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LIGHTNING ARRESTER

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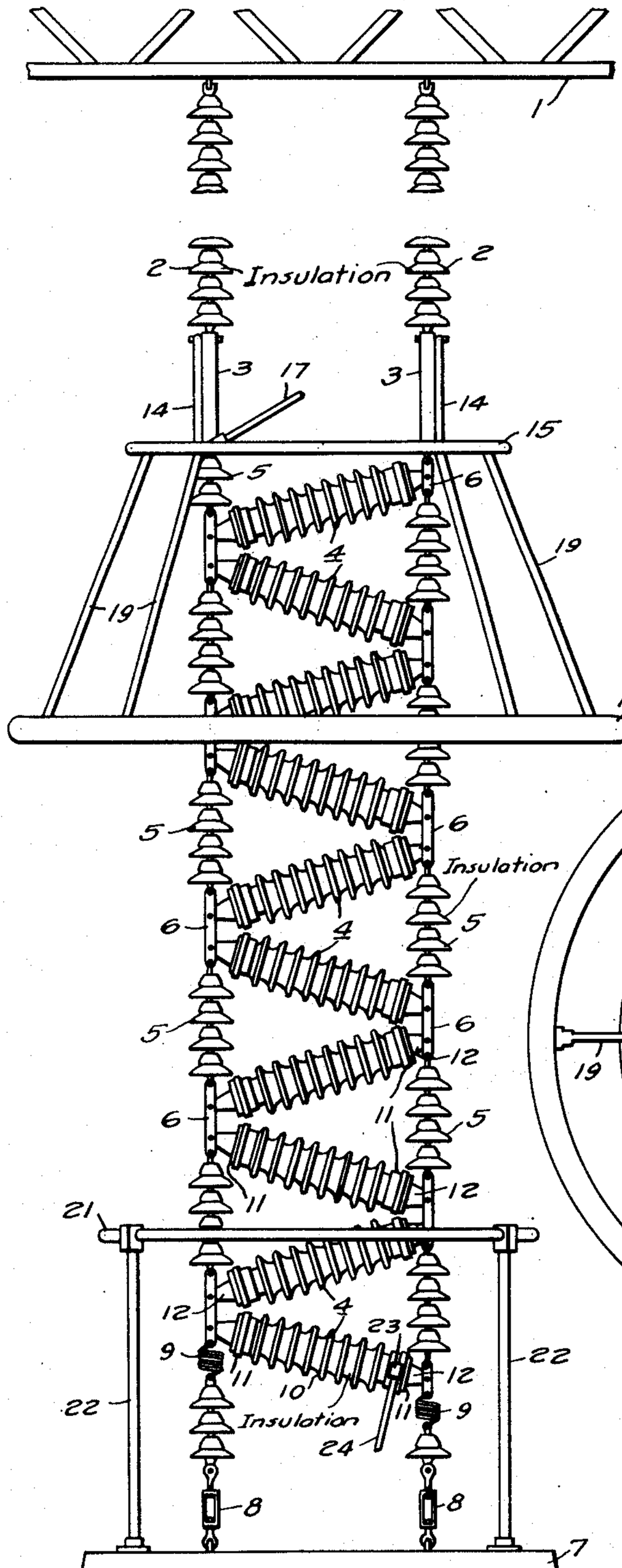
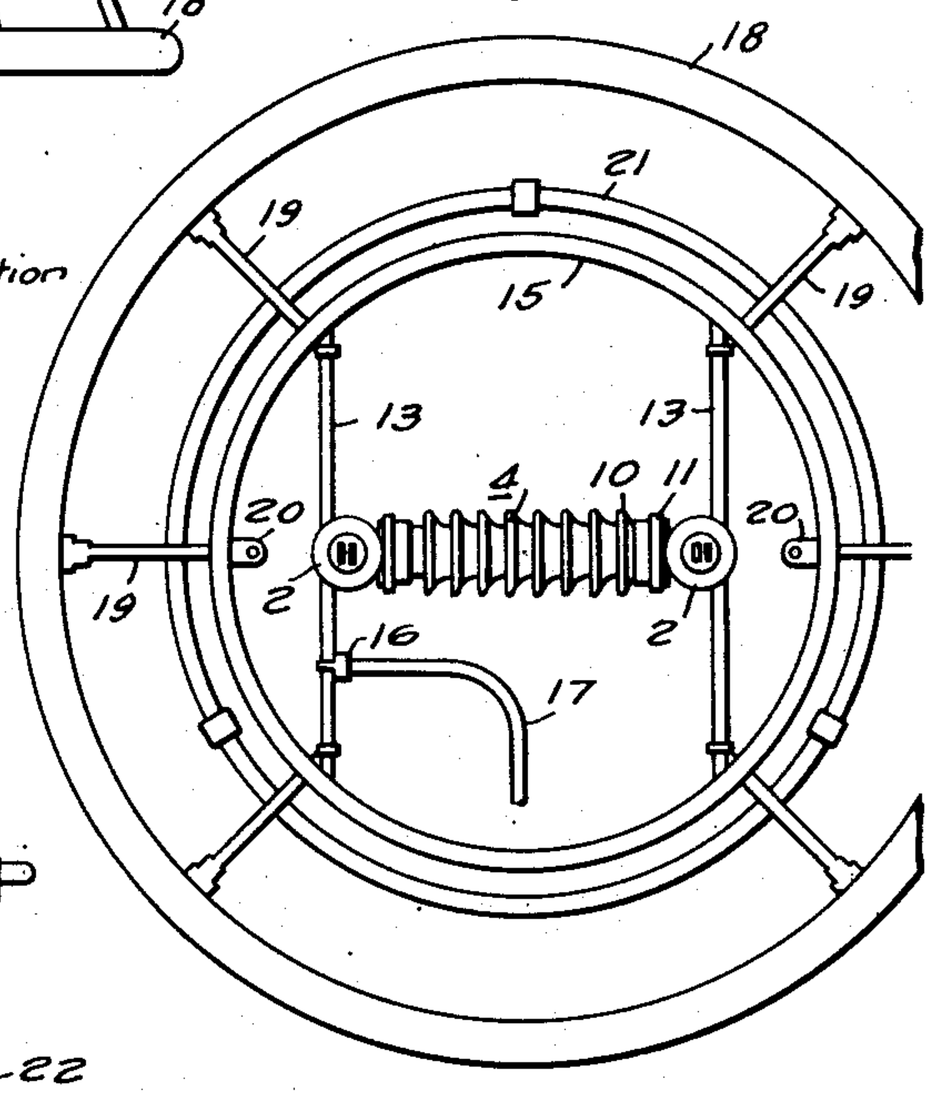


Fig. 1.

Fig. 2.



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LIGHTNING ARRESTER

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2 Claims. (Cl. 175—30)

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The present invention relates to lightning arresters, and more particularly, to a high-voltage station-type lightning arrester.

High-voltage station-type lightning arresters are usually of the so-called unit construction, that is, they are built up of a suitable number of individual lightning arrester units, of standard voltage ratings, connected in series. The individual arrester units are of the valve type, and each consists of a number of spark gaps and resistors, or valve blocks, disposed in series relation in a porcelain housing, with metal end caps which serve to make electrical connection to the arrester unit. In the conventional construction, the necessary number of these units is assembled end-to-end in a vertical column, with the end caps of adjacent units bolted together for electrical and mechanical connection.

In high-voltage lightning arresters, this construction results in a vertical column of great height as compared to its diameter, and if the height exceeds a definite maximum, the column is not self-supporting and must be supported from a suitable fixed support, such as part of a sub-station structure, either by bracing to the supporting structure or by suspension mounting. In very high-voltage arresters of great height, the required bracing and supporting structure becomes relatively complicated and expensive. The necessity for bracing the arrester can be avoided by the use of a suspension mounting, or so-called earthquake-proof construction, in which the arrester column is suspended by flexible supporting means which can yield under mechanical shocks, such as earthquake shocks, to prevent damage to the arrester. In the usual suspension mounting, the arrester column is supported between two flexible strings of insulators, which are suspended from the sub-station structure and secured at the bottom to a suitable foundation. The great height of very high-voltage arresters of conventional construction, however, requires a relatively elaborate and expensive supporting structure, which is undesirable as it considerably increases the cost of the installation.

Another problem in the design of high-voltage lightning arresters is that of obtaining sufficiently uniform distribution of voltage along the column of lightning arrester units. The arrester column is connected between a transmission line conductor and ground and is, therefore, subjected to the line-to-ground voltage. When the arrester column is very high, the voltage is not uniformly distributed across the individual arrester units, and the voltage across the units at

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the top of the column is considerably greater than the voltage across the units at the bottom. Satisfactory operation, however, requires a fairly uniform distribution of the voltage, and this has been obtained heretofore by the use of grading rings, which provide sufficient electrostatic capacitance to balance the unequal capacitances to ground of the different arrester units and thus make the voltage distribution reasonably uniform. As the height of the arrester column is increased, however, it becomes increasingly difficult to obtain sufficiently uniform voltage distribution by this means, and when it is attempted to extend conventional lightning arrester designs to voltage ratings substantially higher than those which have been used heretofore, it is found that it is extremely difficult, if not impossible, to obtain sufficiently uniform distribution of the voltage by the use of grading rings, because of the great height of the arrester.

The principal object of the present invention is to provide a high-voltage lightning arrester of the suspension type which is very considerably reduced in height, as compared to lightning arresters of conventional design, so that very high voltage ratings can be obtained without exceeding a reasonable height.

Another object of the invention is to provide a high-voltage lightning arrester of the suspension type in which satisfactory distribution of the voltage between the individual arrester units can readily be obtained by the use of grading rings, even when the arrester is designed for substantially higher voltage ratings than the maximum voltages which have heretofore been used.

A more specific object of the invention is to provide a high-voltage, suspension-type lightning arrester in which the individual lightning arrester units extend transversely between two spaced supporting insulator strings and are arranged in substantially zig-zag fashion, so that the height of the arrester is substantially reduced, as compared to an arrester of equivalent voltage rating of the conventional design in which the individual units are placed end-to-end in a vertical column.

The invention will be more fully understood from the following detailed description, taken in connection with the accompanying drawing, in which:

Figure 1 is a view in elevation of a high-voltage lightning arrester embodying the invention; and

Fig. 2 is a top plan view of the lightning arrester of Fig. 1.

The invention is shown in the drawing em-

bodied in a suspension-type lightning arrester which can be designed for extremely high voltage ratings, which may be considerably in excess of the maximum voltage ratings utilized heretofore, but without the disadvantages resulting from excessive height of the arrester discussed above. For example, the particular lightning arrester shown in the drawing for the purpose of illustration is rated at 345 kv., although it will be understood that the invention is not limited to any particular voltage, or range of voltages.

In the construction shown in the drawing, the lightning arrester is suspended from a suitable fixed support 1, which may be a part of a substation structure, by means of two spaced strings of suspension insulators 2. The insulator strings 2 are long enough to withstand the voltage between the line terminal of the lightning arrester and the supporting structure 1, which is normally at ground potential, and to space the upper end of the arrester proper far enough from the supporting structure 1 to prevent any possibility of flashover. The insulator strings 2 are secured at their upper ends to the supporting structure 1, and their lower ends are attached to steel tension members or supporting members 3 from which the arrester itself is suspended.

The lightning arrester proper consists of a suitable number of individual lightning arrester units 4, supported between two flexible supporting members which are suspended from the tension members 3. Each of the supporting members consists of a string of suspension insulators 5 and steel connecting links 6, the steel links 6 alternating with groups of insulators 5 in each string. Each of the supporting insulator strings is attached at its upper end to one of the tension members 3, and its lower end is secured to a suitable concrete base or foundation 7 by means of a turnbuckle 8. A tension spring 9 is also included in each of the supporting insulator strings near its lower end. By adjustment of the turnbuckles 8, the insulator strings can be tensioned so as to be sufficiently rigid to adequately support the arrester units 4, but by reason of the springs 9, and the flexible connections between the steel links 6 and the insulators 5, the strings have sufficient flexibility to yield to severe mechanical shocks and thus prevent damage to the arrester from earthquakes, and similar shocks. The two supporting insulator strings are arranged so that the insulators 5 and links 6 of the two strings are staggered with respect to each other, that is, the links 6 of one string are directly opposite the insulator groups 5 of the other string, so that the upper end of one string terminates in a steel link 6, while the upper end of the other string terminates in a group of insulators 5.

The individual lightning arrester units 4 which are supported on the insulator strings may be of any suitable type, and each comprises a number of spark gaps and resistors, or valve blocks, assembled in series relation and enclosed in a porcelain housing 10 with metal end caps 11 at each end of the housing to close the housing and to provide for electrical connection to the unit. One suitable construction for the arrester units 4 is shown, for example, in a patent to L. R. Ludwig et al., No. 2,135,085, issued November 1, 1938, although any other suitable construction may be used.

The arrester units 4 extend transversely between the supporting insulator strings, and the metal end caps 11 are provided with extending

portions or lugs 12 by means of which they are secured to the steel links 6. Thus, one end of each arrester unit 4 is secured to a link 6 of one insulator string, and the other end is secured to a link 6 of the other insulator string. The end caps of two adjacent arrester units 4 are secured to each of the links 6, except the last links at the top and bottom of the assembly, and arrester units which are secured to the same link 6 at one end are secured to different links 6 at their other ends, so that the latter ends are separated by a group of insulators 5. As a result of this disposition, the arrester units 4 are arranged in a substantially zig-zag manner, and they are all connected together in series by means of the steel links 6, as will be readily apparent from the drawing. The groups of insulators 5 space the ends of adjacent arrester units which are at different potentials far enough apart to prevent any danger of flashover. It will be obvious that this arrangement results in a lightning arrester of very considerably less height than would result if the same number of individual arrester units 4 were placed end-to-end in a vertical column, as in the conventional arrangement.

In the case of a very high-voltage lightning arrester, such as that illustrated in the drawing, it is usually necessary to provide means for obtaining sufficiently uniform voltage distribution, and the arrester shown in the drawing is provided with grading rings for this purpose. An upper grading ring and terminal assembly is provided consisting of two horizontal, transversely extending metal rods or bars 13, which have vertical mounting members 14 attached to their midpoints, and which carry, and are connected by, an upper grading ring 15 encircling the upper end of the lightning arrester. The steel mounting members 14 are attached to the tension members 3, and thus the bars 13 and grading ring 15 are electrically connected to the upper end of the top arrester unit 4, which is connected to one of the tension members 3 by the topmost steel link 6. A line terminal device 16 of any suitable type may be attached to either one of the bars 13 for connecting a line lead 17 to the arrester. If necessary, or desirable, a second upper grading ring 18 may also be provided, encircling the upper part of the arrester below the grading ring 15. The grading ring 18 is supported by means of steel rods or supports 19, which are secured to the outer ends of the bars 13 or to lugs 20 on the upper grading ring 15, as clearly shown in Fig. 2. Thus, the grading ring 18 is also electrically connected to the line terminal of the arrester.

In extremely high-voltage lightning arresters, for which the present invention is especially adapted, a grounded grading ring 21 may also be necessary or desirable. The grounded grading ring 21 encircles the arrester near its lower end, and may be supported in any suitable manner, as by vertical steel supports 22 which are mounted on the base 7 and connected to ground. The end cap 11 at the lower end of the bottom lightning arrester unit 4 is provided with a ground terminal device 23, of any suitable type, to which a ground lead 24 is connected, so that the complete arrester assembly is connected between line and ground, by the leads 17 and 24.

It should now be apparent that a high-voltage lightning arrester has been provided which is of very considerably less height than an arrester of equivalent voltage rating of conventional construction. Thus, for example, the lightning ar-

rester shown in the drawing is rated at 345 kv. A lightning arrester of conventional construction of this voltage rating would be about fifty feet high, while the arrester of the present invention is only slightly over thirty-five feet high, or approximately thirty per cent less than the conventional construction. This reduction in height is very important, since it permits the use of a much simpler and less expensive supporting structure, and also because it makes it possible to obtain reasonably uniform voltage distribution by the use of grading rings, while in an arrester of the great height required by the conventional construction, it would have been extremely difficult, if possible at all, to obtain sufficiently uniform distribution of the voltage. Thus, the new construction makes it possible to design lightning arresters for considerably higher voltage ratings than have been utilized heretofore, but without the difficulties resulting from the great height of arresters of the conventional construction.

A particular embodiment of the invention has been shown and described for the purpose of illustration, but it is to be understood that various modifications may be made within the scope of the invention, and in its broadest aspect it is not limited to the specific details of construction shown, but includes all equivalent embodiments and modifications which come within the scope of the appended claims.

I claim as my invention:

1. A high-voltage, suspension-type lightning arrester comprising two spaced, vertical, flexible supports, each of said supports including a plurality of groups of insulators spaced apart and connected by conducting links, the links and insulators being flexibly connected together, means for suspending said supports from a supporting structure, means for flexibly securing the lower ends of the supports to a fixed base, means for tensioning the supports, the supports being arranged so that the links of one support are opposite the insulators of the other support, a plurality of lightning arrester units disposed between the supports, each of said lightning arrester units having one end secured to a link of one support and the other end secured to a link of the other support, so that the arrester unit extends transversely between the supports and is supported in an inclined position, each arrester unit having one end secured to the same link as one end of an adjacent unit and the other end secured to a different link from the other end of the adjacent unit, whereby adjacent units are

connected together at one end and spaced apart by intervening insulators at their other ends and all the arrester units are connected by the links in a series circuit extending vertically in a zig-zag manner.

2. A high-voltage, suspension-type lightning arrester comprising two spaced, vertical, flexible supports, each of said supports including a plurality of groups of insulators spaced apart and connected by conducting links, the links and insulators being flexibly connected together, means for suspending said supports from a supporting structure, means for flexibly securing the lower ends of the supports to a fixed base, means for tensioning the supports, the supports being arranged so that the links of one support are opposite the insulators of the other support, a plurality of lightning arrester units disposed between the supports, each of said lightning arrester units having one end secured to a link of one support and the other end secured to a link of the other support so that the arrester unit extends transversely between the supports and is supported in an inclined position, each arrester unit having one end secured to the same link as one end of an adjacent unit and the other end secured to a different link from the other end of the adjacent unit, whereby adjacent units are connected together at one end and spaced apart by intervening insulators at their other ends and all the arrester units are connected by the links in a series circuit extending vertically in a zig-zag manner, at least one grading ring encircling the upper part of the lightning arrester, and means for securing said grading ring to the supports and for effecting electrical connection between the grading ring and the upper end of the uppermost arrester unit.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,449,694	Peek	Mar. 27, 1923
2,002,042	Pittman	May 21, 1935
2,476,791	Ackermann	July 19, 1949

FOREIGN PATENTS

Number	Country	Date
40,108	Switzerland	Apr. 22, 1907
92,434	Sweden	May 31, 1938