Nov. 17, 1953 S. TESZNER 2,659,842

LIGHTNING ARRESTER

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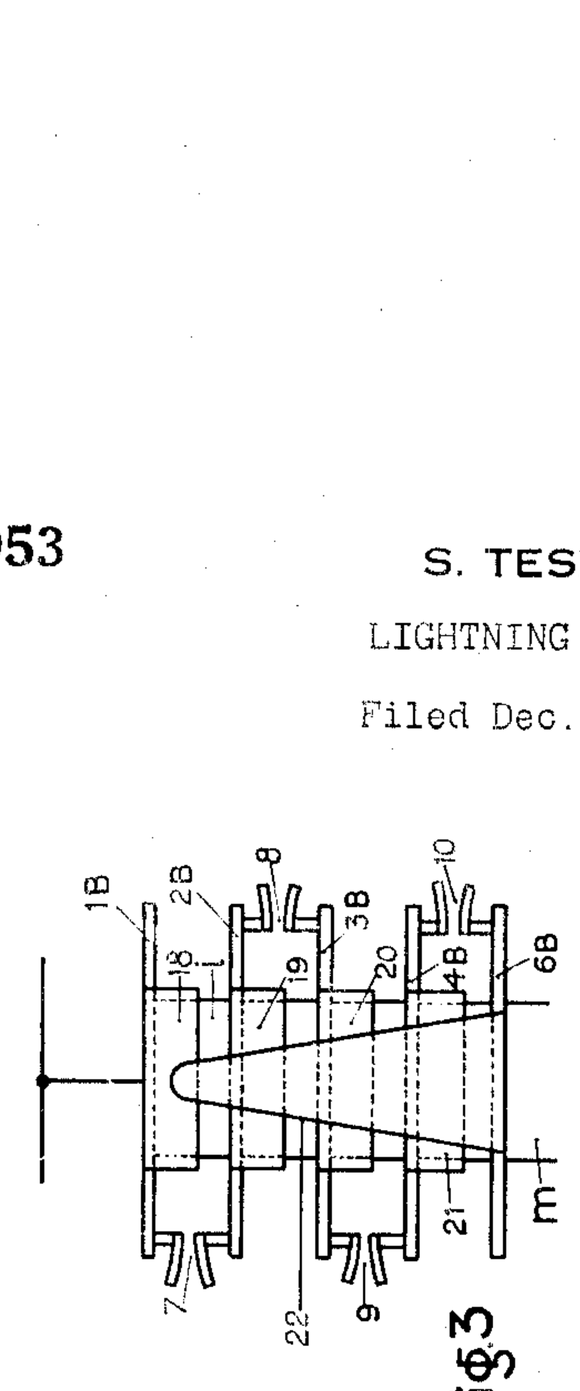

Fig. 3

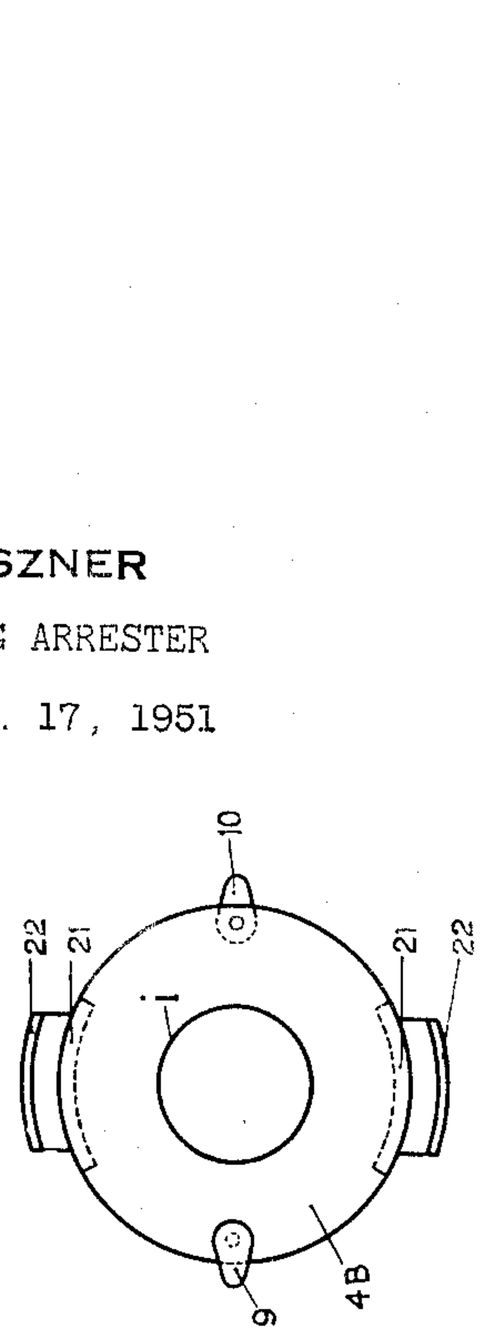

Fig. 4

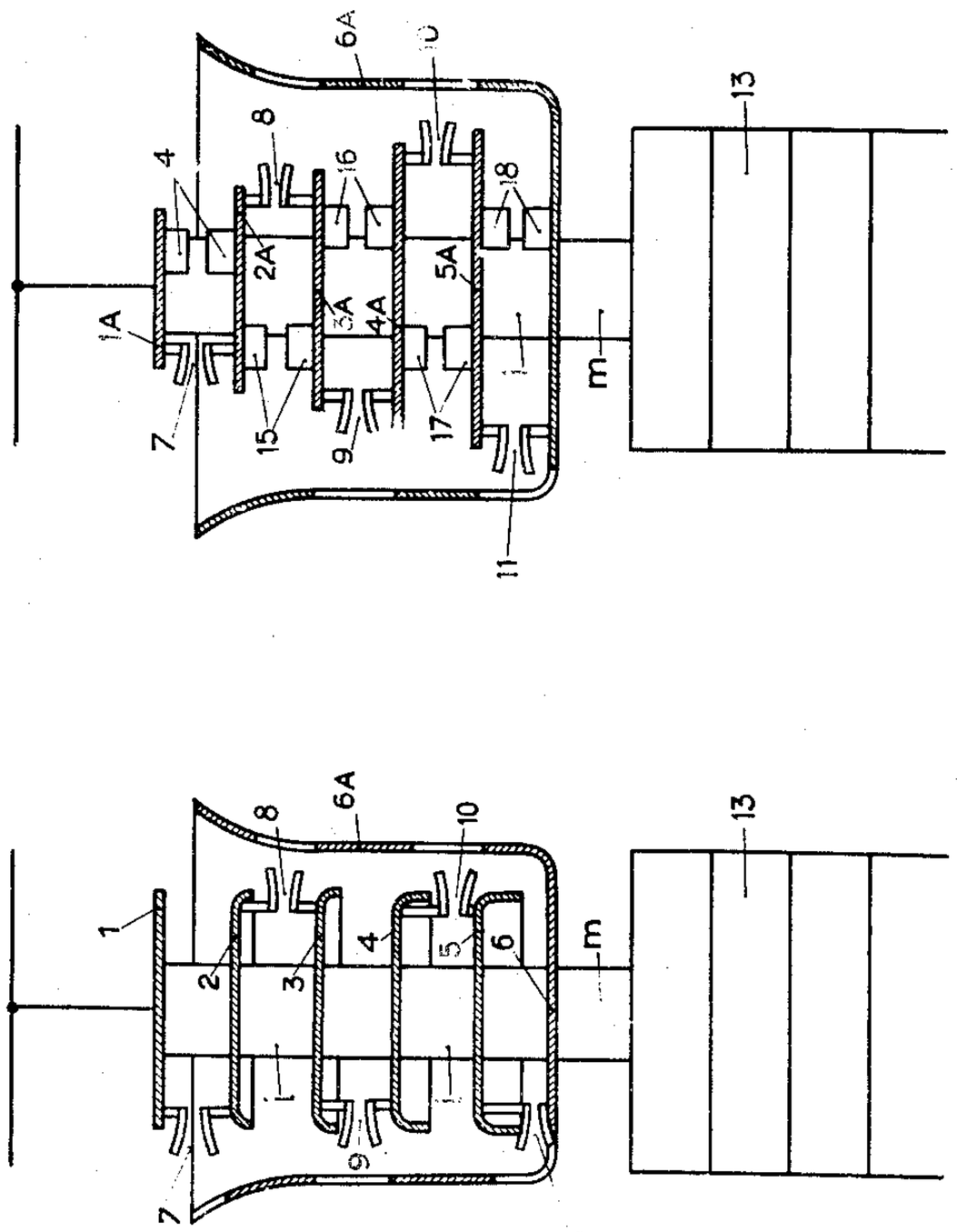

Fig. 2

Fig. 1

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LIGHTNING ARRESTER

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7 Claims. (Cl. 317—70)

1

The present invention relates to lightning arresters and more especially, but not exclusively, to lightning-arresters for direct-current apparatus or supply systems; it comprises means for lowering considerably the impulse spark-over voltage, without unduly reducing the distances between the electrodes of the arc or spark gaps.

The invention provides simple structures, low in cost and protected against the effects of external electrostatic fields which are capable of modifying the characteristics of the lightning arrester.

The invention further provides a combination of these structures with means for effective blow-out of the individual arcs, whereby the operation of the apparatus is rendered more certain.

It is known that the main difficulty in designing such lightning arresters is due to the fact that, in order to ensure the extinction of the arc maintained by the follow-current at normal line voltage, it is advantageous to subdivide the arc.

As, moreover, it is necessary to have a relatively low spark-over voltage, the usual practice leads to unduly small gaps between the electrodes; these small gaps are dangerous, for below a certain distance, it is practically impossible to cause displacement of the arc at a sufficient speed for avoiding erosions of the metal and also the formation upon the electrodes of excrescences which finally lead to their becoming welded together.

According to the present invention, a lightning arrester having several spark-gaps in series with a resistance, is characterized by the fact that the metallic supports of the arc electrodes co-operate electrostatically with a screen connected to earth by the said resistance, the shapes and dimensions of the supports and screen, as well as the spacing intervals between them being adapted so that the series capacities, formed between the several adjacent supports, and the shunt capacities to earth, formed between the several supports and the screen, shall be distributed in a non-homogeneous manner, whereby the impulse spark-over voltage is reduced, without it being necessary to reduce the distances between the arc electrodes.

The invention is hereinafter described with reference to the accompanying drawing, in which:

Fig. 1 represents a lightning arrester diagrammatically in section.

Fig. 2 relates to a modification, and

Figs. 3 and 4 to another modification.

In Fig. 1, there are shown several metallic plates 1, 2, 3, 4, 5, 6, which support the electrodes

2

of the spark gaps 7, 8, 9, 10, 11, connected in series with resistance elements 13, preferably of non-linear type, connected to earth. As shown in the drawing, the supporting plates, carried by insulating spacers "*i*" and by conducting spacers "*m*," are provided with flanged or turned-over edges, of increasing width, so as to modify, on a definite scale, the respective electrostatic capacities formed between adjacent superposed plates, all of which are connected in series by the gaps. As a result, in the structure represented, the capacity between the plate elements 4 and 5 for example is greater than between the plate elements 1 and 2.

The last plate 6, which, before the breakdown and spark-over, is at the earth potential, comprises a part 6A which surrounds completely or partly the whole assembly of the spark-gaps, so as to constitute an electrostatic screen. At the level of the spark-gaps and in front of the latter, the screen 6A may be provided with openings, as shown, in order to facilitate the blowing-out of the arcs.

The shape of this screen 6A is such that its electrostatic capacities in relation to the upper supporting plates, for example the plate 1, are less than its capacities in relation to the lower plates, for example the plate 5. This difference is due to the inequality of the distances separating the screen from the several plates. The variable width of the vertical flanged edges of the respective plates contributes further to increase the inequality of these capacities, which are shunt-connected, that is, connected between the several plates and the screen 6A.

In these conditions, the "series capacities" formed between the successive plates increase downwardly in proportion as they approach the earth; the "shunt capacities" formed between the plates and the screen 6A likewise increase downwardly. It follows that due to the respective shunt capacities in relation to earth, which are increasingly large, the capacity currents which circulate between the plates in the upper part of the structure, are much greater than in its lower part; as, moreover, the series capacity impedances are lower near the bottom than near the top, the voltages which appear at the upper spark gaps are considerably higher than those at the lower gaps.

Such an arrangement allows of providing between the electrodes larger gaps, easier to provide and to regulate than the very small gaps which were hitherto indispensable in direct-current lightning arresters for moderate voltages,

These increased gaps allow moreover of obtaining a better operation of the electrodes, as explained above.

The invention thus allows of increasing the number of arc or spark-gaps for a given voltage; that facilitates likewise the extinction of the arcs, which is particularly important in the case of direct-current lightning arresters.

It is to be noted that in normal conditions, where the arrester is exposed to its normal line voltage, without any steep-fronted wave, the various series and shunt capacities mentioned above do not intervene in practice; the voltage is therefore fairly uniformly distributed over the gaps, and the breakdown or spark-over voltage is substantially higher; there is thus obtained an impulse ratio less than unity.

During the actual extinction of the arcs, the voltage is likewise distributed in a uniform manner, due to their residual resistances, a fact which contributes also to the definitive extinction of the arcs.

On the other hand, the screen 6A protects the spark-gaps effectively against disturbances or stray fields coming from the exterior, including the harmful effects of damp or other deposits lying upon the outer insulating surface of the lightning arrester.

According to the modification shown in Fig. 2, the plates 1A, 2A, 3A, etc., which support the electrodes, are plane but of different diameters, which modifies their capacities in relation to the screen 6A. In order to adjust their mutual capacities conveniently, there may be provided a number of projections 14, 15, 16, 17, 18, of which the dimensions and spacing intervals may be varied.

According to Figs. 3 and 4, which represent another modification, in elevation and in horizontal section respectively, the plates 1B, 2B, 3B, 3B, are all identical and comprise flanged or downturned edges 18, 19, 20, 21, all of equal dimensions. The bottom plate 6B comprises instead of a complete screen, as in the previous embodiments of the invention, two vertical wings 22 of suitable shape, for example triangular, acting as partial screens in relation to the edges 18, 19, 20, 21, like condenser electrodes of unequal capacities, the width of the wings 22 varying with the level.

Fig. 4 shows more clearly the arrangement of the flanged edges 21 of one plate, for example the plate 4B, in relation to the wings 22. In this example, the "series capacities" are all equal to one another, and only the "shunt capacities" are different; in order to modify the series capacities, there may be provided upon the plates suitable projections, as in the embodiment of Fig. 2.

The spark-gaps are preferably arranged in quincunx, or located alternately on opposite sides of the vertical axis, according to prior Patent No. 2,554,278, with a view to producing several discharge-current loops and thus blowing out the arcs at the spark gaps. This electrodynamic blow-out may be combined with a magnetic blow-out such as described in the aforesaid patent.

The arrangements described may be modified various ways, without departing from the scope of the invention; it is to be understood that they can likewise be applied to lightning arresters for alternating current supply systems or apparatus.

Having thus disclosed the invention, what is claimed is:

1. In a lightning arrester having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, means for reducing the impulse sparkover voltage by a predetermined distribution of inner capacitances, comprising superposed metallic supports carrying said electrodes, projections upon said supports for adjusting the series capacitances formed between respective pairs of said supports, and means for adjusting the shunt capacitances of said electrodes to ground comprising an electrostatic shield grounded through said resistance, said shield being shaped to present with respect to said supports unequal values of capacitances.

2. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, a structure for reducing the impulse sparkover voltage without reducing the spark-gap intervals, comprising a plurality of electrode-carrying metallic supports, the sizes, shapes and spacings of which are adjusted to form between respective pairs of said supports different values of series capacitances, and means for adjusting the shunt capacitances of said electrodes to ground comprising an electrostatic shield grounded through said resistance, said shield having a shape presenting with respect to each of said supports a different value of the capacitances.

3. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, electrostatic means for lowering the impulse sparkover voltage by an adjustment of inner capacitances, comprising electrode-carrying metallic supports located and shaped to present therebetween different values of series capacitances, and a shield grounded through said resistance, said shield being shaped to present with respect to said metallic supports unequal values of shunt capacitances to ground.

4. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, electrostatic means for lowering the impulse sparkover voltage by an adjustment of inner capacitances, comprising electrode-carrying metallic supports located and shaped to present therebetween different values of series capacitances, and a shield grounded through said resistance, said shield being shaped to present with respect to said metallic supports unequal values of shunt capacitances to ground, to surround partially said group of spark-gaps and to have openings in front of the spark-gaps.

5. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, electrostatic means for lowering the impulse sparkover voltage by an adjustment of inner capacitances, comprising electrode-carrying metallic supports located and shaped to present therebetween different values of series capacitances, and a shield grounded through said resistance, said shield comprising upright wings which are shaped to present with respect to said metallic supports unequal values of shunt capacitances to ground.

6. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, electrostatic means for lowering the impulse sparkover voltage by an adjustment of inner capacitances, comprising electrode-carrying metallic supports located and shaped to present therebetween series capacitances which have on the line side of said group lower values than on the ground side, and a shield grounded through said resistance, said shield being shaped

to present with respect to said metallic supports unequal values of shunt capacitances to ground.

7. In a lightning arrester of the type having a group of spark-gaps with a plurality of electrodes and a grounded resistance in series with said spark-gaps, electrostatic means for lowering the impulse sparkover voltage by an adjustment of inner capacitances, comprising electrode-carrying metallic supports located and shaped to present therebetween different values of series capacitances, and a shield grounded through said resistance, said shield being shaped to present with respect to said metallic supports unequal values of shunt capacitances to ground.

with respect to said metallic supports shunt capacitances to ground which have on the line side of said group lower values than on the ground side.

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