

Nov. 10, 1931.

W. BOHRAUS

1,831,587

BACK FIRE TRAP FOR RECTIFIERS OR CONVERTERS

Filed Sept. 3, 1929

2 Sheets-Sheet 1

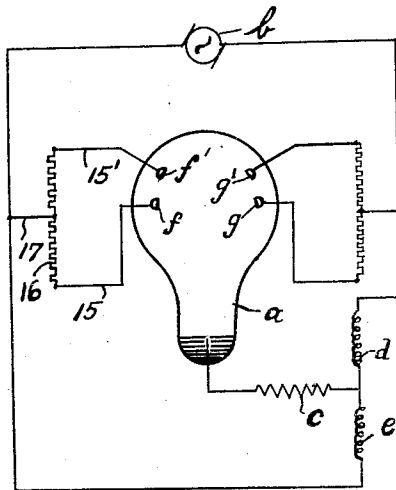


FIG. 1.

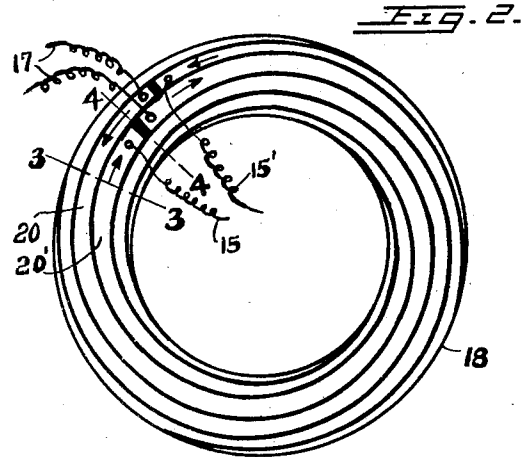


FIG. 2.

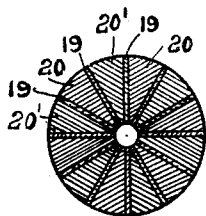


FIG. 3.

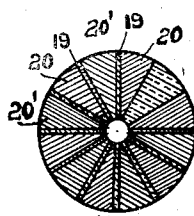


FIG. 4.

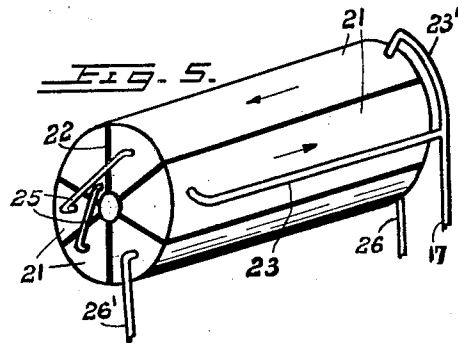


FIG. 5.

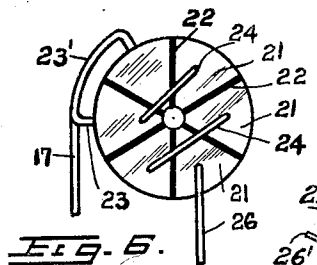


FIG. 6.

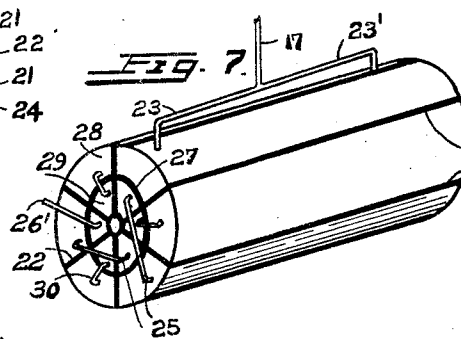


FIG. 7.

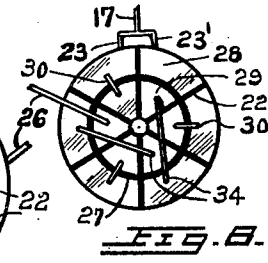


FIG. 8.

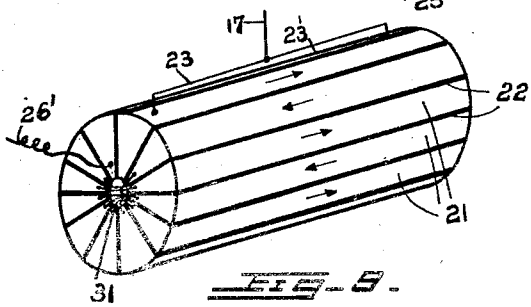


FIG. 9.

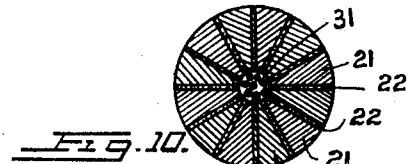


FIG. 10.

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BACK FIRE TRAP FOR RECTIFIERS OR CONVERTERS

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2 Sheets-Sheet 2

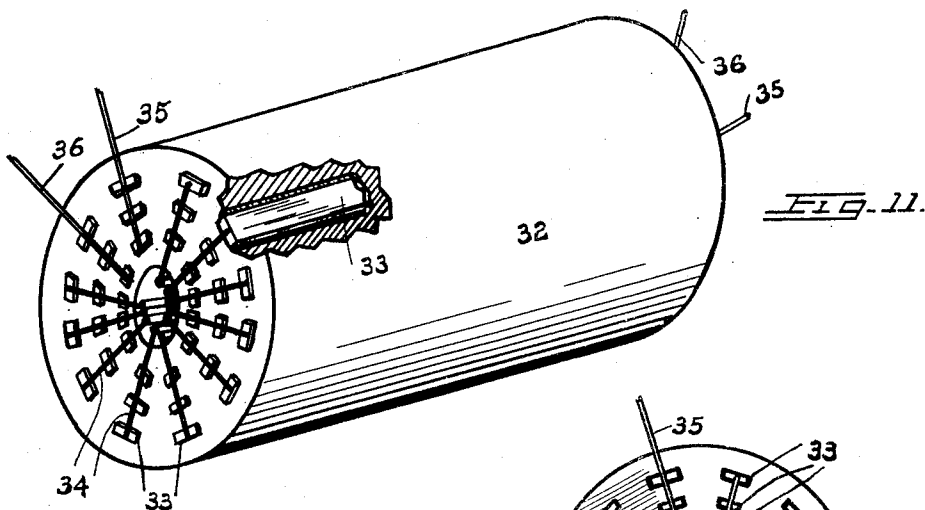


FIG. 11.

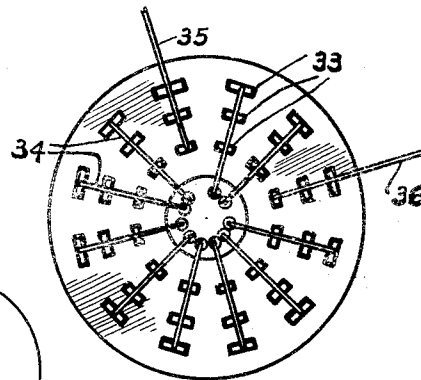


FIG. 12.

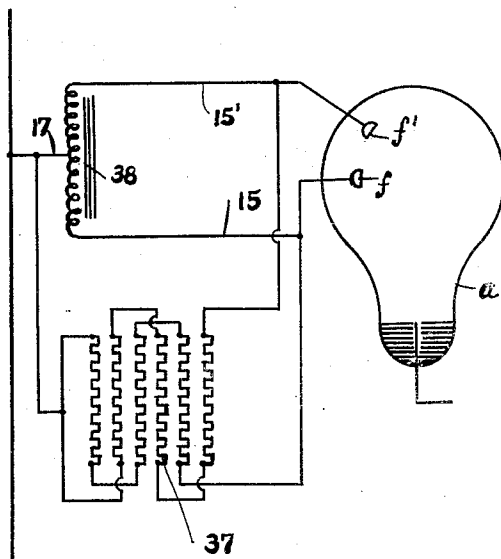


FIG. 13.

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UNITED STATES PATENT OFFICE

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BACK-FIRE TRAP FOR RECTIFIERS OR CONVERTERS

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In thermionic rectifiers where electrons are relied upon as current carriers, or converters of the mercury vapor type in which ionic phenomena are utilized, they commonly break down when subjected to abnormal stresses, with the result that a reverse current flows and they are said to "back-fire". The inter-electrode space in the converter tube loses its characteristic of unilateral conductivity. Even though the causative condition be set up for only the duration of a moment, the consequent abnormality in the functioning of the system is prone to persist and so aggravate itself that ultimately external protective devices of the general class known as "circuit breakers" must be brought into play to relieve it and its associated apparatus. In consequence there is an unavoidable interruption of service to the load.

The object of this invention is to restore the characteristic unilateral conductivity to a converter or rectifier which has momentarily ceased to function properly. By means of my invention restoration to normal working follows a back-fire before it is necessary for circuit breakers to function, and thus uninterrupted service is maintained automatically and safely.

According to the present invention, suppression of deleterious reverse current is achieved by means of setting up a counteracting resistance in the circuit of the affected anode which continues until the disruptive influence is entirely overcome. Then the characteristic unilateral conductivity is reassumed by the space in the vicinity of the anode with the result that the normal full load current is returned to its regular path.

In carrying out this invention the rectifier or converter is equipped with anodes in duplicate which are in circuit with a specially constructed resistance device designed to function according to the phenomena of "skin-effect". The resistance device in substance consists of a conductor divided into a plurality of sub-conductors insulated from one another. Certain of these sub-conductors carry current from a common source to one of the anodes of a pair, while the other sub-conductors carry current from the same source

to the anode but essentially in the opposite direction so that no skin-effect may normally occur in the aforesaid conductor as a whole. In the event however of a back-fire the reversal of the current to the affected anode makes a unidirectional current flow through the conductor as a whole and thus sets up a high counteracting resistance due to the skin-effect.

In the accompanying drawings are illustrated several embodiments of the invention, in which Figure 1 is a diagrammatic illustration of the present invention applied to a rectifier or converter.

Figure 2 is a side elevation of a circular resistance device.

Figure 3 is a cross-sectional view taken on the line 3—3 thereof.

Figure 4 is a further section taken on the line 4—4 thereof.

Figure 5 is a perspective view of a straight type of resistance device.

Figure 6 is a view of the end thereof not seen in Figure 5.

Figure 7 is a perspective view of a modification of the straight type above mentioned.

Figure 8 is a view of the end thereof not seen in Figure 7.

Figure 9 is a perspective view of a further modification of a straight resistance device.

Figure 10 is a typical cross section thereof.

Figure 11 is a perspective view of a still further modification of this form of device. In this view a portion is broken away to illustrate the interior construction.

Figure 12 is a view of the end thereof not seen in Figure 11.

Figure 13 is a diagram showing the invention connected in parallel with a reactance.

Like numerals of reference indicate corresponding parts in each of the figures throughout the drawings.

Referring to Figure 1, the reference character *a* denotes a full-wave rectifier of the mercury vapor type connected, as shown, to the source of single phase alternating current *b*. The load to carry pulsating unidirectional current is denoted at *c*. The conventional reactances to maintain the arc in continuous operation are denoted at *d* and *e*. One pair of

anodes is denoted at f, f' and connected by the wires 15, 15' to the resistance device 16 which is centre tapped by the lead-in wire 17 from the current source. The other pair of anodes g, g' are similarly connected to a like resistance device. It may be here mentioned that the anodes of each pair are of identical shape and so located within the tube that normally the space current path of each has the same electrical dimensions.

Turning to the structural form of the resistance device depicted in Figures 2, 3 and 4, this consists of a ring 18 of a sectoral cross section, the component sectors of which are suitably insulated from each other as at 19. The ring is preferably constructed of two strands 20 and 20' of conducting material, each of a sectoral cross section. The strands are coiled about each other a number of times to form a cylindrical ring and are also helically curved as shown in Figure 2. By this construction the coils of one strand are alternately disposed with relation to those of the other strand.

An end of the strand 20 and the opposite end of the strand 20' are connected to the centre tap wire 17 referred to in connection with the diagram of Figure 1. The other opposing ends of these strands are connected respectively to the circuit wires 15, 15' of the anodes f, f' . It will be evident that the current from the source b is thus divided, part flowing through the sectoral coils of the strand 20 while the other part flows in the opposite direction through the alternate sectoral coils of the strand 20', as indicated by the arrows in Figure 2. Hence no skin-effect exists in the ring as a unit. When, however, some transient influence changes the impedance of one of the anodes, thus causing a back-fire in the affected anode and reversing the current in its circuit, this reversal of current in one of the anodes is transmitted to the ring 18 with the result that all its coils convey the current in the same direction and set up a skin-effect that produces a suppressing resistance to the passage of the reversed current. This resistance functions to decrease the reversed current until normal conditions are resumed. An analogous action to that above described ensues should the transient alteration occur in the impedance of the other anode.

Adverting to the modification shown in Figures 5 and 6, this consists of a cylindrical resistance device composed of conductors 21 of sectoral cross sections insulated from each other as at 22. The centre tap wire 17 is branched as at 23, 23' in order that one branch, 23, may be connected to an end of one of the conductors 21, while the other branch 23' is connected to the opposite end of an adjacent conductor; thus forming a lead-in. At one end of the resistance device the alternate conductors are connected by wires 24, and at

the opposite end of the other alternate conductors are similarly connected as at 25. Lead-out wires 26, 26' extend from adjacent conductors and correspond to the wires 15, 15' of the diagram of Figure 1.

By this construction it will be manifest that under ordinary conditions current is conducted in opposite directions through the alternate conductors to the lead-out wire 26, 26' and thence to the respective anodes. In the event of a back-fire this straight type of resistance device functions in similar manner to that previously described.

The modification depicted in Figures 7 and 8 only differs from that just described in that each sectoral conductor 21 is lengthwise divided into two members insulated from each other as at 27, thus forming a segmental outer conductor 28 and a sectoral inner conductor 29; which conductors are electrically connected to each other by wires 30. These wires are alternately located oppositely to the respective wires 24 and 25. According to this construction the current from the lead-in 23 must pass along one segment then return along its complementary inner sector from where it is conveyed by one of the wires 24 to the segment of an alternate conductor, and so on around the resistance device. Current from the lead-in 23' passes through a segment of an alternate conductor but in a contrary direction, being returned by the complementary inner sector and then conducted by one of the wires 25 to the next alternate segment, and so on around the resistance device which functions in similar manner to its prototype should a back-fire occur.

The alternate form depicted in Figures 9 and 10 closely resembles that of Figures 5 and 6, the only variation being that instead of using alternate conductors to return the current insulated wires 31 are used for this purpose. These wires are disposed in the axial opening formed by the conductors 21 and each wire electrically connects the opposite end of two adjacent conductors.

Figures 11 and 12 show a somewhat dissimilar construction to any previously described. In this case a body 32 of a good magnetical material is employed to hold a number of axial rods 33 of conducting material, which rods may be embedded in the body in suitable manner and insulated individually by suitable sheaths. These rods it is suggested may be arranged in radial groups as shown. The opposite ends of alternate radial groups may be connected by wires 34 in a manner as recounted in the description of Figures 9 and 10. Lead-in wires 35 are provided and also lead-out wires 36. This presents a highly efficient construction in that when a back-fire occurs the surrounding body 32 creates a magnetic flux that enhances the skin-effect.

Adverting to Figure 13, the reference numeral 37 indicates a resistance device constructed according to the present invention and connected in parallel to a reactance 38 with a view to cooperating with it in suppressing back-fires. It is to be understood that the invention may also be connected in series to a reactance if so desired or may be used alone.

Referring generally to the various structures disclosed in the drawings it may be pointed out that wherever the conductors are mentioned these may be of a magnetical or a non-magnetical material: further, they may be constructed partly of a good conducting material and partly of a good magnetical material, or a body of good magnetical material could be combined with the conductors to provide magnetic flux. Moreover, if so desired, features of one type of construction could be combined with features of another type, or changes made in the shape and form of the invention without departing from its spirit and scope.

Whereas this invention has been shown and described as means for producing a high alternating current resistance for suppressing reverse currents of rectifiers or converters, it is equally susceptible of use for other devices and it is not intended to limit its scope in this respect.

What I claim is:—

1. A device of the class described comprising a conductor composed of two strands of intercoiled conducting material insulated from each other, said strands being of a sectoral cross section to form a ring, a lead-in connected to opposite ends of the said two strands so that current will pass through each in opposite directions, and a lead-out connected to each of the other ends of said strands.

2. A device of the class described comprising a conductor composed of a complement of sub-conductors each of a sectoral cross-section forming a ring, said sub-conductors being insulated from one another, a lead-in connected to opposite ends of two adjacent sub-conductors, conducting elements interconnecting alternate subconductors beginning at the lead-in, conducting elements interconnecting in like manner the other sub-conductors so as to constitute two opposite current paths, and a lead-out connected to each of the two end sub-conductors of said opposite current paths.

3. A device of the class described comprising a conductor composed of a complement of sub-conductors each of a substantially sectoral cross section forming a ring having an axial opening, said sub-conductors being insulated from one another, a lead-in connected to opposite ends of two adjacent sub-conductors, insulated wires disposed in said opening and interconnecting alternate

sub-conductors beginning at the lead-in, further insulated wires disposed in said opening and connecting the other sub-conductors so as to constitute two opposite current paths, and a lead-out connected to each of the two terminating sub-conductors of said opposite current paths.

4. A device of the class described comprising a body of magnetic material, a number of parallel insulated conducting rods therein, a lead-in connected to opposite ends of two adjacent rods, conducting elements interconnecting certain of said rods beginning at the lead-in, conducting elements likewise interconnecting the other rods so as to constitute two opposite current paths, and a lead-out connected to each of the two terminating rods of said opposite current paths.

Signed at Montreal, Canada, this 27th day of August 1929.

WERNER BOHRAUS.