March 5, 1940. J. B. MacNEILL 2,192,772

CIRCUIT INTERRUPTER

Filed Sept. 26, 1935 2 Sheets-Sheet 1

Fig. 1.

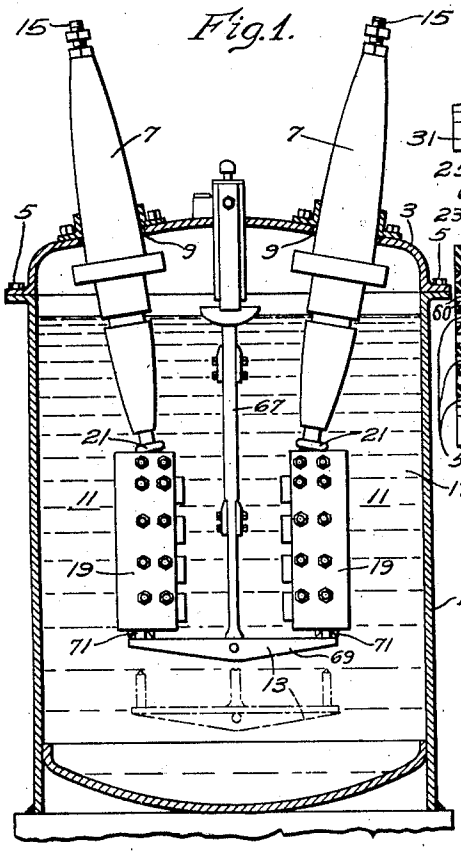


Fig. 3.

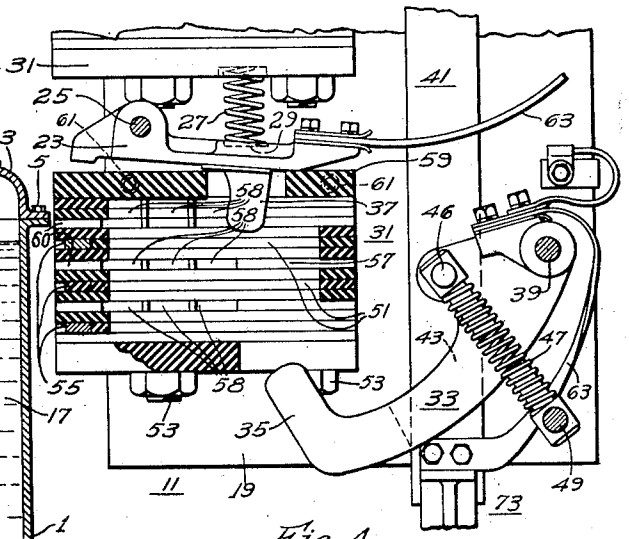


Fig. 4.

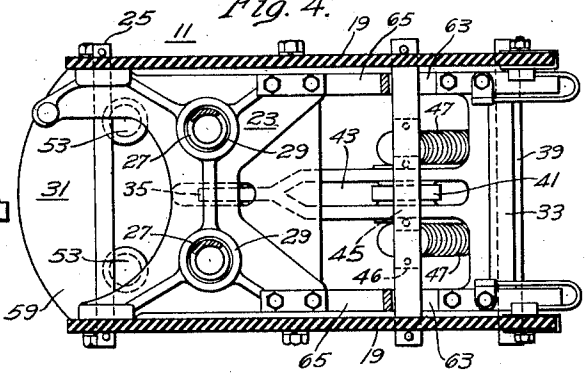


Fig. 5.

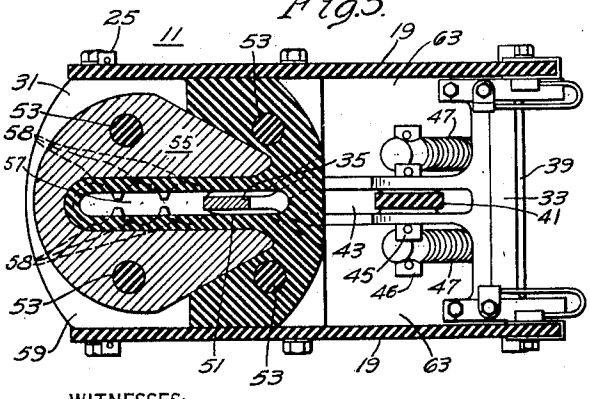
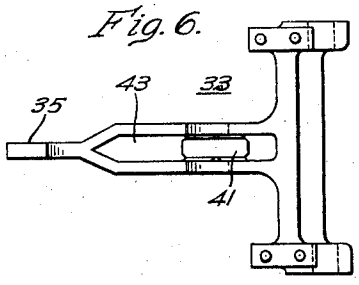


Fig. 6.



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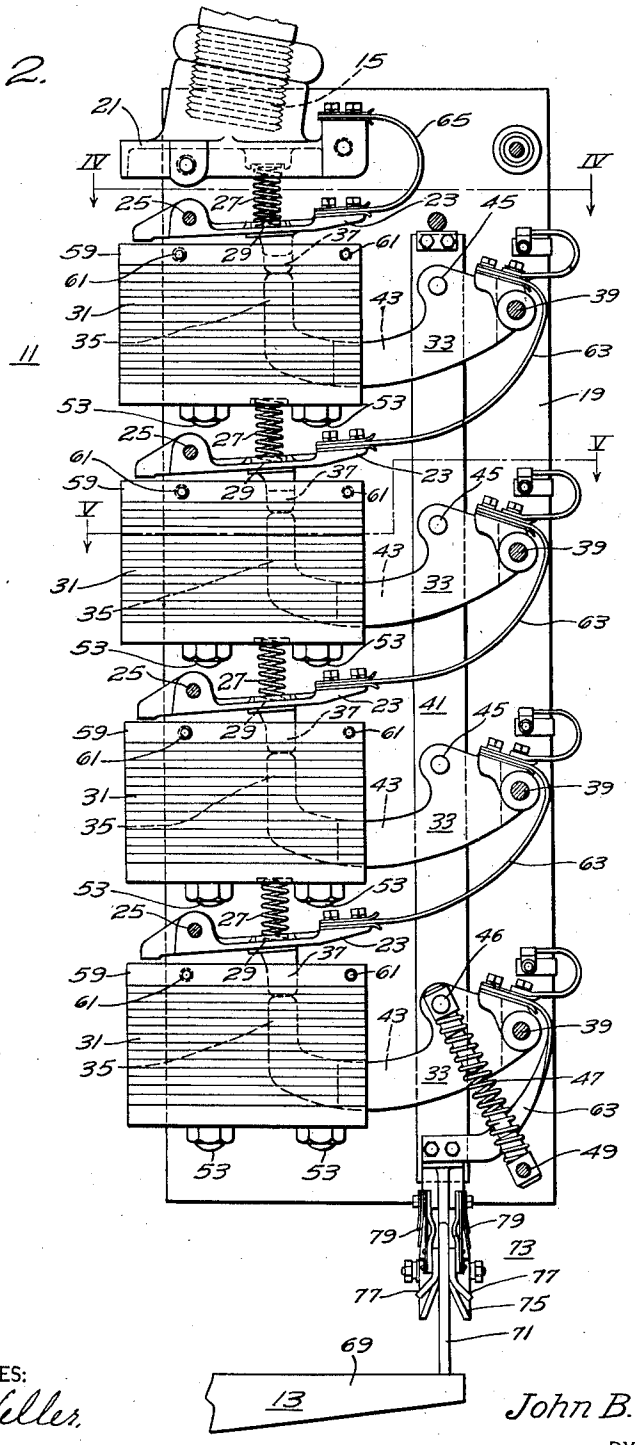
CIRCUIT INTERRUPTER

Filed Sept. 26, 1935 2 Sheets-Sheet 2

Fig. 2.



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UNITED STATES PATENT OFFICE

2,192,772

CIRCUIT INTERRUPTER

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Application September 26, 1935, Serial No. 42,183

33 Claims. (Cl. 200—145)

My invention relates generally to circuit interrupters and more particularly to contact structures and arc extinguishers for use with high capacity circuit breakers.

Heretofore the practice in the circuit breaker art has been almost universal in the adoption of a double break construction in which the two breaks of the circuit interrupter were introduced in series. However, in view of the increasing demand for higher transmission voltages and for high speed interrupting operations the simple double break circuit interrupter is no longer able to meet modern requirements. Generally, it may be said that for a given method of arc extinction the amount of electrode separation necessary for effective interruption varies nearly directly with the voltage. Although it is conceivable that a simple double break interrupter may be constructed which has the ability of interrupting extremely high voltages, such a structure would not meet modern requirements since the time interval required to separate the movable contacts the requisite distance from the stationary contacts would be prohibitive.

The main object, therefore, of my invention is to provide a high voltage high power circuit breaker structure in which a large electrode separation and arc extinction are accomplished in a shorter time interval than that required heretofore with structures of the prior art. In order to accomplish the aforenamed object, I have provided an arc interrupting structure whereby the circuit is opened simultaneously at more than two points so as to produce a plurality of serially related arcs. The several pairs of separable contacts whereby such a plurality of arcs are drawn are so arranged that when actuated to the open circuit position the separation of each pair of contacts is that best suited for arc extinction.

In accordance with a further object of my invention, I provide additional separable contacts in series with those for initially drawing the series related arcs adapted to be opened subsequently to the opening of the latter contacts for the purpose of introducing an insulating gap distance over and above that produced by the contacts for initally drawing the series related arcs, thereby assuring adequate insulation for the interrupter when the latter is in the open circuit position.

A further object of the invention is to provide contact members of a novel design for use in a stationary contact assemblage which is operable to produce a plurality of serially connected breaks in the controlled circuit during its operation.

A still further object of my invention is to provide a novel arrangement for the various elements of the interrupter in order to facilitate the assembling of those elements and to render the servicing of the interrupter easier and simpler.

The above objects and one method of accomplishing them will be made more apparent in the following description and drawings of a preferred embodiment of the invention. Referring particularly to the drawings:

Figure 1 is a sectional view, partially in elevation, of a single pole, liquid immersed circuit interrupter which utilizes multi-break contact structures according to the present invention;

Fig. 2 is an enlarged sectional view, partially in elevation, of one of the stationary contact assemblages forming a part of the interrupter shown in Fig. 1;

Fig. 3 is an enlarged sectional view of a portion of the stationary contact assemblage shown particularly in Fig. 2, the single pair of cooperating contacts shown are in the open circuit position and the associated arc extinguishing device is in section;

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

Fig. 5 is an enlarged sectional view taken on the line V—V of Fig. 2; and

Fig. 6 is a plan view of one of the contact members used in the contact assemblages shown particularly in Fig. 2.

The circuit breaker shown in Fig. 1 includes a cylindrical tank 1, of sheet steel or other suitable material, a flanged cover 3 fastened thereto by bolts 5 or other means, a pair of insulating bushings 7, which are rigidly supported upon the cover 3 and extend through the openings 9 formed therein into the inner portion of the tank 1, a stationary contact assemblage 11 mounted upon the lower end of each of the insulated bushings 7, a bridging contact 13 which is movable into and out of engagement with the stationary contact assemblages 11 to effect the operation of the breaker, and actuating mechanism (not shown) for moving the bridging contact 13 from one position to the other. A rod 15 or other means of conducting material extends through each of the insulating bushings 7 in order to allow the breaker to be connected into an electrical circuit. A body of insulating liquid 17, preferably oil, is contained within the tank 1 and the level of this liquid is normally

kept sufficiently high to assure that the stationary contact assemblages 11 and the movable bridging contact 13 shall be submerged therein at all times.

As is shown particularly in Figs. 2 and 4, the various structural elements of each of the stationary contact assemblages 11 are mounted between a pair of opposed support plates 19 of insulating material. A stationary support member 21 of conducting material, is bolted to the upper end of each of the pairs of opposed side plates 19 and constitutes the means for supporting each of the assemblages upon the lower end of the conductor 15 forming a part of the associated bushing 7.

Four pairs of separable contacts are provided for each of the stationary contact assemblages 11, and each of these pairs includes one of the pivotally supported contact members 23, shown particularly in Figs. 3 and 4. The contact members 23 are substantially X-shaped (plan view) and are each supported upon a pivot pin 25 which extends through both of the opposed side members 19 supporting the assemblage. They are each biased toward the cooperating contact therefor by two biasing springs 27, which springs are held in position by suitable recesses 29 formed in the contact members. Movement of each of the contact members 23 in the downward direction under the biasing action of these springs 27 is limited by the proximity of the adjacent arc extinguishing device 31, one of which devices is associated with each of the pairs of contacts.

The other contact member 33 for each of the pairs of separable contacts is shown particularly in Fig. 6, and comprises a T-shaped member (plan view) having an upturned end 35 for engaging the contact portion 37 of the cooperating contact 23. The contacts 33 are pivotally supported upon pins 39 which extend through the two opposed support plates 19, and they are mechanically interconnected by a tie rod 41 of insulating material which extends through the central opening 43 formed therein, this tie rod being pivotally connected to each of the contact members 33 by a suitable pivot pin 45. The interconnected contact members 33 are biased toward the open circuit position by a pair of springs 47, one end of each of which is connected to the pivot pin 46 connecting the lowermost contact 33 with the common actuating member 41, and the other end of each of which is connected to a pin 49 extending through the two opposed side members 19.

As mentioned above, an arc extinguishing device 31 is associated with each of the pairs of separable contacts which form a part of the stationary contact assemblages 11. Each of these arc extinguishing devices 31 comprises a stack of plates of insulating material, each of which plates has a slotted opening 51 formed therein. The plates are assembled upon four through bolts 53 of insulating material and slotted iron plates 55 are interposed in the stack structure at spaced intervals. The slots 51 in the several plates align to form an arc passage 57 having a length several times its maximum width, and it is within this passage 57 that the arc incident to the separation of each of the pairs of cooperating contacts is established. The proximity of the slotted iron plates 55 to the arc so alters the magnetic field set up thereby that the arc is moved longitudinally within the passage formed by the aligned slots.

A quantity of the arc extinguishing liquid 17 is entrapped within each of the passages 57 wherein the individual arcs are drawn and are moved, and this liquid is at least partially volatilized during the arc extinguishing operation by being brought in contact therewith. The resulting outflowing fluid, part of which is in the vapor and part of which is in the liquid state, causes a transverse blast through the arc and out vents 60 to effect a rapid extinguishment of the arc. Certain of the plates comprising the stack structures are provided with cut-out portions 58 for defining liquid retaining pockets which assure an adequate supply of arc extinguishing gas at all times during the operation of the extinguisher. For a more complete description of an arc extinguishing device of this type, reference may be had to Patent No. 2,039,054, issued April 28, 1936, to S. H. Boden and S. T. Schofield, and which is assigned to the assignee of this invention.

The upper plate 59 in each of the arc extinguishing structures 31 is substantially square and is provided with four suitably threaded openings 61 formed therein for permitting the plate to be bolted to the side members 19 which support the several elements of the contact assemblage. Through this arrangement, each of the arc extinguishing devices 31 is individually supported in position in the completed structure by means which allows that device to be readily removed for inspection or other purposes. The devices 31 are so arranged, of course, that the contact portion 35 of the T-shaped contact member 33 moves within the passage 57 formed therein when it is being moved into and out of engagement with its cooperating contact member 23.

The several pairs of contacts are electrically connected in series with each other by a plurality of flexible shunts 63, one end of each of these shunts being bolted to each of the adjacent contacts 23 and 33. The upper contact member 23 is electrically connected to the support member 21 which engages the conductor 15 disposed within the associated insulating bushing 7 by means of a pair of similar shunts 65.

The bridging contact 13 includes an actuating rod 67 of insulating material which is engaged by the breaker actuating mechanism, a bridging portion 69 of conducting material and a pair of upstanding contact portions 71, one of which is adapted to engage and effect the actuation of each of the stationary contact assemblages 11. A suitable contact 73 for cooperating with each of these upstanding contact portions 71 is supported upon the lower end of each of the tie members 41, which interconnects the T-shaped contacts 33 in the stationary contact assemblages 11. Entry of the cooperating upstanding contact portion 71 into the contact 73 is facilitated by a V-shaped guide 75 forming a part thereof, and the opposed contact members 77 which directly engage the sides of the upstanding contact portion 71 which is moved therebetween are biased toward each other by suitable leaf springs 79. The lower end of each of the lowermost shunts 63 in each of the contact assemblages is bolted to the contact means 73 in order to complete the electrical circuit through the interrupter.

Since the interconnected T-shaped contacts 33 are biased toward the open circuit position, proper engagement of the upstanding contact portions 71 with the contact means 73 is assured during each operation of the interrupter. The device is so arranged that the upstanding contact portions 71 disengage the contact means 73 during the final stages of each circuit opening operation.

Thus, two gaps of insulating fluid in addition to the gap existing within the contact assemblages 11 are interposed in the electrical circuit through the interrupter when that device is in the open circuit position. This provides an increased factor of safety during the operation of the interrupter.

The interrupter is shown in the closed circuit position in Fig. 1. Upon the operation of the actuating mechanism, either in response to an overload in the controlled circuit or other means, the movable bridging contact 13 begins to move downwardly away from the two stationary contact assemblages 11. The springs 47, which bias the interconnected T-shaped contacts 33 away from the cooperating contacts 23 therefor, cause the interconnected contacts 33 in each of the assemblages 11 to move downwardly with the downwardly moving bridging member. As a result, a plurality of serially connected arcs are established within each of the stationary contact assemblages 11, each individual arc being established within the passage 57 formed within one of the arc extinguishing devices 31.

Since the shortest distance from the center of each of the pivot pins 45, which connect the common actuating member 41 with the T-shaped contacts 33, to the center of the pivot pin 39 which supports that contact 33 is considerably less (about one-half) than the distance from the center of the support pivot pin 39 to the point of engagement of the T-shaped contact 33 with its cooperating contact 23, the speed of separation of each of the pairs of cooperating contacts is at least double the speed of movement of the bridging contact 13. Thus, the circuit through the interrupter is opened at a rate which is at least sixteen times the speed of movement of the bridging contact 13, and further, since each of the serially connected arcs is drawn within an individual arc extinguishing device, the efficiency of arc extinction is brought to an extremely high value.

The very high speed at which the electrical circuit through the interrupter is opened makes possible the utilization of breakers employing this form of contact structure in very high voltage circuits, and by proper design of the parts extremely large amounts of power may be interrupted thereby.

As the circuit opening operation progresses, the downwardly moving interconnected contacts 33 reach their limit of motion and subsequent movement of the movable bridging contact 13 causes the upstanding contact portions 71 thereof to disengage the conducting means 73 affixed to the lower end of each of the common actuating members 41. The amount of possible downward movement of the movable bridging contact 13 is so arranged that a substantial gap of predetermined length exists between the upstanding contact portions 71 and the cooperating conducting means 73 therefor when the breaker is in the open circuit position. This assures that an insulating gap shall exist between the bridging contact 13 and each of the cooperating stationary contact assemblages 11 when the interrupter is in the open circuit position.

This gap, in series with the arc-rupturing contacts, may be made of any desired length when the movable contact member is in the open position without affecting the break distance or length of separation of the intermediate arc-drawing contacts. It will be apparent, therefore, that this final insulating gap alone can be relied upon for protection against voltage surges or high potentials from any source which may be impressed upon the circuit breaker when it is standing in its open position. The distance to which the intermediate, arc-drawing contacts are separated will, then, be governed only by the length of arc most suitable for interrupting purposes at that voltage for which the circuit breaker is designed, and will be in no way affected by considerations of insulation safety while the contacts stand in their open position. I have, therefore, by my invention separated the main functions of an open gap between contacts—arc interruption and insulation safety—into its two subdivisions and have provided separate insulating gaps, each particularly designed to carry out its own function most effectively for accomplishing each function. In the previous devices of like nature both functions have been performed by a single gap, or series of gaps, and the result has been a compromise in design which did not permit the most effective performance of either function.

While in accordance with the patent statutes, I have, in the foregoing, disclosed the details of one embodiment of my invention, it is to be understood that these details are merely illustrative and that variations in the structure shown will be both necessary and desirable in certain instances. It is my wish, therefore, that the language of the accompanying 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 the following as my invention:

1. In a circuit interrupter, a stationary conducting means, a movable contact, actuating means for moving said movable contact to an open and to a closed circuit position, and means positioned intermediate said stationary conducting means and said movable contact when said interrupter is in the closed circuit position for completing the electrical circuit therebetween, said intermediate means including a plurality of pairs of serially connected, cooperating contacts and means for causing said pairs of contacts to separate simultaneously when said movable contact is moved to the open circuit position in order to effect the establishing of a plurality of serially connected arcs, said last mentioned means causing the separation of each pair of said cooperating contacts to take place at a speed of movement which is greater than the speed of movement of said movable contact.

2. In a circuit interrupter, a stationary support means which is at least partially of conducting material and which is electrically connected to one of the terminals of said interrupter, a stationary contact assemblage supported thereby, a movable contact for cooperating with said stationary contact assemblage, and actuating means for moving said movable contact to an open and to a closed circuit position, said stationary contact assemblage including a plurality of pairs of cooperating contacts, at least one of the contacts of each of said pairs comprising a pivotally supported member movable into and out of engagement with its cooperating contact, means for electrically connecting said pairs of cooperating contacts in series, and means engageable by said movable contact for causing each of said pivotally supported contacts to simultaneously disengage its cooperating contact and move simultaneously to the open circuit position when said movable contact is moved to the open circuit position.

3. In a circuit interrupter, a contact structure including a plurality of pairs of cooperating contacts, at least one of each of said pairs of contacts comprising a pivotally supported member movable into and out of engagement with the cooperating contact therefor, means for electrically connecting said pairs of contacts in series, actuating means for said contacts including a contact actuating member having releasable engagement with at least one of said contacts, and means whereby the movement of said contact actuating member causes the simultaneous separation of each of said pairs of cooperating contacts, at a speed greater than the speed of movement of said actuating member, said last mentioned means including a motion-magnifying means interconnecting all of said pivotally supported contact members.

4. In a circuit interrupter, a stationary conducting means, a movable contact, actuating means for moving said movable contact to an open and to a closed circuit position, and means positioned intermediate said stationary conducting means and said movable contact when said interrupter is in the closed circuit position for completing the electrical circuit therebetween, said intermediate means including a plurality of pairs of cooperating contacts, at least one of the contacts of each of said pairs comprising a pivotally supported member movable into and out of engagement with its cooperating contact, means for electrically connecting said pairs of contacts in series with each other, arc extinguishing means associated with each of said pairs of contacts, and means actuated by said actuating means whereby each of said pivotally supported contact members may be moved simultaneously from the closed circuit position to the open circuit position in order to effect the establishing of a plurality of serially connected arcs, said last mentioned means causing the separation of each pair of said cooperating contacts to take place at a speed of movement which is greater than the speed of movement of said movable contact.

5. In a contact structure for a circuit interrupter, a plurality of pairs of separable contacts, at least one of each of said pairs of separable contacts comprising a pivotally supported member movable into and out of engagement with the other member of said pair, and means for simultaneously actuating said contact members comprising a bar which engages each of said pivotally supported contact members during the operation of said contact structure, the shortest distance between the pivot point of each of said pivotally supported contact members and the point at which that member is engaged by said actuating bar being less than the shortest distance from the pivot point of each of said pivotally supported contact members to the point at which that member engages the cooperating contact member therefor, this arrangement causing the separation of each of said pairs of contacts to take place at a greater speed than the speed of movement of said common actuating bar therefor.

6. In a contact structure for a circuit interrupter, a plurality of resiliently supported contact members, a plurality of pivotally supported contact members, one of which is adapted to cooperate with each of said resiliently supported contact members, means for electrically connecting said pairs of cooperating contacts in series with each other, and a common actuating means for simultaneously moving all of said pivotally supported contacts into and out of engagement with the cooperating contact therefor, said common actuating means comprising a member pivotally connected to each of said pivotally supported contact members, the shortest distance between the point at which said member is pivotally connected to each of said contact members and the pivot point of that member being substantially less than the shortest distance between the pivot point of said contact member and the point at which that member engages the cooperating contact therefor in order that the separation of said contact members may be effected at a greater speed than the speed of motion of said common actuating member.

7. In a circuit breaker, a plurality of pairs of separable contacts, means for connecting said contacts in series, and common actuating means for simultaneously separating all of said pairs of contacts except one a predetermined distance to form a plurality of serially related arcs of limited arc energy and for subsequently separating the remaining pair of contacts a greater distance to provide an insulating gap capable of withstanding high voltage.

8. In a circuit breaker, a plurality of arc extinguishing units, a pair of separable contacts within each unit, means connecting said pairs of contacts in series, common actuating means for simultaneously separating said pairs of contacts a predetermined distance to establish a plurality of serially related arcs, an additional pair of separable contacts connected in series with said plurality of pairs of contacts and disposed exteriorly of said arc-extinguishing units, said additional pair of contacts being adapted to be separated a distance greater than the separation of said simultaneously actuated pairs of contacts by said actuating means subsequent to the opening of said simultaneously actuated pairs of contacts.

9. In a circuit breaker, a plurality of arc extinguishing units arranged end to end, a relatively fixed and a movable contact for each unit, means for connecting said contacts in series, means including a common actuating member operatively coupling said movable contacts in tandem for simultaneous operation to open and closed positions, a contact carried by said actuating member and connected in series with the contacts of said units, and a second actuating member having a contact thereon adapted for releasable contacting engagement with the contact on said first actuating member, said second actuating member being movable with said first actuating member during the opening of said movable contacts for maintaining the contacts carried by said respective members in engagement and movable therefrom immediately following the opening operation of said movable contacts to cause a separation of said contacts carried by said respective actuating members.

10. In a circuit breaker, a plurality of arc extinguishing units, a relatively fixed and a movable contact for each unit, means for connecting said contacts in series, means including an operating rod coupling said movable contacts in tandem for simultaneous operation to open and closed positions, means biasing said movable contacts to the open position, a contact member secured to one end of said actuating rod and connected in series with the contacts of said units, an actuating member having a contact member thereon for cooperative engagement with the contact member on said rod, said actuating member being movable in one direction for engaging said contact member and for causing said operating rod to move said movable contacts to the closed

position against said biasing means, said actuating member being movable in the opposite direction to open said contact members, said latter movement enabling said biasing means to move said movable contacts to the open position prior to the final separation of said contact members.

11. In a circuit interrupter, an enclosure having an insulating liquid therein, a plurality of arc-extinguishing units, means for supporting said units in aligned spaced relation within said enclosure, each of said units having an arc chamber therein, a contact member yieldingly supported on each unit having a contact portion extending within the arc chamber of the unit, a movable contact member for each unit having a contact portion thereon for cooperative engagement with said first-named contact portion, means for connecting the cooperating pairs of contacts of said units in series, means for pivotally supporting said movable contact members, a common operating rod coupled to each of said movable contact members and operable to simultaneously rock said movable contact members about their pivotal supports to open and closed positions, means biasing said movable contact arms to the open position, an auxiliary pair of contacts one of which is secured to one end of said operating rod and connected in series with the contacts of said units, and an actuating member supporting the other of said auxiliary pairs of contacts, said actuating member being movable in one direction to cause the engagement of said auxiliary pair of contacts and the movement of said operating rod to the closed position, and movable in the opposite direction to cause said biasing means to operate said contact arms to the open position prior to the opening of said auxiliary pair of contacts.

12. In a circuit interrupter, a tank, an insulating liquid within said tank, an arc-extinguishing assemblage supported within said tank comprising a plurality of arc-extinguishing units arranged end to end in aligned spaced relation, a pair of cooperating contacts within each unit, a movable carrier for at least one of the contacts of each pair of contacts, a common actuating member operatively coupled to said contact carriers for simultaneously separating said pairs of contacts a predetermined distance to establish a series arc within each of said arc-extinguishing units, an auxiliary pair of separable contacts connected in series with said simultaneously actuated contacts, and means for operating said actuating member, said last-named means being operable to separate said auxiliary pair of contacts subsequent to the separation of said simultaneously actuated contacts, and to provide a greater gap distance between said auxiliary contacts than between said simultaneously actuated contacts.

13. In a circuit breaker, a plurality of pairs of separable contacts, means for connecting said contacts in series and a common actuating means for simultaneously separating all of said pairs of contacts except one a predetermined distance to form a plurality of serially related arcs of limited arc energy and for subsequently separating the remaining pair of contacts a greater distance to provide an insulating gap capable of withstanding high voltage, said common actuating means including means for biasing said simultaneously separable pairs of contacts to the open circuit position independently of the force applied by said actuating means for separating said remaining pair of contacts.

14. In a circuit breaker, an arc extinguishing structure, a plurality of pairs of separable contacts for drawing a plurality of arcs within said arc-extinguishing structure, means connecting said pairs of contacts in series, a common actuating means for simultaneously separating said pairs of contacts a predetermined distance to establish a plurality of serially related arcs, means biasing said simultaneously actuated pairs of contacts to the open circuit position, an additional pair of separable contacts connected in series with said plurality of pairs of contacts and disposed exteriorly of said arc extinguishing structure, said additional pair of contacts being adapted to be separated a distance greater than the separation of said simultaneously actuated pairs of contacts by said actuating means subsequent to the opening of said simultaneously actuated pairs of contacts, said biasing means being operative to move said simultaneously actuated pairs of contacts to the open circuit position independently of the force applied by said actuating means for separating said additional pair of contacts.

15. In a circuit breaker, a plurality of pairs of separable contacts, means for connecting said contacts in series, and common actuating means for simultaneously separating a plurality of said pairs of contacts a predetermined distance to form a plurality of serially related arcs of limited arc energy and for subsequently separating at least one of said pairs of contacts a greater distance to provide an insulating gap capable of withstanding high voltage.

16. An electric circuit interrupter of the extinguishing chamber type comprising insulating casing means forming pressure-confining chamber means, an arc-extinguishing liquid substantially filling said chamber means, a plurality of contact members, each pivotally mounted with respect to said casing means and disposed to move within said chamber means, coacting fixed contact structure arranged to form with said contact members a plurality of breaks in series in the circuit, said casing means having a pressure exhaust port opposite each of said breaks, an operating member for moving said contact members substantially in unison, a disconnecting contact connected in series with said contact members and carried by said operating member at one end of said chamber means, and a movable switch member for coacting with said disconnecting contact exteriorly of said chamber means.

17. An electric circuit breaker of the liquid blast type comprising pressure confining casing means, an arc-extinguishing liquid in which said casing means is immersed, relatively movable contacts mounted to move within said casing means arranged to form at least two breaks in series in the circuit to be interrupted, said casing means having an exhaust port disposed adjacent and opposite one of said breaks and arranged so that arc pressure created within said casing means is effective to drive arc-extinguishing liquid through said port to extinguish the arc thereat, and a movable switch member operable within said liquid exteriorly of said casing means for controlling the movable contact structure in said casing means and being in series therewith, circuit opening movement of said switch member causing initially separation of the contact structure within said casing means for interrupting the circuit and subsequently separation of said

switch member from said contact structure to form an isolating gap in said liquid.

18. An electric circuit breaker of the fluid blast type comprising relatively movable contact structure separable to open the circuit, pressure confining chamber means for enclosing a comparatively fixed portion of said contact structure, said fixed portion including a plurality of contact elements adapted to form a plurality of breaks in series in the circuit, said chamber means being provided with exhaust ports disposed opposite certain of said breaks so that pressure within said chamber means is effective to drive arc-extinguishing fluid through the breaks at said ports, means for moving said contact elements towards open-circuit position, and movable switch structure coacting with said contact elements exteriorly of said pressure-confining chamber means so as to move said contact elements to the closed circuit position and to break connection therewith subsequent to circuit-opening movement of said contact elements.

19. An electric circuit breaker of the fluid blast type comprising relatively fixed contact structure adapted to form a plurality of breaks in series, means forming pressure-confining chamber means for said contact structure, a movable switch member adapted to be connected in series with said fixed contact structure operable exteriorly of said chamber means, a source of arc-extinguishing fluid, said chamber means having exhaust ports opposite certain of said breaks so that pressure within said chamber means is effective to drive arc-extinguishing fluid through the breaks at said ports, said movable switch member being operative to move said fixed contact structure to close said breaks in the circuit-closing operation and adapted in the circuit-opening operation to form an isolating break with respect to said fixed structure subsequent to formation of the aforesaid breaks in said chamber means.

20. An electric circuit breaker of the fluid blast type comprising fixed insulating casing means forming extinguishing chamber means, relatively movable contacts mounted for limited movement within said chamber means and arranged to form a plurality of breaks in series in the circuit, a source of arc-extinguishing fluid, said insulating casing means having exhaust ports opposite certain of said breaks so that pressure within said chamber means is effective to drive arc-extinguishing fluid through the arcs at said breaks, means for operating as a unit said contact structure within said extinguishing chamber means and a coacting movable switch member operable exteriorly of said chamber means for biasing said unit to the closed circuit position in accordance with the circuit-closing operation and for controlling opening movement of said unit in accordance with initial circuit-opening movement of said switch member, the circuit-opening operation within said chamber means being effective to interrupt said circuit independently of said movable switch member, and said movable switch member being movable to form an isolating gap between said member and said extinguishing chamber means.

21. In a circuit interrupter, an outer casing, an arc-extinguishing structure in said outer casing, a plurality of pairs of separable contacts electrically connected in series for drawing a plurality of relatively short arcs within said arc-extinguishing structure, a pair of disconnecting contacts electrically connected in series with said plurality of pairs of contacts, one of said disconnecting contacts being movable within said outer casing to a point a considerable distance away from said arc-extinguishing structure, and operating means for first separating said plurality of pairs of contacts and then separating said pair of disconnecting contacts.

22. In a circuit interrupter, a casing, a body of arc-extinguishing liquid therein, an arc-extinguishing structure in said body of liquid, a plurality of pairs of separable contacts electrically connected in series for drawing a plurality of relatively short arcs within said arc-extinguishing structure, a pair of disconnecting contacts electrically connected in series with said plurality of pairs of contacts, one of said disconnecting contacts being movable through said arc-extinguishing liquid to a point a relatively great distance away from said arc-extinguishing structure, and operating means for first causing said plurality of pairs of contacts to begin to separate substantially simultaneously to interrupt the current in said arc-extinguishing structure and for then separating said pair of disconnecting contacts.

23. In a circuit interrupter, an arc-extinguishing structure, a plurality of pairs of separable contacts electrically connected in series for drawing a plurality of relatively short arcs within said arc-extinguishing structure, actuating means connecting said plurality of pairs of contacts, means biasing said actuating means and said plurality of pairs of contacts to move to separated position, a pair of disconnecting contacts electrically connected in series with said plurality of pairs of contacts, one of said disconnecting contacts being mechanically connected to said actuating means and the other of said disconnecting contacts being movable in one direction to engage the first said disconnecting contact and thereafter move said actuating means and said plurality of pairs of contacts to engaged position against their bias and being movable in the other direction to cause said plurality of contacts to begin to separate substantially simultaneously and to thereafter separate from the first said disconnecting contact and move to a point at a considerable distance from said arc-extinguishing structure.

24. In a circuit interrupter, a casing, a body of arc-extinguishing liquid therein, an arc-extinguishing structure in said body of liquid, a plurality of pairs of separable contacts electrically connected in series for drawing a plurality of relatively short arcs within said arc-extinguishing structure, said arc-extinguishing structure including pressure-confining chamber means for causing fluid to flow through at least several of said arcs to quickly extinguish them and interrupt the circuit, actuating means connecting said plurality of pairs of contacts, means biasing said actuating means and said plurality of pairs of contacts to move to separated position, a pair of disconnecting contacts electrically connected in series with said plurality of pairs of contacts one of said disconnecting contacts being mechanically connected to said actuating means and the other of said disconnecting contacts being movable in one direction to engage the first said disconnecting contact and thereafter move said actuating means and said plurality of pairs of contacts to engaged position against their bias and being movable in the other direction to cause said plurality of contacts to begin to separate substantially simultaneously and to separate

from the first said disconnecting contact after the current has been interrupted in the arc-extinguishing structure and to move to a point within said casing at a relatively great distance from said arc-extinguishing structure.

25. An electric circuit breaker of the liquid blast type comprising relatively movable contact structure separable within an arc-extinguishing liquid, insulating pressure confining chamber means for enclosing a comparatively fixed portion of said contact structure, said fixed portion including a plurality of contact elements adapted to form a plurality of breaks in series in the circuit, said chamber means being provided with exhaust ports disposed adjacent and opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing liquid through the breaks at said ports, means for biasing said contact elements towards open-circuit position, and movable switch structure coacting with said contact elements exteriorly of said pressure-confining chamber means so as to bias said contact elements to the closed circuit position and to break connection therewith subsequent to circuit-opening movement of said contact elements.

26. An electric circuit breaker of the liquid blast type comprising relatively fixed contact structure adapted to form a plurality of breaks in series, insulating casing means forming pressure-confining chamber means for said contact structure, a movable switch member adapted to be connected in series with said fixed contact structure operable exteriorly of said chamber means, an arc-extinguishing liquid in which said fixed and movable contact structures are immersed, said insulating casing means having exhaust ports adjacent and opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing liquid through the breaks at said ports, said movable switch member being operative to bias said fixed contact structure to close said breaks in the circuit-closing operation and adapted in the circuit-opening operation to form an isolating break with respect to said fixed structure subsequent to formation of the aforesaid breaks in said chamber means.

27. An electric circuit breaker of the liquid blast type comprising fixed insulating casing means forming an extinguishing chamber means, relatively movable contacts mounted for limited movement within said chamber means and arranged to form a plurality of breaks in series in the circuit, an arc-extinguishing liquid in which said insulating casing means is immersed, said insulating casing means having exhaust ports adjacent and opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing liquid through the arcs at said breaks, means for operating as a unit said contact structure within said extinguishing chamber means and a coacting movable switch member operable in said arc-extinguishing liquid exteriorly of said chamber means for biasing said unit to the closed circuit position in accordance with the circuit-closing operation and for controlling opening movement of said unit in accordance with initial circuit-opening movement of said switch member, the circuit-opening operation within said chamber means being effective to interrupt said circuit independently of said movable switch member, said movable switch member being movable into said arc-extinguishing liquid so as to form an isolating gap between said member and said extinguishing chamber means.

28. An electric circuit breaker of the fluid blast type comprising pressure confining casing means, an arc-extinguishing liquid in which said casing means is immersed, relatively movable contacts mounted to move within said casing means arranged to form at least two breaks in series in the circuit to be interrupted, said casing means having an exhaust port disposed opposite one of said breaks and arranged so that arc pressure created within said casing means is effective to drive arc-extinguishing fluid through said port to extinguish the arc thereat, and a movable switch member operable within said liquid exteriorly of said casing means for controlling the movable contact structure in said casing means and being in series therewith, circuit opening movement of said switch member causing initially separation of the contact structure within said casing means for interrupting the circuit and subsequently separation of said switch member from said contact structure to form an isolating gap in said liquid.

29. An electric circuit breaker of the fluid blast type comprising relatively movable contact structure separable within an arc-extinguishing liquid, insulating pressure confining chamber means for enclosing a comparatively fixed portion of said contact structure, said fixed portion including a plurality of contact elements adapted to form a plurality of breaks in series in the circuit, said chamber means being provided with exhaust ports disposed opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing fluid through the breaks at said ports, means for biasing said contact elements towards open-circuit position, and movable switch structure coacting with said contact elements exteriorly of said pressure-confining chamber means so as to bias said contact elements to the closed circuit position and to break connection therewith subsequent to circuit-opening movement of said contact elements.

30. An electric circuit breaker of the fluid blast type comprising relatively fixed contact structure adapted to form a plurality of breaks in series, insulating casing means forming pressure-confining chamber means for said contact structure, a movable switch member adapted to be connected in series with said fixed contact structure operable exteriorly of said chamber means, an arc-extinguishing liquid in which said fixed and movable contact structures are immersed, said insulating casing means having exhaust ports opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing fluid through the breaks at said ports, said movable switch member being operative to bias said fixed contact structure to close said breaks in the circuit-closing operation and adapted in the circuit-opening operation to form an isolating break with respect to said fixed structure subsequent to formation of the aforesaid breaks in said chamber means.

31. An electric circuit breaker of the fluid blast type comprising fixed insulating casing means forming an extinguishing chamber means, relatively movable contacts mounted for limited movement within said chamber means and arranged to form a plurality of breaks in series in the circuit, an arc-extinguishing liquid in which said insulating casing means is immersed, said

insulating casing means having exhaust ports opposite certain of said breaks so that arc pressure created within said chamber means is effective to drive arc-extinguishing fluid through the arcs at said breaks, means for operating as a unit said contact structure within said extinguishing chamber means and a coacting movable switch member operable in said arc-extinguishing liquid exteriorly of said chamber means for biasing said unit to the closed circuit position in accordance with the circuit-closing operation and for controlling opening movement of said unit in accordance with initial circuit-opening movement of said switch member, the circuit-opening operation within said chamber means being effective to interrupt said circuit independently of said movable switch member, said movable switch member being movable into said arc-extinguishing liquid so as to form an isolating gap between said member and said extinguishing chamber means.

32. In a circuit breaker, a plurality of movably mounted contacts electrically connected in series, arc-extinguishing means for the arc established at each of a plurality of said contacts, means for simultaneously moving a plurality of said contacts to draw a plurality of arcs to a length which is sufficient to cause efficient extinguishing of said arcs by said arc-extinguishing means but which is insufficient to provide a gap which can be relied upon to meet the normal open circuit insulation requirements of the circuit breaker, and one of said contacts being automatically movable after the extinguishing of said arcs upon each opening operation of the circuit breaker to provide a gap which is sufficient to meet the normal open circuit insulation requirements of the circuit breaker.

33. In a circuit breaker, a plurality of movably mounted contacts electrically connected in series, arc-extinguishing means in which a plurality of said contacts establish a plurality of arcs, means for simultaneously moving said plurality of contacts for establishing the plurality of arcs in the arc-estinguishing means to draw said plurality of arcs to a length which is sufficient to cause efficient extinguishing of said plurality of arcs by said arc-extinguishing means but which is insufficient to provide a gap which can be relied upon to meet the normal open circuit insulation requirements of the circuit breaker, and one of said movably mounted contacts being automatically movable outside of said arc-extinguishing means after the extinguishing of said arcs upon each opening operation of the circuit breaker to provide a gap which is sufficient to meet the normal open circuit insulation requirements of the circuit breaker.

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