet comprising a U-shaped core 90 around one side arm of which is an energizing coil 91 having leads 92 which are connected, as

by solder, to the inner ends of terminal-posts 93 sealingly and insulatingly mounted in openings through an end wall of housing 83. The electromagnet is held in place by the receptacle 85 and by a cooperating cupped member 101 which fits within the expanded mouth of the receptacle; the side arms of the core 90 extending freely through openings in the member 101 and corresponding openings in the bottom wall of the receptacle. A piece of fibrous material or fish-paper 102, is inserted below the coil 91 so as to prevent the possibility of dirt, or flakes of the insulating compound with which the coil is customarily impregnated, from falling through the core-openings in the receptacle.

Secured by a rivet 94 to the top wall of the housing is a name-plate 95 having an opening in register with an opening 96 through a portion of the top wall of the housing which is dished to receive a glass or plastic window 97 and sealing gasket 98; the shouldered margin of the window being engaged by the name-plate. The window is preferably in the form of a magnifying lens, as shown, and permits observation of an indicator 99 which conveniently consists of a U-shaped wire extending through a slot 100 in the bottom of receptacle 85, the lower extremities of the wire being bent for reception in openings through the opposite side walls of the channelled arm 81. When the lever 70, 81 is rocked, the cross-arm of the indicator is moved to opposite ends of the window so that the position of the lever can readily be ascertained.

Cooperable with the ends or pole-faces 103 of the core 90 is an armature 104 which is yieldably and rockably mounted on the right-hand end of the lever-arm 81 by means of a headed pin 105 riveted to the arm and freely extending through a central opening in the armature, the armature being urged by a compression spring 106 against the head of the pin, for which head a shallow recess is provided. When, by operation of the push-button 83, the lever 70, 81 is rocked from its position shown, the closure member 71 is brought to open position and the armature is moved arcuately so that its surface 107 engages the pole faces 103, continued movement of the lever effecting depression of the armature against the force of spring 106 so that the armature slides on the core and these parts are intimately interengaged. If when this occurs the core is sufficiently energized by passage of current through the coil 91, upon release of the push-button the lever is retained in its moved position, against the bias of spring 77, by the force of the electromagnet. When the electromagnet is sufficiently deenergized, the armature is released and the valve closes.

Because of the relatively rigid construction of the arm 81 it is necessary to mount the armature yieldably in order to effect the desired intimate interengagement of the armature and core; in the embodiment of the invention shown in Figs. 1 and 2 the inherent resilience of the arm 36 is sufficient to permit such action. One or both of the cooperating surfaces 103 and 107 is preferably chromium-plated for the reasons stated in connection with the corresponding surfaces 46 and 57 in the embodiment of Figs. 1 and 2.

In this form, the force applied to the armature 104 is oblique to the interengaging surfaces; and since the mounting of the armature permits yielding, a sliding movement of the ar-

mature is effected upon continued pressure on button 83.

While I have herein shown and described specific embodiments of the invention, it will be understood that modifications may be made without departing from the spirit of the invention and its scope as defined by the appended claims.

I claim as my invention:

1. In an electromagnetically controlled device: an electromagnet, fixed with respect to said device, comprising a core member having a plane polar surface, and a coil in flux-inducing relation to the core member for energizing the same; a movable armature member having a plane surface cooperable with said polar surface of the core member; said electromagnet when energized being incapable of attracting said armature member through space, but adapted while, and only while, energized to retain the armature member in engagement with said core member after said surfaces are first mechanically brought together; and a lever member, pivoted on said device on an axis other than in the plane of said polar surface, for supporting the armature member and movable to swing the armature member arcuately into engagement with the core member, said lever member being so constructed that it can yield to a limited extent so that after initial engagement of said surfaces a sliding movement of the surfaces is effected.

2. In an electromagnetically controlled device: an electromagnet, fixed with respect to said device, comprising a core member having a plane polar surface, and a coil in flux-inducing relation to the core member for energizing the same; a movable armature member, of rigid construction, having a plane surface cooperable with said polar surface of the core member; said electromagnet when energized being incapable of attracting said armature member through space, but adapted while, and only while, energized to retain the armature member in engagement with said core member after said surfaces are first mechanically brought together; and a lever member, pivoted on said device on an axis other than in the plane of said polar surface, for rockably supporting the armature member and movable to swing the armature member arcuately into engagement with the core member, said lever member being so constructed that it can yield to a limited extent so that after full engagement of said surfaces a sliding movement of the surfaces is effected, whereby intimacy of the engagement of the surfaces is ensured.

3. In an electromagnetically controlled device: an electromagnet comprising a core member and a coil in flux-inducing relation to the core member for energizing the same; an armature member; said members having interengaging plane surfaces; said electromagnet when energized being incapable of attracting said armature member through space, but adapted while, and only while, energized to retain the surfaces interengaged after the surfaces are first mechanically brought together; a support carrying one of the members; means for applying a force to the support to cause the members to be brought into full interengagement; and means determining the path of movement of the said one of the members so that the direction of the force urging the members together is oblique to the surfaces when the surfaces are in full engagement; said support including means yieldable in such man-

ner as to cause a sliding movement between the surfaces upon continued application of the force after the surfaces are brought into full engagement.

4. In an electromagnetically controlled device: an electromagnet comprising a core member and a coil in flux-inducing relation to the core member for energizing the same; an armature member; said members having interengaging plane surfaces; said electromagnet when energized being incapable of attracting said armature member through space, but adapted while, and only while, energized to retain the surfaces interengaged after the surfaces are first mechanically brought together; a support carrying one of the members; means for applying a source to the support to cause the members to be brought into full interengagement; and means determining the path of movement of the said one of the members so that the direction of the force urging the members together is oblique to the surfaces when the surfaces are in full engagement; said support including parts capable of relative movement, for causing a sliding movement between the surfaces upon continued application of the force after the surfaces are brought into full engagement.

5. In an electromagnetically controlled device: an electromagnet comprising a core member and a coil in flux-inducing relation to the core member for energizing the same; an armature

member; said members having interengaging plane surfaces; said electromagnet when energized being incapable of attracting said armature member through space, but adapted while, and only while, energized to retain the surfaces interengaged after the surfaces are first mechanically brought together; a support carrying one of the members; means for applying a force to the support to cause the members to be brought into full interengagement; and means determining the path of movement of the said one of the members so that the direction of the force urging the members together is oblique to the surfaces when the surfaces are in full engagement; said support including a loose connection between the support and the said one member, for causing a sliding movement between the surfaces upon continued application of the force after the surfaces are brought into full engagement.

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