

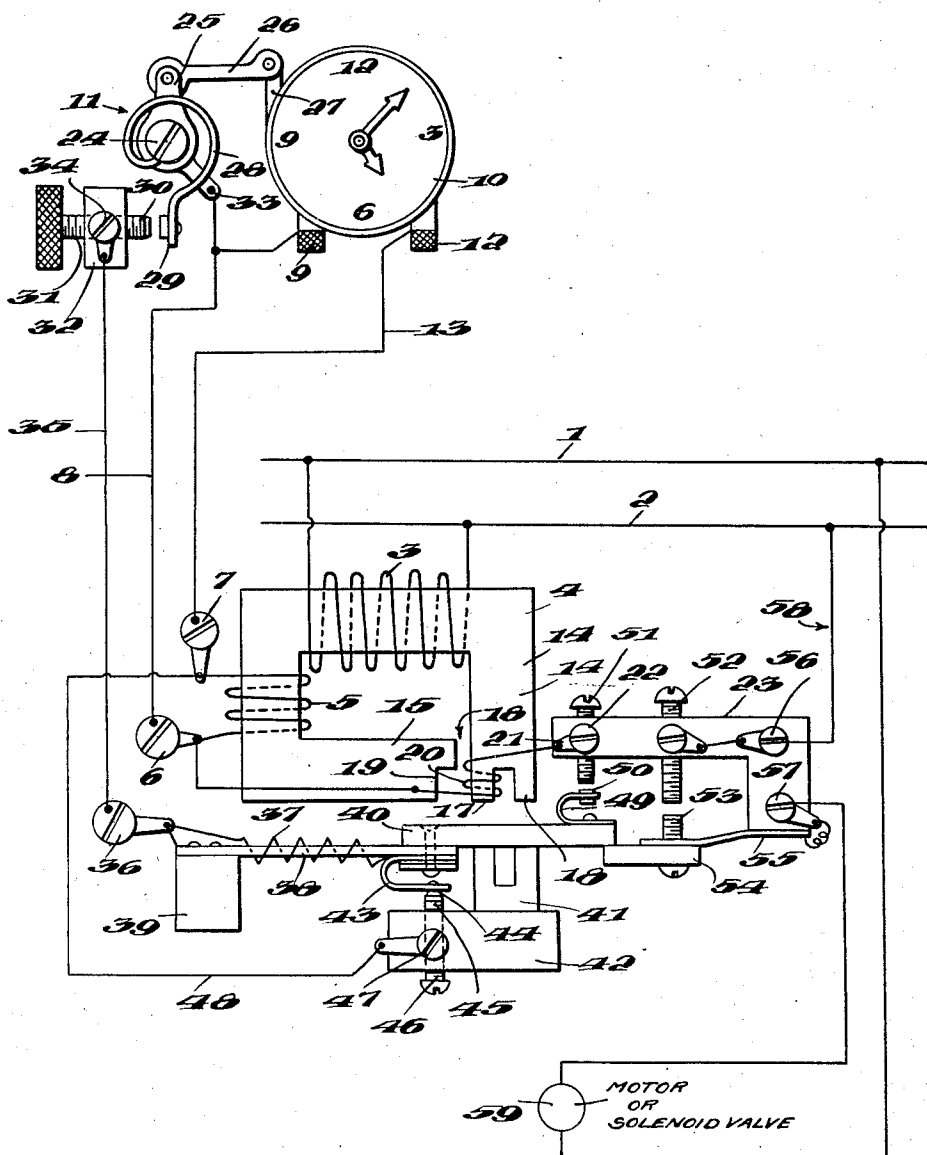
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G. W. CRISE

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THERMO-MAGNETIC RELAY

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Inventor
George W. Crise

By W. A. McHowell

Attorney

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THERMOMAGNETIC RELAY

George W. Crise, Columbus, Ohio, assignor to
Crise Electric Manufacturing Company, Co-
lumbus, Ohio, a corporation of Ohio

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The purpose of my invention is to provide an improved relay for effecting the operation of electric motors or valves used by furnace stokers, oil burners and the like, in accordance with the correlated operation of a thermostat, or other delicate switch, a principal object being to improve present devices for this purpose from a standpoint of efficiency, reliability and structural simplicity.

Another object of the invention is to provide a relay having incorporated in its operation a time delay feature adapted to prevent chattering or dangerous short cycle operation of associated electrical equipment, since undesired short cycle operation tends to burn or fuse the starting windings of a stoker motor, or the coil windings of a solenoid valve, and is often attributable to vibration or improper adjustment or installation of an associated room thermostat.

A further object is to provide a relay capable of making and breaking a heavy electric circuit while consuming in its own windings a very small current.

An additional object is to provide a relay in which is incorporated means whereby the associated thermostat is required to interrupt only a small fraction of the current flowing through the relay windings.

For a further understanding of the invention, reference is to be had to the accompanying drawing wherein is illustrated a schematic view disclosing the relay comprising the present invention, and associated clock-controlled thermostat and uniting circuits.

Referring more particularly to the drawing, the numerals 1 and 2 indicate the leads of a commercial power circuit which may be of a standard alternating current type. Connected with these leads are the terminals of a primary transformer coil 3 which, preferably, is applied around one of the legs of a substantially rectangular, laminated transformer frame 4. Surrounding another leg of the frame 4 is a low-voltage secondary coil 5 in which current flow is induced from the continuously energized primary coil 3. The ends of the coil 5 extend to terminals 6 and 7. From the terminal 6, a conductor 8 leads to one of the terminal posts 9 of a clock mechanism 10, the latter being employed for effecting day and night control over an associated thermostat, indicated generally by the numeral 11. The other terminal post 12 of the clock mechanism is joined with a conductor 13 which leads to the terminal 7. By this arrangement, a low voltage alternating current is continuously applied to the clock mechanism to effect its operation.

The transformer frame is formed to provide spaced poles 14 and 15, the space between the poles providing a flux and current limiting gap 16. The bottom of the pole 14 is bifurcated to provide spaced legs indicated at 17 and 18, and the terminating end of the pole 15 is notched as at 19. Wrapped around the leg 17 is a shading coil 20, one end of this coil being connected as at 21 with a terminal screw 22 mounted in the insulated contact frame 23, the other end of the shading coil extending to and being joined with the terminal 6.

The thermostat 11 has been shown as comprising a rockable stud 24, which carries a crank arm 25. The outer end of this arm is linked as at 26 to the operating arm 27 of the clock mechanism 10, so that the stud 24 may be rocked at different hours of the day by the clock mechanism to control the operation of the thermostat in a well-known manner.

Connected with the stud 24 is one end of a spiral bimetallic element 28, the free end of which terminates in a movable contact 29. This contact, through the operation of the element 28, in responding to different temperatures, is adapted to be brought into and out of engagement with a normally stationary but adjustable contact 30 provided on the outer end of a screw 31, the latter being supported in a threaded bore provided in an insulating block, shown at 32.

The conductor 8 is electrically joined as at 33 with the stud 24, and when the contacts 29 and 30 are in relative engagement, current from the secondary winding of the transformer flows through the element 28, the contacts 29 and 30 and the screw 31 to a terminal post 34, mounted in the block 32 and disposed in electrical engagement with the screw 31. From the post 34, a conductor 35 extends to a terminal post 36. To this post there is connected one end of a resistor coil 37, the latter surrounding but being electrically spaced from a bimetallic warping bar 38, said bar having its high expanding side arranged at the bottom thereof.

One end of the warping bar is secured to a block 39 of insulating material, while the outer or free end of the bar carries an armature 40. Normally, this armature is disposed in engagement with a permanent magnet indicated at 41, the latter being, in turn, mounted on an insulated support shown at 42, the armature being spaced from the pole extremities of the transformer frame. Also, mechanically carried by the outer end of the warping bar but electrically spaced therefrom is a bowed spring 43 which carries at

its free end a contact 44 and is joined with resistor coil 37. With the warping bar positioned as shown in the drawing, the contact 44 engages with a stationary but adjustable contact 45 formed in the upper end of a screw 46 which is threaded in the support 42. Contacting the screw 46 is a terminal member 47 from which extends a conductor 48, leading to the terminal 7 of the secondary winding of the transformer.

It will be seen that when the temperature surrounding the thermostat 11 falls to a predetermined extent, the bimetallic element 28 of said thermostat will flex to bring the contacts 29 and 30 together. When this engagement occurs, current flows from the secondary winding of the transformer through the thermostat to the conductor 35, and thence through the resistor coil 37 of the warping bar, passing through contacts 44 and 45 and returning to the secondary winding of the transformer through the conductor 48. The flow of current through the resistor coil causes the latter to release heat which, in turn, produces flexure of the warping bar 38. After a certain period of time, this flexure forms sufficient energy to overcome the attraction exercised by the permanent magnet 41 on the armature 40, so that the latter is brought into engagement, by a quick motion, with the terminal pole 14 of the transformer. When this occurs, a bowed spring 49 carrying at its free end a contact 50, and which spring is mounted on the armature 40, is brought into contact with one end of a stationary but adjustable screw 51 threaded in the contact frame 23, so that current may flow through the shading coil 20.

Carried by the frame 23 is a second contact screw 52 normally spaced from a contact 53 carried by an insulating strip 54. This strip is supported by the outer end of a leaf spring 55, the inner or fixed end of said spring being secured to the lower leg of the frame 23. The tendency of the spring 55 is to maintain the contact 53 in engagement with the contact 52. However, when the armature 40 is attracted by the magnet 41, one end of the armature bears on the strip 54, holding the contacts 52 and 53 out of engagement with each other. When the armature is attracted by the pole extremities 17 and 18 of the transformer, the upward movement of the armature releases the strip 54, allowing the latter to respond sharply to the action of the spring 55 so that the contacts 52 and 53 are quickly engaged.

The screw 52 is electrically connected with a terminal 56, and likewise the spring 55 is electrically connected with a terminal 57. These terminals are disposed in a circuit 58 in which is arranged an electric motor 59 used as the operating unit of a furnace stoker. In the event the heater is of the type consuming a gaseous or liquid fuel, the energizing coil of a solenoid operated valve may be substituted for the motor 59.

Operation

With the armature 40 held down by the action of the permanent magnet 41, and the room thermostat 11 in its warm or open circuit condition, the only energy flowing is through the transformer to the clock mechanism 10, this energy flow being regulated by the air gap 16, which limits the saturation of the transformer core or frame and thereby limits the current flow in both the primary and secondary coils of the transformer to a safe value, particularly in case of accidental short-circuiting or over-voltage. Upon closure of the thermostat contacts 29 and 30, by

a drop of room temperature, the circuit is completed through the heater coil 37, causing the bimetallic warping bar 38 to be gradually heated. In approximately one minute's time, more or less, sufficient tension will be established in the bimetallic bar to cause the armature 40 to separate from the magnet 41, moving the armature by quick action against the pole terminals 14 and 15 of the transformer core. Concurrently with this action, current flow through the resistor coil 37 is interrupted by the separation of the contacts 44 and 45. However, the contacts 50 and 51 are brought into engagement, thus energizing the shading coil 20 through the room thermostat.

As the warping bar 38 cools off, over a period of 1 to 2 minutes, the armature would normally be drawn down into engagement with the magnet 41 were it not for the action of the shading coil 20. This coil increases the normal holding action of the transformer poles 14 and 15 on the armature to an extent about 8 to 10 times that necessary to hold the armature, this condition obtaining just as long as the shading coil circuit is complete through the room thermostat.

While the armature 40 is raised and held by the transformer poles, the insulating strip 54 is released, thereby allowing the spring 55 to close the contacts 52 and 53, completing the control circuit which governs the operation of associated electrically actuated fuel-supplying means for furnaces or other heaters.

When sufficient heat has been generated by the action of the furnace or heater to satisfy the room thermostat, the contacts 29 and 30 will separate, breaking the circuit through the shading coil 20. This results in releasing the armature 40, which falls under the pull of gravity, the spring tension of the unheated warping bar and the action of the magnet 41, causing quick movement of the armature so that the same strikes the strip 54 and separates the contacts 52 and 53, thereby interrupting the circuit 58 and discontinuing active operation of the heating means. At the same time, it will be observed that the contacts 50 and 51 are separated and the heater circuit through contacts 44 and 45 reestablished except for the closing of the thermostat contacts, thus completing one complete cycle of operation.

It will also be noted that when the armature 40 is in contact with the pole pieces of the transformer, it partially shunts the magnetic gap 16, which offsets the magnet's flux consumed by the shading coil 20, thus maintaining substantially constant voltage in the secondary winding of the transformer, supplying a low voltage current for the electric clock mechanism.

The thermostat 11 is required merely to handle a small part of the current flowing through the relay, since the thermostat is connected either in the warping bar heating circuit or the shading coil circuit, and not in the primary or directly across the secondary as is common in the art. Since a period of time of approximately one minute is consumed to heat the warping bar 38, a thermostat current of less than one watt is sufficient to handle a heavy switching load.

It is important that the heated warping bar shall hold the armature 40 firmly against the pole pieces 14 and 15 until the bar cools sufficiently irrespective of the action of the shading coil 20. This prevents the relay from stopping the stoker or fuel burner of an associated heater until it has operated approximately one minute, even though the thermostat for some cause should break connections momentarily; for instance, as

the result of vibration, the slow heating of the warping bar preventing a restarting of the heater for a like period after being stopped. Once the warping bar has cooled, however, the room thermostat can stop the stoker or oil burner instantly upon separation of its contacts 29 and 30.

It is also important to note that since only approximately one-eighth to one-tenth of the energy is required to hold the armature 40 against the transformer poles as would be required to lift the armature magnetically, the relay saves more than enough current by this method of operation to supply current for an electric clock, which would otherwise require a separate transformer to supply low voltage in accordance with wiring codes, a simplified installation of the complete equipment thus resulting.

I claim:

1. Thermally responsive switch mechanism comprising a transformer having a frame formed with spaced poles, a primary coil surrounding said frame connected with a source of electrical energy, a low voltage secondary coil surrounding said frame, a thermostat including an electrically actuated clock mechanism, a circuit for said clock mechanism joined with said secondary coil, a turnable member adapted to be rocked at predetermined intervals by said clock mechanism, a bimetallic element having one end secured to said turnable member, a movable contact carried by the free end of said bimetallic element, a stationary but adjustable contact adapted for engagement and disengagement with said movable contact upon flexure of said element in response to temperature changes, a circuit leading from the secondary coil of said transformer to said movable and stationary contacts, a bimetallic warping bar, a support to which one end of said bar is secured, an armature carried by the outer movable end of said bar, a heating resistor disposed adjacent to said warping bar, a circuit for said resistor forming a branch of the circuit passing through said thermostat, a permanent magnet disposed adjacent to said armature, a shading coil surrounding one of the poles of said transformer frame, a circuit for said shading coil

forming another branch of said thermostat circuit, and circuit making and breaking devices for said resistor and shading coil circuits actuated by the movements of said armature in response to thermal changes in said warping bar and the attraction exerted on said armature by said permanent magnet and transformer poles.

2. Thermally responsive switch mechanism comprising a transformer having a frame formed with spaced poles, a primary coil surrounding said frame connected with a source of electrical energy, a low voltage secondary coil surrounding said frame, a thermostat including an electrically actuated clock mechanism, a circuit for said clock mechanism joined with said secondary coil, a turnable member adapted to be rocked at predetermined intervals by said clock mechanism, a bimetallic element having one end secured to said turnable member, a movable contact carried by the free end of said bimetallic element, a stationary but adjustable contact adapted for engagement and disengagement with said movable contact upon flexure of said element in response to temperature changes, a circuit leading from the secondary coil of said transformer to said movable and stationary contacts, a bimetallic warping bar, a support to which one end of said bar is secured, an armature carried by the outer movable end of said bar, a heating resistor disposed adjacent to said warping bar, a circuit for said resistor forming a branch of the circuit passing through said thermostat, a permanent magnet disposed adjacent to said armature, a shading coil surrounding one of the poles of said transformer frame, a circuit for said shading coil forming another branch of said thermostat circuit, circuit making and breaking devices for said resistor and shading coil circuits actuated by the movements of said armature in response to thermal changes in said warping bar and the attraction exerted on said armature by said permanent magnet and transformer poles, a power circuit, and circuit making and breaking devices for said power circuit actuated by the movements of said armature.

GEORGE W. CRISE.