Nov. 22, 1932. F. C. TODD 1,888,707

CIRCUIT INTERRUPTER

Filed July 14, 1928

Fig. 1.

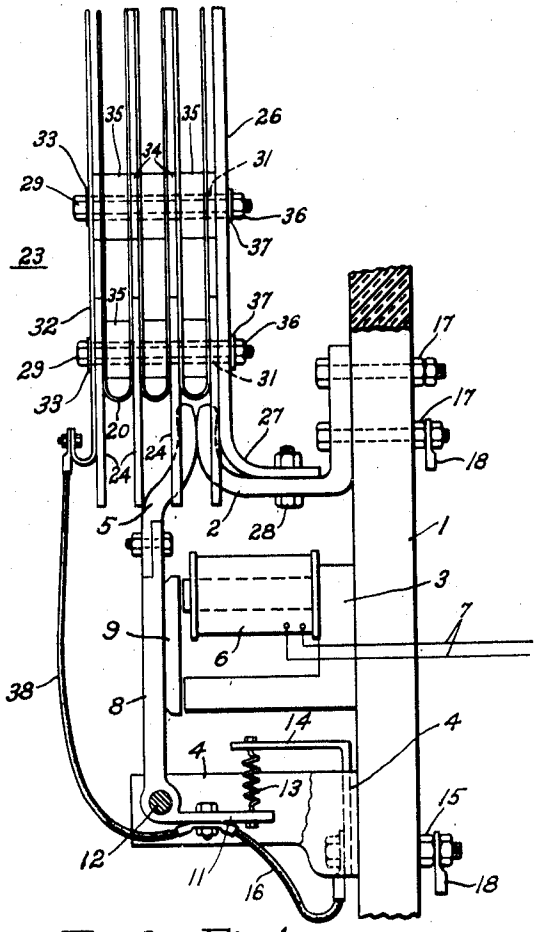


Fig. 2.

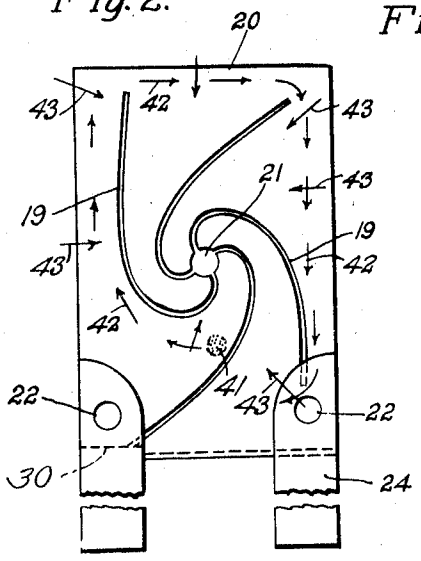


Fig. 3.

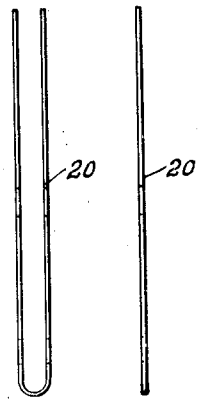
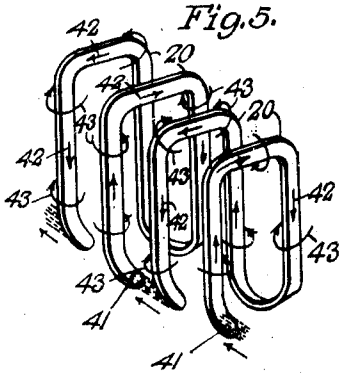


Fig. 4.

Fig. 5.



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UNITED STATES PATENT OFFICE

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CIRCUIT INTERRUPTER

Application filed July 14, 1928. Serial No. 292,824.

My invention relates to electrical contactors and particularly to arc-extinguishing devices therefor.

One object of my invention is to provide an electrical circuit interrupter that shall be capable of interrupting circuits of large capacity in air without the necessity of resorting to the employment of oil or other media for quenching the arc at the contacts thereof.

While, however, my invention is applicable to the interruption of circuits of large interrupting capacities, it may also be applied with advantage for interrupting circuits of low capacities.

As a particular feature of my invention here described, the arc consequent upon the opening of the circuit is drawn into the arc-extinguishing means by a magnetic structure employed in said means and is rapidly moved thereby within the means to deionize and cause it to be quickly extinguished.

The rapid movement of the arc within the extinguishing means prevents the burning and vaporizing of metal which would otherwise occur if the arc terminals stood still for any appreciable proportion of the time of duration of the arc. Metal vapors continuing to burn after the arc proper is extinguished are a frequent cause of restriking or reignition of the arc and these are prevented by my invention.

In the particular embodiment here shown, the deionizing means comprises plates of magnetic metal which provide the electrodes for the terminals of the short arcs into which the main arc is broken and also provides, in itself, the means for causing the short arcs to move rapidly over the electrode plates.

With these and other objects in mind, the invention comprises the novel structure, combination and arrangement of parts that will be herein fully pointed out in the following description, taken in conjunction with the drawing, in which:

Figure 1 is a side view, partly in section and partly in elevation, of a particular embodiment of my invention;

Figs. 2, 3 and 4 are views, in elevation, of a component element in the assembly shown in Fig. 1.

Fig. 5 is a schematic diagram showing so much of a pair of the double electrode plates as is effective in conducting the current at an instant when the arc is playing as is shown in Fig. 2, and illustrates the magnetic relations between the flux due to the current flow in the plates and the arcs.

My invention comprises, in general, an insulating base 1 upon which is mounted a stationary contact member 2, a magnetic core member 3 and a bracket 4 that supports a movable contact 5. The foregoing elements may be of any type well known in the art to be suitable, their precise structure not being claimed herein.

The core member 3 has mounted thereon a potential coil 6 that may be energized through leads 7 that are in circuit therewith. The movable contact 5 is attached to a pivoted member 8 that is supported on the bracket 4. Member 8 has an armature 9 attached thereto that cooperates with the core member 3, when the coil 6 is energized. The member 8 has an extended portion 11 on the opposite side of its pivot point 12 that is attached by means of a spring 13, to a stationary extension 14.

A circuit is completed from the extension 11 to a mounting stud 15 through a flexible shunt 16. The terminal 2 is fixed to the base 1 by bolts 17, one of which contains a terminal member 18 that is employed to form a connection with the circuit to which the contactor is connected. A similar terminal 18 is attached to the lower stud 15 to be employed as a means for connecting the contactor to the other side of the circuit.

The contactor shown in Fig. 1 is in closed position which is that position in which contact 5 has been moved to engage the stationary contact 2 through the energization of the coil 6 and the attraction of the armature 9 by the core member 3. This attraction causes the spring 13 to be stressed, the energy therein being later employed to move the contact member 5 and the armature 9 away from their engaged positions after the coil 6 has been deenergized. It is clearly apparent to any one familiar with the contactor art that any other means for the engagement and sep-

aration of contact members could be employed besides the one herein described, and, therefore, I do not wish to limit the application of this arrangement to use with any particular contactor, as my invention, that will now be described, may be employed on practically any such device.

Referring to Fig. 2, a plate 20 is made of magnetic material and is provided with a series of curved slots 19 in its face converging to the aperture 21 that is located at substantially the center of the plate. Holes 22 are located in the lower parts of the plate 20 and, together with the center hole 21, are employed as a means for mounting the plates in the arc-extinguishing device 23 shown in Fig. 1.

Insulating members 24 are supported on the lower part of the plate and extend along the side of the contacts 2 and 5 to cover the side end portions of the plate and guide the arc to the central part of the plates. The lower left-hand corner of the U-shaped plate 20 is cut away as at 30 to prevent the current at this point from forcing the arc along the left-hand side of the plate and out of the assembled structure 23.

Fig. 3 is a side view of the plate 20 and shows that it comprises a narrow U-shaped member, the slots 19 being located in each leg.

Fig. 4 shows a modification in which the member 2 is a single plate. A pair of such plates may be employed in the same manner as the U-shaped member 20.

Experiment has shown that, where iron plates not provided with the slots above-described, are employed as a means for moving and deionizing the arc, it is impossible to so control the arc as to prevent it from running to the sides of the plates. To avoid this difficulty, applicant employs slots 19 extending from the outer edges of the plate 20 to the central hole 21, either in straight lines or in spiral curves such as are shown in Fig. 2. The sectors between adjacent slots are the paths upon which the arc travels and it is found that the magnetic force due to the current acts to move the arc inwardly toward the central hole 21.

After the arc has moved to the portion of the plate about the central opening 21, it is found that the continued magnetization of the plates 20 produces a force of rotation that acts on the arc to keep it rotating about the opening 21 until it is extinguished. By thus preventing the arc from standing still for any appreciable portion of the duration thereof, the burning and vaporization of the metal terminals is avoided.

From the drawing, it is seen that, as the arc plays between the adjacent U-shaped plates 20, the arc current flows from one plate across the air gap to the next plate and then around the U-shaped bend to the other side of the double plate, from which an arc plays to the next adjacent U-shaped plate. The direction in which the current may flow in the plates is limited by the slots 19, cut 30 and hole 21 which divide each plate into a plurality of sectors which are insulated from each other except around the outer edge of the plate where the sectors are connected together. This means that, if the arc is playing on the right-hand side of the U-shaped plate 20, as shown in Fig. 3, with the current flowing toward the plate, the direction of current flow on the face of the plate, as shown in Fig. 2, will be in a curved or spiral path in a clockwise direction. For example, it may be assumed that the arc at a given instant is playing on the plate 20, in Fig. 2, to the left of the slots 19 at point 41. It is seen that current flowing from the arc terminal cannot flow downwardly around the U-shaped bend to the other side of the double plate due to the cut 30 and the lower slot 19 which intersects the cut 30. The direction of the current flow must, therefore, be upward on the left side of the plate, across the top and down on the right side of the plate as indicated by arrows 42. In the same way, it is seen that, irrespective of the sector on which the arc is playing, the current flow will always be in a clockwise direction in a curved or spiral path around the plate.

This spiral flow of current in the plates 20 sets up a substantially radial magnetic field between the plates as indicated by arrows 43. The sense of the flux lines between adjacent U-shaped plates is the same in each of the spaces in which the arc plays, with the return path of opposite sense in the spaces between each U as shown schematically in Fig. 5. The reaction between the radial field in the spaces between the plates and the arcs across these spaces is such that the arcs are rotated in a curved path about the hole 21 as a center. It is thus seen that the arcs are rapidly rotated during the whole time that they play between the plates so that burning of the plates is prevented.

For mounting the arc-extinguishing device 23, I provide a backing plate 26 of magnetic material having a bent portion 27 along its lower edge. The latter supports the member 23 upon the contact member 2 and is clamped thereto by a bolt 28. To assemble the above-described plates 21 in the structure 23, bolts 29 are provided having insulating sleeves 31 which insulate the bolts 29 from the iron plates 20. Upon the bolts 29, a front plate 32 is positioned, and insulated from the bolt heads by washers 33. Spacing-washers 34 are employed to provide the exact space required between plates 20 so that the through bolts 29 may be drawn tight without having the members 20 bent out of shape.

A sufficient number of the members 20 are assembled to correspond to the current and voltage to be interrupted and spaced from

each other by the spacing washers 35. The backing member 26 and all of the members are drawn together by clamping nuts 36 which are insulated by washers 37.

A flexible connector 38 is connected in circuit with the front plate 32 and the flexible connector 16 so that, after the contact member 5 has separated from the contact member 2, and an arc has been established thereby and drawn into the extinguishing member 23, a circuit is formed from the contact 2 through the backing plate 26, through the sections of arcs between the U-shaped members 20 through the U-shaped members 20 themselves, through the front plate 32, thence through the conductors 38 and 16 to the other side of the line at the terminal 18.

The mode of operation of my circuit interrupter will now be described. When the contacts are closed, as shown in Fig. 1, they are held in that position by the energy supplied to the holding coil 6, which attracts armature 9 to retain it in closed position. When the circuit 7 is opened, the circuit 6 becomes deenergized, releasing the armature 9 which is pulled away from the magnetic circuit 3 by the tension in the spring 13. This movement separates the contact members 2 and 5, and an arc is established therebetween. This arc will move upwards in a manner well known and, because of the close proximity of the sheets 24 to the arc path, the arc will immediately be moved into the slots between the U-shaped members and be broken up into short arcs therebetween. The current in the sections of the arc will set up a magnetic field in the iron plate 20 and, because of the sectors formed by the slots, will be moved thereon toward the center of the plates. If the arc is sustained until it has reached the center 21, the magnetic force produced by the current will rotate the arc about this central portion until the current passes through zero in the course of the alternating-current cycle. The arc voltage will be such, at this time, that the arc will be extinguished, and the air in the passage between the plates will be deionized so rapidly that the line-voltage structure will not be able to restrike an arc thereafter. By this means, the arc will be extinguished within one half cycle of the alternating current.

The arc-extinguishing device 23, herein shown, employs the iron sheets 20 that are bent in U-shape, as shown in Fig. 3, but the single iron sheets 20, shown in Fig. 4, may be employed under certain conditions with equal success. For this reason, I do not wish to be limited to the particular shape of the plates 20 shown in Fig. 3. It is also apparent that a greater number of plates could be employed than is here shown, so that my invention would be capable of operating on circuits of greater voltage. The number of sets of plates should be proportioned to the voltage of the circuit to be interrupted. For ordinary loads, such number of units should be employed that the maximum instantaneous voltage per arc section will not exceed three hundred.

It will be seen that my invention may be employed on low-capacity circuits as well as on circuits of very much higher capacity that have heretofore employed circuit interrupters in which arcs were extinguished in oil or other media.

By means of my invention, therefore, the arc incident to opening of the contactor is driven into a deionizing structure where its movement along the surface of the plates from its place of initial formation takes place so rapidly that no appreciable burning of the plates occurs and the arc is readily extinguished. In consequence, where the prior art has found oil switches necessary, air-break contactors may be designed according to the principles of my invention for many conditions of service, with a resulting decrease of cost and a greater ease of installation and also elimination of fire hazard. Even on services where air-breaks have previously been used, the contactors may have lighter parts and are of increased durability.

Many modifications of the precise embodiment of my invention here described will, in fact, be evident to those skilled in the art from the mere attempt to adapt the problems here disclosed to circuits of particular voltage or current ratings.

These principles are, in fact, of broad applicability to many types of apparatus other than arc-interrupting apparatus and to many types of arc interrupters besides contactors. I desire, therefore, that the language of the appended claims shall be construed broadly to cover all modifications and arrangements within the spirit of my invention.

I claim as my invention:

1. An arc-quenching device comprising a plurality of U-shaped members having a plurality of slots in the surfaces thereof for causing rotation of the arc.

2. An arc-quenching device comprising a plurality of U-shaped members having a plurality of centrally converging curved sections formed by slots cut in the surface thereof for causing the current to flow spirally in said members.

3. A circuit-interrupting means comprising a pair of separable contact members, operating means therefor, a series of U-shaped members associated with the contact members and having a plurality of slots in the surfaces thereof and means for spacing the said members to permit arc movement between the adjacent surfaces thereof.

4. In combination with a circuit interrupter having separable contact members, means for operating the said members, arc-extinguish-

ing means adjacent to the contact members comprising U-shaped members of magnetic material in perpendicular relation to the arc and spaced apart to permit movement of the arc between the surfaces of adjacent members and means on the surface of each member for causing rotary movement of the arc between said members.

5. In combination with a circuit interrupter having a pair of separable contact members, means for operating the contact members, and deionizing means for an arc located adjacent to the contact members and comprising a plurality of spaced U-shaped sheets insulated from each other and forming an arc path between the surfaces of adjacent pairs and a series of sectors formed by slots in the adjacent faces to cause the current of the arc to set up a magnetic field to keep the arc moving until it is extinguished to cool and deionize it.

6. In combination with a circuit interrupter having separable contact members, means for operating the said members, a plurality of sheets having sectors formed in the surface thereof and so connected electrically as to cause movement of the arc thereon.

7. In combination with a circuit interrupter having separable contact members, means for operating the said members, a plurality of spaced sheets of magnetic material arranged substantially perpendicular to the path of the arc drawn between said contacts, each sheet containing a plurality of sectors insulated from each other except at the edges of the sheet to cause the movement of the arc in the space between a pair of sheets, by the magnetic reaction of the arc current.

8. In combination with a circuit interrupter having separable contact members, means for operating the said members, a plurality of spaced sheets arranged substantially perpendicular to the path of the arc drawn between said contacts, and a plurality of sectors formed in the surface of said sheets so as to set up a radial magnetic field to keep the arc moving between said sheets.

9. An arc-quenching device including a plurality of metal sheets bent upon themselves to form U-shaped members having open spaces between the sides forming said U, the said members being spaced apart to permit arc play between the adjacent surfaces thereof, the said surfaces having slots therein to cause movement of the arc between said surfaces in a curved path.

10. A circuit-interrupting means including a pair of separable contact members, operating means therefor, a plurality of U-shaped members having slots in the surfaces thereof, the closed portions of said U-shaped members being adjacent said contact members.

11. In an arc-extinguishing device, a conducting member having a plane face on which an arc plays, and means for causing a flow of current in a curved path in said face of said member.

12. In an arc-extinguishing device, a conducting member on which an arc plays, and means for causing the arc current to flow in a spiral path in said member, the plane of said spiral being substantially perpendicular to the arc.

13. In an arc-extinguishing device, a conducting member on which an arc plays, and means for causing a flow of current in said member in such direction as to cause a substantially radial magnetic field about said member.

14. In an arc-extinguishing device, a conducting member on which an arc plays, and means for causing a flow of current in said member in such direction that the reaction between the flux set up by the current in said member and the arc is such as to give a rotary motion to the arc.

15. In an arc-extinguishing device, spaced plates between which an arc plays, said plates being so shaped and connected as to cause a magnetic field therebetween in such direction as to cause motion of said arc between said plates in a curved path.

16. In an arc-extinguishing device, spaced plates between which an arc plays, said plates being so shaped and connected as to cause the arc current to flow in a looped path in said plates to set up substantially radial lines of flux between said plates and move said arc in a rotary path until it is extinguished.

17. In an arc-extinguishing device, an arc terminal member comprising a plate having an electrical connection and a slit extending from one edge thereof adjacent to said electrical connection to a point spaced from the edge of the plate and remote from said electrical connection.

18. In an arc-extinguishing device, a plate on which one end of the arc plays, said plate having an electrical connection and a slit extending from one edge thereof adjacent to said electrical connection to a point near the center thereof, said slit being curved in a spiral having a decreasing radius of curvature as the center of the plate is approached, and a similar spiral slit extending from said first slit to a point spaced from the edge of the plate and remote from said electrical connection.

19. In an arc-extinguishing device, a plate forming an arc terminal member having an electrical connection thereto, said plate having a plurality of slits radiating from a point, one of said slits extending through the edge of the plate near said electrical connection, and others of said slits having their ends spaced from the edge of said plate.

20. In an arc-extinguishing device, a plate having an electrical connection thereto for conducting the current supplying an arc

playing thereon, said plate comprising a plurality of sectors insulated from each other except at their outer ends, the sector to which said electrical connection is made being completely insulated from its adjacent sector along one side thereof.

21. In a device for interrupting an electric circuit, a pair of spaced conducting plates electrically connected in said circuit and between which an arc plays, said plates having means for causing a rotary movement of said arc, said means including a slit in each plate extending from one edge thereof adjacent to said electrical connection to a point spaced from the edge of the plate and remote from said electrical connection.

22. In a device for interrupting an electric circuit, a plurality of spaced conducting plates electrically connected in pairs and having the end plates electrically connected in said circuit, means for causing an arc between said pairs of plates, and a slot in said plates for causing the current to flow in a looped path to set up a substantially radial magnetic field.

23. In an arc extinguishing structure, a plurality of conducting plates for splitting up the arc into a plurality of shorter arcs, means for rotating said shorter arcs between said plates, and through ventilating passages between said plates extending from one edge to another edge of said plates.

24. In a circuit interrupter, means for drawing an arc, means for deionizing said arc comprising a plurality of metallic sheets for subdividing said arc into a series of arcs, means connected in series with said arcs for setting up a magnetic field for moving said series of arcs over a recurrent path between said plates, and continuous open spaces between said plates extending from adjacent said arc drawing means to the opposite side of said plates.

25. An arc-quenching device including a plurality of metal sheets conductively joined in pairs and on which the arc plays, means causing the arc current to flow in said sheets so as to set up a radial magnetic field for rotating the arc, said sheets being spaced apart to provide open passages therebetween for the free flow of air through said plates.

In testimony whereof, I have hereunto subscribed my name this 11th day of July, 1928.

FRANCIS C. TODD.