Sept. 16, 1969 J. S. HALL ET AL 3,467,920

MOLDED CASE CIRCUIT BREAKER WITH SENSITIVE THERMAL AND MAGNETIC TRIP MECHANISM

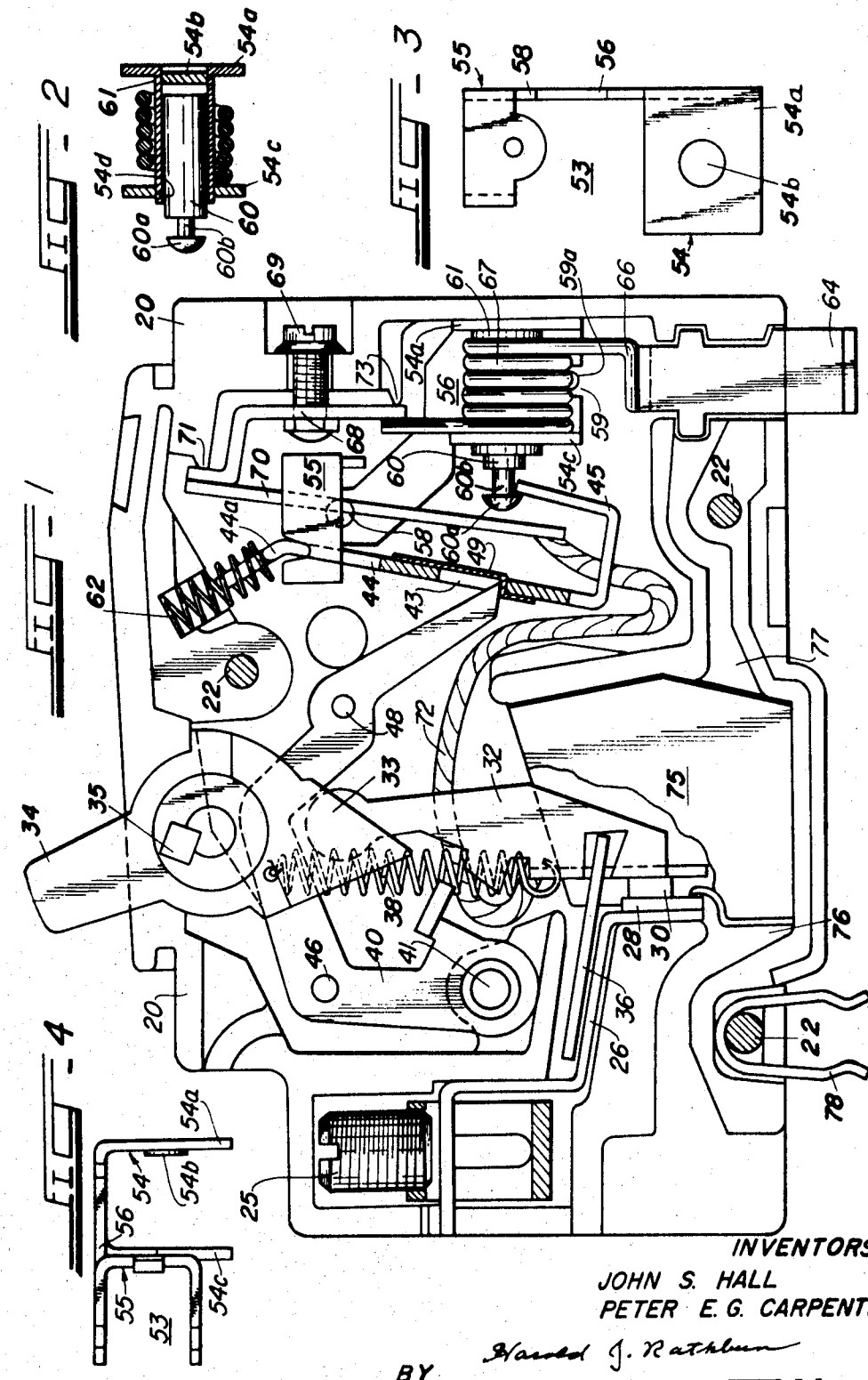
Filed Oct. 24, 1967

FIG - 2

FIG - 3

FIG - 1

FIG - 4



INVENTORS.

JOHN S. HALL

PETER E. G. CARPENTER

BY Harold J. Rathbun

Atty.

United States Patent Office 3,467,920
Patented Sept. 16, 1969

3,467,920

MOLDED CASE CIRCUIT BREAKER WITH SENSITIVE THERMAL AND MAGNETIC TRIP MECHANISM

John S. Hall, Highworth, and Peter E. G. Carpenter, Newbury, England, assignors to Square D Company, Park Ridge, Ill., a corporation of Michigan

Filed Oct. 24, 1967, Ser. No. 677,535
Claims priority, application Great Britain, Nov. 5, 1966, 49,691/66
Int. Cl. H01h 73/48
U.S. Cl. 335—23 6 Claims

ABSTRACT OF THE DISCLOSURE

A latch lever of the circuit breaker has a reversely-bent tail portion received in an annular groove in a solenoid plunger which moves magnetically in response to a relatively low fault current to move the latch lever thereby to cause release of a trip lever. When heated by an overload current, a bimetallic thermal element impinges on the outer end of the plunger to cause the plunger to move the latch lever.

This invention relates generally to automatic electric circuit breakers, and more particularly to a thermally and magnetically responsive circuit breaker of the molded case variety operable to effect the automatic opening of an electric circuit thermally at less than twice the current rating of the circuit and magnetically at as low as 2.4 times the current rating.

Circuit breakers of the general type disclosed in U.S. Patent No. 2,902,560, issued Sept. 1, 1959, are often used to protect relatively low voltage and low power circuits against overload and fault conditions. Basically, such a circuit breaker comprises a pair of separable contacts, a spring-operated mechanism for effecting separation of the contacts, and a trip device that automatically releases the spring-operated mechanism upon the occurrence of predetermined conditions in the circuit in which the circuit breaker is connected.

One form of trip device often utilized in circuit breakers of the general type disclosed in the aforementioned patent comprises a thermally responsive element in the form of an elongated bimetallic strip arranged to carry the current of the circuit to be protected and which, upon continuation of a moderate overload, flexes sufficiently as a result of the heat produced by the overload current to release the spring-operated mechanism. The trip device also includes a magnetic assembly that becomes operative upon the occurrence of a severe overload or a fault condition in the circuit to release the spring-operated mechanism more quickly than can the thermally responsive element. The former circuit breakers operate satisfactorily thermally upon moderate overloads but the former circuit breakers do not operate magnetically unless the overload or fault current in many times and current rating of the circuit being protected. For use in some relatively low voltage and low power circuits, it is desirable that a molded case circuit breaker be capable of opening the circuit magnetically when the current is as low as 2.4 times the current rating of the circuit.

Such prior molded case circuit breakers are usually mounted in panelboards which have become standardized in design, and thus the exterior dimensions and configuration of the circuit breakers must be such that they can be accepted in the panelboard. Therefore, it is important that any improvement or change in the trip device of a circuit breaker be accomplished without necessitating a change in a critical external dimension or the general configuration of the circuit breaker.

Because of cost and insulation space requirements, the electrical spacing between conductive components of prior molded case circuit breakers is at the acceptable minimum and cannot be materially reduced without reducing the rating of the circuit breaker. Therefore, in order to maintain the critical external dimensions, a trip device operable magnetically at lower currents than prior trip devices preferably is of comparable size and has the same general configuration as the prior trip devices.

Accordingly, a principal object of the present invention is to provide a circuit breaker having an improved trip device that is rendered operative magnetically promptly upon flow of relatively low overload or fault currents to open the contacts of the circuit breaker.

Another object is to provide a trip device of increased magnetic sensitivity in a circuit breaker of relatively low current and low voltage rating without requiring a change in a critical external dimension of the circuit breaker, thereby enabling the circuit breaker to be used in the same electrical panelboard as prior circuit breakers of less magnetic sensitivity.

A further object is to provide a circuit breaker having a trip device of the same general configuration as the trip devices of the type described above and usable with the same type of operating mechanism, but having a more sensitive magnetic trip characteristic.

One way of increasing the magnetic sensitivity of a trip device comprising, as the magnetic tripping means, a magnetic core and an associated clapper-type armature is to increase the effective ampere-turns of the magnetic circuit. Since the amount of current is determined by the circuit in which the circuit breaker is used, the effective ampere-turns can be increased only by increasing the number of turns of the electrical conductor wound about the core. Because the exterior dimensions of the trip device cannot be materially increased, the increased number of turns must be accommodated substantially within the confines of the space occupied by the original trip device.

In U.S. Patent No. 3,246,098, there is disclosed a molded case circuit breaker having a trip device in which a thermally responsive conductor and non-thermally responsive conductor are electrically connected in series and are supported in cooperative relation with a magnetic core of a clapper-type magnet to provide a plurality of turns about the core without materially increasing the critical dimensions over those of similar circuit breakers, not having a multi-turn coil, thereby rendering the circuit breaker usable in the same electrical panelboard as the other circuit breakers although being more sensitive magnetically.

An electric circuit breaker in accordance with the present invention comprises a molded case, a stationary contact in the case, a contact arm mounted in the case for pivotal movement between an open position and a closed position, a movable contact secured to the contact arm adjacent a free end thereof and engageable with the stationary contact in the closed position of said contact arm, a releasably latchable trip lever pivotally mounted in the case, an overcenter spring mechanism operatively connected to the contact arm and trip lever, a coil in the case, and a slidable plunger associated with the coil, the trip lever being releasably latchable adjacent a free end by a latch lever pivoted in the case. In addition, a bimetallic member in the case is electrically connected in series with the coil and contacts and has a free end portion adjacent the plunger. An outer end portion of the plunger is loosely coupled to the latch lever so that movement of the plunger into the coil when the contact arm is in the closed position and the trip lever is latched effects release of the trip lever and operation of the overcenter mechanism to move the contact arm to the open posi-

tion. When the coil is sufficiently energized, the plunger is caused to be attracted by magnetic action into the coil, and upon the bimetallic element being sufficiently heated by an overload current, the free end portion thereof pushes the plunger into the coil. Thus the latch lever is moved by either magnetic or thermal action to effect release of the trip lever and operation of the overcenter spring mechanism.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a side elevational view of circuit breaker in accordance with this invention, the mechanism being shown in "on" position and the cover of the case having been removed;

FIG. 2 is a sectional view of the magnetic tripping means of the circuit breaker of FIG. 1;

FIG. 3 is a side view of a combination solenoid frame and latch lever support of the circuit breaker of FIG. 1; and

FIG. 4 is a top view of the combination solenoid frame and latch lever support of FIG. 3.

Referring to the drawings, the molded case of the circuit breaker includes a base **20** and a cover (not shown) molded of insulating material and secured together by a plurality of rivets **22**. The base and cover are provided with molded recesses and barriers for supporting many of the other parts of the circuit breaker, as will be understood.

A load terminal **25** is provided adjacent one end of the case and is electrically connected to one end portion of a terminal strap **26**. A stationary contact **28** is secured to the other end portion of the terminal strap **26** for cooperation with a movable contact **30** secured to the bight portion of a generally U-shaped contact arm **32** pivotally supported, between a pair of inwardly extending spaced handle leg portions **33**, on an operating handle **34** which in turn is pivotally supported in the case. A rectangular hole **35** is provided through the handle **34** for the reception of a handle tie bar (not shown) when it is desired to provide a multipole circuit breaker in a manner similar to that shown in U.S. Patent No. 2,889,428, issued June 2, 1959.

A slidable arc shield member **36** formed of insulating material is hooked to the contact arm **32**. An overcenter tension spring **38** is hooked at one end to the bight portion of the contact arm **32** and at the other end to a generally U-shaped releasable trip lever **40** pivotally mounted adjacent one end on a projection **41** of the base **20** between the load terminal **25** and the contact arm **32** and releasably latched at the other end in a window **43** of a latch lever **44** provided with a reversely-bent tail portion **45**. The latch lever **44** is made of non-magnetizable material to prevent spurious magnetic paths. The trip lever **40** extends between the leg portions **33** of the handle **34** and carries a reset pin **46** cooperable with the leg portions **33** for resetting or relatching of the trip lever after it has tripped. A hole **48** is provided in the trip lever for the reception of a pin (not shown) cooperable with a common-trip crossbar (not shown) mountable in the base **20** and cover when knockouts (not shown) in the base **20** and cover are removed to provide a multipole circuit breaker similar to that shown in aforementioned Patent No. 2,889,428. The window **43** of the latch lever **44** is provided with a thin generally Z-shaped latch plate **49** shown as being thicker than it is in actual practice due to scale limitations of the drawing.

In accordance with this invention, a combination solenoid frame and latch lever support **53** (see FIGS. 3 and 4) is provided. The support **53** has a relatively large generally U-shaped solenoid frame portion **54** at its lower end, a smaller generally U-shaped latch lever support portion **55** at its upper end, and a flat connecting portion **56** connecting the bight portion of the solenoid frame portion **54** with a leg portion of the latch lever support portion **55**. The connecting portion **56** is positioned against a side wall of the base **20** and a cylindrical projection **58** on the base **20** is received in an opening partly in the connection portion **56** and partly in the adjoining leg portion of the support portion **55**. A downwardly opening slot **59** in the bight portion of the solenoid frame portion **54** receives a boss **59***a* on the base **20**. Thus the solenoid frame and latch lever support **53** is held in position on the base **20** when the cover is in place.

The solenoid frame portion **54** has one leg portion **54***a* adjacent an end wall of the base **20**. Extending inwardly from the leg portion **54***a* is a projection **54***b* (FIG. 2) and an opposite leg portion **54***c* has an aligned circular opening **54***d*. A tube **61** of non-magnetizable material, such as brass, is snugly fitted over the projection **54***b* and extends through the opening **54***d*. The tube **61** preferably has a longitudinally disposed slit along its entire length to reduce eddy currents. A cylindrical slug or plunger **60** of magnetizable material is disposed within the tube **61** with clearance to provide easy linear movement longitudinally thereof. The plunger **60** has a protruding end portion comprising a spherically rounded tip portion **60***a* positioned outwardly of a reduced diameter portion **60***b*.

The latch lever **44** is pivotally supported on the support portion **55** by means of a pair of ears **44***a* received in complementary slots in respective leg portions of the support portion and is biased clockwise as viewed in FIG. 1 by a helical compression spring **62** seated in an upper wall portion of the base **20**. The tail portion **45** of the latch lever **44** has an end portion received in the reduced diameter portion **60***b* of the plunger **60**.

A line terminal **64** is provided adjacent the other end of the case from the load terminal **25**. In the embodiment shown, the line terminal **64** is generally U-shaped to provide a pair of plug-in type terminal jaws. A conductive wire **66** is electrically connected at one end to the line terminal **64** and is wound several times around the tube **61** forming a solenoid coil **67** and is electrically connected at the other end to one end of a mounting bracket **68** held in position, as by an adjustment screw **69**, against a pair of rounded raised bearing portions **71** and **73** formed on the base **20**. A bimetallic member **70** is secured at one end to the upper end of the bracket **68** and extends between the latch lever **44** and the rounded tip **60***a* of the plunger **60**. The bracket **68** is resiliently deformable by rotation of the screw **69** to vary the position of the free end of the bimetallic member **70** with respect to the tip portion **60***a* of the plunger **60** thus to calibrate the thermal tripping point of the circuit breaker. A flexible braided wire conductor or cable **72** is electrically connected at one end to the free end of the bimetallic member **70** and is secured at the other end to the contact arm **32**.

An arc chute assembly including a plurality of deionizing plates (not shown) held in spaced relationship to each other in a formed insulating fiberboard enclosure **75** is provided for the separable contacts **28** and **30**. The base **20** is provided with a pair of vent passages **76** and **77** extending from opposite sides of the arc chute assembly, the passage **77** venting between the jaws of the line terminal **64**. A mechanical mounting clip **78** is provided adjacent the other end of the case from the line terminal **64**.

Movement of the handle **34** clockwise from the position shown in FIG. 1 shifts the pivot point of the contact arm **32** across the line of action of the spring **38** and causes the spring to pivot the contact arm to the "off" position, and conversely, movement of the handle back to the position of FIG. 1 causes the spring to pivot the contact arm back to the "on" position.

Pivoting the latch lever **44** counterclockwise as viewed in FIG. 1 unlatches the trip lever **40** and causes the spring **38** to pivot the contact arm **32**, handle **34**, and trip lever **40** to their "tripped" positions. Movement of the handle **34** clockwise toward the "off" position from the tripped position causes the leg portions **33** to engage

the reset pin **46** thereby to move the trip lever **40** counterclockwise about the projection **41** to reset or relatch the trip lever.

The unlatching of the trip lever **40** from the latch plate **49** in the window **43** of the latch lever **44** is caused thermally upon sustained moderate overloads of approximately twice the normal current rating of the circuit by engagement of the free end of the bimetallic member **70** with the plunger tip **60***a* upon flexure of the bimetallic member as a result of an increase in its temperature. This forces the plunger **60** to the right, as viewed in FIG. 1, so that the tail portion **45** of the latch lever **44** is engaged by the tip **60***a* thereby to swing the latch lever counterclockwise against the bias of the spring **62** to effect release of the trip lever **40**.

The unlatching of the trip lever **40** from the latch plate **49** is caused magnetically promptly upon flow of a fault current or an overload current having a minimum value slightly in excess of twice the normal current rating by movement of the plunger **60** to the right by magnetic attraction by the coil **67**. The magnetic action becomes operative to release the trip lever **40** much more quickly than can the thermally responsive action. The magnetic responsive action is obtained by sufficient energization of the coil **67** to cause the plunger tip **60***a*, which is in engagement with the tail portion **45**, to move the latch lever **44** thereby to effect release of the trip lever **40**.

The thermal and magnetic tripping unit herein disclosed lends itself very readily to production of circuit breakers of various current ratings. Thus, for the lowest rating, a relatively large number of turns may be provided in the winding of the conductor **66** to form the solenoid coil **67** to produce sufficient magnetic flux to trip the circuit breaker upon occurrence of relatively low overload or fault currents, and the conductor **66** may be made of nickel-chromium or other high resistance wire to produce additional heat for activating the bimetallic member **70** upon relatively low sustained overload currents. For higher trip ratings, fewer turns may be provided in the solenoid **67**, and the material thereof may be changed to copper to reduce the heat input to the bimetallic member **70**.

The distance between the line terminal **64** and the mounting clip **78** has been maintained the same as in the circuit breaker of the aforementioned patents, and the distance between the handle **34** and the line terminal **64** and the mounting clip **78** has also been maintained the same as in the aforementioned patents although the line terminal and mounting clip have been reversed from their position in Patent No. 2,902,560 relative to each other. Thus, the circuit breaker of this invention and that of the aforementioned patents can be mounted in the same panelboard.

We claim:

1. An electric circuit breaker comprising a molded case, a pair of separable contacts in the case, a releasably latchable trip lever pivotally mounted in the case, means in the case rendered operative to effect separation of the contacts upon release of the trip lever, a latch lever pivotally mounted in the case, the latch lever normally releasably latching the trip lever and being movable in one direction to effect release thereof, a magnetic tripping device in the case including a coil electrically connected in series with the contacts and a plunger reciprocably mounted in the coil, the plunger having an outer end portion connected to the latch lever and being attractable into the coil to a retracted position upon predetermined energization of the coil to move the latch lever in said one direction toward the coil to effect release of the trip lever, and a bimetallic member in the case adjacent said outer end portion of the plunger, the bimetallic member being electrically connected in series with the contacts and the coil and being deflectable upon heating to move the plunger toward its retracted position in the coil.

2. An electric circuit breaker as claimed in claim **1** wherein biasing means is provided which biases the latch lever in a direction opposite said one direction and biases the plunger outwardly of the coil.

3. An electric circuit breaker as claimed in claim **1** wherein a slot is provided in the outer end portion of the plunger and a free end portion of the latch lever is received in the slot.

4. An electric circuit breaker as claimed in claim **3** wherein the plunger is cylindrical and the slot is a peripheral slot extending around the outer end portion of the plunger.

5. An electric circuit breaker as claimed in claim **1** wherein a free end portion of the bimetallic member is positioned adjacent an outer end face of the plunger with the low expansion side of the bimetal facing the outer end face of the plunger.

6. An electric circuit breaker as claimed in claim **1** wherein a spring is provided to bias the latch lever in a direction opposite said one direction, a free end of the latch lever has a reversely bent portion, a slot is provided in the outer end portion of the plunger, a free end portion of the reversely bent portion is received in the slot so that the plunger is biased outwardly of the coil by the spring, and the bimetallic member extends generally parallel to a main body portion of the latch lever and has a free end portion between the main body portion and the reversely bent portion of the latch lever and adjacent an outer end face of the plunger with the low expansion side of the bimetal facing the outer end face of the plunger.

References Cited

UNITED STATES PATENTS

2,154,237	4/1939	Frank	337—71
3,023,288	2/1962	Bodenschatz	337—70
3,116,388	12/1963	Hobson	337—70
3,246,098	4/1966	Hall	335—35

BERNARD A. GILHEANY, Primary Examiner

H. BROOME, Assistant Examiner

U.S. Cl. X.R.

337—71

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,467,920 Dated September 16, 1969

Inventor(s) John S. Hall and Peter E. G. Carpenter

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

Column 1, line 58, change "in" to -- is -- ;
change "and" to -- the -- .

SIGNED AND
SEALED
DEC 30 1969

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents