Aug. 18, 1959 G. J. GIESSNER 2,900,473

MAGNETIC SHIELD

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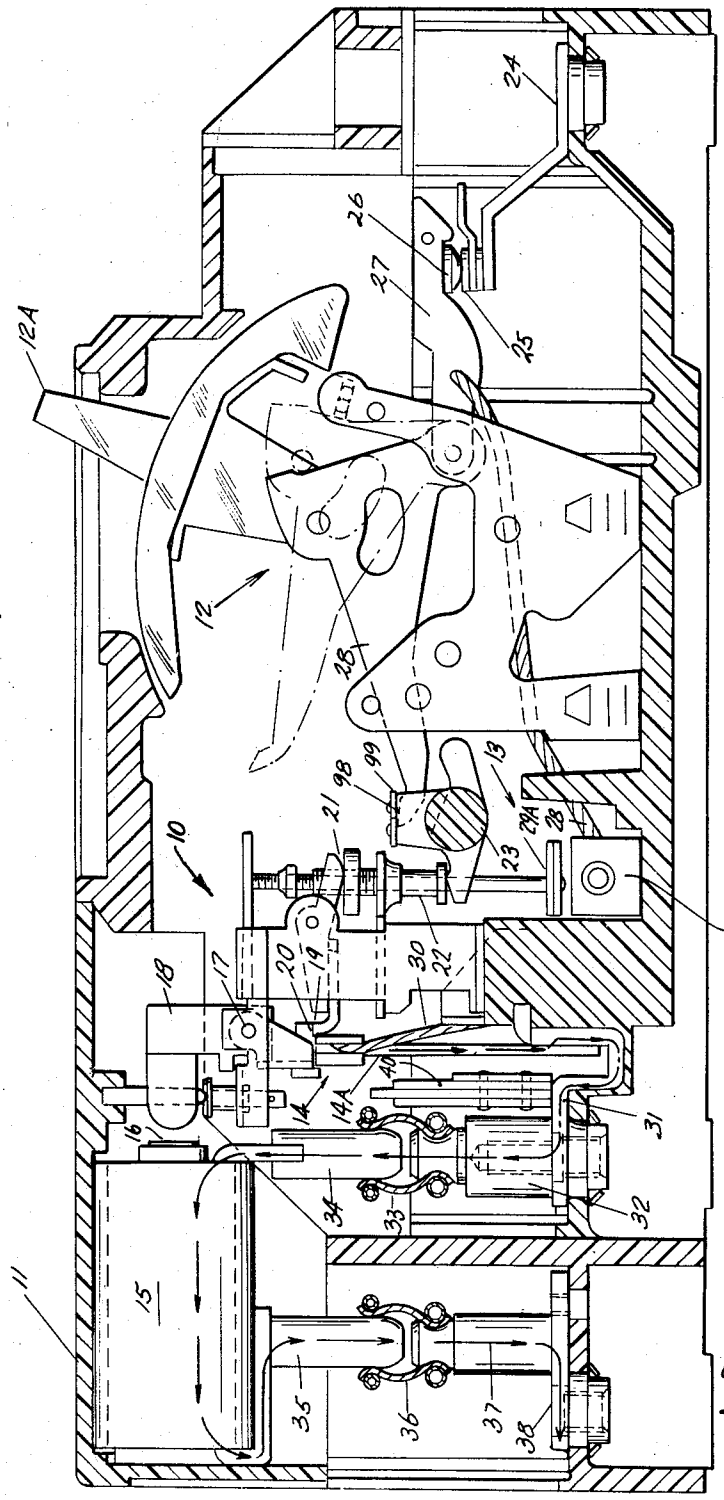


FIG. 1.

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FIG. 2.

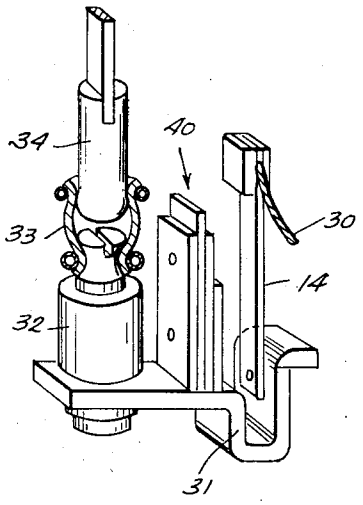


FIG. 3.

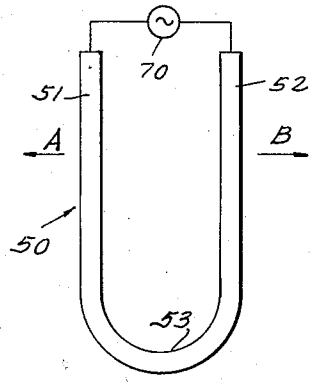
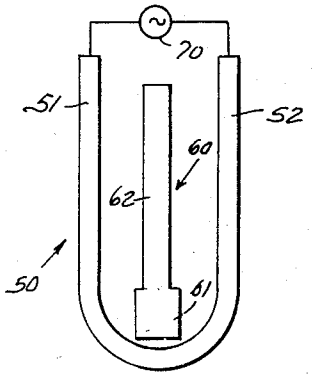


FIG. 4.



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MAGNETIC SHIELD

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Application December 28, 1956, Serial No. 631,151

7 Claims. (Cl. 200—88)

My invention relates to a magnetic shield and more particularly to a magnetic shield that will prevent the bimetal, or time delay trip, of a circuit breaker from being distorted due to the magnetic forces developed during short circuit currents of high magnitude.

The flow of electric current in a conductor is accompanied by the establishment of a magnetic field which surrounds the conductor. If the conductor is straight the magnetic forces on opposite sides of the conductor are equal. When the conductor is bent in a U-shape, this forms an open ended loop which may be likened to two parallel conductors carrying currents in opposite directions. In this case the flux lines surrounding each arm of the U are more crowded in the space between the arms than are the flux lines on either side of the U. Therefore, an imbalance of magnetic forces is present which tends to urge the arms of the U outward and thereby straighten the loop.

When a body of magnetic material is placed in the loop, the magnetic flux path is considerably changed. That is, a magnetic material working below its saturation point presents a lower reluctance magnetic path than air and thereby increases the number of flux lines generated by a given flow of current. There being a greater number of flux lines in the same air path on the outside of the loop, the inward forces on the loop are increased and at the same time the outward forces acting on the loop are decreased since the low reluctance path of the magnetic material alleviates crowding of the flux lines within the loop.

By using a suitably shaped body of magnetic material the internal and external forces acting on the conducting loop may be equalized so that there will not be any net force tending to distort the loop. Since the undesirable straightening effect is felt most greatly at the bottom of the open-ended loop, it has been found desirable to have the greatest volume of magnetic material concentrated in this region.

In many circuit breakers as they are presently designed, there is incorporated therein a current limiting device in series with the more conventional thermal and magnetic trip devices. Lower rated thermal and trip devices may now be housed in a small size casing since heating during high short circuit currents occurs for but a very short interval of time because of the rapid action of the current limiting device in interrupting short circuit currents. However, problems of magnetic stresses of short duration are now present.

One such problem occurs when the thermal or time delay tripping device is controlled by a bimetallic element which also forms part of the current path from the line side to the load side of the circuit breaker and in these cases the bimetallic element may form part of a current carrying loop. This is well illustrated in circuit breakers wherein a current limiting device is mounted at one end of a circuit breaker housing adjacent to the bimetallic element. Such an arrangement is disclosed in co-pending application Serial No. 671,531 filed July 12, 1957, entitled Tripping Mechanism for a Combined Circuit Breaker and Current Limiting Fuse, by Walter W. Uecker and assigned to the assignee of the instant invention.

A current carrying loop is formed by the bimetalic element and the circuit connections to the fuse in the current limiting device. The current flowing in this loop is accompanied by magnetic forces which tend to straighten out the loop as previously explained. Since one end of the bimetal is rigidly secured while the other end is free to move as it is required to do under normal overloads to trip the circuit breaker, and the circuit connections forming the remainder of the loop being rigid members, the full effect of the magnetic forces is most disturbing to the bimetal. The straightening of the loop causes the bimetal to be deflected beyond its elastic limit and become distorted.

At best, the calibration and continued reliable operation of a bimetallic element is a delicate matter. The distortion upsets the calibration and makes future operation of the time delay trip an uncertainty.

I have solved this distortion problem by placing a soft iron mass within the current loop to equalize the internal and external magnetic forces acting on the loop. This magnetic shield serves to prevent distortion of the bimetal under high short circuit currents and thereby preserve the calibration of the time delay trip.

Accordingly, the primary object of my invention is to provide a means for preventing distortion of a current carrying loop.

Another object is to provide a magnetic shield for equalizing magnetic forces acting on a current carrying loop and tending to lengthen that loop.

Still another object is to provide means whereby the current carrying bimetal of a circuit breaker will be protected from the distorting forces of high overload currents.

A further object is to provide a soft iron magnetic shield placed within a current carrying loop, including a bimetalilc element, whereby the magnetic forces set up by the current in the loop, and tending to straighten out the loop, are counterbalanced by the external forces acting on the loop.

Another object is to provide a separate mass of magnetic material for each phase of a multiphase circuit breaker to prevent distortion of the time delay trip elements.

These objects, as well as other objects of this invention will become more apparent after reading the following description and considering the accompanying drawings in which:

Figure 1 is a longitudinal cross-section of a side elevation of a circuit breaker incorporating a magnetic shield.

Figure 2 is a perspective view of a fragmentary section of one phase of the circuit breaker of Figure 1 including the magnetic shield.

Figure 3 is a diagrammatic representation of a current carrying loop.

Figure 4 is a diagrammatic representation of a mass of magnetic material positioned within a current carrying loop.

Referring to the figures, multi-phase circuit breaker **10** is enclosed in a molded case **11** with operating mechanism **12** thereof being operable by handle **12A** to bring the cooperating contacts **25**, **26** into and out of engagement. The operation of operating mechanism **12** is fully explained in Patent No. 2,574,093. Each phase of the circuit breaker **10** includes a current limiting device **15**, an instantaneous trip mechanism **13** and a time delay trip mechanism **14**. The striker pin **16** of the current limiting device **15** acts upon member **18**, which is pivoted on pin **17**, to release latch tip **19** from latch surface **20** and thereby enable member **21** to urge actuating mem-

ber 22 downward so that it can rotate common tripper bar 23 counterclockwise.

This will release latch tip 98 of member 28 from the latch surface 99. The time delay trip mechanism 14 comprising bimetallic element 14A will when heated deflect to the left as seen in Figure 1 and thereby urge member 18 in a clockwise direction about pin 17 releasing latch tip 19 from latch surface 20 and thereby actuating the common tripper bar 23. The instantaneous trip mechanism 13 comprises magnet 29 and armature 29A, which is attracted thereto on the occurrence of an overload condition. At this time actuating member 22 will be urged downward so as to operate the common tripper bar 23. The operation of these trip mechanisms is more fully explained in the above mentioned copending application Serial No. 671,531 filed July 12, 1957.

The current path of each phase may be traced from the line terminal 24 having contact 25 secured thereto, through movable contact 26 and contactor arm 27. The current then passes through braid 28 to the coil of magnet 29 and from there through braid 30 to the free end of the bimetallic element 14A. The current then passes through the bimetallic element 14A to the rigid member 31 having post 32 secured thereto. Mounted on post 32 is a tulip connector 33. The current passes through the tulip connector to a first contact 34 of the current limiting device 15, through the current limiting device 15 to a second terminal 35 thereof, then through tulip connector 36, to post 37, which is mounted on load terminal 38.

The bimetallic element 14A, member 31, post 32 and tulip connector 33 form a substantially U-shaped open ended loop. Placed within this loop is a laminated mass of magnetic material 40 preferably made of soft iron. The mass of magnetic material 40 acts as a magnetic shield. It may be secured in position by any suitable means such as by welding directly to rigid member 31 or by having brackets extending from rigid member 31 or from the barriers within the case 11.

The operation of the magnetic shield 40 is best explained by reference to Figures 3 and 4 which are schematic representations of the conditions existing in the region of the bimetallic element 14A and the tulip connector 33. The loop 50 is connected across a source of electrical energy 70. When a current is passed through loop 50, the flux lines generated by the current are more crowded between the arms 51 and 52 than are the flux lines external to the loop 50. Since the internal flux lines are more crowded, they will exert a force in the direction of arrow A on arm 51 and in the direction of arrow B on arm 52 thus tending to straighten out the loop. The arm 52 may be considered to correspond to the bimetallic element 14A and the arm 51 to the rigid member 31, post 32 and tulip connector 33.

Under the conditions represented in Figure 3, since loop 50, except for arm 52, is stationary, the full effect of the excessive internal forces will be felt on arm 52 and the arm 52 will thereby be deflected in the direction of arrows B.

When a magnetic shield 60 is placed within loop 50 a greater number of flux lines are generated by a given flow of current in the loop 50. This increased number of flux lines increases the external forces acting upon arms 51, 52 but the presence of the magnetic shield diverts the flux lines internal to the loop 50 so that they are not so crowded as they were without the presence of the shield 60 and the forces generated thereby on arms 51 and 52 is reduced. The size and shape of magnetic shield 60 is such that the internal and external forces acting on loop 50 will be equal to one another and under these conditions the loop 50 will not be subjected to any net force. The lower end 61 of magnetic shield 60 usually contains a greater volume of magnetic material than upper end 62 since, as previously pointed out, the flux

lines are most crowded in the lower region 53 of loop 50.

Referring more particularly to Figures 1 and 2, in the case where the magnetic shield 40 is not present, the magnetic force accompanying the short circuit currents will act to deflect bimetallic element 14A so far to the right that a degree of permanent distortion will set in thus upsetting the previously determined calibration of the time delay tripping mechanism 14. With the magnetic shield 40 positioned as indicated, the flux lines on the left side of bimetallic element 14A will exert a force to the right which is equal to the force exerted on the bimetallic element 14A to the left by the flux lines on the right side of bimetallic element 14A. Thus, the net magnetic force on bimetallic element 14A will be zero and the deflection of the bimetallic element will be due exclusively to heating.

In the foregoing, I have described my invention only in connection with preferred embodiments thereof. Many variations and modifications of the principles of my invention within the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein but only by the appending claims.

I claim:

1. A multiphase circuit breaker; each phase of said circuit breaker including a current path comprising a current limiting device and a bimetallic element; a rigid connecting means joining a first end of said bimetallic element and said current limiting device; a second end of said bimetallic element being free to move as said bimetallic element is heated; said bimetallic element and said connecting means comprising a loop; a body of magnetic material placed within said loop; said magnetic material constructed and positioned to balance magnetic forces on said loop accompanying a current flow therethrough and thereby protect said bimetallic element from permanent distortion.

2. The circuit breaker as set forth in claim 1 in which the current path also includes a magnetic tripping means.

3. A multiphase circuit breaker; each phase of said circuit breaker including a current path comprising a current limiting device and a bimetallic element; a rigid connecting means joining a first end of said bimetallic element and said current limiting device; a second end of said bimetallic element being free to move as said bimetallic element is heated; said bimetallic element and said connecting means comprising a loop; a body of magnetic material placed within said loop; said magnetic material comprising a first section and a second section wider than said first section; said second section being positioned in the bottom region of said loop.

4. The circuit breaker as set forth in claim 3 in which the current path also includes a magnetic tripping means.

5. A circuit interrupter comprising a line terminal and a load terminal connected by a current path including a magnetic trip device, a bimetallic element, and a current limiting device; a first end of said bimetallic element being rigidly positioned in said current path and a second end being free to deflect when said bimetallic element is heated; said bimetallic element comprising part of an open ended loop with said second end being positioned at the open end of said loop; a mass of magnetic material placed within said loop to prevent distortion of said bimetallic element upon the occurrence of a short circuit current of high magnitude.

6. A circuit breaker; said circuit breaker including a current path comprising a current limiting device and a bimetallic element; a rigid connecting means joining a first end of said bimetallic element and said current limiting device; a second end of said bimetallic element being free to move as said bimetallic element is heated; said bimetallic element and said connecting means comprising a loop; a body of magnetic material placed within said loop; said magnetic material constructed and positioned to balance magnetic forces on said loop accompanying a cur-

rent flow therethrough and thereby protect said bimetallic element from permanent distortion.

7. A circuit breaker; said circuit breaker including a current path comprising a rigid conductive means and a bimetallic element; a first end of said bimetallic element being rigidly connected to said rigid conductive means; said bimetallic element and said rigid conductive means comprising a loop; a body of magnetic material stationarily positioned within said loop; said magnetic material constructed and positioned to balance magnetic forces on said loop accompanying a current flow therethrough and thereby protect said bimetallic element from permanent distortion.

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