

Feb. 22, 1938.

L. W. DYER

2,109,211

CIRCUIT BREAKER

Filed Sept. 12, 1934

2 Sheets-Sheet 1

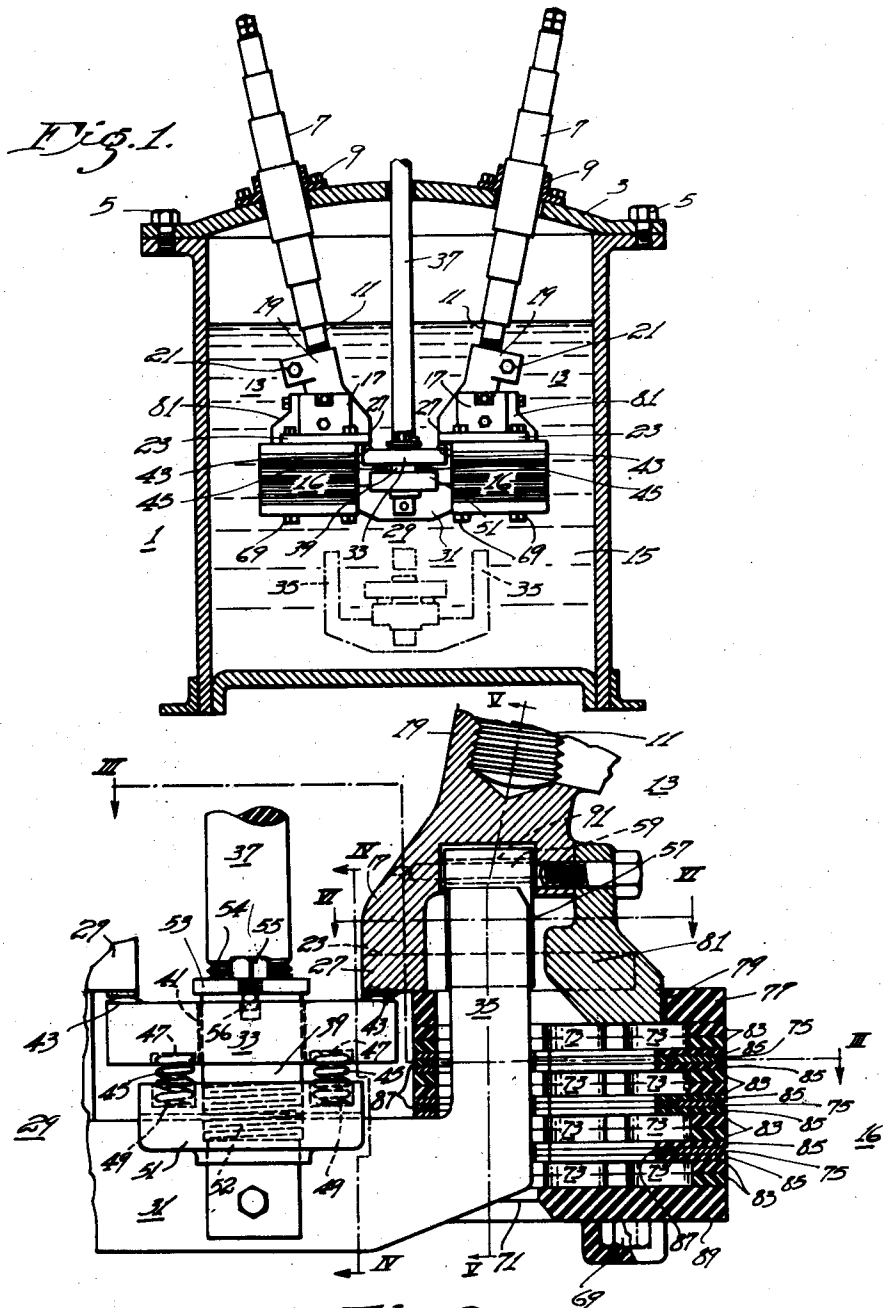


Fig. 2.

WITNESSES:

E. C. Harding
Paul D. Staister

INVENTOR

Lloyd W. Dyer.
 BY

F. W. Lyle.
 ATTORNEY

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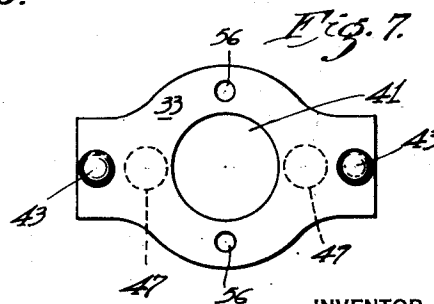
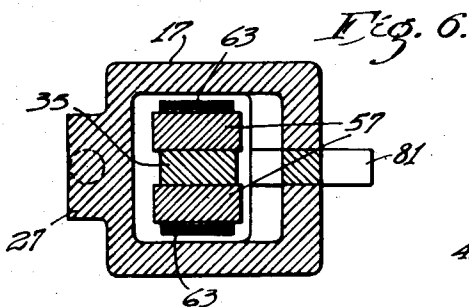
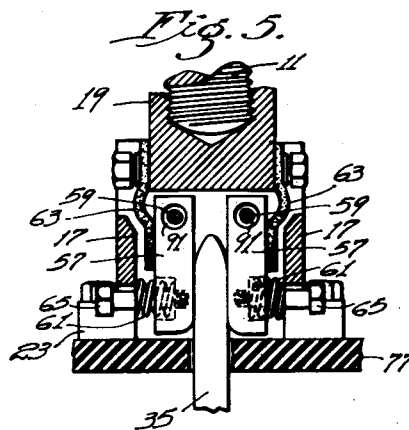
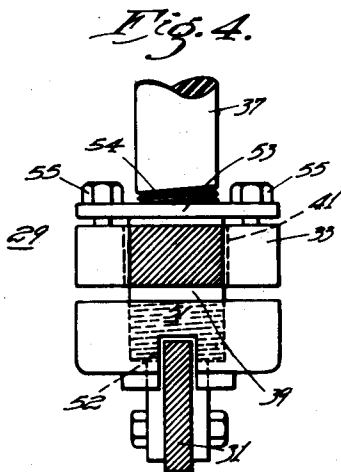
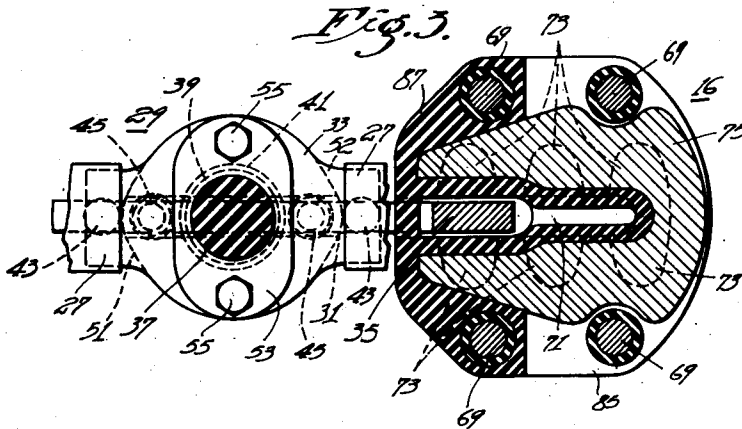
L. W. DYER

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CIRCUIT BREAKER

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2 Sheets-Sheet 2



WITNESSES:

E. C. Gidding
Paul D. Christen

INVENTOR

Lloyd W. Dyer.
BY *F. W. Lyle.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,109,211

CIRCUIT BREAKER

Lloyd W. Dyer, Swissvale, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 12, 1934, Serial No. 743,661

6 Claims. (Cl. 200-146)

My invention relates to circuit interrupters and it has particular application to contact structures for use with high capacity circuit breakers of the type used for protecting interconnected distribution network systems or the like.

The design of a commercially successful breaker for this type of service has always presented a rather complex problem to the electrical art, and one of the more important components of that problem has been the design of a satisfactory contact structure. The magnitude of the normal line currents which are carried on present day power network systems of this sort is constantly increasing. This necessitates that the current carrying parts shall have large cross-sectional area and that the cooperating contact surfaces shall be of such size and character that they are not readily corroded or otherwise caused to form high resistance contacts. Despite this requirement for large mass conductors, it is necessary that the breakers be capable of interrupting large amounts of power at fairly high voltages, this latter requirement making it imperative that the circuit interrupter be provided with an arc extinguishing device of one sort or another.

Arc extinguishing devices, as a general proposition, are not adapted for use with current carrying conductors of large cross-sectional area, due to the fact that it is extremely difficult to design an arc extinguishing device which is capable of effectively interrupting variable amounts of power which does not utilize a more or less restricted arc passage or vent opening. Thus, to secure a satisfactory arc extinguishing characteristic, it is necessary to utilize small current carrying parts, while to satisfactorily handle the normal amounts of power flowing in the circuits under consideration, it is necessary to utilize current carrying members of very considerable cross-sectional area. The requirements are hopelessly conflicting and the only satisfactory solutions, so far developed in the art, consist in the provision of two separate sets of contacts, one of very large cross-sectional area for carrying the normal line current and another particularly designed for securing effective operation of an arc extinguishing device.

In the past, various forms of this double contact arrangement have been used. Practically all of these, however, employed what is known as a brush-type bridging contact,—that is, a contact which is formed of a plurality of thin laminations of copper or other conducting material, which are either bent into an arcuate form and

then rigidly bolted together, or which are formed in some other convenient shape. This type of contact is satisfactory for most general applications; it is inherently resilient to a more or less extent, thereby assuring good contact over the entire area of the cooperating contact surfaces; it is capable of carrying large amounts of power; and it is fairly readily assembled.

Brush-type contacts, however, have a number of serious disadvantages. One important disadvantage is their high cost, due to the large number of pieces ordinarily employed and the necessity for assembling and machining those pieces. Another disadvantage, and this perhaps is more serious, is that this type of contact cannot be heated, during its normal operation, more than a comparatively moderate amount, due to the fact that even slight heating anneals the laminations and destroys their inherent resiliency. If this heating does occur and the resiliency of the laminations is impaired, the cooperating contact surfaces no longer engage each other with a low resistance contact and the resultant additional heating causes a progressive aggravation of the difficulty, eventually resulting in causing the brush contact to become quite useless as a conductor.

As contrasted with the undesirable features of the brush-type contact, the so-called butt-type contact offers a great number of advantages. As used in the electrical art, a "butt-type contact" is the term applied to an electrical contact which comprises two rigid cooperating members having solid contact surfaces which are pressed into engagement with each other by a means capable of producing high contact pressure. This type of contact is very inexpensive to manufacture, it being formed from solid material which may be cast or machined into the desired shape.

Further, butt-type contacts may be operated at very high temperatures over prolonged periods without any injurious results. This means that butt-type contacts for a circuit breaker need be made merely of sufficient size to carry the normal load currents without undue heating, because the additional heating which results during abnormal conditions will not produce any seriously objectionable results. If brush-type contacts are used, they must be capable of carrying the maximum load to which the breaker may be subjected without causing more than moderate heating. It is obvious that a very appreciable saving in the material may be effected through the use of the butt-type contacts.

In structures utilizing both main and aux-

illary contacts, no satisfactory arrangement whereby butt-type contacts could be used has heretofore been known, and it is toward the solution of that problem that this invention is particularly directed. The first and principal object of my invention, therefore, is to provide a contact structure of the butt-type which shall include both main and auxiliary contacts and which shall be suitable for use with circuit breakers utilizing arc extinguishing devices.

A further object of my invention is to provide a butt-type contact structure for use with a high capacity circuit breaker, which structure shall be self-aligning in operation and which shall be inexpensive to manufacture.

A still further object of my invention is to provide a contact structure which shall include main contacts of the butt-type and auxiliary contacts which may or may not be of the butt-type, the structure being so arranged that the electrical circuit therethrough is always initially established and finally interrupted through the auxiliary contacts.

In the preferred embodiment of my invention, I provide a single-pole, double-break, liquid circuit breaker. The main stationary contacts are non-resilient and are rigidly mounted, as are the auxiliary contacts. The bridging means employs one rigidly mounted conducting member adapted to engage the auxiliary contacts and a resiliently mounted bridging member which engages the main stationary contacts with a butt-type engagement. Both of the bridging members are supported upon a single movable actuating member, and the entire mechanism is so arranged that the main contacts are always opened before the auxiliary contacts, during the circuit opening operation, and are always closed after the auxiliary contacts, during the circuit closing operation, arcing at the main contacts being thus effectively eliminated.

Referring to the drawings,—

Figure 1 is a sectional view, partially in elevation, of a single-pole double-break, fluid submerged, circuit breaker which includes the principal features of my invention;

Fig. 2 is a fragmentary view, partially in section and partially in elevation, of the movable contact structure, one of the stationary contact structures, and one of the arc extinguishing devices of the circuit interrupter shown in Fig. 1;

Fig. 3 is a sectional view taken on the line III—III of Fig. 2;

Fig. 4 is a sectional view taken on the line IV—IV of Fig. 2;

Fig. 5 is a sectional view taken on the line V—V of Fig. 2;

Fig. 6 is a sectional view, taken on the line VI—VI of Fig. 2, which shows certain of the structural features of one of the contact structures; and

Fig. 7 is a plan view of the main bridging member which is adapted to cooperate with the main stationary contacts.

The circuit breaker shown in Fig. 1 includes a tank 1 having a cover 3 which is rigidly affixed thereto by means such as the stud bolts 5. A pair of insulating bushings 7 are supported on the cover 3 by means of suitable flanges and bolts 9, and are adapted to extend into the central portion of the tank 1. A conducting member 11, which is threaded at either end, extends through each of the conducting bushings 7, and one of the stationary contact structures 13 is supported upon the lower end of each of these

conducting members. The level of the body of liquid 15 contained within the tank 1 is sufficiently high to completely cover the contact structures during the normal operation of the breaker. Oil or any other suitable fluid may be utilized without in any way affecting the invention. Two arc extinguishing devices 16 are provided for extinguishing the two arcs which are established during the normal operation of the breaker.

Each of the stationary contact structures 13 comprises a substantially bell-shaped body portion 17 and a split sleeve portion 19 which may be cast integral therewith. These sleeve portions 19 are adapted to engage the lower ends of the conducting members 11, and in the assembled structure are rigidly secured to those conducting members by suitable bolts 21. The lower end of each of the bell-shaped portions 17 terminates in a flange 23 which has the double function of supporting the associated arc extinguishing device 16 and for defining one of the main stationary contact members 27.

A bridging means 29, which consists of two rigid bridging members 31 and 33, is provided for cooperating with the contact structures 13 in order to permit the opening and the closing of the electrical circuit through the interrupter. The lower of the two bridging members 31 is provided with a pair of upstanding contact portions 35 for engaging the auxiliary stationary contacts, and is rigidly affixed at its midpoint to a pull-rod 37 of insulating material, which is adapted to be engaged by a suitable actuating mechanism (not shown).

The other of the two bridging members 33 is shown particularly in Fig. 7, and is adapted to be resiliently supported upon a cylindrical guide member 39 of conducting material disposed intermediate the lower bridging member 31 and the body portion of the pull-rod 37. The opening 41 in the central portion of the main bridging member 33 is slightly larger than the outer dimension of this cylindrical shaped member 39, and the main bridging member is adapted to slide thereon during the operation of the breaker. Suitable contact portions 43 are brazed or otherwise rigidly affixed to each of the outer ends of the first mentioned bridging members 31 for cooperating with the main stationary contacts 27.

The main bridging member 33 is biased upwardly by means of a pair of springs 45, the upper ends of which engage suitable recesses 47 formed therein. The lower end of each of the springs 45 engages a similar recess 49 formed in a circular spring retaining member 51 which engages the threaded lower portion 52 of the guide member 39. The amount of upward movement which may be produced by these springs 45 is definitely limited by a stop member 53 which engages the upper end of the cylindrical guide member. A pair of guide bolts 55 extend through suitable openings 56 in the stop member 53 for preventing rotary movement of the bridging member 33 relative to the guide member 39.

Through the provision of the threaded portions 54 on the lift rod 37, the main bridging member 33 on the guide member 39 may be moved on the lift rod 37 a distance sufficient to compensate for contact wear or manufacturing inaccuracies. Also, the threaded portion 52 on the guide member 39 provides a convenient means

for adjusting the contact pressure securing springs 45.

Each of the auxiliary contact structures comprises a pair of opposed contact fingers 57 which are pivotally supported upon pins 59 extending through the sides of the bell-shaped portion 17 of the main stationary contact frames and are biased toward each other by coil spring 61. Each of the pivoted fingers is electrically connected to the body portion 17 of the stationary contact frame by a suitable flexible shunt 63, the upper end of which is bolted to the frame and the lower end of which is brazed or otherwise conductively joined to the associated contact finger.

The amount of movement of the opposed fingers 57 under the action of their biasing springs is defined by suitable guide bolts 65 which project through the walls of the bell-shaped portion 17 of the frame. Castellated nuts 67 permit the ready adjustment of those guide bolts. Each of the pairs of opposed fingers 57 is adapted to engage the sides of one of the upstanding portions 35 of the lower bridging member 31, and, as shown in Fig. 5, they are so disposed that considerable downward movement of the bridging member may be effected before the electrical circuit through the auxiliary contact structure is broken. This arrangement assures the opening of the contacts in proper order.

Each of the arc extinguishing devices 16 is of the side vented chamber type, and comprises essentially a plurality of superposed plates which are assembled upon suitable through bolts 69. These plates have centrally disposed openings therein which align to form an arc passageway or slot 71, the length of which is several times its width. Some of the plates also have cutout portions for defining oil pockets 73 along the arc passage, and at spaced intervals throughout the assembled stack are positioned U-shaped iron plates 75. These iron plates so distort the magnetic field about the arc which is established within the arc passage 71 during the circuit interrupting operation that that arc is caused to move in the direction of the closed end of the arc passage. During this movement, the arc is brought into contact with the fresh volumes of the oil or other liquid retained in the pockets 73, and the resulting gases are caused to flow laterally therethrough in venting. The combined result of the arc movement and the gas evolution is to cause a turbulent intermingling of the arc stream with the gaseous arc products and with some of the unvolatilized arc extinguishing liquid, thereby effecting a rapid cooling and extinguishment of the arc.

The particular arc extinguishing structures illustrated in the drawings are generally similar to those shown in the application of S. H. Boden and S. T. Schofield, Serial No. 654,626, which was filed February 1, 1934 and which is assigned to the assignee of this invention. Specifically, each extinguisher comprises a rather thick upper plate 77 of insulating material, which has a centrally disposed slot 79 therein for permitting the passage of the cooperating upstanding portion 35 of the movable bridging means 29, and for permitting an arcing horn 81 to extend downwardly into the arc passage 71 for a short distance.

A pair of insulating plates 83 having cutout portions therein for defining the upper set of oil pockets 73 are disposed immediately beneath this upper plate 77. Next in the stack is one of the insulating plates 85 which is provided with a slotted opening for defining the outline of the

arc passage itself. This insulating plate is followed by one of the iron plates 75 and an insulating liner plate 87 (shown particularly in Fig. 3), and the next element in this stack is a second insulating plate 85.

Two more of the pocket defining plates 83 are positioned immediately beneath the second insulating plate 85, and these plates are followed by one of the groups comprising an iron plate 75 with its insulating liner plate 87 sandwiched between two of the insulating plates 85. The remaining portion of the stack assemblage comprises, successively, two of the pocket defining plates 83, the third of the iron plate arc moving units, and two more of the pocket defining plates 83. The lower unit in the stack structure comprises a thick insulating plate 89 somewhat similar in outline to the upper insulating plate 77.

All of the plates are provided with suitable openings for accommodating the through bolts 69 upon which they are assembled. The lower end of each of these bolts, as shown particularly in Fig. 2, is embedded in insulating material in order to prevent insulation breakdown when the breaker is not in the closed circuit position. The inner portion of the lower plates in each of the arc extinguishing devices is cut out in order to provide vents along one side of the arc passage 71 and to permit the free movement therethrough of the central portion of the lower bridging member 31.

The circuit breaker is shown in the closed position in Figs. 1, 2, 3, and 5. In this position, it will be seen that each of the upstanding portions 35 of the lower bridging member is engaged by one of the pairs of opposed contact fingers 57 which comprise the auxiliary contacts. Similarly, it will be seen that the main contact portion 27 of each of the stationary contact structures 13 is engaged by the cooperating contact portion 43 of the main bridging member 33. It will further be noted that the main bridging member 33 has been moved downwardly (on the guide member 39) out of engagement with the stop member 53 and is, therefore, substantially floating upon the biasing springs 45. This arrangement assures an equalization of the contact pressure between the two pairs of separable main contacts, and at the same time it allows the securing of almost any reasonable amount of contact pressure through the selection of proper springs.

Further, the slidable and resilient mounting of the main bridging member 33 makes that member self-aligned. This feature, in combination with the automatic equalization of contact pressure, and the possibility of securing any reasonable amount of contact pressure, makes possible the utilization of butt-type contacts for the main current carrying portions of the breaker. The advantages of this, in reducing the cost of the entire structure and in making possible the operation of the contacts at a high temperature, have been pointed out in some detail above.

The pivot opening 91 in each of the contact fingers 57 is somewhat larger than the pivot pin 59 extending therethrough. Thus, the auxiliary contacts are likewise substantially self-aligning, and by virtue of the fact that the upstanding portions 35 of the auxiliary bridging member 31 extend a considerable distance therebetween when the breakers are in the closed circuit position, they permit of considerable downward movement of the bridging means before the electrical circuit through the breaker is opened.

This large amount of allowable relative movement between the auxiliary contacts before the electrical circuit therethrough is opened, and the small amount of possible movement of the main bridging member 33 (which results from the positioning of the stop means 53) assures that the electrical circuit through the breaker will always be opened by the auxiliary contacts.

Upon the occurrence of an overload of sufficient magnitude or duration to effect the actuation of the operating mechanism, the pull-rod 37 is caused to move in a downwardly direction.

Very shortly thereafter the electrical circuit through the main bridging member 33 is opened, due to the engagement of that member with the stop portion 53 affixed to the cylindrical guide 39 therefor. No appreciable arcing occurs upon the separation of these contacts, due to the fact that a large proportion of the contact areas of each of the upstanding portions 35 of the auxiliary bridging member 31 is still engaged by the auxiliary contact fingers 57. As the opening movement progresses, however, the upstanding portions 35 are moved out of engagement with the contact fingers 57 and an arc is established within each of the arc passages 71.

The magnetic plates 75 embedded in the walls of the arc extinguishing devices 16 immediately exert a force on each of these arcs tending to move them toward the inner portion of each of the arc passages. The upper end of each of the arcs, shortly after it is established, transfers from the opposed pivoted fingers 57 onto the arcing horn 81 which is bolted onto the frame of the contact structure, thereby minimizing the burning of the fingers. As each of the arcs is moved laterally within one of the arc passages 71, a considerable amount of the fluid retained in the pockets 73 is decomposed, and as explained before, the resultant arc products flow laterally through the arc thereby effecting its extinguishment.

From the foregoing, it will be seen that I have provided a new and improved contact structure for use with circuit breakers or similar equipment. My improved contact structure makes possible the use of butt-type main contacts in a structure utilizing both main and auxiliary contacts, and at the same time it includes means for assuring that the circuit shall finally be opened by the auxiliary contacts. Moreover, my improved contact structure is extremely simple in form, in that both the main and auxiliary contacts may be actuated through the movement of a single operating member, and it is readily adjustable to compensate for wear of the contacts or manufacturing inaccuracies.

While certain of the structural arrangements shown are particularly suitable for carrying out the objects of my invention, it is to be understood that many of these details are merely illustrative, and that the broad feature of my invention, namely the provision of means whereby butt-type contacts may be utilized for the main contacts of a device employing both main and auxiliary contacts, is capable of wide application to numerous other structures. It is my desire, therefore, that the following claims shall be accorded the broadest reasonable construction, and that my invention shall be limited only by what is expressly stated therein and by the prior art.

I claim as my invention:

1. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts of solid

material, a rigid member of solid material for bridging said main contacts, a pair of spaced auxiliary contact means mounted adjacent said main contacts and connected in parallel therewith, a bridging member for said auxiliary contact means, a single actuating member for moving said rigid member and said bridging member into and out of engagement with their respective co-operating contacts, said rigid member being resiliently mounted upon said actuating member for relative movement longitudinally with respect thereto and to said bridging member, and guide means associated with said actuating member for preventing rotational movement of said rigid member relative to said actuating member and for determining the amount of relative longitudinal movement of said rigid member with respect to said actuating member.

2. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts of solid material, a rigid member of solid material for bridging said main contacts, a pair of spaced auxiliary contact means mounted adjacent said main contacts and connected in parallel therewith, a bridging member for said auxiliary contact means, a single actuating member secured to said bridging member for moving the latter into and out of engagement with said auxiliary contact means, means for operatively securing said rigid member to said actuating member comprising a support, spring means interposed between said support and said rigid member for disturbing the reactive pressure between said rigid member and said main contacts, said support being adjustable longitudinally of said actuating member for varying the contact pressure between said rigid member and said main contacts, and guide means for limiting the relative movement of said rigid member with respect to said support.

3. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts of solid material, a rigid bridging bar of solid material adapted to be moved into pressure engagement with said main contacts, a pair of spaced auxiliary contact means adjacent said main contacts and electrically connected in parallel therewith, a bridging member for said auxiliary contact means, an operating rod secured to said bridging member for moving the latter into and out of engagement with said auxiliary contact means, a floating support for said rigid bridging bar mounted upon said operating rod and being adjustable longitudinally with respect to said rod, said support comprising a guide member for determining the amount of relative movement of said rigid bridging bar with respect to said operating rod and for preventing relative rotative movement of said rigid bridging bar with respect to said support, and resilient means interposed between said guide member and said rigid bridging bar to provide a uniform distribution of pressure between said rigid bridging bar and said main contacts.

4. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts, a main rigid bridging bar adapted for movement into and out of engagement with said main contacts, auxiliary contact means adjacent each of said main contacts and electrically connected thereto, a rigid bridging member having non-yielding contact portions rigidly mounted at each end thereof adapted for sliding contacting engagement with said auxiliary contact means, an operating rod rigidly secured to said rigid bridging

ing member, means for resiliently supporting said main rigid bridging bar upon said operating rod to provide for relative movement of said main rigid bridging bar with respect to said rigid bridging member, said operating rod being movable between predetermined positions for sequentially moving said main rigid bridging bar and said rigid bridging member into and out of engagement with their respective contacts, and means for adjusting said resilient support means longitudinally of said operating rod for adjusting the contact pressure between said main rigid bridging bar and said main contacts.

5. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts, an auxiliary contact electrically connected to each main contact, a rigid auxiliary bridging member adapted to be moved into and out of engagement with said auxiliary contacts, an operating rod rigidly secured to said auxiliary bridging member, a tubular guide member surrounding said operating rod and adjustably secured thereto, said guide member having a support flange and a stop member thereon, a rigid main bridging member of solid material slidably mounted on said guide member between said support flange and said stop member and adapted to be moved by said operating rod into and out of engagement with said main contacts and spring means disposed between said support flange and said main bridging member for biasing said main bridging member against said stop member, said stop member holding said main bridging member against relative rotative movement about said

guide member for maintaining said main bridging member in alignment with said main contacts.

6. In a circuit breaker, a pair of spaced non-yielding rigidly supported main contacts, an auxiliary contact electrically connected to each main contact, a rigid auxiliary bridging member adapted to be moved into and out of engagement with said auxiliary contacts, an operating rod rigidly secured to said auxiliary bridging member at a point intermediate its ends, said operating rod having a threaded portion adjacent said auxiliary bridging member, a cylindrical guide member having threaded engagement with said threaded portion of said operating rod, said guide member having a support flange and stop member disposed thereon in axially spaced relation, a rigid main bridging member of solid material disposed for sliding movement on said guide member between said support flange and said stop member and adapted to be moved into and out of pressure engagement with said main contacts by said operating rod, and spring means between said main bridging member and said support flange for biasing said main bridging member against said stop member, said stop member holding said bridging member against relative rotative movement about said guide member, said guide member having a transverse slot at its lower end into which said auxiliary bridging member is adapted to extend for holding said guide member against rotation with respect to said operating rod.

LLOYD W. DYER.