April 6, 1965 R. W. BETHKE 3,177,332

HIGH VOLTAGE CIRCUIT BREAKERS WITH CONTACT PRESSURE BOOSTERS AND ARCING CONTACTS

Filed June 11, 1962

3 Sheets-Sheet 1

Fig. 4

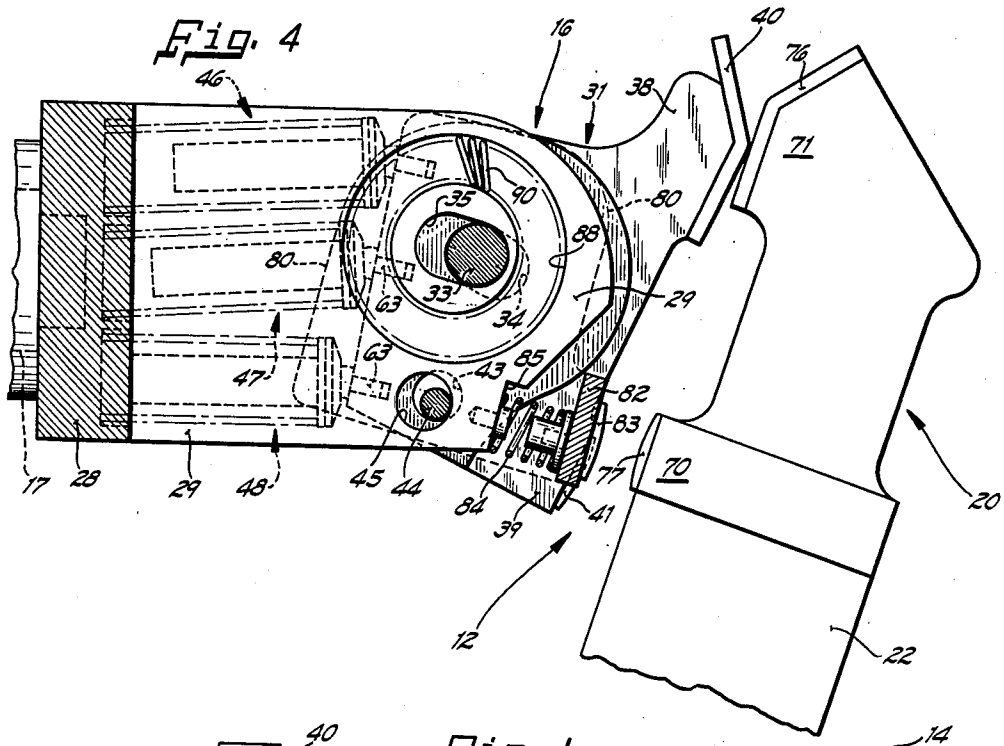


Fig. 5

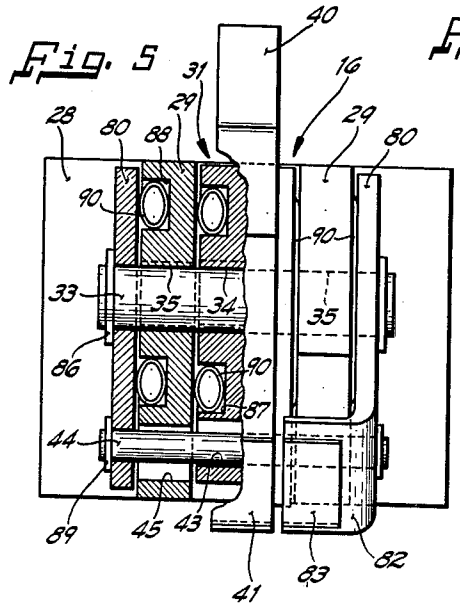
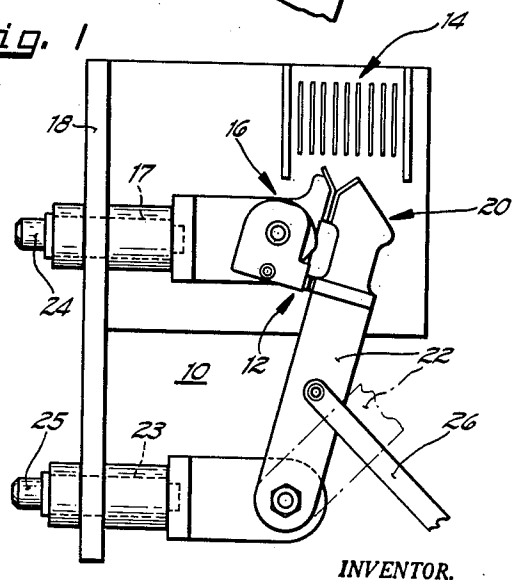


Fig. 1



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Fig. 2

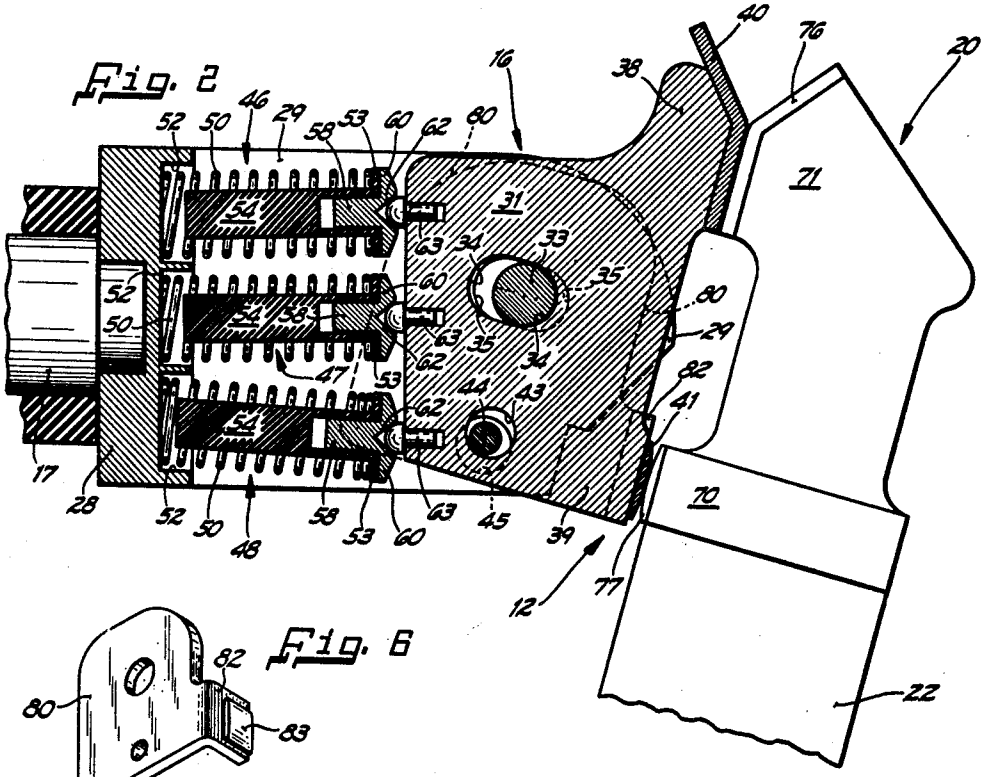


Fig. 6

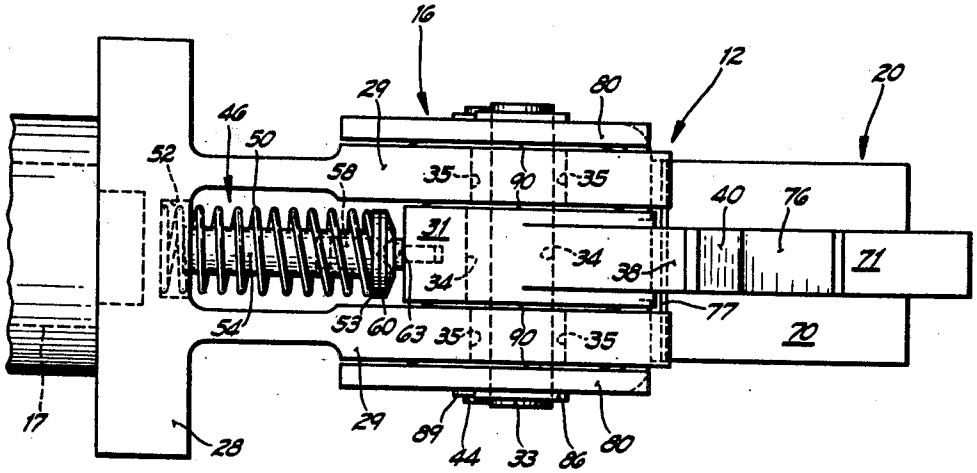


Fig. 3

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Fig. 7

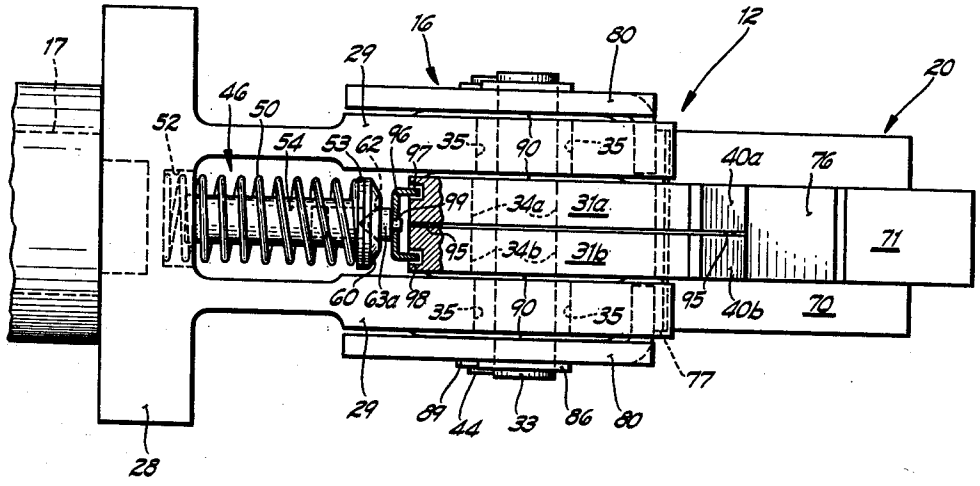
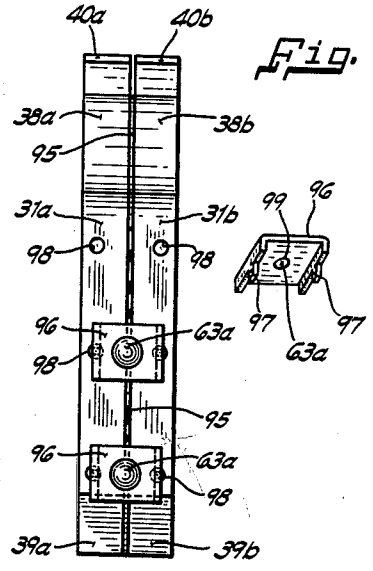


Fig. 8



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3,177,332

HIGH VOLTAGE CIRCUIT BREAKERS WITH CONTACT PRESSURE BOOSTERS AND ARCING CONTACTS

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Filed June 11, 1962, Ser. No. 201,662
4 Claims. (Cl. 200—170)

This invention relates to circuit breakers and more particularly to the contact structure for high voltage circuit breakers.

High voltage circuit breakers of the type having contacts which part in air and magnetic or gas blast means for blowing an arc into interrupting structure, are generally provided with main current carrying contacts and auxiliary arcing contacts. The auxiliary arcing contacts are normally connected in shunt with the main current carrying contacts and are arranged to part after the main current carrying contacts have parted so that the arc will be carried by the auxiliary contacts. In addition, such auxiliary contacts are arranged to engage upon closure of the circuit breaker prior to the engagement of the main current carrying contacts so that any pre-strike will also be carried by these auxiliary contacts. This insures that the main current carrying contacts will not become damaged by repeated arcings.

In order to insure that no arc is struck between the main current carrying contacts, the auxiliary contacts should remain in engagement until after the main current carrying contacts have separated a predetermined distance. One method of accomplishing this result is to mount one of the auxiliary contacts for pivotal movement toward the other and to employ a relatively large contact pressure spring to hold the auxiliary contacts in engagement for a short portion of the switch arm's pivotal movement.

This prior art arrangement had the disadvantage that the auxiliary contact spring pressure had to be relatively large, because once the main current carrying contacts part the auxiliary contact carries the entire load current, so that the electromagnetic contact blow-apart forces are substantially increased. Such high contact pressures inhibit rapid closing of the circuit breaker and exert an inordinate force on the circuit breaker latching mechanism.

It is an object of the invention to provide high voltage circuit breaker having auxiliary arcing contacts wherein the spring pressure increases substantially when the main current carrying contacts part and which decreases sharply upon the re-engagement of these contacts.

Another object of the instant invention is to provide auxiliary arcing circuit breaker contacts when their contact pressure is relatively high after the main current carrying contacts have parted and which is substantially lower when the circuit breaker is in its latched position.

A more specific object of the invention is to provide a circuit breaker with a pair of contact assemblies mounted for movement into and out of a closed position and each having a main current carrying contact and an auxiliary arcing contact, wherein one of the contact assemblies includes a contact member for supporting its auxiliary contact and which is mounted for limited translational and pivotal movement toward the other assembly and spring means are provided for urging the auxiliary contacts into high pressure engagement when the assemblies are in a closed position so that relative movement of said assemblies toward an open position allows initial translational movement of the contact member and pivotal movement thereof upon the termination of translational movement

and after the separation of the main current carrying contacts to hold the auxiliary contacts in engagement, whereby the spring means begins acting through a moment arm around the pivotal axis of the contact member to increase the force holding the auxiliary contacts together.

These and other objects and advantages of the instant invention will become more apparent from the detailed description thereof taken with the accompanying drawings in which:

FIG. 1 shows a portion of a circuit breaker illustrating how the contact structure, according to the instant invention, may be employed;

FIG. 2 is a side elevational view, partly in section, of contact structure according to the instant invention;

FIG. 3 is a top plan view of the contact shown in FIG. 2;

FIG. 4 shows the contact structure during a switch opening operation;

FIG. 5 is a front view of the contact structure with parts broken away;

FIG. 6 is a perspective view of a component of the contact structure shown in FIGS. 2–5; and

FIGS. 7 and 8 illustrate an alternate embodiment of the instant invention.

Referring to the drawings in greater detail, FIG. 1 shows a circuit breaker designated generally by the reference numeral 10, and including contact structure 12 and schematically illustrated arc interrupting structure 14. The contact structure 12 includes a stationary contact assembly 16 carried at the inner end of a stud 17 which is supported on the circuit breaker frame 18, and a movable contact assembly 20 carried at the upper end of a switch arm 22. The switch arm 22 is pivotally mounted at its lower end on the inner end of a second stud 23.

Each of the studs 17 and 23 carries a disconnect contact 24 and 25, respectively, at its outer end for engagement with coacting disconnect contacts (not shown) which connect the circuit breaker 10 to the system being protected. This establishes a series circuit through the device defined by the stud 17, the stationary contact assembly 16, the movable contact assembly 20, the switch arm 22, and the stud 23. It will be understood that a suitable switch operating mechanism, which is not shown but is well known in the art, will be connected to the switch arm 22 by a link 6 so that the switch arm 22 may be pivoted clockwise from its closed position shown by full lines in FIG. 1 to an open position shown by dotted lines.

It will also be understood by those skilled in the art that upon separation of the contact structure 12, an arc will be struck between the stationary contact assembly 16 and the movable contact assembly 20. Means (not shown) such as a magnetic coil and/or gas blast structure will be provided for blowing the arc up into the interrupting structure 14 where it is extinguished.

Referring now to FIGS. 2, 3, 4 and 5, the stationary contact assembly 16 is shown to include a conductive base 28 secured to the inner end of the stud 17 and a pair of arms 29 integral with and extending from the base 28. A contact member 31 is mounted between arms 29 by means of a first pin 33 extending therebetween and through an elongate aperture or slot 34 in the member 31 and through a pair of elongate apertures or slots 35 in the arms 29. While the apertures 34 and 35 are shown to be elongate they may have any suitable configuration such as circular so long as they are oversized relative to the pin 33. The contact member 31 also has an oversized aperture 43 formed adjacent its lower end below the slot 34. Aperture 43 loosely receives a second pin 44 which also loosely extends through an oversized aperture 45 formed in the arms 29.

The contact member 31 consists of a shaped body of conductive material having an auxiliary arcing contact 38 formed at its upper end and a main current carrying contact 39 formed at its lower end. High conductivity inserts 40 and 41, composed of a material such as silver, are provided at the auxiliary contact 38 and the main current carrying contact 39 respectively. Three contact spring assemblies 46, 47 and 48 extend between the base 28 and the rear surface of the contact member 31. Each of the spring assemblies is shown in FIG. 2 to include a spring 50 whose left end resides in and bears against a recess 52 formed in the base 28 and whose right end bears against the head 53 of a spring guide 54. The spring guides 54 each include a rod-like body portion which extends back from the head 53 toward the recesses 52 and are disposed interiorly of their respective springs 50. The right ends of the spring guides 54, as viewed in FIG. 2, each have a bore 55 formed therein which is telescopically received over the body of a pivot base 58. Each pivot base 58 has a conical head 60 and a reverse conical recess 62 formed at the point of the head 60 to provide a bearing surface for receiving the head of a pivot pin 63. The spring guides 54 and pivot bases 58 and the pivot pins 63 prevent the springs 50 from buckling as the contact member 31 moves.

The movable contact assembly 20 includes a main current carrying contact 70 for cooperatively engaging the stationary current carrying contact 39 and a movable arcing contact 71 for engaging the stationary arcing contact 38 when the switch arm 22 is in its closed position as shown in FIGS. 1 and 2. Inserts 77 and 76 are also provided in the current carrying contact 70 and the arcing contact 71 respectively of the movable contact assembly 20.

In the event that the contact structure according to the instant invention is required to carry relatively heavy currents, additional main current carrying contacts may be provided. In the illustrated embodiment of the instant invention these may take the form of a pair of contact plates 80, see FIGS. 3–6, mounted adjacent the outer surfaces of the arms 29 by the pins 33 and 44 and each of which has an inwardly directed contact ear 82 having an insert 83 mounted thereon. In order to accommodate these additional main current carrying members the movable main current carrying contact 70 will be elongate and provided with a plurality of inserts 77. While the pins 33 and 44 will normally secure the contact members 80 so that the ears 82 will be in firm engagement with the movable main current carrying contacts 70 when the latter is in its closed position, a contact pressure spring 84, see FIG. 4, may be provided between the rear of each of the ears 82 and a recess 85 formed in the arms 29 to insure firm electrical engagement in the event there is some loosening of the members during operation. In addition, retaining rings 86 and 89 affixed to the ends of the pins 33 and 44 and engaging the outer surfaces of the members 80 hold the assembly together.

When the contact assembly is in its closed position, current must be transferred from the arms 29, which are integral with the base 28, to the contact members 31 and 80 which are movably mounted relative thereto. For this purpose an annular groove 87 is formed in each side of the contact member 31 and encompassing the pin 33. A similar annular groove 88 is formed in each of the outer surfaces of the arms 29. Disposed in each of these annular recesses is a helically wound current interchange spring 90. As seen in FIG. 5, the distance between the bottom of the recesses 87 and 88 and the opposite surfaces of the arm 29 and the contact member 80 respectively, is less than the normal outside helical diameter of the springs 90 so that each of the convolutions of said springs are forced to lay over at an angle relative to their helical axes. As a result of the resiliency of the springs 90, each convolution bears in firm electrical engagement with their recesses and the opposed conductive surface to provide a current path therebetween. Thus, a large number of parallel current paths are provided between the arms 29 and the contact members 31 and 80 to form a low friction high current capacity joint therebetween. For a more detailed description of the current interchange structure just described, reference is made to copending application Serial No. 847,263, filed October 19, 1959 now Patent No. 3,056,101 and assigned to the assignee of the instant invention.

It can be seen in FIG. 2 that when the contact structure 12 is in its closed position the line of action of the upper spring assembly 46, acting through its associated pivot pin 63, will be through the contact member 31 at a point above the slot 34. The line of action of the middle spring assembly 47 will be through the contact member 31 at a point slightly below the center of the slot 34 and the line of action of the lower spring assembly 48 will be through the contact member 31 at a point slightly below the axis of the recess 43. Thus, it will be appreciated that when the switch arm 22 is in its closed position, substantially the entire force of the upper spring assembly 46 will act on the arcing contact 38 and substantially the entire force of the lower spring assembly 48 will act on the main current carrying contact 39, while the force of spring assembly 47 will be split between the two.

It can be seen from FIGS. 2 and 3 that when the contact arm 22 is in its closed position, the pin 33 will be intermediate the slots 35 in the arms 29 and adjacent the right end of the slot 34 in contact member 31. In addition, the pin 44 is substantially in the center of the aperture 43 in the contact member 31 and the apertures 45 in the arms 29. As the switch arm 22 begins pivoting away from the stationary contact assembly 16, during a switch opening operation, the contact assembly 20 will begin moving toward the right as viewed in FIG. 2. This will allow the spring assemblies 46, 47 and 48 to translate the contact member 31 toward the right so that the arcing contact 38 and the main current carrying contact 39 remain in engagement with their counterparts 71 and 70 respectively in the movable contact 20.

After the contact member 31 has moved a short distance toward the right, the left side of the aperture 43 in the contact member 31 will engage the pin 44 and move it into engagement with the right side of the apertures 45 in the arms 29. As a result, further forward movement of the lower end of the contact member 31 will be prevented. However, because the slot 34 in contact member 31 is substantially longer than the diameter of the apertures 43 and 45, the pin 33 will be at a point intermediate the ends of the slot 34. Such forward movement of the contact member 31 will also move the left edge of the slot 34 toward engagement with the pin 33. As a result, the contact member 31 will begin pivoting around the lower pin 44.

As the contact member 31 begins pivoting clockwise about the pin 44, the stationary main current carrying contacts 39 and 82 will disengage from the movable main current carrying contacts 70. However, such pivotal movement of the contact member 31 allows the stationary arcing contact 38 to remain in engagement with the movable arcing contact 71 as seen in FIG. 4.

It will be appreciated that at this point all of the current will now be flowing through the arcing contacts 38 and 71 so that the electromagnetic force tending to blow them apart will be substantially increased over that which existed when the major portion of this current was carried by the main current carrying contacts. As a result, a substantially greater spring force is necessary to hold these arcing contacts in engagement.

This additional spring force, which is required only during a switch opening operation and when the main current carrying contacts have parted, is supplied by two factors. Firstly, the force of the upper spring assembly 46, which formerly acted directly on the arcing

contact 38, now acts through a moment arm equal to the distance from the center of pin 44 to its line of action. As a result, the force exerted by the spring assembly 46 acting through this moment arm, provides substantially greater contact pressure and this increase occurs at the moment that the main current carrying contacts part. Secondly, the force exerted by the center spring assembly 47, which was formerly split between the arcing contact 38 and the main current carrying contact 39, is now all transferred to the arcing contact 38. It can be seen too that this tranfer of the entire force of the center spring assembly 47 to the arcing contact 38 will also occur at the moment that the contact member 36 begins pivoting and the main current carrying contacts part.

Clockwise pivotal movement of the contact 31 will continue until the left end of the slot 34 engages the pin 33 and moves said pin into engagement with the right end of the slots 35 in the arms 29. Upon this event the contact member 31 will come to rest and the arcing contacts 38 will be disengaged from the movable arcing contact 71 and any arc struck therebetween will be extinguished in the arc extinguishing structure 14, in a manner well known in the art.

While the switch 10 is in its open position the contact member 31 will remain in its pivoted position shown in FIG. 4. As a result, movement of the switch blade 22 toward its closed position will cause the movable arcing contact 71 to engage the stationary arcing contact 38 so that any prestrike, which would occur if the device were closed under load, would be drawn through these arcing contacts.

After the arcing contacts engage, the contact member 31 will be rotated counterclockwise around the pin 44 until the main current carrying contacts 39, 70 and 82 engage. Further movement of the switch blade 22 will move the contact member 31 toward the left compressing the spring assemblies 46, 47 and 48 until the contact member 31 is returned to its initial position as shown in FIG. 2.

It will be appreciated also that this increase contact pressure will be available at the arcing contact 38 during a switch closing operation and will exist until contact between the main current carrying contacts is re-established at which time the normal and substantially smaller contact pressure required to hold the arcing contacts closed will be re-established. Thus, when the switch is in its closed position, the contact pressure at the arcing contacts will be substantially smaller than that available during a switch opening or switch closing operation. As a result a substantially smaller strain will be placed on the circuit breaker mechanism for holding the contacts 12 closed.

In the alternate embodiment of the invention shown in FIGS. 7 and 8, the contact member 31 is divided into two mirror image portions 31*a* and 31*b* to provide an additional point of engagement at the main current carrying and arcing contacts for increased current carrying capacity. This construction requires that the portions 31*a* and 31*b* be independently pivotable to allow for uneven contact wear. As a result, a Teflon sheet 95 is disposed between the portions 31*a* and 31*b* to permit low-friction relative sliding movement. In addition, a yoke 96 is provided between each of the spring assemblies 46, 47 and 48 and the contact portions 31*a* and 31*b* to divide the spring pressures between the two.

As seen more particularly in FIG. 8 each yoke 96 consists of a U-shaped member having an ear 97 extending from the base of each of its legs. A small aperture 98 formed in the back of each of the portions 31*a* and 31*b* and adjacent their upper ends loosely receives the ears 97 while the base of one leg of the yoke 96 bears against each of said portions. A hole 99 in the central portion of the yoke 96 receives the truncated pivot pin 63*a*.

The various other elements of the contact portions 31*a* and 31*b* correspond to the elements of the contact member 31 and accordingly will not be discussed in detail for the sake of brevity, it being sufficient to state that such corresponding elements are identified by corresponding numerals which are distinguished by the letters *a* or *b*.

While only a few embodiments of the invention have been shown and described, it is intended that the invention not be limited thereto, but only by the scope of the appended claims.

I claim:

1. A pair of contact assemblies mounted for movement into and out of a closed position, one of said contact assemblies having a main current carrying contact and an auxiliary arcing contact, the other of said contact assemblies including a base member and a contact member, a first aperture formed in each of said members, a first pin means extending through each of said apertures and being loosely received in at least one of them to mount said contact member on said base member for limited translational and pivotal movement toward said other assembly, a second aperture formed in each of said members and a second pin means extending through said second apertures and being loosely received in at least one of them for limiting the pivotal movement of said contact member, a main current carrying contact mounted on said contact member and being disposed adjacent its pivotal axis and an auxiliary contact mounted thereon and being remotely disposed from said axis, a first spring means operatively engaging said contact member at a point adjacent said pivotal axis and a second spring means operatively engaging said member at a point remote from said axis, said spring means urging the main current carrying and auxiliary contacts into high pressure engagement when said assemblies are in a closed position with said pins in intermediate positions within the apertures which loosely receive them, relative movement of said assemblies toward an open position allowing translational movement of said contact member until said first pin means engages the margin of said first apertures whereupon pivotal movement thereof commences to separate said main current carrying contacts and to hold said auxiliary contacts in engagement so that said second spring means acts through a moment arm around the pivotal axis of said contact member to increase the pressure holding said auxiliary contacts together, said pivotal movement being arrested upon the engagement of said second pin means between the margins of said second apertures.

2. The contact assemblies set forth in claim 1, wherein said contact member comprises two side-by-side portions, each of said portions including an auxiliary contact and a main current carrying contact, and wherein each of said spring means including yoke means for dividing the contact pressure between each of said portions.

3. The contact assemblies set forth in claim 1 wherein said first and second pin means are loosely received in the apertures in each of said members, and including a pair of contact elements one of which is disposed on each of the opposite sides of said other contact assembly and engaging the opposite ends of said first and second pin means, and spring means urging said contact elements into engagement with the main current carrying contacts of said one contact assembly when said assemblies are in a closed position.

4. The contact assemblies set forth in claim 3, wherein current interchange spring means is disposed between said members and said contact elements to provide a low frictional current path therebetween.

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