

Feb. 7, 1933.

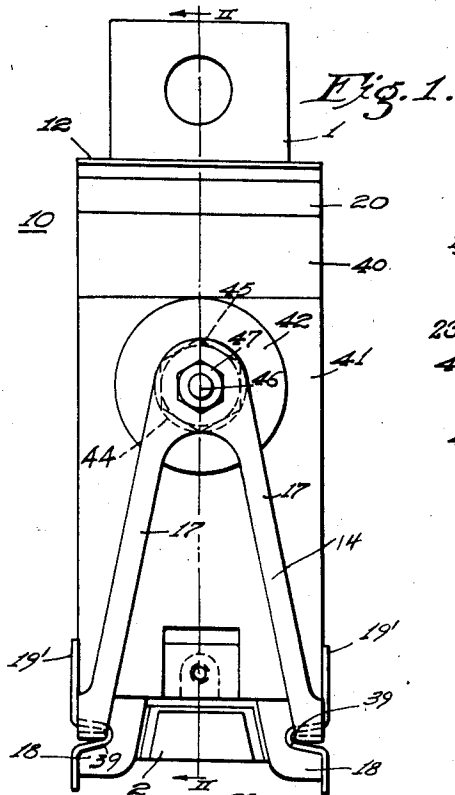
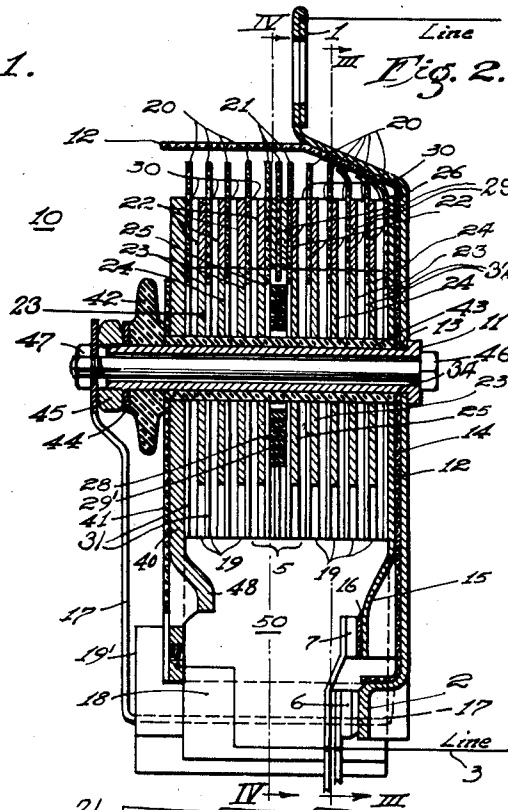
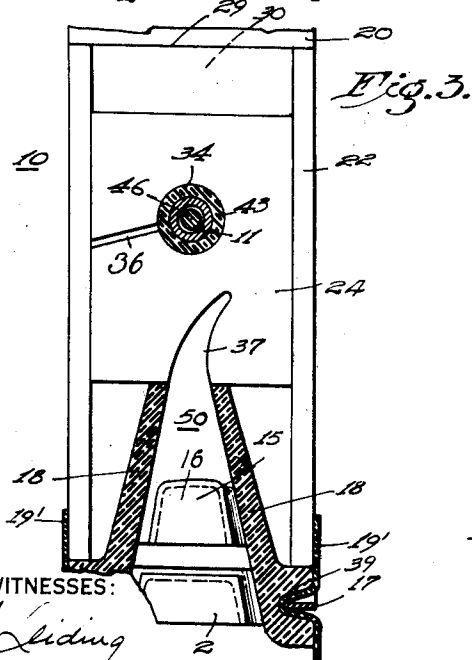
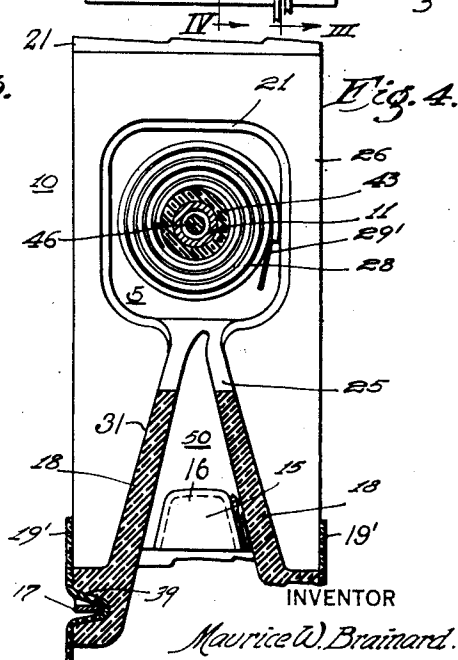
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1,896,764

CIRCUIT BREAKER

Filed Feb. 16, 1932

3 Sheets-Sheet 1



WITNESSES:

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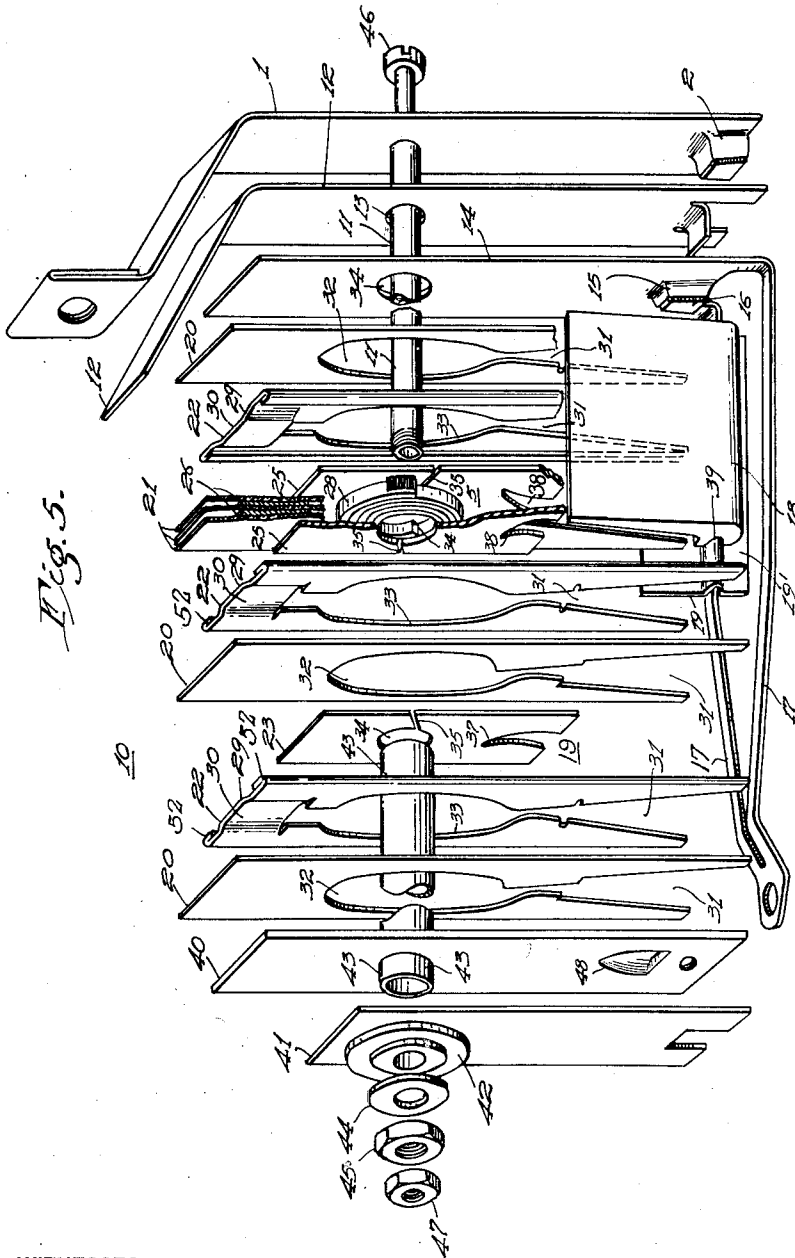
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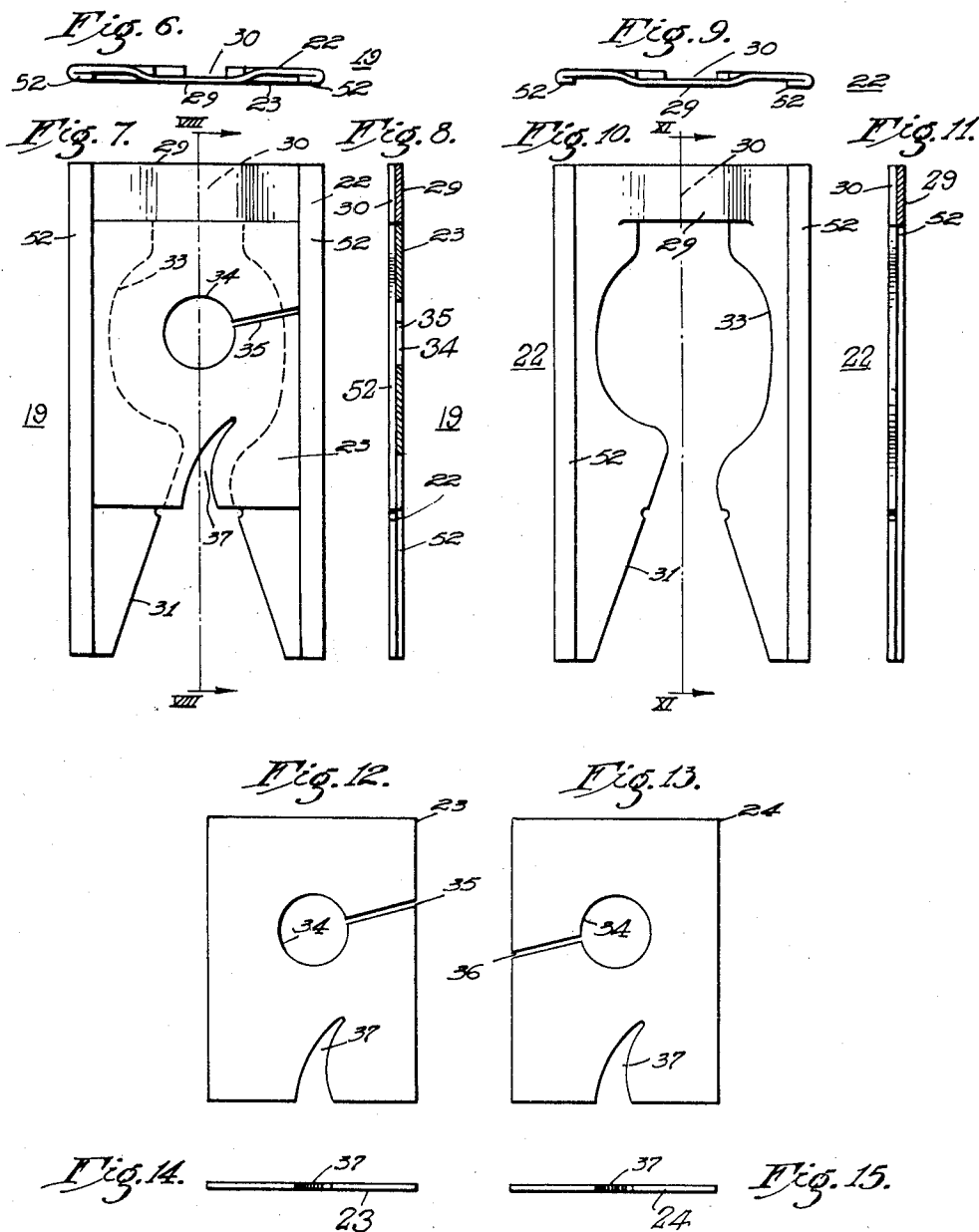
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CIRCUIT BREAKER

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3 Sheets-Sheet 3



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CIRCUIT BREAKER

Application filed February 16, 1932. Serial No. 593,236.

My invention relates generally to circuit breakers and more particularly to devices for extinguishing large current arcs in air or gas.

The arc extinguisher of my invention is of the cold cathode-spaced plate type. The arc is established adjacent to the extinguisher proper, and is moved, by magnetic action, through a converging slot into the extinguishing chamber which includes a plurality of spaced conducting plates. These spaced conducting plates subdivide the arc into a plurality of short arcs which, under the influence of the flux of a radial field, rotate at a very high velocity—while existing as cold cathode arcs—until they become extinct.

My invention is a further improvement of circuit breakers of the type disclosed in Patent No. 1,784,760, issued to Joseph Slepian, December 9, 1930, and certain subject matter described herein is claimed in the applications for Letters Patent, Serial No. 510,981, filed January 24, 1931, by Frederick B. Johnson, and Serial No. 511,010, filed January 24, 1931, by Robert C. Dickinson, all of which are assigned to the assignee of the present invention.

One object of my invention is to provide an arc extinguishing structure that shall be effective and reliable in operation and that shall be economical to manufacture.

Another object of my invention is to generally simplify the construction of the above-mentioned type of arc extinguisher by providing spacing and aligning means integral with the plates themselves.

A further object of my invention is to provide means integral with the unit plates of the arc extinguishing structure for ventilating each of the short arcs and for providing through passages within the structure.

A further object of my invention is to provide ventilating passages having a width substantially the same as the width of the conducting plates, and, at the same time to prevent the short arcs from passing out of the structure through the ventilating passages.

A further object of my invention is to prevent the building-up of gas pressure in advance of the arc as it moves into the spaces between the conducting plates, and thus per-

mit the use of a relatively weak blow-in field, without the provision of heavy, multi-turn, blow-in coils, for moving the arc into said spaces.

A still further object of my invention is to provide a composite plate for use in arc extinguishing structures that shall have an edge portion of magnetic material and a central portion, upon which the short arcs are caused to rotate, of non-magnetic conducting material; the edge portions of said composite plates having raised edge portions thereon for engaging and positioning the central portions of said composite plates, and for spacing the composite plates, and having depressed portions extending from the central portion to the edges of the plates for providing ventilating passages therebetween.

The features of my invention which I believe to be new are particularly pointed out in the appended claims. For a full understanding of the principles of the invention and the best mode of applying the same, reference may be had to the accompanying drawings, in which:

Figure 1 is a view in elevation of the arc extinguishing structure of my invention;

Fig. 2 is a sectional view of my arc extinguishing structure taken along the line II—II of Fig. 1, and illustrating the contact members associated therewith;

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

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

Fig. 5 is an exploded perspective view of my arc extinguishing structure. In view of the limited available space, only a few of centrally disposed plates have been shown;

Figs. 6 to 8, inclusive, are detail views of one of the composite plates embodied in my structure;

Figs. 9 to 11, inclusive, are detail views of one of the edge portions of the composite plates embodied in my structure;

Figs. 12 to 15, inclusive, are detail views of the two types of central portions used in forming the composite plates.

Inasmuch as my invention does not pertain to circuit breaker operating mechanisms, and

since those mechanisms are well known in the art, I have illustrated only the contact member part of a circuit breaker in association with my arc extinguishing structure. A diagrammatic representation has been provided in order to show the electrical connections involved. I prefer to mount the structure of my invention adjacent to the contact members and in such position that the plane of the composite plates is substantially normal to the arc path. This greatly facilitates the movement of the arc into the structure and makes for more reliable operation.

As shown in Fig. 2, the current carrying plate 1 of copper, which also forms the base of the arc-extinguishing structure 10, terminates in a raised portion 2 which is used as the main stationary contact. The contact members 6 and 7 are, respectively, the main moving contact and the auxiliary moving contact. These contact members are connected to the line 3 and to the top plate 40 of the arc-extinguishing structure, as shown by the diagrammatic representation. An auxiliary contact plate 14 of copper is provided; this member is insulated from the main contact plate 1 by the insulating plate 12 and has integral therewith (as shown in Fig. 5) a raised portion 15 which is used as an arcing contact, conducting members 17, and a contact portion 16 of arc-resisting conducting material. The arc-resisting conducting material which I prefer to use is a silver-tungsten alloy composed of 40% silver and 60% tungsten. Any conducting material, however, having similar properties would be quite satisfactory. The contact portion 16 is disposed on top of the raised arcing contact 15 and is utilized as a facing for protecting the contact surface from the arc. During the opening and closing of the circuit breaker the electrical circuit is first established and finally interrupted between the auxiliary moving contact 7 and the arcing contact 15. The main moving contact 6 engages the main stationary contact 2 only when the breaker is in the fully closed position. This construction is in accordance with the usual high-voltage, high-current circuit breaker design in which separate members are used for carrying normal line current and for establishing the arc when the circuit is interrupted. This construction is especially desirable in that a low resistance contact may be preserved between the main contact members despite any arcing or pitting of the auxiliary contact.

Referring more particularly to the drawings, my invention comprises, generally, a stack of composite plates 19 disposed substantially at right angles to the arc path, and having means associated therewith for moving the arc into the spaces between these composite plates 19 and there rotating at high speed until extinguished. The current

carrying member 1, as has been previously pointed out, is utilized as a base for the entire structure; it has rigidly fixed thereto a tubular iron member 11 which is threaded on the free end. An insulating washer 42 and an insulating tube 43 are associated with the tubular member 11 and serve to insulate that member from the remainder of the structure. Assembled about the insulating member 43 are the composite plates 19 and a coil assemblage 5 which is used for providing a radial field within the structure.

Beginning with the current carrying plate 1, the next element in the stack structure is an insulating member 12 having an opening 13 to permit the passage of the tubular member 11. This insulating member 12 serves to separate the current carrying member 1 and the plate member 14. The plate member 14 has a circular opening 34 of sufficient diameter to admit the insulating tube 43. An insulating plate 20 substantially rectangular in outline and having a converging slot 31 and an annular opening 32 separates the plate member 14 from the other plates in the structure. Four composite plates 19 each separated from the other by one of the insulating plates 20 are assembled adjacent to the plate member 14 and its associated insulating plate 20. The coil assemblage 5, which includes the iron plates 26, comprises the next unit in the structure. Following this are three more of the composite plates 19 which are likewise insulated from each other and from the coil assemblage 5 by insulating plates 20. The top plate 40 is of heavy gauge sheet copper and it has a portion 48 which projects outwardly from the plane of the plate. This projecting portion 48 facilitates the transfer of the arc from the auxiliary moving contact 7 to the arc extinguishing structure. The top plate 40 is insulated from the adjacent composite plate by one of the insulating planes 20, and has another insulating plate 41 on the outer side thereof.

All of the composite plates 19 and the iron plates 26 have converging slots 31 similar to those in the insulating plates 20. Thus, when the arc extinguishing structure is completely assembled a converging wedge shaped opening 50 extends inwardly from the arc path. It is in this opening 50 that the arc is moved during the initial stage of the arc interruption. The barriers 18 of arc resisting insulating material are provided for protecting the exposed edges of the plates.

The central portion of the composite plates 19, the coil assemblage 5, and the top plate 40 all have the common opening 34 for engaging the insulating tube 43 which surrounds the tubular iron member 11. This opening 34 provides a convenient positioning means and permits the entire structure to be rigidly fastened together by the nut 45 which engages the threaded portion on the end of the tubu-

lar iron member and presses against the iron washer 44 and the insulating member 42.

Each of the barriers 18 has a slot 39 therein. This slot 39 is adapted to receive the conducting members 17 which form an integral part of the plate member 14. A fish paper insert 19' is provided to assist in securing a tight fit between each of the members 17 and the walls of the slot 39. When the plate sections are completely assembled the outwardly projecting ends of the conducting members 17 are bent upwards (Fig. 2) and conductively fastened to the nut 45 by the fillister head screw 46 which passes through the central opening in the tubular iron member 11 and its associated nut 47. The resultant structure is compact, rigid and has considerable mechanical strength.

Referring to Figs. 5 to 15, inclusive, each of the composite plates 19 comprises an iron plate 22 and a rectangular copper plate 23 or 24. In each of the iron plates 22 there is a cutout portion in the center comprising a converging slot 31 and an annular portion 33 connecting therewith. On the edges of each of the iron plates 22, there are edge portions 52 extending outwardly from the plane of the plate and a raised portion 29 extending from the annular cutout portion to the edge of the plate. These portions define three sides of a rectangular depression into which the copper-conducting plates 23 and 24 fit. The raised central portion 29 not only serves to assist in positioning the central portion of the composite plate, but, in addition, it provides a ventilating passage 30 in the plane of the iron plates 22 for each of the central portions.

Each of the copper plates 23 and 24 used in forming the composite plates 19 has a slot 37 therein which is adapted to form the continuation of the slot established by the iron plates 22 and 26 and their associated insulating members. In addition each of the plates 23 and 24 has a central opening 34 and a cutout portion 35 or 36 for preventing the building up of eddy currents.

In the assembled arc extinguishing structures each composite plate 19 having a central portion 23 is disposed adjacent to a composite plate 19 having a central portion 24. This is done in order that the cutout portions 35 and 36 shall not align to form a continuous opening through the structure. Except for the position of the cutout portions 35 and 36 the plates 23 and 24 are identical.

The unitary coil structure 5 is provided for setting up the radial field within the arc extinguisher. This structure includes two copper, coil-end plates 25 of substantially the same outline as the copper plates 23 and 24 used in building up the composite plates 19, three insulating members 21 and four iron members, two of which are the same as the iron

plates 22 used in the composite plates. The coil 28 comprises several turns of copper ribbon, each turn being insulated from the adjacent turn by an insulating member 29' wound therewith. One end of the coil 28 is connected to one of the copper, coil-end plates 25 and the other end is connected to the other copper coil-end plate 25. Disposed about the coil itself are two iron members 26 insulated from each other and insulated from the end plates 22 by suitable insulating plates 21. These iron members 26 assist in equalizing the radial field and provide a low reluctance path in the magnetic circuit. The two iron plates 22 which engage the copper plates 25 form a structure which is dimensionally the same as the remainder of the plates in the arc-extinguishing structure.

The slots 38 in copper plates 25 are of less depth than the similar slots 37 in the plates 23 and 24; the reason for this will be pointed out is some detail later. The cutout portion 35 is common to all the copper plates.

In manufacturing the composite plates 19, I prefer to form the raised portions 52 thereon by rolling the edges of the plates 22 which are made of magnetic material. Likewise, I prefer to form the vent 30 for each of the individual arcs by making a depression 29 in the magnetic portions 22 of each of the composite plates 19. It is quite conceivable that a similar result could be accomplished by the establishing of suitable depressions or raised means in or upon the central portion of the composition plates, and it is my wish and intention that the appended claims should read on structures of either type.

It is also quite conceivable that a magnetic material other than iron could be used for the plates 22, and that copper is not the only satisfactory material for the central portions of the composite plates 19.

The operation of my arc extinguishing structure may best be described by considering the sequence of events following the opening of the circuit breaker contacts. Assuming that the contacts begin to separate when the line potential is such that the current flows in through the current carrying plate 1, through the main contacts 2 and 6, and out the line 3, the first step is the separation of the main stationary contact 2 and the main moving contact 6. No arc is established at this time, but the path of the current through the interrupter is considerably changed, instead of flowing straight through the current carrying member 1 to the main moving contact 6, the current now flows through the upper part of the current carrying plate 1, the tubular member 11 which extends through the center of the structure, the paralleled conductors 17, the arcing contact 15, the auxiliary moving contact 7, and thence to the outgoing line 3. Next, the auxiliary moving contact 7 moves out of engagement with the arc-

ing contact 15, and the arc is initially established. The separation of the auxiliary moving contact member 7 and the arcing contact 15 increases until the moving contact 7 has moved to the full open position. It is to be noted, at this point, that the top plate 40 of the arc extinguishing structure is at all times electrically connected with the moving contacts 6 and 7 and the line 3. Thus, when the arc is completely established it exists between the arcing contact 15 and the top plate 40. Simultaneously with the formation of the arc, the magnetic effect created by the adjacent slotted plates 22 and 26 of magnetic material causes the arc to begin to move through the converging wedge shaped opening 50 toward the copper conducting plates 23, 24, and 25 within the structure. This movement of the arc is further assisted by the magnetic attraction existing between the centrally disposed current carrying conductor (the tubular element 11) and the arc itself, the direction of current flow in the arc and in this conductor being the same, and by the repulsion between the arc and the paralleled conductors 17. The combined effect of these magnetic forces results in an almost instantaneous movement of the arc through the converging wedge shaped opening 50 and into the structure.

The arc first makes contact with the coil-end plates 25—by reason of the shorter slot 38 in those plates. Then, since the impedance of the coil 28 which is connected between the coil-end plates 25 is considerably less than the corresponding path of ionized air, the arc divides into two parts, one on each side of the coil. The arc current now flows through the coil 28, and thus establishes a radial field normal to the axis of the arc. Upon continued movement of the arc or more correctly upon continued movement of the two arcs, the other copper plates 23 and 24 are contacted, and each of the large arcs splits up into a plurality of short arcs. Under the influence of the radial field each of these short arcs is caused to rotate at high speed about the central current carrying conductor.

The path of travel of each of the short arcs is defined by the cutout portion 32 in the insulating members 20. These insulating members 20 also serve to keep the short arcs within the structure by providing insulation across the vent openings 30.

The rapid motion of the short arcs and the accompanying rapid removal of the heat—made possible by the vents 30 and by the intimate conductive relationship of the copper and the magnetic plates—combine to effect a very rapid extinguishing of all of the individual arcs existing within the structure.

It will be noted that the arc extinguishing structure is assembled with the composite plates 19 facing in opposite directions on the opposite sides of the central coil assemblage

5. This is done in order that the curved slots 37 in the copper plates 23 and 24 shall face in the same direction as the short arcs are caused to move by the radial field. The short arcs must, perforce, rotate in opposite directions on opposite sides of the coil.

It will thus be seen that I have disclosed an arc extinguishing structure that is reliable and effective in operation, that is simple and economical to manufacture, and that has means integral with the composite plates of the structure for venting each of the small arcs while, at the same time, retaining those small arcs within the structure.

While, in accordance with the patent statutes, I have given the foregoing details of a practical embodiment of my invention, it is to be understood that many of these are merely illustrative and that variations of their precise form will be both possible and in some applications desirable. I desire therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction and that my invention be limited only by what is explicitly stated in the claims and by the prior art.

I claim as my invention:

1. In an arc extinguishing structure, a plurality of plates of conducting material, and a plurality of plates of magnetic material, some of said plates of magnetic material having raised portions on the outer edge thereof.

2. In an arc extinguishing structure, a plurality of composite plates, each of said plates having a portion of conducting material, a portion of magnetic material, and raised portions along the outer edges thereof.

3. In an arc extinguishing structure, a plurality of composite plates, each of said plates having a central portion of non-magnetic conducting material, an edge portion of magnetic material, and raised portions along the outer edge thereof.

4. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material, and a plurality of plates of magnetic material having slots therein, some of said plates of magnetic material having raised portions along the outer edge thereof.

5. In an arc extinguishing structure, a plurality of plates of magnetic material having raised portions along the outer edge thereof, and a plurality of plates of conducting material, each fitting within and engaging the raised portions on one of said plates of magnetic material.

6. In an arc extinguishing structure, a plurality of composite plates, each of said composite plates having a central portion of non-magnetic conducting material and an edge portion of magnetic material having a depression therein; said depression extending outwardly from said central portion and defining a ventilating passage between said plates.

7. In an arc extinguishing structure, a

stack of composite plates, each of said plates having a central portion of non-magnetic conducting material and a portion of magnetic material, and means for giving the arc a rotary motion on said portion of non-magnetic conducting material, some of said plates having raised portions on the outer edges thereof for positioning said plates in alignment in said stack.

8. In an arc extinguishing structure, a plurality of plates of magnetic material having raised portions on the outer edges thereof, and a plurality of non-magnetic conducting plates substantially rectangular in shape, each of said rectangular plates fitting within the raised portions on one of said plates of magnetic material.

9. In an arc extinguishing structure, a plurality of composite plates for subdividing the arc into a plurality of short arcs, and a plurality of insulating members for separating said composite plates, each of said composite plates including an edge portion of magnetic material and a central portion of non-magnetic conducting material substantially rectangular in shape, said edge portion of magnetic material having a depression therein extending outwardly from said central portion for ventilating said short arcs.

10. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material substantially rectangular in shape, a plurality of plates of magnetic material having annular cutout portions therein and raised portions on the outer edges thereof, said raised portions engaging said plates of non-magnetic material.

11. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material substantially rectangular in shape, and a plurality of plates of magnetic material having a uniform width and raised portions on the outer edges thereof.

12. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material, a plurality of plates of insulating material, and a plurality of plates of magnetic material, said insulating plates and said plates of magnetic material having annular cutout portions therein, said plates of magnetic material having, in addition, depressed portions extending outwardly from said annular cutout portion to the edge of said plate.

13. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material substantially rectangular in shape, a plurality of plates of magnetic material having a substantially annular opening therein, each of said plates of non-magnetic conducting material being placed over the annular opening in one of said plates of magnetic material and means integral with said plates for spacing said plates.

14. In an arc extinguishing structure, a

plurality of plates of non-magnetic conducting material, and a plurality of plates of magnetic material; said plates of magnetic material having raised portions on the outer edges thereof, and having other raised portions for providing ventilating passages between said plates; said raised portions defining a depression of substantially the same outline as said plates of non-magnetic conducting material.

15. In an arc extinguishing structure, a plurality of plates of non-magnetic conducting material, and a plurality of plates of magnetic material having an annular cutout portion therein; some of said plates of magnetic material having raised portions on the outer edges thereof, and having other raised portions extending from said annular cutout portion to the edge of said plates; said raised portions defining a recess of substantially the same outline as said plates of non-magnetic material.

In testimony whereof, I have hereunto subscribed my name this 11 day of February, 1932.

MAURICE W. BRAINARD.