April 7, 1959 C. I. CLAUSING 2,881,287

MAGNETIC LATCH SYSTEM FOR HIGH SPEED CIRCUIT BREAKERS

Filed March 4, 1958

2 Sheets-Sheet 1

FIG. 2.

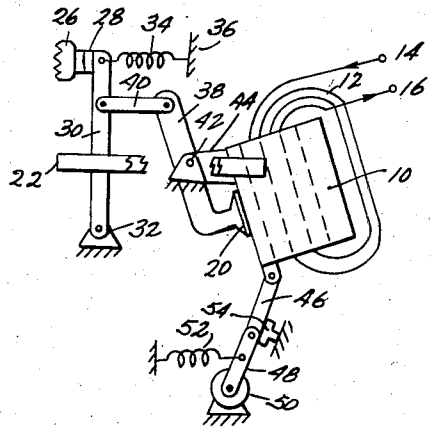


FIG. 1.

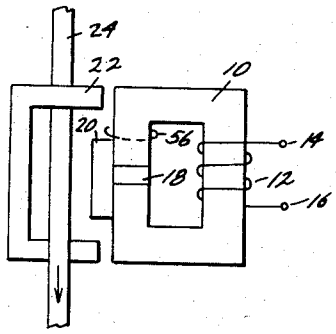


FIG. 3.

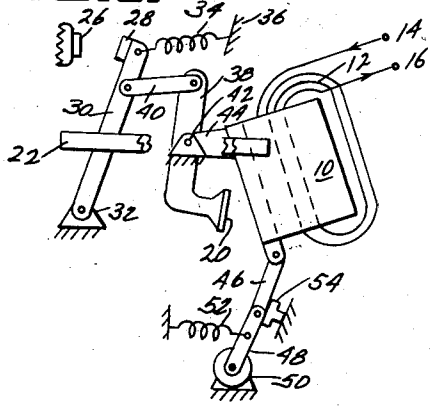


FIG. 5.

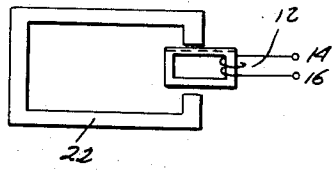
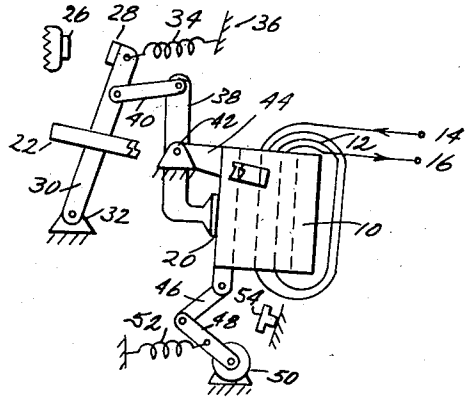


FIG. 4.



INVENTOR.
CHALLISS I. CLAUSING

BY Ostrolenk, Faber, Gerb & Soffen

ATTORNEYS

April 7, 1959 C. I. CLAUSING 2,881,287

MAGNETIC LATCH SYSTEM FOR HIGH SPEED CIRCUIT BREAKERS

Filed March 4, 1958

2 Sheets-Sheet 2

FIG. 6.

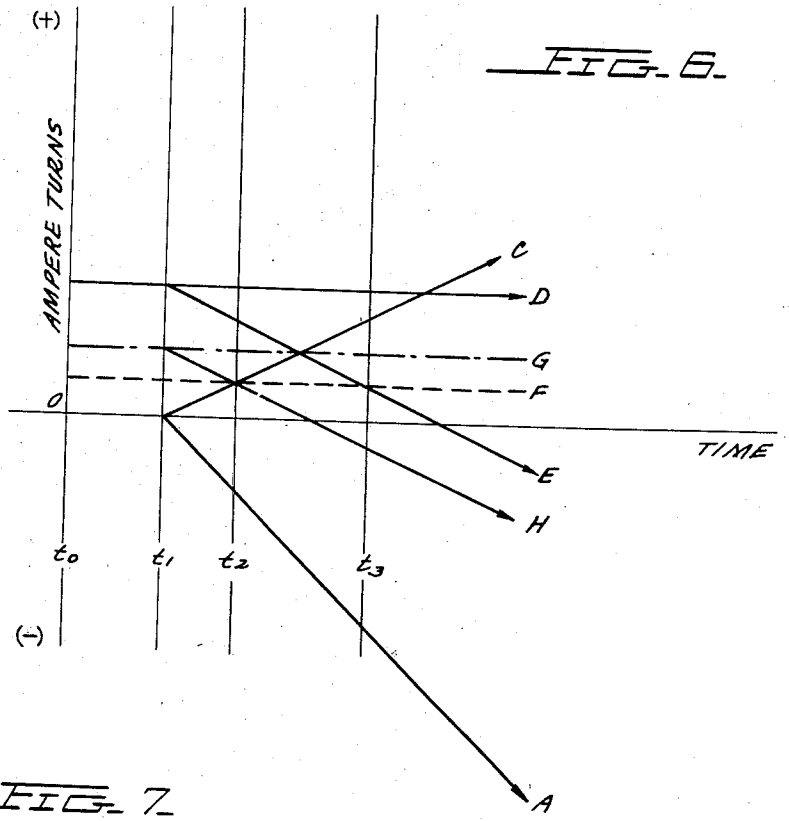


FIG. 7.

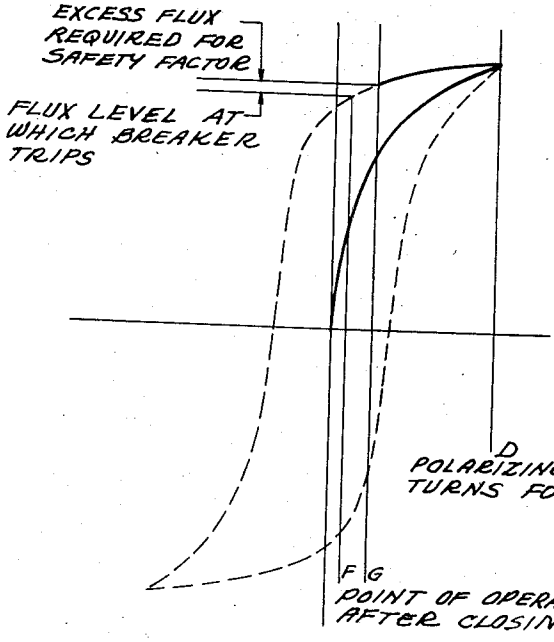
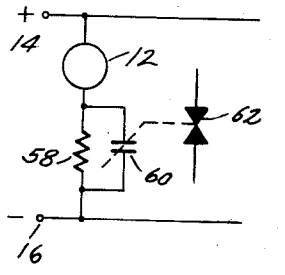


FIG. 8.



INVENTOR.
CHALLISS I. CLAUSING

By Ostrolenk, Faber, Gerb & Soffen

ATTORNEYS

United States Patent Office 2,881,287
Patented Apr. 7, 1959

2,881,287

MAGNETIC LATCH SYSTEM FOR HIGH SPEED CIRCUIT BREAKERS

Challiss I. Clausing, Collingswood, N.J., assignor to I-T-E Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application March 4, 1958, Serial No. 719,067

3 Claims. (Cl. 200—106)

My invention relates to a high speed magnetic latch for circuit breakers, and is an improvement over the magnetic latch set forth in my copending application Serial No. 660,970, filed May 22, 1957, entitled High Speed Circuit Breaker and assigned to the assignee of the instant invention, wherein the energization of the polarizing coil is controlled after latching, so that the time for flux shifting during release of the magnetic latch is decreased.

Most high speed circuit breakers utilize a magnetic latch of the so-called flux shifting type, as described in my copending application Serial No. 660,970 described above. In general, this latch comprises a magnetic circuit which includes an armature, and the armature is normally sealed against its cooperating magnetic structure to hold the circuit breaker contacts in their engaged position. Responsive to the occurrence of a fault, the flux circulating from the magnetic structure to the armature is shifted to a different path or bucked down by a new flux generating source so that the armature may thereby be released from its magnetic structure and release the opening springs of the circuit breaker to separate the circuit breaker contacts.

In this type of magnetic latch system, a polarizing coil operates as a first source of magnetic flux to seal the armature to the magnetic structure. This flux operates in conjunction with an auxiliary flux source which generates magnetic flux which is functionally related to the current conducted by the breaker. In the event that the flux generated by the circuit breaker current varies in some predetermined manner, then this flux will operate to buck down the flux of the polarizing coil so that the armature may be released from its sealed-in position.

The time required for this flux change in the portion of the magnetic circuit including the armature takes a predetermined time, this time adding to the time required to open the circuit breaker after the occurrence of the fault. I have found that, while the polarizing coil should generate a relatively strong flux during the closing in of the breaker so as to provide a strong holding force for the armature to hold it against the mechanical shock of the closing, that after the closing, the polarizing ampere turns can be decreased to approximately 30% before drop-out of the armature occurs and to 60% with an adequate safety factor still maintained. By so decreasing the polarizing ampere turns, the normal holding flux through the armature is smaller and, accordingly, the time required to shift the flux is smaller so that the armature is released more quickly and the circuit operating speed is thereby increased.

Accordingly, a primary object of my invention is to provide a high speed magnetic latch system for circuit breakers.

Another object of my invention is to provide a novel magnetic latch where the polarizing ampere turns through the polarizing coil are decreased after closing of the circuit breaker.

A further object of my invention is to reduce the time required to de-energize a magnetic latch.

These and other objects of my invention will become apparent from the following description when taken in connection with the drawings, in which:

Figure 1 schematically illustrates the magnetic latch of my invention.

Figure 2 shows the magnetic latch when associated with its circuit breaker with the circuit breaker closed.

Figure 3 is similar to Figure 2 and illustrates the latch with the circuit breaker in the tripped position.

Figure 4 is similar to Figures 2 and 3 where the magnetic latch is reset after the automatic operation of Figure 3.

Figure 5 is a top view of the magnetic latch structure of Figures 2, 3 and 4.

Figure 6 is a plot of the ampere turns as a function of time for various portions of the magnetic structure of Figures 1 through 5.

Figure 7 illustrates the B—H curve of the magnetic structure of Figures 1 through 5.

Figure 8 illustrates a relay circuit wherein the polarizing ampere turns of the polarizing coil are automatically decreased after the circuit breaker is closed.

Referring now to Figure 1, the general latch structure is comprised of a magnetic structure **10** having a polarizing coil **12** thereon which is energized from a D.-C. energizing source connected to terminals **14** and **16**. The magnetic circuit of magnetic structure **10** includes a gap of relatively high reluctance **18** and armature member **20** positioned across the gap **18**.

The flux due to polarizing coil **12** is normally sufficient to maintain the armature **20** sealed thereto in the absence of any other flux source. However, a second flux source is provided by magnetic structure **22** which contains a so-called bucking bar **24** therein which carries the load current of the circuit breaker, or some portion of the load current of the circuit breaker. The bucking bar **24** will generate a magnetic flux in core **22** which will operate to normally aid the flux in that portion of the magnetic structure **10** which includes armature **20**. However, when there is a fault on the system and the current through bucking bar **24** reverses, the flux through the portion of the magnetic circuit including armature **20** will be bucked down or shifted so that the armature **20** will be released.

One application of this type of magnetic latch system is set forth in the circuit breaker device of Figures 2, 3 and 4 and 5. The circuit breaker is comprised of a stationary contact **26** and movable contact **28**. Movable contact **28** is carried by a conductive contact arm **30** which is pivoted at pivot point **32** and is biased to a contact disengaged position by opening spring **34** which is connected to the contact arm **30** at one end and to a fixed point **36** at its other end. Contact arm **30** is then connected to a walking beam **38** through connecting link **40** where the walking beam **38** is pivotally supported at pivot **42**. The lower end of walking beam **38** then supports the armature **20** described in Figure 1. The magnetic structure **10** is provided with a protruding support arm **44** which is pivotally connected to the same pivot **42** that supports walking beam **38**.

The lower end of magnetic structure **10** is connected to the upper end of the toggle linkage including toggle links **46** and **48**. The lower end of toggle link **48** is rotatably driven by motor **50** in the manner set forth in my above noted copending application Serial No. 660,970 to drive the toggle linkage **46** and **48** against its normal bias to break to the left as caused by biasing spring **52**, while the right-hand motion of the toggle linkage is limited by the stop member **54**.

As was described in connection with Figure 1, the

polarizing coil 12 operates as a first flux source for magnet 10 of Figures 2, 3 and 4, while the second flux source, as best seen in Figure 5, includes magnetic structure 22 which surrounds the movable contact arm 30 which generates a flux in the structure 22.

In operation, when the armature 20 is sealed to magnetic structure 10, as shown in Figure 2, the circuit breaker movable contact arm 30 will be rigidly positioned to the left to maintain movable contact 28 in engagement with fixed contact 26 against the opening force of opening spring 34. If, however, the current through contact arm 30 reverses, the net flux in magnetic structure 10 at the area where armature 20 is sealed will be shifted or bucked down so that the armature 20 will be released, as seen in Figure 3, to thereby unlatch movable contact arm 30 which is pulled to the right by opening spring 34.

This operation then allows the toggle including links 46 and 48 to be broken to the left, as shown in Figure 4, whereby the magnet 10 rotates about pivot point 42 and is brought into engagement with armature 20, at which time the armature will again seal itself to the magnetic structure. After such sealing, the motor 50 may be energized to drive toggle link 48 clockwise whereby the complete magnet assembly including magnet 10 and armature 20 will be driven counterclockwise so as to drive contact arm 30 to the left and into engagement with stationary contact 26 against the biasing force of spring 34.

The operation of the magnetic structure heretofore described may be best understood with reference to Figure 6 which shows the ampere turns through the portion of the magnetic structure which includes the armature as plotted as a function of time.

Curve D illustrates the closing polarizing coil current (which heretofore was maintained constant after circuit breaker closing) while the dot-dash line G illustrates the minimum polarizing current allowable while still having a safety factor for preventing accidental unlatching of armature 10. The dotted line F illustrates the magnitude of ampere turns at which the armature will be released.

From time t_0 to time t_1, it is assumed that the circuit breaker is closed and line conditions are normal. At time t_1, however, it is assumed that the current through bucking bar 24 of Figure 1 (for contact arm 30 of Figures 2, 3 and 4) has reversed due to a fault in the system being protected. Therefore, at time t_1 the bucking bar begins to generate ampere turns in a reverse direction, so far as the portion of the magnetic circuit containing the armature is concerned, this being shown as curve A.

It has been found that, because there will be a rapid flux change in the leg of Figure 1 which includes armature 20, substantial eddy currents will be generated in the leg, and thus serve as a further source of ampere turns. For purposes of simplicity, Figure 1 accounts for this effect by assuming a shorted turn 56 which will imitate the operation of these various eddy currents. These eddy currents may then be shown to affect the operation, as indicated in line C of Figure 6, where they generate additional ampere turns as time proceeds.

The system of Figure 6 may be further understood with reference to Figure 7 which shows the so-called B—H characteristic of the system where lines D, G and F of Figure 6 are reproduced.

Assuming that the polarizing coil is continually energized at the level of line D, then the resultant ampere turns of the system shown in line E which includes the ampere turns of the polarizing coil, the ampere turns of the bucking bar (line A), and the ampere turns of line C, will not cross line F, which is the tripping value of ampere turns until time t_3. When, however, the polarizing ampere turns are decreased from line D to line G in accordance with my invention, then the net ampere turns applied to that portion of the magnetic circuit including the armature will decrease along line H so as to reach the limiting value of line F at time t_2.

Hence, when utilizing my novel invention, the circuit breaker tripping time will be decreased by the difference in time between time t_3 and time t_2.

As was heretofore described, it is desirable to have the ampere turns of the polarizing coil at a relatively high level during closing conditions to assure a relatively good sealing between the armature and the magnetic structure, even under relatively severe mechanical closing conditions. After closing, however, it is desirable to decrease the polarizing coil ampere turns to achieve a faster de-energization of the magnet.

One circuit for automatically achieving such a result is set forth in Figure 8 which schematically shows the polarizing coil 12 of Figure 1 energized from terminals 14 and 16 where polarizing coil 12 is connected in series with the parallel combination of a resistor 58 and relay contact 60. Relay contact 60 is of the normally closed type and operable to an open position responsive to closing of the circuit breaker contacts schematically shown as circuit breaker contacts 62. The interconnection between the circuit breaker contacts 62 and relay 60 may be of any of the many well known types and, if desired, a predetermined time delay may be built into the system so that contact 60 will not disengage until some predetermined time after closing of circuit breaker 62.

Accordingly, during circuit breaker closing conditions, contact 60 will be closed to short circuit resistor 58 so that polarizing coil 12 will have the full voltage of terminals 14 and 16 applied thereacross, and the polarizing coil 12 will generate a relatively large number of ampere turns, as seen on curve D of Figures 6 and 7.

After the closing of circuit breaker contacts 62, however, contact 60 will open so as to insert current limiting resistor 58 in series with polarizing coil 12 and thus decrease the ampere turns of polarizing coil 12 to the level of curve G of Figures 6 and 7, at which point extremely fast operation of the circuit breaker will proceed.

Although I have described preferred embodiments of my novel invention, many variations and modifications will now be obvious to those skilled in the art, and I prefer therefore to be limited not by the specific disclosure herein but only by the appended claims.

I claim:

1. In a high speed magnetic latch system; a magnetic structure having an air gap therein, an armature, and a coil for generating ampere turns through said magnetic structure; said armature being positioned across said air gap of said magnetic structure; said armature being movable into and out of a magnetically sealed position with respect to said magnetic structure; an energizing means for said coil; said energizing means being constructed to generate a relatively high number of ampere turns when said armature is moved into said magnetically sealed position; said energizing means thereafter decreasing the number of ampere turns generated thereby to a level sufficient to normally maintain said armature in said magnetically sealed position; said coil comprising a first source of ampere turns; a second source of ampere turns energizable responsive to a predetermined condition; the ampere turns generated by said second source being directed in a direction opposite to the ampere turns of said first source in the portion of said magnetic structure having said armature sealable thereto; said ampere turns of said first source being bucked down below the value required to maintain said armature sealed relatively quickly when said ampere turns of said first source are at said decreased level.

2. In a high speed circuit breaker; a relatively fixed contact and a relatively movable contact movable into and out of engagement with said relatively fixed contact; a magnetic latch means for latching said circuit breaker contacts in engagement; said magnetic latch means including a magnetic structure, and an armature, a polarizing

coil and a bucking coil for said magnetic structure; said armature being movable into and out of a magnetically sealed position with respect to said magnetic structure; said armature being operatively connected to said circuit breaker movable contact to latch said contact in its engaged position when said armature is sealed to said magnetic structure, and to unlatch said contact when said armature is moved away from its said sealed position; said polarizing coil having energizing means associated therewith; said energizing means being constructed to energize said polarizing coil to cause said polarizing coil to generate a relatively large number of ampere turns to circulate from said magnetic structure to said armature when said armature is being moved towards its said magnetically sealed position and said movable circuit breaker contact is moved toward its said engaged position; said energizing means decreasing the number of ampere turns generated by said polarizing coil after said armature is in its said magnetically sealed position to a level sufficient to normally maintain said armature in said magnetically sealed position; said bucking coil being operable responsive to fault conditions to buck down the ampere turns sealing said armature to said magnetic structure to thereby unlatch said movable circuit breaker contact.

3. In a high speed circuit breaker; a relatively fixed contact and a relatively movable contact movable into and out of engagement with said relatively fixed contact; a magnetic latch means for latching said circuit breaker contacts in engagement; said magnetic latch means including a magnetic structure, and an armature, a polarizing coil and a bucking coil for said magnetic structure; said armature being movable into and out of a magnetically sealed position with respect to said magnetic structure;

said armature being operatively connected to said circuit breaker movable contact to latch said contact in its engaged position when said armature is sealed to said magnetic structure, and to unlatch said contact when said armature is moved away from its said sealed position; said polarizing coil having energizing means associated therewith; said energizing means being constructed to energize said polarizing coil to cause said polarizing coil to generate a relatively large number of ampere turns to circulate from said magnetic structure to said armature when said armature is being moved towards its said magnetically sealed position and said movable circuit breaker contact is moved toward its said engaged position; said energizing means decreasing the number of ampere turns generated by said polarizing coil after said armature is in its said magnetically sealed position to a level sufficient to normally maintain said armature in said magnetically sealed position; said bucking coil being operable responsive to fault conditions to buck down the ampere turns sealing said armature to said magnetic structure to thereby unlatch said movable circuit breaker contact; said energizing means including a voltage source connected in series with said polarizing coil and a relay system, said relay system being operable responsive to closing of said circuit breaker contacts to decrease the voltage of said voltage source applied to said polarizing coil.

References Cited in the file of this patent

UNITED STATES PATENTS

1,563,688	Charpentier	Dec. 1, 1925
1,753,180	Whittingham	Apr. 1, 1930