Nov. 20, 1928. 1,692,486

A. COHN

THERMAL AND ELECTRORESPONSIVE DEVICE

Filed May 2, 1927

Fig. 1.

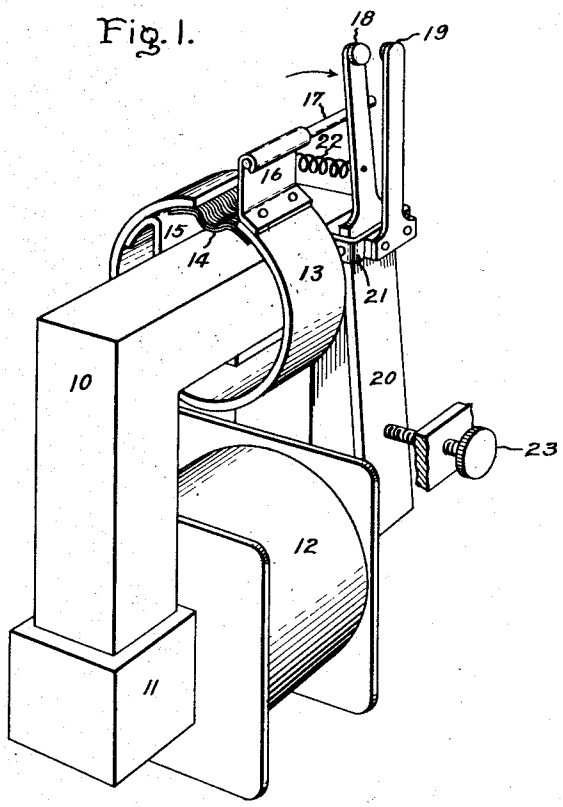
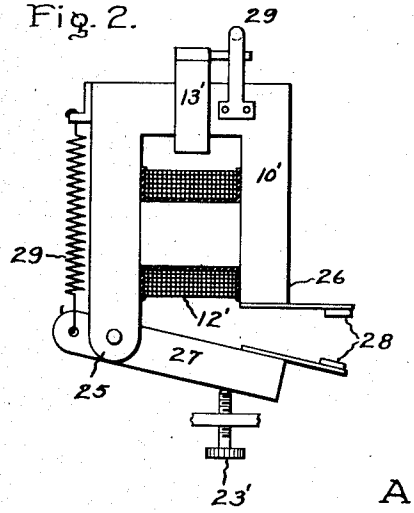


Fig. 2.



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UNITED STATES PATENT OFFICE.

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THERMAL AND ELECTRORESPONSIVE DEVICE.

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This invention relates to combined thermal and electroresponsive devices particularly for alternating current service, and one of the objects of the invention is to provide an improved device of the above character in which a common energizing winding is employed to effect operation of either an electrically heated thermal responsive element or a movable magnetic member depending upon the value of the energizing current of the winding.

A further object of the invention is to provide a combined thermal and electroresponsive device of the above character wherein the response of the thermal actuating element, as well as the electromagnetic element may be controlled in such a way that the value of current required to effect operation of the thermal responsive element may be decreased and at the same time the value of current required to effect operation of the movable magnetic member is increased and vice versa. Thus where the thermal responsive element is employed to provide time delay overload circuit protection upon long continued slight overloads, and the movable magnetic member is employed to provide instantaneous overload circuit protection upon the occurrence of excessive overloads, the particular values of current at which each of the elements responds may be varied inversely.

In accordance with the invention the thermal responsive actuating element is arranged to be heated by the currents induced by transformer action from a magnetic circuit which also produces the magnetic attractive force for operating the movable magnetic member. The magnetic structure is so constructed as to provide a substantially closed magnetic path for the flux interlinking the primary and secondary windings of the transformer, and in addition provides a stray flux path having an air gap therein for operating the movable magnetic member when the primary winding is energized at excessive current values. In this way variation in the air gap through which the movable magnetic member operates serves to inversely vary the flux in the substantially closed path with which the secondary circuit including the thermal responsive element is inductively linked. Thus when the air gap is reduced so as to produce operation of the magnetic member by the stray flux set up at a lower current value in the primary energization winding, the flux inductively interlinking the transformer secondary including the thermal responsive element necessarily is reduced thereby requiring a higher current in the energizing winding to produce the required heating effect to operate the thermal responsive element. On the other hand, when the air gap of the magnetic armature is increased so as to increase the value of the energizing current required for operation thereof, the flux supplied to the substantially closed magnetic circuit of the inductively heated thermal element is increased, thereby producing the required heating effect with a lower value of current in the energizing winding. This permits very nice and accurate adjustment of the respective current values required to produce operation of the overload protective device either thermally or electromagnetically. Moreover, with the substantially closed magnetic circuit for inductively heating the thermal element the efficiency of the inductive heating action is at all times relatively high since there are no air gaps in the inductive magnetic circuit.

In carrying the present invention into effect in a preferred form, use is made of a magnetic structure having a completely or substantially completely closed magnetic circuit which is so dimensioned that a portion thereof is of restricted cross sectional area so as to become substantially saturated upon excessive energization of the magnetizing winding therefor, and there is produced without any air gap in the magnetic circuit sufficient stray flux adjacent the portion of restricted cross sectional area to magnetically attract a movable magnetic member or armature. This armature may be arranged to actuate the same indicating or releasing relay contact or tripping mechanism of the switch as controlled by the inductively heated thermal responsive member. However, the thermal responsive member and the movable magnetic member also may be arranged to operate entirely independent indicating or releasing devices if desired.

With a magnetic structure providing a closed magnetic path of this kind, an appreciable flux leakage occurs only with a relatively high energization of the magnetizing winding. Consequently the transformer action for heating the thermal responsive element is produced at a high efficiency in the

neighborhood of the normal current values and the saturation limit is reached with a much lower value of energizing current than where the magnetic structure is provided with an air gap for producing operation of the movable magnetic member.

The thermal responsive element that is arranged to be inductively heated by the current in the transformer secondary circuit may be of any customary form, such, for example, as a heating wire, a container with vaporizing liquids or expanding gases, solder, temperature sensitive magnetic alloys or resistances, or the usual bi-metallic movable thermal responsive element or the like. Where the thermal responsive element itself is of conducting material it preferably is arranged directly to form the transformer secondary winding. The magnetic structure with which the secondary heating circuit is inductively interlinked with the primary energizing winding may consist of a laminated core with the laminations interleaved or butt jointed in order to concentrate the stray magnetic flux produced upon the saturation of the laminated iron core for operating the movable magnetic member. The core preferably is provided with polar extensions located on either side of the transformer primary winding and the magnetic movable member is so mounted that with the stray flux of sufficient value it is attracted to these polar extensions.

The accompanying drawings illustrate diagrammatically two forms of combined thermally and electromagnetically operated electroresponsive devices embodying the invention.

Fig. 1 is a perspective view showing the general structural arrangement of one form of the combined thermal and electroresponsive device for alternating current circuits, and Fig. 2 is a view showing a modified structural arrangement.

In Fig. 1 the magnetic structure is composed of the upper U-shaped laminated iron part 10, and the yoke 11 preferably of larger section than 10 is butt-jointed to it from below. Upon the yoke 11 is mounted the primary or energizing winding 12 which is energized in accordance with the controlled current when the device is to function as an overload relay. The heating member consists of an annular bi-metallic thermal responsive strip 13 which is short-circuited upon itself by the flexible connection 14 and is fixed to the iron core by the angle piece 15. Its free end 16 carries a pin 17 which on the heating of the bi-metallic ring moves in the direction of the arrow and moves the contact 18 towards the cooperating contact 19—which is fixed upon and insulated from the iron core 10—and so closes the circuit of the releasing coil of a switch (not shown) located in the controlled circuit. An iron armature 20 is rotatably mounted in the bearing 21 fixed to the core 10 so as to move in a plane at right angles to the plane of core 10; on its upper end it carries the contact 18 and closes the circuit controlled thereby, even without heating of the bi-metallic ring 13 by moving in the direction of the arrow when, on the occurrence of considerable excess currents, the part 10 of the magnetic structure becomes substantially saturated and armature 20 is attracted to the core by the stray field set up adjacent part 10 of the magnetic structure by the winding 12 against the force of the spring 22. In order to adjust the value of current required to effect operation of the armature 20, the adjustable stop 23 is provided for moving the armature 20 into and out of the stray flux field of the energizing winding 12. By adjusting the stop 23 the value of current in the energizing winding 12 required to operate the armature may be either increased or decreased, while at the same time the energizing current required to effect operation of the thermal responsive element 13 is varied inversely.

Fig. 2 shows a modified constructional example of the device in which the magnetic structure 10′ is provided with poles extending beyond that part of the iron core which carries the primary coil and forms the stray flux poles 25 and 26. To the pole 25 is pivoted the armature 27 which, when attracted to the pole 26, closes the pair of contacts 28 against the pull of the spring 29. The circuit controlling parts 29 belonging to the bi-metallic ring may be similar to those shown in Fig. 1 and may be connected in parallel with the contacts 28 to control the same circuit as controlled by the contacts 28, if desired. In this case the adjustable stop 23′ is provided for varying the air gap between the armature 27 and the stray flux pole 26. When the air gap is decreased, a lower value of energizing current in the energizing winding 12′ is required to attract the armature 27. At the same time the value of current in the energizing winding 12′ required to effect response of the inductively heated thermal responsive element 13′ is increased. Adjustment of the stop 29 to increase the air gap has just the opposite effect.

Instead of the thermal responsive element being formed of a single bi-metallic strip, it is also possible to place several bi-metallic strips, one within the other, in order, for example, to increase the time-constant of the thermal responsive element or its resistance to bending.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An electroresponsive device for alternating currents comprising a transformer having a closed magnetic structure provided with polar extensions for the stray flux set up

upon excessive energization of the primary circuit of the transformer, a thermal responsive element arranged to be heated by the current in the secondary circuit of the transformer to effect operation thereof, and a movable magnetic member mounted to be operated by the stray flux through said polar extensions.

2. An alternating current electroresponsive device comprising a transformer having a magnetic structure provided with a restricted portion which becomes saturated upon excessive energization of the transformer, a movable thermal responsive element arranged to be heated by the secondary current of the transformer to effect operation of the thermal element, a movable magnetic member mounted adjacent said restricted portion to be operated by the stray flux set up adjacent thereto upon excessive energization of the primary circuit of the transformer, and means jointly responsive to operation of the thermal element and the magnetic member.

3. A combined thermally and electromagnetically operated protective device comprising an energizing winding and a magnetic structure therefor providing a pair of flux paths in parallel relation, a thermal responsive element arranged to be heated in accordance with the value of the flux in one of said paths and a movable armature arranged to be operated in accordance with the value of the flux in another of said paths.

4. A combined thermally and electromagnetically operated device comprising a thermal-responsive actuating element, an electromagnetically operated actuating element, a common energizing winding for producing a heating effect in the thermal element and a magnetic attractive effect upon the armature, and means for inversely varying said effects.

5. A combined thermal and electromagnetic device comprising an energizing winding and a magnetic structure therefor providing a substantially closed magnetic flux path and a stray flux path having an air gap therein, a thermal responsive element arranged to be heated in accordance with the value of the flux in the closed magnetic path, and a movable armature mounted to be operated in accordance with the value of the flux in the air gap of the stray flux path.

6. A combined thermal and electromagnetic device comprising an energizing winding and a magnetic structure therefor providing a substantially closed magnetic flux path and a stray flux path having an air gap therein, a thermal responsive element arranged to be heated in accordance with the value of the flux in the closed magnetic path, and a movable armature mounted to be operated in accordance with the value of the flux in the air gap of the stray flux path, and means for varying the position of the armature in said stray field flux path to inversely vary the attractive effect upon the armature and the heating effect upon the thermal element.

7. An electrically-actuated, thermo-responsive device including a transformer having a primary winding adapted to be energized by the circuit current, a secondary winding comprising an expansible thermo-responsive member having a fixed end and a free end arranged for movement in response to expansion and contraction of said thermo-responsive secondary winding, and a flexible conductor connecting said ends electrically.

8. An electrically-actuated, thermo-responsive device including a transformer having a primary winding adapted to be energized by the circuit current, a secondary winding comprising an expansible thermo-responsive member having a fixed end and a free end arranged for movement in response to expansion and contraction of said thermo-responsive secondary winding, a flexible conductor connecting said ends electrically, and means controlled by said free end.

9. An electrically-actuated, thermo-responsive device including a transformer having a magnetic core, a primary winding adapted to be energized by the circuit current, a secondary winding comprising a thermo-responsive member wound about said core and having a fixed end and a free end, and a flexible conductor electrically connecting said fixed and free ends.

In witness whereof, I have hereunto set my hand this 9th day of April, 1927.

ALFRED COHN.