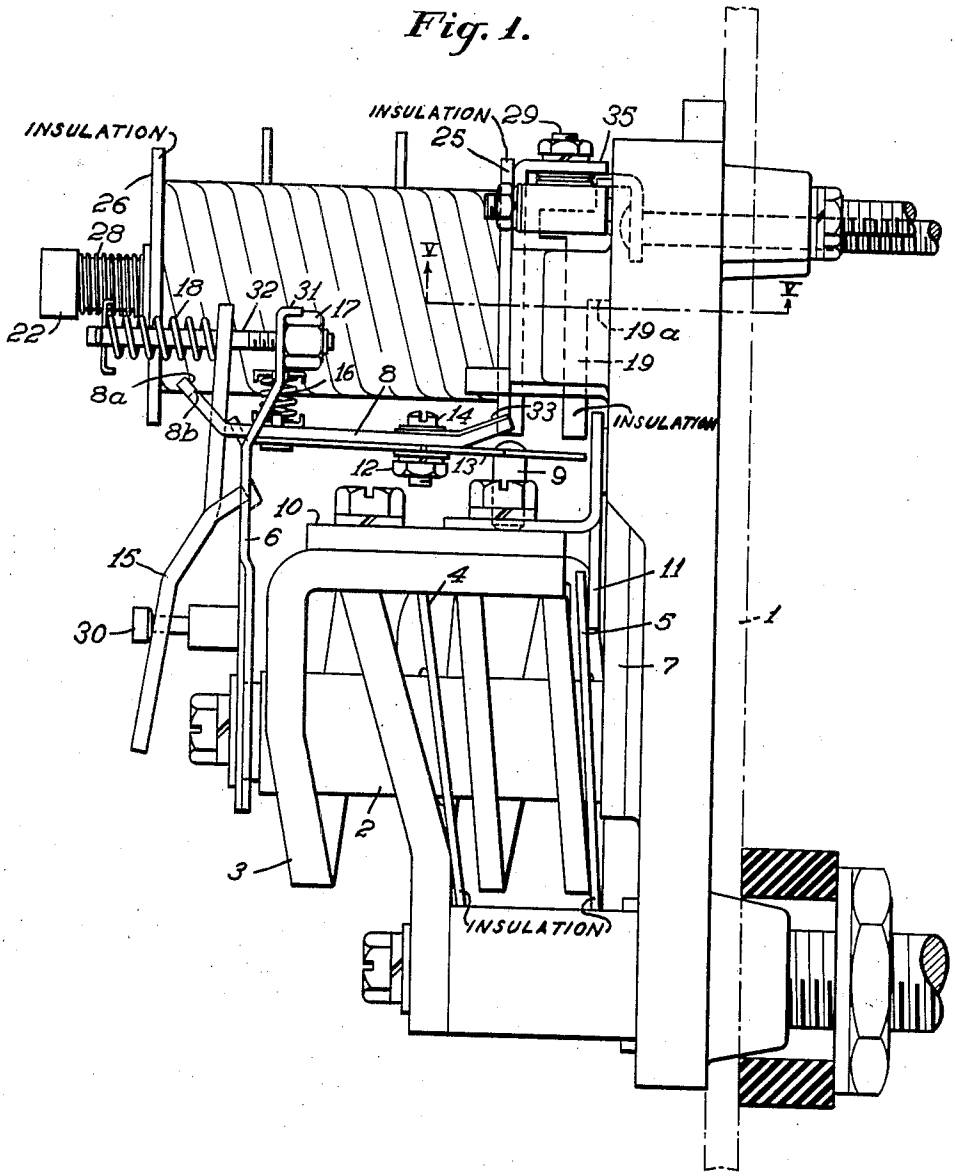
April 18, 1944. G. C. ARMSTRONG 2,347,018

OVERLOAD RELAY

Filed July 26, 1940 2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

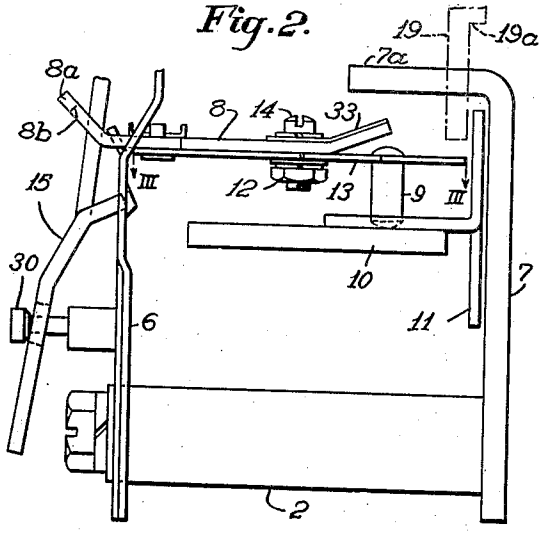


Fig. 3.

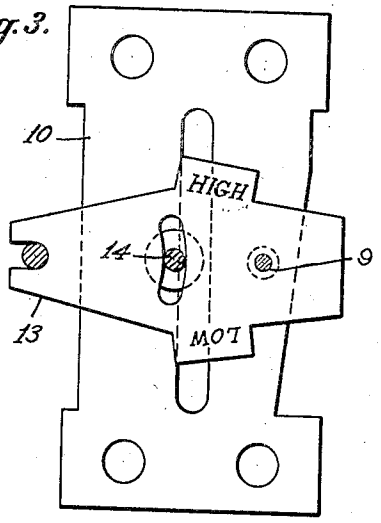


Fig. 4.

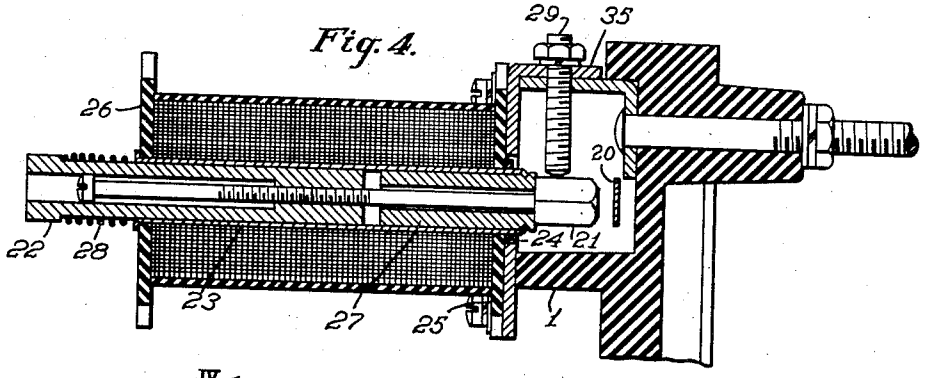


Fig. 5.

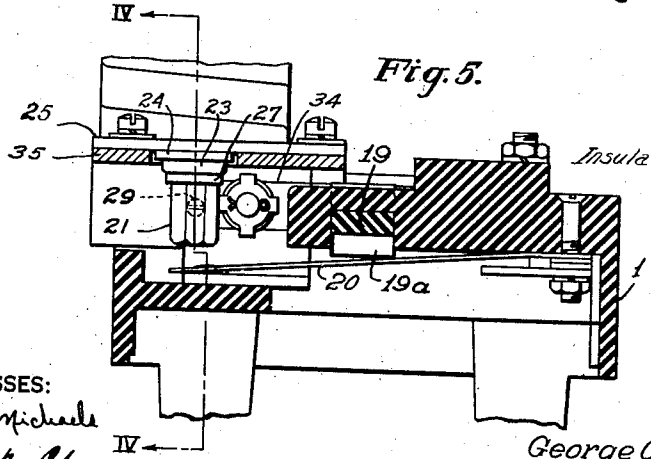
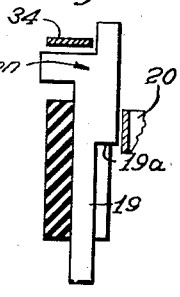


Fig. 6.



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UNITED STATES PATENT OFFICE

2,347,018

OVERLOAD RELAY

George C. Armstrong, Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 26, 1940, Serial No. 347,636

11 Claims. (Cl. 175—372)

My invention relates to an overload relay particularly useful in protecting a motor from excessive currents and which relay is responsive either to magnetic or thermal effects.

More specifically, my invention relates to an overload relay having a heater element of Invar or similar material which loses its magnetic properties upon predetermined heating, and which is effective to trip the relay on moderate overloads, and at the same time which relay has an armature which can be attracted by a magnetic core in the event of an excessively high overload.

In a copending application of Willard G. Cook, Serial No. 331,347, filed April 24, 1940, and entitled Overload protection, a combination thermal and magnetic overload relay is disclosed having an adjustable gap between an armature element and an "Invar" heater strip.

Some difficulty has been experienced in production due to the very small air gap which must be maintained between the lockout screw and the Invar heater. This requires accurate alignment of the armature parts and the heater, and the design is not such that such alignment can be readily realized nor maintained in changing the adjustments. Further, the instantaneous trip adjustment is critical and difficult to correctly set in commercial production. It is affected somewhat by changing the rating adjustment. On some heater sizes the relay fails to trip at high overloads due to saturation of the core and magnetic leakage.

An object of my invention is to provide a combination thermal and magnetic relay which is readily adjustable without danger of faulty operation due to misalignment of the remaining parts.

Another object of my invention is to provide an overload relay which has two independent overload responsive means, one of which is initiated by the change in magnetic properties of a heater element, and the other of which is operated by electromagnetic attraction upon an armature.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawings, in which:

Figure 1 is a side view of an overload relay embodying the principles of my invention;

Fig. 2 is a side view showing only the core structure included in Fig. 1;

Fig. 3 is an enlarged showing of an adjusting element which contacts the Invar heater, taken along line III—III of Fig. 2;

Fig. 4 is a cross-sectional view taken along line IV—IV of Fig. 5;

Fig. 5 is a cross-sectional view taken along the line V—V of Fig. 1; and

Fig. 6 is a sectional view of a detail from Fig. 5.

Referring more particularly to Fig. 1 of the drawings, numeral 1 denotes a panel or other supporting structure which carries a magnetic core 2, which is surrounded by a magnetic coil 3, the turns of which are separated by insulating spacer members 4 and 5. Referring to Fig. 2, the core 2 forms a magnetic path together with brackets 6 and 7, and with an armature 8, element 13 carrying a contacting pin 9, an Invar heating element 10 and a bracket 11 which is spaced by a small air gap from bracket 7. Element 10, which has been described as being of Invar, may likewise be of any other material which loses appreciably its magnetic properties upon predetermined heating.

The Invar heater 10 is connected in series with coil 3 and thereby carries the same current, that is, the overload current (under abnormal load conditions) carried by coil 3. The armature 8 is normally biased into the position shown in Fig. 2, that is, with the contacting pin 9 in contacting engagement with the Invar heater 10 by virtue of the magnetic attractive force of the Invar element when relatively cold and by virtue of the small force of spring 16. Such point of contact may be adjusted along the locus of an arc by unscrewing the nut 12, thereby making it possible to move element 13 angularly about pin 14.

The range of adjustment is shown more clearly in Fig. 3 of the drawings. Such angular movement of pin 9 results in the placement of pin 9 in a hotter or cooler section of the Invar element 10 by virtue of the fact that the Invar element has a tapered width as shown clearly in Fig. 3. This adjustment exposes either a high or low marking on the element 13, thereby providing a means for adjusting the rating of the relay insofar as moderate overloads are concerned. Pivoted on bracket 6 is a second armature 15, the lower end of which armature is attracted toward core 2 upon the occurrence of excessive overloads. A non-magnetic stop member 30 having a shank portion extending through a hole in armature 15 limits both clockwise and counter-clockwise movement of the armature, fixing the open gap and preventing residual sticking to the core bolt head. When so attracted due to overload, the

upper end of armature 15, due to the fact that it extends through an upstanding portion 8a of armature 8, abuts an edge 8b thereof and effects counter-clockwise movement of armature 8 about the upper end of bracket 6 as a pivot. Both the second armature 15 and armature 8 are pivoted on bracket 6 through a "line" bearing, that is, through a fulcrum type of bearing in which the bearing surface in cross-section is merely a point, but throughout the width it exists as an interrupted line. By such line bearings, turning cannot be impeded by magnetic forces in the bearing. This eliminates the necessity for non-magnetic spacing materials in the bearing.

As shown in Fig. 1, a spring 16 normally biases armature 8 into its normal position as shown. The flux which traverses the magnetic path including armature 8, pin 9, bracket 11, etc., also tends to maintain armature 8 in the position shown due to the magnetic attraction of Invar element 10 when relatively cold. However, there always exists a force tending to rotate armature 8 in a counter-clockwise direction about its pivot, and such force is exerted by means of the pole piece 7a. However, this force is normally insufficient to attract armature 8, due to the magnetic attractive force exerted by the Invar element 10. On moderate overloads, however, the Invar element 10 loses its magnetic properties and its attractive force, thereby allowing separation of elements 9 and 10 and allowing the armature to move counter-clockwise under the magnetic influence of pole piece 7a.

A second method of effecting counter-clockwise movement of armature 8 is initiated by excessive overload currents which substantially increase the attractive force of core 2 upon armature 15. This effects a small counter-clockwise movement of armature 8 and the separation of the contact which exists between pin 9 and the Invar heater 10. Upon such separation, however, the magnetic influence of pole piece 7a is sufficient to cause the remainder of travel of armature 8 in a counter-clockwise direction. This instantaneous trip at high currents is adjusted by turning of the nut 17, which effects variation in the tension of spring 18, thereby making the excessive overload feature adjustable. One or more ears, such as 31, is provided on bracket 6 to lock nut 17 against turning. Bolt 32 has a square cross-section cooperating with a corresponding rectangular slot in armature 15 to keep it from turning. It will be noted that such instantaneous magnetic tripping is independent of the rating adjustment, as determined by the angular adjustment of element 13, which is an important feature.

Bracket 6 is made of relatively thin steel so that it saturates at high currents, thereby increasing the attraction between armature 15 and core 2. Element 13 is of thin steel to decrease the holding effect of the Invar heater and to facilitate its being knocked free from the attraction of the Invar heater by the action of armature 15. A thin strip of non-magnetic material 33 is provided on the end of armature 8 to prevent sticking of the armature on pole piece 7a.

Thus I have provided two means for effecting counter-clockwise movement of armature 8, namely, an instantaneous magnetic trip responsive to excessive overloads and a time-delay thermal trip responsive to change of magnetic attractive force of an Invar heating element when subjected to a predetermined amount of heating, due to overload. Now the electrical reset or latch-out device for effecting opening or closing of a pair of contact members will be described.

Figs. 4, 5 and 6 of the drawings show such structure. A moldarta or other insulating rod 19 is moved upwardly by armature member 13 as a result of overload (see Fig. 2). Such rod 19 has a shoulder 19a (see Fig. 6) which cooperates with a leaf spring element 20, which spring maintains it in its upward position by virtue of its contacting engagement underneath shoulder 19a. When rod 19 is in its upper or operated position, it is effective to either close or open a pair of contact members, the moving contact member 34 being indicated in section in Fig. 6. The fixed contact is not shown.

The structure shown in Fig. 4 is arranged to give either electrical reset, in which case the relay is reset when the coil is energized, or electrical latch-out, in which case it is reset when the coil is deenergized. The change is effected by simply reversing the mounting of the coil and its associated parts on the supporting bracket 35. The moving contact of the relay is tripped open when the relay armature 8 forces push rod 19 upwardly and is latched open. In order to reset the relay, electromagnet means, as shown in Fig. 4, is provided for forcing the flat spring 20 out of latching position, inasmuch as such spring is normally biased inwardly. The relay is reset when the flat spring 20 is forced outwardly toward the panel 1 by the plunger bolt 21. Plunger bolt 21 is a non-magnetic screw-threaded bolt which is screw-threaded into a magnetic plunger 22. A brass tube 23 has a washer 24 soldered on one end to hold one insulating washer 25, and is flanged on the other end to hold the other insulating washer 26. The right-hand end of tube 23 protrudes beyond the soldered washer and is crimped into a neck in a steel core or stop member 27. When these are assembled with the plunger and with a helical spring 28, which normally biases plunger 22 to the left, a complete solenoid magnet is formed which may be mounted in either of one of two positions, as previously explained. A lock screw 29 has its end abutting the end of plunger bolt 21, therefore, locking it in any adjusted position. Adjustment of the plunger 22 is accomplished by backing the lock screw 29 out of engagement with the flat surface on the end of the plunger bolt. It is then possible to rotate the plunger bolt 21 and adjust plunger 22 with respect to the coil in some predetermined position. The assembly may then be locked to prevent relative position change of the plunger and plunger bolt during plunger actuation by threading the lock screw 29 into sliding engagement with a flat surface on the end of plunger bolt 21.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other devices embodying my invention, and I, therefore, do not wish to be limited to the specific showings made in the drawings and the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims.

I claim as my invention:

1. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined

heating, which element is electrically connected to said coil, said core having two parallel magnetic paths, the first of which includes said element, biasing means for normally maintaining said armature in contact relationship with said element, thereby completing said first magnetic path, separate means operable under the magnetic influence of said core upon heavy magnetization thereof due to overload current flowing through said coil for moving said aforementioned armature in opposition to said biasing means and into a position so that it can be moved independently of movement of said separate means by the magnetic attraction afforded by the flux flowing through the second parallel magnetic path.

2. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined heating, which element is electrically connected to said coil, said core having two parallel magnetic paths, the first of which includes said element, biasing means for normally maintaining said armature in contact relationship with said element, thereby completing said first magnetic path, separate means operable under the magnetic influence of said core upon heavy magnetization thereof due to overload current flowing through said coil for moving said aforementioned armature in opposition to said biasing means and into a position so that it can be moved independently of movement of said separate means by the magnetic attraction afforded by the flux flowing through the second parallel magnetic path, said first magnetic path including an air gap which is considerably smaller than the gap normally formed between the armature and the cooperating portion of the second magnetic path while said element is relatively cold.

3. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined heating, which element is electrically connected to said coil, said core having two parallel magnetic paths, the first of which includes said element, biasing means for normally maintaining said armature in contact relationship with said element, thereby completing said first magnetic path, a second armature pivotally mounted on said core and operable under the magnetic influence of said core upon heavy magnetization thereof due to overload current flowing through said coil for moving said aforementioned armature in opposition to said biasing means and into a position so that it can be moved independently of movement of said separate means by the magnetic attraction afforded by the flux flowing through the second parallel magnetic path.

4. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined heating, which element is electrically connected to said coil, said core having two parallel magnetic paths, the first of which includes said element, biasing means for normally maintaining said armature in contact relationship with said element, thereby completing said first magnetic path, a second armature pivotally mounted on said core and operable under the magnetic influence of said core upon heavy magnetization thereof due to overload current flowing through said coil for moving said aforementioned armature in opposition to said biasing means and into a position so that it can be moved independently of movement of said separate means by the magnetic attraction afforded by the flux flowing through the second parallel magnetic path, said first magnetic path including an air gap which is considerably smaller than the gap normally formed between the armature and the cooperating portion of the second magnetic path while said element is relatively cold.

5. An overload device comprising an electromagnet having a core, coil and armature, said core including an element having the characteristic of losing appreciably its inherent magnetic properties upon predetermined heating, electrically connected to said coil, means for normally biasing said armature into contacting relationship with said element, a saturable magentic plate pivotally secured to said armature, contacting means secured to said plate for contacting said element, thereby providing an adjustable point of contact with said element over a multiplicity of points, said element having a progressively changing width so as to form relatively cool and warm spots for selective contact with said adjustable armature portion along the locus of an arc so as to selectively change the rating of the device, a pole element on said core which tends to attract said armature away from said normal position and which is effective to move said armature towards it upon a predetermined loss of magnetization of said element as the result of electrical heating thereof due to overload current flowing therethrough.

6. An overload device comprising an electromagnet having a core, coil and armature, said core including an element having the characteristic of losing appreciably its inherent magnetic properties upon predetermined heating, electrically connected to said coil, means for normally biasing said armature into contacting relationship with said element, a saturable magnetic plate pivotally secured to said armature, contacting means secured to said plate for contacting said element thereby providing an adjustable point of contact with said element along the locus of an arc, said element having a progressively changing width so as to form relatively cool and warm spots for selective contact with said adjustable armature portion so as to selectively change the rating of the device, a pole element on said core which tends to attract said armature away from said normal position and which is effective to move said armature towards it upon a predetermined loss of magnetization of said element as the result of electrical heating thereof due to overload current flowing therethrough.

7. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined heating, which element is electrically connected to said coil, said core having two parallel magnetic paths, the first of which includes said element, biasing means for normally maintaining said armature in contact relationship with said

element thereby completing said first magnetic path, the contacting portion of the armature being adjustably secured to the remainder of said armature thereby providing an adjustable point of contact with said element, said element having a progressively changing width so as to form relatively cool and warm spots for selective contact with said adjustable armature portion so as to selectively change the rating of the device, separate means operable under the magnetic influence of said core upon heavy magnetization thereof due to overload current flowing through said coil for moving said aforementioned armature in opposition to said biasing means and into a position so that it can be moved independently of movement of said separate means by the magnetic attraction afforded by the flux flowing through the second parallel magnetic path.

8. An overload device comprising an electromagnet having a core, coil and armature, said core including an element having the characteristic of losing appreciably its inherent magnetic properties upon predetermined heating, electrically connected to said coil, means for normally biasing said armature into contacting relationship with said element, a saturable magnetic plate pivotally secured to said armature, contacting means secured to said plate for contacting said element thereby providing an adjustable point of contact over a multiplicity of points with said element along the locus of an arc, said element having a progressively changing width so as to form relatively cool and warm spots for selective contact with said adjustable armature portion so as to selectively change the rating of the device, a pole element on said core which tends to attract said armature away from said normal position and which is effective to move said armature towards it upon a predetermined loss of magnetization of said element as the result of electrical heating thereof due to overload current flowing therethrough, said first magnetic path including an air gap which is considerably smaller than the gap normally formed between the armature and the cooperating portion of the second magnetic path while said element is relatively cold.

9. A magnetically and thermally responsive overload device comprising an electromagnet having a core, a coil mounted thereon, and an armature, said core including an element having the characteristic of losing, appreciably, its inherent magnetic properties upon predetermined heating, which element is electrically connected to said coil, said core having two magnetic paths, the first of which includes said core, a member of magnetic material secured to said core, an armature pivoted on said member of magnetic material spring biased to engage said element and finally including a pair of brackets in spaced relation forming a fixed air gap therebetween, one of said brackets being connected to said element and the other being connected to said core, the second of which parallel magnetic paths includes said member of magnetic material, said armature and finally including said bracket connected to said core, a second armature pivotally mounted on said member of magnetic material responsive to magnetic effects only for cooperating with said first mentioned armature to initiate movement in response to excessive overload, saturable magnetic means secured to said first mentioned armature which upon saturation during excessive overload conditions limits the holding effect of said element on said first mentioned armature.

10. Apparatus as set forth in claim 9 in which said saturable magnetic means comprises a thin plate of magnetic material pivotally secured to said first mentioned armature between said armature and said element and having a pin of magnetic material projecting therefrom which during normal operation contacts said element.

11. Apparatus as set forth in claim 9 in which said member of magnetic material secured to said core is a thin plate having the characteristic of saturating during periods of excessive overload to rapidly develop a high magnetic field thereby positively and quickly actuating said second armature.

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