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[45]	Patented	Sept. 28, 1971
[73]	Assignee	I-T-E Imperial Corporation Philadelphia, Pa.

3,302,146	1/1964	Zocholl	335/230
3,391,360	7/1968	Hayden	335/230

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[54] MAGNETIC LATCH
10 Claims, 8 Drawing Figs.

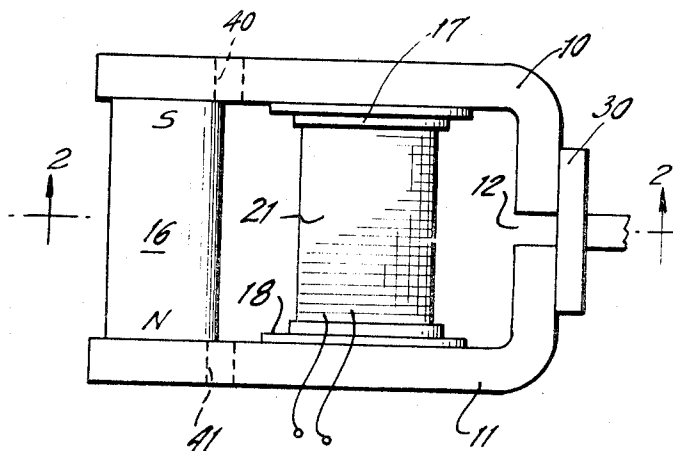
[52]	U.S. Cl.....	335/230, 335/179
[51]	Int. Cl.....	H01f 7/04
[50]	Field of Search.....	335/230, 170, 179

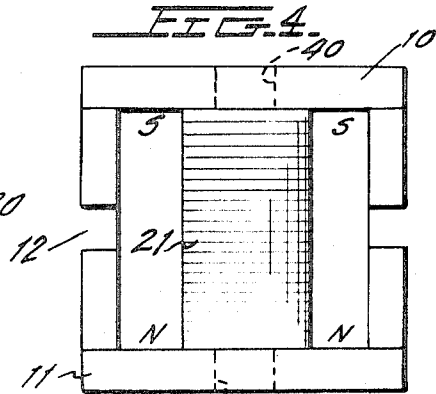
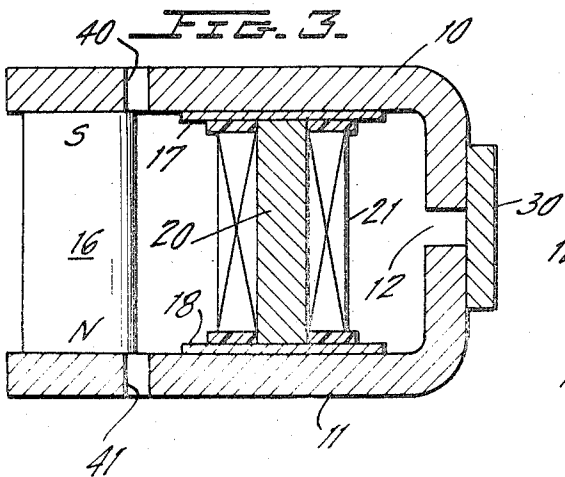
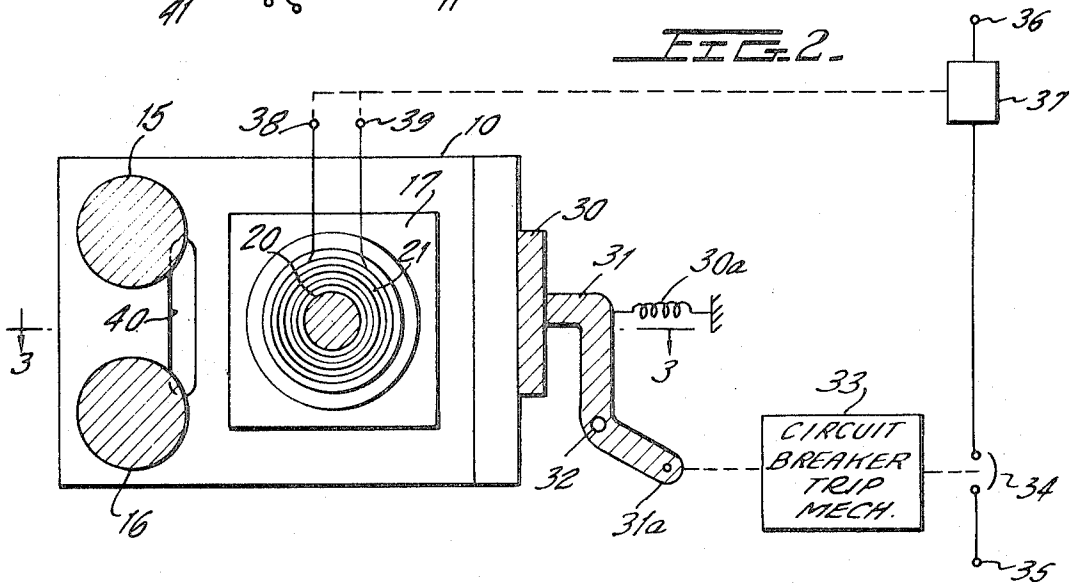
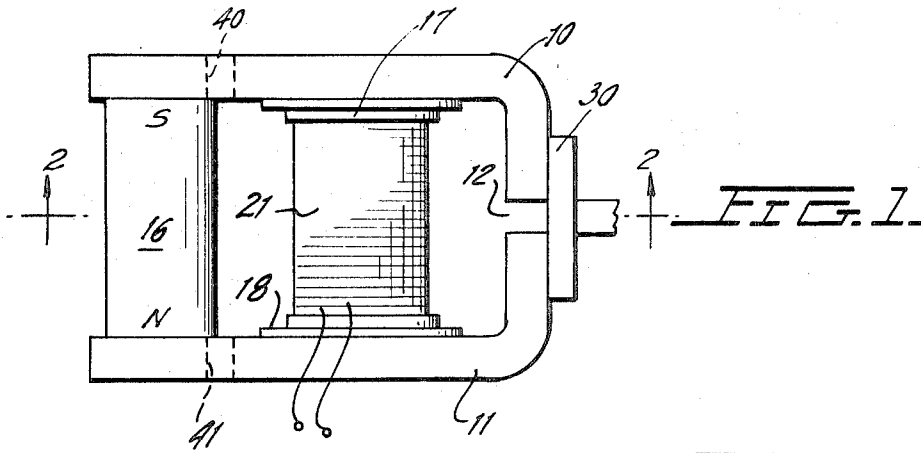
[56] **References Cited**

UNITED STATES PATENTS

3,161,806	12/1964	Gordon	335/230
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ABSTRACT: A magnetic latch for circuit interrupters in which a movable armature is attracted against pole faces in a magnetic structure by the circulating flux of a permanent magnet. A magnetic leg having a winding is magnetically in parallel with the armature and with the permanent magnet and is energized by energy derived from a circuit being protected, in response to fault conditions therein. The energization of the winding creates a flux which opposes the flux through the armature. A saturable magnetic section is provided between the coil and the permanent magnet such that the added flux of the coil saturates this section and creates a high-reluctance path between the coil and the permanent magnet path.





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FIG. 5.

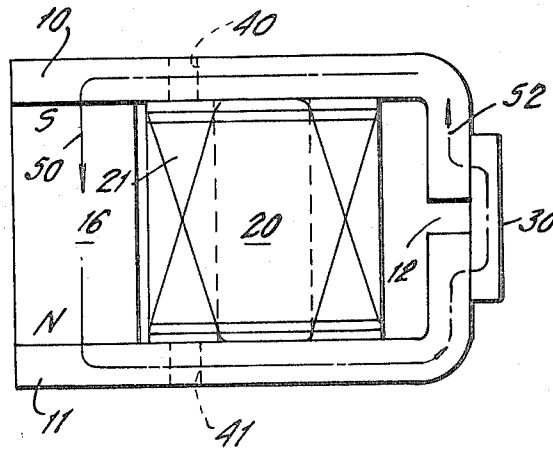


FIG. 6.

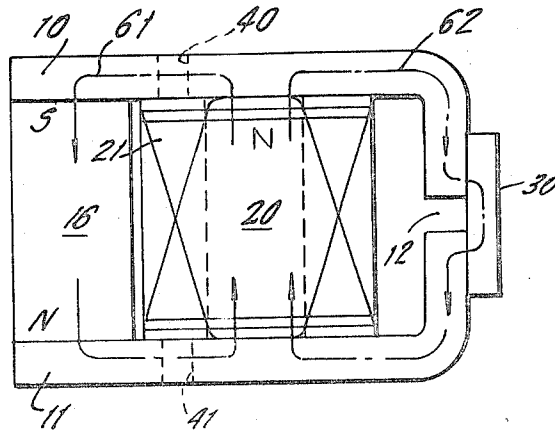
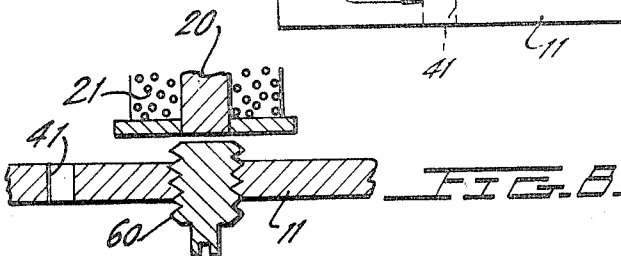
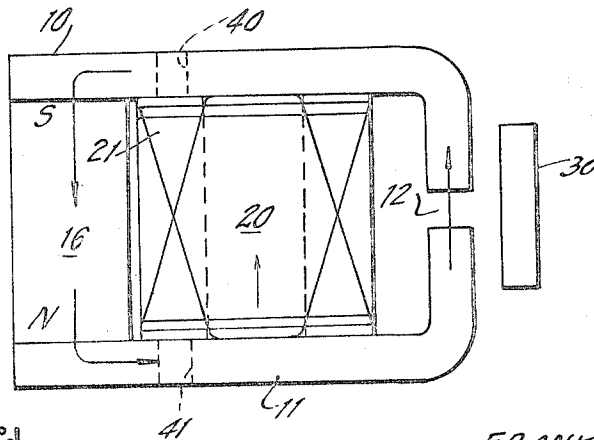


FIG. 7.



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MAGNETIC LATCH

RELATED CASES

This application is an improvement of the magnetic latch structure shown in U.S. Pat. No. 3,302,146, in the name of Zocholl, which is assigned to the assignee of the present invention.

THE PRIOR ART

The use of magnetic latches is well known for circuit interrupters wherein the magnetic latch includes an armature which is movable into and out of sealing engagement with the magnet structure when a coil, associated with the magnet structure, is energized. The armature may be connected to some suitable trip mechanism within the circuit breaker where the release of the armature, due to the energization of the magnetic latch coil, will cause the operation of the circuit breaker. The latch may then be suitably reset in any desired manner to be prepared for a new operation.

Magnetic latch structures known in the past, such as the latch structure of U.S. Pat. No. 3,302,146, have been relatively large and the operating coil requires a relatively large amount of operating power. This is because the coil is in parallel with two magnetic circuits; the circuit including the armature, and the circuit including a permanent magnet or magnetic flux bias source. The flux generated during the energization of the coil will, therefore, pass around two closed circuits so that, to force a given amount of flux to flow in the armature path, a relatively high level of energy is required for the energizing coil. An auxiliary power source is connected to the coil, commonly by a switching action caused by fault responsive elements in the circuit being protected.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, substantially all of the energy applied to the operating coil of a magnetic latch is caused to flow in the armature path and to buck down the biasing flux in that path which normally seals the armature to the magnet structure. This is obtained by making the magnetic bridging structure between the energizing coil and the biasing flux source saturable, such that it can carry the flux of the biasing source alone with low reluctance, but, when the additional flux of the coil is added to this flux, the sections will saturate and become a relatively high-reluctance path to the additional flux from the operating coil.

Accordingly, virtually all of the flux generated by the operating coil will flow to the relatively low-reluctance armature path in order to buck down the biasing flux in the armature path. The novel invention will, therefore, substantially reduce the required energy requirements for operating the magnetic latch whereby the latch size is decreased. Moreover, the energy requirements are so reduced that the structure can be conveniently energized directly from fault sensing elements in the circuit being protected. That is to say, it is not necessary for the present invention to provide an auxiliary power source for the coil. With the present invention, the latch is operated directly from the energy of the source being protected so that auxiliary source requirements are eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a magnetic latch constructed in accordance with the present invention wherein unessential structural elements have been eliminated from the drawing.

FIG. 2 is a cross-sectional view of FIG. 1 taken across the section line 2—2 in FIG. 1.

FIG. 3 is a cross-sectional view of FIG. 2 taken across the section line 3—3 in FIG. 2.

FIG. 4 is an end view of FIG. 3 as seen from the left-hand elevational view of FIG. 3.

FIG. 5 schematically illustrates the magnetic latch arrangement and indicates the flux path when the latch is closed.

FIG. 6 is similar to FIG. 5 and indicates the flux condition for the energization of the operating winding.

FIG. 7 is similar to FIGS. 5 and 6 and illustrates the latch with the armature in the open position.

FIG. 8 is a partial view of the structure of FIG. 3 and illustrates a modification of FIG. 3, which includes the addition of an adjustable airgap for sensitivity adjustment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIGS. 1 and 4, it will be understood that the magnetic latch structure illustrated therein could take many various forms and use all varieties of supporting structure. The illustration of FIGS. 1 to 4 shows only the basic components necessary to the operation of the present invention and the support and assembly details of the structure will be obvious to those skilled in the art. In FIGS. 1 to 4, there are provided two main side plates 10 and 11 which are each bent at one end thereof toward one another to form the airgap 12. Main side plates 10 and 11 may be formed of any suitable ferromagnetic material and, for example, could be of steel. For purposes of illustration, plates 10 and 11 may have a thickness of five thirty-seconds of an inch, a height of about 1½ inches (the height being the height in FIG. 2), a length of about 2½ inches, and may be spaced from one another by about 1¼ inches. The airgap 12 may be about one-eighth of an inch.

Two stacks of permanent magnets 15 and 16 are provided adjacent the left-hand end of spaced plates 10 and 11 and, for example, may have their north poles at the bottom and adjacent plate 11. Permanent magnets 15 and 16 may be of Alnico disks stacked atop one another which have a diameter of about one-half inch and may have central mounting openings therein (not shown) with diameters of about three-sixteenth of an inch. Permanent magnets 15 and 16 could be replaced by any desired source of constant, biasing flux. A pair of nonmagnetic spacer shims 17 and 18 made, for example, of brass which may have a thickness of about one sixty-fourth of an inch, are secured to the interior surfaces of plates 10 and 11, respectively, and receive, between them a steel core 20 which, in turn, receives the winging 21 therearound. Note that only one shim 17 or 18 is necessary, it being desired to form a relatively high reluctance between magnetic core 20 and plates 10 and 11, as compared to the reluctance of the magnetic path including airgap 12 when this airgap is closed by its armature, as will be later described. Thus, the flux of the permanent magnets 15 and 16 will primarily flow through such an armature rather than through core 20, when the latch is in its normally closed position.

Magnetic core 20 may have a diameter of about one-half inch and winding 21 may be formed of 450 turns of number 23 wire. The trip voltage for this winding is 1.2 volts DC, with a trip current of 0.64 amperes.

If desired, additional windings could be wound on core 20 where, for example, one winding could be the automatic trip winding, while the other could be used for nonautomatic tripping, and in place of a shunt trip device.

The armature is shown in FIGS. 1, 2 and 3 as armature 30 which may be a magnetic disk, for example, having a diameter of three-fourth of an inch and a thickness of one-eighth of an inch.

Armature 30 is then schematically illustrated in FIG. 2 as mounted on a lever 31, which is pivoted on a fixed pivot 32 which may, if desired, be carried directly on one of plates 10 or 11, in a manner not shown. A suitable biasing spring 30a is connected to lever 31 at one end and to a fixed support at its other end and biases lever 31 clockwise with a given biasing force. The biasing action of spring 30a is overcome by the sealing action of armature 30 against the pole faces of plates 10 and 11 when the latch is closed.

An extending portion 31a of lever 31 is connected to the circuit breaker trip mechanism, schematically illustrated in block 33, of the circuit breaker 34. The circuit breaker 34 is schematically illustrated in FIG. 2 as connected between terminals 35 and 36, with a fault current sensing means being connected between terminals 35 and 36. Fault sensing device

37, for example, could consist of a solid-state type relay, of the type shown in the patent to Zocholl et al. U.S. Pat. No. 3,319,127. The output of whatever circuit is selected, and which may derive all of its energy from the energy of the line including terminals 35 and 36, is connected to terminals 38 and 39 of winding 21. The polarity of the signal injected into winding 21 will be in a direction such that terminal 39 is the positive input terminal of the coil. Therefore, when the coil is energized, the top (in FIGS. 1, 3 and 4) of core 20 will become a north pole.

In accordance with the invention, a saturable section is formed in one and preferably both of plates 10 and 11 in the region joining the permanent magnet stacks 15 and 16 and the core section 20. The saturable section can be formed in any desired manner and is illustrated in FIGS. 1 to 4 as being formed by placing elongated slot openings 40 and 41 in plates 10 and 11, respectively. Obviously, this result could have been obtained by any other desired means which would make the bridging section of plates 10 and 11 relatively saturable. By "relatively saturable" is meant that there is a smaller effective cross section for carrying flux in the region connecting the ends of magnets 15 and 16 and core 20 than in the remainder of magnetic members 10 and 11. Moreover, by making this short section saturable, it will conduct the flux of magnets 15 and 16 alone with virtually the same reluctance as the remainder of the magnetic members 10 and 11, whereas the flux generated by coil 20, when added to the flux of magnets 15 and 16, will cause these sections to move into a substantially saturated region of their magnetization characteristic so that the reluctance at this increased flux level between the core 20 and magnets 15 and 16 is relatively high as compared to the reluctance in the magnetic circuit including core 20 and the closed armature 30.

The operation of the novel latch structure may now be considered in connection with FIGS. 5, 6 and 7. Referring first to FIG. 5, the armature 30 is shown sealed against its pole faces, due to the flux circulating around the magnetic structure and indicated by arrows 50 and 52, this flux being generated by the permanent magnets 15 and 16. Note that very little flux will flow through the magnetic core 20 because of the relatively high reluctance caused by spacers 17 and 18 (FIG. 1) as compared to the relatively low reluctance through the sealed armature 30. It will be noted that the closed flux path from permanent magnets 15 and 16 through armature 30 is a relatively low-reluctance path and that the openings 40 and 41 have not reduced the cross-sectional area of plates 10 and 11 sufficiently to appreciably increase the reluctance of the closed circuit. Moreover, the flux through armature 30 and its pole faces is sufficiently high to maintain the armature 30 sealed against the open biasing force of spring 30a, shown in FIG. 2.

Assuming now that it is necessary to open the magnetic latch so that the circuit breaker trip mechanism can be operated, the coil 21 is energized by connecting a suitable potential to its terminals 38 and 39. This can occur by connecting some auxiliary power source to these terminals, although, in accordance with an important feature of the present invention, this energization may be derived directly from some suitable fault sensing and signal generating device 37 which is energized directly from the circuit being protected by the circuit breaker 34. In either event, the energization of winding 21 (FIGURE 6) will be in a direction to create a north pole at the top of core 20. The flux generated by winding 21 can flow into the magnetic circuit, as indicated by arrows 61 and 62. The flux indicated by arrow 62 flows in a direction opposite (in a bucking direction) to the biasing flux 52 which seals the armature 30 (FIG. 5). The net flux flowing through armature 30 then becomes sufficiently small that the armature 30 is released under the influence of the biasing spring 30a. As previously noted, a second winding can be provided on core 20 which can be otherwise energized to release armature 30.

The flux flowing path 61 flows in the same direction as the flux due to the permanent structure. In accordance with the invention, a portion of the flux from coil 21 which can flow

through the saturable regions of plates 10 and 11, in addition to the flux of permanent magnets 15 and 16, is sufficient to cause substantial saturation of this region. Therefore, this region assumes a relatively high reluctance in comparison to path 62 through armature 30. Accordingly, a large percentage of the flux generated by winding 21 will flow through the right-hand path in FIG. 6 which includes armature 30 for bucking down the flux of the permanent magnets 15 and 16 while only a relatively small percentage can flow in the path 61. That is to say, the energy applied to winding 21 is most efficiently used in that the largest percentage of this energy is used for releasing armature 30.

Once the flux through armature 30 has been reduced sufficiently and armature 30 is released, the structure assumes the condition of FIG. 7 where the armature 30 is released, so that the trip mechanism 33 of FIG. 2 opens the circuit breaker 34, thereby deenergizing sensing device 37 and deenergizing winding 21. With the deenergization of winding 21, the flux in the magnetic circuit is only the flux created by the permanent magnets 15 and 16, with flux in core 20 and across airgap 12 dividing according to the reluctances of the respective circuits.

If desired, additional mechanism may be provided, which is not shown, which automatically resets armature 30 to the condition of FIG. 5 after the circuit breaker has operated. By way of example, an extension from the circuit breaker jackshaft, which pivotally carries the circuit breaker contacts, can move the armature 30 back to its sealing position against the biasing force of spring 30a, whereby the armature can be resealed against pole faces of magnet structure.

FIG. 8 illustrates a modification of the invention which permits sensitivity adjustment of the latch. Thus, in FIG. 8, the spacer 18 of FIG. 3 is removed and replaced by a threaded ferromagnetic insert 60 which is threaded into a threaded opening in leg 11. The end of threaded insert 60 may then be adjustably spaced from the end of magnetic core leg 20, thereby to adjust the reluctance of the second magnetic path of the device as desired. As the airgap between members 20 and 60 is decreased, it is clear that more flux will be shunted through the second magnetic path from the permanent magnet, thereby to adjust the sensitivity of the device.

Although this invention has been described with respect to preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art, and, therefore, the scope of this invention is limited not by the specific disclosure herein, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. A magnetic latch structure comprising, in combination: a magnetic structure having a pair of spaced magnetic members, first, second and third parallel magnetic paths extending between said pair of spaced magnetic members; said first magnetic path containing therein a source of biasing flux; said second magnetic path containing therein a magnetic core having an energizing winding thereon; said third magnetic path containing therein a pair of spaced pole faces and an armature movable with respect to said pole faces and between sealing and released positions relative to said pole faces; said second magnetic path being disposed between said first and third magnetic paths; and a saturable magnetic region in at least one of said pair of spaced magnetic members; said saturable magnetic region being disposed between the regions at which said first and second magnetic paths intercept said at least one of said pair of spaced magnetic members; the magnetic flux generated by said source of biasing flux circulating in a first direction in the closed magnetic path containing said pair of spaced magnetic members and said first and third magnetic paths; the magnetic flux generated by said energizing winding upon the energization thereof circulating in said third magnetic path in a direction opposite to said first direction and circulating in said first magnetic path in said first direction; said saturable region having a higher reluctance than the

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remainder of said magnetic members when said energizing winding is energized and the flux thereof adds to the flux of said source of biasing flux in said saturable region; the flux through said saturable region due solely to said source of biasing flux being insufficient to saturate said saturable region.

2. The structure of claim 1 wherein said saturable magnetic region has at least one opening therethrough, thereby to define a reduced magnetic cross section for at least one of said pair of magnetic members.

3. The structure of claim 1 wherein said second magnetic path includes a relatively high-reluctance gap therein.

4. The structure of claim 1 wherein said source of biasing flux includes a permanent magnet.

5. The structure of claim 1 which further includes biasing means for biasing said armature away from said pole faces.

6. The structure of claim 2 wherein said second magnetic path includes a relatively high-reluctance gap therein.

7. The structure of claim 6 wherein said source of biasing flux includes a permanent magnet.

8. The structure of claim 1 which includes an adjustable air-gap in series with said second magnetic path for adjusting the sensitivity of said latch.

9. The structure of claim 1 which includes a second winding on said second magnetic path; said second winding being insulated from said first winding.

10. A magnetic latch for the trip mechanism of a circuit breaker; said latch being directly operable from the energy of a circuit being protected by said circuit breaker; said magnetic latch comprising a magnetic structure having a pair of spaced magnetic paths extending between said pair of spaced mag-

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netic members; said first magnetic path containing therein a source of biasing flux; said second magnetic path containing therein a magnetic core having an energizing winding thereon; said third magnetic path containing therein a pair of spaced pole faces and an armature movable with respect to said pole faces and between sealing and released positions relative to said pole faces; said second magnetic path being disposed between said first and third magnetic paths; and a saturable magnetic region in at least one of said pair of spaced magnetic members; said saturable magnetic region being disposed between the regions at which said first and second magnetic paths intercept said at least one of said pair of spaced magnetic members; the magnetic flux generated by said source of biasing flux circulating in a first direction in the closed magnetic path containing said pair of spaced magnetic members and said first and third magnetic paths; the magnetic flux generated by said energizing winding upon the energization thereof circulating in said third magnetic path in a direction opposite to said first direction and circulating in said first magnetic path in said first direction; said saturable region having a higher reluctance than the remainder of said magnetic members when said energizing winding is energized and the flux thereof adds to the flux of said source of biasing flux thereof adds to the flux of said source of biasing flux in said saturable region, the flux through said saturable region due solely to said source of biasing flux being insufficient to saturate said saturable region; said armature connected to said trip mechanism; and coupling means for coupling said circuit being protected to said energizing winding.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,609,608 Dated 28 September 1971

Inventor(s) Frank J. Pokorny

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

(1) Column 5, line 23 (Claim 9), delete "1" and replace by

-- 10 --

(2) Column 5, Line 30 (Claim 10), after "magnet" and before

"paths", insert the following -- members, first, second
and third parallel magnetic --

(3) Column 6, line 23, delete the second occurrence of

"thereof" at the end of the line.

(4) Column 6, line 24, delete "adds to the flux of said
source of biasing flux".

Signed and sealed this 9th day of January 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents