Aug. 7, 1934.

A. O. AUSTIN

1,968,868

RADIOTOWER

Filed Feb. 10, 1930

3 Sheets-Sheet 1

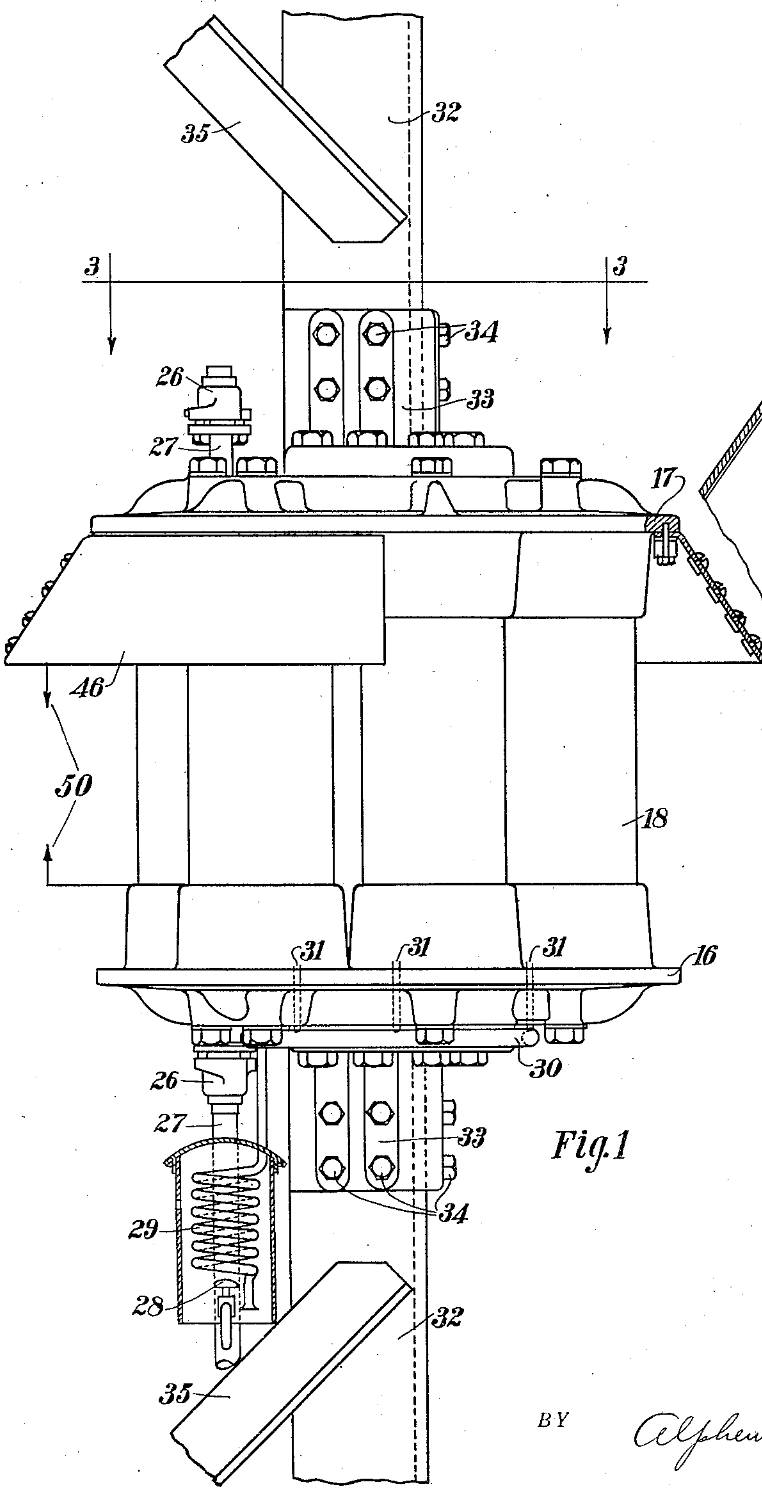

Fig.1

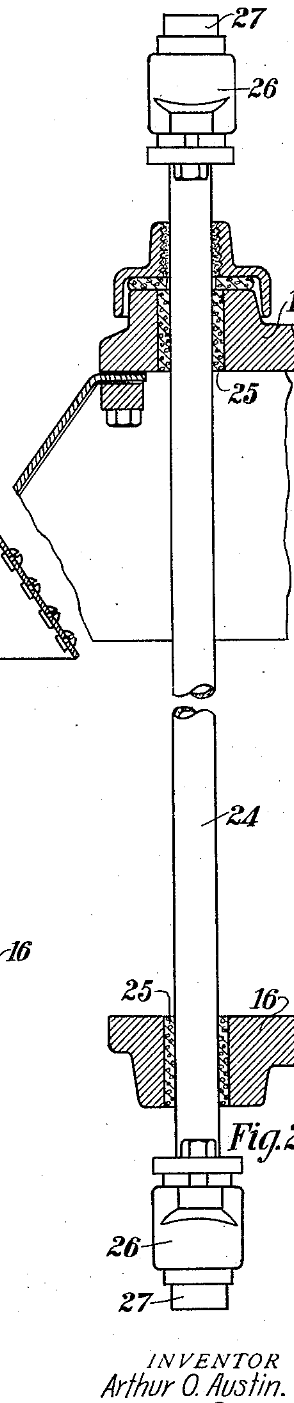

Fig.2

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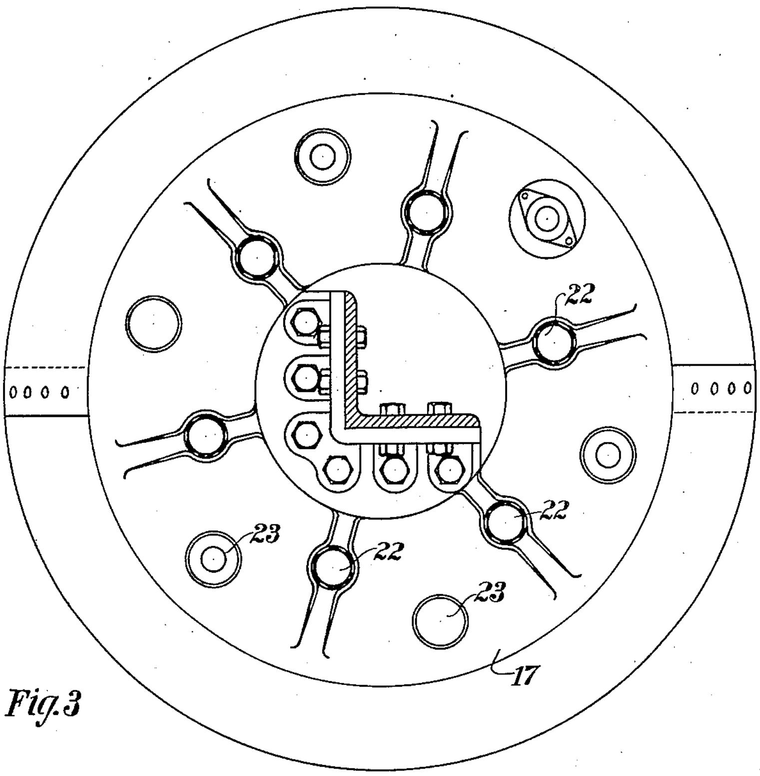

Fig. 3

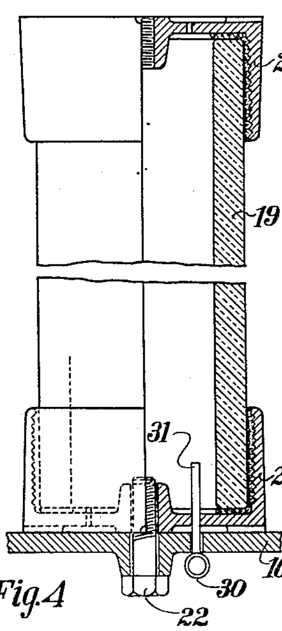

Fig. 4

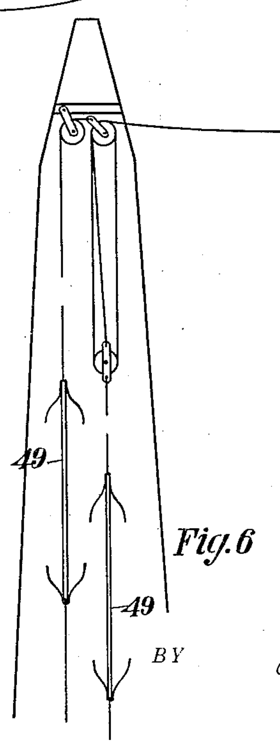

Fig. 6

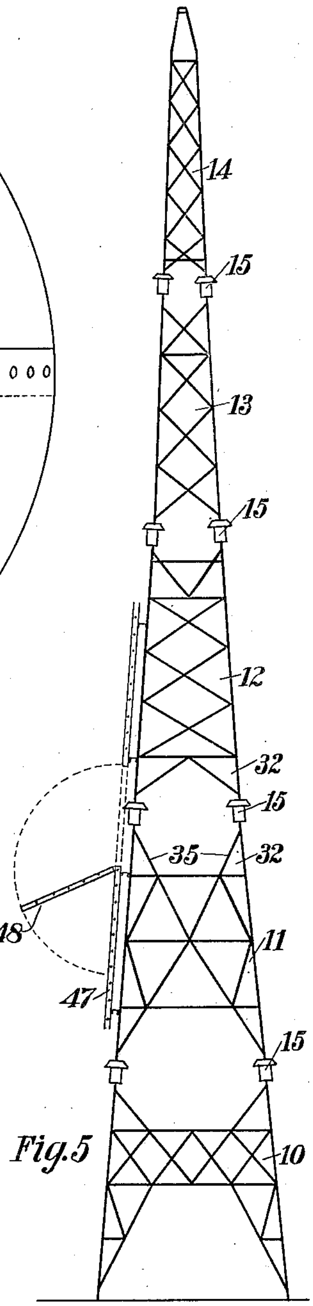

Fig. 5

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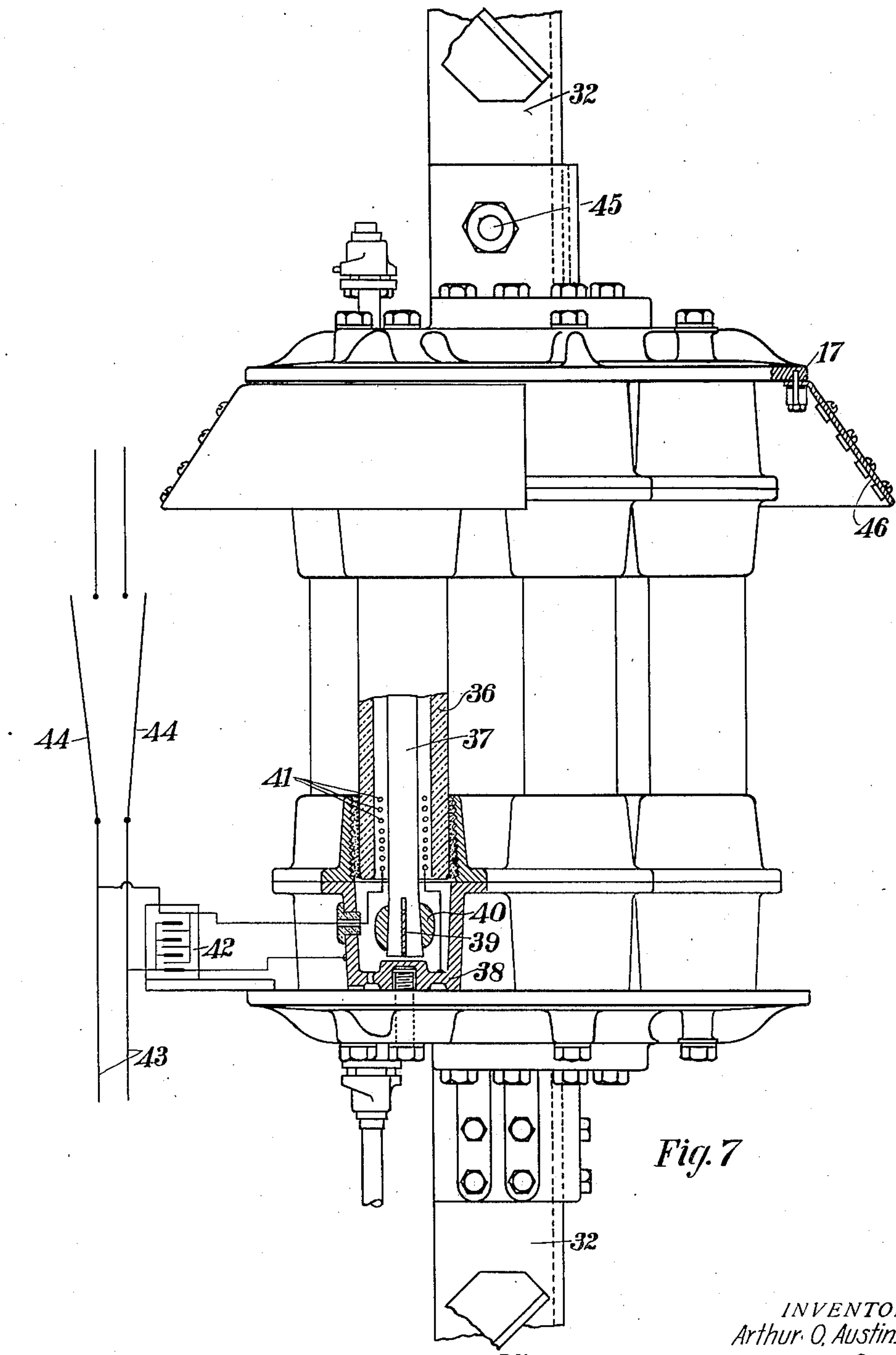

Fig. 7

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UNITED STATES PATENT OFFICE

1,968,868

RADIOTOWER

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Application February 10, 1930, Serial No. 427,128

9 Claims. (Cl. 173—251)

This invention relates to radio transmission towers and has for one of its objects the provision of a tower which shall have a minimum effect on the radiation from the supported antenna.

Another object of the invention is to provide improved insulation for the tower.

A further object of the invention is to provide improved means for sectionalizing the tower so as to reduce to a minimum the electrostatic capacity of the tower.

A further object is to provide an antenna support 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 an elevation with parts in section showing one form of sectionalizing insulator constituting a part of the present invention.

Fig. 2 is a vertical section of a detail of construction.

Fig. 3 is a horizontal section on line 3—3 of Fig. 1.

Fig. 4 is an elevation partly in section of one of the insulating members employed in the insulators shown in Figs. 1 and 3.

Fig. 5 is a diagrammatic elevation of the complete tower.

Fig. 6 is a diagrammatic view of the top of the tower showing the counter-weight connection for the antenna.

Fig. 7 is a view similar to Fig. 1 showing a slightly modified construction.

In radio transmission towers, the electrostatic capacity of the tower tends to cause an absorption of energy and frequently produces oscillations when the transmitting frequency approaches the natural period of the tower harmonics and is also likely to cause oscillation of the tower. This lowers the effective radiation or distorts the field appreciably. The current ascending in the antenna lead is counteracted to some extent by a current in the opposite direction in the towers. The current descending in the tower will depend upon well known electrical laws.

Insulating the tower by placing insulators at the base of the tower is of benefit, but in general the large electrostatic capacity of the tower to ground permits current to flow in the tower, particularly where the towers are large in size.

Even though the tower may be very thoroughly insulated at the base, the large electrostatic capacity between the tower and ground will permit of an appreciable flow of the undesirable current in the tower itself. Any current flowing in the tower tends to neutralize the current in the antenna or aerial so that to obtain a given radiation it is necessary to increase the current in the aerial. This requires an increase in the energy employed without an increase in useful output in radiation.

Another serious disadvantage due to the electrostatic capacity of the tower is that it tends to increase the electrostatic field about the aerial so that losses from brush discharge may be appreciable. This loss from brush discharge may be reduced by placing the towers at a considerable distance from the live part of the antenna system. Where this is done, however, the towers must be considerably higher, which increases the cost and makes it necessary to obtain greater available space. Where aerials are placed upon buildings, the limited space is a decided disadvantage in this connection.

If the electrostatic capacity of the tower could be eliminated, the tower would have little or no effect upon the energy losses or the effective radiation. It is possible to eliminate the effect of the tower to a very great extent by sectionalizing it. Where the tower is cut up into a number of zones using insulators of small electrostatic capacity, the effective electrostatic capacity of the tower as a whole is greatly reduced so that its adverse effect upon the transmitting system will be greatly reduced. While it is not possible entirely to eliminate the electrostatic capacity between the various sections of the tower, cutting the tower up into a number of sections, is equivalent to placing a number of condensers in series and this greatly reduces the effective electrostatic capacity for the upper sections of the tower, so that the undesirable current flowing in the tower is reduced very materially. The more completely the tower may be broken up the less will be its detrimental effect.

The difficulty of effectively sectionalizing a tower has heretofore been such that insulation has been confined almost entirely to the base of the tower where it is generally of least benefit. Where the sectionalizing of a tower is to be effective, it is necessary to provide small electrostatic capacity in the insulator. This requires a considerable length of dielectric so that the metal parts attached to the end of the insulator will be far enough apart so that the capacitance will be small. This may be accomplished by using insulators made preferably of porcelain to which end metallic members are attached.

Insulators of tubular section provided with a resilient connection are particularly suitable for this kind of work, as it is possible to utilize the mechanical strength of the dielectric to a very high degree and at the same time avoid serious stress produced by differential expansion and contraction between the metal and insulating member which might otherwise cause the destruction of the dielectric and the failure of the tower.

In the diagrammatic illustrative embodiment shown in Fig. 5, the tower comprises sections 10, 11, 12, 13 and 14 separated by insulators 15, the insulators 15 being shown more in detail in Figs. 1 to 4 inclusive. Each of the insulators 15 comprises a pair of attachment plates 16 and 17 spaced from each other by interposed insulating members 18. Each of the insulating members as shown in Fig. 4 is formed of a porcelain tube 19 made sufficiently strong to support its portion of the load with an ample factor of safety. Caps 20 and 21 are secured to the opposite ends of the tube 19 by means of cement interposed between the caps and tube, the cement being connected to the tube by a treated sanded surface similar to that shown in my prior Patent No. 1,284,975, issued November 19, 1918. The caps 20 and 21 are secured to their respective attachment plates by cap screws 22. The plates 16 and 17 are provided with extra perforations 23 for the insertion of temporary or supplemental supports between the plates to take the weight of the tower during its installation or in case of breakage of one or more of the porcelain tubes 19. When the tower is not in use, metal or wood struts of comparatively small diameter may be inserted between the plates and attached at the openings 23 and will not interfere with the insertion or removal of the insulating supports 19. The plates 16 and 17 are also perforated for the passage of an insulating tube 24 which may be made of porcelain or other suitable material for conducting gas to the top of the tower. Cork or other suitable packing 25 may surround the tube 24 where it passes through the metal plates to protect it against injury, and suitable unions 26 are provided for connecting the ends of the tube 24 to the metal gas pipe 27. This permits gas to be conducted to the top of the tower for beacon lights to illuminate the tower and the insulating tube 24 breaks the pipe up into sections so that it does not interfere with the operation of the antenna. The pipe 27 may also be employed for furnishing gas to burners 28 which heat coils 29 having their lower ends open to atmosphere and having their upper ends connected with pipes 30 which supply hot air through passages 31 to the interior of the tubes 19. In this manner the tubes may be heated to keep them dry at all times and maintain effective insulation. The plates 16 and 17 are attached to the corner members 32 of the tower by means of attachment blocks 33 and joints 34. It should be noted that the brace members 35 are spaced away from the ends of the corner posts 32 and extend obliquely upward and downward respectively so that the amount of metal adjacent the opposite terminals of the insulators 18 is reduced to a minimum and a certain amount of resiliency at the point of connection between the corner posts and the insulators is provided.

In the modification shown in Fig. 7, the porcelain tubes 36 are provided with inner reinforcing members 37 which may be made of wood and secured to their end caps 38 by friction plates 39 and clamping plates 40, in a manner more fully described in my prior Patent No. 1,497,319, issued June 10, 1924. The insulators 36 in this instance are heated by electrically energized heat coils 41 supplied by storage batteries 42 which are charged from conductors 43 provided with switch members 44 for opening the circuit across the insulators when the line 43 is not being employed for charging the batteries 42 or for illuminating the tower. The switches 44 are opened during transmission so that the conductor line 43 will not short-circuit the insulators. Instead of a rigid connection between the upper section of the corner post 32 and the plate 17, a pivot bolt 45 is provided in this case to permit of a degree of movement between the insulating section and the tower so that the parts may adjust themselves and thus eliminate unnecessary stresses in the insulator.

It is evident that a large sized tower having members near together, although separated by the insulators, will have an appreciable electrostatic capacity, which tends to neutralize the effect of the insulators. To obtain a good working combination, it is therefore desirable to use a different type of construction from that heretofore used for this class of work. In the particular construction which has been found advantageous, the corner tower members 32 to which the insulators are attached are made sufficiently strong so that they may project beyond the point of atachment of bracing members 35. Cross tie members are omitted in the tower where they would materially increase the electrostatic capacity between adjacent zones and thus neutralize the effect of the insulators. This construction has the material advantage that the spring in the corner tower members 32 permits of the installation of the insulator without setting up serious stress due to irregularities in the fabrication or warping in the steel members. This construction permits the insulator to be inserted so that the mechanical result is similar to that where the corner members extend directly through and is very advantageous, as it permits of the insertion of dummy or false members, if desired, during erection, at which time the tower may be subjected to very severe shock.

Where the tower design is such that it is necessary to prevent a high bending stress, the insulator may be attached rigidly to either the upper or lower member 32, and a pivotal connection provided at the other point of attachment, as shown in Fig. 7. This may be readily obtained by using a single bolt 45 to attach a shoe or other attachment member to one of the corner tower members.

In order to effectively insulate a tower, it is essential that insulation be maintained under various weather conditions. This is provided by making the upper plates 17 so that they will shed water. Further protection against wetting the surface of the insulator may be provided by additional weather or rain sheds 46. Where a very high degree of insulation is desired at all times, the insulators may be heated by a current of hot air allowed to flow through the bushing. In this case, the bases are made so that a hot current of air may be allowed to flow into the body of the insulator. A very slight rise in temperature on the surface of the insulator will keep these insulators dry; in fact all that is necessary is to keep these insulators slightly above the dew point. Heating is readily accomplished even though the tower is insulated as gas may be used for heating. The gas flows through a tubular member and the insulating zones are crossed by an insulating tube, preferably placed with the large insulators. Suitable tap-offs are provided for taking off a supply of gas for heating a supply of air which is allowed to flow up through the insulators. It is preferable to heat the air rather than allow the gases of combustion to flow through the insulator. If desired, a liquid fuel may be supplied or any other suitable arrangement for heating the various stacks of insulators.

One method of providing sufficient heat is to provide a storage battery at each zone placing small heaters inside the insulators or as to keep a current of air flowing into the insulators. These batteries may be charged when the tower is not in use for sending, by suitable switches which will make contact with an electrical source of supply but which will permit the insulating zones to function at other times. They may also be used for providing the tower with beacons when desired.

In providing means for climbing the tower, it is generally advisable to provide a ladder 47 provided with a pivoted section 48 which will require short-circuiting the insulating zone by anyone ascending the tower. Unless this is done, there is danger that anyone climbing the tower may be hurt by an induced voltage or a static charge. By providing movable or angle sections, it is possible readily to take care of this feature.

For the adjustment of the antenna or aerial, it is possible to use a rotating shaft with insulating sections corresponding to the insulating sections of the tower so that the aerial or cross conductor may be raised or lowered without ascending the tower. Where the aerial system is counterweighted, it is necessary to break up the tower leads or cables with insulators 49 so that under normal operating conditions the effect of the insulating zones will not be eliminated. This requires insulators of low electrostatic capacity. Where the induced voltage is low, wood strains or a combination of wood and porcelain insulators may be used to avoid burning. Discharge or arcing gaps may be provided across the sectionalizing insulators for lightning or other surge protection as shown at 50 in Fig. 1.

One effective method of insulating a tower is to use a wood member 37 made up of a single piece or of a number of pieces in the corner members. This member must have sufficient stiffness so that it will act as a compound beam when attached to the corner members. In order to provide effective insulation and to reduce the probability of burning as much as possible, the wood member is preferably covered by an end cap and a weather resisting jacket. Means of gripping the wood member so as to make it reliable in tension may be readily provided by utilizing one of the schemes shown in my prior Patent No. 1,497,319 for heavy strain insulators.

As the insulated tower makes it possible to install a station of smaller physical design for a given radiation, it may be possible to use a single tower in some cases running the aerial either to one side of the tower or up through the center of the sectionalized tower. In the so-called flat top aerial, used on high power telegraphic stations, the live part of the antenna or aerial comes very close to the tower. Where the aerial comes near the tower, the field is intensified and brush discharge or corona is likely to form on the aerial. This danger of brush discharge in the vicinity of the tower either requires a large increase in the size of the conductors in the aerial or limits the voltage of the aerial. Since the radiation will increase, approximately as the square of the current in the aerial, and since the current flowing into the aerial increases directly as the voltage, the effective radiation may be greatly increased by operating at a higher voltage, as permitted by the present invention, or a much smaller station may be provided for a given radiation or sending power by increasing the voltage.

In the sectionalized tower, it is possible to charge the upper portion of the tower to the same potential as the aerial. This eliminates the danger of discharge in the vicinity of the tower and in fact permits a material increase in the effective operating voltage for a given size of conductor or aerial. The larger tower members are comparatively easy to form so that brush discharge will not develop. By sectionalizing the tower, the electrical gradient of the tower may be controlled so that the neutralizing current in the tower will be reduced to a minimum, as previously explained. In addition to reducing the neutralizing current, the increased operating voltage is a material advantage. In addition, the sectionalized tower permits of the elimination of insulators at the tower for this class of construction since the aerial may be carried directly on the upper insulated tower section.

It is evident that the same scheme may be applied to a gravity supporting structure such as brick or cement stacks provided with insulating zones and suitable weather sheds. Between the insulating zones, the resistance of the structure should be low. If of tile, brick or cement, this portion should be screened or shunted by low resistance conductors, so that loss will not be incurred due to the current flow in these sections.

I^2R losses may be reduced by making the resistances very high so that the current is exceedingly small or by making the resistances very low. In the insulating zone the resistance is made exceedingly high and in the other zone the resistance should be preferably low.

I claim:

1. A radio transmission tower, comprising support members of conducting material and an insulator for separating a portion of said tower from ground, and a ladder for scaling said tower, said ladder having a grounded movable section of conducting material for spanning the tower insulator, said section electrically connecting the portions of said tower separated by said insulator when said section is in position to permit a person to ascend the tower.

2. A radio transmission tower, comprising support members of conducting material and an insulator for separating vertically spaced sections of said tower, an electrical heater for said insulator, a storage battery for energizing said heater, and an electrical circuit for charging said battery, said electrical circuit having a switch therein for opening said circuit when said transmission tower is in service.

3. A tower structure, comprising support members of conducting material and a sectionalizing insulator for said tower structure, said insulator comprising vertically spaced horizontally extend-

ing attachment members, a plurality of tubular porcelain insulators interposed between said attaching members and having their opposite ends secured to said attaching members respectively for withstanding both tension and compression, and means for removably securing supplemental supports between said attachment members.

4. A radio transmission tower comprising a plurality of legs and bracing members connecting said legs and separate sectionalizing insulators interposed in said respective legs and dividing said tower into a plurality of insulated sections, the bracing members for said tower being spaced a distance away from the insulators and inclined away from said insulators and leaving a portion of each leg section adjacent the insulators extending to the respective insulators beyond the connection between said legs and bracing members to provide resiliency in the portions of said tower connected with said insulators and to minimize the electrostatic capacity of said tower.

5. An insulator for sectionalizing the legs of radio towers comprising upper and lower frame members connected to adjacent sections of a tower leg respectively, a plurality of tubular dielectric members interposed between said frame members and connected to said frame members in spaced relation to one another, said dielectric members being separately removable from said frame members, and means for connecting temporary supports between said frame members to hold said frame members in spaced relation during erection of a tower.

6. An insulator for sectionalizing legs of a radio tower comprising upper and lower frame members adapted to be secured to adjacent ends of separated leg sections, a plurality of tubular dielectric members interposed between said frame members and detachably connected to said respective frame members and arranged to receive the compression due to the weight on the leg section above said insulator, and tension members of fibrous insulating material disposed within said tubular dielectric members and arranged to resist tension on said insulator produced by bending moments on the tower.

7. A radio tower comprising a plurality of legs spaced apart and insulators for sectionalizing each of said legs, each insulator comprising upper and lower frame members secured to adjacent ends of spaced leg sections, a plurality of spaced tubular dielectric members interposed between said frame members and having their opposite ends secured to the upper and lower frame members respectively, and tension members of fibrous dielectric material connecting said frame members for withstanding tension on the leg members due to bending moments on the tower.

8. A radio transmission tower having a plurality of legs each formed of sections of conducting material, and sectionalizing insulators interposed in said legs between said sections and electrically insulating said sections from one another and dividing said tower into vertically separated sections of conducting material insulated from one another, said sectionalizing insulators each comprising a plurality of dielectric, tubular members having their axes extending vertically to provide a minimum electrostatic capacity between the sections of the tower, said tubular members being mechanically attached in multiple relation to one another to the respective sections of said legs to transmit both tension and compression between said leg sections caused by bending moments on said tower, reinforcing members of dielectric material extending through each of said tubular dielectric members and attached to said leg sections to supplement said tubular members in transmitting tension between said leg sections, said tubular members and their reinforcements constituting the sole mechanical stress transmitting members connecting said leg sections.

9. A radio transmission tower comprising a plurality of legs, insulators individually separating vertically spaced sections of said legs, some of said insulators being rigidly connected to one adjacent leg section and pivotally connected to the other leg section, and cooperating with the other insulators to hold the tower sections in substantially fixed relation while permitting individual adjustment of leg sections relative to each other.

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