

Feb. 27, 1934.

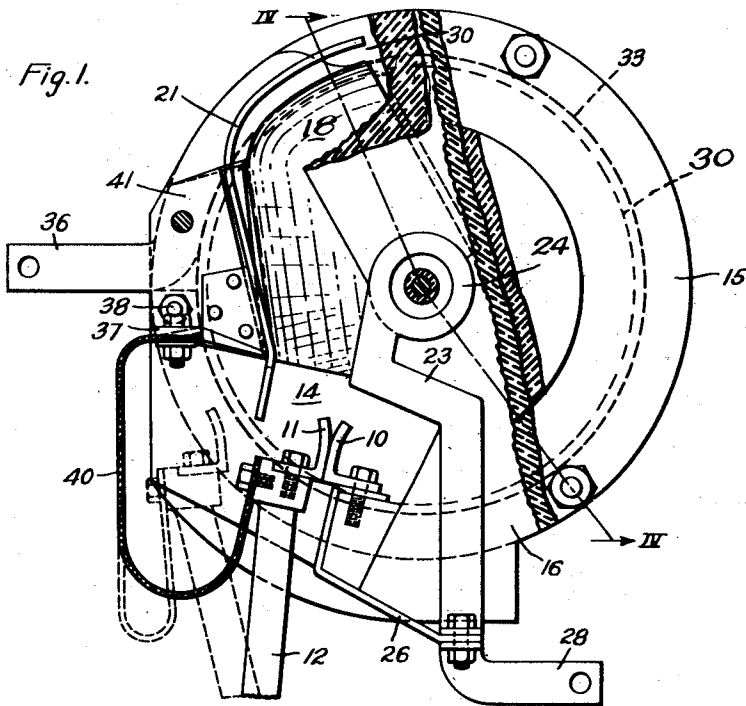
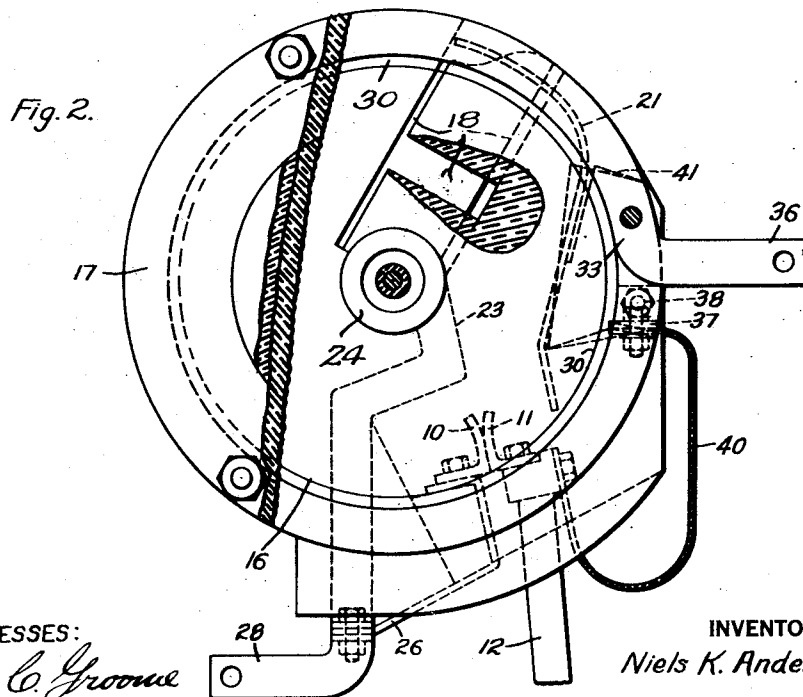
N. K. ANDERSEN

1,948,741

CIRCUIT INTERRUPTING DEVICE

Filed May 2, 1931

2 Sheets-Sheet 1



WITNESSES:

Wm. C. Groome ☐
George V. Haddling

INVENTOR

Niels K. Andersen.

BY
Sherry L. Carr
ATTORNEY

Feb. 27, 1934.

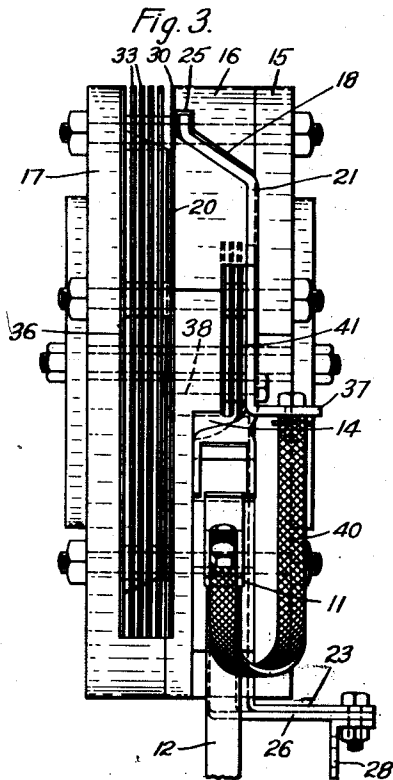
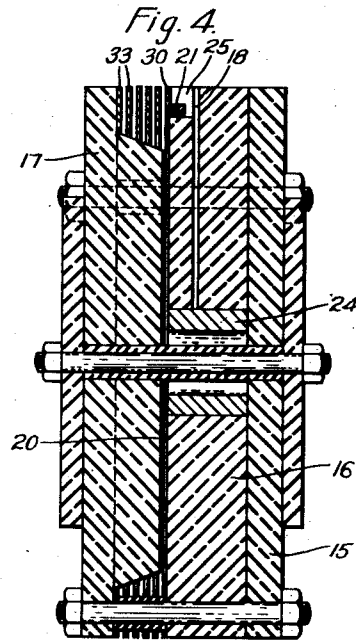
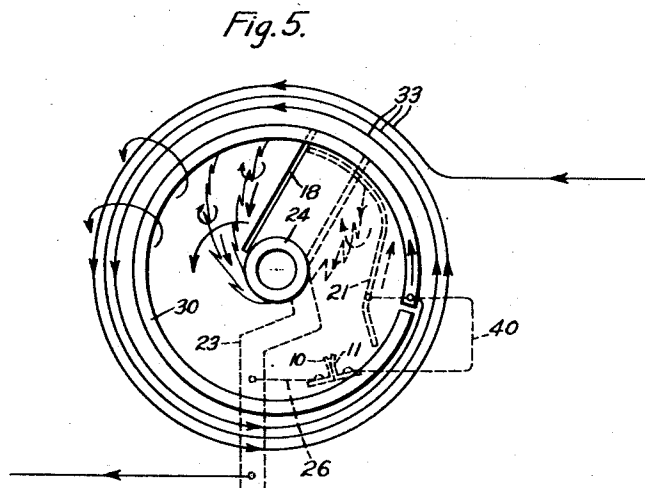
N. K. ANDERSEN

1,948,741

CIRCUIT INTERRUPTING DEVICE

Filed May 2, 1931

2 Sheets-Sheet 2



WITNESSES:

Chas. C. Groome
George W. Hoodling

INVENTOR

Niels K. Andersen.

BY *Charles F. Carr*
ATTORNEY

UNITED STATES PATENT OFFICE

1,948,741

CIRCUIT INTERRUPTING DEVICE

Niels K. Andersen, Forest Hills, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, a corporation of Pennsylvania

Application May 2, 1931. Serial No. 534,555

8 Claims. (Cl. 200—144)

My invention relates generally to circuit-inter-
rupting devices and particularly to those em-
bodying the "narrow-slot" principle.

In circuit-interrupting devices embodying the
"narrow-slot" principle, the arc is confined be-
tween closely spaced insulating members as it is
carried from an arc-establishing means, such, for
example, as contact members of a switch.

Because of the close spacing of the insulating
members, the arc is brought in intimate relation
to the walls of the insulating members. After an
arc rupture, the recombination of the ions is,
therefore, many times greater than would be the
case if the arc were unrestricted. As a result of
this rapid recombination of ions, a higher circuit
voltage per unit length of arc can be interrupted
by devices embodying the "narrow-slot" principle
than can be interrupted by circuit interruptors
that do not confine the arc.

It has been determined by arc-rupturing tests
that, as the distance between the insulating mem-
bers is reduced, the circuit voltage which can be
interrupted per unit length of arc is materially
increased. By further tests, it has also been de-
termined that the best results may be obtained
by confining the arc in slots approximately $\frac{1}{8}$
to $\frac{3}{8}$ of an inch wide. For a more detailed de-
scription of the theory pertaining to the "narrow-
slot" principle, reference may be had to an ap-
plication for Letters Patent of Joseph Slepian,
Serial No. 208,686, filed July 27, 1927 and relating
to high-voltage fuses and assigned to the as-
signee of this invention.

It is apparent that the walls of the insulating
members since the arc is brought in close rela-
tion to them will be subjected to intense heat thus
causing the melting of the arc terminals and the
deterioration of the insulating members. There-
fore, in constructing arc-interrupting de-
vices embodying the "narrow-slot" principle for
commercial application, where the operating con-
ditions require the frequent interruption of cir-
cuits impressed with a relatively high voltage
and carrying a relatively large amount of cur-
rent, it is necessary to provide for rapidly dis-
sipating the heat generated by the arc.

It is an object of my invention to provide a
circuit-interrupting device that shall be simple
and reliable and be readily and economically
manufactured and installed.

It is also an object of my invention to provide
a circuit-interrupting device that shall be ap-
plicable to interrupting circuits impressed with
a relatively high voltage and transmitting a
relatively large amount of current.

A more specific object of my invention is to
provide for confining the expansion of an arc be-
tween closely spaced insulating members, and
for maintaining the arc in continuous motion be-
tween said insulating members as long as the arc

continues to flow, thereby insuring a uniform
distribution of the heat generated by the arc.

Another object of my invention is to provide
for rapidly dissipating the heat generated by an
arc, thereby preventing excessive burning and
deterioration of the parts that are exposed to the
arc.

It is a further object of my invention to pro-
vide for cooling an arc by maintaining it in con-
tinuous motion as long as it continues to flow.

Other and more specific objects of the inven-
tion and a fuller understanding of the nature
thereof may be had from the following detailed
description, taken in connection with the accom-
panying drawings, in which:

Figure 1 is a side view of an arc-interrupting
device constructed in accordance with my in-
vention, parts being broken away to show the
arrangement of the structural elements.

Fig. 2 is a view of the opposite side of the arc-
interrupting device shown in Fig. 1, parts being
broken away to show the arrangement of the
structural elements.

Fig. 3 is a front view of the arc-interrupting
device constructed in accordance with my inven-
tion.

Fig. 4 is a transverse cross-sectional view
of the arc-interrupting device taken along the
line IV—IV of Fig. 1.

Fig. 5 is a diagrammatic view of an arc-in-
terrupting device embodying the features of my
invention, and illustrating the flux action for
maintaining the arc in continuous motion, as
long as it continues to flow.

Referring now to the drawings, the reference
characters 10 and 11 designates a pair of con-
tact members of a switch to which my invention
may be applied. The movable contact member
11 is actuated by a rod 12 that may be controlled
by any suitable means (not shown).

In this particular embodiment of the invention,
the contact members are disposed in an outer
arc chamber 14 that is provided between the in-
sulating members 15 and 16, (see Figs. 1 and 3).
In communication with the chamber 14 is a
narrow transfer slot 18 through which the arc
travels as it is conducted to the narrow space
20 that is provided between the insulating mem-
bers 16 and 17.

As shown, the insulating members 15, 16 and 17
which constitute the main body portion of the
arc-interrupting device, are secured together by
bolts but it is apparent that any other suitable
means may be utilized for this purpose.

As shown best in Figs. 1 and 3, the transfer
slot 18 extends from one side of the insulating
member 16 to the opposite side. In Fig. 1, parts
of the insulating members 15 and 16 are indi-
cated as broken away in order to show a portion

of one wall of the transfer slot. Also, the width of the transfer slot is shown in Fig. 4.

Records of arc-rupturing tests on a device constructed in accordance with my invention, disclose that the best results are obtained when the width of the space 20 is approximately $\frac{3}{8}$ of an inch wide. Therefore, as the arc enters this narrow space 20, it expands annularly in a fan-like shape between the closely spaced insulating members 16 and 17. Accordingly, the arc is brought into intimate relation to the walls of the insulating members 16 and 17, and, as a result, the recombination of the ions is many times greater than what it would be if the arc were unrestricted.

A pair of arc terminals 21 and 23 are provided to carry the arc through the transfer slot 18 into the narrow space 20, where it is rotated as long as it continues to flow. The upper end of the arc terminal 21 is disposed in a groove 25 that is adjacent to the transfer slot as it extends from one side of the insulating member 16 to the opposite side (see Figs. 3 and 4), and the remaining portion thereof is gradually bent radially inward through the transfer slot. Its other end extends into the outer arc chamber 14 near the travel of the movable contact member 11 (see Figs. 1 and 3).

The arc terminal 23, which is constructed of a narrow strip of material, passes radially inward, between the insulating members 15 and 16, to the central portion of the arc-interrupting device. Integrally formed with the inner end of the arc terminal 23, is an enlarged cylindrical portion 24 which constitutes a concentric arc terminal for the arc as it passes from one side of the insulating member 16 to the other side, and as it rotates in the narrow space 20. As shown in Fig. 4, the enlarged portion 24, extends transversely through the central portion of the insulating member 16. The other end of the arc terminal 23 is connected to the contact member 10 by means of a connecting member 26, both of which, in turn, are connected to a line terminal 28.

The end of the arc that travels upon the arc terminal 21, immediately upon its passing through the transfer slot 18 and into the space 20, is transferred to an outer concentric arc terminal 30. In this manner, the arc terminal 30 and the enlarged portion 24 constitute a pair of concentric arc terminals between which the arc flows as it rotates in the space 20. The upper end of the arc terminal 21 is not connected to the concentric arc terminal 30, but is supported in closely spaced relation thereto, so that, prior to the transfer of the arc to the concentric arc terminal 30, the current flows through the arc terminal 21 instead of the concentric arc terminal 30. (See Figs. 3, 4 and 5). As illustrated in Fig. 5, a gap is provided between the adjacent ends of the concentric arc terminal 30, thus making an incomplete turn. This is to cause the current to flow in a counter-clockwise direction through the concentric arc terminal 30.

In order to establish a flux for directing the arc through the transfer slot and then for rotating it in the space 20, a coil 33, having spaced turns, is provided. The coil is disposed adjacent to the concentric arc terminal 30 and between the insulating members 16 and 17. In this manner, the open spaces between adjacent turns constitute means through which the heat generated by the arc is dissipated.

The concentric arc terminal 30 is preferably

constructed of steel or any other suitable magnetic material, so that the arc is magnetically attracted to it, instead of flashing over and short-circuiting the spaced turns of the coil 33, thereby destroying the flux for rotating the arc in the space 20. Also, in order to provide for further assurance that the arc will not short-circuit the spaced turns, the internal diameter of the concentric arc terminal 30 is somewhat less than the internal diameter of the coil 33 (see Figs. 1, 2 and 4).

One end of the coil 33 is connected to a line terminal 36, and the other end is connected to both the concentric arc terminal 30, at a point near the illustrated gap, and to the terminal lug 37 by means of a through bolt 38 (see Figs. 3 and 5). The terminal lug, in turn, is connected to the movable contact member 11 by means of a flexible conductor 40. These connections are shown diagrammatically in Fig. 5.

In explaining the action of the flux for directing the arc through the transfer slot 18 and then for rotating the arc in the space 20, let it be assumed that an arc is established between the arc terminals 21 and 23 (see Fig. 5). Under this condition, the current that maintains the arc or, in other words, the circuit current flows, through the coil 33 in a counterclockwise direction, the arc horn 21 and the arc itself, to the opposite side of the line through the arc terminal 23. Since the general direction of the flux caused by the coil 33 is upward in the region between the coil, and since the general direction of the flux produced by the arc itself is downward in advance of the arc and upward in rear of the arc, a weak field, because of the opposition of the two fluxes, is produced in advance of the arc, and a strong field, because of the addition of the two fluxes, is produced in rear of the arc. With the presence of a weak field in advance of the arc and a strong field in rear of the arc, a resultant force is set up for transferring the arc through the transfer slot and for rotating the arc in a counterclockwise direction in the space 20. It will also be observed that, since the upper end of the arc terminal 21 is not connected to the concentric arc terminal 30, the general direction of the current in the arc terminal 21, when the arc is travelling through the transfer slot, is the same as that in the coil 33, thereby producing a flux which aids the flux produced by the coil 33 in transferring the arc through the slot. After the arc is transferred into the narrow space 20, and upon the concentric arc terminal 30, the current flows in a counterclockwise direction through the concentric arc terminal 30 instead of the arc terminal 21. In this manner, the arc terminal 30 not only provides for carrying one end of the arc as it rotates but also constitutes a turn, or a portion of a turn, depending upon the position of the arc, for establishing a flux which aids the flux produced by the coil in rotating the arc.

The rotation of the arc in the narrow space 20 provides for uniformly distributing the heat generated by the arc and, in consequence, prevents the burning of the arc terminals and the deterioration of the walls of the insulating members. Also, the rotation of the arc provides intervals during which that portion of the walls of the space 20 which the arc has just passed at any particular instant is permitted to cool before being encountered by the arc again. Therefore, the arc is continuously brought into contact with a region of low ionization density caused by the cooling, and, as a result the recombination of ions is greatly hastened.

In order to dissipate as much heat as possible before the arc enters the space 20, I provide for ventilating the transfer slot 18 in the region near the outer arc chamber 14. To this end, spaced metal members 41 are placed directly above the transfer slot, through which the heat may be discharged. (See Figs. 1, 2 and 3.) As illustrated, the general outline of the metal plates 41 define an irregular four-sided figure, with their innermost edges lying near the region of the arc terminal 21. The narrow spaces, between the metal plates 41, allow the hot gases to escape; but because of their deionizing effect, prevent the arc from passing out therebetween. Likewise, further cooling is effected since that portion of the slot which passes through the insulating member 16, is open directly to the atmosphere (see Figs. 3 and 4).

Arc-rupturing tests, which were conducted on a device constructed in accordance with my invention the distance between the pair of concentric arc terminals 24 and 30 being 8 inches demonstrated that 3000 amperes at 2300 volts, 60 cycle, and 4000 amperes at 1500, 60 cycle, could be successfully interrupted. It was further demonstrated that 2000 amperes direct current at 2300 volts, and 6000 amperes direct current at 750 volts could be successfully interrupted.

Therefore, I have disclosed an arc-interrupting device embodying the "narrow-slot" principle, which provides for confining the expansion of an arc between closely spaced insulating members, and for maintaining the arc in continuous motion between said insulating members as long as the arc continues to flow, thereby hastening the recombination of the ions and insuring a uniform distribution of heat generated by the arc.

Since certain changes may be made in the invention without departing from the scope thereof, it is intended that all matter contained in the above description, or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A circuit-interrupting device, in combination, means for establishing an electric arc, a pair of spaced insulating members for confining the expansion of the arc, one of said members having a transfer slot through which the arc enters the space between the said members, means for carrying the arc through the slot, and means for maintaining the arc in continuous rotation within the space between said spaced members as long as it continues to flow.

2. In combination with means for establishing an electric arc, a pair of spaced insulating members for confining the expansion of the arc, one of said members having a transfer slot through which the arc enters the space between the said members, a coil which the arc current traverses for establishing a flux, the general direction of which is substantially perpendicular to the arc, thereby producing a resultant force for transferring the arc through the transfer slot and then for rotating the arc between said spaced members as long as the arc continues to flow, and a pair of concentric arc terminals for carrying the arc as it is being rotated.

3. A circuit-interrupting device, in combination, means for establishing an electric arc, spaced members for confining the expansion of the arc, said members being so shaped that their

confining walls define an endless path for the continuous rotation of the arc in its own plane, means for directing the arc from said establishing means into the space between said members, means for maintaining the arc in continuous rotation as long as it continues to flow, and concentric-arc terminals upon which the arc is carried during its continuous rotation.

4. A circuit-interrupting device, in combination, means for establishing an electric arc, spaced insulating members for confining the expansion of the arc, said members being so shaped that their confining walls define an endless path for the continuous rotation of the arc in its own plane, one of said members having a transfer slot through which the arc enters the space between the said members, and means for directing the arc through said slot and for maintaining the arc in continuous rotation as long as it continues to flow.

5. In combination with means for establishing an electric arc, a pair of spaced insulating members for confining the expansion of the arc, one of said spaced members having a transfer slot through which the arc enters the space between the said members, means for directing the arc through the slot and then for rotating the arc between the insulating members as long as it continues to flow, part of said means including a coil having spaced turns disposed between the outer portions of the insulating members, and concentric arc terminals for carrying the arc as it is being rotated.

6. In combination with means for establishing an electric arc, spaced members for confining the expansion of the arc, an arc terminal, a second arc terminal surrounding the first-mentioned arc terminal and disposed between the outer portions of said members, means for maintaining the arc in continuous motion as long as it continues to flow, part of said means including a coil having spaced turns disposed between the outer portions of said members, said coil being connected in circuit relation with said arc establishing means.

7. In combination with means for establishing an electric arc, a pair of spaced insulating members for confining the expansion of the arc, one of said spaced members having a transfer slot through which the arc enters the space between the said members, a coil having spaced turns disposed between the outer portions of the insulating members, said coil being connected in circuit relation with the arc establishing means, and arc terminals upon which the arc is carried as it passes through the transfer slot and as it rotates between the spaced insulating members.

8. In combination with means for establishing an electric arc, a pair of spaced insulating members for confining the expansion of the arc, one of said spaced members having a transfer slot through which the arc enters the space between the said members, a coil having spaced turns disposed between the outer portions of the insulating members, said coil being connected in circuit relation with the arc establishing means, arc terminals upon which the arc is carried as it passes through the transfer slot and as it rotates between the spaced insulating members, and spaced members disposed above the transfer slot to allow the hot gases to escape.

NIELS K. ANDERSEN.