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EXCESS-VOLTAGE PROTECTIVE STRUCTURE FOR OVERHEAD CONDUCTORS

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Fig. 1

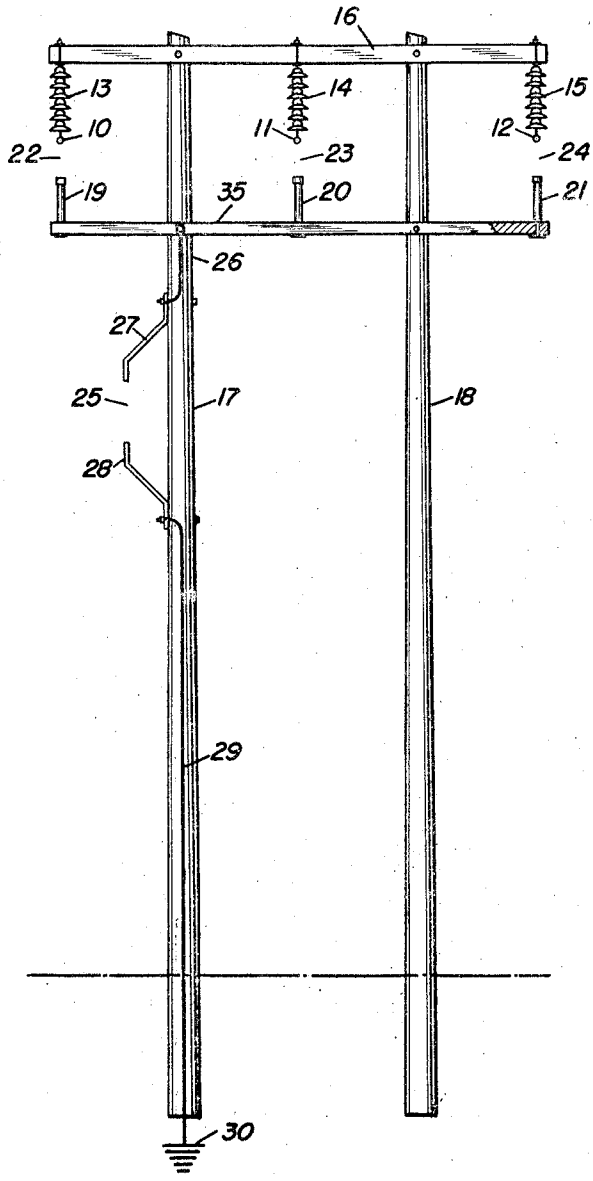
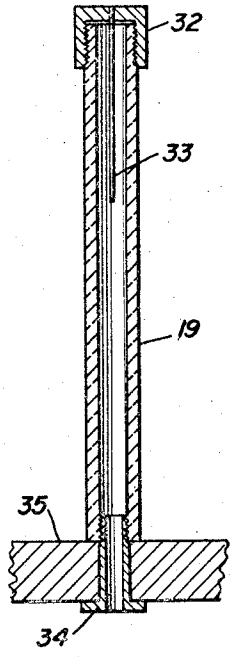


Fig. 2



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EXCESS-VOLTAGE PROTECTIVE STRUCTURE FOR OVERHEAD CONDUCTORS

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4 Claims. (Cl. 175—30)

An object of the present invention is to provide means for protecting from the effects of lightning two or more overhead conductors each of which normally operates at a potential differing from that of all of the others, through the use of an arrangement such that discharge of excess voltage occurs first between conductors differing in potential before any discharge occurs from any conductor to ground. Other objects will be in part obvious and in part pointed out hereinafter.

The invention comprises the elements and combinations thereof, features of construction, and arrangement of parts to be exemplified in the description to follow, and the scope of the invention will be indicated in the accompanying claims.

In the drawing: Fig. 1 illustrates one embodiment of the invention, shown as a front elevational view of a power transmission line supporting structure; and Fig. 2 is a sectional view of the simple and well known type of arc interrupter which is embodied in the construction.

In the application to transmission lines of the simplest types of arc interrupters, such as that illustrated, it has long been recognized that the current passing through an arc interrupter following breakdown from one phase conductor to another phase conductor may differ greatly from that passing through the same arc interrupter at another time from any phase conductor to ground; also that the current from any phase conductor to ground at one structure may differ greatly from that at another structure at a different location, since the phase to phase current is independent of ground, and, in comparison to the phase to ground currents which may occur along a transmission line, is relatively constant.

Further, the application of such arc interrupters as are here considered to three phase transmission lines normally operated without grounded neutral has not been heretofore successfully accomplished, for the reason that the line to ground current from a single conductor is only that due to the unbalanced capacitance of the conductors, and in comparison to the phase to phase fault current, is a very small fractional part.

Arc interrupters such as that illustrated, having a definite spacing of internal electrodes and a fixed internal diameter, function best at only a single value of current at a definite voltage, and while satisfactory operation may be obtained over a range of current values, such a range is necessarily limited by the inherent characteristics of the device. For a fixed electrode spacing, a large bore tube will fail to extinguish a small current arc, being effective only on relatively greater currents, while a relatively smaller bore tube may be exploded by a high current readily discharged by a larger bore tube without damage.

Various schemes have been suggested in the attempt to compensate for the limitations of the arc interrupters as described above. One such scheme is to modify the grounding construction so that each structure has the same ground resistance, and so that the value of the ground resistance is such that line to ground currents will always be substantially the same as phase to phase currents. Obviously such a construction may be quite expensive if possible, and may be impossible of attainment, depending upon the type of soil traversed by the transmission line. Another scheme advocated is the insertion of an additional arc interrupter in a common ground lead, this interrupter to have a smaller bore than the others. This scheme is objectionable because of the differing ground resistances likely to be encountered at the spaced structures. A third scheme, and the only one heretofore believed effective, is to provide another design of arc interrupter which will discharge and extinguish an extremely wide range of follow currents, this scheme being undesirable only from the standpoint of additional cost above that of the simple form illustrated.

From the foregoing remarks, it may be noted that a simple construction, which will assure passage of the relatively constant phase to phase currents through the interrupters whenever operation thereof occurs, will eliminate the effect of widely varying ground resistance, and will provide a solution to the problem.

The manner in which my invention meets the requirements stated will be clear from the following description.

Referring to the drawing, Fig. 1 illustrates a widely used transmission line structure, comprising the upright wood poles 17 and 18, the wood cross arm 16, and the three suspended insulator strings 13, 14 and 15, which respectively support from the cross arm the spaced conductors 10, 11 and 12. Below the conductors 10, 11 and 12, and substantially parallel to the wood cross arm 16, a metal cross arm 35, which may be a steel member of angle section, is supported by the poles 17 and 18. To the arm 35 is secured the arc interrupters 19, 20 and 21, which extend upwardly therefrom toward and in spaced relation respectively to the conductors 10, 11 and 12,

the air gaps so provided being indicated respectively at 22, 23 and 24.

Between the cross arm 35 and the ground surface, a horn gap arrangement is mounted on the pole 17, which includes the spaced opposed conducting electrodes 27 and 28, the air gap therebetween being indicated by the numeral 25. For the purpose of electrically interposing the air gap 25 between the conducting member 35 and the ground 30, the upper horn 27 is electrically connected to the former by means of the conductor 26, and the lower horn 28 electrically connected to the ground 30 by means of the conductor 29. The spacing of the electrodes 27 and 28 is such that the dielectric strength of the air gap 25 is greater than the dielectric strength of each of the paths provided through the arc interrupters from the conducting cross arm 35 and the respective conductors of the transmission line.

The arc interrupter embodied in the strueture is shown in Fig. 2, and includes a hollow tube of insulating material 31, the upper end of which is closed by means of the metal cap 32, and the lower end of which is open through the hollow metal electrode 34. The upper electrode 33 extends downwardly from the cap 32 within the hollow of the tube 31 for a sufficient distance to assure electrical breakdown within the tube 31 between the upper electrode 33 and the lower electrode 34.

From the above description, it may be noted that the arc interrupters will function at their maximum effectiveness (1) as dischargers of lightning currents and (2) as extinguishers of normal frequency follow current arcs provided phase to phase current can be assured at each operation of any arc interrupter, for the reason that such currents enable use of maximum bore of the tubes, and therefore maximum ability both with respect to surge current and to follow current.

The simple manner in which my transmission line structure functions to accomplish this result will now be explained. The construction is such that the weakest electrical path from any conductor to the metal cross arm 35 is through the associated arc interrupter, and the weakest electrical path from the metal arm 35 to ground includes the flashover control gap 25; also, as previously mentioned, the dielectric strength of the latter is greater than that from any conductor to the metal arm 35.

Assume, for the purpose of illustrating the operation of the invention, that the conductor 10 is struck by lightning when the conductors are energized at normal voltage. With respect to the superimposed voltage on the conductor 10, the metal arm 35 and the remaining conductors are at substantially ground potential. When the potential of the conductor has risen to a predetermined value above ground potential, the preferred path from the conductor 10 through the arc interrupter 19 breaks down. Since the metal cross arm 35 is insulated from ground, it closely follows the potential of the conductor 10. At this time, two paths are available from the metal cross arm 35 to points of ground potential, one through an arc interrupter to one of the remaining conductors, and the other through the flashover control gap 25 to the ground 30. Since the former path has been intentionally made the weaker of the alternate paths, the desired phase to phase path for the follow current is thereby established. It may be, and usually will be the case, that the lightning stroke is such that all three conductors become involved before the potential of the cross arm 35 rises enough above ground to flash over the horn gap 25. However this may be, it may be noticed that establishment of a phase to phase fault through the arc interrupters is accomplished.

In the event that two or more conductors are impinged by the same lightning stroke, it will be clear that at least two of the arc interrupters carry phase to phase current, and that no single interrupter can discharge to ground without first carrying phase to phase current.

It will be apparent from the foregoing that the use of the structure of the present invention will result in improved operation of transmission lines embodying arc interrupters in a simple and economical manner. It may be noted that changes and modifications may be made in the structure without departing from the scope of the invention as pointed out in the following claims, and it is intended that my description shall be regarded as illustrative rather than limiting.

I claim:

1. The combination with a wood structure having thereon insulating means supporting at least two spaced high-voltage alternating current power conductors, of conducting elements arranged to provide a preferential arc path from one of said conductors to the other, said preferential arc path including in series relation a conducting member mounted on said structure below said conductors and an arc interrupter mounted on said conducting member between said conducting member and each of said conductors and extending upwardly toward and spaced from each of said conductors, each arc interrupter including a hollow tube of insulating material having electrodes secured at the respective ends thereof, said electrodes being so related to one another as to cause sparkover therebetween to occur within the hollow of said tube and so combined with said hollow tube as to cause arc exitinguishment therein only when the current traversing the arc exceeds a predetermined magnitude, and elements constituting an open air gap of unlimited discharge ability comprising spaced conducting electrodes mounted on said structure between said conducting member and ground, the spacing of the electrodes of said open air gap being such that the dielectric strength thereof is greater than the dielectric strength of that portion of said preferential arc path from either conductor to said conducting member whereby flashover of said open air gap occurs only after flashover of said preferential arc path.

2. The combination with a wood structure having thereon insulating means supporting at least two spaced high-voltage alternating current power conductors, of conducting elements arranged to provide a preferential discharge path from one of said conductors to the other, said preferential discharge path including in series relationship an arc interrupter associated with each of said conductors and a conducting member electrically connecting said arc interrupters, said arc interrupters having ability to interrupt arcs therein when the current traversing the arc exceeds a predetermined magnitude and elements constituting an open air gap of unlimited discharge ability comprising spaced conducting electrodes mounted on said structure, the spacing of the electrodes of said open air gap being such that the dielectric strength thereof is greater than the dielectric strength of that portion of said preferential discharge path from either conductor to said conducting member, and connecting means electrically interposing said open air gap between said conducting member and ground.

3. The combination with a wood structure having thereon insulating means supporting at least two spaced high-voltage alternating current power conductors, of conducting elements arranged to provide a preferential discharge path from one of said conductors to the other, said preferential discharge path including in series relationship an arc interrupter associated with each of said conductors and a conducting member electrically connecting said arc interrupters, said arc interrupters having ability to interrupt arcs only when the current traversing the arc exceeds a predetermined number of amperes, and elements constituting a flashover control gap comprising upper and lower opposed spaced conducting electrodes mounted on said structure, the spacing of said electrodes being such that the dielectric strength of said open air gap is greater than the dielectric strength of that portion of said preferential discharge path from either conductor to said conducting member, means electrically connecting the upper electrode of said open air gap to said conducting member and means electrically connecting the lower electrode of said open air gap to ground.

4. The combination with a structure for overhead conductors comprising insulating means supporting at least two spaced high-voltage alternating current power conductors, of an arc interrupter associated with each of said conductors, said arc interrupters having ability to interrupt arcs only when the current traversing the arc is greater than a predetermined magnitude each of said arc interrupters including a hollow tube of insulating material having an upper electrode secured at the upper end of said hollow tube and a lower electrode secured at the lower end of said tube and normally insulated and spaced from said upper electrode, said electrodes being arranged to provide a preferential arc path within the hollow of said tube, means supporting said arc interrupters to provide a preferential breakdown path including a first spark gap between each conductor and the upper electrode of the associated arc interrupter and a second spark gap in series with said first spark gap between said upper and lower electrodes, means electrically connecting said lower electrodes to a common conducting member, and elements constituting an open air gap supported on said structure and connected between said common conducting member and ground, the dielectric strength of said open air gap being greater than the dielectric strength of said preferential breakdown path from either conductor to said lower electrode.

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