

Oct. 12, 1937.

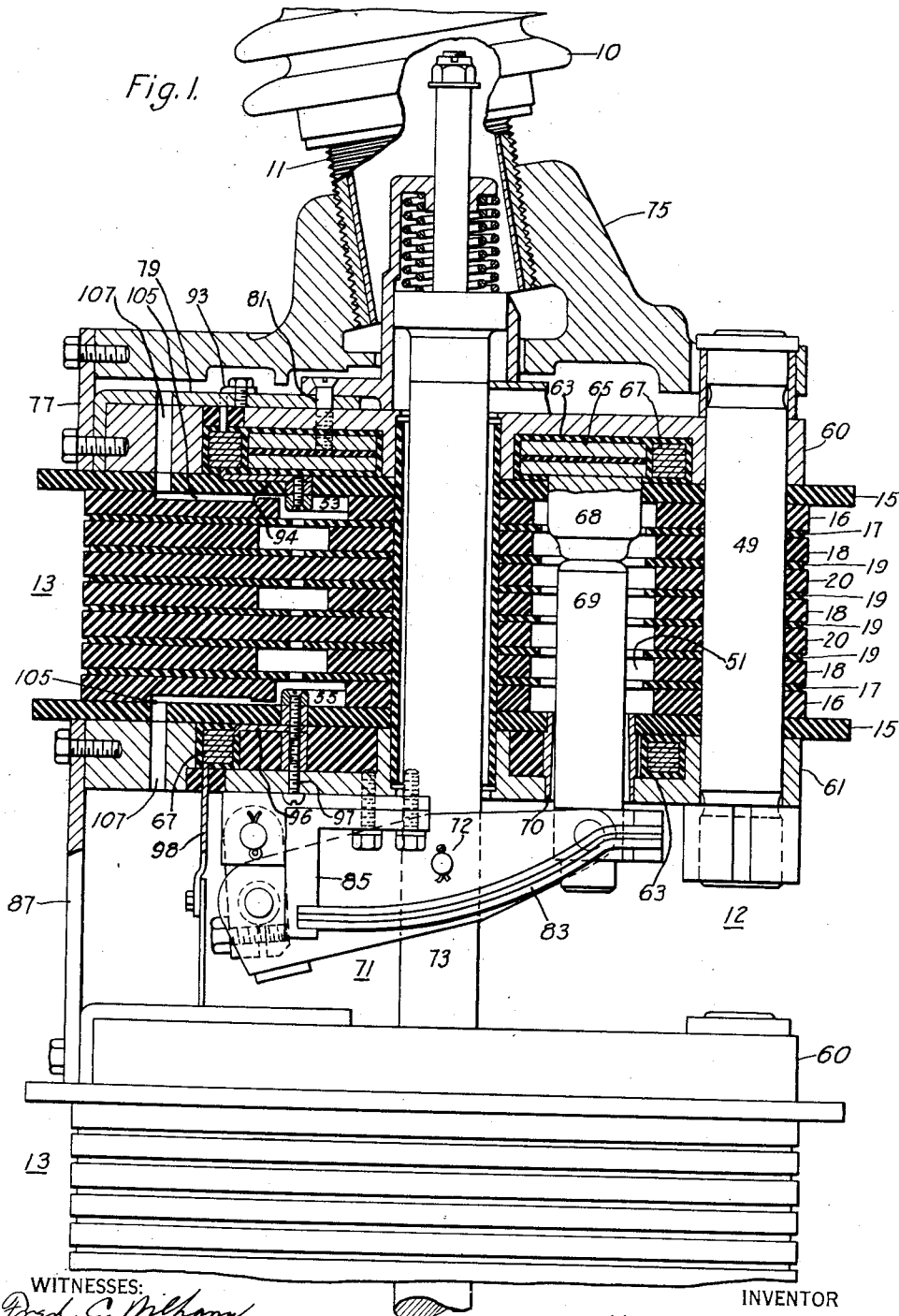
H. M. WILCOX

2,095,301

CIRCUIT BREAKER

Filed June 5, 1936

3 Sheets-Sheet 1



WITNESSES:

WITNESSES:
Frank C. Wilhelm
Walter E. Mueller

Walter E. Mueller

INVENTOR

Howard M. Wilcox

BY

BY
Ralph W. Swingle
ATTORNEY

ATTORNEY

Oct. 12, 1937.

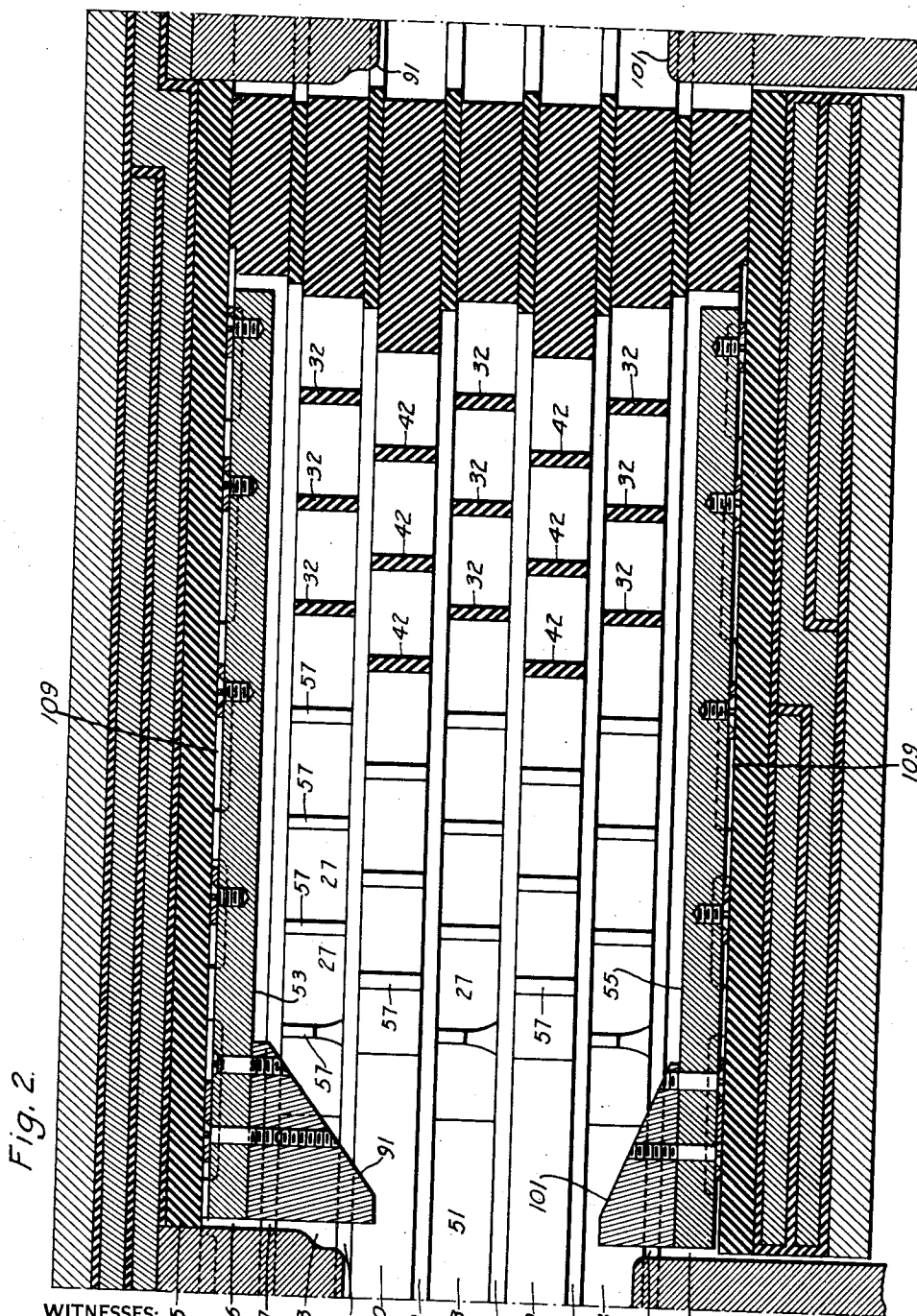
H. M. WILCOX

2,095,301

CIRCUIT BREAKER

Filed June 5, 1936

3 Sheets-Sheet, 2



WITNESSES:
Frank C. Miller
Walter E. Mueller

INVENTOR
Howard M. Wilcox
BY
Ralph H. Swingle
ATTORNEY

Oct. 12, 1937.

H. M. WILCOX

2,095,301

CIRCUIT BREAKER

Filed June 5, 1936

3 Sheets-Sheet 3

Fig. 3.

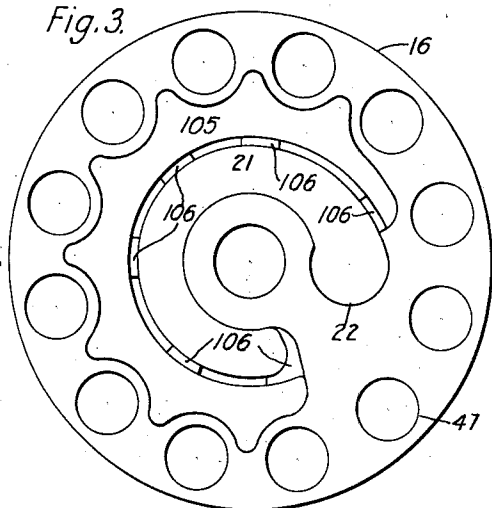


Fig. 4.

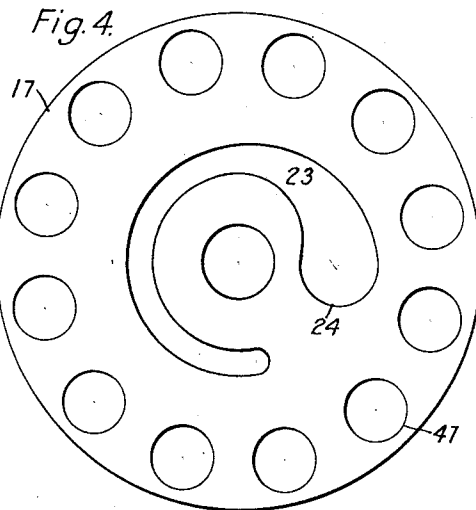


Fig. 5.

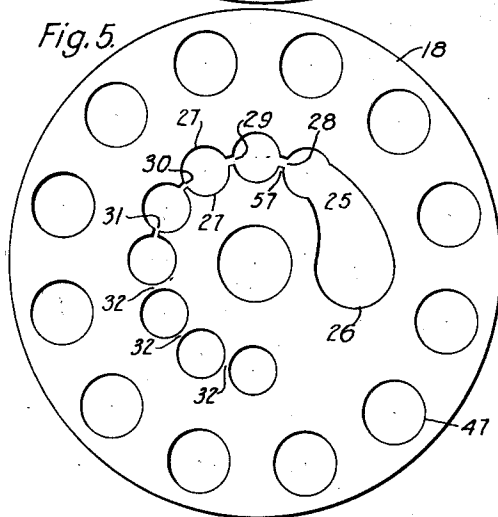


Fig. 6.

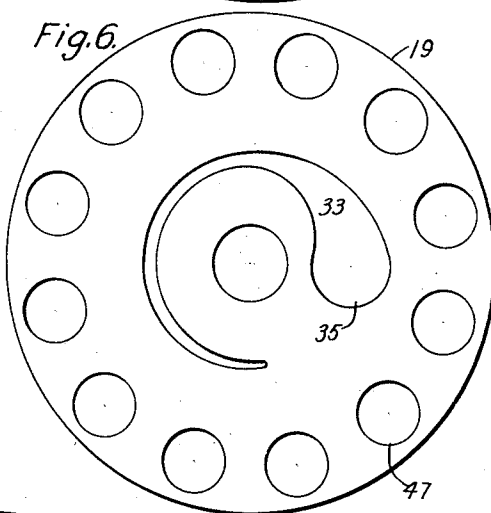
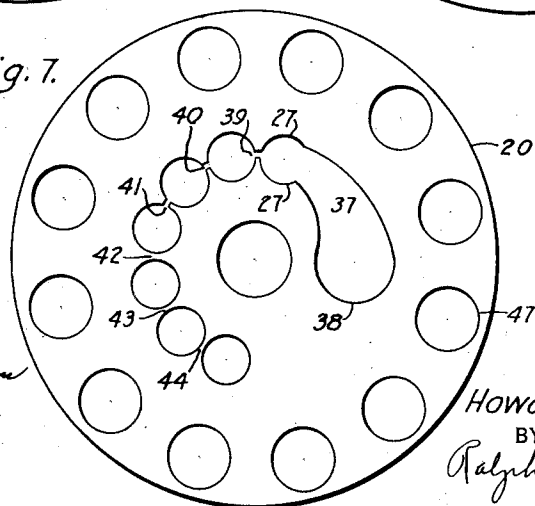


Fig. 7.



WITNESSES:
Paul C. Williams
Walter E. Mueller

INVENTOR
Howard M. Wilcox
BY
Ralph H. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,095,301

CIRCUIT BREAKER

Howard M. Wilcox, Wilkinsburg, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, East Pittsburgh, Pa., a corporation of
Pennsylvania

Application June 5, 1936, Serial No. 83,597

9 Claims. (Cl. 200—150)

This invention relates to circuit breakers and more particularly to arc extinguishers therefor of the liquid immersed type.

In the copending application of H. J. Lingal and R. C. Dickinson, Serial No. 743,697, filed September 12, 1934, and assigned to the assignee of this application, is shown and described a structure for extinguishing alternating-current arcs which comprises a generally annularly shaped passage defined by a stack of insulating plates. The arc to be extinguished is drawn longitudinally of the passage by a pair of separable contact members positioned therein and is caused to rotate, with its ends in engagement with a pair of arc horns, around the passage by means of a radial magnetic field set up across the passage. The arc extinguishing structure is immersed in oil or other arc quenching liquid which completely fills the passage. Upon the formation of an arc, the oil or other arc quenching liquid is decomposed and gas is produced which contains a high percentage of relatively cool un-ionized particles. These un-ionized gas particles flow through and are intermingled with the arc stream so that when it passes through the current zero sufficient deionization will take place to prevent the arc from restriking when the voltage builds up in the opposite direction.

In order to provide for an ample supply of un-ionized gas particles, the arc is driven through the oil so that the leading side thereof is continuously in engagement with fresh gas producing liquid.

In a copending application of B. P. Baker and W. M. Leeds, Serial No. 82,408, filed May 29, 1936, and assigned to the assignee of this application, is shown and described a circuit breaker employing a multiple unit arc extinguishing structure embodying the general principles of arc extinction set forth in the aforementioned Lingal and Dickinson application. The Baker and Leeds application is more particularly directed to magnetic means for producing arc movement and relates to the arrangement of field coils and their connections for producing the requisite arc velocity necessary for arc extinction with arcs of variable current magnitude. However, in view of the relatively large air gap inherent in the magnetic circuit of structures of this type, there is very little tendency for saturation, and consequently arcs of high current magnitude have a tendency to move faster than necessary. Therefore, during the extinction of high current arcs, it often occurs that the arc is driven at such a velocity that it reaches the rearward portion of the slot before it

is extinguished. In other words, the arc movement is faster than necessary for the effective operation of the gas upon the arc stream to provide the requisite deionizing action.

It is, therefore, an object of my invention to provide an arc extinguishing structure for circuit breakers of the type above referred to adapted to produce more consistent, reliable and effective arc extinction over a broad range of current values.

A further object of my invention is to provide an arc extinguishing structure of the aforesaid type in which arc velocities for a broad range of current values are maintained at a sufficient amount above the critical value to provide positive arc extinction.

A more specific object of my invention is to provide an arc extinguishing structure having an arc receiving passage, the configuration of which gradually contracts the arc stream during arc movement in one direction without causing the arc to have a tendency to strike back or reform adjacent the main arc drawing electrodes.

A still further object of my invention is to provide in a circuit interrupter of the type aforesaid an arc extinguishing passage having adequate means for retaining arc extinguishing liquid therealong, and in addition providing a succession of interfering surfaces along the side walls of the passage so as to effectively direct the gas produced by the arc acting upon the arc extinguishing liquid into the arc stream and for breaking up the arc reignition paths so as to aid in extinguishing the arc.

Other objects and advantages relate to the specific parts of the structure and the arrangement thereof and will appear more fully in the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a side elevation, partially in section, showing the upper and a portion of the next succeeding arc extinguishing unit of a multiple break arc interrupter;

Fig. 2 is a developed sectional view taken longitudinally through the arc passage of one of the arc extinguishing units embodying my invention; and

Figs. 3 to 7, inclusive, are plan views of the several types of insulating plates employed in each of the arc extinguishing units of my invention.

Referring to the drawings, the reference character 10 designates an insulated bushing adapted to be supported in any conventional manner in the tank or other circuit breaker housing (not shown). The insulating bushing 10 houses a

lead-in line terminal 11, the lower end of which is threaded and adapted to support an arc interrupting assemblage generally indicated at 12. The arc interrupting assemblage 12 may comprise a plurality of arc extinguishing units generally indicated at 13, the uppermost one of which is shown in section in Fig. 1, whereas the next succeeding unit is partially shown in elevation.

The arc extinguishing units 13 are composed of a plurality of, in this instance, fifteen plates of insulating material arranged in a stack. The plates comprising the stack have a generally circular configuration, some of which differ from the others in form. With particular reference to Fig. 1, plates having the same form are given the same numeral of reference. Thus in the order named from top to bottom, the plates 15, 16, 17, 18, 19, 20, 19, 18, 17, 16 and 15 form that portion of the stack defining the arc extinguishing passage.

Referring more particularly to Fig. 3, the plates 16 are shown in plan and comprise a curved slot 21, one end of which has an enlarged portion 22. The plate 17, which is shown in Fig. 4, has a concentrically positioned slot 23 of somewhat narrower width than the slot of plate 16. Plate 17 also has the enlarged end portion 24, which is of a dimension somewhat smaller than the end portion 22 of the slot 21 in plate 16. The plates 18, as shown in Fig. 5, also have a generally curved slot indicated at 25 and an enlarged end portion 26 which is similar to the enlarged end portion previously described in connection with plate 16. The remaining portion of the slot 25, however, is provided with depressions or indentures 27 on opposite sides thereof. The indentures 27 are preferably formed by making circular apertures through the plate in spaced relation along the center line of the slot 25 as shown. The portions of the material between the recesses 27 are slotted as shown at 28, 29, 30 and 31. The width of these slots gradually decrease in inverse order of their designation. The portions between the depressions 27, as indicated at 32, are not slotted, but are allowed to remain in full. The purpose of this construction will be more fully explained hereinafter.

Plate 19, as shown in Fig. 6, has a circularly shaped slot therethrough designated at 33, one end of which is enlarged as shown at 35 in a manner similar to that shown in the plate 17, whereas the remaining portion tapers gradually having an intermediate portion of substantially uniform width and a rearward portion which again tapers to a narrower width. The slot 33 in plate 19, as will appear hereinafter, defines the general shape of the arc passage horizontally.

The plate 20, as shown in Fig. 7, is similar in construction to that of plate 18 in that it has the same general arrangement of slot designated at 37 and having an enlarged portion 38 identical in shape and dimension to that of the portion 26 of the slot 25. The indentures 27 along the slot 37 of plate 20, however, are located at relatively different angular positions with respect to the end portions of the slots. The theoretical centers of the apertures forming the indentures 27 of plate 20 are so positioned so as to coincide respectively with the center of the slot passages 28, 29, 30 and 31 of plate 18. Consequently, the slot passages between adjacent indentures 27 of the plate 20, as designated at 39, 40 and 41, would fall substantially in the center of the theoretical aperture forming the indentures 27 of the plate 18. The portions 42, 43

and 44 between the remaining indentures 27 of plate 20 are not slotted for the reason as will appear hereinafter.

Each of the plates 15 to 20 is provided with a plurality of apertures 47 positioned adjacent the circumference thereof in order to enable the respective plates to be assembled upon suitable tie-rods 49 as shown in Fig. 1. When the plates forming the arc extinguishing stack are assembled with their respective slots in alignment, as shown in Fig. 1, an arc passage 51 is formed which is more clearly shown in a developed view of Fig. 2. The ends of the arc passage are, respectively, substantially completely enclosed vertically by the circular end plates 15 which also have apertures near the circumference thereof to permit assembly therewith upon the tie-rods 49.

The entrance to the passage 51 is enlarged and defined by the respective end portions 22, 24, 26, 35 and 38 of the slots in the plates 16 to 20, respectively. Since plates 16 are located next adjacent to the upper and lower ends of the passage 51, the slot 21 contained therein is relatively wide and substantially of uniform width throughout the slot length so as to provide for an upper arc horn designated at 53 and a lower arc horn designated at 55, which horns are respectively secured to the upper and lower end plates 15 at the closed ends of the passage 51. Inasmuch as it is desirable to maintain symmetry of the arc passage on either side of the central plate, the description of the arc passage will proceed by describing the plates from the upper portion of the stack towards the center.

Plate 17 lies adjacent plate 16, and the slot 23 contained therein is somewhat narrower than that of the slot 21 in plate 16 and lies immediately below the arc horn 53 and concentric with it. The enlarged end portion 24 of the slot 23, however, is somewhat smaller than the end portion 22 of slot 21 in plate 16. The next plate which is designated as 18 has its enlarged end portion 26 of the same dimensions as the end portion 22 of plate 16. The slot 25 of plate 18 gradually tapers, and may be said to be generally defined by the slot portions 28, 29, 30 and 31. The plate 19 which lies adjacent the plate 18, as previously indicated, forms the general cross-sectional outline of the arc passage 51 which takes the shape of the slot 33 in the plate 19. The enlarged end portion 35 of the slot 33 is of the same dimension as the end portion 24 of the slot 23 in the plate 16. It will be noted that the slot 33 tapers from the end portion to its intermediate portion, the extent of which taper is of material importance in obtaining the proper movement of the arc along the passage. By way of example, a taper of 1 to 1.5 has been considered satisfactory for the particular purpose at hand.

Immediately underlying the plate 19 is the plate 20, which is similar in general relation to plate 18 with the exception that the indentures 27 are offset with respect to the indentures of the former plate. Plate 20 is followed with a plate 19, previously described, which is followed by plate 18, also above described. The last-named plate 18 forms the center line of the stack and succeeding plates are arranged so as to preserve the symmetry of the stack previously mentioned.

It will thus be noted, with particular reference to Fig. 1, that at the entrance of the arc passage 51, as formed by the enlarged end portions 22, 24, 26, 35 and 38, respectively, the edges of the

enlarged end portions 24 and 35 of the plates 17 and 19, respectively, project into the entrance so as to form an irregular wall longitudinally of the passage.

5 With particular reference to Fig. 2, it will be noted that the plates 17 and 19 forming the general outline of the arc passage 51 provide a broken irregular side wall longitudinally of the passage. The indentures 27 form pockets along the side walls of the arc passage for the purpose of providing a greater quantity of arc quenching liquid along the passage. It will also be noted that since plates 18 and plates 20 alternate with the plate 19 interposed therebetween 10 will cause the respective indentures 27 to be staggered longitudinally of the passage 51. The projections or nodes between the indentures 27, indicated respectively at 57, of the plates 18 and 20 are also staggered for the same reason. The same will also apply to the bridging portions designated at 32 in plate 18 and 42 in plate 20. These bridging portions extend across the rearward portion of passage 51, as shown in Fig. 2, so as to provide barriers for impeding the movement of the arc in this portion of the passage.

The stack of insulating plates 15 to 20 are also provided with upper and lower end plates 60 and 61, respectively, preferably of magnetic material. These magnetic end plates are also adapted to be secured to the stack in clamping engagement by the tie-rods 49. The upper magnetic end plates 60 are provided with an annular recess 63 for receiving a pair of coils 65 and 67, respectively. The coil 65 has one end thereof connected to a main contact 68 which projects through a suitable aperture in the upper end plates 15 and is adapted to make contact with a movable contact 69, which, in this instance, is movable into and out of engagement with the contact 68 through a suitable guide member 70 positioned between the lower end plates 15 and 61. The moving contact 69 is adapted to be actuated by a suitable linkage generally indicated at 71, which in turn is pivotally connected by pin 72 to an operating rod 73 passing centrally through the arc extinguishing unit 13. It will, of course, be understood that in a multiple unit extinguishing structure each of the units 13 are of the same construction and are provided with a linkage mechanism 71 for connecting each of the moving contacts 69 with the operating rod 73 so as to obtain simultaneous operation of the movable contacts either into the open or closed position.

It may also be stated at this point that the separate units 13 may be maintained in spaced relation with each other by means of tie-rods (not shown) passing through some of the apertures 47. The upper ends of such tie-rods may be secured to a supporting bracket or contact foot designated at 75 which has threaded engagement with the incoming terminal 11 for supporting the group of arc extinguishing units 13 therefrom.

The electrical circuit through the breaker when the contacts 68 and 69 are in the closed position proceeds from the line terminal 11, the contact foot 75, the bridging connection 77 connecting the contact foot 75 with the upper end plate 60 and also a connector 79. The connector 79 makes connection with one end of the coil 65 by means of a screw 81. The other end of coil 65, as previously indicated, is secured to and provides a support for the fixed contact 68. The circuit proceeds through the movable contact 69 through a flexible shunt 83 which in turn is connected to a bracket 85 having electrical and mechanical

connections with the lower end plates 61. The lower end plate 61 has connection with the upper end plate 60 of the next succeeding unit by means of a connector 87, from which point the circuit repeats itself through any of the succeeding units 13 which may comprise a complete arc interrupting assemblage.

Upon the drawing of an arc within the enlarged or the entrance portion of the passage 51 by the separation of contacts 68 and 69, a current flowing through the coil 65 will set up a radial magnetic field across the upper end of the arc passage 51, the direction of current through the coil being such that the resulting magnetic field will tend to drive an arc drawn between the parting contacts laterally along the open passage. The arc thus drawn within the influence of this field will have at least its upper end transferred onto the arc receiving tip 91 of the upper arc horn 53.

As soon as this transfer occurs, the coil 67, which has one end connected by a connection 93 to the connector 79, and its other end connected by a connection 94 to the arc horn 53 will be inserted in the arc circuit. The lower magnetic end plate 61 is also provided with an annular recess 63 in which a coil 67, identical with the coil 67 in the upper end plate 60, is inserted. One end of the lower coil 67 is connected by a connector 96 to the lower arc horn 55, which arc horn is also connected to the lower end of plate 61 by a screw 97. The other end of coil 67 is connected by connection 98 to one end of the coil 67 in the upper end plate 60 of the next lower unit 13, thereby connecting these two latter coils in series. In view of this series connection, it will be apparent that as soon as the upper end of the arc of the next succeeding unit 13 transfers to its upper arc horn 53, which is connected to the other end of the upper coil 67, that the lower coil 67 of the uppermost unit will also be energized. As soon as this takes place, the joint action of the upper and lower coils 67 produces a strong magnetic field across the upper and lower ends of the arc passage 51 to transfer the arc completely on to the arc horns 53 and 55 and move it therealong.

The lower arc horn 55 is also provided with an arc receiving tip designated at 101, as more clearly shown in Fig. 2. As soon as the arc transfers to the arc horns 53 and 55, the circuit through the extinguishing unit proceeds from the line terminal 11, contact foot 75, connection 77, connection 79, connection 93, upper coil 67, connection 94, upper arc horn 53, through the arc stream to lower arc horn 55, connection 96, lower coil 67, connection 98 to the upper coil 67 of the next succeeding unit from whence the circuit repeats itself through the successive units 13.

As soon as the arc is transferred to the arc tips 91 and 101 of the arc horns 53 and 55, respectively, and is acted upon by the strong magnetic field produced by the coils 67, it is moved along the inclined surfaces of the arc receiving tips 91 and 101 and progressively lengthened as it proceeds along the passage 51. During its progressive forward movement, it is gradually being contracted by the tapering passage and further restricted into sections by the inwardly projecting edges of the plates 17 and 19. The contraction of the arc into these restricted sections causes a more gradual diminution of the cross-section of the arc and, consequently, its current density, thereby lessening the tendency of the arc to strike back into the enlarged space occupied by the main electrodes 68 and 69, as might be the case were the

current density and, consequently, the voltage necessary to maintain that density, increased less gradually.

As the arc proceeds, it first encounters the nodes 57 of the slot passage 28 in the plates 18. The nodes 57 projecting slightly into the arc passage 51, as defined by the slot 33 of plates 19 further restrict the arc at three points lengthwise thereof. After passing the nodes 57 in the plates 18, the arc still being under the influence of the confining edges of the plates 19 next encounters the oil pockets 27 which provide an abundance of gas producing material which is decomposed into unionized gas particles which are caused to flow through the arc stream. The arc then engages the nodes 57 of the plates 20 which are staggered with respect to the nodes 57 of the plates 18. It will be noted that, inasmuch as there are only two plates 20, the arc would only be subjected to the additional restricting action at two points along the arc stream. However, while the arc is being restricted at these two points, the intermediate portions thereof are subjected to the gas blast produced by the oil or other arc quenching liquid in the pockets 27 in line therewith. It will thus be seen that as the arc proceeds along the passage 51 alternate longitudinal sections thereof between the plates 19 are subjected to a contracting action and a gas blast action for effectively deionizing the arc stream.

During the extinction of arcs of high current magnitude, the velocity of arc movement may be in excess of that necessary for the effective deionization of the arc stream and, consequently, the arc may be driven to the rear of the slot before it is extinguished unless means for impeding its movement are provided. In order to render the arc extinguishing operation more efficient for these high current arcs, the bridging portions 42 provided toward the rearward portion of the passage between the apertured recesses 27 in the plates 18 and 20, provide an impedance in the arc path so as to decrease the velocity thereof. From Fig. 2, it will be noted that the arc stream first encounters the bridges 42 of the plates 20 of which there are two in number. In order to have the arc proceed beyond this point, it must loop over the bridges and reform on the rearward side. If the arc successfully passes the first set of bridges 42, it next encounters three bridges 32 formed in the plates 18, thereby offering still greater impedance to its travel towards the rear of the passage 51. Thus by staggering the bridges 32 and 42, the resistance to the forward movement of the arc stream is gradually increased, thereby lessening the tendency for the arc to strike back, which may occur if too great an impedance were placed in its path.

In order to further impede the progress of the high speed arc, the slot 33 in the plates 19 toward the rearward end thereof is also tapered in the direction of the arc movement so as to further contract the arc into sections. It will be observed that by making the slot passages between the projections or nodes 57 of the central plates of greater width than the passages between the nodes of the plates near the arc horns 53 and 55 a more uniform arc movement may be obtained, since the ends of the arc are in the stronger portions of the magnetic field and, therefore, tend to move at a more rapid rate than the central portion. It will be apparent that by providing less impedance to the flow of the arc in the central portion of the passage 51,

more uniform lateral movement of the arc may be obtained.

In order to provide for the escape of gas from the arc passage 51, the plates 16 are provided with a generally annularly shaped recess 105 adjacent the slot 21. The recess 105 communicates with the slot 21 by a plurality of ports 106. When the plates 16 are in engagement with the respective end plates 15, the recess 105 forms a chamber into which gas formed in the arc passage 51 may escape by way of the ports 106. In order to allow the escape of gas from the recess 105, axially positioned conduits 107 extending through the upper end plates 15 and 50 and the lower end plates 15 and 61, respectively, communicate with the chamber formed by the recess 105. The arc horns 53 and 55 are provided with notches or recesses 109 along their engaging surfaces with the end plates 15 so as to allow the free passage of gas from the ends of the passage 51 to the ports 106. Thus, by placing the vent openings in the respective ends of the passage 51, the flow of gas and the oil or other arc extinguishing liquid, as a result of the gas pressure, are parallel to the arc. The control of the flow of oil and gas, therefore, is of considerable importance.

From the previous description, it will be apparent that in order to have more effective arc extinction, the flow of gas must be directed through the arc stream and that adequate quantities of arc extinguishing liquid must be maintained adjacent the arc. This flow of oil and gas is controlled by the arc passage defining plates 19, that is, the edges of the slots 33 in these plates project into the passage so as to restrict the slot width.

From the foregoing description, it will be apparent that I have provided an improved arc extinguishing structure which is highly effective in the extinction of both low and high current arcs. It is also apparent that arc extinction has been made more positive in that the arc passage is of such configuration that the arc stream is contracted in sections, thus breaking up the reignition paths and increasing the surface creepage at the point where the greatest amount of carbon is formed which would tend to increase the danger of potential breakdown. Arc extinction has also been made more effective by providing adequate recesses in the walls for retaining oil or other arc extinguishing liquid, the boundaries of which recesses are free from breakdown surfaces between the upper and lower arc horns.

Furthermore, the arc passage above-described readily lends itself to control of the movement of the various portions of the arc so as to maintain a uniform lateral advance thereof along the arc passage. The form of arc passage herein described also provides adequate control of the velocity of arc movement so as to maintain such velocity slightly in excess of the critical value required for arc extinction.

From the foregoing, it will also be apparent that I have provided an arc extinguishing structure in which the forward or advancing movement of the arc is continually enhanced, and the tendency for arcs of varying magnitude to strike back and reform, and thereby hinder arc extinction, has been eliminated.

Although I have shown and described a particular arc extinguishing structure adapted for operation in a circuit interrupter, it is to be understood that the same is for the purposes of illustration and that many changes and modifications may be made by those skilled in the art

without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In an arc extinguisher for circuit breakers, means of insulating material defining the walls of a slot-like substantially enclosed arc passage, said passage being enlarged at the entrance thereof, a pair of separable contacts within said enlarged portion for establishing an arc longitudinally of said passage, means for moving said arc laterally along said passage, said passage having a portion extending from said entrance in the direction of arc movement which gradually decreases in width, means positioned along the walls of said passage for contracting the arc into a plurality of longitudinally spaced restricted sections, and means in addition to said decrease in width positioned rearwardly within the passage for impeding the movement of said arc.

2. In an arc extinguisher for circuit breakers, means of insulating material defining the walls of a slot-like substantially enclosed arc passage, said passage being enlarged at the entrance thereof, a pair of separable contacts within said enlarged portion for establishing an arc longitudinally of said passage, means for moving said arc laterally along said passage, said passage having a portion extending from said entrance in the direction of arc movement which gradually decreases in width, means positioned along the walls of said passage for contracting the arc into a plurality of longitudinally spaced restricted sections, means in addition to said decrease in width positioned rearwardly within the passage for impeding the movement of said arc and a liquid in said passage which gives off a gas when acted upon by an arc to aid in extinguishing the arc.

3. In an arc extinguisher for circuit breakers, means of insulating material defining the walls of a slot-like substantially enclosed arc passage, said passage being enlarged at the entrance thereof, a pair of separable contacts within said enlarged portion for establishing an arc longitudinally of said passage, means for moving said arc laterally along said passage, said passage having a tapering portion extending from said enlarged portion in the direction of arc movement for gradually restricting the cross-section of said arc, the side walls of said enlarged portion and said tapering portion having ribs spaced longitudinally of the passage and extending rearwardly therealong for contracting said arc into a plurality of restricted sections without materially increasing the resistance to movement of the arc along said passage, and a liquid within said passage which gives off a gas when acted upon by said arc to aid in extinguishing the arc.

4. In an arc extinguisher for circuit breakers, means of insulating material defining the walls of a slot-like substantially enclosed arc passage, said passage being enlarged at the entrance thereof, a pair of separable contacts within said enlarged portion for establishing an arc longitudinally of said passage, means for moving said arc laterally along said passage, said passage having a tapering portion extending from said enlarged portion in the direction of arc movement for gradually restricting the cross-section of said arc, the side walls of said passage having ribs spaced longitudinally of the passage and extending from the enlarged entrance portion toward the rear of the passage for contracting said arc into a plurality of restricted sections to facilitate its movement along said passage, a plurality of

bridging sections positioned between said ribs and extending transversely across said passage in the rearward portion thereof for impeding the movement of said arc, and a liquid within said passage which gives off a gas when acted upon by an arc and which is adapted to flow through the arc stream to aid its extinguishment.

5. In an arc extinguisher for circuit breakers, a stack of contiguous plates of insulating material, each of a plurality of side plates having a tapering slot therethrough, said slotted plates being arranged with their slots in alignment to form a narrow arc passage, means for establishing an arc longitudinally of the passage within the portion having the greater width, means for setting up a magnetic field across the passage for moving the arc therealong, alternate slotted plates having a narrower slot width over a portion adjacent the arc establishing means than the remaining slotted plates for contracting the arc into restricted sections to facilitate its movement along the passage, and liquid means within said passage which gives off a gas when acted upon by an arc to aid in extinguishing the arc, the said remaining slotted plates having pockets distributed along their slots to entrap said liquid, said pockets being arranged in staggered relation lengthwise of said passage.

6. In an arc extinguisher for circuit breakers, a stack of contiguous plates of insulating material, each of a plurality of said plates having a slot therethrough, one end of which is enlarged, said slotted plates being arranged with their slots in alignment to form a generally narrow arc passage, said enlarged end portions of said slots forming the entrance of said passage, means for drawing an arc longitudinally within the entrance of said passage, magnetic means for moving said arc laterally along said passage, said arc passage having a portion adjacent the entrance thereof tapering in width in the direction of arc movement, an intermediate portion of generally uniform width and a rearward portion also tapering in width in the direction of arc movement, alternate slotted plates having a narrower slot width than the remaining slotted plates for contracting the arc into restricted sections to facilitate its movement along the passage, said remaining slotted plates having alternate nodes and depressions along opposite sides of their slots forming the intermediate portion of said passage, the opposed nodes of said last-named plates having successively less clearance in the direction of arc movement, and alternate apertures and bridging portions adjacent the rearward portion of said passage, said bridging portions being adapted to extend transversely across said rearward portion of the passage for retarding the movement of said arc, and a liquid within said passage which gives off a gas when acted upon by an arc to aid in extinguishing the arc.

7. In an arc extinguisher for circuit breakers, a stack of contiguous plates of insulating material, each of a plurality of said plates having a slot therethrough, one end of which is enlarged, said slotted plates being arranged with their slots in alignment to form a generally narrow arc passage, said enlarged end portions of said slots forming the entrance of said passage, means for drawing an arc longitudinally within the entrance of said passage, magnetic means for moving said arc laterally along said passage, said arc passage having a portion adjacent the entrance thereof tapering in width in the direction of arc movement, an intermediate portion of generally

uniform width and a rearward portion also tapering in width in the direction of arc movement, alternate slotted plates having a narrower slot width than the remaining slotted plates for contracting the arc into restricted sections to facilitate its movement along the passage, said remaining slotted plates having alternate nodes and depressions along opposite sides of their slots forming the intermediate portion of said passage, the opposed nodes of said last-named plates having successively less clearance in the direction of arc movement, and alternate apertures and bridging portions adjacent the rearward portion of said passage, said bridging portions being adapted to extend transversely across said rearward portion of the passage for retarding the movement of said arc, and a liquid within said passage which gives off a gas when acted upon by an arc to aid in extinguishing the arc, said depressions, nodes and bridging portions being arranged in staggered relation lengthwise of the passage, said depressions serving to retain liquid along the passage.

8. In an arc extinguisher for circuit breakers, a stack of contiguous plates of insulating material, each of a plurality of said plates having a tapering slot therethrough, said slotted plates being arranged with their slots in alignment to form a narrow arc passage, means for establishing an arc longitudinally of the passage within

the portion having the greater width, means for setting up a magnetic field across the passage for moving the arc therealong, alternate slotted plates having alternate nodes and depressions along opposite sides of their slots, the opposed nodes of said last named plates having a graded clearance to provide resistances to movement of portions of said arc in proportion to the magnetic field strength tending to advance the respective portions of said arc.

9. In an arc extinguisher for circuit breakers, a stack of contiguous plates of insulating material, each of a plurality of said plates having a curved tapering slot therethrough, said slotted plates being arranged with their slots in alignment to form a narrow arc passage, means for establishing an arc longitudinally of the passage within the portion having the greater width, a coil adjacent each end of said arc passage for setting up a radial magnetic field thereacross for moving the arc therealong, alternate slotted plates having alternate nodes and depressions along opposite sides of their slots, the opposed nodes of said last named plates having successively less clearance from the center portion of the stack towards each end thereof for causing a uniform lateral advance of the arc throughout the entire arc length.

HOWARD M. WILCOX. 30