July 3, 1934. F. S. SMITH 1,965,007

ELECTRIC CONDENSER CONSTRUCTION

Filed Dec. 14, 1931

Fig. 1.

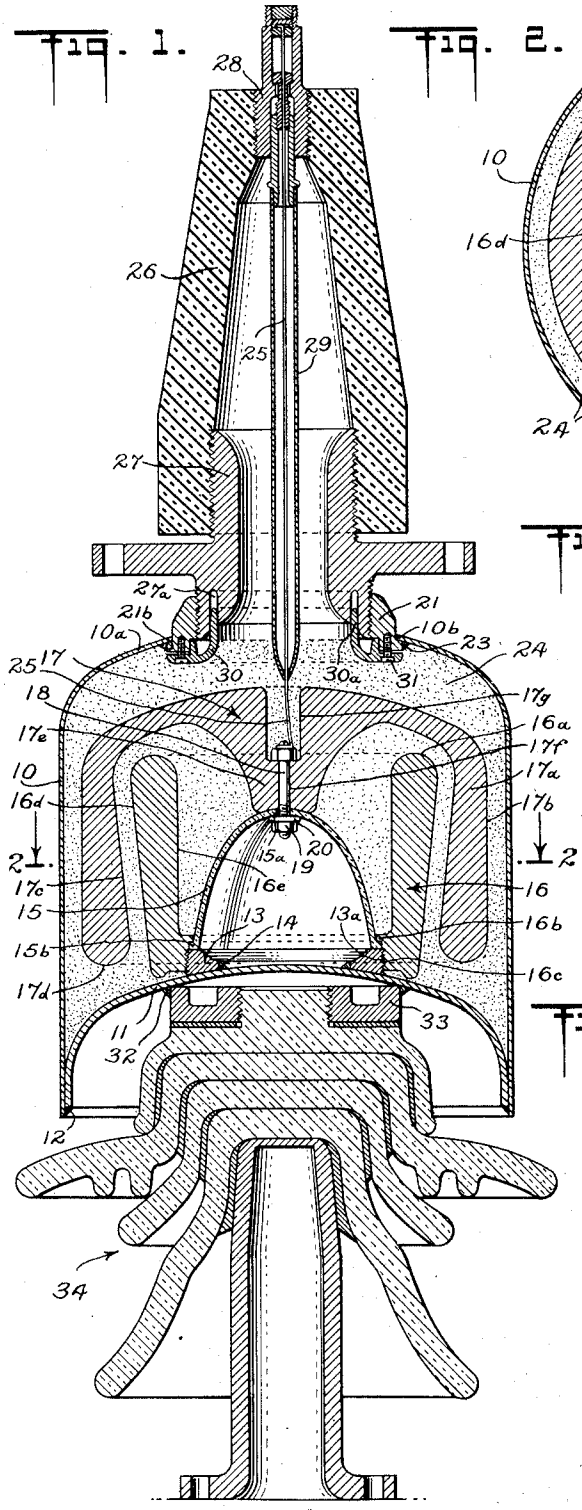


Fig. 2.

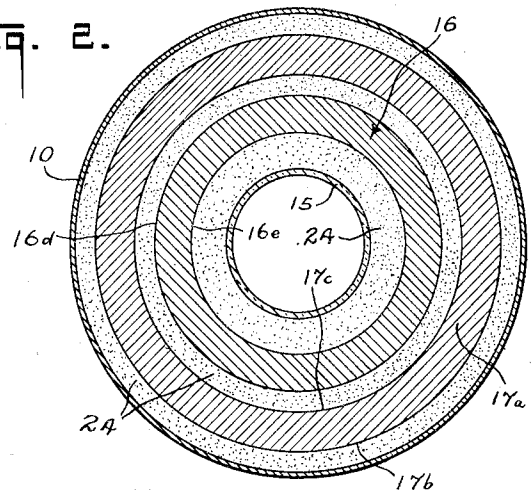


Fig. 3.

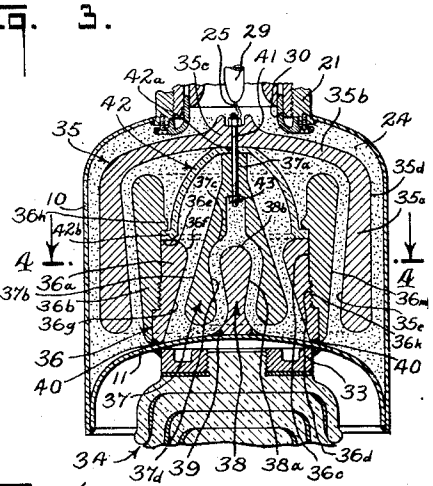
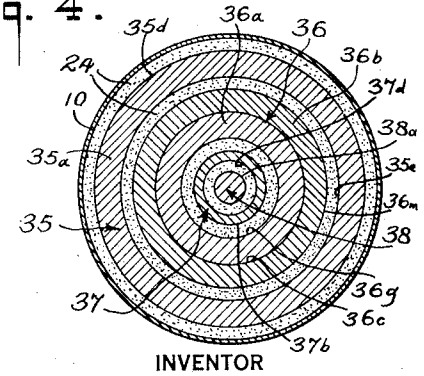


Fig. 4.



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ELECTRIC CONDENSER CONSTRUCTION

Franklin S. Smith, New Haven, Conn.

Application December 14, 1931, Serial No. 580,911

22 Claims. (Cl. 175—41)

This invention relates to electric condenser construction and more particularly to a high voltage condenser construction of relatively low capacity such as is used in relating a relatively low voltage carrier current signalling system to a high tension transmission line or the like.

One of the objects of this invention is to provide a simple, inexpensive but thoroughly practical condenser construction of the above mentioned type which will be small, compact and yet provide adequate capacity while withstanding dependably and reliably the high voltages to which it is subjected. Another object is to provide a condenser construction of the above mentioned character in which there is achieved a high capacity per unit volume and a high voltage rating per unit volume. Another object is to provide a condenser construction of the above mentioned character that may be readily and easily related to a high voltage transmission line, which will be capable of long continued operation without supervision and in which maintenance is reduced to a negligible minimum if not entirely eliminated. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing in which are shown two of the various possible embodiments of my invention,

Figure 1 is a vertical central sectional view of a condenser embodying certain features of my invention;

Figure 2 is a horizontal sectional view as seen along the line 2—2 of Figure 1;

Figure 3 is a vertical central sectional view, like that of Figure 1, certain parts however being omitted, showing a modified form of condenser construction also embodying features of my invention; and

Figure 4 is a horizontal sectional view as seen along the line 4—4 of Figure 3.

Similar reference characters refer to similar parts throughout the several views of the drawing.

As conducive to a clearer understanding of certain features of my invention, it might at this point be noted that, in high voltage transmission lines, there is frequently related to the conductors of the line a relatively high frequency carrier current system of signalling so that one or more of the conductors of the high voltage line may be utilized to form the circuit of the signalling system. The voltages at which transmission lines are operated frequently exceed 150,000 volts, and this fact presents a number of difficulties in associating a manually operated signalling system such as a telephone circuit to the high voltage line. The high frequency carrier current system is preferably related to the high voltage transmission line by capacity couplings, and great care must be exercised in isolating the high voltage energy of the transmission line from signalling circuit or system, while at the same time insuring an adequate capacity at the carrier current frequency to achieve the desired coupling.

One of the dominant aims of this invention is to provide a coupling capacity that will be inexpensive, light in weight, easily installed, preferably upon poles or like outdoor construction, while at the same time achieving safety and dependability of operation.

Turning now to Figure 1 of the drawing, I provide a tank or casing 10 preferably made of pressed steel and heavy enough to withstand substantial pressures; the casing 10 has formed integrally therewith the upper wall 10*a* through which, in a manner more clearly described hereinafter, connection of the condenser contained within the casing 10 is made to the high tension transmission line.

The lower end of the casing 10 is closed by a steel shell 11 that is preferably outwardly concave and that is welded about its periphery to the lower peripheral portions of the casing or tank 10 as at 12, the welding not only achieving a secure and strong mechanical connection but also one that is air-tight.

Before assembling the closure 11 to the container 10, these parts being of round or cylindrical cross section, there is secured to the upper face of the shell 11 and positioned coaxially therewith a metal collar 13 exteriorly threaded as at 13*a* and welded to the shell 11, as at 14, about the inner peripheral portions of the collar 13.

Resting upon the upper flat face of the ring or collar 13 is an inverted dome-like member 15 of any suitable solid dielectric material, such as Pyrex glass, having an opening 15*a* at its apex and having about its lower end a laterally and peripherally extending flange 15*b*.

There is first slipped over the dome-shaped insulating member 15 a condenser plate or element 16 of annular form (see Figure 2) and made of any suitable metal, conveniently cast and with

its exposed surfaces suitably smoothed over to avoid sharp projecting points. The member 16 is of substantial thickness, but is of lesser thickness at its lower end than it is at its upper end; in fact it preferably gradually increases in thickness towards its upper end (see Figure 1) where it is rounded, as at 16*a*, into an upwardly exposed annular surface that is of relatively long radius of curvature, the purpose of which is more clearly described hereinafter.

At its lower interior end the condenser element 16 is bored out to provide an inwardly directed lip or flange 16*b* adapted to rest upon and about the flange 15*b* of the insulator 15 and to provide a substantially cylindrical portion which is threaded as at 16*c* ultimately to mate with the threaded portion 13*a* of the collar 13.

There is then related to the upper end of the insulating dome 15 a coacting condenser element generally indicated at 17; the latter has a generally cylindrically shaped portion 17*a* whose outer face 17*b* is truly cylindrical so that ultimately it is parallel to the inside wall of the casing 10 with which it is ultimately assembled concentrically but spaced therefrom. Its inner face 17*c* is tapered or inclined so as to extend parallel to the outer face 16*d* of the condenser element 16 but spaced therefrom, it being noted here that the inner face 16*e* of the condenser element 16 is preferably truly cylindrical.

The maximum outside diameter of the member 16 and the minimum inside diameter of the portion 17*a* of the member 17 are substantially equal or so proportioned that the member 16 can be easily fitted up into the member 17, or so that the member 17 may be brought down over and about the member 16.

The part 17*a* of the condenser element 17 (see Figure 1) thus gradually increases in thickness so that at its lower end 17*d* it has sufficient thickness to give its outer and downwardly directed exposed face a curvature of large radius, the purpose of which is more clearly described hereinafter.

The member 17 has an upper central portion that is downwardly extended as at 17*e* to form a boss adapted to rest upon the upper or apex portion of the insulating dome 15 and it has a central opening 17*f*, counterbored as at 17*g*, to receive a bolt 18 that passes through the opening 15*a* in the member 15 whereupon its lower threaded end receives a nut 19, a suitable washer 20, such as fiber, felt or the like, of suitable yieldable material being interposed between the nut and the member 15.

Thus the condenser element 17 may be rigidly and coaxially secured to the insulating member 15, and, the condenser element 16 being now virtually locked between the member 17 and the flange 15*b* of the insulator 15, the assemblage is now ready to be related to the ring or collar 13.

This assemblage is now placed upon the collar 13, the latter already being welded onto the shell or wall member 11, with the insulating dome 15 resting upon the upper face of the collar 13 and centered with respect thereto; thereupon the condenser element 16 is threaded down upon the threaded portion 13*a* of the collar 13, access thereto being permitted through the space between the lower end portion 17*d* of the member 17 and the shell 11. Thus the condenser element 16 is secured in position onto the ring 13 while the lip or flange 16*b* thereof comes down over and seats upon the flange 15*b* of the member 15, thus locking the latter to the collar 13 and thus holding the condenser element 17 properly centered and coaxially related not only to the condenser element 16 but also to the shell 11.

Moreover the condenser elements will be seen to be held in spaced relation to each other but dependably insulated from each other by the insulating support 15.

The shell 11, with the above mentioned parts carried thereby, is now related to the cylindrical container 10 and the peripheral portions of the two welded together as at 12, as above already pointed out. The upper end wall 10*a* has a relatively large opening 10*b* therein, into which has been fitted an interiorly threaded collar 21, the latter preferably having a flange 21*b* overlapping the under or inner face of the wall 10*a* and being welded to the latter as at 23.

The space between the condenser elements 16 and 17 and between the latter and the casing 10—11 is now filled with a solid dielectric material which preferably and illustratively, to achieve certain advantages pointed out hereinafter, consists of ground or powdered fused quartz or ground or powdered Pyrex glass; it is indicated in Figures 1 and 2 by the strippling 24. This powdered material may be injected into the spaces in any suitable way, and if desired, some of it may be filled into the interior spaces prior to the assembly of the closing shell 11 to the container proper 10.

A suitable conductor 25 is electrically connected to the condenser element 17 in any suitable way and that conductor is to be electrically connected to the high voltage lead or terminal of the high voltage terminal construction.

This terminal construction, certain details of which are not described in detail herein but as to which reference may be made to my copending application, Serial Number 580,910 filed December 14, 1931, includes a solid dielectric tube-like or sleeve-like housing 26 having in sealed threaded connection therewith, at its lower end, a metal bushing 27, and at its upper end a hollow plug 28 which holds, in depending relation, a tubular conductor 29 which is to be held coaxially with the inner cylindrical face of the bushing 27. The housing 26 is preferably made of phenolic condensation product, molded in any suitable manner, and the threaded connections thereof with the parts 28 and 27 may be sealed in any suitable manner as by means of a cement if desired. The lower end of bushing 27 is threaded so as to be received within the threaded collar 21 welded to the upper part of the casing 10. The conductor 25 which leads from the condenser element 17 is intended to be threaded up through the tubular lead 29 and through the plug 28 and related parts, when the terminal is ready to be assembled to the casing 10.

Before assembling the high voltage terminal to the casing 10, there is threaded into the collar 21 a suitable plug (not shown) through which a connection leads to a suitable exhaust pump. The condenser construction thus far described is then placed in a suitable oven or the like and heated to a temperature of around 300° or 400° centigrade, during which heating process the exhaust pump, connected to the plug threaded into the collar 21, removes the moisture that is driven out of the apparatus and particularly out of the powdered solid dielectric material and thus the latter is thoroughly dried. Where the member 26 of the high voltage terminal is made of phenolic condensation product, the drying process is carried on as above described in the absence

of the high voltage terminal because the high temperature that should be employed to drive off the moisture might be detrimental to the molding or to the sealed threaded joints that it has with other parts, or both.

The drying having been completed, the high voltage terminal construction, after having been heated to about 150° centigrade to thoroughly dry it, is now ready to be assembled to the casing 10, the plug that was related to the collar 21 having been removed. The conductor 25 is threaded up through the tubular conductor 29 and through the upper terminal plug 28 and the threaded portions of the bushing 27 and of the collar 21 are coated or "tinned" with an alloy such as "Amaloy" which consists of about 98% lead, a little less than 2% tin, and a small fraction of 1% of phosphorus.

The interthreading of the bushing 27 and collar 21 now proceeds, the resistance to relative turning therebetween generating sufficient heat to fuse the alloy and cause it to flow evenly and to be distributed uniformly throughout the interengaging threaded surface so that upon cooling a reliable seal is achieved well adapted to withstand high pressures.

During this latter action any metallic parts that may be sheared off or that may be fused or melted and become detached and which thus might fall into the inside of the container 10 and become intermingled with the powdered dielectric 24 are caught and entrapped by a device 30 (see Figure 1) which is of generally annular shape and is tightly interfitted with and secured to the collar 21 as by screws 31; the device 30 has an upwardly projecting annular flange 30*a*, tapered throughout its upper end, and adapted to be received within and tightly interfitted with an annular recess 27*a* formed in the lower end of the bushing 27.

The device 30 thus not only catches any metal parts that drop off from the threaded joint, but thus also completely entraps them inasmuch as the device 30 is in tight connection with the collar 21 as well as with the bushing 27.

While the terminal construction has been rotated, conductor 25 has been freely projecting through the upper end of the plug 28, being thus not subjected to rotation or twisting. It may now be mechanically and electrically connected to the plug 28 and the latter sealed by the construction shown in the drawing, but more clearly described in my above mentioned copending application, to which reference may be had in that particular.

The sealed construction may now be filled with a gaseous dielectric under pressure and the latter conveniently and illustratively takes the form of nitrogen, suitably dried, and injected into the sealed tank 10—11, in any suitable manner (not shown) to a pressure on the order of 15 atmospheres.

To the lower or under side of the bottom member 11 may be welded, as at 32, an interiorly threaded collar 33 whereby the above described construction may be related to a suitable insulating support generally indicated at 34 and which may be of any suitable construction, illustratively of a suitable number of petticoated insulating members of porcelain or the like and through which the condenser construction may be supported from a suitable base or on a pole or other outdoor construction.

The supporting insulator 34 is constructed safely to withstand the voltage of the carrier current signalling circuit and that may be on the order of several thousand volts, but the plug 28 is electrically connected to the high voltage transmission line upon which the carrier current signalling system is to be superimposed by the capacity coupling formed by the condenser elements above described. The condenser element 17, through the conductor 25, is thus also maintained at the high potential of the transmission line. The signalling circuit may be connected directly to the casing or tank 10—11 which is in mechanical and electrical connection with the condenser element 16.

The greater fraction of the transmission line voltage must therefore be withstood by the dielectric between the condenser elements and the latter, in coaction with the dielectric therebetween, must provide a suitable value of capacitance to form the capacity coupling between the two circuits. The gaseous dielectric under this high pressure has a very high dielectric strength but is of relatively low permittivity, having a permittivity of unity. With such a low permittivity dielectric between the condenser elements, relatively large areas in the latter with correspondingly greatly increased bulk and volume would have to be provided to achieve the necessary capacity. But the permittivity of the powdered solid dielectric is on the order of 3 and it is that dielectric that is also interposed between the condenser elements, and this feature makes it possible to achieve the necessary capacity with a vastly less area of condenser elements and correspondingly with vastly smaller bulk or volume.

But these two dielectrics moreover coact to achieve other advantages. They are related in series-multiple with one another between the parts that they are to insulate in that the gas under pressure fills all of the minute spaces between the particles of the solid dielectric material illustratively in the form of powdered Pyrex glass or powdered fused quartz. When so related in series, the dielectric stress is distributed between the ground material 24 and the gaseous dielectric under pressure inversely as their respective permittivities and directly as their physical dimensions. The gas particles, of high dielectric strength because of the high pressure, can and do assume three times the dielectric stress that is imposed upon the particles of the ground material while the ground material assumes one-quarter of the total stress, assuming substantial equality of physical dimensions. Thus I am enabled to cause this composite dielectric to achieve insulation and the desired capacity, in coaction with the condenser elements, that it would be impossible to achieve with either alone. The spacing of the condenser elements, were I to use powdered material alone, would have to be vastly increased while, were the gaseous dielectric under pressure to be used alone, the effective plate areas would have to be vastly increased. In either case there results an enormous increase in bulk and volume.

Furthermore the frequency which the condenser has to handle is relatively high, a typical carrier current frequency being 150 kilocycles. At such high frequencies, dielectric losses become an important factor and thus impose a further limitation upon the character of solid dielectric material that can be employed between the condenser elements. The power factor of the material should be as low as possible but there are available but few solid dielectrics of sufficiently low power factor to meet the requirements of such high frequency low loss condensers. These

few solid dielectrics are available in forms that are expensive or difficult (if not impossible) to use practically or they have other disadvantages that heretofore have been commercially insuperable. Fused quartz has perhaps the lowest power factor of any solid dielectric while pyrex glass has an advantageously low power factor. But in accordance with my invention, I make it commercially practicable to achieve the advantages of these solid dielectrics in a high frequency condenser.

Referring to Figure 1 it will be noted that the coacting or juxtaposed faces of the condenser elements 16 and 17 are parallel and the same is true of the outer cylindrical surface 17*b* of the element 17 and the inner surface of the container 10, the latter functioning, if desired, as a condenser element in coaction with the element 16. The ends of the condenser elements will be seen to be rounded and of large radius of curvature, thus making it possible to cope successfully, in conjunction with the insulating medium employed, with the tendency of concentration of flux at these portions; undue flux concentration is thus greatly minimized and high voltage gradients eliminated.

Furthermore the composite dielectric above described will be seen to be interposed between the high voltage condenser element 17 and the casing 10 and related parts, and it is thus made to coact to achieve maximum possible diameter of condenser elements with minimum possible diameter of tank or casing employed.

Turning now to Figure 3, I have there shown by way of example a modified construction illustrating further advantages and features of my invention, though I have omitted from the drawing the illustration of the high voltage terminal construction and the insulating support, both of which are shown in Figure 1 and both of which are to be understood as embodied in Figure 3.

Within the sealed tank 10—11 of Figure 3 are the alternated condenser elements generally indicated at 35, 36, 37 and 38 arranged concentrically (see Figure 4) and supported by the bottom member 11 to which they are assembled prior to the joining of the bottom 11 to the casing 10 and with respect to which they are coaxially arranged.

Condenser element 38 comprises an upstanding stud of circular cross section and shaped in vertical cross section substantially as shown in Figure 3, having downwardly and inwardly tapering side walls 38*a* and an upper face 38*b* of large radius of curvature. It is welded or otherwise mechanically and electrically connected to the member 11, as at 39.

Arranged concentrically with the member 38 is the condenser element 36 which is made up of two parts 36*a* and 36*b*, the former including an outer cylindrical face 36*c* having a portion thereof threaded as at 36*d* and having an upper horizontal annular face 36*e* which merges through the curve part at 36*f* into the frusto-conical face 36*g*. Part 36*a* is welded to the member 11 as at 40.

Condenser element 35 is not unlike condenser element 17 of Figure 1, but it lacks the inner and downwardly projecting boss 17*e* of the latter. Instead, its annular portion 35*a* is bridged over at the top by the dished part 35*b* which may have an upwardly directed shoulder 35*c* that is recessed to receive a bolt 41. Bolt 41 passes through the opening 42*a* of a dome-shaped solid dielectric member 42, not unlike the member 15 of Figure 1 and made for example of Pyrex glass; it has a laterally projecting flange 42*b* about its lower end which is adapted to rest upon and mate with the flat face 36*e* of the part 36.

Before assembling the dome member 42 to the part 35, there is inserted into the latter the part 36*b* which is substantially cylindrical in shape and has an inwardly directed shoulder or lip 36*h* adapted to overlap the flange 42*b* on the member 42.

The bolt 41 also passes through the opening 37*a* in the condenser element 37 whose outer face 37*b* is substantially frusto-conical and whose inner face is generally of similar shape excepting that it is curved, as at 37*c*, concentrically with the curvature of the part 38*b* of the member 38. The bolt 41 with its nut 43 serves to hold the parts 37, 42 and 35 assembled in the relation shown in Figure 3.

Part 36*b* is threaded, as at 36*k*, so that it may be threadedly interconnected with the part 36*a*, the latter being welded, as above noted, to the bottom 11 of the casing. As the part 36*b* is threaded onto its mating part 36*a*, the lip or flange 36*h* on the former comes down upon the flange 42*b* of insulating member 42 and clamps the latter between itself and the upper end 36*e* of the part 36*a*.

The various condenser elements are tapered in cross section, as shown in Figure 3, and are concentric with each other, as is shown in Figure 4. Also their free ends are of large radius of curvature to function in a manner and with advantages above described in connection with Figure 1.

The outer face 35*d* of member 35 is cylindrical and parallel to the inside face of the container 10. Its inside face 35*e* and the outer face 36*m* of member 36, though inclined, are parallel and thus uniformly spaced; a similar relation exists between the inner face 36*g* of member 36 and the outer face 37*b* of the condenser element 37, and again a similar relation exists between the inner face 37*d* of member 37 and the outer face 38*a* of the member 38.

The maximum inside and outside diameters of the various condenser elements are proportioned substantially as shown in Figure 3 and thus permit the fitting of one into the other and the assembly as above described.

The spaces between the various parts are filled with the composite dielectric, namely the gaseous dielectric under pressure and the ground material above described in connection with Figure 1, and in view of what has in detail been set forth in connection with Figures 1 and 2, the functioning and advantages and operation of the modified arrangement of Figure 3 are believed to be clear, it being noted that by the arrangement of Figure 3, I am enabled to increase the capacity for a given size of container or tank construction, condenser elements 36 and 38 being connected together (by the part 11) and condenser elements 37 and 35 being electrically connected together by the bolt 41—43 and in turn connected to the high voltage circuit through the conductor 25 and the high voltage terminal construction.

Thus it will be seen that there has been provided in this invention a condenser construction in which the various objects above pointed out together with many thoroughly practical advantages are successfully achieved. It will be seen that an unusual compactness of construction is achieved, a high capacity per unit volume made possible with low or negligible dielectric losses

at the high frequencies which the apparatus is to attain, and great dependability of operation at the high voltages made possible.

As many possible embodiments may be made of the above invention, and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth, or shown in the accompanying drawing, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a condenser construction, in combination, a cylindrical casing having a circular end wall, a plurality of concentric spaced condenser plate members carried by said end wall, a plurality of concentric condenser plate members interleaved with said first-mentioned plate members, and means insulatingly supporting said second-mentioned plurality of plate members from a plate of said first-mentioned plurality of plate members, and means securing said end wall with said plate members carried thereby to said casing.

2. In condenser construction, in combination, a cylindrical casing having a circular end wall, a plurality of concentric spaced condenser plate members carried by said end wall, a plurality of concentric condenser plate members interleaved with said first-mentioned plate members, and means insulatingly supporting said second-mentioned plurality of plate members from a plate of said first-mentioned plurality of plate members, said plate members presenting parallel surfaces in juxtaposition to each other and being of tapering cross-section, the free ends thereof having curvatures of large radius.

3. In condenser construction, in combination, a cylindrical casing having a circular end wall, a plurality of concentric spaced condenser plate members carried by said end wall, a plurality of concentric condenser plate members interleaved with said first-mentioned plate members, and means insulatingly supporting said second-mentioned plurality of plate members from a plate of said first-mentioned plurality of plate members, said plate members presenting parallel surfaces in juxtaposition to each other and being of tapering cross-section, the free ends thereof having curvatures of large radius, the spaces between said plate members being filled with a composite dielectric comprising gaseous dielectric under pressure and powdered solid dielectric material of low power factor.

4. In condenser construction, in combination, a cylindrical casing having a circular end wall, a plurality of concentric spaced condenser plate members carried by said end wall, a plurality of concentric plate members interleaved with said first-mentioned plate members, and means insulatingly supporting said second-mentioned plurality of plate members from a plate of said first-mentioned plurality of plate members, said plate members presenting parallel surfaces in juxtaposition to each other and being of tapering cross-section, the free ends thereof having curvatures of large radius, said plate members being made of cast metal, and means securing said bottom wall in place so that the axes of said container and of said concentric plate members are substantially coincident.

5. In condenser construction, in combination, a cylindrical casing having a circular end wall, a threaded member mounted upon the inner side of said end wall, an open-ended cylindrical plate member threaded onto said threaded member, an insulating support carried by said end wall, and an open-ended cylindrical plate member interfitted but spaced by said insulating support from said first-mentioned plate member.

6. In condenser construction, in combination, a casing having a threaded member upon a wall thereof, insulating supporting means related to said threaded member, condenser plate means related to said supporting member, one of said means being interthreaded with said member and holding the other means in place, and condenser plate means carried by said insulating means.

7. In condenser construction, in combination, a sealed casing having therein juxtaposed condenser plate members of substantial thickness and whose end portions are of relatively large radius of curvature, one of said plate members having a concaved portion of large radius of curvature that is juxtaposed to an end portion of another plate member but spaced therefrom.

8. In condenser construction, in combination, a sealed casing having therein juxtaposed condenser plate members of substantial thickness and whose end portions are of relatively large radius of curvature one of said plate members having a concaved portion of large radius of curvature that is juxtaposed to an end portion of another plate member but spaced therefrom, and a dielectric medium of low power factor filling the space between said plate members.

9. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, and an inner plate member having an outer wall substantially parallel to said inner wall.

10. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, an inner plate member having an outer wall substantially parallel to said inner wall, and solid dielectric means secured to one plate member and supporting the other.

11. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, an inner plate member having an outer wall substantially parallel to said inner wall, one of said plate members having a threaded connection with said casing, and insulating means held in place by said threaded connection and supporting the other plate member.

12. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, an inner plate member having an outer wall substantially parallel to said inner wall, and solid dielectric material of low power factor filling the space between said plate members.

13. In condenser construction, in combination, a cylindrical casing having therein a plu-

rality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner plate member having an outer wall substantially parallel to said inner wall, and fused quartz interposed between said plates.

14. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, an inner plate member having an outer wall substantially parallel to said inner wall, and pyrex glass interposed between said plates.

15. In condenser construction, in combination, a casing having an end wall, condenser plate means carried by said end wall, condenser plate means juxtaposed to said first-mentioned condenser plate means, means insulatingly supporting said second-mentioned condenser plate means from said end wall, and means securing said end wall with both of said plate means carried thereby to said casing.

16. In condenser construction, in combination, a casing having an end wall having fixedly related thereto threaded means, condenser plate means threaded to said threaded means, condenser plate means juxtaposed to said first-mentioned condenser plate means, insulating means held in place by said first-mentioned condenser plate means and said threaded means and supporting said second-mentioned condenser plate means, and means securing said end wall with both said plate means carried thereby to said casing.

17. In condenser construction, in combination, supporting means having a threaded part, condenser plate means threadedly secured to said threaded part, said condenser plate means having a shoulder, condenser plate means juxtaposed to said first-mentioned plate means, and means holding said second-mentioned plate means in juxtaposed relation to said first-mentioned plate means and comprising a support related to said threaded means and held in position with respect thereto by said shoulder on said first-mentioned plate means.

18. In condenser construction, in combination, supporting means having a threaded part, condenser plate means threadedly secured to said threaded part, said condenser plate means having a shoulder, condenser plate means juxtaposed to said first-mentioned plate means, and means holding said second-mentioned plate means in juxtaposed relation to said first-mentioned plate means and comprising a support of insulating material related to said threaded means and having a shoulder over which said first-mentioned shoulder engages and which is clamped between said threaded means and said first-mentioned shoulder.

19. In condenser construction, in combination, a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall substantially parallel to the axis of said annular plate elements and an inner wall inclined to the said axis, and an inner plate member having an outer wall substantially parallel to said inner wall.

20. In condenser construction, in combination, a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall substantially parallel to the axis of said annular plate elements and an inner wall inclined to the said axis, and an inner plate member having an outer wall substantially parallel to said inner wall, said inner plate member having an end portion of relatively large radius of curvature and said outer plate member having a concave portion juxtaposed to said portion of large radius of curvature but spaced therefrom.

21. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, an inner plate member having an outer wall substantially parallel to said inner wall, and an insulating medium filling the space between said plate members.

22. In condenser construction, in combination, a cylindrical casing having therein a plurality of condenser plate elements of annular shape and fitted one within the other but spaced apart, the outermost plate member having an outer wall parallel to the inner wall of said casing and an inner wall inclined to the axis thereof, and an inner plate member having an outer wall substantially parallel to said inner wall, the maximum diameter of the outer wall of said inner plate member being sufficiently less than the smallest diameter of the inner wall of said outermost plate member, whereby said inner plate member may be assembled with respect to said outermost plate member upon relative movement therebetween in an axial direction.

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