Jan. 8, 1957 R. E. FRINK ET AL 2,777,036

CIRCUIT INTERRUPTER

Filed Jan. 21, 1954 3 Sheets-Sheet 1

Fig. 1.

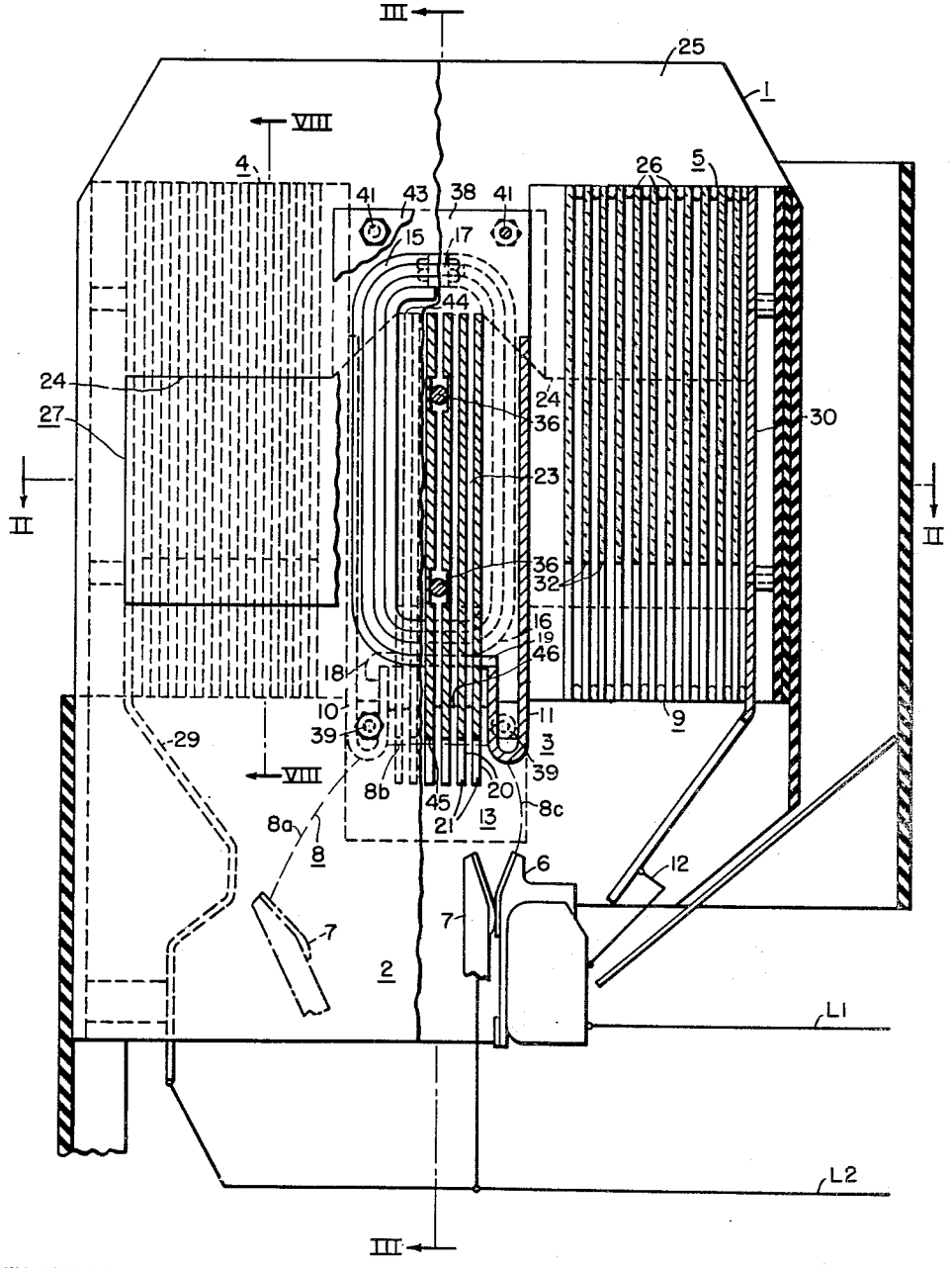

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Fig. 2.

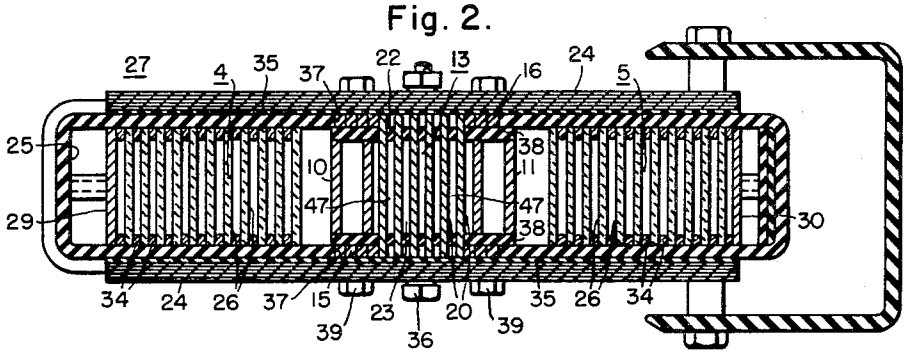
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Fig. 3.

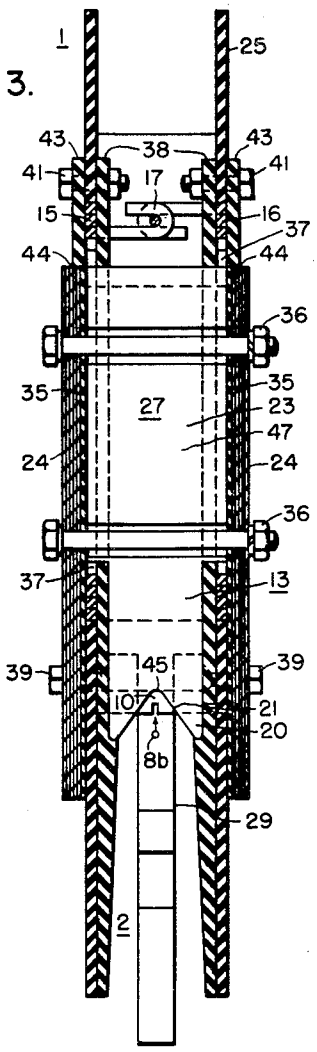
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Fig. 4.

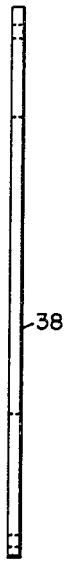


Fig. 5.

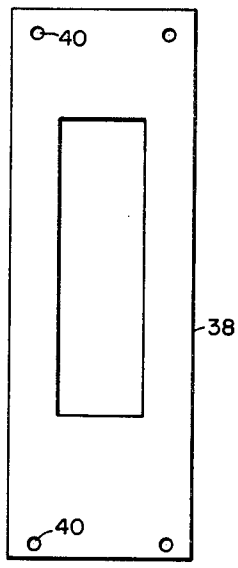


Fig. 6.

Fig. 7.

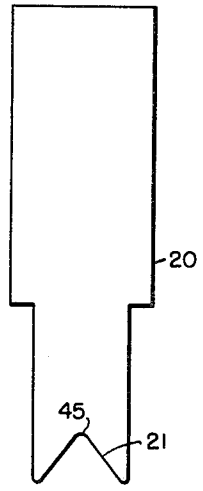


Fig. 9.

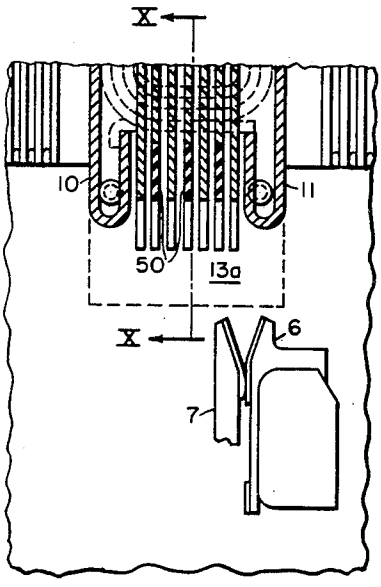


Fig. 8.

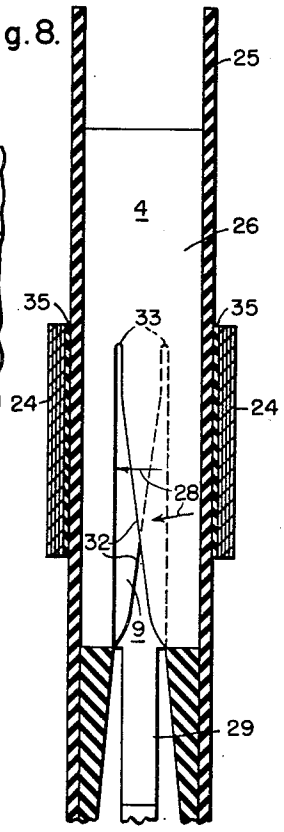
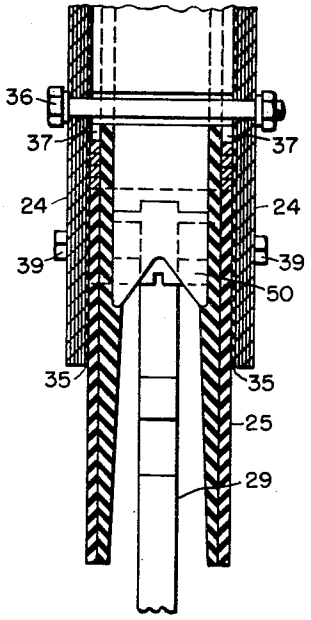


Fig. 10.



United States Patent Office

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CIRCUIT INTERRUPTER

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Application January 21, 1954, Serial No. 405,322

11 Claims. (Cl. 200—147)

This invention relates generally to circuit interrupters, and, more specifically, to arc-extinguishing structures for magnetic air circuit interrupters.

The general object of our invention is to provide an improved circuit interrupter, in which improved and more effective arc-extinguishing action takes place.

Another object is to provide an improved transfer arc-extinguishing means for a circuit interrupter of the type having an electrically floating blowout coil.

Still, a further object is to speed up the transfer into series circuit of the magnetic blowout coil so as to bring about more rapid and effective operation.

A further object is to provide an improved venting arrangement for a circuit interrupter of the type having a floating blowout coil.

Another object is to use the core or yoke portion of the magnetic circuit in a magnetic circuit interrupter to extinguish the transfer arc portion in electrical parallel with the terminals of the blowout coil.

Further objects and advantages will readily become apparent upon reading the following specification taken in conjunction with the drawings, in which:

Figure 1 is a side elevational view, partially in vertical section, of a circuit interrupter embodying the principles of our invention, and the contact structure being shown in the closed circuit position;

Fig. 2 is a plane sectional view of the circuit interrupter of Fig. 1 taken along the line II—II thereof;

Fig. 3 is a vertical sectional view taken along the line III—III of Fig. 1;

Figs. 4 and 5 are end and side elevational views, respectively, of a blowout coil mounting plate utilized in the embodiment of our invention illustrated in Fig. 1;

Figs. 6 and 7 are end and side elevational views, respectively, of the magnetic plates utilized in the yoke portion of our improved circuit interrupter;

Fig. 8 is a vertical sectional view taken along the line VIII—VIII of Fig. 1, looking in the direction of the arrows;

Fig. 9 is a fragmentary vertical sectional view through a modified type of transfer arc-extinguishing means; and

Fig. 10 is a sectional view taken along the line X—X of Fig. 9.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 generally designates a circuit interrupter, in this instance being one of the air-break type. Although the illustrated specific embodiment of our invention is an air-break type of circuit interrupter, it is to be clearly understood that certain features of our invention may be applicable to other types of circuit interrupters, say for instance one of the liquid-immersed type or one operating in a gaseou medium. Merely for purposes of illustration do we describe a specific embodiment of our invention which operates in air.

Generally, the circuit interrupter 1 includes contact structure 2 operable to establish an arc, which is moved upwardly into an arc-chute structure 3, including a pair

of arc-extinguishing sections 4 and 5 of substantially identical construction.

As well understood by those skilled in the art, one terminal L1 of the circuit interrupter is connected to the stationary contact 6 of our device, whereas the other terminal L2 of the interrupter is electrically connected to the movable contact 7 of the device. If desired, suitable bridging and secondary contacts may be employed to relieve the stationary and movable arcing contacts 6, 7 from carrying the current in the fully closed-circuit position, as shown in Fig. 1.

During the opening operation, the moving arcing contact 7 moves away from the stationary arcing contact 6 to establish an arc 8, as shown by the dot-dash line of Fig. 1. This arc, generally designated by the reference character 8, may be considered as composed of three sections 8*a*, 8*b* and 8*c*. The arc 8, of course, bows upwardly because of the natural convection current of air, which is heated by the hot arc 8, and also because of the magnetic forces set up by the arc 8 which act to expand the loop of the arc, as well understood by those skilled in the art.

Adjacent the top portion of the arc 8 is a pair of transfer arc horns 10, 11, between which is disposed a transfer arc-extinguishing means, generally designated by the reference numeral 13. The arc portion 8*a* extends between the movable arcing contact 7 and the transfer arc horn 10. The arc portion 8*b* extends within the transfer arc-extinguishing means 13 between the transfer arc horns 10 and 11. The arc portion 8*c* extends between the stationary arcing contact 6 and the transfer arc horn 11.

The function of the transfer arc-extinguishing means 13 is to interrupt the arc portion 8*b*, and so bring into series circuit the pair of serially related, centrally disposed blowout coils 15, 16, the location of which is more clearly shown in Fig. 2 of the drawings. Such coils, of course, have insulating windings. As mentioned, the centrally disposed blowout coils 15, 16 are connected in series circuit together, as by a connection 17 (Figs. 1 and 3), and the other ends 18, 19 of the blowout coils 16, 15, respectively, are secured to the transfer arc horns 10, 11, respectively, as shown more clearly in Fig. 1 of the drawings.

Because of the reactance of the blowout coils 15, 16, it is difficult to force current to flow through them because of the countervoltage set up in the coils. The transfer arc-extinguishing means 13, is therefore, desirable to assist in this transfer into series circuit of the blowout coils 15, 16 by extinguishing the arc portion 8*b*. Generally, the transfer arc-extinguishing means 13 includes a plurality of spaced magnetic plates 20, the configuration of which is more clearly shown in Figs. 6 and 7 of the drawings. As shown, each magnetic plate 20 has a slot 21 provided therein, within which the arc portion 8*b* is moved. The spaced magnetic plates 20 are spaced laterally apart, as shown more clearly in Fig. 2, by insulating spacers 22 cemented between their outer edges.

It will be observed that the several spaced magnetic plates 20 collectively provide the interconnecting core portion, or yoke 23 which magnetically interconnects the two side pole plates 24, which extend lengthwise along the outside of the arc chute jacket 25, the latter enclosing the several plates 26, collectively defining the arc-extinguishing sections 4 and 5 of the circuit interrupter 1.

Following extinction of the arc portion 8*b* within the transfer arc-extinguishing means 13, the blowout coils 15 and 16 are serially connected into the circuit, and the energization of these coils 15, 16 sets up a magnetic flux within the magnetic circuit 27, which includes the pair of side magnetic pole plates 24 and the interconnecting

yoke 23. Preferably, the pole plates 24 are formed of vertically extending sheets of a suitable magnetic material to form a laminated structure, more clearly shown in Fig. 2 of the drawings. Magnetically interconnecting the side pole plates 24 is the central interconnecting core or yoke portion 23, about which encircles the two serially related blowout coils 15 and 16.

As will be obvious to those skilled in the art, the H-type of magnetic circuit 27 shown, upon the energization thereof, causes magnetic flux to flow between the pole plates 24 in the manner indicated by the arrows 28 in Fig. 8. This magnetic flux extending transversely between the pole plates 24 causes upward movement of the arc portions 8*a*, 8*c* upwardly into the arc-extinguishing sections 4, 5 of the arc-chute structure 3.

The left-hand end of the arc portion 8*a*, as viewed in Fig. 1, quickly transfers to the outer arc horn 29, the lower end of which is connected, as shown, to the movable arcing contact 7 and hence to the lower terminal L2 of the device. Also, the right-hand end of the arc portion 8*c* quickly transfers to the right-hand arc horn 30 of the device, which is electrically connected to the stationary contact 6 by the connection 12 and hence to the upper terminal L1 of the interrupter.

Disposed within the arc-extinguishing sections 4, 5 are the plurality of spaced, slotted, ceramic plates 26, the configuration of which is more clearly shown in Fig. 8 of the drawings. As shown, each ceramic plate 26 has a slot 32 provided therein, the upper closed end 33 of which is slightly off-center. The plates 26 are staggered during the assembly operations so as to form a horizontally disposed, zigzag arc passage 9 throughout the length of the arc-chute sections 4, 5 to quickly bring about extinction of the arc portions 8*a*, 8*c*. The plates 26 are spaced laterally apart, as shown more clearly in Fig. 1, by sections of asbestos rope 34 cemented between the plates 26 adjacent the outer edges thereof, the method being identical to that previously referred to in spacing the magnetic plates 20 of the transfer arc-extinguishing means 13 apart.

Certain features of the disclosed structure have been set out and claimed in United States patent application, filed November 28, 1952, Serial No. 323,009, now United States Patent 2,769,065, issued October 30, 1956, to Russell E. Frink, entitled "Circuit Interrupter," and assigned to the assignee of the instant application. This application, in part, claims the disposition of the serially related blowout coils 15, 16 in the plane of the arc-chute jacket 25 to brace the blowout coils against the magnetic forces occurring during the interruption of high-fault currents.

Proper operation of the transfer arc-extinguishing means 13 is necessary to ensure rapid blowout-coil transfer, and it is an important object of our invention to provide a more effective transfer arc-extinguishing means 13, while at the same time providing a more compact and effective structure. We have found that in prior devices so far built and tested involving an H-type of magnetic circuit, with a floating blowout coil, that a time interval of approximately 0.4 cycle (on a 60-cycle basis) is required after contacts part to transfer the blowout coil into the circuit. This time is not too important for a breaker having 5 or 8 cycles rated interrupting time. However, when this design is applied to high-speed D. C. breakers, or other breakers of the high-speed type, this time is a matter of concern. Breakers of the D. C. type may be applied on railway circuits, mercury arc rectifier circuits, etc. which are capable of delivering short-circuit currents of such great magnitude that they would damage equipment if the current is not interrupted just as quickly as possible. The breakers needed are, therefore, very high speed, and are relied upon to interrupt faults before they have reached anywhere near their ultimate value.

Higher speed interruption is obtained with the construction disclosed herein of the center-coil magnetic type because of better venting between the magnetic plates 20, and a closer proximity of the arc portion 8*b* to the iron plates 20, giving a shorter time interval from contact part to blowout coil transfer. At the same time, the construction is more simple since the magnetic plates 20 collectively provide the magnetic yoke 23 interconnecting the pole plates 24 on the opposite sides of the circuit interrupter 1. The yoke 23 is made up of the spaced iron plates 20 having the shape indicated in Fig. 7. The plates are cemented together with the insulating spacers 22 between the edges, and a thin sheet of insulating material 35 is placed between the yoke 23 and the pole plates 24 to prevent the pole plates 24 shorting the iron plates 20 and hence the blowout coils 15 and 16. The magnetic circuit is preferably held together by a plurality of bolts 36 extending across the yoke 23.

To retain the blowout coils 15 and 16 within the cutout portions 37 provided in the arc chute jacket 25, rectangularly-shaped bracing plates 38 of an insulating material are preferably employed, having a configuration more clearly set out in Figs. 4 and 5 of the drawings. The disposition of the bracing plates 38 is more clearly apparent from an inspection of Figs. 1 and 3 of the drawings. A pair of bolts 39 extend through two openings 40 at the lower ends of the insulating bracing plates 38 and through the pole plates 24 to maintain the bracing plates 38 in a fixed position on the inner sides of the blowout coils 15, 16. A second pair of bolts 41 extend through openings 40 at the upper ends of the bracing plates 38, and cooperate with externally mounted clamping plates 43 having a configuration more clearly apparent from an inspection of Figs. 1 and 3 of the drawings. The two clamping plates 43 are preferably formed of an insulating material, and are disposed externally of the arc-chute jacket 25 immediately above the top portion 44 of the pole plates 24.

From the foregoing, it will be apparent that the insulating bracing plates 38 and the clamping plates 43, together with the bolts 36, 39 and 41 maintain the structure in assembled condition, and are able to withstand high magnetic forces resulting from the interruption of large amperage fault currents.

From the foregoing description, it will be apparent that we have provided an improved and more effective circuit interrupter of the magnetic type involving an H-type of magnet with a transfer arc-extinguishing means. The use of magnetic material in the form of the plates 20 having slots 21 therein causes rapid extinction of the arc portion 8*b*, the latter moving into the slots 21 in the manner indicated in Fig. 3 of the drawings. The arc portion 8*b* is attracted toward the closed ends 45 of the slots 21, and moves between the plates 20 in the form of serially related arc portions 46, as indicated in Fig. 1 of the drawings. Since the surfaces of the plates 20 are cool, and since the venting passages 47 provided between the spaced magnetic plates 20 afford adequate venting, the arc portions 46 are soon extinguished, and the serially related blowout coils 15, 16 are connected into series circuit with the remaining arc portions 8*a* and 8*c*.

The construction described results in a shorter time interval from contact part to blowout coil transfer because venting occurs directly above the space where the arc portion 8*b* is drawn, and because the arc portion 8*b* is drawn in closer proximity to the iron, or magnetic material 20, which results in a greater attractive force. At the same time, the construction has been simplified over that in the foregoing application by making the plates 20 in the yoke 23 act as both transfer arc-interrupting plates, and also as a yoke for the magnetic circuit 27. A separate transfer arc-interrupter is therefore eliminated.

A device was built and tested, as described above, which reduced the coil transfer time by approximately 0.1 cycle, or 25% as compared to a similar sample with a separate ceramic transfer stack, as outlined in the aforegoing application. This is a very worth-while gain where the current is increasing at the rate of several million amperes per second.

From the foregoing description of our invention, it will be apparent that we have provided a compact and highly effective interrupter in which the magnetic plates **20** are not only used to provide the yoke portion of the magnetic circuit, but also they are utilized to provide an effective transfer arc-extinguishing means to more quickly bring the blowout coils into series circuit and cause rapid upward movement of the arc portions *8a, 8c,* upwardly into the staggered arc passages **9** of the arc-extinguishing sections **4** and **5** to bring about circuit interruption.

Although we have shown an H-type of magnetic circuit interrupter with a floating blowout coil, it is to be clearly understood that features of the invention are applicable to a conventional U-shaped magnetic circuit interrupter where a portion of the core could be used as a transfer arc-extinguishing means. Note U. S. Patent 2,632,075 to Rawlins et al. in this connection.

Figs. 9 and 10 collectively describe a modification of the transfer arc-extinguishing means *13a,* in which every other magnetic plate **20** is shortened at its lower end to abut against an insulating plate portion **50**. The plate **50** may have the notch **21** therein to align with the notches **21** in the longer magnetic plates **20**. Thus the modified arc-extinguishing means *13a* comprises alternately insulating and conducting plates to interrupt more voltage between the center arc horns **10, 11**.

Although we have shown and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the invention.

We claim as our invention:

1. A circuit interrupter including means for establishing an arc, means for causing the extinction of the arc including a pair of cooperating magnetic pole plates and an interconnecting yoke portion, insulating means having edge portions for engaging at least a portion of said arc to effect the extinction thereof, a blowout coil for energizing the magnetic pole plates, and means including the yoke portion for extinguishing the transfer arc portion which is in electrical parallel with the terminals of the blowout coil, the yoke portion including a plurality of spaced magnetic plates which will cool and deionize the transfer arc portion, and the spaced magnetic plates opening to the space beyond said insulating means.

2. The combination in a circuit interrupter of contact means for establishing an arc, magnetic blowout means for extinguishing the arc including a pair of pole plates and an interconnecting core portion, insulating means having edge portions for engaging at least a portion of said arc to effect the extinction thereof, a blowout coil for energizing the magnetic blowout means, said arc having a transfer arc portion which is in electrical parallel with the terminals of the blowout coil and which must be extinguished to insert the blowout coil into series circuit, and means utilizing the core portion for effecting extinction of the transfer arc portion, the core portion including a plurality of spaced magnetic plates which will cool and deionize the transfer arc portion, and said spaced magnetic plates extending alongside of said insulating means.

3. A circuit interrupter including means for establishing an arc, means for causing the extinction of the arc including a pair of cooperating magnetic pole plates and an interconnecting yoke portion, a blowout coil for energizing the magnetic pole plates, means including the yoke portion for extinguishing the transfer arc which is in electrical parallel with the terminals of the blowout coil, and the yoke portion including a plurality of spaced magnetic plates which will cool and deionize the transfer arc.

4. The combination in a circuit interrupter of contact means for establishing an arc, magnetic blowout means for extinguishing the arc including a pair of pole plates and an interconnecting core portion, a blowout coil for energizing the magnetic blowout means, said arc having a transfer arc portion which is in electrical parallel with the terminals of the blowout coil and which must be extinguished to insert the blowout coil into series circuit, means utilizing the core portion for effecting extinction of the transfer arc portion, and the core portion including a plurality of spaced magnetic plates which will cool and deionize the transfer arc portion.

5. A circuit interrupter including contact means for establishing an arc, an H-type magnetic circuit for effecting movement of the arc, the core portion of the H-type magnetic circuit having a blowout coil associated therewith, said arc having a transfer arc portion in electrical parallel with the terminals of the blowout coil, means utilizing the core portion to effect extinction of the transfer arc portion to insert the blowout coil into series circuit, and the core portion including a plurality of spaced magnetic plates having venting passages therebetween.

6. A circuit interrupter including means for establishing an arc, means for causing the extinction of the arc including a pair of cooperating magnetic pole plates and an interconnecting yoke portion, a blowout coil for energizing the magnetic pole plates, the interconnecting yoke portion including a plurality of spaced magnetic plates, at least some of the plates having notches provided therein, and means including the notched magnetic plates for extinguishing the transfer arc which is in electrical parallel with the terminals of the blowout coil.

7. The combination in a circuit interrupter of contact means for establishing an arc, magnetic blowout means for extinguishing the arc including a pair of pole plates and an interconnecting core portion, a blowout coil for energizing the magnetic blowout means, said arc having a transfer arc portion which is in electrical parallel with the terminals of the blowout coil, the interconnecting core portion including a plurality of spaced plates, one or more of the spaced magnetic plates being shortened, insulating plate portions abutting the shortened magnetic plates, and means utilizing the core portion for effecting extinction of the transfer arc portion.

8. A circuit interrupter including contact means for establishing an arc, an H-type magnetic circuit for effecting movement of the arc, the core portion of the H-type magnetic circuit having a blowout coil associated therewith, a pair of arcing plates connected to the ends of the blowout coil, the core portion of the magnetic circuit including a plurality of spaced magnetic plates disposed between the arcing plates, and the arc moving into engagement with the arcing plates and having the portion thereof between the arcing plates extinguished by the spaced magnetic plates.

9. A circuit interrupter including contact means for establishing an arc, an H-type magnetic circuit for effecting movement of the arc, the core portion of the H-type magnetic circuit having a blowout coil associated therewith, a pair of arcing plates connected to the ends of the blowout coil, the core portion of the magnetic circuit including a plurality of spaced magnetic plates disposed between the arcing plates, the arc moving into engagement with the arcing plates and having the portion thereof between the arcing plates extinguished by the spaced magnetic plates, and one or more of the spaced magnetic plates having notches provided therein.

10. A circuit interrupter including contact means for establishing an arc, an H-type magnetic circuit for effecting movement of the arc, the core portion of the H-type magnetic circuit having a blowout coil associated therewith, a pair of arcing plates connected to the ends of the blowout coil, the core portion of the magnetic circuit including a plurality of spaced magnetic plates disposed between the arcing plates, the arc moving into

engagement with the arcing plates and having the portion thereof between the arcing plates extinguished by the spaced magnetic plates, one or more of the spaced magnetic plates being shortened, and one or more insulating plate portions abutting the shortened magnetic plates and being coextensive therewith.

11. A circuit interrupter including means for establishing an arc, means for causing the extinction of the arc including a pair of cooperating magnetic pole plates and an interconnecting yoke portion, a blowout coil for

energizing the magnetic pole plates, and means forcing the transfer arc which is in electrical parallel with the terminals of the blowout coil against the surface of the yoke portion to cool the same and to effect the extinction thereof.

References Cited in the file of this patent

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2,558,075	Dickinson et al.	June 26, 1951