Nov. 23, 1937. L. W. DYER ET AL 2,100,102

CIRCUIT BREAKER

Filed March 8, 1935 2 Sheets-Sheet 1

Fig. 1

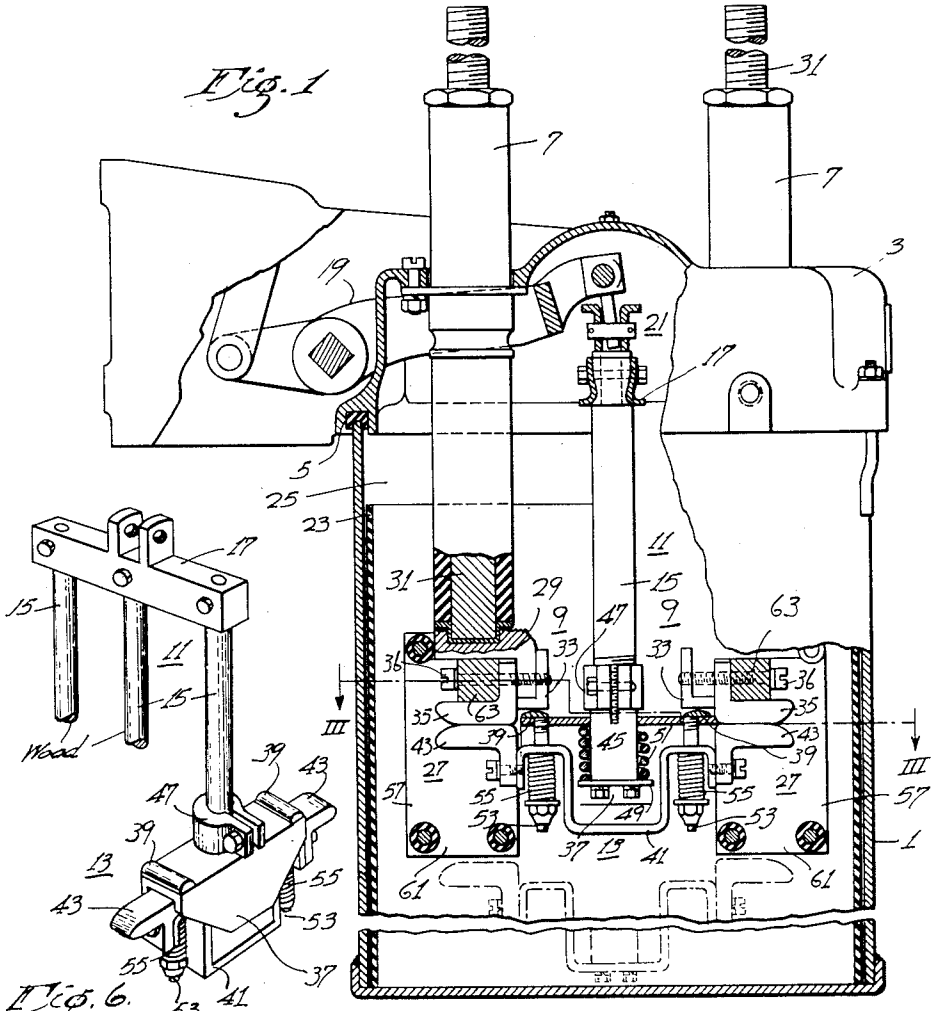


Fig. 6.

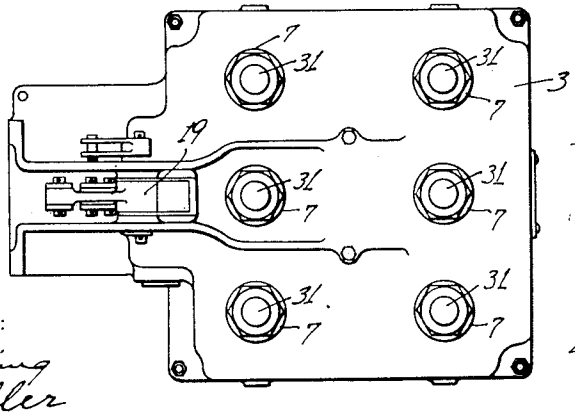


Fig. 2.

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CIRCUIT BREAKER

Filed March 8, 1935 2 Sheets-Sheet 2

Fig. 3.

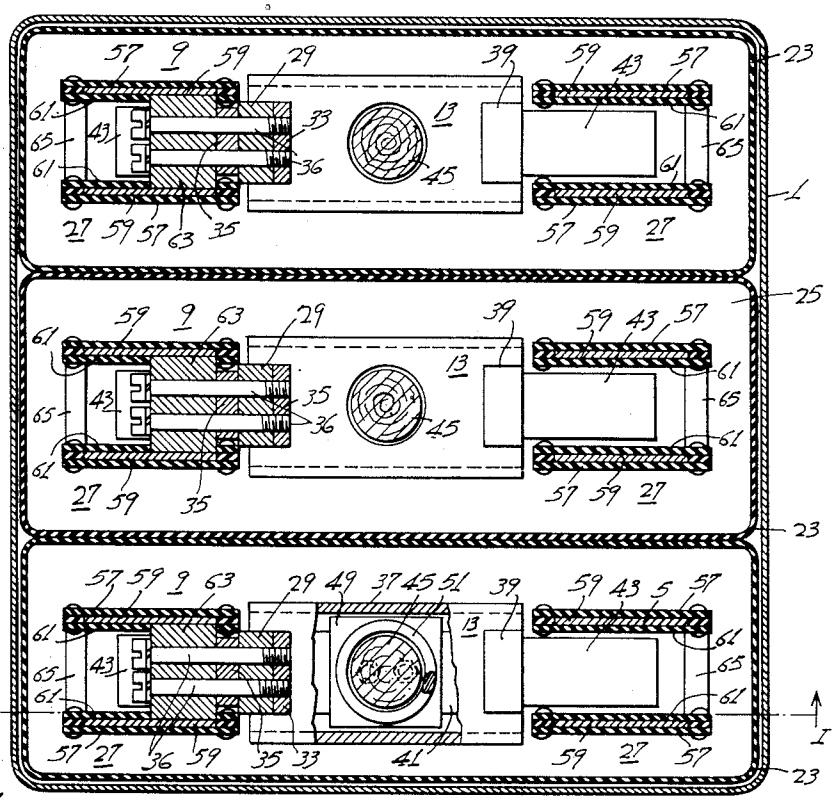
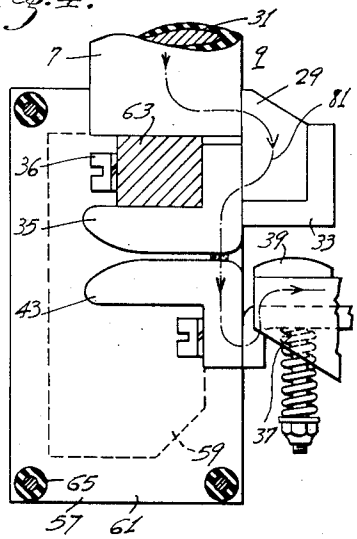


Fig. 4.



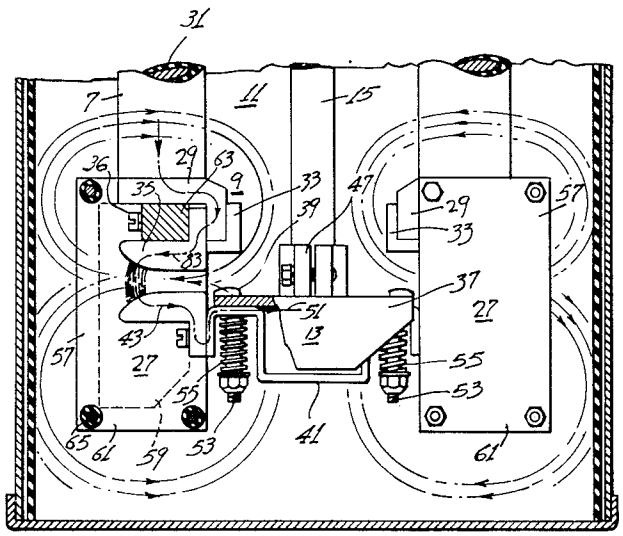


Fig. 5.

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Patented Nov. 23, 1937

2,100,102

UNITED STATES PATENT OFFICE

2,100,102

CIRCUIT BREAKER

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Application March 8, 1935, Serial No. 10,000

9 Claims. (Cl. 200—146)

Our invention relates generally to circuit interrupters, and more particularly to arc extinguishing and contact structures for use with circuit breakers of the type employed for controlling moderate voltage, power distribution systems.

The main object of our invention is to provide a circuit breaker of high interrupting capacity which is safe and reliable in operation and capable of opening a short circuit in a short interval of time and which is simple in design, low in cost and easy to service.

This principal object of our invention is accomplished through the provision of a new and improved type of arc extinguishing structure in combination with an improved contact structure, particularly intended for use therewith. The arc extinguishing structure, while of simple design, is capable of interrupting very large amounts of power within extremely short intervals of time, and the contact structure is likewise simple in design and economical to keep in repair.

Our invention is particularly applicable to arc extinguishing structures wherein the arc is confined within a chamber or arc chute, normally submerged within a body of an insulating or arc extinguishing fluid, and is moved laterally therein to effect its extinguishment, and a further object of the invention is to provide a new arrangement for the several elements of arc extinguishing devices of this type, in order that the lateral movement of the arc shall result in the creation of flow currents within the main body of arc extinguishing liquid which aid in effecting arc extinction.

A still further object of the invention is to provide a novel arrangement of baffles within a liquid type circuit interrupter, which baffles shall so direct the flow of arc extinguishing fluid during the circuit opening operation of the interrupter as to aid in effecting the extinguishment of the arc and thereby increase the reliability of operation of the interrupter.

An ancillary object of the invention is to provide a novel arc extinguishing and contact structure for a circuit interrupter which shall be readily assemblable with a minimum of fastening agencies.

These and other objects of the invention will be made more apparent by reference to the following drawings and description of a circuit breaker which utilizes arc extinguishing and contact structures constructed in accordance with the principles of our invention. Referring particularly to the drawings:

Figure 1 is an elevational view, partially in section, of a three-pole, double-break circuit-interrupter embodying the features of the present invention. The view is taken on the line I—I of Fig. 3;

Fig. 2 is a top plan view of the circuit interrupter illustrated in Fig. 1;

Fig. 3 is an enlarged sectional view taken on the line III—III of Fig. 1;

Fig. 4 is an enlarged fragmentary view showing the position of one pair of the arcing contacts and the arc at an intermediate position during the circuit opening operation of the breaker;

Fig. 5 is a fragmentary view showing the direction of the flow currents set up within the arc extinguishing liquid of the circuit interrupter during its normal operation; and

Fig. 6 is a fragmentary, perspective view of the moving contact assemblage.

The circuit breaker shown in Fig. 1 includes a rectangular tank 1, a cover 3 therefor, which is provided with a suitable recessed edge portion 5 for engaging the top of the tank 1, six insulating bushings 7, each of which is supported upon the cover 3 and is adapted to extend into the tank 1, a stationary contact structure 9 supported upon the lower end of each of the insulating bushings 7, and a bridging contact assemblage 11 for cooperating therewith in order to open and to close the electrical circuit through each of the poles of the breaker. The bridging contact assemblage 11 includes a separate bridging structure 13 for each of the three poles of the breaker, and each of these bridging structures 13 is supported upon a rod member 15 of insulating material. The three rod members 15 are mechanically interconnected at their upper ends by a suitable tie member 17, and the entire assemblage is in turn mechanically connected to the pivoted link member 19 which is engaged by the breaker actuating means (not shown). A universal joint mechanism 21 intermediate the bridging contact assemblage 11 and the cooperating end of the link member 19 allows that assemblage to be moved up and down with a substantially straight-line motion.

Each of the poles of the breaker is defined by a pair of the bushings 7, their associated stationary contact structures 9, and the movable bridging structure 13 which cooperates therewith and each of the pole structures is insulated from the structures of adjacent poles by a hollow member 23 of insulating material which is suitably positioned within the lower portion of the tank 1. A body 25 of an insulating liquid, preferably a

liquid of high arc extinguishing ability such as oil, is contained within the tank 1 and the level of this liquid is normally maintained sufficiently high to assure that the stationary contact structures 9 and the bridging contact assemblage 11 shall be submerged therein.

During the circuit opening operation of the breaker, the bridging contact structure 13 for each of the poles is adapted to disengage the cooperating stationary contacts 9 in order to establish a pair of serially connected arcs. Each of these arcs is established within an arc extinguishing device 27 associated with each of the stationary contact assemblages 9, and is therein extinguished.

More particularly, each of the stationary contact assemblages 9 includes an L-shaped frame portion 29 (Fig. 1) which is soldered or otherwise rigidly affixed to the lower end of the conductor 31 extending through the supporting insulating bushing 7 therefor, a main current-carrying contact 33, and an arcing contact 35, both of these contacts being rigidly affixed to the L-shaped frame 29 by means of a pair of bolts 36.

The bridging structure 13 which cooperates with each pair of the stationary contact assemblages 9 includes a main bridging portion which consists of a rigid, channel-shaped member 37 of conducting material having suitable contact portions 39 for engaging each of the cooperating stationary contacts 33, and an auxiliary bridging portion which consists of a suitably shaped bar member 41 provided with a pair of arcing contacts 43 for engaging the cooperating stationary arcing contacts 35. Each of the channel-shaped main bridging portions 37 is adapted to slidably engage a cylindrical guide member 45 which is mechanically connected to the lower end of the adjacent operating rod 15, and each of the cylindrical guide members 45 is provided with an enlarged upper portion 47 for defining the upward limit of motion of the channel-shaped conducting portion 37 which is supported thereon. A square plate member 49 is bolted to the lower end of each of the cylindrical guide portions 45 for positioning the channel-shaped member 39 and for preventing that member from turning with respect to the guide 45 during the operation of the breaker. A spring 51 is interposed between each of these plate members 49 and the associated channel-shaped bridging member 37, these springs serving to bias the channel-shaped bridging conductors 37 in the direction of the cooperating main current-carrying contacts 33.

A pair of studs 53 are screwed into the opposite ends of each of the channel-shaped bridging members 37 in order to provide a support and guide means for the associated auxiliary bridging portion 41. Each of these portions 41, as pointed out above, comprises a rigid, formed bar of conducting material which is provided with a suitable opening for engaging each of the aforesaid studs 53 and with suitable threaded openings in order to permit the two arcing contacts 43 associated therewith to be bolted thereon. Springs 55 are positioned on the stud bolts intermediate the rigid, auxiliary bridging portion 41 and adjusting nuts placed at the lower ends of the studs. These springs 55 resiliently bias each of the auxiliary contact portions 41 upwardly toward the cooperating arcing contacts 35, and the upward limit of movement of each of the bridging portions 41, under this biasing action is determined by the distance between the upper surfaces of the auxiliary bridging portion and the lower surface of the associated main bridging portion 37.

Each of the arc extinguishing devices 27 comprises generally a pair of opposed, rectangular plate structures 57 of insulating material which are disposed in parallel planes, spaced some distance from each other, in order to define two of the opposed walls of an arc chute. Each of the cooperating pairs of arcing contacts 35 and 43 is adapted to be separated within one of these chutes during the circuit opening operation of the interrupter, and each of the several arcs incident to the opening of the interrupter is thus drawn within one of the arc extinguishers.

As shown particularly in Figs. 3 and 4, a flat plate 59 of magnetic material, preferably iron, is positioned adjacent each of the two plate members 61 which form the inner wall surfaces of each of the arc chute structures. The two iron plates 59 for each arc extinguisher are mechanically and magnetically connected at their upper ends by a substantially square rod 63 of iron or other magnetic material which is welded thereto. This rod member 63 is provided with two centrally disposed openings through which the bolts 36 extend, these bolts 36 thus serving to support each of the arc extinguishing devices 27 upon the frame 29 of the associated stationary contact assemblages. From the foregoing, it will be seen that each of the arc extinguishing devices 27 includes a pair of opposed members 57 which define the side walls of an arc chute, and a substantially U-shaped pole piece of magnetic material (formed by the plates 59 and the member 63 welded thereto) which is disposed about the arc chute for providing a magnetic field which aids in moving the arc laterally therein during the arc extinguishing operation.

In order to insulate each of the side portions 59 of the U-shaped pole pieces, additional plates of insulating material are affixed to the inner wall defining members 61 so as to substantially embed the portions 59 in insulation, as is shown particularly in Fig. 3. By embedding these plates in insulating material, the danger of breakdown within the device during the operation is considerably reduced. The lower end of each of the pairs of wall defining members 57 are mechanically connected together by an insulating bolt and spacer 65 in order to preserve the proper alignment of the side walls of the arc chute.

The inner plate member 61 of each of the wall defining members 57 is preferably formed of an insulating material such as horn fibre, which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, and each of the pairs of wall defining members 57 are spaced sufficiently close together to assure that any arc which may be established therein during the operation of the interrupter shall contact both of the walls of the arc chute which they define. The spacing of the wall defining members 57 is considerably exaggerated in Fig. 3 in order to permit a clearer showing of the several parts of the interrupter. Through this arrangement, the arc established within each of the arc chutes is caused to act as a piston during its lateral movement therein, and, as will be explained in detail later, increased efficiency of the arc extinguishing operation is thereby accomplished. If desired, the plate members 61 which define the inner wall surface of each of the arc chutes may be formed of a material which is

capable of absorbing substantial amounts of the arc extinguishing liquid 25 contained within the tank 1. If such absorbent insulating material is used, a somewhat higher efficiency of arc extinction may be effected, by virtue of the increased volumes of gas made available during the arc extinguishing operation.

The circuit interrupter is shown in the normal closed circuit position in Fig. 1. Upon the operation of the breaker actuating mechanism, either in response to an overload or other conditions, the three interconnected operating rods 15 for the bridging contact assemblage 11 and the guide portions 45 supported thereon are moved downwardly, and as soon as each of the channel-shaped main bridging portions 37 engages the enlarged portion 47 of the guide 45 on which it is supported, the downward movement of those portions begins. This movement causes each of the main current-carrying contacts 39 to disengage the cooperating stationary contact 33 and this causes the opening of the main current path through the breaker. Due to the fact that the amount of possible relative motion between the guide member 45 and the main bridging portion 37 supported thereon is substantially less than the possible motion between the auxiliary bridging portion 41 and the guide means therefor, the cooperating pairs of arcing contacts 35 and 43 are not separated until there has been a substantial separation of the main cooperating pairs of current-carrying contacts. This arrangement assures that the arcs incident to the opening of the interrupter shall each be established within one of the arc chutes.

At the instant of separation of each of the pairs of cooperating arcing contacts 35 and 43, the current-carrying path through each of the associated stationary contact assemblages 9 takes the substantial form shown by the dot and dash line 81 of Fig. 4. It will be seen that this path is looped about the central rectangular portion 63 of the adjacent U-shaped magnetic member, and thus immediately upon the establishing of an arc within one of the arc chutes, that arc is subjected to a transverse magnetic field of substantial strength. This field causes the arc to move laterally along the arcing contacts 35 and 43 within the arc chute wherein it is established, and as the lateral movement along those contacts progresses (the contacts being in effect arcing horns) the length of the magnetizing path for the associated means of magnetic material is substantially increased, over its initial length, as may be seen by comparison of the path 81 shown in Fig. 4 and the path 83 shown in Fig. 5. Thus as the several arcs established during the operation of the breaker are lengthened by the downwardly moving contacts 43, and as they are moved laterally within the arc chutes wherein they are established, the force producing that lateral movement is progressively increased at a very substantial rate. This arrangement has been found to be of great value in assuring reliable operation of the arc extinguishers even under extremely adverse conditions.

Due to the fact that the two plate members 61, which define the inner surfaces of the walls of each of the arc chutes 27, are spaced sufficiently close together to assure that any arc which may be drawn therein shall contact both of those members, the above described lateral movement of each of the arcs within one of the arc chutes produces a piston action which moves a quantity of fresh arc extinguishing liquid laterally through each of the arc extinguishers during the operation thereof. In addition, since the two arcs for each pole of the breaker are moved away from each other, the flow currents, which are set up in the main body 25 of insulating fluid, by the two arc extinguishing devices 27 for each pole are in the same direction and serve to aid each other. These flow currents are illustrated by the arrows in Fig. 5. The presence of the enclosing baffles 23 aids in directing these flow streams and prevents interference between those set up in adjacent poles.

The combined effect of the lateral movement of the individual arcs within the arc chutes wherein they are drawn and the resultant piston action which causes cool insulating fluid to flow through the arc chutes and between the space previously occupied by those arcs on the arcing horns assures that the arc extinguishing operation shall take place at high speed even during the interruption of extremely large overloads. During the circuit closing operation, the electrical circuit through each of the poles of the breaker is always initially established by the engagement of the cooperating arcing contacts 35 and 43, and by this means pitting of the main current-carrying contacts is reduced to a minimum and the operative life of the device is considerably increased.

It should be noted that the arc extinguishing and stationary contact structure which is affixed to the lower end of each of the insulating bushings 7 may be entirely removed from the breaker merely by unscrewing a pair of bolts. Thus, the arcing contacts 43 and 35, the main current-carrying contacts 33, and the arc extinguisher 27 are readily removable for replacement or inspection during the life of the breaker. Moreover, each of the arcing contacts 35 serves as a support for the U-shaped magnetic portion of the associated arc chute, and those contacts are so arranged that the energization of the magnetic field-producing lateral movement of the arc in each of the arc chutes is increased as the movement of that arc progresses during the arc extinguishing operation. The entire structure is not only simple and readily serviceable, but it is highly efficient in operation.

The main bridging portion 37 of each of the bridging structures 13 and the auxiliary bridging portion 41 of each of those contacts are, in effect, resiliently supported upon the actuating rod 15 therefor through separate lost motion connections which allow differing amounts of relative motion between the frame and the two sets of bridging portions. This assures that the circuit shall always be opened and closed through the auxiliary contacts. Further, the fact that springs form a part of the means for mechanically connecting each of the bridging portions with the support means therefor allows the use of butt type contacts throughout the interrupter. Flexible shunts are thereby eliminated and high pressure low resistance contacts are assured during the entire operative life of the device. Not only are the resultant butt type contacts less expensive, but the operation is much more reliable, than the older forms which use shunts, flexible brushes, or the like.

From the foregoing, it will be seen that we have provided an arc extinguishing structure which includes means for defining an arc chute and means for moving the arc laterally therein by the agency of a force which substantially increases as the lateral movement progresses,

thereby adding much to its reliability of operation. The contact structure permits the use of butt type contacts throughout, while at the same time preserving the proper sequence of operation.

Further, we have disclosed certain novel arrangements of the structural features of our invention which cause flow currents to be set up within the main body of arc extinguishing liquid during the operation of the interrupter, these flow currents aiding in the extinction of the arc. In addition, we have shown how baffle means can be provided for aiding in directing these flow currents so as to assure the highest degree of operational efficiency.

While in accordance with the patent statutes we have shown, in the foregoing, the details of a preferred embodiment of our invention, it is to be understood that many of these details are merely illustrative and that variations in their precise form will be both necessary and desirable in certain instances. It is our intention, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction, and that our invention shall be limited only by what is expressly stated therein and by the prior art.

We claim as our invention:

1. In a circuit interrupter, a pair of terminal members, and bridging means movable into and out of engagement therewith, each of said terminal members having a solid main contact rigidly supported thereon and a solid arcing contact rigidly supported thereon, said bridging means including a rigid bar member of conducting material having solid contact portions rigidly mounted thereon for engaging said main contacts, a second substantially rigid bar member of conducting material having solid contacting portions rigidly secured thereto for engaging said arcing contacts, and a common actuating member for said rigid bar members, a resilient connection between said actuating member and said first bar member, and a lost motion connection between said bar members, said lost motion connection enabling said contacts to open in a predetermined sequence.

2. In a circuit interrupter, a pair of terminal members, and bridging means movable into and out of engagement therewith, each of said terminal members having a solid main contact rigidly supported thereon and a solid arcing contact rigidly supported thereon, said bridging means including a rigid bar member of conducting material having solid contact portions rigidly mounted thereon for engaging said main contacts, a second substantially rigid bar member of conducting material having solid contacting portions rigidly secured thereto for engaging said arcing contacts, and a common actuating member for said rigid bar members, a resilient connection between said actuating member and said first bar member, and a second resilient connection between said bar members, each of said bar members being movable a predetermined distance independently of said common actuating means in order that the electrical circuit through said interrupter shall be always finally interrupted by said cooperating arcing contacts.

3. In a circuit breaker, a terminal member, a fixed main current carrying contact secured thereto, a fixed arcing contact connected to said terminal member, cooperating main and arcing contacts adapted to be moved sequentially out of engagement with said respective fixed contacts for establishing an arc between said arcing contacts, a core of magnetic material, said terminal member in conjunction with said fixed arcing contact forming a loop about said core for conducting arc current therearound to magnetize the core, a single means for releasably holding said core and said fixed contacts in cooperative engagement with said terminal member, and a plate of magnetic material secured to each end of said core, said plates extending on opposite sides of said arcing contacts to direct the magnetic flux concentrated in said core across the arcing contacts for moving the arc therealong.

4. In a circuit breaker, a terminal member, a fixed main current carrying contact secured thereto, a fixed arcing contact connected to said terminal member, cooperating main and arcing contacts adapted to be moved sequentially out of engagement with said respective fixed contacts for establishing an arc between said arcing contacts, a core of magnetic material, said terminal member in conjunction with said fixed arcing contact forming a loop about said core for conducting arc current therearound to magnetize the core, a single means for releasably holding said core and said fixed contacts in cooperative engagement with said terminal member, a plate of magnetic material secured to each end of said core, said plates extending on opposite sides of said arcing contacts to direct the magnetic flux concentrated in said core across the arcing contacts for moving the arc therealong, and plates of insulating material adjacent at least the inner surface of said plates of magnetic material for defining the side walls of an arc passage with which the arc is adapted to make intimate contact during its extinction.

5. In a circuit breaker, a terminal member, a fixed main current carrying contact secured thereto, a fixed arcing contact connected to said terminal member, cooperating main and arcing contacts adapted to be moved sequentially out of engagement with said respective fixed contacts for establishing an arc between said arcing contacts, a core of magnetic material, said terminal member in conjunction with said fixed arcing contact forming a loop about said core for conducting arc current therearound to magnetize the core, unitary fastening means for jointly and releasably attaching said core and said fixed contacts to said terminal member, a plate of magnetic material secured to each end of said core, said plates extending on opposite sides of said arcing contacts to direct the magnetic flux concentrated in said core across the arcing contacts for moving the arc therealong, plates of insulating material adjacent at least the inner surface of said plates of magnetic material for defining the side walls of an arc passage with which the arc is adapted to make intimate contact during its extinction, and a material along said wall defining plates which gives off a gas when acted upon by an arc to aid in extinguishing the arc.

6. In a circuit breaker, the combination with a terminal member of a fixed main current carrying contact, a core of magnetic material, unitary releasable means for jointly securing said contacts and said core to said terminal member, cooperating main and arcing contacts adapted to be moved sequentially out of engagement with said respective fixed contacts to establish an arc between said arcing contacts, said terminal member and said fixed arcing contact being arranged to provide a loop about said core for conducting arc current therearound to magnetize said core, and

pole pieces secured solely to the ends of said core for directing the magnetic flux concentrated therein across said arcing contacts to move the arc laterally therealong.

7. In a circuit interrupter of the oil immersed type having a casing and arc extinguishing liquid therein, the combination with a terminal member of a fixed main contact, a fixed arcing contact, a core of magnetic material, clamping means for jointly and releasably securing said contacts and said core to said terminal member, cooperating main and arcing contacts adapted to be moved sequentially out of engagement with said respective fixed contacts to establish an arc between said arcing contacts, said terminal member and said fixed arcing contact being arranged to provide a loop about said core for conducting arc current therearound to magnetize the core, and arc extinguishing means surrounding said contacts comprising a pair of plates of magnetic material disposed in spaced parallel relation and secured to the ends of said core, plates of insulating material disposed between said contacts and said plates of magnetic material for defining a relatively narrow arc passage, said plates of magnetic material being adapted to distribute the magnetic flux concentrated in said core across said arcing contacts to move the arc laterally therealong, the separation of said plates of insulating material being substantially equal to the width of said arcing contacts, said arcing contacts having a width such that the arc drawn thereby is made to contact the walls of said arc passage and to thereby cause circulation of the arc extinguishing liquid between the arcing contacts during lateral movement of the arc to aid in extinguishing the arc.

8. In a circuit breaker, a pair of spaced terminal members, a solid main and a solid arcing contact rigidly secured to each terminal member, a core of magnetic material rigidly secured to each terminal member, said terminal member and said main and arcing contacts being disposed to provide a loop about the respective cores for conducting current therearound to magnetize the cores, a rigid bridging member having solid main contact portions rigidly secured thereto for cooperating engagement with said main contact, a second rigid bridging member having solid arcing contact portions rigidly secured thereto for cooperative engagement with said arcing contacts, a lost motion connection between said bridging members to provide for relative parallel lateral displacement therebetween, resilient means biasing said bridging members toward each other, a common actuating member for said bridging members, means for resiliently coupling said actuating member to said first bridging member, said lost motion connection and said biasing means enabling said main and arcing contacts to open in a predetermined sequence in response to movement of said actuating member and a plate of magnetic material secured to each end of said cores, said plates of each respective core extending on opposite sides of the respective arcing contacts to direct the magnetic flux thereacross for moving the arc therealong.

9. In a circuit breaker, a pair of spaced fixed main contacts having their contact surfaces disposed in a given plane, a pair of fixed arcing contacts spaced a greater distance than said main contacts and having their contact surfaces disposed in a different plane, rigid bridging means for said main contacts adapted to be moved between said arcing contacts, said bridging means comprising a channel member, the web portion of which is provided with solid contact portions on each end thereof adapted to cooperate with said fixed main contacts, an actuating rod resiliently coupled to said channel member intermediate its ends for moving said bridging means to open and closed positions, a bridging bar supported within said channel member having predetermined lateral movement with respect to the web portion thereof, means biasing said bridging bar toward said web portion, and a solid arcing contact secured to each end of said bridging bar, said last named arcing contacts being adapted to engage said fixed arcing contacts prior to the engagement of said bridging means with said main contacts during the closing movement of said actuating rod.

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