March 14, 1933. W. M. ELLINGSON 1,901,708

INVAR RELAY

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Fig. 1.

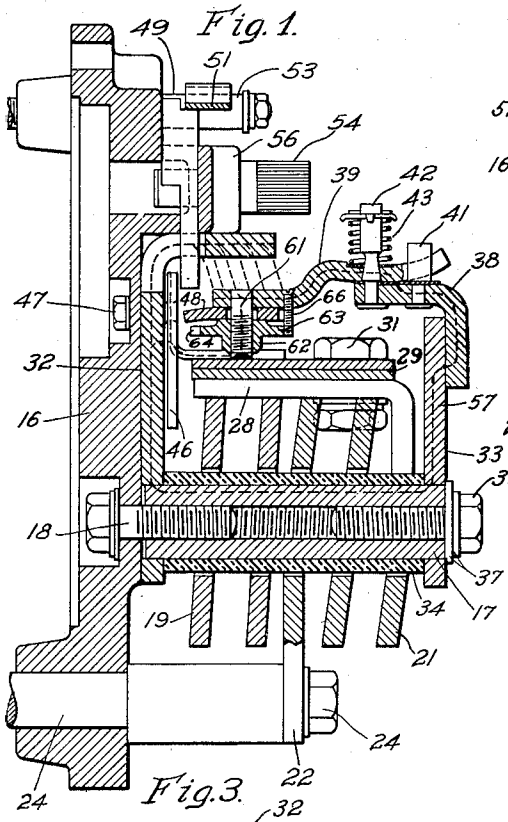


Fig. 2.

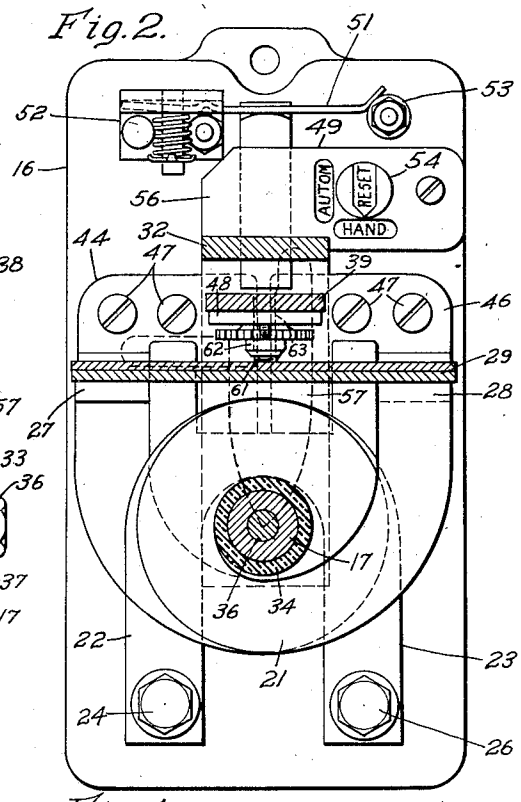


Fig. 3.

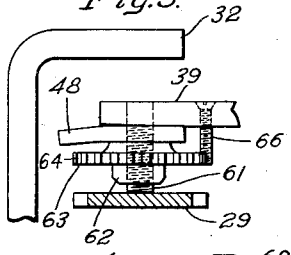


Fig. 4.

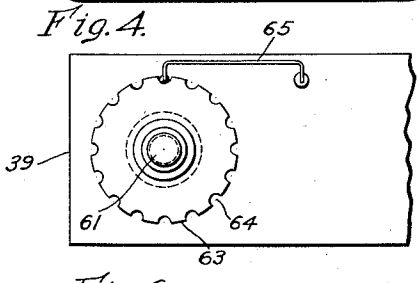


Fig. 5.

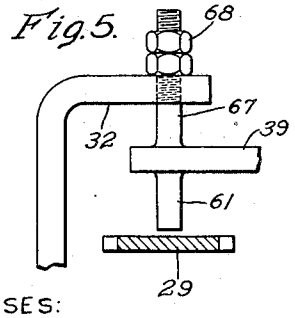
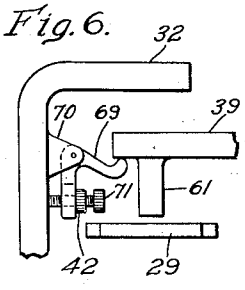


Fig. 6.



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INVAR RELAY

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Fig. 7.

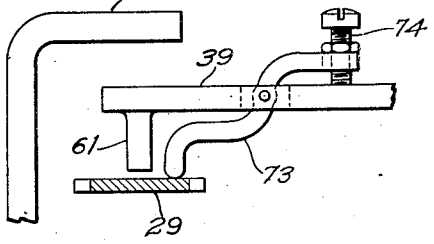


Fig. 8.

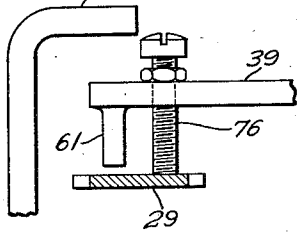


Fig. 9.

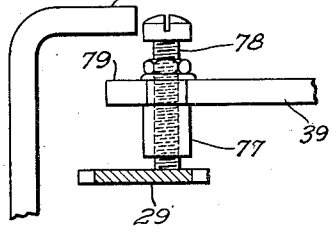


Fig. 10.

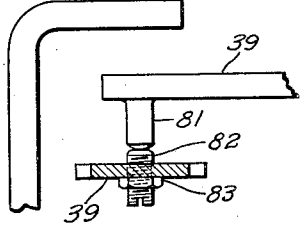
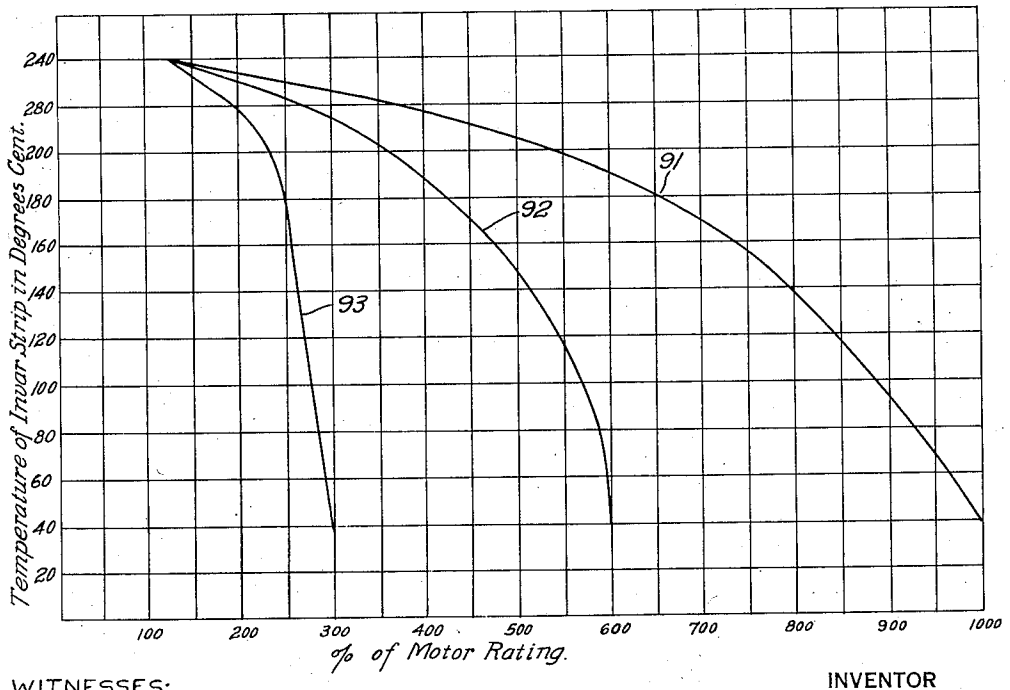


Fig. 11.



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Patented Mar. 14, 1933 1,901,708

UNITED STATES PATENT OFFICE

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INVAR RELAY

Application filed November 11, 1931. Serial No. 574,317.

My invention relates to relays and particularly to thermal relays.

An object of my invention is to provide means in a thermal relay to vary the value of the current at which the relay will operate.

My invention is particularly applicable to a thermal relay of the type utilizing a member having a thermally-variable magnetic reluctance heated in accordance with the relay current and embodying also an energizing coil and a flux-carrying structure including fixed and movable elements. The fixed element includes two spaced portions, the movable element extending therebetween, whereby two parallel-related flux paths are provided in a certain part of the total magnetic circuit. My invention provides a magnetic member of relatively small area of cross-section extending from the movable member towards one of the spaced elements, and an adjusting means associated therewith.

While I have illustrated and will describe my invention as associated with and applied to a specific form of thermal relay, I desire it to be understood that all of those details not specifically claimed herein are shown and described in a copending application, Serial No. 593,994, filed February 19, 1932, by W. J. Hudson and assigned to the Westinghouse Electric & Manufacturing Company. As already stated, my invention relates more particularly to adjusting means for a relay of the kind disclosed and claimed in the other application.

In the drawings,

Figure 1 is a view in vertical lateral section through a device with which the elements particularly embodying my invention are associated,

Fig. 2 is a view mainly in front elevation thereof,

Fig. 3 is a view mainly in side elevation of the elements most particularly characteristic of my invention,

Figs. 4 to 10, inclusive, are views either in bottom plan or in side elevation, of modified forms of devices embodying my invention, and

Fig. 11 is a set of curves illustrating the results obtained by the use of my invention.

Referring to Figs. 1 and 2, I have there illustrated a base plate 16 which is preferably made of electric-insulating material and on which there is supported a tubular magnetic core 17 as by a machine bolt 18 extending into it and through the base 16.

An energizing coil may consist of two series-connected portions 19 and 21, each including a plurality of turns made up of a copper strip or strap bent on edge in such manner as to include downwardly depending end portions 22 and 23 whose outer ends are connected to and supported by terminal studs 24 and 26 in a manner well known in the art. The other end portions of the energizing coil sections are located above the coil, one end portion 27 extending horizontally forwardly of or from the base 16, while the other end portion 28 extends toward the front of the base, the upper surfaces of the end portions 27 and 28 being located in the same horizontal plane and spaced apart in order to receive and support a connecting strip 29 of a metal or alloy which has a thermally variable magnetic reluctance. Such a material may be constituted by a nickel steel having approximately 36% of nickel, usually called Invar which material is normally magnetic but loses its magnetic characteristic at a temperature of about 240° C. The strip 29 may be secured to the ends of the coil sections by any suitable means, such as bolts 31, which are not shown in Fig. 2 of the drawings for the sake of simplicity.

A rear frame 32 of magnetic material and of substantially L-shape may be provided, as well as a front frame 33 also of magnetic material, both the rear and front frames being held in proper operative positions relatively to the core 17 by the inclusion of a tubular spacer 34 of electric-insulating material and by the use of a clamping bolt 36 at the front end of the core 17, together with suitable washers 37.

A sliding bracket 38 is adjustably secured to the upper end of the front frame 33 as is set forth in the copending application here-

inbefore referred to and supports a movable element or armature 39 at one end thereof. A locating pin 41 is fixed in the sliding bracket 38 and extends into a recess in the forward end of armature 39, a second fixed pin 42 being fitted into the sliding bracket 38 and surrounded by a biasing spring 43 to bias the armature 39 downwardly toward the strip or bar 29.

Two aprons 44 and 46 are provided and are secured against the front surface of base 16 by short machine bolts 47, the apron 44 being of magnetic material, while apron 46 is of non-magnetic material. Each of these aprons has a forwardly extending portion, as shown particularly in Fig. 1 of the drawings, which assists the end portions 27 and 28 of the coil sections to support the strip 29 and, in general, to provide a more rigid assembly of all of the elements of the structure.

The inner end of armature 39 is provided with a striker plate 48 which may be secured thereto in any desired manner and which engages a vertically extending push rod 49, the upper end of which is adapted to engage a biased switch bar 51 which is resiliently supported at one end thereof on a contact block 52, the movable end normally engaging a second contact block or terminal 53, the movement of switch arm 51 controlling a circuit in a manner well known in the art.

A reset push button 54 is provided and is located in a cover plate 56 so that, by turning the same, the push rod may either be permitted to move upwardly and downwardly or its downward movement may be arrested after an upward movement.

It will be noted that the structure hereinbefore described provides a flux carrying path which may be said to start at the core member 17, extend through the front frame 33, the bracket 38 and the armature 39 in a single path, carrying substantially all of the flux but providing two parallel-related flux paths from the inner end of the armature to the other portion or part of the frame structure and more particularly the rear frame 16 and the apron 44. As shown more particularly in Fig. 1 of the drawings, by the heavy broken line 57 a certain part of the flux will traverse the air gap between the upper surface of the armature 39 and the forwardly extending part of rear frame 32, while the rest of the flux will normally traverse a downwardly extending lockout pin 61 of magnetic material, one end of which may be secured in the armature 39, while the other end extends toward the apron 44 and more particularly toward the mid portion of strip 29. The flux traversing the member or lockout pin 61 will flow in part through the normally magnetic strip 29 as long as it is magnetic, as well as through the forwardly extending portion of apron 44 and from there into the vertical part of rear frame 32 through which it then may flow to the core member 17. It is, of course, obvious that, under all conditions of operation, the ampere turns for the two parallel related flux paths will be the same, but there will be a difference in the amount of flux lines traversing the respective parallel related paths under different current conditions of the relay itself.

In order to provide adjusting means by which the distance between the lock-out pin 61 and invar strip 29 may be varied, I provide an adjusting nut 62 on pin 61 which has a relatively large annular flange 63 having a plurality of recesses 64 therein engageable by a machine screw 66 which may extend through armature 39 in the manner shown particularly in Figs. 1 and 3 of the drawings. Fig. 3 illustrates a position of adjusting nut 62 in which the lower end of lock-out pin 61 is in direct engagement with strip 29 so that the magnetic reluctance between the lock-out pin and strip 29 is a minimum.

Referring to Fig. 4 of the drawings, I have there shown the use of a resilient spring latch 65, one end of which is mounted on armature 39 and the other end of which engages a selected recess 64.

Referring to Fig. 5 of the drawings, I have there illustrated a modified form of adjusting means including, more particularly, a non-magnetic stud 67 extending upwardly from armature 39 through the forwardly extending portion of rear frame 32 and held in an adjusted position by a plurality of nuts 68 which are preferably made of non-magnetic material.

Referring to Fig. 6 of the drawings, I have there illustrated another modification of an adjusting means including a bell crank lever 69 of non-magnetic material pivotally mounted in a lug 70 secured to rear frame 32. One end of lever 69 engages the lower face of armature 39, while the other end thereof is provided with a suitable adjusting screw 71 and a lock nut 72, all made of nonmagnetic material.

Referring to Fig. 7 of the drawings, I have there shown another modification of an adjusting device including a lever 73 of substantially S-shape whose mid point may be pivotally mounted in the armature 39, the lower end portion extending below the armature and engaging the strip 29, while the other end portion is located above the armature 39 and is provided with an adjusting screw 74, members 73 and 74 both being preferably made of non-magnetic material.

Referring to Fig. 8, I have there illustrated another modification in which an adjusting screw 76 of non-magnetic mate-

rial is directly and adjustably mounted in armature 39.

Fig. 9 illustrates another modification in which the lock-out pin takes the form of a tubular member 77 of magnetic material, and a non-magnetic adjusting bolt 78 extends therethrough and is locked in any position by a lock nut 79.

Referring to Fig. 10, a lock-out pin 81 of magnetic material may be welded or otherwise secured to the armature 39 and engage an adjustable stud 82 of non-magnetic material, whose position in the strip 29 is held by a lock nut 83. While I have illustrated a number of modifications disclosing means for adjusting the position of the lock-out pin relatively to the strip of material having a thermally variable magnetic reluctance, it is obvious that other modifications of these various structures may be employed so long as they make it possible to adjust the position of the lock-out pin easily and quickly.

Let it be assumed that the energy translating device, such as an electric motor, is traversed by a current corresponding to the normal load which may be considered as being 100%. It is, of course, desirable that the thermal relay operatively associated with the motor shall not operate to deenergize the motor by suitable means well known in the art so long as the motor is not overloaded. The use of a bar or strip 29 which is heated in accordance with the current traversing the relay and also traversing the motor ensures that the relay will operate after the relay and the motor have been traversed by an over-load current of a predetermined value for a predetermined length of time, which length of time is necessary to effect heating of the strip 29 to a temperature which will cause it to lose its magnetic characteristic. When this condition occurs, in a relay of the types shown in the drawings, it is obvious, of course, that the reluctance of one of the parallel-related paths will have been changed, that is, increased by reason of the change of the magnetic condition of the strip 29 to a non-magnetic condition. It is further obvious that the pull-in torque attendant upon the flux flowing from the armature 39 to the forwardly extending end portion of frame 32 will be increased and the resultant upward pull will be sufficient to effect movement of armature 39, which movement may be utilized to control the circuit of an actuating coil of a suitable contactor or circuit breaker controlling the motor circuit.

It may also be noted that an excessive overload current traversing the relay and the armature will result in increasing the flux density in the magnetic circuit and particularly in the area of the lock-out pin 61. It is, further, obvious that a value of motor current will soon be reached at which the reluctance of one of the parallel related flux paths, namely, that including the lock-out pin 61, will increase to such an extent as to cause most of the flux to traverse the other parallel-related path which includes, more particularly, an air gap whose area is relatively large and whose length is relatively small, so that again movement of the armature 39 will be effected, this movement being independent of any variation in the magnetic reluctance of the strip 29. We thus obtain operation of the relay with a time delay in the case of moderate overloads and instantaneously in the case of excessive overloads.

The device more particularly embodying my invention is incorporated in a thermal relay of this type to permit of varying the current value at which operation of the relay will be effected. Reference to Fig. 11 of the drawings will show three curves 91, 92 and 93 illustrating the operation of a relay with different settings of the lock-out pin relatively to the magnetically reversible strip 29. Curve 91 illustrates the operation of a relay embodying my invention when the outer end of the lock-out pin normally actually engages the strip 29. Curve 92 illustrates the action of the relay with a small air gap and curve 93 illustrates the action with a somewhat larger air gap.

Referring first to curve 91, it is to be noted that it will require a motor current corresponding to about 10 times normal current to effect instantaneous operation of the relay to open the circuit to protect the motor against such excessive current. The temperature of the magnetically reversible strip 29 will remain substantially at room temperature which, in the case of the particular set of tests illustrated in Fig. 11, is 40° C. If a current be caused to traverse the motor corresponding to 5 times normal current, the relay will operate with a time delay which will permit the armature of the magnetically reversible strip 29 to reach a little over 200° C, so that it will still be magnetic but not to as great a degree as if its temperature were much lower. For the same curve 91, a motor load of 125% would cause heating of the strip to substantially 240° C. whereby it would become non-magnetic and cause operation of the relay with an appreciable time delay, and it is to be understood that this time delay will be such as the motor itself can withstand, that is, for such a length of time as the motor can carry 125% of normal load without dangerous overheating.

Referring now to curve 92, it will be noted that instantaneous actuation of the relay will be effected with 600% of normal load and that it will require a much longer time for actuation of the relay with a 300%

load, which load will heat the strip 29 to a temperature of about 215°. When a large air gap is used between the lock-out pin and the magnetically reversible strip, instantaneous operation of the relay will be effected at 300% of normal full load. The use of the device more particularly embodying my invention as applied to a relay of this general kind makes it possible to fully protect a motor against overload currents and the range of operation of such a relay is, as will be noted from the curves of Fig. 11, relatively wide and as there shown, from 300% to 1000% of normal load current value. It is, therefore, possible to meet any ordinary and probably also extraordinary operating conditions by the use of a relay of this kind equipped with a device particularly embodying my invention.

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 or are set forth in the appended claims.

I claim as my invention:

1. A thermal relay including a source of magneto-motive force, a flux-carrying structure therefor including a movable armature, said structure providing two parallel related flux paths and means for manually varying the reluctance of one of said parallel related flux paths.

2. A thermal relay including a source of magneto-motive force, a flux-carrying structure comprising fixed and relatively movable parts, said structure providing two parallel related flux paths between a movable and a fixed part, and manual means for varying the reluctance of one of said parallel related flux paths.

3. A thermal relay including an energizing coil, a fixed magnetizable frame structure embodying two spaced portions, a movable magnetizable member extending between said spaced portions, a magnetic element, of relatively small area of cross section extending from the movable magnetizable member toward one of said spaced portions to provide a flux path therebetween, said spaced portion embodying a magnetically reversible element heated in accordance with the relay current to vary the magnetic reluctance and effect movement of the movable member.

4. A device as set forth in claim 3 in which the magnetic element of relatively small area of cross section is supported by and movable with the movable magnetizable member.

5. A device as set forth in claim 3 in which the magnetic element of relatively small area of cross section has means associated therewith to adjust the distance between it and the magnetically reversible element.

6. A thermal relay comprising a current-traversed energizing coil, a flux-carrying structure associated with the coil and including a fixed portion embodying two spaced elements and a portion extending therebetween and movable relatively thereto, and means extending from the movable portion toward one of the spaced elements causing movement of the movable portion at a predetermined value of overload current.

7. A device as set forth in claim 6 in which the movement effecting means is constituted by a magnetic member of relatively small area traversed by the flux.

8. A device as set forth in claim 6 in which the movement effecting means has operatively associated therewith a means for varying the value of current at which movement occurs.

In testimony whereof, I have hereunto subscribed my name this 28th day of October, 1931.

WILLIAM M. ELLINGSON.