United States Patent

[11] 3,632,932

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[73] Assignee General Electric Company

[54] CURRENT-LIMITING CIRCUIT BREAKER HAVING A FIELD STRAP ASSEMBLY
4 Claims, 6 Drawing Figs.

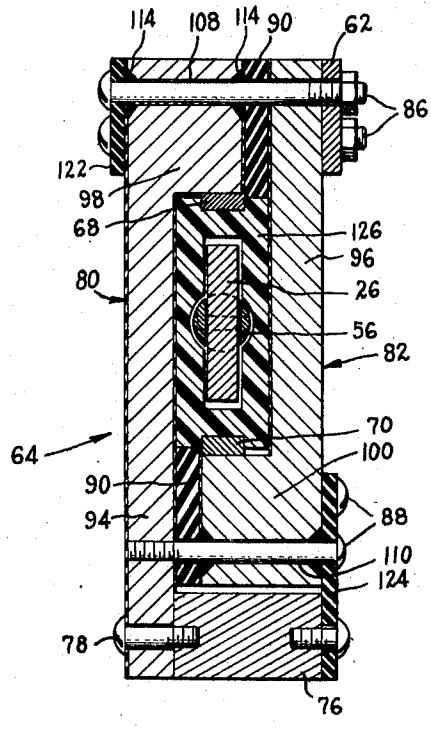
[52] U.S. Cl. ..... 200/147 R
[51] Int. Cl. H01h 33/18
[50] Field of Search 200/147, 144

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ABSTRACT: A current-limiting electric circuit breaker is provided with a field strap assembly wherein the straps are arranged in close insulated proximity and secured against relative movement by retaining bolts insulating from at least one of the straps. The field strap assembly carries the circuit breaker stationary contacts.



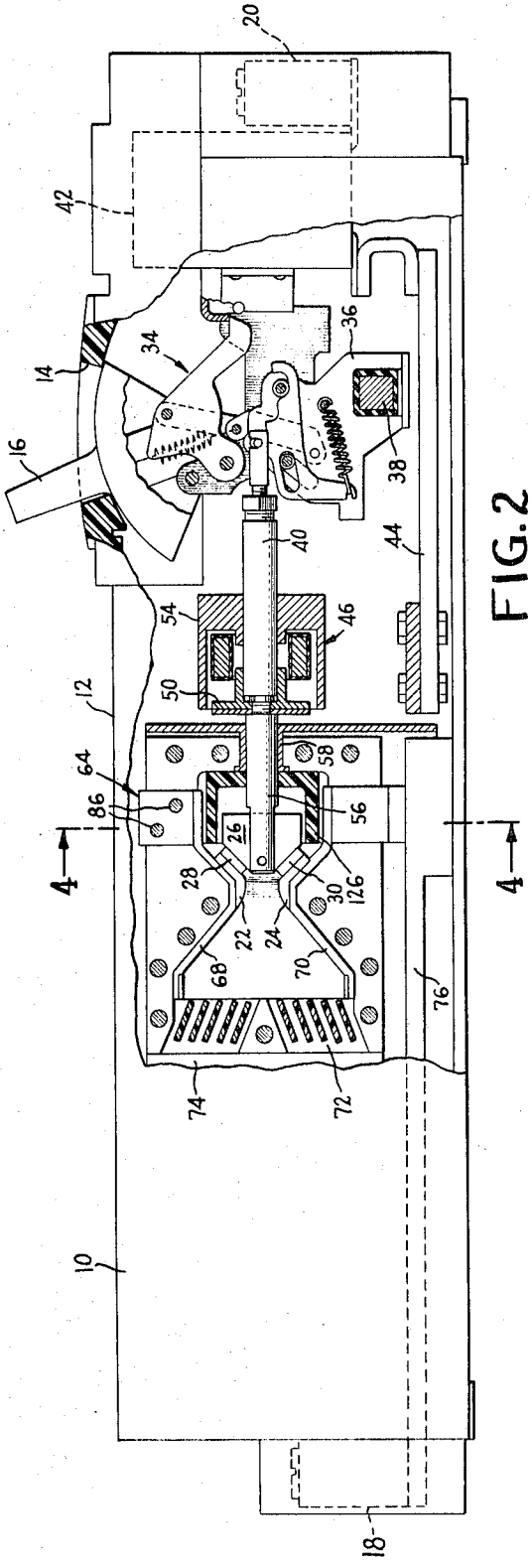


FIG. 2

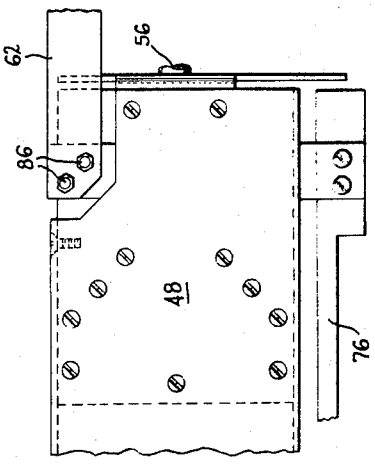


FIG. 3

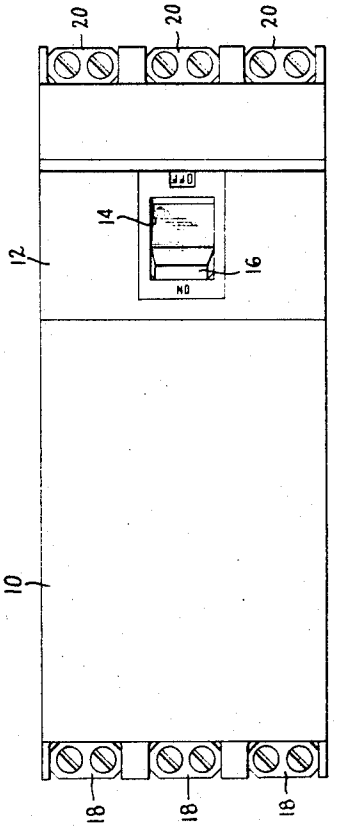


FIG. 1

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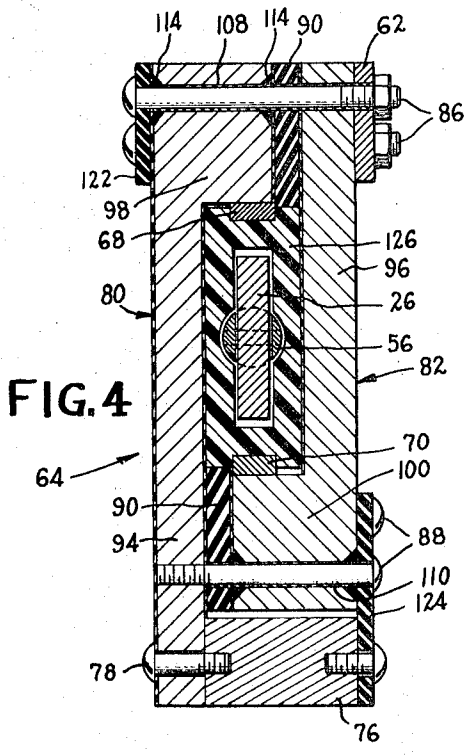


FIG. 4

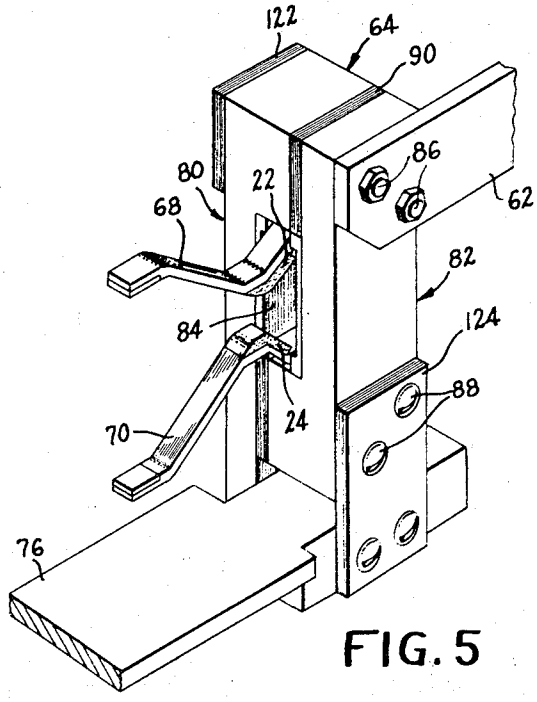


FIG. 5

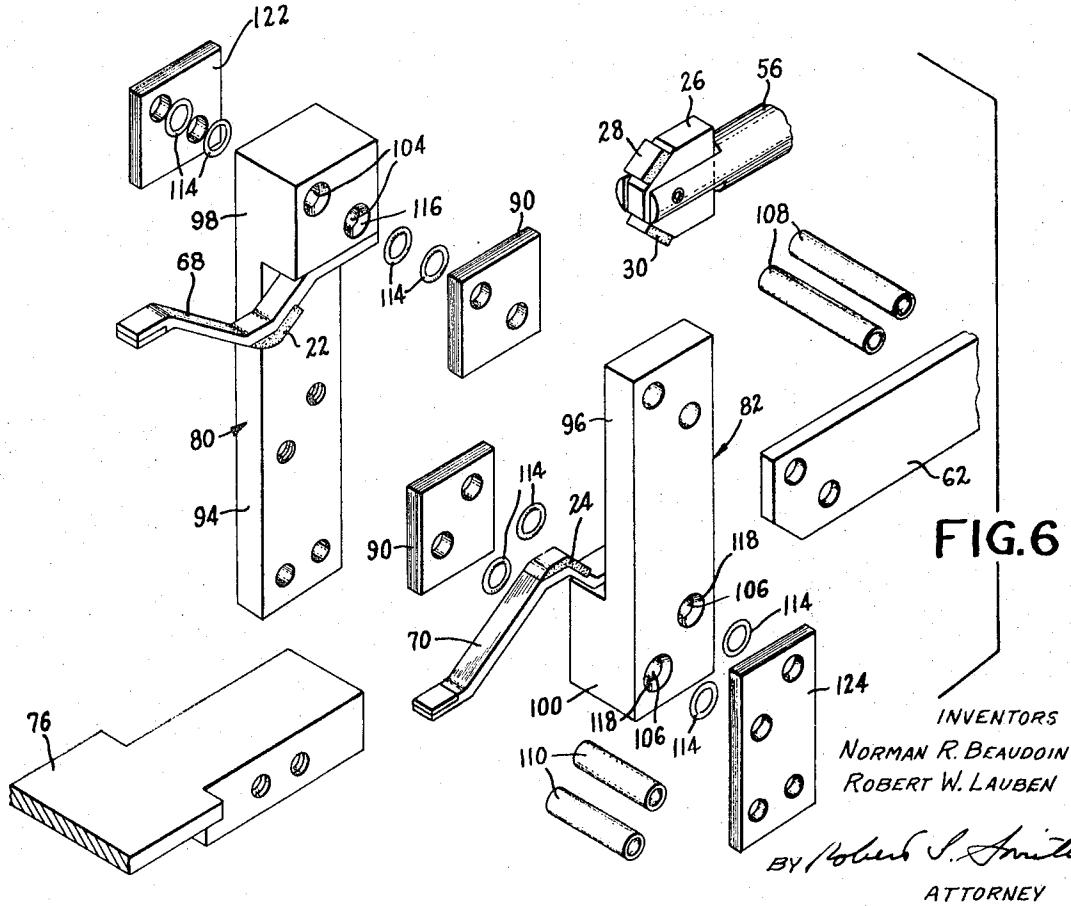


FIG. 6

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CURRENT-LIMITING CIRCUIT BREAKER HAVING A FIELD STRAP ASSEMBLY

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to electric circuit breakers and the like. More particularly, it is concerned with a new and improved electric circuit breaker of the current-limiting type having arc-initiating means for repeatedly and reliably interrupting high level short-circuit currents.

In the past, true current-limiting circuit interruption required the use of fusible elements within the circuit. Recently, however, a new type of highly efficient current-limiting electric circuit breaker has been developed. The new circuit breaker is free of fusible elements and causes the desired current interruption by first creating, and then merging, at high speed a pair of serially related arcs into one arc having a voltage drop in excess of the system line voltage. The merged high voltage arc is then maintained until the current and voltage are driven to zero and the arc extinguished. Such circuit breakers generally include an arc-initiating chamber having a pair of spaced stationary contacts and a pair of spaced field straps electrically connected to the stationary contacts. The stationary contacts are interconnected by a movable bridging member operable between open and closed circuit positions. A high-speed solenoid operator is conveniently provided for opening the contacts upon the occurrence of a high short-circuit current condition, thus causing the high-voltage-drop arc and providing the true current-limiting action with complete interruption in substantially less than one-half cycle of a 60 cycle per second time wave. A current-limiting circuit breaker of the type described is shown in U. S. Pat. Nos. 3,515,829 and 3,516,090, both issued June 2, 1970 to R. L Hurtle et al., and assigned to the same assignee as the present invention. A particular type of stationary contact arrangement for such a circuit breaker is shown and described in U.S. Pat. No. 3,483,343 issued Dec. 9, 1969 to E. B Heft and assigned to the same assignee as the present invention.

The present invention is an improvement on this type of current-limiting electric circuit breaker and has as a general object the provision for a substantially simplified and improved field strap assembly providing maximum use of the available space within the arc-initiating chamber.

Another object of the present invention is to provide a new and improved current-limiting electric circuit breaker for interrupting high level short-circuit currents, the circuit breaker including a compact field strap assembly with the straps mounted in close proximity but insulated to prevent rapid deterioration or failure of the materials within the circuit breaker.

Still another object of the present invention is to provide a new and improved circuit breaker of the type described which permits maximum use of copper in the available space thereby minimizing temperature buildup within and adjacent to the contacts while continuously carrying a current load on the order of about 400 amps.

A further object of the present invention is to provide a new and improved current-limiting electric circuit breaker of the type described having a field strap assembly which can be manufactured and assembled in a rapid, facile, efficient and economical manner without adversely affecting its performance, reliability or durability characteristics.

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

These and other objects are accomplished in accordance with the present invention by providing an electric circuit breaker with a compact stationary contact assembly including a pair of field straps assembled and secured in intimate yet electrically isolated relationship. The field straps are of generally L-shaped configuration having elongated planar stem portions in spaced confronting relationship and blocklike base portions integral with the stem portions and extending perpendicular thereto. The base portion of each strap projects toward the confronting stem portion of the opposite strap and thereby forms a generally rectangular central opening in the assembly for receiving the movable contact-bridging member. Each base portion and the confronting stem portion of the opposite strap are secured in closely spaced relationship and are separated by an insulating medium of high thermal conductivity. The field straps are bolted into a fixed relative relationship while assuring a continued electrical isolation therebetween. Arc runners supporting the spaced stationary contacts are affixed to opposite base portions of the field straps so that the stationary contacts are positioned adjacent the central opening of the assembly for simultaneous contact by the movable contact-bridging member.

A better understanding of the objects, advantages, features, properties and relationships of the invention will be obtained from the following detailed description and the 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 elevation view, partially broken away and partially in section, revealing the internal operating mechanism of the circuit breaker;

FIG. **3** is a side elevation view showing the exterior wall of the muffle enclosure at the arcing chamber of the circuit breaker of FIG. **2**;

FIG. **4** is a sectional view of the field strap assembly of the present invention taken along the line **4—4** of FIG. **2**;

FIG. **5** is a perspective view of the assembly of FIG. **4** in its open circuit position; and

FIG. **6** is an exploded perspective view of the structure shown in FIG. **5** including a movable contact-bridging member of the circuit breaker.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings in greater detail wherein like reference numerals indicate like parts throughout the several figures, the invention is shown as incorporated in a three-pole electric circuit breaker having a generally rectangular casing comprised of an outer shell member **10** and an insulating cover **12** having a central aperture **14** through which extends a manually operated handle **16**. Each pole of the circuit breaker includes a line terminal **18** and a load terminal **20** supported on opposite ends of the casing, the terminals being electrically connected to opposite spaced stationary contacts **22, 24**. A reciprocating contact-bridging member **26** carries contacts **28, 30** for movement into and out of engagement with stationary contacts **22, 24** thereby closing and opening the circuit across the breaker between the line and load terminals.

The circuit breaker shown in FIGS. **1** and **2** of the drawings is adapted to perform the usual functions of an automatic electric circuit breaker as well as its current-limiting function and, of course, facilitates the simultaneous opening and closing of all three poles upon movement of the manually operated handle **16** between its "on" and "off" positions. In the embodiment illustrated this is accomplished through an operating mechanism, generally designated by the numeral **34**, operatively connected to the manually operated handle **16** and to individual control plates **36** of each pole's contact assembly. The control plates **36** of all three poles are rigidly interconnected for simultaneous operation by an insulating crossbar **38** and are independently linked to individual operating rods **40** for each contact assembly.

In addition to the operating mechanism for manually opening and closing the contacts, the circuit breaker includes means for automatically opening the contacts upon the occurrence of predetermined excess current conditions. Where the excess current is of a low level, the contact assembly can be moved to an open circuit condition by means of a trip unit as-

sembly, schematically shown at **42**, electrically connected to the contact assembly by a strap **44** and operatively connected to the operating mechanism **34**. In accordance with the present invention, high level excess current conditions up to about 100,000 amperes are handled by a high-speed current-limiting mechanism including a high-speed solenoid operator **46** and an arc control assembly housed within the muffle enclosure **48** (FIG. **3**).

The high-speed solenoid operator **46** includes an armature **50** securely connected to the operating rod **40** for movement in response to activation of a magnetic field piece or stator **54**. The operating rod **40** is threadably connected to a contact rod **56** passing through a bushing **58** in the muffle enclosure **48** for operatively supporting the trapezoidal contact-bridging member **26** during its reciprocal movement between open and closed circuit positions. An electrical conductor **62** electrically connects the high-speed solenoid operator **46** to the circuit breaker's field strap assembly **64** so that upon the occurrence of a high level short-circuit condition, the solenoid operator becomes sufficiently energized to draw the armature **50** to the right as viewed in FIG. **2**, causing movement of the bridging member **26** out of the closed circuit position shown in FIG. **2**. This movement, in turn, causes separation of movable contacts **28, 30** from stationary contacts **22, 24** and creates an arc therebetween. The arc thus produced travels along diverging arc runners **68, 70** toward a baffle assembly **72** and into a muffle chamber **74** where the thermal energy of the arc is absorbed and dissipated as the noise created by the arc is muffled. An operating mechanism of the type described and suitable for use with the subject invention is shown in U.S. Pat. No. 3,384,845 issued May 21, 1968 to J. F. Johnson et al. and assigned to the same assignee as the present invention. Certain aspects of the high-speed solenoid construction shown herein are disclosed and claimed in application Ser. No. 873,968 filed Nov. 4, 1969 by N. R. Beaudoin et al. and assigned to the same assignee as the present invention.

The field strap assembly **64** of the circuit breaker is connected to the line terminal **18** by an elongated line terminal strap **76** extending longitudinally of the circuit breaker along the exterior of the muffle enclosure **48**. As best seen in FIGS. **4–6**, the field strap assembly is comprised of a pair of L-shaped field straps **80, 82** arranged in confronting relationship to define a generally rectangular cross-sectional configuration having a central aperture **84** for receiving the movable contact-bridging member **26**. As will be appreciated the central aperture **84** also serves as part of an arc-initiating chamber of the circuit breaker. The line field strap **80** is securely attached to line terminal strap **76** by fasteners **78** while both the line field strap **80** and load field strap **82** are interconnected in secure assembled relationship by means of two sets of retaining bolts **86, 88** extending therethrough. It is an advantage of the present invention that the field straps are assembled in close proximity and at the same time are electrically insulated from each other by suitable insulating means which includes a pair of thin electrically insulating gaskets **90**. The gaskets are preferably made of glass fiber reinforced plastic capable of also acting as a heat conduction transfer medium. In this connection, gaskets made from glass fiber and plastic composition such as glass-melamine have been used with repeated success. As will be appreciated, this construction advantageously affords sufficient isolation to assure an open circuit condition upon withdrawal of the contact-bridging member **26** toward its open circuit position.

Both line field strap **80** and load field strap **82** are solid copper components of considerable bulk having substantially the same L-shaped configuration. The straps are comprised of elongated striplike stem portions **94, 96** and respective integral block base portions **98** and **100** extending from the stem portions at substantially a right angle thereto. As mentioned, the field straps are positioned in a generally rectangular confronting relationship whereby the block base portion **98** of line field strap **80** faces toward but is spaced from stem portion **96** of load field strap **82**, the gasket **90** being sandwiched therebetween in abutting contact with both portions. As shown, the portions **100** and **94** are in a similar confronting yet insulated relationship.

The retaining bolts **86, 88** securing the two field straps in assembled relationship conveniently extend through apertures **104, 106** in the respective base portions of the field straps and are individually isolated from the base portions by insulating tubes or sleeves **108, 110** of glass fiber epoxy composition. As shown in FIGS. **4** and **6** the apertures **104, 106** are provided with chambers **116, 118**, respectively, at both ends for receiving O-rings **114** therein. In the preferred embodiment, the O-rings **114** are compressed within the cone-shaped chamfers **116** and **118** and against the sleeves **108, 110** to hold the sleeves against slidable displacement within the apertures. This compressive retention of the sleeves by the O-rings is caused not only by the operation of the flat insulating gaskets **90** on the O-rings but also by a pair of exterior insulating sheets **122** and **124** confinably abutting the exterior surface of the respective base portions **98, 100**. Thus the retaining bolts **86** securing the base portion **98** to the confronting stem of the load field strap traverse the entire assembly **64** and abuttably secure the sheet **122** and conductor **62** to opposite sides of the assembly while maintaining firm assembled relationship of the field straps and compression gripping of the tubes **108** by the O-rings **114**. The electrical insulating sheet **124** secured to load field strap **82** is also fastened to line terminal strap **76** to stabilize the assembly, conduct heat from the field strap assembly **64** to the line terminal strap **76**, and maintain the firm rigid construction of the assembly. The electrical insulating sheets **122** and **124** are composed of a glass fiber reinforced plastic such as that used for electrically insulating gaskets **90**.

The block base portions of the respective field straps each supportably carry a spaced stationary contact through the individual arc runners **68, 70** brazed thereto. Upon assembly of the field straps the arc runners are disposed in alignment within a plane passing through the central operating **84** and parallel to the principal planes of stem portions **94, 96**. The stationary contacts **22, 24** are secured to their respective arc runners forwardly of the field straps and are disposed at an acute angle relative to each other to provide mating engagement with the movable contacts **28, 30** carried by the contact-bridging member **26**.

As shown in FIGS. **2** and **4**, the movable contact-bridging member **26** is further provided with a cup-shaped insulating sleeve **126** fully lining the walls of the central opening and effectively insulating movable member **26** from the field strap assembly **64** and those portions of the arc runners located within the central opening **84**.

As can be seen from the foregoing detailed description, the present invention provides a simplified field strap assembly employing heavy-duty copper field straps which make maximum use of the available space and minimize the temperature buildup within the contact area under continuous current loads of about 400 amps. The construction permits mounting of the individual field straps in close proximity without relative movement under magnetic forces, or the possibility of ionized air between confronting strap surfaces during arc interruption, or other adverse effects on performance, reliability or durability.

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:

1. An electric circuit breaker comprising:

a. a support;

b. a contact assembly supported on the support including a pair of spaced stationary contacts and movable contact-bridging means movable into and out of a closed circuit position in engagement with the stationary contacts;

c. a field strap assembly of generally rectangular cross section electrically connected to the stationary contacts,

d. said field strap assembly comprising a pair of elongated conductive straps extending in spaced parallel relation parallel to a line defining the shortest distance between said stationary contacts; one of said straps supporting one of said stationary contacts and having its major portion extending in a direction from said one stationary contact toward and beyond the other of said stationary contacts; the other of said straps supporting said other of said stationary contacts and having its major portion extending from said other stationary contact toward and beyond said one of said stationary contacts;

e. said one of said conductive straps having an integral portion adjacent said one stationary contact at the side thereof opposite from said other stationary contact and closely spaced from said major portion of said other of said conductive straps; said other of said conductive straps having an integral portion adjacent said other stationary contact at the side thereof opposite from said one stationary contact and closely spaced from said major portion of said one of said conductive straps;

f. first solid insulating spacing means positioned between said integral portion of said strap and said major portion of said other strap; second solid insulating spacing means positioned between said integral portion of said other strap and said major portion of said one strap;

g. first fastening means connecting said integral portion of said one strap to said major portion of said other strap with said first insulating spacing means therebetween; and second fastening means connecting said integral portion of said other strap to said major portion of said one strap with said second insulating spacing means therebetween, whereby said conductive straps are positively connected together to resist forces tending to move them away from each other,

h. said first and second fastening means each comprising at least one elongated fastening member extending through said insulating spacing means.

2. An electric circuit breaker as set forth in claim 1 wherein each of said elongated fastening members comprises a metallic member and wherein said circuit breaker includes insulating means preventing said metallic fastening member from electrically interconnecting said integral portion and said major portion of said straps respectively.

3. An electric circuit breaker as set forth in claim 1 wherein said contact assembly also includes insulating means positioned along the mutually confronting surfaces of said major portions of said conductive straps in the region thereof between said extension.

4. An electric circuit breaker as set forth in claim 3 wherein said contact assembly also includes a pair of outwardly diverging arc runners each attached to one of said stationary contacts respectively.

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