June 28, 1955 C. F. E. MAUPAS 2,712,043

INSTANTANEOUS-ACTING RELAY FOR CONTROLLING THE STRENGTH OF A CURRENT

Filed March 17, 1952 2 Sheets-Sheet 1

Fig. 1

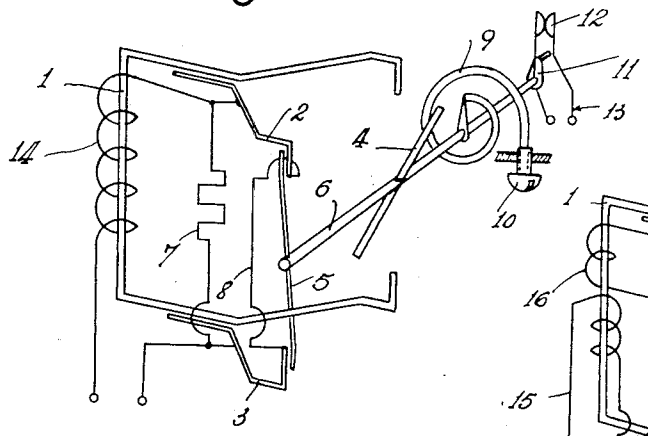


Fig. 2

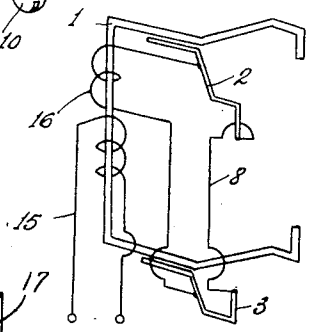
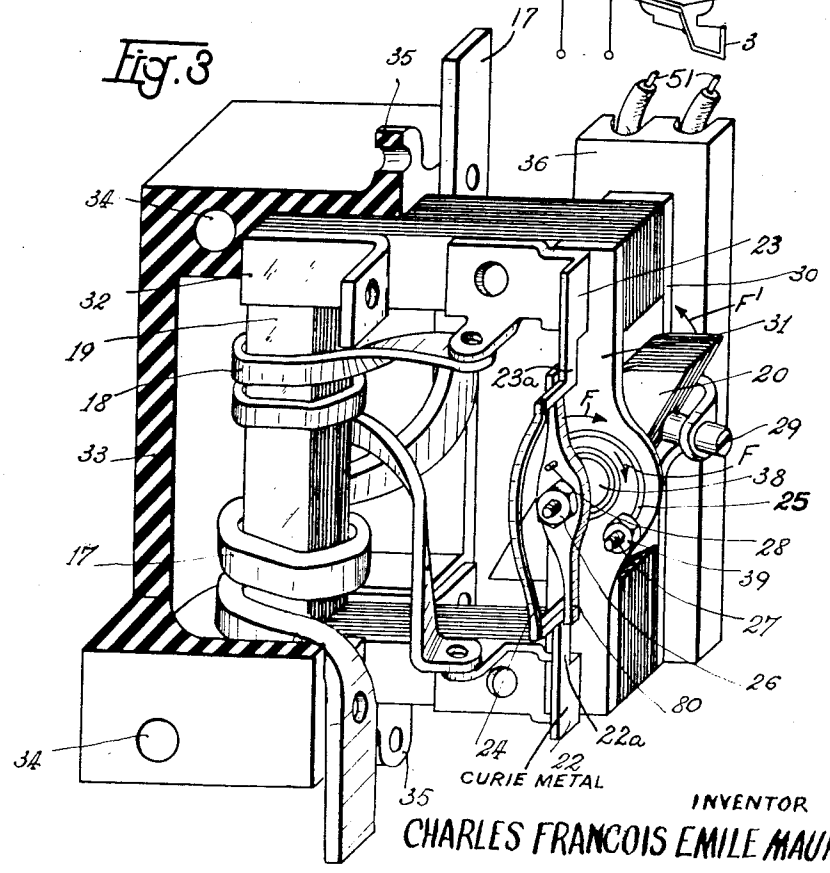


Fig. 3



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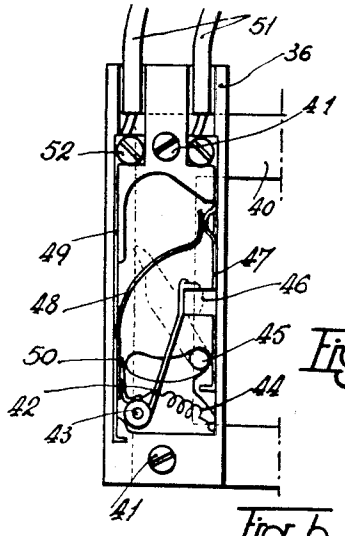


Fig. 4

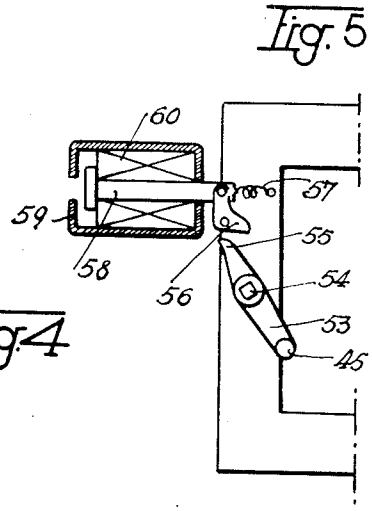


Fig. 5

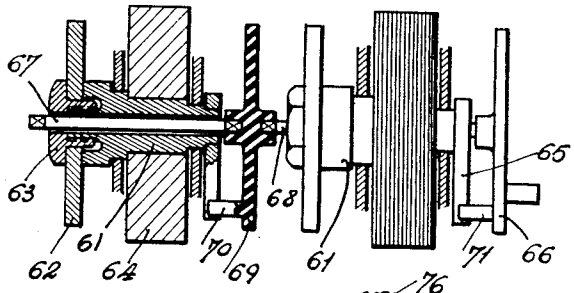


Fig. 6

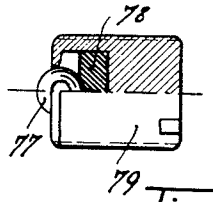


Fig. 8

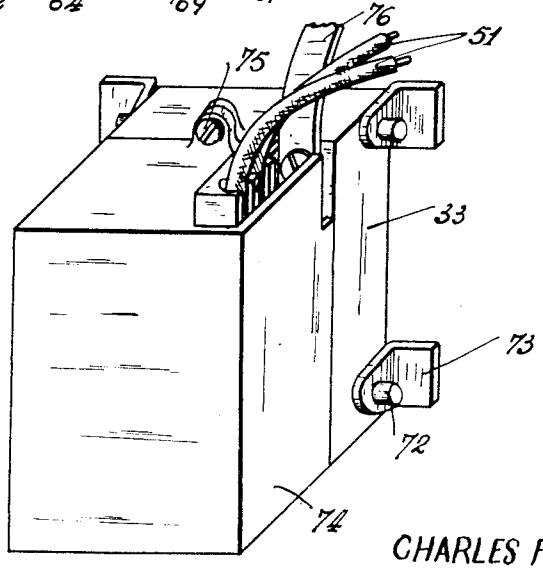


Fig. 7

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INSTANTANEOUS-ACTING RELAY FOR CONTROLLING THE STRENGTH OF A CURRENT

Charles François Emile Maupas, Paris, France

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Claims priority, application France March 22, 1951

16 Claims. (Cl. 200—88)

It is already known to use the property of certain magnetic alloys of losing their ferromagnetism at not too high a temperature to realize delayed-action relays for controlling the strength of a current.

An instantaneous-action overload relay for breaking or controlling the strength of a current according to the present invention is an improved relay of a new type characterised by the provision of two magnetic circuits excited by the same one coil traversed by the current to be controlled, these circuits being respectively called the "principal" magnetic circuit and the "auxiliary" magnetic circuit, which act upon two movable armatures, respectively, a "principal" armature and an "auxiliary" armature, which armatures are integral with each other and form a movable assembly rotatable on the same shaft and adapted to operate an electric switch contact or a mechanical release. In its normal position, particularly when the coil is not energised, this movable assembly is brought back to initial rest position when the coil is not energised, by means of a return spring into a position such that the auxiliary armature is then spaced from the auxiliary magnetic circuit by a very small air gap, while the principal armature then forms with the principal magnetic circuit a wide air gap arrangement. The auxiliary magnetic circuit is made in one or more parts, for instance in the parts that are closest to the auxiliary armature, of a magnetic alloy which has the property of losing its ferromagnetism at a temperature which is not very high, such as a nickel and iron alloy containing 32% of nickel which loses its ferromagnetism at about 170° C., this alloy being heated either directly by the passage therethrough of a current equal in strength to the current to be controlled, or a function thereof, or heated indirectly by a separate heater unit traversed by a current equal in strength to the current to be controlled, or a function thereof. The auxiliary magnetic circuit is of relatively small cross-section. The principal magnetic circuit is made of ordinary ferromagnetic material, which does not have the temperature characteristic mentioned. When the current supplied exceeds a determined value, the current passing through the auxiliary magnetic circuit heats it above the temperature at which loses its ferromagnetism, which causes the switch to operate.

This relay operates as follows. The torque due to the attracting force acting on the auxiliary armature and the force of the return spring act in the same direction which is opposite to that of the torque due to the attracting force acting on the principal armature of the movable assembly. The strength of the current at which the relay instantaneously operates is the current strength at which the torque due to the attracting force acting on the principal

armature of the movable assembly exceeds the sum of the torque due to the force exerted by the spring and the return torque attracting force exerted on the auxiliary armature. This action is aided by the saturation of the auxiliary magnetic circuit. The torque due to the attracting force acting on the auxiliary armature becomes practically zero when the reluctance of the auxiliary magnetic circuit abruptly markedly increases on the disappearance of the ferromagnetism of at least one of its parts which is made of an alloy of special characteristics, which is heated, as previously explained, by a current equal to or a function of the current flowing in the relay coil. If the current strength is the minimum which will cause the disappearance of the attracting force acting on the auxiliary armature, and for this minimum value, the torque causing the return of the return spring is lower than the torque to the attracting force acting on the principal armature, the movable assembly will start moving and the relay will then operate like an ordinary temperature responsive relay, the minimum current strength involved being the minimum strength causing thermal release. If for the minimum current strength causing the disappearance of the torque due to the attracting force acting on the auxiliary armature, the torque due to the force of the return spring is still greater than the torque due to the attracting force acting on the principal armature, then the relay will be heat blocking and instantaneously operate at two different current strengths according to the heat conditions.

The response characteristics of the relay can be adjusted in either of the following ways:

By modifying the heat characteristics of the auxiliary magnetic circuit to cause the strength of the current corresponding to the abrupt reluctance increase of the auxiliary magnetic circuit to vary, and consequently the abrupt reduction or practically the disappearance, of the attracting force acting on the auxiliary armature, to vary;

By modifying the magnitude of the air gap between the auxiliary magnetic circuit and the auxiliary armature when the movable assembly is in its idle position on a stop, therefore by modifying the value of the attracting force acting on the auxiliary armature;

By modifying the magnitude of the air gap between the priacipal magnetic circuit and the principal armature when the movable assembly is in its idle position on a stop;

By modifying the tension of the return spring.

Figs. 1 and 2 show diagrammatically two embodiments of the principle of a relay according to the present invention.

Fig. 1 shows an embodiment of the principle of the relay of the present invention, particularly adapted to the control of a direct current.

Fig. 2 shows another embodiment of the principle of the relay of the present invention, particularly adapted to the control of an alternating current.

Figs. 3, 4, 5, 6, 7 and 8 are illustrations of a particular embodiment of the present invention, according to the arrangement of Fig. 2.

Fig. 3 is an isometric projection of the relay showing particularly the arrangement of the movable assembly, that of the coils and that of the insulating base of the relay.

Fig. 4 is a partial view of the relay showing an embodiment of an electric contact controlled by the relay.

Fig. 5 is a partial view of a relay showing the release arm arranged on the extremity of the shaft of the movable assembly, the parts forming the electric contact being supposed to have been removed; and this figure showing in principle the arrangement of a mechanism for connecting the relay with an electro-magnet for restarting the operation.

Fig. 6 shows the arrangement of the movable assemblies of two juxtaposed relays for controlling a single electrical contact or a single mechanical release.

Fig. 7 is an isometric projection of a relay with its insulating casing, showing the arrangement of the electric connections and the assembling of the insulating base.

Fig. 8 shows by way of example a particular arrangement of the screw serving as a stop for the movable assembly.

Fig. 1 shows the principal magnetic circuit **1** formed of ordinary magnetic material, and the auxiliary magnetic circuit formed by the parts **2** and **3** made of a magnetic alloy having the property of losing its ferromagnetism at a temperature which is not very high. The auxiliary magnetic circuit is closed by using a part of the principal magnetic circuit **1**. At least one of the auxiliary parts **2** and **3** of the auxiliary magnetic circuit is electrically insulated from the principal magnetic circuit **1**. The movable assembly comprises the shaft **6**, the principal armature **4** carried by shaft **6**, the auxiliary armature **5**, the fastening rod of the return spring **9** whose tension can be adjusted by means of the screw **10**, and the release rod **11** acting during the movement of the movable assembly on the flexible part **12** to open the electrical contacts between the parts **12** and **13**.

The current to be controlled flows in the energising coil **14** and in the parts **2**, **8** and **3**. The part **8** is a conductive strip which may be of silver, brazed on the parts **2** and **3**. The shunt **7** permits the adjustment of the strength of the current flowing in the parts **2** and **3** of the auxiliary magnetic circuit for a given value of the current flowing in the coil **14**. The conducting cross-section area of the parts **2** and **3** in the proximity of the auxiliary armature **5** through which the current flows, is so adjusted as to obtain the temperature at which their ferromagnetism disappears, for the desired strength of the current flowing therethrough.

Fig. 2 shows another arrangement of the electric circuit of the relay adapted for alternating current. The magnetic circuits arranged as shown in Fig. 1 are excited by the coil **15** which is traversed by the current to be controlled. The circuit formed by coil **16**, and the auxiliary pieces **2**, **8** and **3**, form the secondary winding of a transformer of which the coil **15** forms the primary winding. The parts **2** and **3** of the auxiliary magnetic circuit are therefore heated by the passage of a current whose strength is a function of the current to be controlled.

Fig. 3 is an isometric projection of an embodiment of the present invention according to an arrangement similar to the one shown in Fig. 2 for alternating current. Fig. 3 shows the principal magnetic circuit **19**, and the auxiliary magnetic circuit formed by the parts **22** and **23** made of a magnetic alloy having the property of losing its ferromagnetism at not too high a temperature. The auxiliary part **23** is electrically insulated from the principal magnetic circuit **19**. The circuit which heats the auxiliary parts **22** and **23** is formed by the secondary coil **18**, and the parts **22**, **24**, and shunt **23**. The shunt **24** is brazed on the piece **22** and the piece **23**. Primary coil **17** is traversed by the current to be controlled and is attached at both ends to the insulating base **33**. The principal magnetic circuit **19** is fixed on the insulating base **33** by means of two angle irons **32**. The movable assembly shown comprises the shaft **38** rotatable in two bearings provided for this purpose in the plates **30** and **31** of a non-magnetic material.

The movable assembly of Fig. 3 also comprises the

auxiliary armature **80** fixed on the shaft **38** by means of the screw **26**, and further comprises the principal armature **20** fixed on the shaft **38** by means of a square fitting and bearing against the adjustable stop screw **29**. The movable assembly of Fig. 3 also comprises the end of return spring **25**.

The return spring **25** is fixed at one end to the movable assembly by the bent end of this spring, which is engaged in a hole provided for this purpose in the auxiliary armature **20**, and on the other hand, on the plate **30** by means of the piece **27** in which it is held by the screw **39** making it possible to adjust the tension of the spring. The movable assembly of Fig. 3 also comprises the release arm carried on the shaft and corresponding to **11** of Fig. 1 and **53** of Fig. 5.

The insulating piece **36** shown, carries in the arrangement illustrated, an electric contact which is shown in Fig. 4, controlled by the release arm of the movable assembly, which contact is not shown in Fig. 3. The cylindrical holes **34** of the insulating base **33** as shown, serve for fastening the insulating base. The wings **35** of the insulating base **33** as shown, serve for fastening on the base the insulating frame which is not shown in the drawing.

Fig. 4 shows the electric contact carried by the insulating piece **36** of Fig. 3. This insulating piece **36** is affixed on the principal magnetic circuit **40** of the relay by means of two screws **41**. In the arrangement shown in Fig. 4, there are two separate electric contact switch arrangements. A first electric contact is made between the piece **42** which is rotatable about pivot **43** and is urged into the position shown in Fig. 4 by the spring **44**, and, on the other hand, the grip contact **46** electrically connected to the conducting piece **47**. A second electrical contact is made between the conductive piece **47** and the conductive piece **48** which is electrically connected to the conductive part **49** and also the piece **42** through a flexible shunt **50**.

The two current supply conductors **51** are connected to the parts **47** and **49** respectively by means of the two screws **52**, **52**. In its motion, the projecting tenon **45** of the release arm (shown at **53**, Fig. 5) of the movable assembly, as it rotates, first moves to open the contact between the pieces **42** and **46**, and then later opens the contact between the pieces **47** and **48** through the action of the piece **42**. In Fig. 4, the movable assembly consists of tenon **45** of release arm **53** (Fig. 5). In Fig. 4 this arm **53** is shown in dotted lines with its upper nose which is shown at **55** in Fig. 5.

In the arrangement of Fig. 3, the central angle of the principal armature at its normal, unenergized position is about 30° from the fully energized position. Nearly all of the periphery of the principal armature **20** is visible in Fig. 3. The principal armature **20** has substantially rectangular cross section. In Fig. 3 the lower end of principal armature **20** is seen to the left of the bottom of strap **24**.

In Fig. 3 the flat strap extending upward to the right of the ear **35** is the upper end of the primary winding **17** and this end is connected in series with the main circuit which is to be controlled and the apparatus to be protected.

The primary winding **17** can be designed for any value of current, such as between one ampere and 300 amperes. Thus, there can be obtained either actuation of the breaker at the end of a very long time (thermal) of a current equal to 110% of the rated load current, or instantaneous actuation (magnetic) for a current equal to 3 to 10 times the rated load current.

In Fig. 3 and Fig. 4, when the principal and auxiliary magnetic circuits become magnetized, the applied magnetomotive force due to the current in the primary winding **17** tends to rotate the principal armature **20** and the shaft **38** to which it is fixed, in the counter-clockwise direction.

The auxiliary armature **80** is preferably laminated soft iron. The principal armature **20** is laminated silicon

steel not permanently magnetized. The core and other portions of the principal magnetic circuit are laminated.

The auxiliary armature 80 tends to rotate clockwise when the magnetic circuit is energized. Due to the fixed orientation on the shaft 38 of the principal and auxiliary armatures (their axes forming a central angle of about 25°) and due to the fact that the ends of these two armatures are on opposite sides of their respective pole pieces (in Fig. 3 a common vertical plane), the applied magnetic field in urging parts of the system to a position of minimum magnetic reluctance, applies to the two armatures torques in opposed directions.

Thus, as appears from Figs. 1 and 3, the auxiliary armature 80 is normally in a substantially vertical position with its ends on the counter-clockwise side and only slightly spaced from pole pieces 22 and 23. The principal armature 20 is mounted fixedly on the same shaft 38 on which auxiliary armature 80 is fixedly mounted, but the axis of principal armature 20 is angularly spaced by an angle of approximately 30° clockwise from the axis of auxiliary armature 80 so that its axis is on the clockwise side of the pole pieces of the principal magnetic circuit. Hence when the magnetic field is applied to the principal and auxiliary pole pieces, the principal armature is urged in a counter-clockwise direction, and the auxiliary armature is urged in a clockwise direction.

In the normal rest position, when the applied magnetic field is of negligible value, the rotatable unit which is composed of the shaft and the two armatures, is held in a position such that the auxiliary armature is held with its extremities close to, but spaced from, the restricted neck portions 22*a* and 23*a* of Fig. 3 of the pieces 22 and 23 formed of special magnetic alloy, which neck portions are hereafter described.

Therefore, there is no physical contact between the auxiliary armature 80 and the restricted neck portions 22*a* and 23*a*, and it is also possible, if it is desired to have physical contact between the ends of the auxiliary armature and these restricted neck pieces, to provide the ends of the auxiliary armature with intervening insulating wafers of large electrical resistance, and still maintain electrical insulation between the auxiliary armature and the pieces 22*a* and 23*a*.

Thus, the auxiliary armature 80 does not touch the auxiliary pole pieces 22 and 23, although it comes close to them. The thin paper wafers may be interposed between auxiliary armature 80 and auxiliary pole pieces 27 and 28 to be sure that no metallic contact is made between them, so that no electric circuit is completed through the close approach of these pieces. At least one of the pieces 22 and 23 is electrically insulated from the principal magnetic circuit which includes the core 19.

In the normal position of the armatures and their shafts, the principal armature is separated by a wide gap from the pole pieces of the principal magnetic circuit.

The ferro-magnetic pieces 22 and 23 of the special alloy, have a restricted neck portion 22*a* and 23*a* of smaller cross section, and their cross section is designed to produce during the flow of desired current intensity, the temperature at which their magnetism disappears.

These restricted neck portions of smaller cross section 22*a* and 23*a* are interconnected electrically by a silver conducting strap 24 brazed onto the pieces 22*a* and 23*a*, and it is the faces of these restricted neck pieces which face the ends of the auxiliary armature 80.

Necks 22*a* and 23*a* are designed so that when a current greater than the intended rated load current flows through them, they will be heated above the Curie point. These values of resistance are sufficiently large to prevent the short-circuiting of secondary winding 18 and to prevent the flowing in the secondary circuit of a current of value large enough to make it impossible to attain any substantial value of magnetic flux in the magnetic circuits.

In Figs. 3 and 4, the conductors 51, 51, constitute part of the controlled circuit which is actuated upon rotation of shaft 38 and which is closed when shaft 38 rotates for the purpose of opening the circuit breaker in the main load circuit. The two conductors 51, 51, can be connected, for example, to the actuating winding of an electro-magnetic switch or to the no-voltage winding of a breaker in such a manner that the opening of the contact 36 of Fig. 3, at the time of an operation of the relay, breaks the energizing circuit of this actuating winding, which causes the opening of the switch or breaker.

In the normal or rest position, as when there is no magnetizing current flowing in primary winding 17, the armatures are in the set position of the relay. The return spring 25 urges the auxiliary armature 80 to a substantially vertical position, the magnetic circuit not being energized.

The adjustable stop 29 shown in Fig. 3 permits the precise adjustment of the space between the two end portions of the auxiliary armature and the back faces of the pole pieces 22 and 23. In this arrangement there is not a contact between the pieces 22 and 23 and the auxiliary armature 80. As a practical matter, the auxiliary armature is moved fixedly with the displacements of the principal armature 20, this principal armature being stopped by the stop 29, the auxiliary armature 80 thus becomes positioned in a position slightly spaced from the auxiliary pole pieces 22 and 23. One reason for preventing the ends of the auxiliary armature from touching pole pieces 22*a* and 23*a*, is that if they do touch, they will freeze to the pole pieces and render the device inoperative.

The principal armature 20 is held against the adjustable stop 29 by the action of the return spring 25 and by the magnetic torque applied on the auxiliary armature 80 in the same direction, which is opposite in direction to the magnetic torque applied to the principal armature 20.

The pieces 22 and 23 are brought to a temperature of 170° C. when they are traversed by a current of desired value. Dependent upon the form of the pieces 22 and 23 and the characteristics of the strap 24, the value of current necessary to bring pieces 22 and 23 to a temperature of 170° C. may be designed to be of desired value.

As shown, the two pieces made of ferro-magnetic alloy designated by 22 and 23 in Fig. 3 and by 2 and 3 in Fig. 1, comprise a wide portion which provides for their assembly with the core portion of the principal magnetic circuit. The piece 23 is separated and electrically insulated from this principal magnetic circuit and the core, by an insulating plate, for example, while the piece 22 may be in direct contact with the core of the principal magnetic circuit.

The principal armature and the auxiliary armature always move in the same direction of rotation since they are both fixedly attached to the same shaft. In Fig. 3, the arrow F indicates the clockwise direction of rotation towards which the auxiliary armature 80 is urged when the magnetic field is applied to the auxiliary magnetic circuit and this arrow F is in the same direction of rotation as the direction of rotation in which the return spring 25 urges the auxiliary armature 80.

On the contrary the arrow F' (Fig. 3) indicates the counter-clockwise direction in which the principal armature 20 is urged when a magnetic field is applied to the principal magnetic circuit, and when the torque due to the attracting force on principal armature 20 exceeds the torques due to the return spring 25 and to the magnetic attracting force acting on auxiliary armature 80.

In a typical embodiment, the resistance of the secondary circuit connected to the winding 18 is 15 milliohms, and a representative value of the secondary current in winding 18 is 30 amperes, and a representative value of the voltage at the terminals of secondary winding 18 is 0.15 volt. Representative magnitudes of the air gap between the pole pieces and the armatures in typical embodiments are, in the principal magnetic circuit, 4 to 5 millimeters, and in the auxiliary magnetic circuit 0.3 to 0.5 millimeters.

Fig. 5 shows, it being supposed that the insulating piece

36 carrying the electrical contact switch has been removed, the release arm 53 of the movable assembly with its tenon 45, and which moves with the armature. Fig. 5 also shows a possible arrangement for actuating the relay when such an arrangement is necessary, this arrangement being shown as a solenoid. The release arm 53, as shown, is fixed on the end of shaft 54 of the movable assembly and has a gripping nose 55, which, in the movement of the movable assembly moves to engage the bent lever 56 held in the position shown in Fig. 5 by the spring 57. The plunger 58 of magnetic material is also shown, which is fastened on the bent gripping lever 56. The solenoid magnetic circuit 59 as shown, can be excited by the coil 60. When this coil 60 is energized, the plunger 58 of the solenoid is attracted to the left and causes the bent lever 56 to tilt, whereby the release arm 53 is released. The shaft 54 of Fig. 5 corresponds to shaft 38 of Fig. 3 or shaft 6 of Fig. 1, and the release arm 53 of Fig. 5 corresponds to the release arm 11 of Fig. 1.

Fig. 6 is a view of two movable assemblies of two juxtaposed relays, adapted to control a single electric contact or a single mechanical release. The two movable assemblies which are identical are each formed by a separate hollow shaft 61, which carries its auxiliary armature 62 held by a screw 63 and also carries the principal armature 64 held by a square fitting, and also its driving pawl 65. The two driving pawls 65 of the two movable assemblies of the two relays, act upon a rotatable unit formed by the release arms 66 fixedly rotatable with the two colinear shafts 67 and 68, which are mechanically coupled through the medium of insulating plate 69 carrying the driving tenon 70 on which the driving pawl 65 of the left rotatable assembly acts.

Rotation of shafts 67, 68 opens and closes the switch contacts by the release arm. The right movable assembly acts, through its driving pawl 65, on the tenon 71 of the release arm 66. Thus, movement of the armature of either of the two relays will cause rotation of shafts 67, 68, and such an arrangement makes it possible to assemble together more than two relays for controlling a single electric contact or a single mechanical release.

Fig. 7 is an isometric projection of a relay housed in its insulating casing. Fig. 7 shows the insulating base 33 of the relay fixed by means of cylindrical rods 72 which extend through the insulating base and by means of the angle iron 73. Fig. 7 also shows the insulating casing 74, fixed on the insulating base 33 by means of the screws 75.

Fig. 7 also shows a connection 76 through which is supplied the current to be controlled; this connection engages the relay through an aperture therefor provided in the insulating casing. The part of the insulating piece 36, external to the insulating casing 74, is also shown in Fig. 7, and is more clearly illustrated in Fig. 4. Fig. 7 also shows the two conductors 51, 51, which supply the contact switch with current.

Fig. 8 shows a particular arrangement of the screw which serves as a stop for the movable assembly of the relay. The movable assembly bears on the ball 77 which lies on the damping packing 78 which may be made of a rubber of a suitable hardness. The ball 77 and the packing 78 are housed in a recess made in the body of the screw 79 wherein the ball is held by means of a setting.

The general arrangement and the particular embodiments which have been described and illustrated and their details, and the materials used for their construction, may be modified without departing from the spirit of the present invention.

What I claim is:

1. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, at least one part of said auxiliary magnetic circuit made of a magnetic alloy losing its ferromagnetism at a critical temperature of substantially 170° C., an electric circuit for heating said part with a current which is a function of the current to be controlled, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a shaft for supporting said principal and auxiliary armatures forming a single movable assembly, a spring rotatably urging said shaft, a release arm integral with said movable assembly and operating on the strength of the current to be controlled reaching a given value and the torque acting on the principal armature exceeding the total value of the torque acting on the auxiliary armature and the torque pulling on the spring owing to the quicker comparative increase of said first torque or the abrupt dropping of the torque acting on the auxiliary armature due to heat causing the disappearance of the ferromagnetism of at least one part of the auxiliary magnetic circuit when the temperature of said part made of said alloy increases above said critical temperature.

2. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, at least one part of said auxiliary magnetic circuit made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., and an electric circuit for heating said part with a current which is a function of the current to be controlled, in said principal and auxiliary magnetic circuits and also in said principal and auxiliary armatures, common portions, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a shaft supporting said principal and auxiliary armatures and forming a single movable assembly, a return spring on a stop for said movable assembly, a release arm integral with said movable assembly and operating upon the strength of the current to be controlled reaching a given value and the torque acting on the principal armature becoming prevailing with respect to the total value of the torque acting on the auxiliary armature and the torque pulling the spring owing to the quicker comparative increase of said first torque or the abrupt dropping of the torque acting on the auxiliary armature due to heat causing the disappearance of the ferromagnetism of at least one part of the auxiliary magnetic circuit.

3. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, opposite the part of said auxiliary armature in which the torque develops, a portion of said auxiliary magnetic circuit made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for heating said portion of magnetic alloy by a current which is a function of the current to be controlled, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a shaft supporting said principal and auxiliary armatures forming a single movable assembly, a return spring on a stop for said movable assembly, a release arm integral with said movable assembly and operating upon the strength of the

current to be controlled reaching a given value and the torque acting on the principal armature exceeding the total value of the torque acting on the auxiliary armature and the torque pulling the spring owing to the quicker comparative increase of said first torque or the abrupt dropping of the torque acting on the auxiliary armature owing to heat causing the disappearance of the ferromagnetism of at least a portion of the auxiliary magnetic circuit.

4. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, opposite the part of said auxiliary armature where the torque develops, a portion of said auxiliary magnetic circuit made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for direct heating of said magnetic alloy portion by a current which is a function of the current to be controlled, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a shaft supporting said principal and auxiliary armatures forming a single movable assembly, a return spring on a stop for said movable assembly, a release arm integral with said movable assembly operating upon the strength to be controlled reaching a given value and the torque acting on the principal armature exceeding the total value of the torque acting on the auxiliary armature and the torque of the spring owing to the quicker comparative increase of first said torque or the abrupt dropping of the torque acting on the auxiliary armature due to heat causing the disappearance of the ferromagnetism of at least one portion of the auxiliary magnetic circuit.

5. Instantaneous heat acting relay for controlling the strength of a current, comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, opposite the portion of said auxiliary armature in which the torque develops, a portion of said auxiliary magnetic circuit made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., and an electric single coil for exciting both said magnetic circuits traversed by the current to be controlled which is supposed to be alternating, a transformer whose primary winding is constituted by said coil and whose secondary winding supplies the current for heating the portion of magnetic alloy of said auxiliary magnetic circuit, a shaft supporting said principal and auxiliary armatures forming a single movable assembly, a release arm integral with said movable assembly and operating upon the current to be controlled reaching a given value and the torque acting on the principal armature becoming prevailing with respect to the total value of the torque acting on the auxiliary armature and the torque of the spring owing to the quicker comparative increase of first said torque or the abrupt dropping of the torque acting on the auxiliary armature due to heat causing the disappearance of the ferromagnetism of at least one portion of the auxiliary magnetic circuit.

6. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, in said auxiliary magnetic circuit at least one part made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for heating said part by a current which is a function of the current to be controlled, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a hollow shaft supporting said principal and auxiliary armatures forming a movable assembly, a return spring on a stop for said movable assembly, at least one second relay juxtaposed to the first one, a release assembly extending through said hollow shafts of said movable assemblies of said relays, driving pawls carried by said release assembly, parts of an insulating material carried by said release assembly at the level of said driving pawls, and a single release arm for the group of said relays.

7. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small gap between said auxiliary magnetic circuit and said auxiliary armature, in said auxiliary magnetic circuit at least one part made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., and an electric circuit for heating said piece by a current which is a function of the current to be controlled, a single coil for exciting said two magnetic circuits traversed by the current to be controlled, a shaft supporting said principal and auxiliary armatures forming a single movable assembly, a return spring on a stop for said movable assembly, a release arm integral with said movable assembly, a mechanical gripping device integral with said release arm, and a reconnecting device cooperating with said mechanical gripping device.

8. Instantaneous heat acting relay for controlling the strength of a current comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, in said auxiliary magnetic circuit, one part at least made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for heating said part with a current which is a function of the current to be controlled, a single coil for exciting both said magnetic circuits traversed by the current to be controlled, a hollow shaft supporting said principal and auxiliary armatures forming a movable assembly, a return spring on a stop for said movable assembly, at least one second relay juxtaposed to the first one and being similarly constructed, a release assembly extending through said hollow shafts of the movable assemlies of said relays, driving pawls carried by said movable assemblies and actuating said release assembly, parts of an insulating material carried by said release assembly at the level of said driving pawls, a single release arm for the group of said relays, a mechanical gripping device integral with one element of said release assembly, and a re-connecting device cooperating with said mechanical gripping device.

9. Instantaneous heat acting relay for controlling the strength of a current, comprising a principal magnetic circuit and a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said prin-

cipal armature, an auxiliary magnetic circuit, an auxiliary armature, actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, in said auxiliary magnetic circuit, at least one part made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for heating said part with a current which is a function of the current to be controlled, a single coil for exciting both said magnetic circuits traversed by the current to be controlled, a shaft supporting said principal and auxiliary armatures forming a single movable assembly, a return spring with a stop for said movable assembly, a release arm integral with said movable assembly, two electric contacts in parallel energized by said release arm, the first one of which is of the grip type and opens before the second one which is of the ordinary type and reversely closes before the first one.

10. Instantaneous heat acting relay for controlling the strength of a current, comprising a principal magnetic circuit, a principal armature actuated by said circuit, in unactuated rest position of the armatures, a wide air gap between said principal magnetic circuit and said principal armature, an auxiliary magnetic circuit, an auxiliary armature, actuated by said auxiliary circuit, in unactuated rest position of the armatures, a comparatively small air gap between said auxiliary magnetic circuit and said auxiliary armature, in said auxiliary magnetic circuit, at least one part made of a magnetic alloy losing its ferromagnetism at a temperature of substantially 170° C., an electric circuit for heating said part by a current which is a function of the current to be controlled, a single coil for exciting both said magnetic circuits traversed by the current to be controlled, a hollow shaft supporting said principal and auxiliary armatures forming a movable assembly, a return spring with a stop for said movable assembly, at least a second relay juxtaposed to the first one, a release assembly extending through said hollow shafts of the movable assemblies of the relays, driving pawls carried by said movable assemblies and actuating said release assembly, parts of an insulating material carried by said release assembly at the level of said driving pawls, a single release arm for the group of said relays, two electric contacts in parallel energized by said release assembly, the first one of which is of the grip type and opens before the second one which is of the ordinary type and reversely closes before the first one.

11. In a quick acting overload circuit breaker, a rotatable shaft, a switch having separable contacts, a switch actuating member fixedly carried by said shaft and adapted when rotated to a determined position to actuate said switch, spring biasing means mounted for applying a biasing torque to said shaft in a first sense of rotation, a principal magnetic circuit comprising two principal pole pieces, a principal armature for said principal magnetic circuit and which is fixedly carried by said shaft, an actuating winding for said principal magnetic circuit, and surrounding a part of the same, an auxiliary magnetic circuit comprising two auxiliary pole pieces and which comprises the part of said principal magnetic circuit surrounded by said winding, and an auxiliary armature for said auxiliary magnetic circuit and which is fixedly carried by said shaft, said armatures in their rest unactuated position being so oppositely oriented with reference to said pole pieces and angularly with reference to said shaft that excitation of said magnetic circuits causes said auxiliary armature to apply to said shaft torque in said first sense of rotation and causes said principal armature to apply to said shaft torque in a second sense opposite to said first sense, said auxiliary magnetic circuit comprising a current conducting portion thereof electrically insulated from said principal magnetic circuit and which is in electrical relation with said actuating winding to be traversed by a current derived from the current in said actuating winding, said current conducting portion of said auxiliary magnetic circuit being constituted at least in part of a magnetic alloy which becomes non-magnetic at a relatively low temperature of substantially 170° C., whereby the flow of current through said actuating winding of magnitude exceeding a determined value, causes rotation of said shaft and said switch actuating member to switch actuating position.

12. A circuit breaker according to claim 11, said principal armature forming with said principal magnetic circuit a relatively large air gap in the rest position of said principal armature when said winding is not energised, and said auxiliary armature forming with said auxiliary magnetic circuit a relatively very small air gap in the rest position of said auxiliary armature when said winding is not energised.

13. A circuit breaker according to claim 11, and a secondary winding wound on said principal magnetic circuit near said actuating winding, and said current conducting portion of said auxiliary magnetic circuit being electrically connected to said secondary winding.

14. In a quick acting overload circuit breaker, a rotatable shaft, a switch having separable contacts, a switch actuating member fixedly carried by said shaft and adapted when rotated to a determined position to actuate said switch, spring biasing means mounted for applying a biasing torque to said shaft in a first sense of rotation, a principal magnetic circuit comprising two principal pole pieces and a principal core portion, a principal armature for said principal magnetic circuit and which is fixedly carried by said shaft, an actuating winding for said principal magnetic circuit and surrounding said core portion, an auxiliary magnetic circuit comprising two auxiliary pole pieces and which comprises the part of said principal magnetic circuit surrounded by said winding, and an auxiliary armature for said auxiliary magnetic circuit and which is fixedly carried by said shaft, said armatures in their rest unactuated position being so oppositely oriented with reference to said pole pieces and angularly with reference to said shaft that excitation of said magnetic circuits causes said auxiliary armature to apply to said shaft torque in said first sense of rotation and causes said principal armature to apply to said shaft torque in a second sense opposite to said first sense, said auxiliary magnetic circuit comprising a current conducting portion thereof electrically insulated from said principal magnetic circuit and which is in electrical relation with said actuating winding to be traversed by a current derived from the current in said actuating winding, said current conducting portion of said auxiliary magnetic circuit being constituted at least in part of a magnetic alloy which becomes non-magnetic at a relatively low temperature of substantially 170° C., whereby the flow of current through said actuating winding of magnitude exceeding a determined value, causes rotation of said shaft and said switch actuating member to switch actuating position.

15. In a quick acting overload circuit breaker, a rotatable shaft, a switch having separable contacts, a switch actuating member fixedly carried by said shaft and adapted when rotated to a determined position to actuate said switch, spring biasing means mounted for applying a biasing torque to said shaft in a first sense of rotation, a U-shaped magnetic structure having an intermediate bridge core portion and terminal leg portions respectively comprising principal pole pieces, a pair of auxiliary magnetic pole pieces respectively attached to said leg portions in magnetic circuit relation therewith, at least one of said auxiliary pole pieces being electrically insulated from said leg portions, a primary winding and a secondary winding surrounding said bridge core portion, the terminals of said secondary winding being respectively connected to said auxiliary pole pieces, supply terminals for said primary winding, a principal armature for said principal pole pieces and which is fixedly carried by said shaft and positioned with its ends on the side of said principal pole pieces in said first sense of rotation of said shaft, an auxiliary armature for said auxiliary pole pieces and

which is fixedly carried by said shaft and positioned with its ends on the side of said auxiliary pole pieces in a second sense of rotation of said shaft, said auxiliary pole pieces being constituted of a magnetic alloy which becomes non-magnetic at a temperature of substantially 170° C., a stop for limiting the motion of said principal armature in said first sense of rotation, and current conducting means interconnecting the ends of said two auxiliary pole pieces, whereby the current delivered by said secondary winding flows through said auxiliary pole pieces, and when said so delivered current exceeds a determined value, said shaft is caused to rotate and actuate said switch.

16. A current breaker according to claim 15, said two

auxiliary pole pieces respectively having restricted terminal neck portions between which said circuit conducting means is connected.

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