

[54] LIGHTNING ARRESTER

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[58] Field of Search315/36, 190; 317/69, 70

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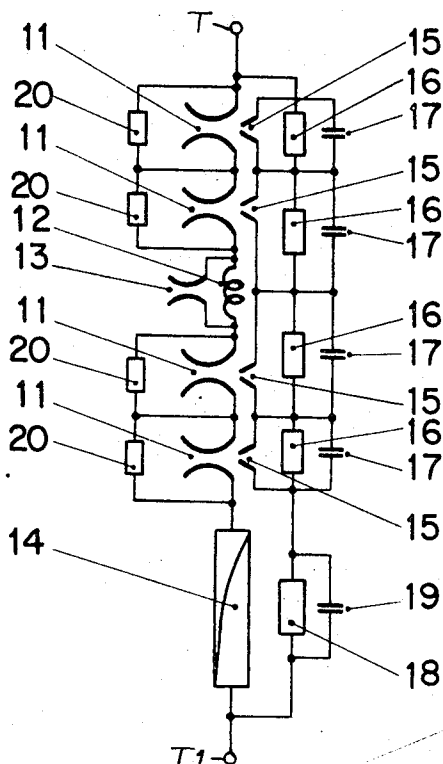
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ABSTRACT

An overvoltage arrester for use on AC or DC voltages comprises a voltage dependent leakage component connected in series with a quenching arc path constituted by a series arrangement of main spark gaps and a magnetic blowing coil for extending the arcs drawn across the main spark gaps. An auxiliary spark gap is structurally associated with and serves when struck to ignite each main spark gap and these ignition are connected in series with a first auxiliary impedance which may be an ohmic resistance to establish an auxiliary series circuit that is connected in parallel with the series circuit formed by the leakage resistance component and the main spark gaps. A second auxiliary impedance component which also may be an ohmic resistance is provided for and connected in parallel with each of the ignition spark gaps. Each of the main spark gaps may be paralleled by an auxiliary impedance component, and each of the auxiliary impedance components may be paralleled by a capacitor. The auxiliary impedance components may be lumped or they may be sub-divided and the partial impedances distributed between and in series with the main and ignition spark gaps, respectively. The string of ignition spark gaps when struck serve to ignite the string of quenching spark gaps whereupon the ignition gaps are then extinguished; the arcs struck at the quenching gaps then expand and cool and are extinguished, and the ignition gaps are then restripped to initiate a new quenching cycle. This cycle is then repeated until the discharge is finally terminated.

4 Claims, 4 Drawing Figures



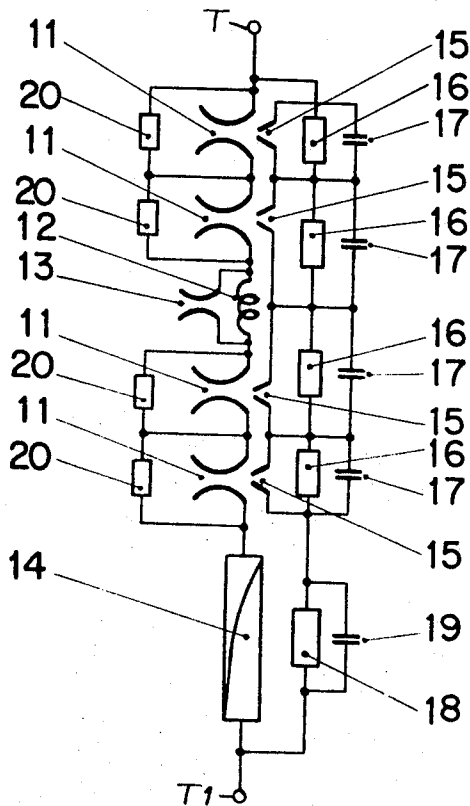
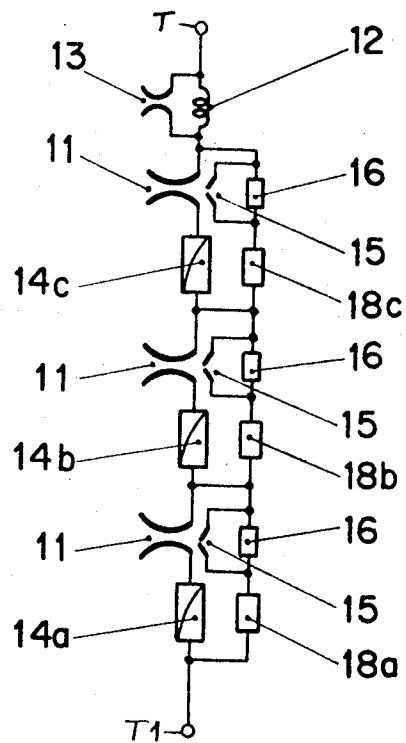


Fig. 1

Fig. 2



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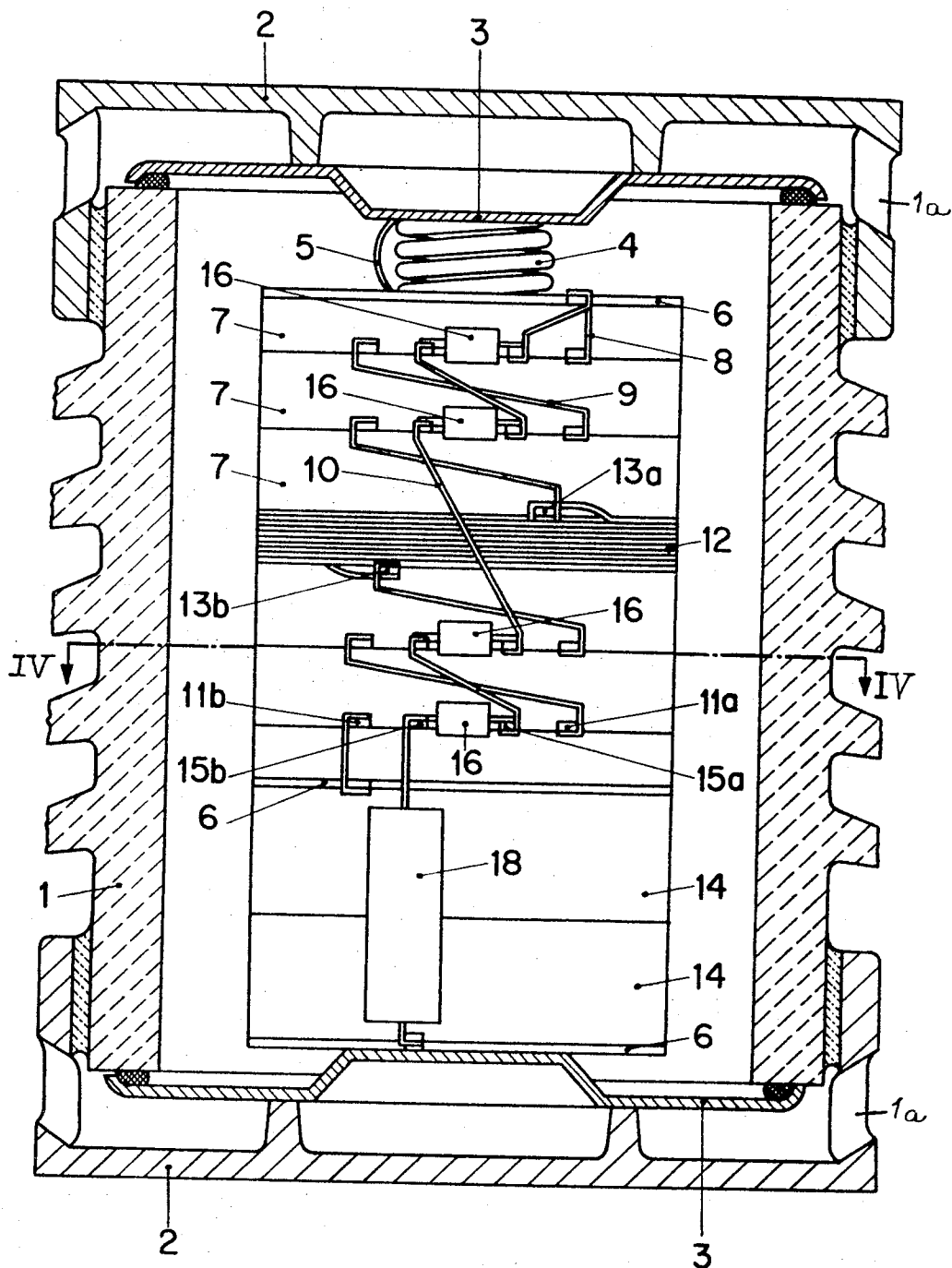


Fig. 3

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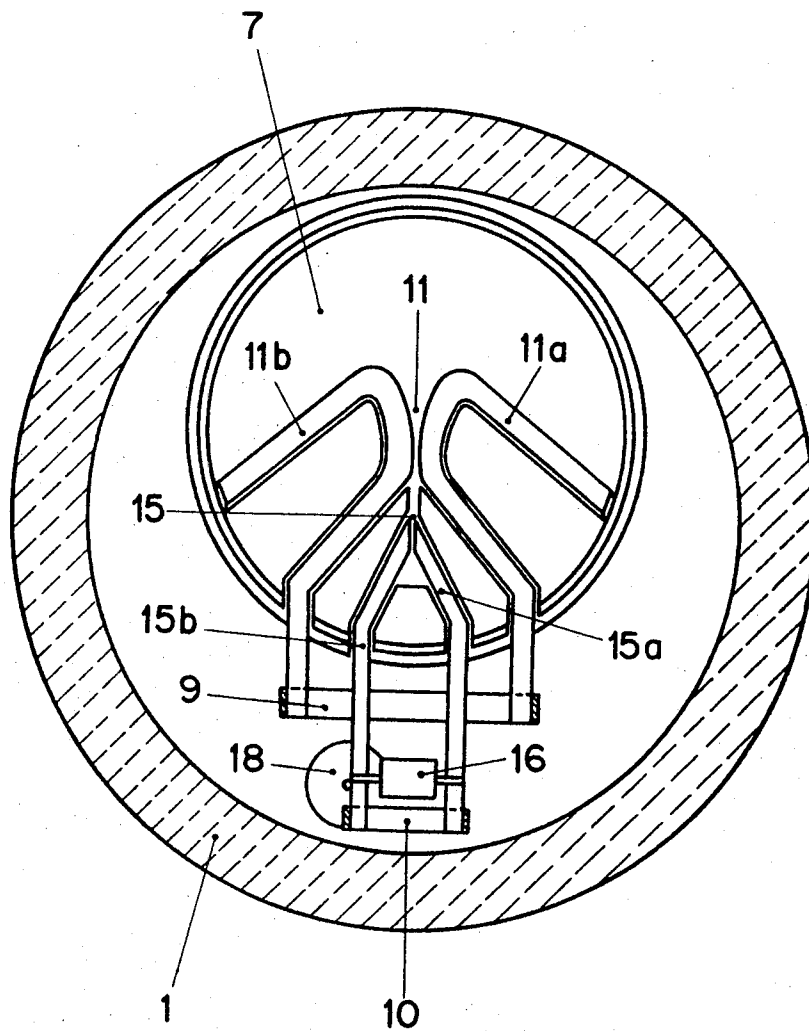


Fig. 4

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LIGHTNING ARRESTER

This invention relates to the art of over-voltage or lightening arrester constructions for use in the protection of direct or alternating current lines which include one or more voltage dependent leakage resistor components connected in series with a quenching arc path made up of a number of spark gaps connected in series, and there being a magnetic coil also connected in series with the spark gaps for producing a magnetic field which is blown upon the arcs established in the gaps for extinguishing them.

Where overvoltage arresters are connected to more or less long lines for limiting switching overvoltages, they must be capable of shunting charges in these lines. In order to absorb the energy formed during the discharge, the arresters are equipped with magnetically blown quenching spark gaps. The ensuing extension and cooling of the arc in the spark chambers results in such a rise of the arc voltage that a large part of the energy is transformed in the spark gaps. In ultra-high voltage transmissions (direct current or alternating current), the discharge currents may reach values of the order of 1,000 amperes, with discharge times of several milli-seconds, so that the arc voltage may reach a very high value during this period. However, for ultra-high voltages, the required level of protection is comparatively low. In the absence of special measures, the sum of arc voltage and voltage drop across the leakage resistance component in the arrester string may exceed the level or protection so that the arrester does not operate correctly.

The object of the present invention is to provide a simple solution for an overvoltage arrester, having a high shunt capacity and in which the arc voltage is limited irrespective of the leakage current so that the prescribed level of protection is observed. In accordance with the invention, this objective is attained by connecting in parallel with the usual series string arrangement of a main leakage resistance component and a multiplicity of main quenching spark gaps, an impedance chain which comprises an auxiliary impedance component and a multiplicity of auxiliary spark gaps connected in series, there being an auxiliary spark gap structurally associated with each of said main gaps for igniting the main gaps and an auxiliary impedance element connected in parallel with each of the auxiliary spark gaps.

The invention will be further described with reference to the accompanying drawings which illustrate representative embodiments thereof and wherein:

FIG. 1 shows in diagrammatic manner a lightning arrester which includes a quenching arc path constituted by a string of four spark gaps connected in series;

FIG. 2 is a view similar to FIG. 1 illustrating a modification in which the main leakage resistance component as well as the auxiliary impedance element are divided into a plurality of impedances distributed along the series string;

FIG. 3 is a view of an actual construction of an arrester in accordance with the invention, the view being mostly in central vertical section; and

FIG. 4 is a transverse section taken on line IV—IV of FIG. 3.

With reference now to FIG. 1, the arrester structure is seen to include a main quenching arc path made up of four spark gaps 11 connected in a series string which also includes a coil 12 energized by a current flow through the arc path that produces a magnetic field for blowing upon and stretching the arcs so as to facilitate extinction. Coil 12 is itself bridged by a spark gap 13. A voltage-dependent leakage resistance component 14 is connected in series with the string of spark gaps 11. In accordance with the invention an impedance chain which comprises an auxiliary impedance component 18 and a multiplicity of auxiliary spark gaps 15 connected in series for igniting the main spark gaps 11 is arranged in parallel across the upper and lower terminals T, T1 of the arrester i.e. in parallel with the series arrangement of the main spark gaps 11 and the main resistance 14. The distance between the electrodes of the auxiliary spark gaps 15 which are interposed between the electrodes of the main spark gaps 11 is less than

the distance between the electrodes of the main spark gaps 11. The impedance chain also includes an auxiliary impedance 16 connected in parallel with each of the auxiliary spark gaps 15. As will be later explained, an auxiliary spark gap 15 is associated with each of the main spark gaps 11. If the auxiliary impedance component 18 and the auxiliary impedances 16 are constructed as linear or voltage-dependent resistances, it may be desirable to connect a capacitor 19, 17 respectively in parallel therewith in order to control the voltage distribution. Similarly, the spark gaps 11 may be provided with parallel-connected control impedances 20, either in the form of resistances, as illustrated, or capacitors.

In the event of an overvoltage occurring on the line to which the arrester is connected, its operation is as follows:

Since the width of the auxiliary spark gaps 15 is less than that of the main spark gaps 11, the ignition spark gaps 15 respond first and the discharge current flows across them and through the auxiliary impedance 18 which limits the amount of the current and thereby keeps the voltage at the arrester at a value necessary for igniting the main spark gaps 11. This causes immediately the ignition of the spark gaps 11 and simultaneously that of the spark gap 13. Then the ignition spark gaps 15 are extinguished and the blow coil 12 takes up more and more of the current which originally flowed across the bridging gap 13 causing the arc to be widened and cooled by the magnetic blowing of the spark gaps 11. When the sum of the arc voltage at the spark gaps 11 and the voltage drop at the leakage resistance component 14 exceeds the value determining the response level for the auxiliary spark gaps 15, these are re-ignited and the widened arc at the spark gaps 11 is short-circuited by the new arc, causing the widened arc at the main, quenching gaps 11 to be extinguished; this cycle is repeated until the discharge is terminated and the arrester quenches finally against the applied line or mains voltage.

FIG. 2 illustrates a modification of the arrangement depicted in FIG. 1 wherein the main leakage resistance element 14 and the auxiliary impedance 18 are sub-divided. Here it will be seen that the main leakage resistance element is constituted by three part resistance components 14a, 14b and 14c connected respectively in series association with each of the three spark gaps 11. The magnetic blow coil 12 and its paralleling spark gap 13 is located at one end of the series string of spark gaps and leakage resistances. Similarly, the auxiliary impedance 18 of FIG. 1 is subdivided into three part impedance components 18a, 18b and 18c connected respectively in series association with each of the three auxiliary spark gaps 15. This arrangement is of advantage where the parts 11, 15, 16, 14a and 18a are assembled always as a structural unit and several such units are combined to form an arrester.

FIGS. 3 and 4 show, by way of an example, one practical embodiment of the arrester in accordance with the principles illustrated in FIG. 1. Identical components are indicated by the same reference numerals as used in FIG. 1. The active parts of the arrester are enclosed within a housing 1 made of insulating material having, at both ends, closures 2 serving also for making the electrical connections to opposite ends of the arrester. A plate 3 rests against each of the closures 2. The plates 3 are constructed as breakage or relief members against undesirable internal overpressures, as known to the art. When the internal pressure rises too high within the housing 1, one or both of the plates 3 fractures and the gas within the housing flows outward through the ports 1a.

A stack of arrester elements is constrained between the plates 3 by means of a compression spring 4 which is paralleled by a copper strap 5 so as to relieve the spring from carrying current. Seen from the bottom, the arrester stack comprises a conductive metallic plate 6 on which rests the main leakage resistance component made up in the form of two blocks 14 of resistance material and a further metallic disc 6. Then follows six ceramic parts 7 arranged in two groups of three each, with the blow coil 12 arranged between the two groups. The parts 7 are constructed in the form of spark chambers, known per se, in each of which are housed, as shown in

more detail in FIG. 4, electrodes 11a, 11b and 15a, 15b forming respectively, one of the main spark gaps 11 and an ignition spark gap 15 the electrodes 15a, 15b being located between the electrodes 11a, 11b of the main, quenching gaps 11 so that as soon as an arc is struck across electrodes 15a, 15b, this arc will serve to ignite the main, quenching gaps 11. The parts are electrically connected by connections 8, 9 and 10 according to the electrical schematic of FIG. 1. The auxiliary impedances 16 and 18 are arranged within the housing 1 but outside of the arrester stack itself. The spark gap 13 connected in parallel with the magnetic blow coil 12 and having electrode ends denoted by 13a, 13b is located within the blow coil itself and hence is not visible in FIG. 3. Also, for the sake of clarity, the control components 17, 19 and 20 depicted schematically in FIG. 1 have not been included in FIGS. 3 and 4.

The advantage of the improved arrangement in accordance with the invention is principally that it is now possible to construct the arrester, by suitably dimensioning the spark chambers and the leakage resistance for a large energy absorption, whilst maintaining a low level of protection as is necessary particularly for transmitting ultra-high voltages.

I claim:

1. In an overvoltage arrester construction for use in conjunction with direct current and alternating current voltages, the combination comprising a first series circuit constituted by a voltage-dependent leakage resistance means connected in series with a quenching arc path constituted by a series arrangement of quenching spark gaps and a magnetic blowing coil for extending the arcs drawn across spaced electrodes defining the quenching gaps, an ignition spark gap structurally and functionally associated with each of said quenching gaps,

each said ignition gap having spaced electrodes thereof positioned adjacent the electrodes of the quenching gap correlated therewith so as to effect ignition of the quenching gap, said ignition gaps being connected in a second series circuit including an impedance means to limit current flow therethrough and said first and second series circuits being arranged in parallel with respect to the arrester connections such that the ignition gaps of said second circuit strike initially upon an occurrence of an overvoltage thereby to effect a striking of the quenching gaps of said first circuit followed by extinction of the ignition gaps, widening of the arcs at said quenching gaps under the magnetic action of said blowing coil, re-striking of said ignition gaps to effect striking of new arcs at said quenching gaps and extinction of the said widened arcs.

2. An overvoltage arrester as defined in claim 1 wherein said impedance means of said second series circuit includes an impedance component connected in parallel with each of said ignition gaps.

3. An overvoltage arrester as defined in claim 1 wherein said impedance means of said second series circuit includes an impedance component and a capacitor connected in parallel with each of said ignition gaps.

4. An overvoltage arrester as defined in claim 1 wherein said impedance means of said second series circuit includes an impedance component connected in parallel with each of said ignition gaps and impedances connected between ignition gaps, and wherein said leakage resistance means of said first circuit includes leakage resistance components connected between quenching gaps.

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