Dec. 12, 1933. P. McSHANE 1,939,076

THERMAL RELAY

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Fig. 1.

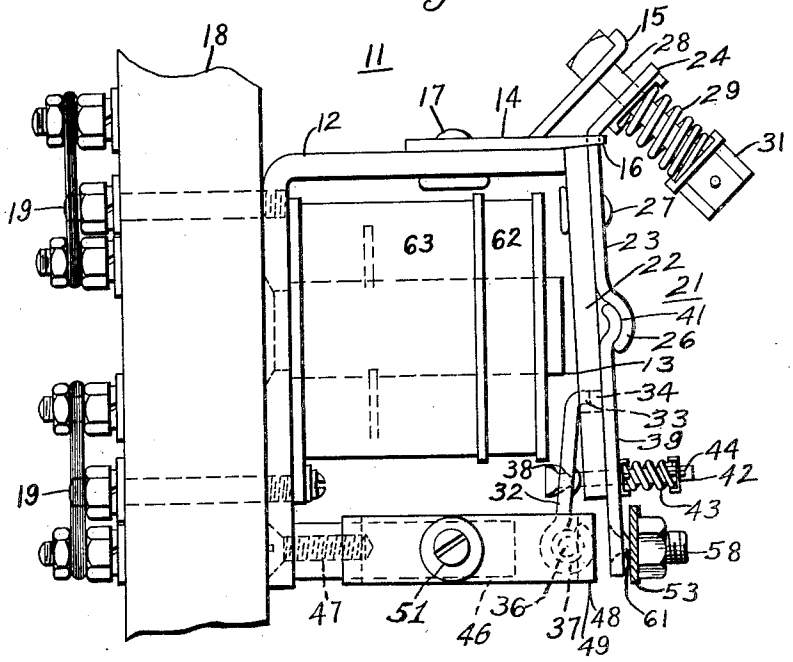
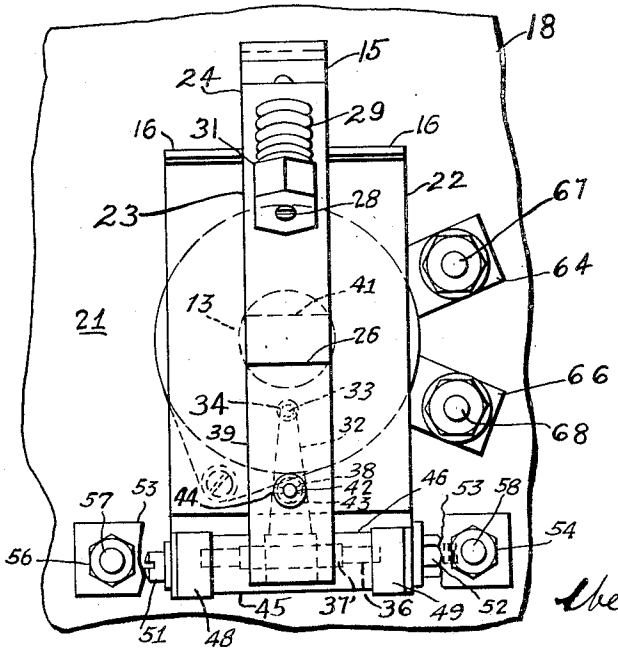



Fig. 2.




INVENTOR
Phelan McShane
BY
Wesley G. Carr
ATTORNEY

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Fig. 3.

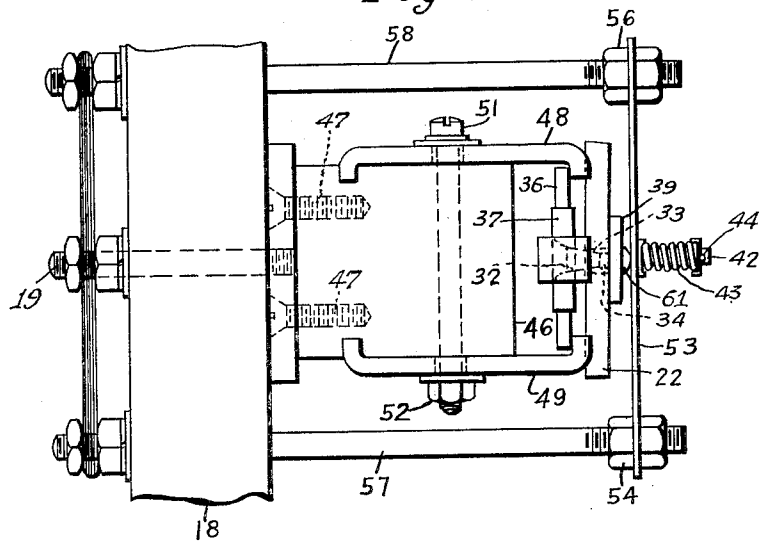
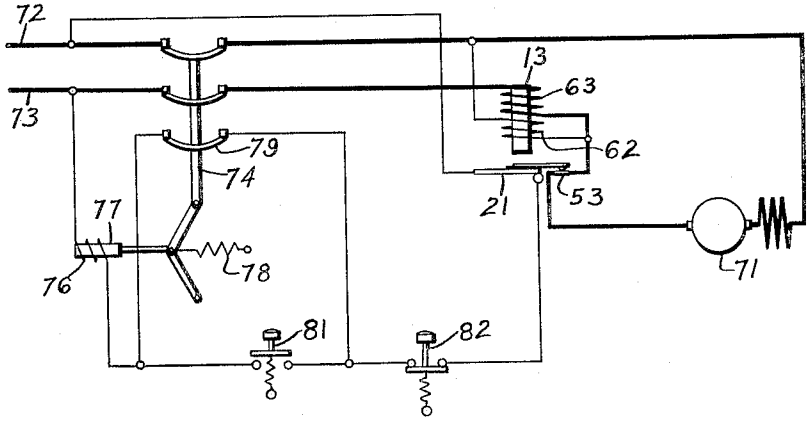



Fig. 4.




INVENTOR
Phelan McShane

BY
Wesley L. Barr
ATTORNEY

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# UNITED STATES PATENT OFFICE

1,939,076

## THERMAL RELAY

Phelan McShane, Pittsburgh, Pa., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application July 18, 1928. Serial No. 293,763

4 Claims. (Cl. 200—88)

My invention relates to protective devices and particularly to thermal relays.

An object of my invention is to provide a relatively simple, efficient and easily manufactured thermal relay.

Another object of my invention is to provide a thermal relay that shall be effective to protect electric-energy translating devices from either long continued moderate loads or from abnormal over-loads that might damage the energy-translating devices.

In practicing my invention, I provide an electromagnetic relay embodying a constant current and a variable-current coil, a pivotally mounted armature structure actuable thereby, cooperating contact members mounted on the armature structure and on a suitable base, and a temperature-responsive means cooperating with the armature structure to normally bias the same to a predetermined position.

In the drawings,

Figure 1 is a view, mainly in side elevation, of a device embodying my invention.

Fig. 2 is a view, in front elevation, of the device shown in Fig. 1.

Fig. 3 is a bottom plan view thereof, and

Fig. 4 is a diagram of electrical connections illustrating the use of the device embodying my invention.

A thermal relay 11 comprises a yoke 12 of substantially L-shape and of magnetic material. A core member 13, of magnetic material, is secured in any suitable or desired manner to one leg of the yoke 12. A pivotal supporting member comprises a piece of sheet metal 14 having a forwardly extending central portion 15 bent outwardly therefrom to extend at an angle with the original plane of the member, thereby providing a forked end portion 16. A rivet 17 is provided to secure the member 14, which is made of magnetic material, to the horizontal portion of the yoke 12.

A base or supporting means 18 may be either an independent piece of electric-insulating material, such as slate or marble, or it may be a switchboard on which the relay 11 is mounted. A plurality of securing bolts 19 extend through the base 18 and into one leg portion of the yoke 12.

An armature structure 21 comprises a rectangular bar 22 of magnetic material which may be of substantially the same width as the yoke 12. A strip 23 of magnetic material, having an upper end portion 24 bent at an angle thereto and having a lower curved portion 26, is fastened to the upper portion of the front surface of the member 22 by means of a rivet 27. The member 23 may be of such length and so located that its lower end extends to substantially the middle of the member 22.

At its upper outwardly-bent portion 24, the member 23 is provided with a hole, as is also the portion 15 of the member 14, so that a bolt 28 may extend therethrough to movably and yieldingly hold the armature structure 21 in a predetermined position. A compression spring 29 surrounds the bolt 28, between the portion 24 and an adjusting nut 31 with which the bolt 28 is provided in order to ensure any desired degree of yielding bias to the armature structure.

A contact-supporting member 32 is yieldingly mounted upon the lower end of the member 22. The upper end 33 of the member 32 is reduced in width and is bent at substantially a right angle and projects into an opening 34 in the member 22 to serve as a pivot. The lower end of the member 32 is bent to substantially annular shape to receive a contact rod 36 from which it is separated by insulation 37.

The member 32 is provided with a hole 38, the material immediately surrounding the hole being embossed or indented, substantially as shown in Fig. 1 of the drawings. A yieldingly mounted member 39 of magnetic material is located against the lower portion of the front face of the member 22 and has an upper end portion 41 so shaped as to fit into the arcuate portion 26 of the member 23, the cooperating portions 26 and 41 constituting, in effect, a ball and socket joint.

A pin 42 extends through the hole 38 in the member 32 and through alined holes in the members 22 and 39 to yieldingly hold the members 32 and 39 in substantially the positions shown in Fig. 1 of the drawings. A spring 43 surrounds the outer end portion of the pin 42 and is held in place by a pin 44.

A contact-supporting structure cooperating with the rod 36, comprises a plate 46 of suitable electric-insulating material, one end of which is secured against the forward face of the yoke 12, closely adjacent to the lower end thereof. Securing screws 47 may be employed to hold the plate 46 in proper operative position.

Two contact members 48 and 49 are located adjacent to the side edges of the member 46, each of which is a metal bar of substantially U-shape. A single bolt 51 and a cooperating nut 52 may be employed to hold the two contact members 48 and 49 in the positions shown in the drawings, (Fig. 3) suitable insulation being provided between the

bolt and the two contact members to insulate one from the other.

A temperature-responsive member 53 is provided in the form of a bar or strip, preferably of nickel steel, the ends of which are clamped between cooperating nuts 54 and 56, mounted, respectively, on current-carrying studs 57 and 58. An alloy made of substantially 35% nickel and 65% iron usually called invar is what may be termed a "magnetically reversible" member. That is, when its temperature is below a predetermined value it is magnetic. However, if its temperature exceeds the predetermined value, it loses its magnetic characteristic, regaining it, however, when the temperature again drops below a predetermined value.

The member 39 is provided with a substantially circular raised portion 61, adjacent to its lower end which normally engages the inner face of the bar or strip 53. The yieldingly mounted members 32 and 39 ensure simultaneous proper engagement of the cooperating contact members and the raised portion 61 with the strip 53.

A constant-current winding 62 and a variable-current winding 63 surround the core member 13. The constant-current winding may comprise a suitable number of turns of fine wire proportioned for the voltage of the circuit across which it is to be connected. The variable-current winding 63 may comprise a plurality of turns of suitable wire or, as shown in the drawings, it may comprise an edge-wound strip of copper, the terminals 64 and 66 of which extend outwardly therefrom. Terminal members 67 and 68, in the form of studs, provide an electrical connection between the terminal portions 64 and 66 and the studs 57 or 58.

In Fig. 4 of the drawings, I have illustrated a diagram of circuits and connections employed in the use of the device embodying my invention. An energy-translating device is here represented by a motor 71 which is energized from a direct-current or a single-phase alternating-current source of electric energy comprising conductors 72 and 73.

An automatic circuit interrupter 74 is normally held in its closed position by the action of a holding coil 76 cooperating with a magnetic core member 77 operatively connected to the circuit-breaker mechanism. Upon de-energization of the coil 76, a spring 78 will cause the circuit breaker to open.

A pair of auxiliary contact members and a contact-bridging member 79 are provided to establish a holding circuit for the coil 76. A "start" push-button switch 81 and a "stop" push-button switch 82 are connected in circuit in substantially the manner shown in Fig. 4 of the drawings.

The device embodying my invention is particularly applicable to the protection of energy-translating devices or electric circuits which are subjected to various kinds of overloads. Thermal means provided for this purpose heretofore have usually comprised a thermal element of some kind which provided a time delay, the length of which varied inversely with the value or amount of current traversing the circuit. That is, while the thermal relay required a relatively long time to cause interruption of its holding circuit, and, therefore, opening of the circuit breaker controlled thereby, in case a relatively small overload current traversed the circuit, it would operate with a shorter time delay if the overload current became larger. However, there was always an appreciable time delay before the circuit was interrupted, even though the current traversing it and an energy-translating device, such as an induction motor, amounted to from 6 to 8 times the normal full-load current of the motor. This time delay might be long enough to permit of serious injury to the motor.

The device embodying my invention is effective to cause operation of all of the armature structure hereinbefore described in case the circuit comprising the device is traversed by a relatively small overload current for a relatively long time. Under this condition, the strip or bar 53, which is traversed by this current, has its temperature gradually raised until, if a sufficient volume of current traverses it for a sufficient length of time, its normal magnetic condition will be destroyed. The effect of the constant-current winding 62, aided by the variable current winding 63, will be to provide a flux which is of sufficient value to cause disengagement of the member 39 from the strip 53 and the consequent movement of the entire armature structure towards the core member 13. That is, the attractive force of the flux produced by the coil 62 on the armature 21, which is normally counter-balanced by the retentive effect between the strip 53 and the member 39, magnetized by some of the flux generated by the coil 62, is no longer sufficient to hold the armature structure in its normal and biased position in which contact member 36 engages the contact members 48 and 49. Hence, the entire armature structure is moved, and the holding circuit through the coil 76 is interrupted to cause actuation of the circuit breaker to its open position.

If a sudden and very heavy overload current traverses the motor 71 and the circuit, such as might be caused by a stalled or blocked rotor, the current value may rise to 6 or 8 times the normal full-load current of the motor. The magnetizing effect produced by the current traversing the coil 63 is, therefore, very large, and the pull on the armature structure 21 is also so large as to exceed the retentive effect heretofore described as normally existing between a portion of the armature structure and the normally magnetic strip 53. Hence, a portion only of the armature is caused to be moved toward the core 13, the member 39 remaining in engagement with the strip 53, as the movement of the rest of the armature structure will be effected substantially instantaneously and before the strip 53 will have been heated sufficiently to cause it to lose its magnetic characteristic. In other words, the device embodying my invention provides means for moving all of the armature structure to interrupt a control or holding circuit in case of small and long continued overloads, as well as means for effecting movement of a part of the armature structure substantially instantaneously in case of very heavy overload currents, the parts so moved including, in each case, the contact rod 36.

It is, of course, also obvious that any intermediate time delay is obtained in the device embodying my invention if, for instance, the circuit and the strip 53 have been traversed by a relatively light overload current for a certain length of time and the circuit is then traversed by a relatively heavy overload current. In such case, movement of the armature is effected at a lower value of current, as the strip 53 may have lost a part of its magnetic characteristic, and its retentive pull may not be as great.

The device embodying my invention thus constitutes a thermal relay for the control of elec-

tric circuits and energy-translating devices which is effective to properly protect electric circuits or energy-translating devices against long-continued moderate overload, as well as against instantaneous very heavy overload currents.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and are set forth in the appended claims.

I claim as my invention:

1. In a relay for protecting electric circuits from moderate overload currents long continued and abnormal overload currents of several times normal value, an armature, temperature-responsive means including a magnetically-reversible current-traversed member for biasing the armature towards a predetermined position, a constant current coil adapted to actuate the armature responsive to a predetermined thermal condition of the temperature-responsive means caused by a moderate overload current long continued, and a variable-current coil energizable in accordance with the current traversing the circuit to be protected for actuating the armature independently of the thermal condition of the temperature-responsive means whereby instantaneous operation of the armature may be effected when abnormal current conditions prevail in the circuit.

2. In a relay for protecting electric circuits both from moderate overload currents long continued and abnormal overload currents of several times normal value, an armature, means responsive to changes in temperature and including a magnetically-reversible current-traversed member for biasing the armature towards a predetermined position, means energized by the current traversing the circuit to be protected for heating the temperature-responsive means, a voltage coil disposed to attract the armature upon a change in temperature of the temperature-responsive means in accordance with normal overload-current values long continued, and a current coil disposed for energization by the current traversing the circuit to be protected for actuating the armature responsive to sudden abnormal overloads independently of the change in temperature of said temperature-responsive means.

3. In a relay for protecting electric circuits, in combination, a movable armature structure, a constant-current and a variable-current coil, a magnetically reversible member cooperating with a portion of the armature structure to bias the armature structure to a predetermined position, one of said coils being effective upon sudden overload to cause movement of a portion only of the armature structure and the other of said coils being effective to cause movement of all of said armature structure upon long continued moderate overloads.

4. A relay including a plural-part movable armature, a contact bridging member thereon, a magnetizing means therefor, a magnetically-reversible member normally operatively engaged by the armature to bias the latter to a predetermined position, said magnetizing means being selectively effective to cause movement of all of the armature with a time delay at a predetermined value of current traversing the relay and to cause movement of part of the armature having the contact bridging member thereon instantaneously at a higher predetermined value of the relay current.

PHELAN McSHANE.