

July 7, 1936.

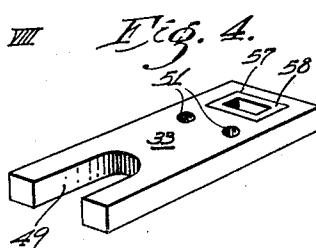
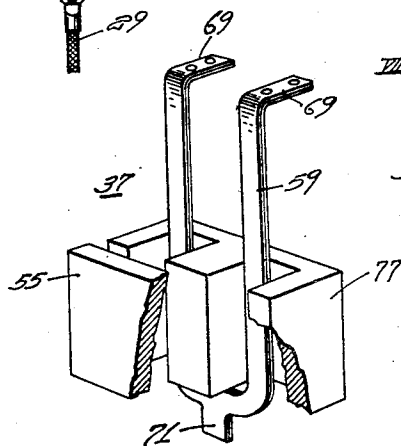
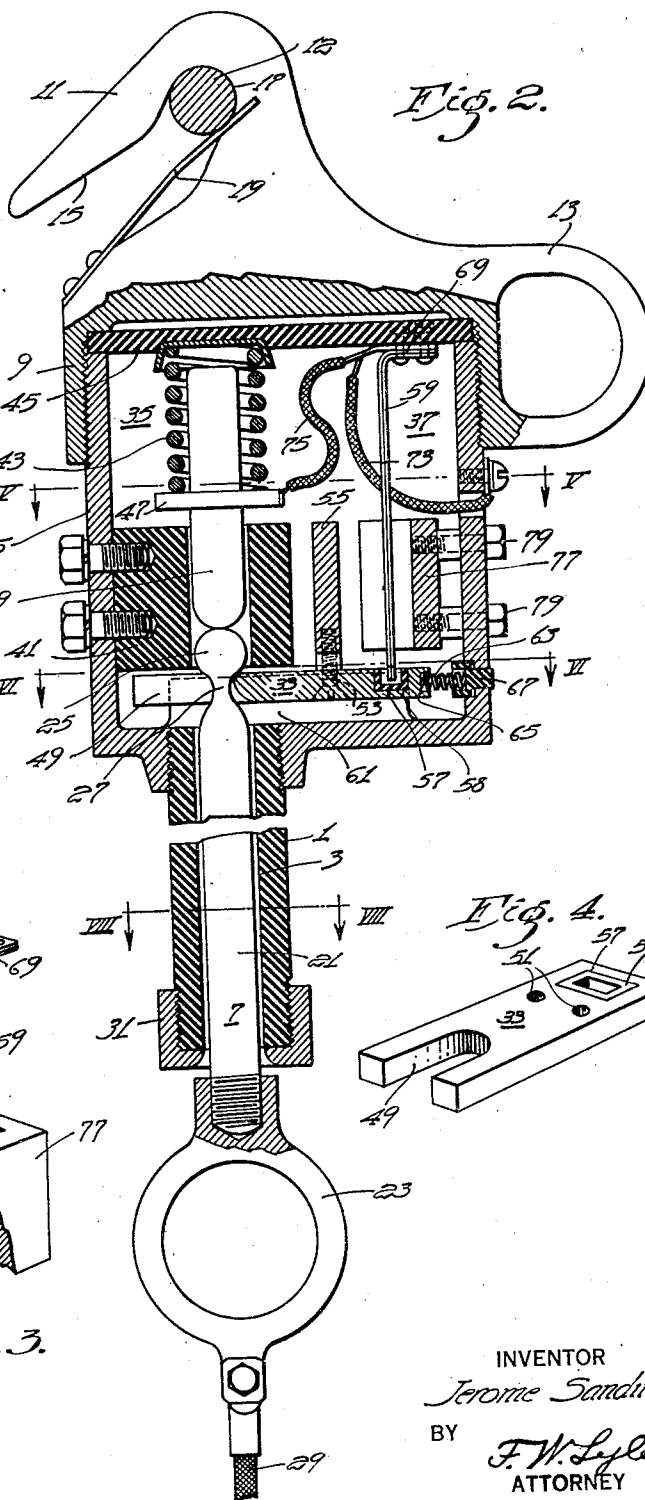
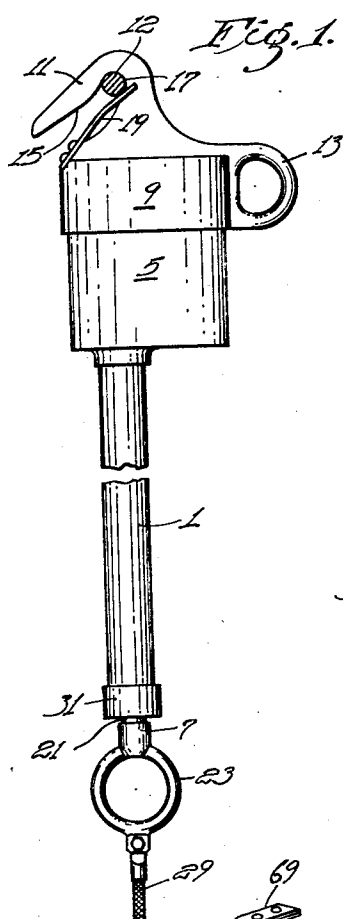
J. SANDIN

2,046,701

CIRCUIT INTERRUPTER

Filed Dec. 20, 1934

2 Sheets-Sheet 1



WITNESSES:

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CIRCUIT INTERRUPTER

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2 Sheets-Sheet 2

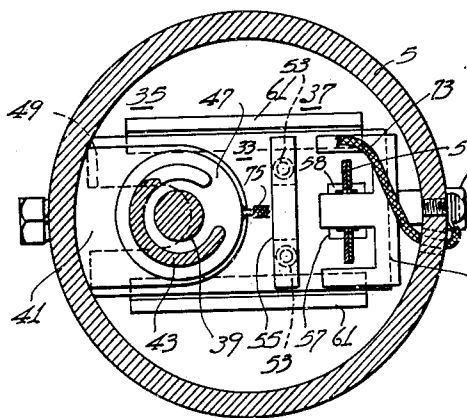


Fig. 5.

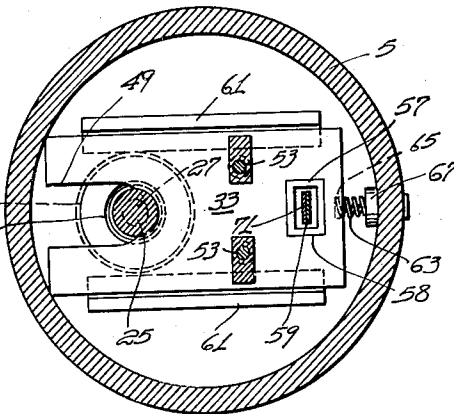


Fig. 6.

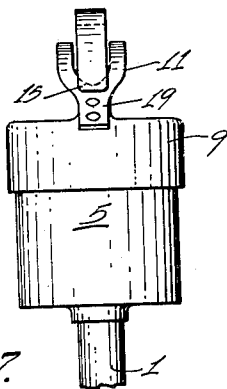


Fig. 7.

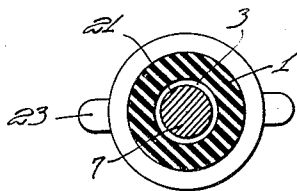


Fig. 8.

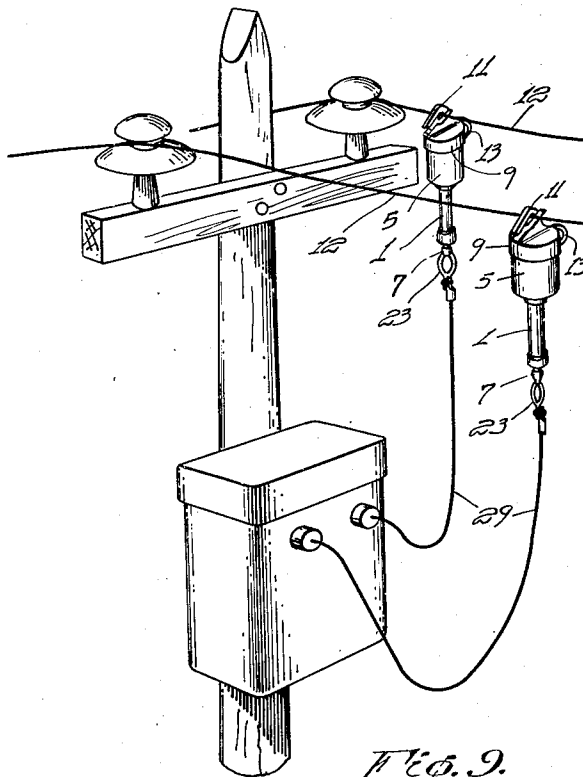


Fig. 9.

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2,046,701

CIRCUIT INTERRUPTER

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Application December 20, 1934, Serial No. 758,393

15 Claims. (Cl. 200—88)

My invention relates to expulsion circuit inter-
rupters, and particularly to that group of expul-
sion circuit interrupting devices which are known
as high voltage protective cutouts. The so-
called expulsion fuse is perhaps, the best known
example of this type of apparatus, and it is with
improving expulsion devices similar in form to
expulsion fuses that the present invention is
particularly concerned.

High voltage cutouts fulfill a very definite
function in the electrical art. Ordinarily they
are utilized for protecting the various portions of
a distribution network system or the transform-
ers and other equipment associated with such a
network. The normal load currents to which
the devices are subjected are ordinarily of a
rather small magnitude, yet despite this, the
overload currents may become extremely large,
due to the feeding in of power from various
parts of the network.

While abnormal conditions which necessitate
the operation of the cutouts to effect the opening
of the controlled circuit occur but infrequently
in this type of service, it is imperative that the
operation of the devices be absolutely reliable
regardless of the magnitude of the overload or
other conditions. This means that the cutouts
must have a very large arc extinguishing
capacity.

In the ordinary distribution system it is
necessary to employ a large number of cutouts
and a commercially successful device must also
therefore be relatively inexpensive. The only
device which in the past has met these require-
ments with any degree of satisfaction is an
expulsion fuse.

Expulsion fuses are comparatively inexpensive,
due to their simple structure. They have large
arc extinguishing capacity, and are extremely
reliable in operation. They have, however, one
very serious inherent difficulty, and that is that
they are a one-operation device. In other words,
once the fusible element which serves to com-
plete the electrical circuit through the fuse has
been ruptured, the device is rendered inoperative
until it has been serviced by the replacing of a
new fuse link.

Another disadvantage of an expulsion fuse
resides in the inability of the device to intro-
duce a sufficient time delay in its operation to
prevent the opening of a circuit when moder-
ately high overloads exist therein for short pe-
riods of time. To give adequate protection the
fuse must be capable of melting when subjected
to any overload of a dangerous magnitude, and

when calibrated to open upon the occurrence of
such an overload there is no means whereby the
opening may be delayed. As a result, expulsion
fuses are rather critical in their operation, and
often open the connected circuit upon the oc-
currence of transient overloads.

The principal object of the present invention
is to provide a cutout which includes all of the
desirable features of an expulsion fuse, but which
is not subjected to the disadvantages of those
devices.

In carrying out this principal object of my
invention, I provide a tubular means for defin-
ing an arc passage similar to that of the ordi-
nary expulsion fuse means for connecting the
device into the circuit, and an arc drawing
means operable to establish an arc within the
tubular means upon the occurrence of predeter-
mined conditions. Instead of using a fusible
means as the arc drawing member, I provide a
solid rod or plunger of suitable conducting mate-
rial which moves through the arc passage during
the operation of the device; and for effecting the
opening of the electrical circuit through the
interrupter, I provide a latch and an electro-
responsive means for effecting the release of the
latch, the plunger member being normally bi-
ased to the open circuit position and being re-
strained in the closed circuit position by the
latch.

Through this arrangement I have made pos-
sible the provision of an electrical cutout which
has the low cost, the reliability of operation,
and the high arc interrupting capacity of an
expulsion fuse device, while at the same time
providing a structure which may be readily re-
closed without necessitating the supplying of a
new fusible element, and which, in addition,
may be provided with electroresponsive means
for assuring that the circuit opening operation
shall take place only when the duration of an
overload indicates that it is of a permanent
nature.

A further object of my invention is to pro-
vide a device similar to that described above
which shall include a plurality of electrore-
sponsive means for effecting the opening of the
electrical circuit therethrough, one of the elec-
troresponsive means being operable following
the occurrence of predetermined overloads
which persist for a substantial period of time,
and the other electroresponsive means being
operable substantially instantaneously upon the
occurrence of predetermined large overload con-
ditions. The provisions of a plurality of electro-

responsive means considerably extends the useful scope of the cutout by assuring selective operation of the device in accordance with the overload upon the circuit, and it overcomes the difficulties experienced with the prior art expulsion fuses which were incapable of distinguishing between overloads above a certain small magnitude.

A further object of my invention is to provide an improved expulsion type cutout which shall be readily mountable upon one of the conductors of a transmission line through the agency of a simple clamp means, which is preferably of the spring type.

These and other objects of my invention will be made more apparent by reference to the following drawings and description of an expulsion cutout wherein are embodied the principal features of my invention. Referring to the drawings:

Figure 1 is a side elevational view of an expulsion cutout constructed according to my invention.

Fig. 2 is an enlarged sectional view through the cutout shown in Fig. 1.

Fig. 3 is a fragmentary, perspective view of the bimetallic, electroresponsive element and portions of the magnetically responsive element utilized in conjunction with the cutout structure shown in Figs. 1 and 2.

Fig. 4 is a perspective view of the latch member utilized in conjunction with the breaker utilized in Figs. 1 and 2.

Fig. 5 is a sectional view taken on the line V—V of Fig. 2.

Fig. 6 is a sectional view taken on the line VI—VI of Fig. 2.

Fig. 7 is a fragmentary front elevational view of the device shown in Figs. 1 and 2.

Fig. 8 is a sectional view taken on the line VIII—VIII of Fig. 2, and

Fig. 9 is a perspective view showing two cutouts, constructed according to my invention, in use on a transmission system.

The cutout illustrated in the figures of the drawings comprises essentially a main tube 1, of rigid insulating material, which defines the walls of the arc passage 3, a cast metallic housing 5 rigidly affixed to the upper end of the main tube, and a plunger 7 which is adapted to move through the arc passage to establish an arc therein during the operation of the device. The upper portion of the housing 5 is screwed into a cap member 9, of conducting material, which is provided with a clamp or hook portion 11 for engaging one of the conductors 12 (Figs. 1 and 2) of a transmission line or the like, and an eye portion 13 which is engageable by an operating stick to position the cutout upon a line.

The tubular means which defines the walls of the arc passage is preferably formed of hard fiber, boric acid, or some other material, which is capable of evolving large quantities of arc extinguishing gas when placed in close proximity to an electric arc. While other materials may be used in place of hard fiber, I prefer to utilize that material because it is relatively inexpensive, it retains its strength and insulation ability when exposed to an arc, and in addition, it may be readily water-proof in order to permit its use outdoors. It is necessary, of course, to renew the fiber tube 1 following a definite number of operations of the device, and as will be pointed out later, this tube engages the other

portions of the apparatus through threaded connections in order that its replacement may be carried out without difficulty.

The hook portion 11 which is provided for engaging one of the conductors of the transmission line, in order to entirely support the fuse device thereon, includes a flared outer portion 15 and a restricted inner portion 17 which is preferably of the same dimensions as the conductor, which the device is adapted to engage. A flat spring 19 is provided for holding the conductor and the hook portion in intimate contact with each other. The hook portion 11 serves as the upper terminal of the device.

The plunger means 7 includes a cylindrical rod portion 21 of slightly smaller cross sectional area than the arc passage 3 wherein it is adapted to move, an eye member 23 rigidly affixed to the lower end of the cylindrical portion, and a contact portion 25 for cooperating with the stationary contact assemblage within the main housing 5. The upper end of the body portion is cut away so as to provide a section 27 of reduced diameter for engaging the latch means 33 which normally holds the cutout in the closed circuit position. A flexible conductor 29, which is bolted to the lower end of the eye portion 23, is provided for connecting the device to the associated apparatus.

An annular cap member 31 is screwed onto the lower end of the main tube in order to increase the mechanical strength of that member. The lower end of the central opening within this cap member is flared (as is shown in Fig. 2) for aiding the entry of the contact end of the plunger member during the operation of the cutout.

The housing 5 serves to close the upper end of the main tube 1 and also to enclose the stationary contact assemblage 35, the latch means 33, and the electroresponsive means 37 which is operable to effect the actuation of the latch means. The stationary contact assemblage 35 includes a rod shaped contact member 39 of conducting material which is adapted to slide within a suitable guide member 41 of insulating material, and is biased downwardly by a spring 43, the upper end of which spring engages an insulating disc 45 positioned at the upper end of the housing proper. The lower end of this biasing spring 43 is adapted to abut against a shoulder member 47 welded or otherwise rigidly affixed to the contact member 39, and in addition to providing a means for transmitting the biasing force of the spring 43 to the contact member 39, this shoulder serves to define the limit of the downward motion of that member within the insulating guide means 41 therefor.

The latch 33 which is utilized for holding the breaker in the closed circuit position is shown particularly in Fig. 4 and comprises a rectangular metallic member having a suitably proportioned slot 49 formed therein for engaging the restricted portion 27 of the plunger rod 21, two openings 51 for accommodating the screws 53 which affix an armature 55 thereto, and a cutout portion 57 for engaging the movable end of the bimetallic trip element 59 which forms a part of the electroresponsive means 37. An insulating insert 58 disposed in the opening 57 serves to insulate the bimetal element 59 from the latch 33. The latch member 33 is adapted to slide upon a pair of suitable guides 61 which are formed integral with the main housing 5, the

guide member 41 for the contact 39 serving to hold the latch from movement in an upward direction. The latch is biased toward the latched position by a compression spring 63, one end of which engages a suitable recess 65 formed therein and the other end of which engages a spring retaining member 67 which is screwed into a suitable opening in the housing 5. By utilizing a threaded retaining member the tension of the spring 63 may be readily adjusted to any desired value.

For causing the latch 33 to release the plunger 21 upon the occurrence of predetermined conditions, I provide a thermally responsive and a magnetically responsive trip element. The thermally responsive element comprises the above mentioned U-shaped member 59 of bimetallic material which is shown particularly in Fig. 3. The member 59 includes a pair of bent feet 69 and a downwardly projecting portion 71 for engaging the latch and is supported upon the insulating disc 45 disposed at the upper end of the housing 5. In order that the operation of the element shall be responsive to the current flow in the controlled circuit it is electrically connected in series with the electrical circuit through the cutout by means of a pair of leads 73 and 75, one of which (73) extends from the cap member 9 to one of the feet and the other of which (75) extends from the other foot to the plate 47 affixed to movable contact member 39.

The magnetically responsive element includes an E-shaped core member 77 of magnetic material which is supported on the side portion of the housing 5 by a pair of stud bolts 79 and the armature 55 which is rigidly affixed to the movable latch member 33. As is shown particularly in Fig. 3, the U-shaped bimetallic element 59 is looped about the central portion of the E-shaped core 77, and thus serves both as a release member for the latch 33 and as an energizing coil for the magnetically responsive element. The movement of the armature 55 toward the E-shaped attracting core 77 therefor is opposed by the spring 63 which biases the latch to the latched position.

The cutout is shown in Figs. 1, 2, and 9 in the closed circuit position. Upon the occurrence of a large magnitude overload the core 77 of the magnetic responsive element is energized sufficiently to cause the cooperating armature 55 to be attracted thereto, this movement taking place substantially instantaneously following the occurrence of the overload. The latch member 33 is moved with the armature 55 and thereby releases the upper end of the plunger 21 so as to allow that member to be moved downwardly under the combined biasing action of the contact pressure securing spring 43 and its own weight. The arc which is incident to the opening of the circuit controlled by the device is drawn within the arc passage 3.

Once the plunger means 7 has been released by the latch 33, it is free to move entirely without the arc passage 3, the walls of which are defined by the main tube 1. The arc which is drawn within the arc passage contacts the lining of the passage and causes the evolution therefrom of a very considerable quantity of arc extinguishing gas, the pressure of which aids in accelerating the downward movement of the plunger member. As soon as the upper end of the plunger disengages the tube, the lower end of the arc passage is open to the atmosphere and the expulsive blast of outflowing arc extinguish-

ing gas which results from the decomposition of the lining of the arc passage results in the rapid extinction of that arc. This usually takes place within a few alternations of the alternating current circuit.

As soon as the plunger means 7 has moved without the arc passage 3, it is free to move under its own weight as far as the flexible conductor 29 connecting the plunger means with the associated equipment will permit. An air gap is thus introduced into the circuit through the cutout and the opening of the controlled circuit is thereby made more positive. In addition, the disengaging of the tubular means 1 by the plunger serves to indicate that the cutout has functioned.

To reclose the breaker following a circuit opening operation, it is necessary merely to support the plunger means 7 upon a suitable operating member, to reinsert the upper end thereof in the lower end of the main tube 1, and to then push the plunger means to the normal closed circuit position, this movement being preferably accomplished with a quick motion of the operating member in order to facilitate the reengaging of the latch 33 by the restricted upper portion 27 of the plunger. If desired, the reclosing may be effected by removing the main housing and the tube 1 from the line, the plunger reinserted into the tube and then replacing the entire structure on the line conductor. Either operation is comparatively simple, and may be accomplished with much less work and with much less danger to the maintenance operator than the servicing of an expulsion fuse wherein the entire expulsion fuse tube must be removed from the circuit, usually by a lineman who climbs the pole. With applicant's device, the restoration to an operative condition may be accomplished from the ground.

The circuit opening operations which are produced as a result of the operation of the bimetallic element 59 differ in no way from the above described operation. Upon the occurrence of an overload which persists for a definite predetermined period of time, the bimetallic element 59 will warp sufficiently to cause the latch 33 to be moved to the unlatched position, thereby releasing the plunger means 7 which will immediately move to the open circuit position. The operation of the cutout in response to the actuation of the bimetallic element takes place after a considerably greater period of time than the operation of an expulsion fuse and can be much more accurately calibrated. Thus, it is possible to so design the bimetallic release element for use in the above described apparatus that the circuit opening operation will take place upon the occurrence of low magnitude overloads only when those overloads have persisted for a very substantial period of time. This assures that the troublesome discontinuities of service following the occurrence of transient conditions which have proved so troublesome with expulsion fuse devices are entirely eliminated. At the same time, the magnetically responsive element which is actuable to cause the operation of the cutout substantially instantaneously upon the occurrence of serious short circuit or other fault conditions assures adequate protection of the controlled equipment at all times.

In some installations it may be desirable to restrain the moving plunger 21 from entirely disengaging the main tube 1 and its associated housing 5 during the final stages of the circuit

opening operation. Any suitable latch or motion limiting means may be utilized for this purpose, but to assure a good arc extinguishing action it is highly desirable that vent openings of considerable area shall be caused to exist in the lower end of the tube when the plunger means 7 is in the open circuit position.

In the foregoing, I have described the structural details of an expulsion cutout which is particularly suitable for use in those installations wherein expulsion fuses are now being utilized. My improved cutout device is not substantially more expensive than an expulsion fuse, it has equally high arc interrupting capacity, and is quite as reliable in operation. In addition, however, my improved expulsion cutout device may be readily re-closed following each circuit opening operation and it includes means for accurately distinguishing between transient overload conditions and prolonged overload conditions. This improved operation is made possible primarily through the provision of a bimetallic thermally responsive means for controlling the operation of the arc drawing portion of the interrupter, and this element, in combination with the magnetically responsive means which I have disclosed, makes possible a device which has a much greater range of satisfactory operation than any expulsion fuse or similar equipment heretofore known to the art.

By making the cutout reclosable, the servicing of the apparatus is simplified, and in addition the resultant structure may be utilized in applications which heretofore required the use of an oil breaker or other device which could be readily moved to open or to close the electrical circuit therethrough, the equally high arc extinguishing capacity of the device of my invention, as compared with an oil breaker, and its much lower cost, being, of course, highly advantageous.

While in accordance with the patent statutes I have disclosed the details of one preferred embodiment of my invention, it is to be understood that many of these details are merely illustrative and that various modifications of their precise form will be both necessary and desirable in certain instances. I desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction, and that my invention shall be limited only by what is expressly stated therein and by the prior art.

I claim as my invention:

1. In an expulsion circuit interrupter, means of solid insulating material for defining the walls of an arc passage, means for closing one end of said arc passage, the other end of said passage being open at least during the circuit opening operation, a contact movable through said arc passage to open and to close the electrical circuit through said interrupter and to establish the arc incident to each opening operation therein, means biasing said contact for movement through said arc passage to an open circuit position, and means including an indestructible, resettable electro-responsive latch means for latching said contact in the closed circuit position against the force of said biasing means, said latch means being operable to release said contact upon the occurrence of predetermined electrical conditions which persist for a predetermined period of time, and being automatically operable to relatch said contact in the closed circuit position when said

contact is moved through said arc passage from said open circuit position to said closed circuit position.

2. In an expulsion circuit interrupter, means for defining the walls of an arc passage, means for closing one end of said arc passage, the other end of said passage being open at least during the circuit opening operation, at least a portion of said arc passage being lined with a solid material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, a contact movable through said arc passage to open and to close the electrical circuit through said interrupter and to establish the arc incident to each opening operation of said interrupter therein, means biasing said contact for movement through said arc passage to an open circuit position, and an electro-responsive latch means for latching said contact in the closed circuit position against the force of said biasing means, said latch means being operable to effect the release of said contact following the occurrence of predetermined electrical conditions which persist for a predetermined period of time, and including means for automatically resetting itself following each operation thereof, in order that said contact shall be relatched in the closed circuit position when said contact is moved through said arc passage from said open circuit position to the normal closed circuit position.

3. In a reclosable, expulsion type circuit interrupter, tubular means of a solid insulating material for defining the walls of an arc passage, means for closing one end of said arc passage, the other end of said passage being open at least during the circuit opening operation, a stationary contact means disposed adjacent said closed end, a cooperating contact comprising a rigid rod member movable through said open end during the circuit closing operation to engage said conducting means in order to complete the electrical circuit through said interrupter and movable through said arc passage, away from said closed end, to open the electrical circuit through said interrupter and to establish the arc incident thereto within said arc passage, said tubular means being so positioned that said movable contact means is biased toward the open circuit position by its own weight, and an electro-responsive latch means restraining said movable contact means in the closed circuit position except upon the occurrence of predetermined conditions, said movable contact moving entirely without said tubular means during each opening operation of said interrupter, in order to introduce an air gap into the electrical circuit through said interrupter, said latch means being automatically operable to relatch said movable contact in the closed circuit position when said contact is moved through said arc passage from the open circuit position to the closed circuit position during each reclosing operation of said interrupter.

4. In a reclosable, expulsion type circuit interrupter, tubular means of solid insulating material for defining the walls of an arc passage, means for closing one end of said arc passage, the other end of said passage being open at least during the circuit opening operation, a stationary contact means disposed adjacent said closed end, a cooperating contact comprising a rigid plunger member movable through said open end during the circuit closing operation to engage said conducting means in order to complete the electrical

circuit through said interrupter, and movable through said arc passage, away from said closed end, to open the electrical circuit through said interrupter and to establish the arc incident thereto within said arc passage, means biasing said movable plunger contact toward the open circuit position, and an electro-responsive latch means for restraining said contact from movement under the biasing action of said biasing means, said plunger member moving entirely without said tubular means when moving to the open circuit position in order to introduce an air gap in the circuit controlled by said interrupter, said electro-responsive latch means, including means operable upon the occurrence of at least two sets of predetermined electrical conditions to cause said latch means to release said plunger contact, and being automatically operable to relatch said plunger contact in the closed circuit position during each reclosing operation of said interrupter.

5. In a reclosable, expulsion type circuit interrupter, tubular means for defining the walls of an arc passage at least a portion of said passage being lined with a solid material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, means for closing one end of said arc passage, the other end of said passage being open, at least during the arc extinguishing operation, to provide a vent for the arc extinguishing gas which is then evolved from said lining, a stationary contact means disposed adjacent said closed end, a co-operating contact means including a plunger member movable through said open end during the circuit closing operation to engage said conducting means in order to complete the electrical circuit through said interrupter and movable through said arc passage, away from said closed end to open the electrical circuit through said interrupter and to establish the arc incident thereto within said arc passage, means biasing said movable contact means toward the open circuit position, latch means for restraining said contact means from movement under the biasing action of said biasing means, and a current-carrying electro-responsive means operable upon the occurrence of predetermined conditions to effect the release of said latch, said conducting means moving entirely without said tubular means when moving to the open circuit position in order to introduce an air gap in the circuit controlled by said interrupter, said latch means being automatically operable to relatch said movable contact in the closed circuit position when said contact is moved through said arc passage from the open circuit position to the closed circuit position during each reclosing operation of said interrupter.

6. In an expulsion type circuit interrupter, a means of a solid material for defining the walls of an arc passage, means for closing one end of said arc passage at least during the arc extinguishing operation, rigid contact means of conducting material movable through said arc passage to establish an arc therein during the circuit opening operation, means for biasing said contact means toward the open circuit position, releasable latch means adapted to directly engage said contact means in order to hold that means in the closed circuit position against said biasing means, a thermally responsive means which is operable after a predetermined substantial time delay following the occurrence of certain predetermined conditions to effect the release of said latch means, and a magnetically

responsive means which is operable, substantially instantaneously, following the occurrence of certain other predetermined conditions to effect the release of said latch means, said contact means being movable through said arc passage from the open circuit to the normal closed circuit position thereof to effect the reclosing of said interrupter, said latch means automatically relatching said conducting means in the closed circuit position during each reclosing operation.

7. In a reclosable, expulsion type circuit interrupter, a tubular means of solid material for defining the walls of an arc passage, a housing affixed to the upper end of said tubular means, a plunger contact movable through said arc passage to open and to close the electrical circuit through said interrupter, means associated with said housing for engaging one of the conductors of an electrical transmission circuit in such manner that said interrupter shall be entirely supported thereon, said plunger contact being freely movable through said arc passage and being biased to the open circuit position by its own weight, latch means disposed within said housing for releasably restraining said plunger in the closed circuit position, and resettable electro-responsive means likewise disposed within said housing for effecting the release of said plunger upon the occurrence of predetermined conditions, said latch means being automatically operable to relatch said plunger contact in the closed circuit position when said contact is moved through said arc passage from the open circuit position to the closed circuit position during each reclosing operation of said interrupter.

8. In a reclosable, expulsion type circuit interrupter, a rigid tubular means for defining the walls of an arc passage, at least a portion of said passage being lined with a solid material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, a substantially completely enclosed housing means affixed to the upper end of said tubular means, said housing closing the upper end of said arc passage, the lower end of said passage being open, at least during the arc extinguishing operation, a plunger contact movable through said arc passage to open and to close the electrical circuit through said interrupter means associated with said housing for engaging one of the conductors of an electrical transmission circuit in such manner that said interrupter shall be entirely supported thereon, said plunger contact being freely movable through said arc passage and being biased to the open circuit position by its own weight, latch means disposed within said housing for releasably restraining said plunger in the closed circuit position, and a current-carrying bimetallic means likewise disposed within said housing for affecting the release of said plunger upon the occurrence of predetermined conditions, said latch means being automatically operable to relatch said plunger contact in the closed circuit position when said contact is moved through said arc passage from the open circuit position to the closed circuit position during each reclosing operation of said interrupter.

9. In a reclosable, expulsion type circuit interrupter, a rigid tubular means for defining the walls of an arc passage, at least a portion of said passage being lined with a solid material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, a

substantially completely enclosed housing means affixed to the upper end of said tubular means, said housing closing the upper end of said arc passage, the lower end of said passage being open at least during the arc extinguishing operation, a stationary contact assemblage disposed within said housing, a cooperating plunger contact movable longitudinally through said arc passage to open and to close the electrical circuit through said interrupter and to establish the arc incident to each opening operation therein, clamp means associated with said housing for engaging one of the conductors of an electrical transmission circuit in such manner that said interrupter shall be entirely supported thereon, said plunger contact being freely movable through said arc passage during the operation of said interrupter, means biasing said plunger to the open circuit position, latch means disposed within said housing for restraining said plunger against movement under the action of said biasing means, and electro-responsive means likewise disposed with said plunger for effecting the release of said latch upon the occurrence of predetermined conditions, said electro-responsive means including a current-carrying bimetallic element which is connected into current responsive relationship with the circuit controlled by said interrupter, said latch means being automatically operable to relatch said plunger contact in the closed circuit position when said contact is moved through said arc passage from the closed circuit position to the open circuit position during each reclosing operation of said interrupter.

10. In a reclosable, expulsion type circuit interrupter, means of solid insulating material for defining the walls of an arc passage having a length at least several times its greatest cross sectional dimension, a contact comprising a rigid rod member movable longitudinally within said arc passage to open and to close the electrical circuit through said interrupter, means biasing said rod member to the open circuit position thereof, electro-responsive latch means which directly engages said contact member so as to hold that member in the closed circuit position and which is operable upon the occurrence of predetermined conditions to disengage said contact member and permit that member to be moved to the open circuit position by said biasing means, said contact member being adapted to be moved entirely without said arc passage during each operation of said interrupter, the several cooperating structural features of said interrupter being so arranged and so correlated that said rod member may be reinserted into said arc passage and moved therein to the closed circuit position following each opening operation of said interrupter, said latching means being automatically operable to relatch said contact in the closed circuit position during each reclosing operation of said interrupter.

11. In a reclosable, expulsion type circuit interrupter, means of solid insulating material for defining the walls of an arc passage having a length at least several times its greatest cross sectional width at least a portion of said wall defining means being formed of an insulating material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, a contact, comprising a rigid rod member of only slightly less cross sectional area than the cross sectional area of said arc pas-

sage, movable within said arc passage to open and to close the electrical circuit through said interrupter, means biasing said rod member to the open circuit position, electro-responsive latch means which directly engages said rod member so as to hold that member in the closed circuit position and which is operable upon the occurrence of predetermined electrical conditions to disengage said rod member and permit that member to be moved to the open circuit position by said biasing means, said rod member being moved entirely without said arc passage during each opening operation of said interrupter and being reinserted into said arc passage and moved longitudinally therein during each reclosing operation of said interrupter, said latch means being automatically operable during each reclosing operation of said interrupter to relatch said rod member in the normal closed circuit position thereof.

12. In a reclosable, expulsion type circuit interrupter, tubular means of solid insulating material for defining the walls of a substantially cylindrical arc passage which has a length at least several times its diameter, at least a portion of said wall defining means being formed of an insulated material which is capable of evolving an arc extinguishing gas when placed in proximity to an electric arc, a contact, comprising a rigid cylindrical rod member of only slightly less cross sectional area than the cross sectional area of said arc passage, movable within said passage to open and to close the electrical circuit through said interrupter and to establish the arc incident to each opening operation thereof within said passage, means biasing said rod member to the open circuit position, a latch which directly engages said rod member so as to hold that member in the closed circuit position, and electro-responsive means operable upon the occurrence of predetermined conditions to cause said latch to disengage said rod member and permit that member to be moved to the open circuit position by said biasing means, said rod member being moved entirely without said arc passage during each opening operation into said arc passage and being reinserted into said arc passage and moved longitudinally therein to the closed circuit position during each reclosing operation of said interrupter, said latch means being automatically operable during the reclosing of said interrupter to relatch said rod member in the normal closed circuit position thereof.

13. In a reclosable, expulsion type circuit interrupter, means of solid insulating material for defining the walls of an arc passage having a length at least several times its greatest cross sectional dimension, a contact member comprising a relatively heavy rod of conducting material movable within said arc passage to open and to close the electrical circuit through said interrupter, means for mounting said interrupter in a vertical position in order that said contact rod shall be biased to the open circuit position by its own weight, and electro-responsive latch means which directly engages said rod member so as to hold that member in the closed circuit position and which is operable upon the occurrence of predetermined conditions to release said rod member and thereby permit that member to move to the open circuit position, said rod member moving entirely without said arc passage during each opening operation of said interrupter in order to introduce an air-gap into the elec-

trical circuit therethrough and being adapted to be reinserted into said arc passage and moved longitudinally therein to the closed circuit position during each reclosing operation of said interrupter, said latch means being automatically operable to relatch said rod member in the closed circuit position during each reclosing operation of said interrupter.

14. In an electro-responsive device, a member supported for slidable movement from a normal inoperative to an operative position to effect the operation of said device, a thermally responsive member of bimetallic material adapted to directly engage said slidable member and to move that member from said inoperative to said operative position upon the occurrence of predetermined electrical conditions, an armature rigidly affixed to said slidable member, and means for attracting said armature to effect the movement of said slidable member from said inoper-

ative to said operative position upon the occurrence of other predetermined conditions.

15. In an electro-responsive device, a member supported for slidable movement from a normal inoperative to an operative position to effect the operation of said device, a looped, current-carrying element of bimetallic material adapted to directly engage said slidable member to move said member from said inoperative to said operative position upon the occurrence of predetermined conditions, an armature rigidly affixed to said slidable member and a core means for attracting said armature to effect the movement of said slidable member to said operative position upon the occurrence of other predetermined conditions, said bimetallic element being looped about at least a portion of said core means in order that it shall serve as the energizing coil therefor.

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