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 [21] Appl. No. **848,426**
 [22] Filed **Aug. 8, 1969**
 [45] Patented **Apr. 20, 1971**
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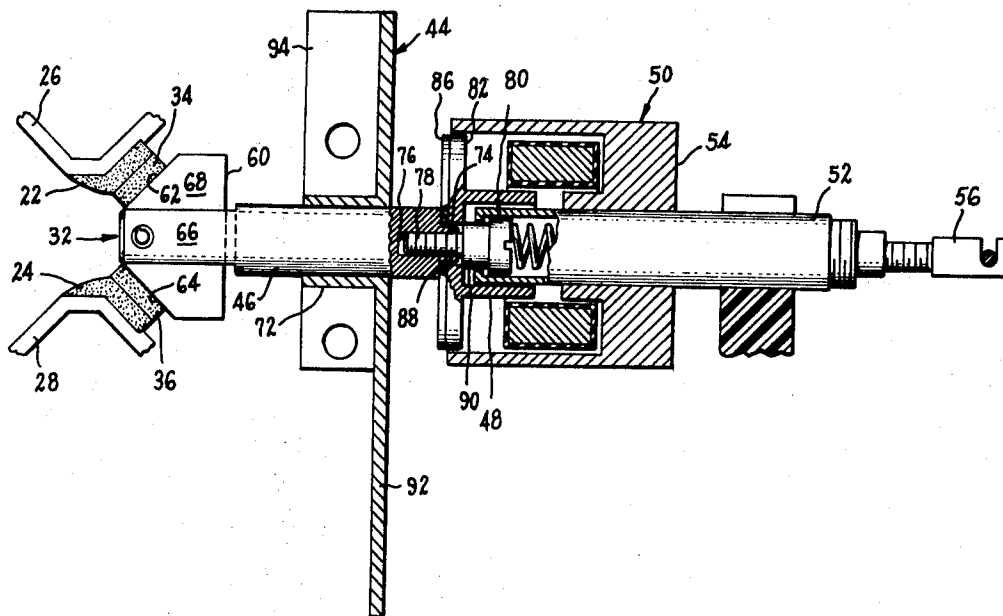
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 Forman

[54] CURRENT-LIMITING CIRCUIT BREAKER 6 Claims, 6 Drawing Figs.

[52] U.S. Cl. 335/201,
 335/16
 [51] Int. Cl. H01h 9/52
 [50] Field of Search 335/201,
 16; 200/166 (K), 144 (Cursory); 337/166, 187;
 317/(Inquired); 219/540, 530

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ABSTRACT: A current-limiting electric circuit breaker utilizes materials of high thermal conductivity in the movable contact assembly and provides means for conducting heat away from the contact area toward other members of the circuit breaker. The heat conducting means includes a heat cap on the muffle assembly having side flanges in intimate surface contact with the muffle enclosure and a heat fin mounted on the contact rod and having a portion in good thermal contact with a large metallic housing member having heat dissipating qualities.



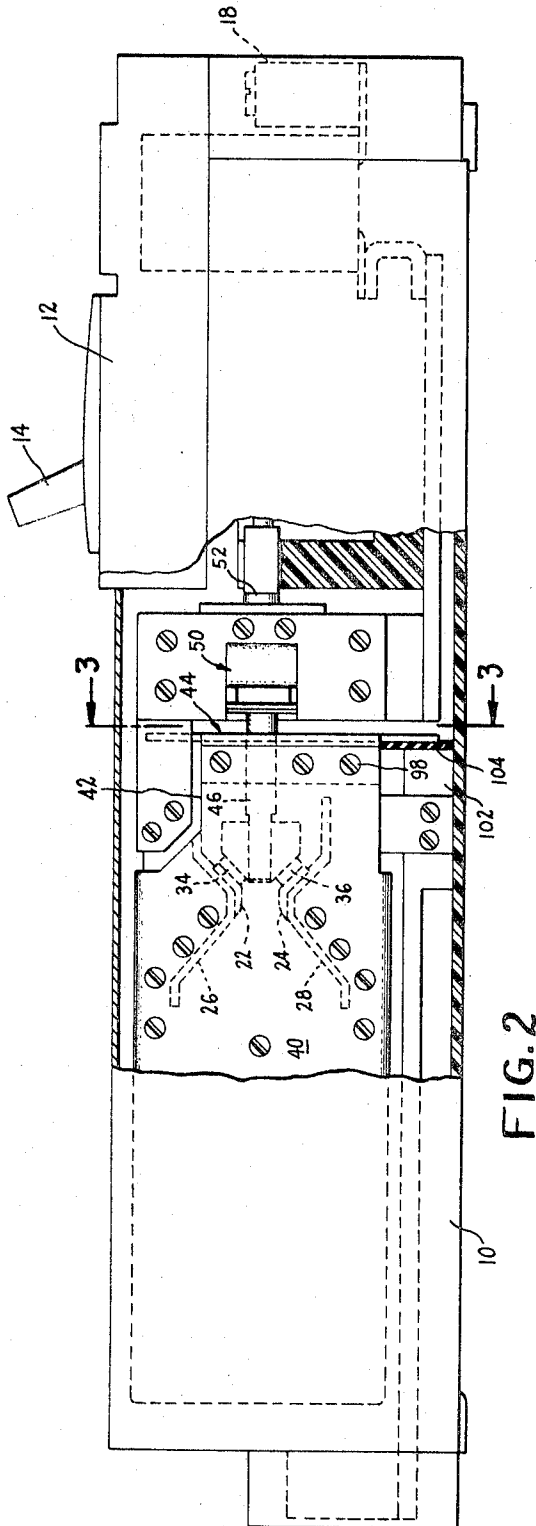


FIG. 2

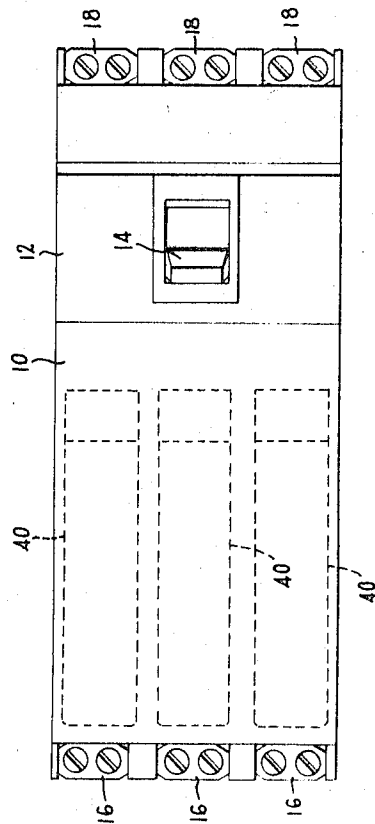


FIG. 1

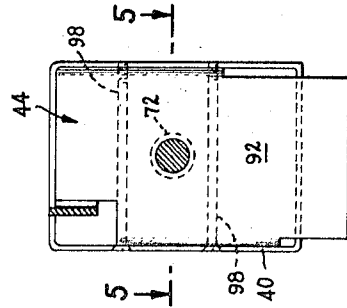


FIG. 3

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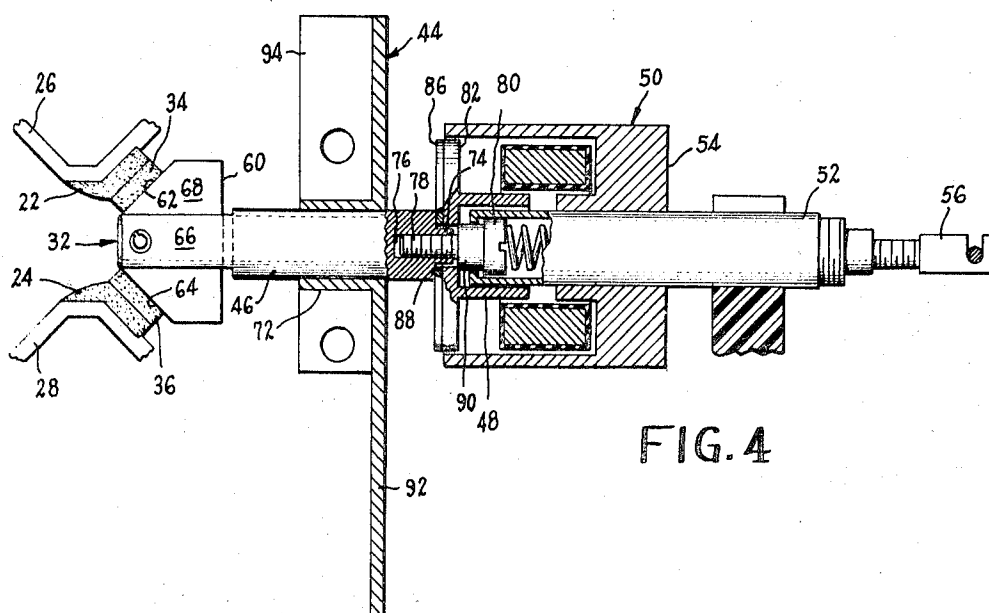


FIG. 4

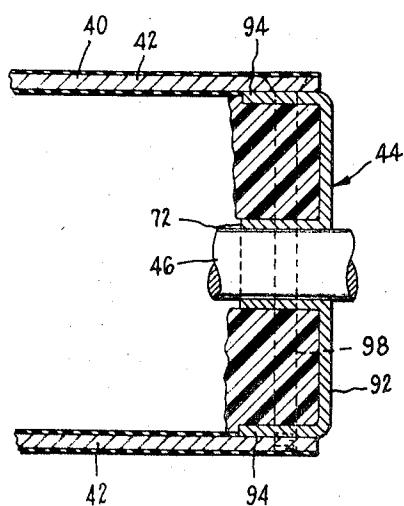


FIG. 5

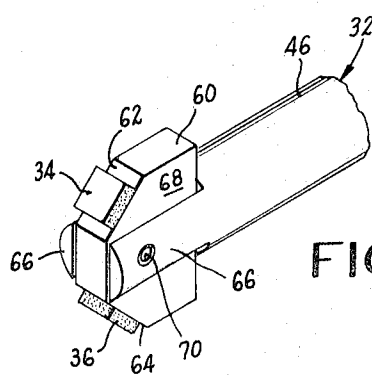


FIG. 6

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CURRENT-LIMITING CIRCUIT BREAKER

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to electric circuit breakers. More particularly, it is desired to electric circuit breakers of the current-limiting type that do not require the use of fusible elements to effect the desired current interruption.

Circuit breakers of the type mentioned generally include an arc chute assembly for creating and elongating an arc having a sufficient voltage drop to interrupt the current. A field strap assembly supports the arc chute assembly including the stationary contacts and, together with a glass arc chute case, is capable of conducting heat away from the contacts when continuous operation of the circuit breaker is carried out at current levels of about 100 amperes. However, when constant current loads of up to about 400 amperes or more continuously flow through the circuit breaker it has been found that substantial problems of heat removal are encountered. These problems are magnified during overload current conditions and substantially affect the operating life of the circuit breaker.

Accordingly, it is an object of the present invention to provide a new and improved electric circuit breaker construction providing improved heat flow away from the contacts particularly during overload current conditions. Included in this object is the provision for utilizing materials of high thermal conductivity in connection with both the movable and stationary contacts of the circuit breaker thereby affording necessary protection to the contacts and prolonged operating life for the breaker.

Another object of the present invention is to provide a current-limiting circuit breaker of the type described which utilizes large metal masses within the circuit breaker as a heat sink for the dissipation of heat created during continuous flow of maximum current loads. This object particularly envisions the provision for a circuit breaker having good thermal conduction between the large mass of material located within the muffle assembly of the circuit breaker and the movable contact assembly.

A further object of the present invention is to incorporate improved heat conducting members into an electric circuit breaker without interfering with the smooth and efficient operation thereof at its designed current level, the heat conducting members being in heat transfer relationship with both the movable contact assembly of the circuit breaker and other components exhibiting good heat dissipating qualities.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

These and related objects are accomplished in accordance with the present invention by utilizing materials of high thermal conductivity in the movable contact assembly including the contact carrier and contact rod and by providing means for conducting heat away from the contact rod toward other members of the circuit breaker including the armature, stator and operating shaft associated with the solenoid operator, the baffle plates and other components of the muffle assembly and the highly conductive line terminal strap of the circuit breaker.

A better understanding of the objects, advantages, features, properties and relationships of the invention will be obtained from the following detailed description and accompanying drawings which set forth an illustrative embodiment and are indicative of the way in which the principle of the invention is employed.

BRIEF DESCRIPTION OF THE DRAWINGS

in the drawings:

FIG. 1 is a top plan view of a three-pole electric circuit breaker incorporating the features of the present invention;

FIG. 2 is an enlarged side elevational view of the circuit breaker of FIG. 1, partly broken away to expose the muffle enclosure and adjacent heat dissipating members;

FIG. 3 is a sectional view taken along the lines 3-3 of FIG. 2 showing the heat cap at one end of the muffle enclosure;

FIG. 4 is an enlarged sectional view of the movable contact assembly and solenoid operator of the circuit breaker of FIG. 2;

FIG. 5 is a sectional view taken along the lines 5-5 of FIG. 3 further depicting the relationship between the heat cap and both the movable contact assembly and the muffle enclosure of the circuit breaker; and

FIG. 6 is a perspective view of the contact end of the movable contact assembly.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings in greater detail wherein like reference numerals indicate like parts throughout the several FIGS. the invention is shown as embodied in a three-pole, current-limiting electric circuit breaker having a generally rectangular casing 10 including an insulating cover 12 through which extends a manually operated handle 14 mounted for oscillation between its "on" and "off" positions. Each pole of the circuit breaker includes a line terminal 16 located at one end of the circuit breaker and a load terminal 18 located at the opposite end thereof. A pair of spaced stationary contacts 22, 24 are fixedly mounted within casing 10 on stationary arc runners 26, 28, respectively, which in turn are carried by separate field straps (not shown) electrically connected to the individual line and load terminals 16, 18. A movable contact assembly, designated generally by the numeral 32, includes a pair of contacts 34, 36 which mate with contacts 22, 24, respectively, to close the circuit across the breaker between the line and load terminals.

Each pole of the circuit breaker is further provided with an elongated muffle enclosure or "can" 40 which confinably houses a suitable muffle assembly, such as steel baffles and stacks of perforated plates, for separating and dissipating the arc and reducing the magnitude of its associated heat and noise. The muffle enclosure 40 fully surrounds the muffle assembly and extends from adjacent the line terminal 16 toward the stationary contacts. The enclosure is a metal member having an insulating coating and includes a pair of integral sideplate extensions 42 projecting rearwardly toward load terminal 18. A heat cap 44 spans one end of the enclosure 40 and is suitably secured to the extensions 42 to provide heat conduction therebetween. A generally cylindrical drive rod or contact rod 46 of assembly 32 extends outwardly through heat cap 44 and fixedly carries a generally cylindrical armature 48 for a high-speed solenoid operator 50 mounted in spaced adjoining relationship to the cap 44 of muffle enclosure 40. As shown in FIG. 4, the contact rod 46 is connected to a tubular operating rod 52 extending axially through the stator 54 of solenoid 50. The operating rod, in turn, is connected to the mechanical operating mechanism (not shown) of the circuit breaker by means of a linkage 56 thereby facilitating manual operation of the movable contacts between their open and closed circuit positions by means of the handle 14.

As will be appreciated, heat generated at the contacts will be conducted away from the arc runners and stationary contacts by the highly conductive field and terminal straps electrically connected thereto. However, for circuit breakers continuously operating at current loads of about 400 amperes it is necessary to provide additional avenues of heat conduction in order to prevent excessively high temperatures at the contacts, particularly upon the occurrence of overload current conditions. In accordance with the present invention this is accomplished by utilizing a construction which promotes the flow of heat away from the movable contact assembly as well as away from the stationary contacts, the construction including the liberal use of materials of high thermal conductivity. As used herein the term "high thermal conductivity" and related terms mean a heat conduction capability comparable to that possessed by copper.

In accordance with the preferred embodiment of the present invention, the movable contact assembly 32 includes a flat blocklike contact carrier 60 having a trapezoidal configuration. As shown, the movable contacts 34, 36 are fixedly mounted on the sloped front faces 62, 64, respectively, of the carrier of movement into and out of firm abutting engagement with the inclined planar portions of the stationary contacts. The contact rod 46 is provided with a bifurcated yoke on one end thereof (FIG. 6) defined by a pair of sidearms 66 which extend along substantially the full length of the trapezoidal contact carrier 60 and firmly engage both planar side faces 68 thereof to promote efficient heat transfer between the carrier and the rod. Both the contact carrier 60 and the contact rod 46 are constructed of material having a high thermal conductivity, such as copper. As shown the contact carrier 60 may also be pivotally secured to the contact rod 48 by suitable means such as a fastener 70 extending between the sidearms 66.

The solid copper contact rod 46 extends rearwardly from the carrier through an axially projecting integral central bushing 72 of heat cap 44 and is provided on its opposite end with a terminal hub portion 74 of reduced diameter. A central axially extending aperture 76 is provided in hub portion 74 for receiving a threaded connector 78 whose head 80 is held within the interior of the tubular operating rod 52.

The cylindrical armature 48 of solenoid operator 50 is telescopically mounted on the operating shaft 52 and includes a flat, disclike terminal flange 82 extending radially from the axis of the armature adjacent the open end of the cup-shaped stator 54 thereby forming a low flux path for the high-speed solenoid operator 50. The armature 48 is fixedly mounted on the hub portion 74 of the contact rod by means of the threaded connector 78 with its flange 82 in full surface engagement with a flat, heat conductive, disclike fin 86 also mounted thereon, the armature 48 and fin 86 being of substantially the same radial dimension and being held on the hub between the shoulder 88 of the contact rod and an enlarged stem portion 90 of the threaded connector 78. The fin 86 is preferably made of copper, as is the connector 78 and shaft 52, so that the intimate surface contact with the shoulder 88 of contact rod 46 facilitates good heat flow from the contact rod toward the magnetic armature 48 and stator 54 of the solenoid operator.

The heat cap 44 through which the contact rod 46 extends is comprised of a generally flat central plate portion 92 having, as mentioned, an integral bushing 72 centrally located therein for slidably receiving the contact rod. In accordance with the present invention the cap 44 additionally includes a pair of integral side flanges 94 extending substantially perpendicular to the flat central plate portion 92 in the same general direction as bushing 72. As best shown in FIG. 5, the flanges 94 are secured to the side extensions 42 of the muffle enclosure 40 by the fasteners 98 and provide good thermal relation with the enclosure, the entire heat cap 44 being constructed of copper to facilitate heat flow toward the enclosure 40. The central plate portion 92 of the heat cap is of generally rectangular configuration and extends below the muffle enclosure, terminating adjacent the line terminal strap 102 of the circuit breaker. A heat conducting sheet 104 of electrical insulation is confinably mounted between the line terminal strap 102 and plate portion 92 to facilitate heat conduction therebetween while maintaining electrical insulation between the line terminal strap and the heat cap. The sheet 104 is preferably made of glass fiber reinforced plastic which has the desired electrical insulation and thermal conductivity characteristics.

Thus, as can be seen, heat generated at the contacts of the circuit breaker can be readily removed not only through the field strap assembly mounting the stationary contacts but also through the movable contact assembly 32. The heat from the movable contacts will flow into and through the contact carrier and contact rod to both the heat cap 44 and heat conducting fin 86, then from these members to the muffle

enclosure and solenoid operator respectively. The heat conveyed through the contact rod to the bushing of the heat cap is conducted away from the bushing toward the planar side flanges of the heat cap and ultimately to the large mass of metal within the muffle assembly. Simultaneously, heat will be conducted to the line terminal strap 102 through the electrical insulating sheet 104 while heat conducted beyond the cap 44 will flow away from the contact rod by means of the disclike heat conducting fin 86, connector 78 and shaft 52 toward both the armature 48 and stator 54 of the solenoid operator.

As will be apparent to persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

What we claim is new and desire to secure by Letters Patent of the United States is:

We claim:

1. An electric circuit breaker adapted to readily conduct heat away from its movable contact especially upon the occurrence of an overload current condition comprising:

- a. a support,
- b. a stationary contact mounted on the support,
- c. a movable contact mounted for movement toward and away from the stationary contact between open and closed circuit positions,
- d. a contact rod of high thermal conductivity connected to the movable contact for moving the contact between its open and closed circuit positions,
- e. a generally planar member of high thermal conductivity having a surface portion in good thermal relation with the contact rod for drawing heat away from the movable contact through the contact rod,
- f. heat dissipating means in heat transfer relationship with the planar member for dissipating the heat generated at the movable contact, and
- g. said planar member being a plate of high thermal conductivity spaced from the movable contact along the contact rod, said plate having side flanges, the heat dissipating means including a muffle assembly having an enclosure in intimate surface contact with the side flanges, said muffle assembly acting as a heat sink for the dissipation of heat conducted thereto through the side flanges of the plate.

2. An electric circuit breaker as set forth in claim 1, said circuit breaker also including a contact carrier of high heat conductivity fixedly connected to said contact rod for conducting heat away from the movable contact toward the shaft, said planar member having an integral axially extending bushing of high thermal conductivity material slidably receiving said contact rod for conducting heat away from said rod.

3. An electric circuit breaker adapted to readily conduct heat away from its movable contact especially upon the occurrence of an overload current condition comprising:

- a. a support,
- b. a stationary contact mounted on the support,
- c. a movable contact mounted for movement toward and away from the stationary contact between open and closed circuit positions,
- d. a contact rod of high thermal conductivity connected to the movable contact for moving the contact between its open and closed circuit positions,
- e. a generally planar member of high thermal conductivity having a surface portion in good thermal relation with the contact rod for drawing heat away from the movable contact through the contact rod,
- f. heat dissipating means in heat transfer relationship with the planar member for dissipating the heat generated at the movable contact, and
- g. said heat dissipating means including a line terminal strap and a thin heat conductive strip of electrical insulation, and insulation being interposed between the strap and the heat conducting planar member and in surface contact therewith.

4. An electric circuit breaker adapted to readily conduct heat away from its movable contact especially upon the occurrence of an overload current condition comprising:
 - a. a support,
 - b. a stationary contact mounted on the support,
 - c. a movable contact mounted for movement toward and away from the stationary contact between open and closed circuit positions,
 - d. a contact rod of high thermal conductivity connected to the movable contact for moving the contact between its open and closed circuit positions,
 - e. a generally planar member of high thermal conductivity having a surface portion in good thermal relation with the contact rod for drawing heat away from the movable contact through the contact rod,
 - f. heat dissipating means in heat transfer relationship with the planar member for dissipating the heat generated at the movable contact, and
 - g. a high-speed solenoid for driving the movable contact out of its closed circuit position, the solenoid having a movable armature and magnetic stator associated with the armature, a dislike fin of high thermal conductivity mounted on the shaft in abutting relationship with the armature for movement therewith relative to the stator, said fin being effective for dissipating heat from the shaft to the armature, the planar member comprising a heat conductive plate intermediate the movable contact and the solenoid, said plate having an integral central bushing slidably receiving the contact rod and a pair of side flanges facilitating dissipation of heat from the rod through the integral central bushing, and the heat dissipating means including a muffle assembly having an enclosure in good thermal conducting relation with the side flanges of the plate.
5. An electric circuit breaker adapted to readily conduct heat away from its movable contact especially upon the occurrence of an overload current condition comprising:
 - a. a support,
 - b. a stationary contact mounted on the support,
 - c. a movable contact mounted for movement toward and away from the stationary contact between open and closed circuit positions,

- d. a contact rod of high thermal conductivity connected to the movable contact for moving the contact between its open and closed circuit positions,
 - e. a generally planar member of high thermal conductivity having a surface portion in good thermal relation with the contact rod for drawing heat away from the movable contact through the contact rod,
 - f. heat dissipating means in heat transfer relationship with the planar member for dissipating the heat generated at the movable contact, and
 - g. said planar member being a plate of high thermal conductivity spaced from the movable contact and having an integral central bushing of high thermal conductivity slidably receiving the contact rod for conducting heat away from the rod, the heat dissipating means including a terminal strap and a thin heat conductive strip of electrical insulation interposed between and in contact with the strap and the heat conducting plate.
6. An electric circuit breaker comprising:
 - a. a support,
 - b. a stationary contact mounted on said support;
 - c. a movable contact mounted for movement toward and away from said stationary contact between open and closed circuit positions;
 - d. a contact rod of high thermal conductivity connected to said movable contact for moving said movable contact between open and closed circuit positions;
 - e. a high-speed magnetic solenoid supported on said support and including an armature rigidly attached to said contact rod, said armature including a disc-shaped portion having a surface facing outwardly of said solenoid, said armature including said disc-shaped portion being of magnetic material, and
 - f. a heat dissipating facing plate of substantially the same diameter as said disc portion of said armature and rigidly affixed thereto;
 - g. said contact rod and said facing plate being composed of a high thermal conductivity material whereby heat generated by said contacts flows along said contact rod to said armature and said facing plate and is absorbed and at least partly dissipated thereby.

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