This invention relates to improvements in circuit interrupters of the excess-voltage protective type and has to do especially with an auxiliary device operative to interrupt a ground circuit wherein an arc is established when the device is subjected to voltages in excess of normal.

A common type of excess-voltage protective device now in use comprises an arc-gap-in-series with a mass of so-called valve material, such as comminuted silicon carbide. Such a device is designed to be connected between an electric transmission line and ground and carries no current except when subjected to a potential surge of predetermined magnitude, in excess of the normal line voltage. When the gap is broken down in response to abnormal voltage, current flows from the line, across the gap, and thence through the valve material to ground. It is the function of the valve material to interpose high resistance in the ground path to the flow of current therein at normal line voltages, thereby causing the arc to be extinguished immediately following each high voltage surge—thus promptly restoring the ordinarily non-conducting ground path to normal.

Frequently, excess-voltage devices of this character become ineptive to interrupt the flow of current to ground because of the valve material and gap having become damaged by the surge current. This normally causes the automatic circuit breakers to operate; or, if the excess voltage device is so far from the circuit breaker that line resistance precludes the breaker from operating, line current will continue to flow to ground and seriously affect transmission of current to the customers.

It has previously been proposed to incorporate in an excess-voltage device of the kind here dealt with, a relatively large mass of fusible material which is intended to melt in response to a continued flow of current for a sufficient period of time. If the location of such an-arrester is such that the current flow is sufficient, the circuit breaker may kick out before the melting temperature is reached; and that gives rise to a locked out line with no indication at the excess-voltage protective device that the trouble is present therein.

More recently there was developed an auxiliary device which is the subject matter of the pending application of Ralph H. Earle, Serial No. 269,985, filed April 21, 1939, now Patent 2,315,520, issued March 30, 1943, which functions by means of an arc-responsive explosive cap to disconnect the ground lead from an excess-voltage protective device and thereby opens the ground circuit. The Earle device is effective and operates under all circumstances before a circuit breaker will open and before a section fuse will blow; but it is possible in some cases where the Earle device is used, for the arc to persist between the protective device and the ground lead, because there is not included any arc extinguishing means.

Accordingly, it is the primary object of the present invention to provide, in combination with an excess-voltage protective device, an auxiliary circuit interrupter which will not only introduce an extended gap in a ground circuit through the device, but which will operate to extinguish an arc across the extended gap irrespective of the operation of an automatic circuit breaker in the line.

A further object is to provide an auxiliary circuit interrupter which, in its normal state, does not include a gap and which, therefore, does not entail the necessity of modifying the gap spacing within the arrester to compensate for gap space introduced exteriorly thereof—thus rendering it practicable to employ arrester construction which is suitably proportioned for use without the auxiliary interrupter, in case it may temporarily be necessary to short out or omit the auxiliary arrester.

Another object is to provide an auxiliary circuit interrupter which gives a visual indication of having operated, which can easily and quickly be attached to an excess-voltage protective device, and which is comparatively inexpensive to manufacture and maintain.

In the drawing which accompanies this specification:

Fig. 1 is a vertical sectional view of a combined excess-voltage protective device and auxiliary circuit interrupter;

Fig. 2 is an enlarged elevational view, partly in section, of a replaceable fuse-link which forms a part of the auxiliary circuit interrupter of Fig. 1, and;

Fig. 3 is an illustration of the manner in which the combined protective device and auxiliary interrupter can conveniently be mounted on a transmission line pole.

The respective parts in each instance are identified throughout the several views by corresponding reference numerals.

The excess-voltage protective device, per se, comprises, as major components, a housing 1, cap 2, multiple arc gap 3, resistor or valve ele-
ment 4, upper valve electrode 5 and lower valve electrode 6.

The housing 1 and cap 2 may be of either porcelain or glass or, in fact, any suitable dielectric material; and the whole assembly is hermetically sealed to the housing to exclude moisture from the interior thereof. The multipole arc gap 3 is a conventional element consisting usually of several cylindrical electrodes 7 spaced apart in vertical alignment and supported on a pair of non-conductive standoffs 8. Valve element 4 is usually a mass of granular silicon carbide, either loose or bonded into a rigid block by means of a binder of sodium silicate intermixed with the carbide and rendered desiccate by baking; and the mass of carbide, if bonded into a rigid block, may also be bonded to the housing as described in the pending application of Herman O. Stoeling, Serial No. 351,366, filed August 4, 1940, now Patent 2,305,577, issued December 15, 1942.

A lead-in conductor 9 is connected at one end to the upper terminal of the multipole arc gap and at its other end is connected to a power line, not shown.

In the absence of an auxiliary circuit interrupting device, lower valve electrode 6 would be connected directly to ground; but in the structure illustrated there is inserted in the ground connection, in series with the protective device, an auxiliary circuit-interrupting device in the form of an expulsion fuse which is identified as a whole by reference numeral 10.

The expulsion fuse is detachably connected directly to the arrester and, as shown, is dependently thereof; and it comprises, as principal components, a terminal member 11, a tubular fuse cartridge 12, and a fuse-link 13.

A nut 14 serves to clamp lower valve electrode 6 in place while at the same time providing an internal thread at 14a to which is detachably secured the correspondingly threaded upper end of terminal member 11.

Fuse cartridge 12 is generally of thick-walled, hard fibre tubing but may, alternatively, be made of Bakelite or other strong dielectric material lined with fibre—such being common practice in the fuse art. The upper end of the cartridge is threaded for securement to the terminal member and to facilitate removal and replacement of fuse-link 13.

The fuse-link, which preferably is a standard replacement item, is shown in detail in Fig. 2. It comprises a relatively thin-walled, hard fibre tube 15, a terminal element 16 having a buttonhead contact 17, a fusible wire 18, a strain wire 19, a rod 20, a tension spring 21, a collar 22, a sleeve 23, and a flexible leader 24.

Fusible wire 18 and strain wire 19 interconnect terminal elements with rod 20 and are disposed within the bore of tube 15.

Collar 22 abuts the lower end of tube 15 and is threaded internally to provide an anchorage for the lower end of spring 21. The latter is normally tensioned and is secured to the upper end of rod 20, which latter is slidable downwardly when released, but is normally supported in the position shown by strain wire 19, against the tension of spring 21. Sleeve 23 serves to interconnect the lower end of rod 20 with the upper end of flexible leader 24.

The fusible wire 18 and strain wire function as fusible elements. When the former blows the additional current load thereby imposed upon the strain wire causes it to yield also. Instantly upon severance of the fusible section, rod 20 is released and is projected downwardly by spring 21 so as quickly to lengthen the arc gap and thereby definitely to interrupt the ground current. The whole assembly, comprising rod 20, spring 21, collar 22, and sleeve 23, is expelled downwardly out of tube 15 both by the action of the spring and the force of the explosion which occurs within the tube.

Upon rupture of the fusible section an arc is established between the arrester assembly, comprising rod 20, spring 21, collar 22, and sleeve 23, is expelled downwardly out of tube 15 both by the action of the spring and the force of the explosion which occurs within the tube.

In normal operation the excess-voltage device will permit high potential surges to pass freely to ground while operating instantly to obstruct the flow of follow current to ground—thus serving to prevent short circuits and consequent outages. And the fuse-link is so proportioned that it will carry any ordinary surge current, but will blow out if subjected to a current of greater magnitude or a substantial current of extended duration.

A surge of current through the excess-voltage device and fuse due to a lightning discharge is of extremely short duration, and even if the current is quite high for an instant, the fuse-link will be capable of handling it whereas it would blow out on a lesser current of longer duration.

If instead of operating normally, the valve element 4 fails, as by a flashover between it and the housing or by the formation of a clinker chain bridging electrodes 5 and 6, the follow-current will not be interrupted but instead will maintain the arc across the gap—once the arc has been established by the surge; and the follow-current thus finding its way to ground via the fuse will cause the fuse to blow. Blowing of the fuse causes rod 21 to be expelled downwardly and out of tube 15 and cartridge 21 and the resultant arc is quickly extinguished—all of which usually transpires within a fraction of a second after the arrester fails and generally within one or two follow-current cycles.

As a rule, the excess voltage device will have failed before the fuse blows, and in that event it would act on the tube with the rod 20 which, but there may be cases where a fuse will blow in the surge current without the arrester being impaired and in that event the fuse-link can be replaced without removing the arrester from its mounting. If the arrester housing is of glass, the lineman can tell from visual inspection whether the valve element is impaired, and if he finds that it is not impaired he merely will replace the fuse-link. With a porcelain housed arrester it would not be possible for the lineman to ascertain the condition of the arrester unless the housing is removed.

It will be self-evident that the structure illustrated is extremely simple and inexpensive; and the fuse type isolator or auxiliary circuit interrupter is capable of being so constructed that it can be substituted in place of the isolator described in the aforementioned Earle Patent 2,315,350.

In Fig. 3 the arrester is shown mounted on a cross-arm 25 of a pole 26—a suitable clamp 27 being used to secure the arrester housing to the cross-arm. A ground wire 28 is shown attached to a connector 29 to which is also connected flexible leader 24.

What is claimed is:

The combination with an excess-voltage pro-
tective device comprising a housing and an arc

gap and valve element within said housing, of
an expulsion fuse detachably connected to and
depending from and supported by said housing,
said fuse being in series with said arc gap and
valve element and included in a connection be-
tween said device and ground, said fuse includ-
ing a vertical tubular expulsion cartridge, a ter-
minal member attached to the upper end of said
cartridge and serving to detachably connect said
cartridge with the arrester and to support said
cartridge, and a fuse-link disposed within said
cartridge, said fuse-link having a button-head
contact secured between said terminal member
and the upper end of said cartridge, said fuse-
link having a flexible leader hanging downwardly
therefrom and adapted for connection to ground.

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