Dec. 15, 1936. R. L. JENNER 2,064,121

INSULATOR FOR RADIO MASTS

Filed Oct. 23, 1933

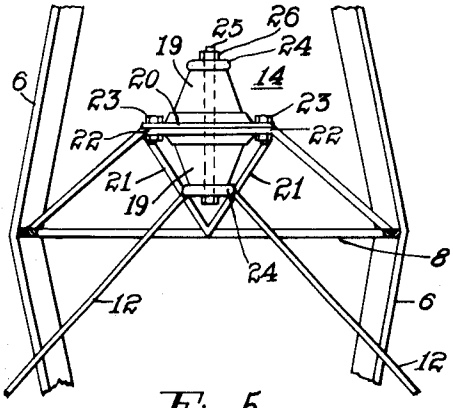


Fig. 5.

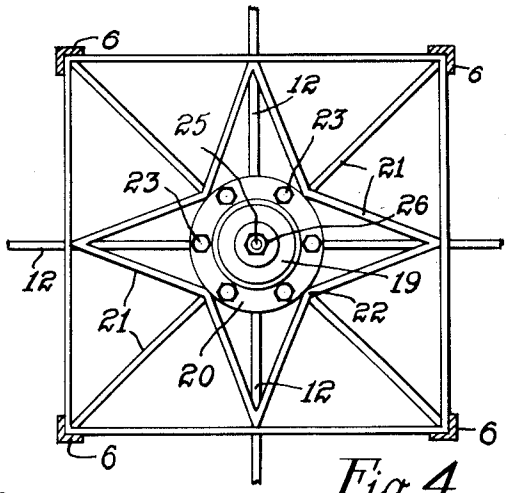


Fig. 4.

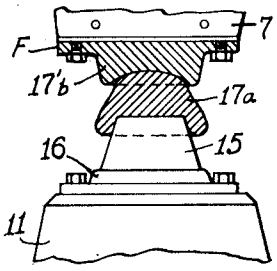


Fig. 6.

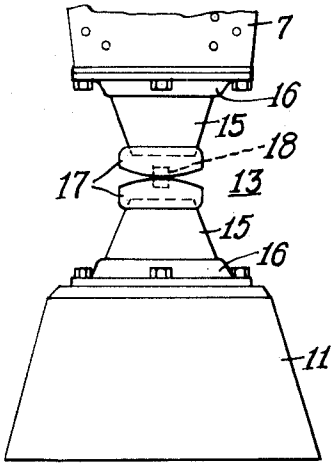


Fig. 2.

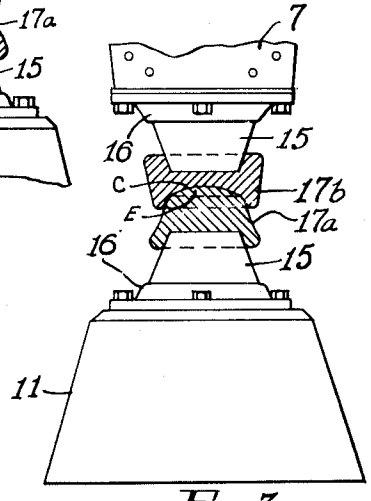


Fig. 3.

Fig. 1.

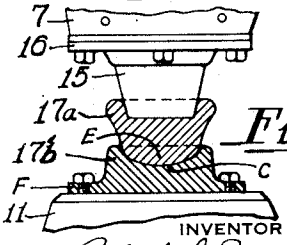


Fig. 7.

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INSULATOR FOR RADIO MASTS

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Application October 23, 1933, Serial No. 694,694

26 Claims. (Cl. 250—33)

This invention relates to radio broadcasting structures of the mast or tower type and to the manner of supporting such structures in a vertical position and insulating the same from ground. This application is a continuation in part of my application for Letters Patent of the United States Serial No. 542,518, filed June 6, 1931, and allowed January 18, 1933.

An object of this invention is the provision of radio broadcasting structures for antennae, of the mast or tower type, having a principal support at its base and auxiliary supporting means supplied thereto at one elevation only and located intermediate the ends thereof.

Another object of the invention is the provision of a radio broadcasting structure or antenna that shall be so mounted on insulator supports and so guyed that the electrical losses occasioned by current leakage through the supports to ground shall be a minimum, and that the capacity of the insulator supports shall be so low that the electrical losses in the circuits associated with the antenna caused by charging current shall be a minimum.

Another object of the invention is the provision of means for so insulating the antenna structure at its points of support that the capacitance to ground and the dielectric losses shall be extremely low.

A further object of the invention is the provision of insulators adapted to carry the weight of the antenna structure and form the principal support therefor, and of such design that the insulators may not be subjected to direct tension loads but only to forces in shear and compression.

Another object of the invention is the provision of a coupling for attaching or connecting the auxiliary or secondary supports to the antenna structure at a point wholly within the same and insulating the structure from ground through such supports.

A still further object of this invention is the provision of insulating elements for radio antennae, of the mast or tower type, that may be formed of duplicate parts so that the volume of insulating material used in the members may be reduced to a minimum, thereby decreasing the electrical losses in the insulation.

Other objects of the invention will in part be apparent and will in part be obvious from the following description taken in conjunction with the accompanying drawing, in which:

Figure 1 is a view in side elevation of a radio broadcasting antenna, of the tower or mast type, which is supported and insulated in accordance with one form of the invention;

Fig. 2 is a partial enlarged view in elevation of the base of the antenna structure and the insulators which form the principal support therefor;

Fig. 3 is a view similar to Fig. 2, partly in section, showing a modified form of principal support for the antenna structure;

Fig. 4 is an enlarged view in section taken on line IV—IV of Fig. 1;

Fig. 5 is a view in section taken on line V—V of Fig. 4; and

Figs. 6 and 7 are still further modified forms respectively of insulator supports utilized at the base of the antenna structure.

Throughout the drawing and specification, like reference characters indicate like parts.

In the drawing, a broadcasting antenna structure 5, of the mast or tower type, is illustrated. Mast 5 is formed from metallic structural members and comprises legs 6 having their lower ends secured to an adapter plate 7 which forms the base of the mast. Legs 6 diverge upwardly from the adapter plate 7 for a portion of the height of the antenna to an elevation slightly below line IV—IV of Fig. 1, and then from this elevation, the legs converge to a point at the top thereof. The mast legs 6 are tied together by horizontal braces or struts 8 and diagonal braces or struts 9.

The base of the antenna structure 5 is supported on a foundation 11 and is maintained in vertical position thereon by supporting members or guy wires 12. The supporting members or guy wires 12 constitute an auxiliary supporting means for the antenna structure and are coupled to the structure at one elevation only located between the base and the top thereof and preferably at a point wholly within the structure.

In order that the antenna structure may be insulated from ground at its base, a base insulator 13 is disposed between the adapter plate 7 and foundation 11 and carries the tower load. The antenna structure is also insulated from ground at its secondary support by means of an insulator 14 which constitutes a coupling whereby the guys 12 are attached to the mast and whereby the mast is insulated from ground through the paths provided by the guys.

The base insulator 13 comprises complementary truncated or frusto-conically shaped insulating members 15, the bases of which are secured in flanged members 16 that are bolted to the adapter plate 7, and to the foundation 11, respectively. The smaller ends or the apices of the conically shaped insulating members 15 are articulated by means of caps 17, the abutting or adjacent surfaces of which may be curved. Caps 17 may be

coupled together by means of dowel pin 18 which takes the shear load imposed on the base of the tower as the result of wind pressure.

Since the abutting or adjacent surfaces of caps 17 are curved as indicated, a joint is formed which in effect functions like a universal joint, whereby, if the tower tends to sway or tilt, there may be freedom of movement between insulator members 15 at the contacting surfaces of these caps. By articulating the insulator members 15 in this manner, they will not be subjected to direct tension loads and will, therefore, be required to withstand only the shear and compression loads encountered.

In Fig. 3 of the drawing, insulator members 15 are articulated by modified forms of caps 17a and 17b. These caps are similar to caps 17 except that cap 17b is provided with a spheroidal cavity C and cap 17a is formed with a spheroidal extension E which when articulated as shown in Fig. 3, form a ball and socket joint. This joint also provides freedom of movement between the insulator members 15, if the tower tends to sway or tilt when blown by the wind, so that the insulators will not therefore be subjected to direct tension loads.

In Fig. 6 of the drawing, the antenna structure is shown as being mounted on only one supporting insulator member 15. In this form of construction the base of the insulator is disposed in a flanged retaining member 16 which is bolted or otherwise secured to foundation 11. The top of the insulator is provided with a cap 17a which has a ball and socket connection with a member 17'b. Member 17'b has a flange F bolted to the adapter plate 7 at the base of the antenna structure.

In Fig. 7 of the drawing, only one base supporting insulator member 15 is utilized, but instead of being secured to the foundation 11 as in Fig. 6, the base of the insulator is disposed within a flanged retaining member 16 which is secured to the adapter plate 7 of the antenna structure, and the small end of the insulator member is provided with a cap 17a which in turn is nested in a socket member 17'b having a flange F bolted to foundation 11.

In each of the forms of base insulator support described above, it is apparent that each constitutes but a single capacitative impedance path to ground. In the form shown in Figs. 1, 2 and 3, such capacitative impedance path comprises a plurality of separate insulator members disposed in line, whereas in the forms illustrated in Figs. 6 and 7, the impedance path is constituted by a single insulator member.

As may be seen by a reference to Figs. 4 and 5, the guy wires 12 are coupled to the antenna structure by means of insulator member 14, and this insulator member with the guys and the structure provides but a single capacitative impedance path to ground; that is, by considering insulator member 14, the antenna structure and the guys 12 as forming a condenser, the condenser is in series with guy wires 12 which wires are in parallel, and for this reason these wires may be considered as a single conductor in series with the insulator support 14 so far as the single capacitative impedance path to ground is concerned. The antenna structure herein illustrated therefore includes but two capacitative impedance paths to ground. For this reason the capacity of the principal insulator support 13, or the supporting insulating member 15 of Figs. 6 and 7, and the capacity of insulator member 14, are relatively low so that the electrical losses in the circuits associated with the antenna structure, caused by condenser charging current will be low. Furthermore, since the principal supporting insulator 13 provides but a single resistance path to ground, the losses in the insulator members thereof caused by leakage current (purely a resistance loss) will also be low.

In the design of antenna structures of the type herein contemplated, temperature rise in the supporting insulators, because of electrical losses, is a factor tending to limit the voltage and frequency at which such structures may be operated.

By way of example, if an antenna is supported on two insulators placed end on end, as in Figs. 1, 2 and 3, and operated at a given voltage and frequency, the electrical loss in the insulators is manifest by a temperature rise of say, 10½ degrees C.; if the antenna is supported on a single insulator member 15, as in Fig. 6, in which case the small end is "live", and operated at said given voltage and frequency, the electrical loss in member 15 is manifested by a temperature rise of say 41½ degrees C.; and if the mast is supported on a single insulator 15, as in Fig. 7, the large end of the insulator member is alive, and operated at said given voltage and frequency, the loss in insulator member 15 is manifested by a temperature rise of say 19 degrees C.

The principal advantage to be gained by having the large end of the insulator member 15 on the foundation, as in Fig. 7, is that the capacity expressed in farads, is much less than in the case where the large end is "live" and secured to the base of the mast as in Fig. 6.

In determining which form of insulating supports that shall be used for mounting the antenna structure on foundation 11, the electrical losses in the insulator and the capacity thereof are taken into account. If the voltage and frequency of the voltage applied to the antenna structure is low and the electrical losses in the insulation are of importance, then the form of mounting shown in Fig 6 may be utilized.

In cases where the voltage and/or the frequency of the voltage to be applied to the antenna structure is high and the expense of construction is of consequence, but the electrical losses are not so important, the base of the insulator may be connected directly to the base of the antenna structure as in Fig. 7, in which case the base of the insulator will be live and the small end thereof will be at ground potential. When the insulator member is disposed with its large end adjacent the base of the tower or antenna structure, the voltage distribution is such that the temperature rise in the insulating material will be lower at any voltage and frequency than in the case where the large end of the insulator is disposed adjacent the foundation and at ground potential.

In cases where the voltage and/or frequency of the voltage impressed on the antenna structure is high and the electrical losses in the supporting insulators are important, then the form of insulation shown in Figs. 1, 2 and 3 is preferred. By using two cone insulators mounted with their small ends adjacent, the temperature rise in the porcelain of the insulators will be relatively low and the insulation necessary to prevent flash over and current leakage to ground will be high.

With either type of base insulator supports illustrated in Figs. 1, 2, 6 and 7 the bending moments imposed on the insulators caused by wind

pressure against the antenna structure will be the same. This bending moment is equal to the horizontal shear force imposed on the insulators multiplied by the height of one of the insulators. The shear force is caused, as stated above, by the horizontal component of the wind pressure exerted on the antenna structure as well as by the horizontal component of the load on the supporting insulators which is set up as a result of tilting of the antenna structure.

In the case where two insulator members 15 are utilized, the bending moments set up in either one of these insulators is equal to the value of the horizontal shear force acting at the center of the articulated members 15 multiplied by the height of one of these members. If a single insulator having a height equivalent to the articulated height of insulator members 15, the bending moment would then be twice as great as the bending moment imposed on either one of these insulators. If an equivalent single insulator were used and such insulator had the same slope as either of insulator members 15, the volume of porcelain required to make such single equivalent insulator would be four times the volume of either insulator 15 and would be much more difficult to manufacture. Therefore, by utilizing two insulators placed end on end, as illustrated, the necessary strength and insulation are provided with only half of the amount by volume, of porcelain. Since the volume of porcelain in two such insulators is only half that which is required in an equivalent single insulator the electrical losses, both electrostatic and resistance, will be much less.

Insulator 14 to which the supporting members or guy wires are attached, comprises two complementary frusto-conical shaped hollow insulating members 19, the bases of which are secured to a metallic flanged plate or retaining member 20 mounted on a frame 21 disposed in the center of the antenna structure 5. The frame 21 which supports member 20 is brought to a crown as at 22. Bolts 23 which extend through member 20 and crown 22 securely hold the insulator 14 on the frame.

The small ends of the frusto-concially shaped insulating members 19 may be provided with caps 24 that are held in place by means of a bolt 25 that extends through members 19. A nut 26 threaded on bolt 25, is drawn up tight so that members 19 are placed in a state of initial compression. A plurality of bolts may be used to plaee the insulating members 19 in compression if desired. The guy wires 12 are connected to the bottom cap 24 of insulator 14.

When the antenna structure 5 is subjected to wind pressure on one side, the guy wires 12, which are initially in tension, tighten on the windward side and slacken on the leeward side, whereby a downward force and a horizontal shear force are imposed on cap 24. These forces are taken by bolt 24 in tension and the insulator members 19 in compression, and transferred downwardly into the structure.

While I have described the supporting members or guy wires 12 as being connected to a single insulator 14 centrally disposed within the antenna structure, it is to be understood that a separate insulator, such as an insulator of the bomb guy type may be provided for each of the supporting members or guy wires and that the supporting members may be secured to any desired part of the mast.

It is readily apparent from the above description that the antenna structure and the insulator support therefor are of simple construction and economical to manufacture. This form of construction permits the use of insulating supporting members of reduced size and weight with a consequent reduction in the volume of insulating material required in the make-up of such insulator supports.

It is also apparent that by the use of a single insulator to which the guy wires are attached, the electrostatic capacity to ground will be much less than in the case where each guy wire is provided with a separate insulator as has been the practice heretofore.

Having thus described the invention it is to be understood that various modifications and changes may be made in the structures herein disclosed without departing from the spirit or the scope of the invention. It is desired, therefore, that only such limitations shall be placed on the invention as are imposed by the prior art and the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. A radio antenna comprising a mast, a foundation for said mast, supporting members connected to said mast at a single point for maintaining it vertically on said foundation, universally connected insulating members between said mast and said foundation whereby the mast is free to turn relative to said foundation, and a single insulating member rigidly mounted within said mast and to which each of said supporting members is connected, said last mentioned insulating member being so disposed as to distribute the forces exerted by the supporting members downwardly through said mast.

2. A radio antenna comprising a vertically extending girder mast and means for supporting said mast at a single point in its height, including an insulator formed of complementary sections disposed within said mast, a coupling for putting said insulator sections in compression, a plurality of guy members attached to said coupling, and means for supporting said insulator within and rigidly securing the same to said mast so as to distribute the forces exerted by the guy members downwardly through the legs of said mast.

3. A radio antenna comprising a base, a vertical canti-lever radiating antenna supported in vertical position on said base and insulating means disposed between said antenna and said base, said means including substantially conically shaped complementary insulating members disposed with their apices articulating together.

4. An insulating support for a radio radiating antenna of the vertical type, comprising complementary frusto conical shaped insulating members designed to be positioned between the antenna and its foundation, one of said insulating members being superimposed over the other of said members and a universal joint connection between said insulating members whereby relative movement of said insulating members may take place.

5. The combination with a vertically extending girder mast forming the radiating antenna, of an insulator disposed between said mast and its foundation, comprising complementary members of substantially frusto conical shape, one of which is superimposed over the other so that their smaller ends are adjacent, and a dowel pin disposed between the ends of and extending

along the longitudinal axes of said frusto-conical members for holding the smaller ends of said members in alinement and resisting relative lateral displacement of said members.

6. An aerial comprising an upright structural mast forming the radiating antenna, members secured to said mast at a single point along its height for maintaining it in vertical position and means for insulating said mast at its base and at its single point of connection to said support members including complementary insulating members of frusto conical shape between said mast and its base and having the smaller ends thereof articulating together, an insulating member rigidly mounted within said mast to which each of said supporting members is connected, and means putting said last mentioned insulating member under initial compression independently of the loading imposed thereon by the support members so as to distribute the loading evenly to the legs of said mast.

7. A radio radiating antenna comprising a vertically extending single conductor canti-lever mast, guy members connected to said mast wholly within the same for maintaining it in vertical position, and means for insulating said mast at its base and at the connection to said supporting members, including complementary articulated insulating members disposed between said mast and its base and connected together by a universal bearing, and an insulator member rigidly mounted within said mast to which said guy members are connected.

8. The combination with a vertical radiating antenna canti-lever mast, of means for insulating and supporting said mast comprising complementary frusto conical shaped insulating members between the mast and its foundation having the bases thereof secured to the mast and foundation and their smaller ends adjacent to each other, caps on the smaller ends of said insulating members, and means for universally joining said caps together.

9. A radio radiating antenna comprising a vertical relatively slender canti-lever mast provided with a single base insulator on which the mast is supported and by which it is insulated from ground, and means to anchor said mast to resist tipping thereof, said anchor means being connected to the mast at a point wholly within the same, and provided with insulation to insulate the mast from ground.

10. In a radiating antenna of the self-supporting canti-lever type, a relatively slender mast adapted to alone function as an antenna and supported at one point at its base and provided with insulation at its base adapted to support the weight of the mast and insulate the same from ground, and guys for holding the mast in a vertical position, said guys having a coupling disposed wholly within and attached to the mast and located intermediate the base and top thereof, there being insulation for insulating the mast from ground through the guys.

11. In an antenna of the self-supporting type, a relatively slender mast adapted to alone function as an antenna and supported at one point at its base provided with insulation at its base adapted to support the weight of the mast and insulate the same from ground, and guys for holding the mast in a vertical position, said guys having a coupling disposed wholly within and attached to the mast and located intermediate the base and top thereof, the coupling comprising an insulator supported by the tower and a tension member so connected to the insulator and guys that the insulator is strained in compression by the load imposed thereon by said guys.

12. A wave antenna comprising a vertical mast constructed of structural members so bonded together that it functions effectually as a single continuous vertical conductor, said mast being supported at a single point at its base and insulated from ground at its base and provided with auxiliary supporting means to hold the same in a vertical position, said auxiliary supporting means being coupled to the mast at a single point wholly within the same and in the vertical axis thereof and located at a substantial distance above the base, the mast also being insulated from ground through said auxiliary supporting means.

13. A wave antenna comprising a vertical mast constructed of structural members bonded together so as to form a rigid substantially continuous conductor adapted to alone function as an antenna, said mast being supported at a single point at its base and insulated from ground at its base and provided with auxiliary supports for holding the same in a vertical position, said supports being anchored in the ground and connected to the mast wholly from within the same and at a single elevation above the base, there being means for insulating the mast from ground through said supports and providing but a single capacitative impedance path therethrough to ground.

14. A wave antenna comprising a vertical mast constructed of structural members so bonded together that it functions effectually as a single conductor, said mast being insulated from ground at its base and provided with auxiliary supporting means coupled to said mast wholly from within the same and at a single elevation intermediate the ends thereof, the coupling including two frusto-conically shaped insulators of ceramic material having their bases articulated and a tension member extending axially through the same to hold the insulators in compression, the tension member being attached to the auxiliary supporting means.

15. In an antenna of the self-supporting type, a relatively slender canti-lever mast adapted to alone function as an antenna, a single support insulator at the base of the mast on which the same is supported, an insulator supported within the mast at a point intermediate the base and top thereof and a plurality of guys connected to said insulator for supporting the mast in vertical position.

16. In an antenna of the vertical type, a relatively slender canti-lever structure adapted to alone function as an antenna, a foundation, a single cone type insulator interposed between the base of the structure and the foundation, said cone having its base secured to the base of the structure and its apex universally connected to the foundation, and a plurality of insulated guys attached to the mast at a point wholly within the same and located at an elevation intermediate the base and top thereof.

17. In an antenna of the vertical mast type, a relatively slender canti-lever mast adapted to alone function as an antenna, a foundation, a single cone type insulator interposed between the base of the mast and the foundation, said cone having its base secured to the foundation and its apex universally connected to the base of the mast, and a plurality of insulated guys

attached to the mast at a point wholly within the same and located at an elevation intermediate the base and top thereof.

18. In an antenna of the self-supporting type, a relatively slender canti-lever mast adapted to alone function as an antenna and mounted on a single support insulator at its base, a rigid frame disposed within the mast and supported by the same at an elevation intermediate the base and top thereof, an insulator supported on the frame, and a plurality of guys connected to said support insulator for supporting the mast in vertical position.

19. A radio antenna comprising a relatively slender canti-lever mast provided with a base insulator adapted to support the mast and insulate the same from ground, and a plurality of guys attached to the mast and insulated therefrom, the points of attachment of the guys being wholly within the mast.

20. A low electric loss guy system for radio antenna of the vertical cantilever type comprising an insulator disposed wholly within and supported by the mast, a plurality of guys arranged to support the antenna against overturning as the result of wind pressure in any direction, and means connecting the guys to the insulator to strain it in compression.

21. Base insulation and support for broadcasting antenna structure of the vertical type comprising a base member adapted to be anchored to a foundation, a single frusto-conical insulator supported in the member, and a bearing member on the apex of the insulator, having means for forming a universal support connection of the base of the structure to the insulator.

22. Base insulation and support for broadcasting antenna of the vertical mast type comprising a base member adapted to be anchored to a foundation, frusto-conical insulators disposed in inverted relation to each other and in axial alinement, one of said members being secured in the base member and the other being provided with means for securing it to the base of the antenna, and means providing a universal joint between said insulators to allow relative movement of the insulators at the joint in response to swaying or tilting of the antenna.

23. An insulator for the purpose set forth comprising two elements of insulating material and of substantially frusto-conical shape disposed in articulated relation with their apexes adjacent each other, the base of one element being provided with means for attaching it to structure to be insulated, and the base of the other element being attached to another element from which the structure is to be insulated.

24. Base insulation and support for broadcasting antenna structure of the vertical type comprising a base member adapted to be secured to the base of the structure, a single frusto-conical insulator disposed in said member, and a bearing member on the apex of the insulator having means for forming a universal connecting joint between the apex of said insulator and said foundation.

25. An insulating and support unit for broadcasting antenna of the vertical mast type comprising a base member adapted to be anchored to a foundation, truncated support members of insulating material disposed one above the other and in vertical alinement, one of said members being secured at one end in the base member and the other being provided with means for securing one end thereof to the bottom of the antenna, and means directly connecting and providing a universal joint between adjacent ends of said insulating support members to allow relative movement of said members at the joint in response to swaying or tilting of the antenna.

26. A radio antenna comprising a foundation, a vertical radiating antenna structure supported in vertical position on said foundation, and an insulating unit composed of insulating members positioned one above the other and between said antenna and said foundation and in substantial vertical alinement with the antenna structure and having a universal joint between and connecting adjacent ends thereof, the opposite ends of said insulating members being rigidly secured to said foundation and said antenna structure respectively.

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