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HEATER FOR INSULATORS

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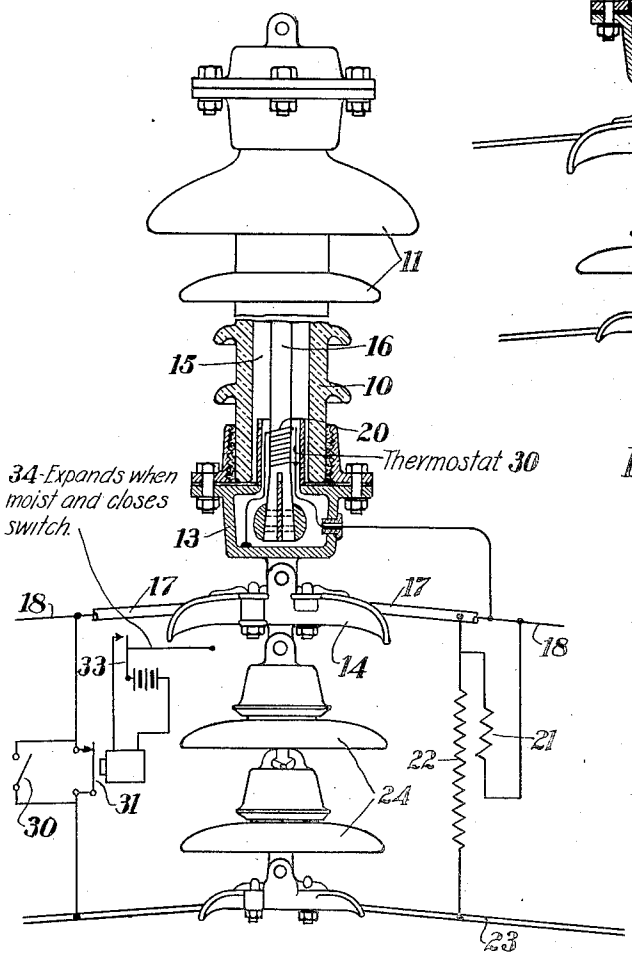


Fig. 1

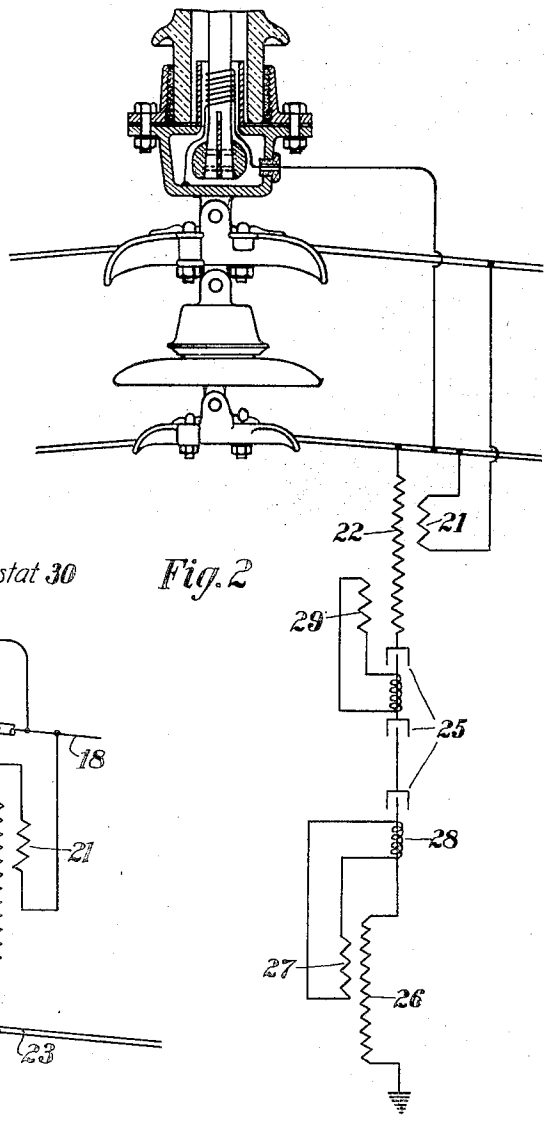


Fig. 2

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UNITED STATES PATENT OFFICE

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HEATER FOR INSULATORS

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This invention relates to heating means for insulators, and has for one of its objects the provision of a heating device which will prevent the accumulation of moisture or other conducting substance on the surface of the insulator tending to reduce the insulation afforded thereby.

A further object is to provide heating means for insulators which will depend upon the voltage in the transmission line and not require a heavy current in the transmission line for its operation.

A further object is to provide heating means for insulators which shall be of improved construction and operation.

Other objects and advantages will appear from the following description.

The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawings and described in the following specification, and it is more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a somewhat diagrammatic elevation showing one embodiment of the present invention.

Fig. 2 is a view similar to Fig. 1 showing another form of the invention.

In transmission lines operating at high voltage, considerable difficulty is caused by heavy leakage currents to ground or by insulators arcing over where the insulators are subjected to fog or to chemical or dust deposits. Lines operating along the seacoast or along lakes where salt or other chemical deposits become heavy, are likely to arc over, particularly when the insulators are subjected to fog or rain. In the vicinity of railroads, cement plants, coke ovens or other locations where there are discharges into the air, conditions are likely to be very severe. Along railroad lines, insulators coated with a deposit are likely to be subjected to heavy discharges of steam from the locomotive which greatly increases the leakage, and sometimes causes an arc to ground interrupting the service. On many lines, the discharges on the insulator, frequently cause radio disturbances.

The above considerations apply not only to transmission insulators of either the suspension, strain or pin type, but also to bushings, bus insulators and other insulating supports; both on the line and at stations. Due to the presence of spray ponds, very severe conditions frequently exist at the electrical station. In many cases, the outer ends of bushings projecting from station walls or roofs have to be increased in size in order to prevent arcing under the more severe conditions existing in fog or rains.

It is well recognized that if the surface of the insulator can be maintained in a dry condition the danger of arcing is greatly reduced or eliminated. Where the surface of the insulator can be maintained in a dry condition, heavy deposits do not cause trouble to the same extent as where they are damp or wet. Where the surface is maintained in a dry condition, the deposits apparently do not adhere so strongly to the surface, consequently, wind or wind and rain tend to keep the surfaces cleaner than where the surfaces are wet for a great portion of the time. This is probably due, in part at least, to the fact that the leakage current or charging current flowing over the surface of the insulator is greatly reduced where the surface is kept dry. This leakage or charging current flowing over the surface undoubtedly forms new compounds with the deposit in many cases, producing deposits which are highly conducting when damp or wet.

While it is recognized that maintaining the temperature of the insulator above the dew point will greatly improve the effective insulation of the insulator and reduce the danger of arcing to ground for a given electrical stress, it has been found difficult and expensive to warm the insulator, particularly where the line voltage is high, without lowering its effective insulation for lightning or other severe conditions.

In the present invention, an arrangement is employed which makes it possible to provide an insulator of high length efficiency or arcing voltage for abnormal conditions so that high electrical integrity may be maintained for these conditions, and, at the same time, permits of heating of the insulator to

raise at least an appreciable portion above the condensation point.

In the scheme used, it is possible to apply the improvement to a part or all of the insulator as desired. In many cases, a part of the insulator only need be equipped with heating means. This reduces the cost and makes it possible to use ordinary insulating elements for the remainder of the insulator. Keeping the insulator surface dry, even though it may be covered by a deposit, makes it possible to provide high effective flashover voltage for very severe conditions, such as lightning, where the surface deposits do not necessarily affect the performance of the insulator to the same degree as fog or damp surface under the normal operating voltage. This applies to suspension or dead end strings, bushing insulators, tandem insulators or other types of insulation.

In transmission lines operating at very high voltage and having comparatively small current flowing in the conductor, it is difficult to obtain the necessary energy for heating elements required to raise the temperature of the insulating surface above the dew point. The present invention secures the necessary heating of the insulators for conditions of this kind.

Although the invention is applicable to practically any transmission line voltage, it is particularly applicable to transmission lines which are lightly loaded at the time when the most severe conditions are likely to be encountered. Many transmission systems are subjected to the most severe conditions in the early morning hours when the temperature is so low that the dew point is reached or severe fogs are encountered. At this time of day, the current flowing in the main conductor is likely to be rather small compared to the current during other portions of the day. If, therefore, dependence is placed upon the current flowing in the conductor to supply the energy for raising the temperature of the insulator, and the energy utilized for heating is a direct function of the current flowing, the insulator may be greatly overheated part of the time and receiving insufficient heat at the time when it is most needed. If, however, as in the present invention, the heating current is a function of the voltage or potential of the conductor, the condition of the insulator or the heat dissipated in the insulator will not depend upon the current flowing in the line and will not depend upon the loading of the line. It is evident that conditions may exist where it is desirable to be able to heat the insulator either proportionally to the current flowing in the line or to the voltage. In general, however, a transmission line may be regarded as energized at all times so that potential can be depended upon to maintain a good condition of the surface at all times. A combination method of heating, depending upon both current and voltage, could be used where a line had not been energized for some time, so that it would be impossible to raise the voltage without danger of causing flashover. Under a condition of this kind, it would be possible to short circuit the line and cause a heavy current to flow through it at a comparatively low voltage. If a heating element, depending upon the flow of current, is available for raising the temperature of the insulator, a good operating condition can be established before it is necessary to raise the voltage. Lines subject to heavy sleet storms some times are energized with a heavy circulating current, in order to melt the sleet from the conductors. At these times, the insulators could receive heat from a system, depending upon the current to raise their temperature above the dew point or even to clear them from accumulation of sleet.

Under normal operating conditions, the insulator heating system depending upon potential would maintain a good operating condition. While whole transmission systems may be equipped with insulator heating means, it is usually necessary to heat the insulators in the vicinity, only, where unusually severe conditions exist or in the cities where leakage or charging current causes complaints from observers not familiar with electrical phenomena.

In the embodiment shown in Fig. 1, the insulating element has an insulating shell 10 with flanges 11. The insulating element is provided with suitable attachments at either end. The attachment at the upper end permits of attaching the insulator to one end of an ordinary insulator string or directly to a supporting tower, if desired. The attachment 13 at the lower end permits the insulator to be attached to a clamp 14 of suitable design. The insulator may be of any suitable shape, the one illustrated being filled with an insulating oil 15. The insulator is preferably provided with a safety core 16 for maintaining the mechanical reliability of the insulator or for taking the mechanical load imposed by the conductor where it is not desired to carry this load by means of the outer shell 10. The clamp 14 carries the main conductor 17 and another conductor 18 is strung parallel to the main conductor 17. This conductor 18 is insulated from the main conductor by suitable insulation. If a hollow conductor 17 is used, as shown in the drawings, the conductor 18 may be run inside of the conductor 17 and insulated from same by any suitable insulation, as the voltage between the two conductors need not be high. Heating elements 20 placed at any suitable location in the insulating shell are electrically connected to the conductors 17 and 18.

The conductors 17 and 18 are connected to

the secondary 21 of a transformer having a primary 22. One end of the primary 22 of the transformer is connected to either conductor 17 or 18, it being illustrated as connected to 17. The other end of the primary 22 is connected to a suitable high voltage condenser 25, as shown in Fig. 2, or to a conductor 23 insulated from the main conductor 17 by insulators 24 and thus forming a condenser of which the conductors 17 and 23 are the conductor elements separated by the dielectric element 24. Where a conductor 23 is used, it must be so located that it will take up a portion of the charging current normally flowing between the main conductor 17 and ground or between the main conductor and other conductors. An appreciable portion of the charging current between conductor 23 and other conductors or between this conductor and ground may be caused to flow over the primary 22 of the step-down transformer. The current flowing between the conductors 17 and 23 will depend upon the difference in potential between the two conductors and impedance in the transformer circuit as well as the leakage over the insulators separating the two conductors. While in general a comparatively high voltage may be obtained, the amount of current flowing is entirely too small to apply to heated elements for practical purposes. It is, therefore, advisable to provide a step-down transformer so that the amount of current flowing to the heated elements may be increased and the voltage reduced. This applies whether the current flowing through the primary of the step-down transformer is due to attaching a suitable condenser or capacitor 25 or a conductor 23. Where a conductor 23 is used for energizing the primary of the transformer, the cost of the step-down transformer will be a very appreciable part of the cost of the installation. It is therefore advisable to reduce the number of these transformers particularly as the out-put of the transformer will not be increased materially with an increase in size.

Where a single transformer is used to supply current for the heating elements for several insulators, it is necessary to supply a conductor for distributing the energy of the secondary to the various insulators. In this case, one side of the transformer secondary is attached to the conductor 18, and the other side to the conductor 17. The heating elements may then be tapped off from these two conductors at any support. In general, the conductor 23 need be supported only at the main insulator supports. In the illustration, the conductor 23 is suspended below the conductor 18 but in some cases it may be desirable to support the conductor 23 between the main conductor 18 and the tower. This will give a greater insulation for the main conductor provided by the insulators 24 for separating the conductors 18 and 23. It is not necessary that a uniform distance be provided for the conductors, and the conductor 23 may be placed above as well as below the main conductor or to one side, if desired. This conductor 23 may be fairly close to the main conductor at the point of support or placed in a suitable location so that clearance to ground, due to the presence of a cross arm or to the swinging of an insulator under wind, will not be seriously reduced. Where the current flowing between conductors 17 and 23 is used to energize the primary of the transformer, the only direct leakage paths to ground from the conductors operating at high voltage will be over the main insulator strings. Where condenser elements 25 are used, it may be necessary to provide an increase in insulation for these elements so that they will not arc to ground under severe weather conditions. In some instances, it may be advisable to place a primary 26 of a step-down transformer in the conductor at the ground side of the condenser. A suitable secondary 27 may be used to energize slightly a heating element 28 for at least a portion of the condenser.

If desired, the transformer having the primary 22 may be equipped with a secondary 29 for heating the upper end of the condenser in any suitable manner. It is evident that the high voltage transformer may consist of a series of auto transformers in place of having primaries and secondaries. In this case, suitable taps are provided on the secondary coil 22. The end coils will, of necessity, be provided with coils of suitable current carrying capacity.

It will be seen that an arrangement of the kind shown will make it possible to supply energy for warming the insulator at all times when there is voltage on the system. If desired, the insulators may be equipped with a simple form of thermostat which will short-circuit the resistance elements 20 when a sufficiently high temperature is reached. Such a thermostat is shown at the point 30. Where a thermostat is used, heating means which will dissipate more energy, can be used more economically than where no thermostat is used. Where the thermostat is used, when the insulators become hot in the sun, the thermostat will prevent unnecessary loss of energy. In many cases, however, the energy is of such small importance compared to reliability that control means for heating the insulators would not be necessary. Where the energizing conductor covers a very long stretch of line, suitable means may be provided for shunting the transformer primary or secondary, as desired, in order to save energy when heating the insulators is not necessary. Any suitable form of manual control, as a switch 31 or a remote control system of suitable design, may be used.

In addition to the manual control switch 30, an automatic relay circuit may be provided depending for its operation on the humidity of the atmosphere near the insulator. This control comprises a relay switch 31 biased to closed position and arranged to be opened when current flows in the control circuit. The circuit includes a switch 33 biased to closed position but held open, when the atmosphere is dry, by a strip or bar 34 which expands when it becomes moist. A strip of absorbent paper held under tension by the switch element 33 will serve the purpose. When the atmosphere becomes moist, the switch 33 closes, causing the relay switch 31 to open, thus removing the short circuit shunt from the transformer winding 22 and permitting the transformer to energize the heating element 20.

I claim:

1. The combination with a transmission line, of an insulator, a capacitance member arranged to be charged by the voltage in said line, a conductor for supplying charging current to said capacitance member, and a heating element for said insulator energized by said conductor.

2. The combination with a transmission line, of an insulator for supporting said line, a capacitance member associated with said line and arranged to be charged by the voltage of said line, a conductor for supplying charging current to said capacitance member, a step-down transformer having the primary thereof energized by said conductor, and a heating element for said insulator supplied with current from the secondary of said transformer.

3. The combination with a transmission line, of an insulator for said line, a supplemental conductor extending along said line and insulated therefrom, a transformer for maintaining a difference of potential between said line and conductor, and a heating element for said insulator, said heating element having its terminals connected respectively with said line and conductor.

4. The combination with a transmission line, of a conductor disposed along said line and insulated therefrom, a capacitance member arranged to be charged by said transmission line, a tap for supplying charging current to said capacitance member, a transformer having its primary winding energized by said tap, the secondary of said transformer having its terminals connected respectively with said transmission line and conductor, and a heating element for said insulator having its terminals connected respectively with said transmission line and conductor.

5. The combination with a transmission line, of a conductor extending along said line and forming with said line the elements of a condenser, a second conductor extending along said line and insulated from said first-named conductor, and means energized by the charging current of said condenser for supplying current to said second named conductor, and a heating element for said insulator electrically connected with said second named conductor.

6. The combination with a transmission line, of an insulator for supporting said line, a capacitance conductor extending along said line and insulated therefrom, a supplemental conductor extending along said line and insulated therefrom, a step-down transformer having its primary connected between said transmission line and conductor, the secondary of said transformer having its terminals connected respectively with said transmission line and supplemental conductor, and a heating element having its terminals connected respectively with said transmission line and supplemental conductor.

7. The combination with a transmission line, of an insulator for supporting said line, a supplemental conductor extending along said line and insulated therefrom, a condenser electrically connected between said supplemental conductor and ground, a step-down transformer having its primary winding electrically connected in series in the connection between said supplemental conductor and ground, the secondary of said transformer having its terminals connected respectively with said transmission line and supplemental conductor, and a heating element for said insulator, said heating element having its terminals connected respectively with said transmission line and supplemental conductor.

8. The combination with an insulator, of a heating element for evaporating moisture from the surface of said insulator, means for supplying energy to said heating element, and means controlled by atmospheric humidity for controlling the supply of energy to said heating element, said means being arranged to supply energy when the air contains a predetermined degree of humidity and to cut off the supply of energy when the air is comparatively drier.

9. The combination with an insulator, of a heating element for said insulator, means for supplying energy to said heating element, and means controlled by the humidity of the atmosphere for controlling the supply of energy to said heating element.

10. The combination with an insulator, of a heating element for said insulator, and means controlled by the humidity of the atmosphere to which said insulator is subjected for automatically supplying energy to said heating element when the humidity of the atmosphere reaches a predetermined amount.

11. The combination with a transmission line, of an insulator for supporting said line, a heater for said insulator, means for divert-

ing energy from said line for energizing said heater, and means controlled by humidity of the atmosphere for controlling the supply of energy from said line to said heater.

In testimony whereof I have signed my name to this specification this 9th day of Dec., A. D. 1929.

ARTHUR O. AUSTIN.