

March 9, 1937.

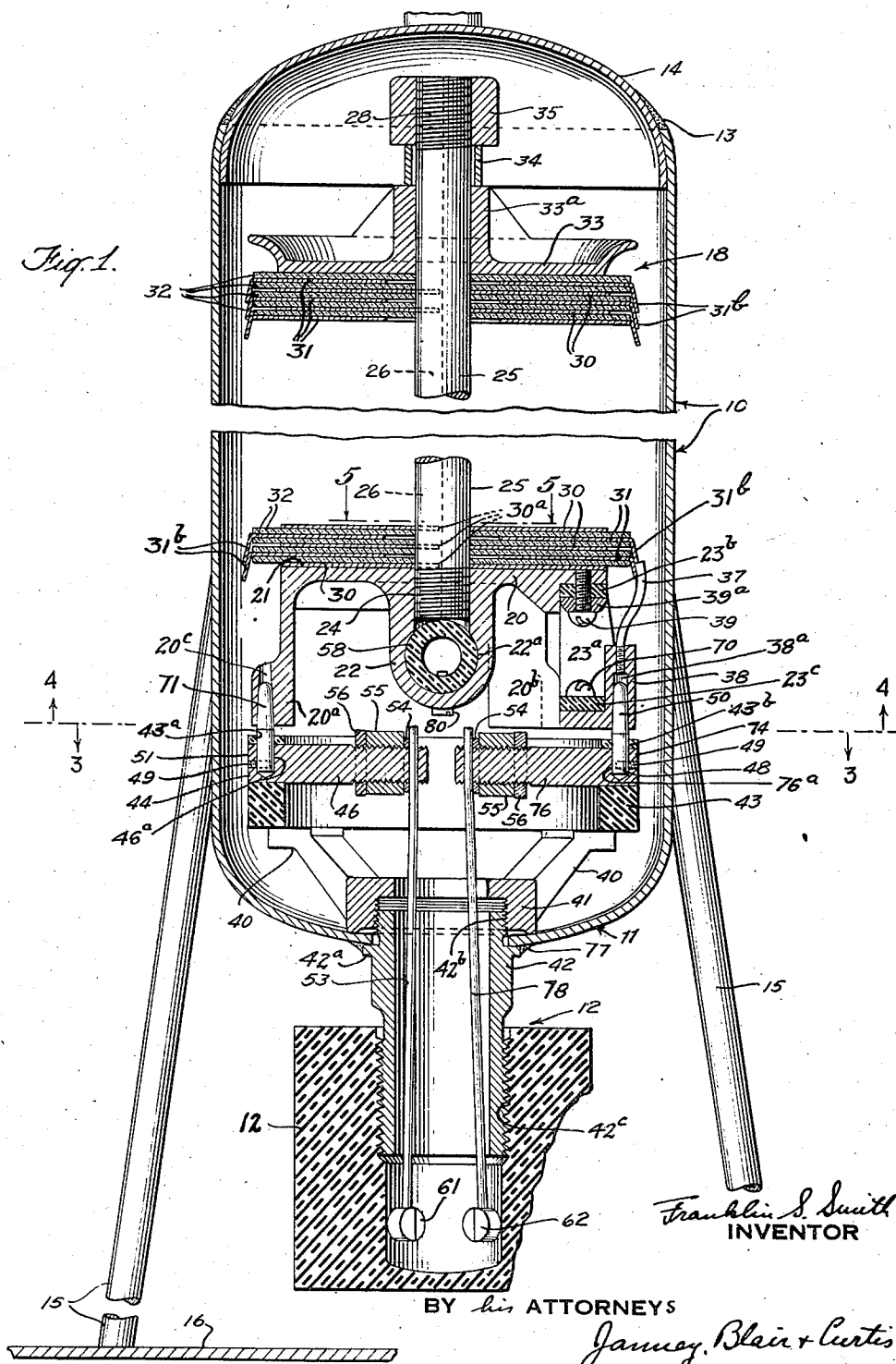
F. S. SMITH

2,073,355

ELECTRIC CONDENSER CONSTRUCTION AND ART OF MAKING THE SAME

Filed Dec. 14, 1931

3 Sheets-Sheet 1



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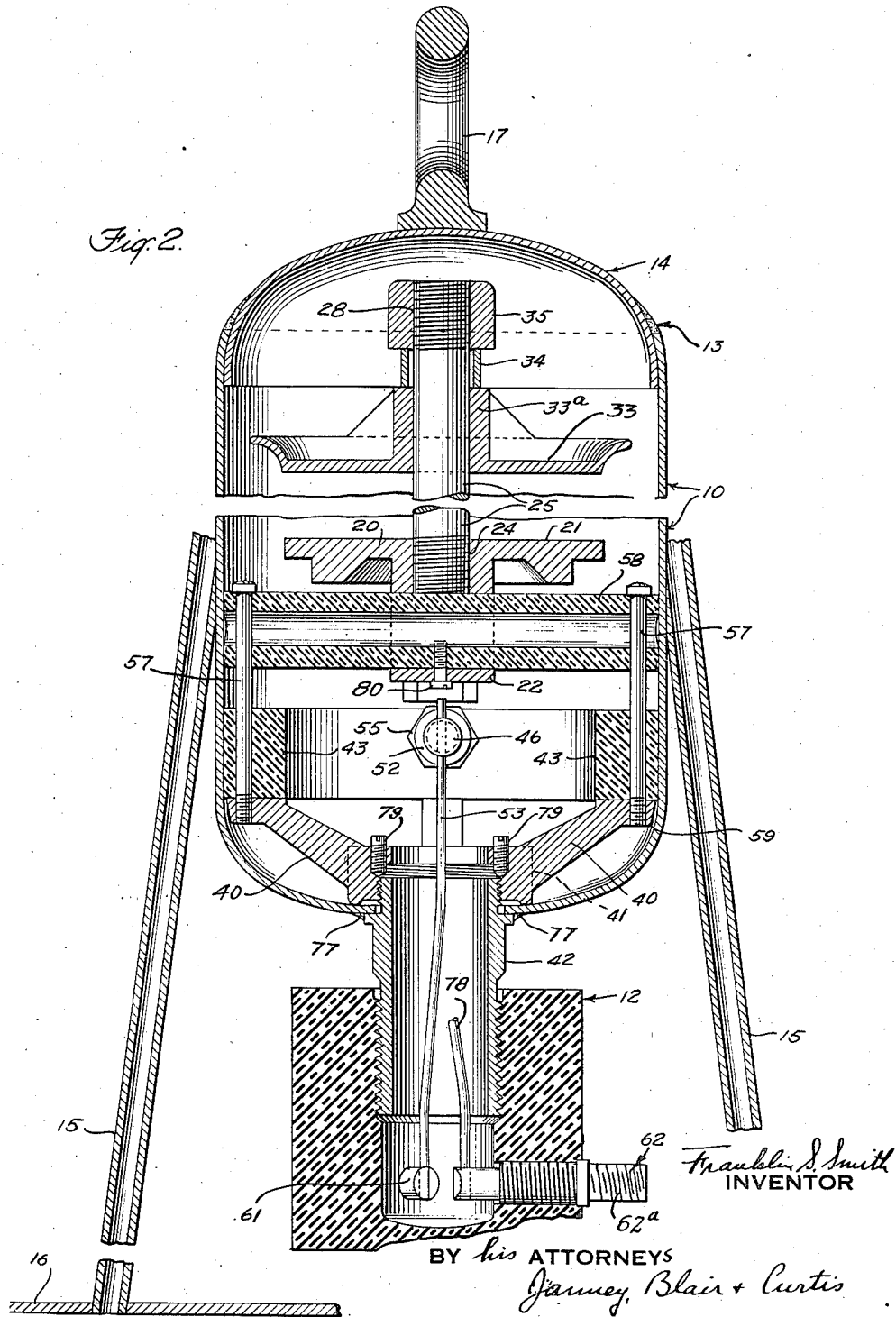
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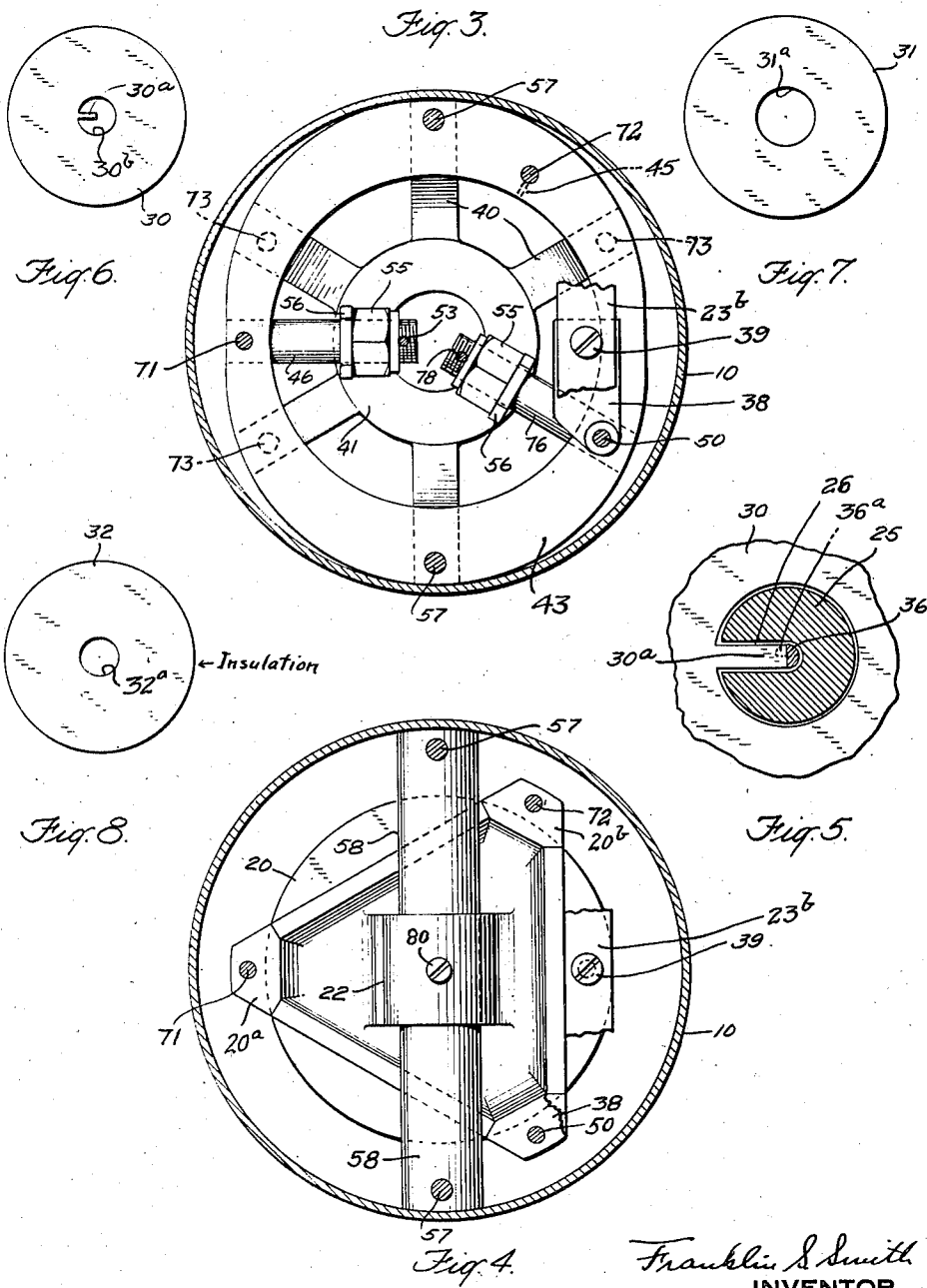
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ELECTRIC CONDENSER CONSTRUCTION AND ART OF MAKING THE SAME

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

2,073,355

ELECTRIC CONDENSER CONSTRUCTION AND  
ART OF MAKING THE SAME

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Application December 14, 1931, Serial No. 580,909

24 Claims. (Cl. 175—41)

This invention relates to electric condenser construction and the art of making the same.

One of the objects of this invention is to provide a rugged and compact condenser construction having a high capacity per unit volume. Another object is to provide a condenser construction that is easily assembled and lends itself to rapid and economical production. Another object is to provide a condenser construction which is dependable and efficient in operation and thoroughly reliable over long periods of use. Another object is to provide a construction of the above-mentioned character which requires a minimum amount of maintenance and attention and is well adapted to meet the varying conditions of actual use. Another object is to provide a condenser construction whose capacity may be quickly and accurately determined in the course of construction or prior to its assembly. 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, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of the various possible embodiments of my invention,

Figure 1 is a central vertical sectional view of a completely assembled condenser;

Figure 2 is a vertical sectional view taken in a plane substantially at right angles to that of Figure 1;

Figure 3 is a horizontal sectional view taken along the line 3—3 of Figure 1 in the direction indicated;

Figure 4 is a horizontal sectional view taken along the line 4—4 of Figure 1;

Figure 5 is a fragmentary horizontal sectional view taken along the line 5—5 of Figure 1 and on an enlarged scale showing certain mechanical relations between certain of the condenser plates and the central rod extending through the plates.

Figure 6 is a plan view on a smaller scale of a condenser plate used in one set of plates;

Figure 7 is a plan view on a similar smaller scale of a condenser plate of a complementary set of plates, and

Figure 8 is a plan view on a like smaller scale of one of the condenser plate separators.

Similar reference characters refer to similar

parts throughout the several views in the drawings.

Referring now to the drawings and more particularly to Figures 1 and 2 thereof, there is shown a casing or container 10 preferably in the form of a cylindrical steel tank capable of withstanding substantial pressures and having a lower integral end portion 11 and an upper open end. The tank, after insertion therein of the apparatus, is closed by an upper shell or closure 14 which is preferably inserted within the upper end portion whose edges are then bent over and welded thereto as at 13 to give a gas-tight fit.

The container 10 is preferably supported with its axis in a vertical position, as by legs 15 secured or welded to the tank 10 and to a base 16. As an aid to handling the completed structure, there is provided a ring 17 (Figure 2) which is preferably welded to the upper end or shell 14 of the casing 10.

Within the container 10, and preferably coaxially therewith, there is provided a condenser plate assembly, generally indicated in Figure 1 at 18, which is supported from the bottom 11 in a manner more clearly described hereinafter.

The condenser assembly 18 includes a lower clamping plate 20 (Figures 1, 2 and 4) which presents an upper disk-like face 21 threaded onto the lower end of a rod 25, the plate 20 being provided with a centrally positioned and downwardly extending boss 22 into which the threaded rod 25 is threaded as at 24, and an upper disk-like plate 33 provided with an upwardly directed cylindrical extension 33<sup>a</sup> through which the upper end of the rod 25 is slidably received (see Figures 1 and 2).

In between the clamping plates 20 and 33 and strung onto the rod 25, all of these parts being preferably made of metal, are the condenser plates alternated with suitable solid dielectric material to form a stack which may be tightly compressed between the end clamping plates 20 and 33 by the action of a nut 35 threaded onto the upper threaded end 28 of the rod 25, a suitable collar 34 being interposed between the nut 35 and the shoulder 33<sup>a</sup> of the plate 33 if desired. The clamping pressure may be exerted through the nut 35 to any extent desired. The collar 34 will be seen (Figures 1 and 2) to be of lesser outside diameter than the outside dimensions of the nut 35, thus to permit the plate assembly to be temporarily grabbed or secured to any suitable hoisting mechanism.

Considering now in detail the assembly of the plates and insulation material, it is first to be noted that I preferably make the condenser plates

of disks of thin metal, such as soft brass foil which may be 0.001 inch or 0.002 inch or the like in thickness. In Figure 6 I have shown on a smaller scale one of the plates 30 that are to be connected together to form one plate electrode of the condenser. In Figure 7 I have shown on a similarly reduced scale a foil plate 31, a suitable number of which are alternated with the plates 30 and which are to be connected together to from the other plate electrode of the condenser. In Figure 8 I have shown an insulating member 32 in a disk-like form or shape made of solid dielectric material, such as mica, a suitable number of which are alternated with the plates 30 and 31 to insulate the latter from each other. The dimensions of these three parts bear a certain relation to each other and to related parts, such as the center rod 25 of Figures 1 and 2.

The foil plates 30 have an outside diameter substantially equivalent to the diameter of the face 21 of the clamping disk 20 (Figures 1 and 2), the lower face of clamping disk 33 being of a like diameter. The rod 25 (see Figure 5) has milled throughout its length a slot 26 not unlike a deep key-way. The foil plates 30 (see Figures 5 and 6) have a central hole 30<sup>b</sup> equal to or slightly greater than the outside diameter of rod 25 and an integral tab 30<sup>a</sup> dimensioned so that it is easily and relatively snugly received into the slot 26 of the rod 25.

In building up the condenser assembly, I may first assemble plate 20 to the one end of rod 25 (Figure 1), then slide onto the rod 25 a plate 30 with its tab 30<sup>a</sup> projecting into the slot 26 of the rod 25. Next I string onto the rod 25 an insulating member 32, the latter having a central hole 32<sup>a</sup> (Figure 8) whose diameter closely matches the diameter of rod 25; the diameter of the insulating member 32 is somewhat greater than that of the foil member 30 so that the former peripherally overlaps the latter (see Figure 1). On top of insulator 32 is now placed a foil plate member 31 (Figure 7), the latter having a central hole 31<sup>a</sup> that is materially greater than the diameter of rod 25. The diameter of the disk foil plate 31 is in turn materially greater than the diameter of the insulating member 32. In stringing the foil plate 31 and putting it into position, it is centered with respect to the rod 25 and the parts already strung onto the latter.

Next there is strung onto the rod 25 a foil plate 30 with its tab 30<sup>a</sup> again in the slot 26, then an insulating disk 32, then a foil plate 31, and so on until the desired number of foil plates and insulators have been alternated with one another.

There is thus achieved an arrangement in which the rod 25 accurately centers and aligns the foil disk plates 30 and also the insulating members 32 with all of the tabs 30<sup>a</sup> of the plates 30 projecting into the slot 26 and with the peripheral portions of the plates 31 projecting uniformly beyond the aligned peripheries of the insulators 32.

As the assembly thus proceeds, these peripheral portions 31<sup>b</sup> of the plates 31 are bent downwardly so that they successively overlap being of sufficient length to do so. If desired, these projecting peripheral portions 31<sup>b</sup> of the plates may be cut radially so as to facilitate the downward bending thereof into overlapping relation. This may be achieved as by drawing a sharp edged instrument three or four or more times across the projecting peripheral portions and in a direction parallel to the rod 25. These overlapping portions are thus brought into electrical connection

with each other and thus all of the plate members 31 are in electrical contact with each other.

In order to determine whether or not the correct number of plates have been strung onto the rod 25, I may test the capacity of the condenser assemblage as far as the latter has proceeded by any suitable form of capacity measuring circuit or instrument or the like, utilizing the overlapping peripheral portions 31<sup>b</sup> of the plates 31 as one terminal of the condenser and utilizing the rod 25 as the other terminal, the tabs 30<sup>a</sup> being in electrical contact therewith.

But in order to insure a good connection electrically to all of the plates 30, during this testing step, I insert into the bottom of slot 26 (see Figure 5) a rod 36 of semi-circular cross-section, the rod fitting or bottoming into the rounded bottom of the slot 26. Thereupon the rod 36 is given a turn through about 90° and into the dotted line position 36<sup>a</sup> of Figure 5, in which its one edge portion embeds itself in the tabs 30<sup>a</sup> and makes a good electrical contact therewith and also with the rod 25. Thus, through either the temporary rod 36 or the rod 25 or both, a good electrical connection to all of the plates 30 is assured for testing purposes. Depending upon what the test indicates as to the capacity of the assemblage, plates and insulators are added to or removed therefrom, as the case may be, the end clamping plate 33 being removable.

The tabs 30<sup>a</sup> of the plates 30 are tinned on both sides prior to their assembly. The inside walls of the slot 26 in the rod 25 (Figure 5) are also tinned with solder but preferably heavily tinned so as to supply the slot with a substantial quantity of solder.

After the desired number of plates and insulating disks have been assembled and the assemblage tightly enough clamped together between the plates 20 and 33, the assemblage is placed in a suitable oven and heated to a sufficient temperature to melt the solder with which the tabs 30<sup>a</sup> and the slot 26 have been supplied by the heavy tinning. The tabs 30<sup>a</sup>, which otherwise fit snugly within the slot 26, are thus all mechanically and electrically connected to the rod 25 and thus a dependable electrical connection of all of the plates 30 to the rod 25 assured. An advantage of soldering the tabs 30<sup>a</sup> to the connecting rod 25 in the above-described manner resides in the fact that the entire condenser assemblage is raised to the same temperature so that the condensation of solder on parts such as the mica or other insulators 32, which might take place if the latter were at a lower temperature, is precluded and thus I do not endanger the insulating properties of the insulators 32.

Then I solder the overlapping flange parts 31<sup>b</sup> of the plates 31 (see Figure 1) together, forming in effect a cylindrical metallic sheath about the capacity-forming portion of the apparatus.

Projecting downwardly from the under side of the lower clamping disk 20 (Figure 1) are three legs 20<sup>a</sup>, 20<sup>b</sup>, and 23, of which legs 20<sup>a</sup> and 20<sup>b</sup> are integrally formed with the plate 20 and are shaped substantially as is shown in Figure 1, each having drilled and reamed through the lower face thereof a tapered opening 20<sup>c</sup>, as is better shown in Figure 1 with respect to the leg 20<sup>a</sup>.

The third leg 23 is made of solid dielectric material such as molded phenolic condensation product and comprises a vertically extending

portion 23<sup>a</sup> and an upper horizontally directed portion 23<sup>b</sup> and a lower horizontally extending portion 23<sup>c</sup>; the portion 23<sup>b</sup> fits into a suitable recess in the under face of plate 20 to which it is secured by a screw 39 with a suitable washer 39<sup>a</sup> interposed therebetween. The lower portion 23<sup>c</sup> has secured to it by a screw 70 a metal member 38 whose under face is in the same plane with the under faces of legs 20<sup>a</sup> and 20<sup>b</sup> and is also provided with a tapered recess 38<sup>a</sup> (see Figure 1) similar to the recess 20<sup>c</sup> of the legs 20<sup>a</sup> and 20<sup>b</sup>. A conductor 37 suitably secured to the vertical shank portion of the member 38 is soldered or otherwise secured to the overlapping peripheral portions 31<sup>b</sup> of the lower few of the plates 31. Thus, the plates 31, electrically interconnected as above described, are electrically connected to the terminal connection member 38 which is insulated from the remaining parts thus far described and which forms a leg which may function as a support in conjunction with the remaining legs 20<sup>a</sup> and 20<sup>b</sup>; the latter, being of metal and integrally formed with the plate 20, are in electrical connection with the shaft 25 to which, as already above described, the plates 30 are electrically connected by the tabs 30<sup>a</sup> and the fused metal, illustratively solder.

The above described condenser plate assembly which, before applying the nut 35, may be tightly compressed in a hydraulic press, is thus unitary and is ready to be let down into the tank 10, as viewed in Figures 1 and 2, the reduced collar 34 permitting any suitable hoisting mechanism or the like to get a good hold underneath the nut 35 for lifting and lowering the condenser unit.

As it is lowered down into the tank 10 the tapered recesses 20<sup>c</sup> of the legs 20<sup>a</sup> and 20<sup>b</sup> and the recess 38<sup>a</sup> of the member 38 are entered by correspondingly tapered pins, three in number, and equidistantly spaced just as are the tapered recesses themselves; in Figure 3 these tapered studs are indicated at 50, 71 and 72, and in Figure 1 two of these studs, namely studs 71 and 50, are clearly shown in side elevation.

These three studs are supported by a heavy ring-like member 43 (Figures 1, 2 and 3) made of solid dielectric material, such as molded phenolic condensation product, while ring member 43 itself is secured to and supported by a spider having a suitable number of arms 40 (Figure 3) certain of which are secured to the member 43 as by screws 73 (Figure 3) and whose central ring member 41, from which the arms 40 radially emanate, is supported in a manner more clearly described hereinafter.

Projecting radially inwardly from and supported by the ring 43 are two metal studs 46 and 76 (Figures 1 and 3) the shanks 44 and 74 of which are received in suitable radially extending openings in the ring member 43. The lower cylindrical end portions of the tapered studs 71 and 50 (Figure 1) are snugly fitted into suitable openings 43<sup>a</sup> and 43<sup>b</sup> in the ring member 43 which register respectively with correspondingly dimensioned openings 46<sup>a</sup> and 76<sup>a</sup>, thus locking the studs against removal from the ring 43. The tapered studs themselves are locked in place by set screws 49 (Figure 1) threaded into the ends of the studs 46 and 76. Thus the latter are rigidly and dependably supported by the ring 43 and likewise are the two tapered studs 71 and 50.

Stud 72 is (Figure 3) fitted into a suitable re-

cess in the ring 43 and locked in place by a set screw 45.

As the condenser unit 18 is thus lowered into place, it is brought into dependable mechanical connection with the supporting ring 43 while the leg 20<sup>a</sup>, in electrical connection with plates 30 (Figure 1) is electrically connected to the stud 46 and member 38, electrically connected with plates 31, is brought into electrical connection with stud 46.

The supporting ring 43 is, of course, mounted in place before the condenser unit 18 is lowered into position inside the container 10 and likewise electrical connection through the wall of the container 10 to the studs 46 and 76 is completed before the unit 18 is placed in the container.

Considering now how these features are achieved, it is first to be noted that the bottom 11 of the tank 10 is provided with an opening into which is passed a metal bushing 42 provided with a flange 42<sup>a</sup> adapted to rest against the outer face of bottom 11 to which it is welded as at 77. Bushing 42 extends upwardly into the tank where it is threaded exteriorly as at 42<sup>b</sup>.

The collar portion 41 of the spider 40-41 (see Figure 2) is internally threaded and, with the ring 43 attached thereto, it is threaded onto the threaded portion 42<sup>b</sup> and driven home, thus not only securely and rigidly holding member 43 in position with its plane perpendicular to the axis of the cylindrical tank 10 but also securely clamping the bottom 11 between itself and the flange 42<sup>a</sup>, thus reinforcing the welded joint 77.

Spider 40-41, after being screwed home on the bushing 42, may be securely locked in place as by set screws 79 (Figures 2 and 3).

The lower portion of bushing 42 is exteriorly threaded as at 42<sup>c</sup> and threaded thereon and sealed thereto, as by any suitable cement, is a heavy cap-like housing 12 of solid dielectric material, such as molded phenolic condensation product which has two radially extending connecting screws 61 and 62 passed therethrough (see Figures 1 and 2) and sealed with a suitable cement or the like. These connecting members may be shaped somewhat as is better shown in Figure 2 and may be exteriorly threaded as at 62<sup>a</sup> to receive a nut or the like so that electrical connections thereto may be made from the exterior.

The inner ends of the connecting members 61 and 62 have secured thereto conductors 53 and 78 which extend upwardly through the bushing 42 and through the spider 40-41 where they are passed through suitable apertures in the inner ends of the studs 46 and 76 respectively (see Figures 1 and 3) to which they are securely fastened.

This fastening may be achieved in any suitable way. For example, before passing the conductors through the openings in the studs 46 and 76, the latter have threaded thereon lock nuts 56, nuts 55, and washers 54 (Figures 1 and 3). The nuts 55 are then rotated to move them toward the inner ends of the threaded studs, thus securely clamping the two conductors between the end portions of the studs and the washers 54. Lock nuts 56 may then be tightened up to hold the connection securely intact. These connections are achieved before the condenser unit 18 is lowered into place and after the spider 40-41 and the ring 43 are mounted in place.

As has been above described and as is better shown in Figures 1 and 2, the lower plate 20 is

provided with a downwardly extending boss 22 into which the clamping rod 25 is threaded; the lower end of boss 22 is provided with a transversely extending cylindrical opening through which is passed a tubular member 58 (Figures 1, 2 and 4) of solid dielectric material, such as molded phenolic condensation product, its tubular cross-section giving it substantial mechanical rigidity and resistance against bending. Member 58 is of a diameter to snugly fit into this opening and is held therein as by a screw 80 (Figures 1, 2 and 4) and it is of a length substantially equivalent to the inside diameter of the tank 10.

At its outer ends it is provided with suitable openings to receive two screws 57 (Figures 2 and 4) which are adapted to be passed through suitable passages in the ring member 43 and then threaded into two diametrically opposed arms 40 of the spider 40-41.

The diameter of the condenser unit 18 is so proportioned with respect to the diameter of tank 10 that, after the unit 18 has been lowered into place as above described so that its weight is carried by the ring 43 and the electrical connections to the studs 46 and 76 made as above described, a long screw driver may be passed down between the unit and the wall of the casing and the two screws 57 (Figures 2 and 3) tightened up. The two screws thus draw the condenser unit downwardly toward the ring member 43 and tightly interfit the tapered pins 71, 72, and 50 (Figures 1 and 3) into the tapered recess of the three supporting lugs not only to insure a good mechanical connection therebetween but also to insure a good electrical connection between the leg 20<sup>a</sup> and pin 71 (Figure 1) and the contact member 38 and pin 50. The screws 57, in thus securely holding the condenser unit 18 against disconnection from the spider 40-41, insure that the unit is held coaxially with the tank even though the ultimate construction is turned upside down or laid over on its side, though it is intended to function in an upright position, as shown in Figures 1 and 2.

The end shell 14 (Figures 1 and 2) is then secured and welded in place whereupon the sealed tank is filled with a gaseous dielectric under pressure such as nitrogen at a pressure on the order of 15 atmospheres; this filling of the apparatus with the gas may be achieved in any suitable manner or through any suitable device (not shown).

The gaseous dielectric under pressure permeates through the condenser unit and coats with the solid dielectric material 32 interposed between the condenser plates and achieves a coaction that is particularly advantageous where the solid dielectric material is mica. The advantages and coactions of the gaseous dielectric with the mica are fully described in my copending application Serial No. 580,908 filed December 14, 1931, to which reference may be made for further details.

However, this gaseous dielectric is of exceptionally high dielectric strength and enables me to achieve a much smaller spacing between the peripheries of the condenser unit 18 and of the inner wall of container 10 than would otherwise be possible. It contacts with the solid dielectric material that is employed and so vastly and greatly reduces surface leakage along the solid dielectric material that I am enabled to make the condenser plates 30 of larger diameter relative to the plates 31 and the openings 31<sup>a</sup> of the latter

of lesser diameter relatively to the diameter of the openings 30<sup>b</sup> of the former than would otherwise be possible. These factors are important in many ways among which may be noted the fact that I am enabled vastly to increase the available capacity per unit volume. In this connection it may be noted that there is a limit in the diameter in which tanks like those that I employ may be made out of pressed steel with one end integral therewith if they are to withstand the high pressures that I employ; but in spite of such limitations, such features as I have above described make it possible for me to still achieve high electrical capacity within the prescribed limits. It may also be pointed out that, in condenser construction, the greatest concentration of dielectric stress between opposed plates occurs at the juxtaposed edges thereof and that it is at the edges of the plates that the dielectric is subjected to a strain or stress far greater than is the case at points intermediate or remote from the plate edges; by the above-described arrangement, I achieve an insulation at the edges of the plates by the same thickness of dielectric material that exists between the plates at other points but coacting with this same thickness of solid dielectric material, at the edge portions, is the gaseous dielectric under pressure arranged in series therewith. The permittivity of the solid dielectric material may be as low as 3 and it may be considerably higher, depending upon the material employed. For example, a material might be employed having a permittivity of 5. The permittivity of the gaseous dielectric under pressure is unity. With two such dielectrics arranged in series and bearing in mind that I use the same thickness of solid dielectric at the edge portions that is used at other portions, this concentrated dielectric stress is sub-divided between the two dielectrics inversely as their permittivities and thus I am enabled to reduce the stress on the solid dielectric material to around one-third, one-fourth, one-fifth, or the like, of what it would otherwise have been, depending upon the permittivity of the material employed.

The apparatus may thus function at substantial voltages and the coaction of the gaseous dielectric under pressure with the solid dielectric material in reducing surface leakage over the latter further makes it possible, by way of illustration, to greatly shorten the solid dielectric member 23 (Figure 1) which forms one of the supporting legs so that I am enabled to make available a greater axial length of the interior of the casing for the electric capacity-forming elements.

The solid dielectric tubular cross-member 58 (Figure 2) and the member 43, also having coacting therewith the gaseous dielectric under pressure, achieve a dependable and reliable mechanical support as well as compact and dependable electrical isolation of the conductive parts of my apparatus from the container and related parts.

I have above pointed out that the condenser plates may be made of brass foil and soldered, through the tongues or tabs 30<sup>a</sup> (Figures 5 and 6) to the rod 25, but I may employ any other suitable metal. Also, instead of initially "tinning" the tabs 30<sup>a</sup> and the slot 26 in the rod 25, and subsequently fusing the solder, I may effect an interconnection of the tabs 30<sup>a</sup> by casting a molten metal such as solder, lead, or the like, into the slot 26 with the unit 18 held horizontally, the metal flowing along the bottom of the slot 26 and

being cast to a sufficient depth to cause the submergence therein of a substantial portion or length of the tabs 30<sup>a</sup>.

It will thus be seen that there has been provided in this invention a condenser construction in which the various objects hereinabove pointed out, together with many thoroughly practical advantages, are successfully achieved.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

#### I claim:

1. The herein described method of condenser construction which consists in coating with solder tab-like portions of condenser plates, aligning the plates so that the tabs project into a groove of a conductive member, and heating the assemblage to cause the solder to melt and join said portions to said member.

2. The herein described method of condenser construction which consists in forming condenser plates with tab-like portions, aligning said plates with respect to a grooved conductive member so that the tab-like portions project into the groove, applying a metal of low melting point to the tab-like portions of said plate prior to their assembly with respect to said member, heating the assemblage to cause the applied metal to melt, and allowing the assemblage to cool.

3. In condenser construction, in combination, a rod having a groove extending therealong, condenser plates and sheet insulation material strung onto said rod to form a condenser, the plates of one polarity having tabs projecting into said groove and the plates of opposite polarity projecting beyond the insulation material, and means for electrically joining said tabs to said rod.

4. In condenser construction, in combination, a rod having a groove extending therealong, condenser plates and sheet insulation material strung onto said rod to form a condenser, the plates of one polarity having tabs projecting into said groove and the plates of opposite polarity projecting beyond the insulation material, said last-mentioned projecting portions being bent over to overlap one another, means for making electrical connection to said overlapping portions, and means for making electrical connection to said rod.

5. In condenser construction, in combination, a rod having a groove extending therealong, condenser plates and sheet insulation material strung onto said rod to form a condenser, the plates of one polarity having tabs projecting into said groove and the plates of opposite polarity projecting beyond the insulation material, means securing said tabs to said rod, and means electrically interconnecting said plate portions that project beyond said insulating material.

6. In condenser construction, in combination, a rod having a groove extending therealong, condenser plates and sheet insulation material strung onto said rod to form a condenser, the plates of one polarity having tabs projecting into said groove and the plates of opposite polarity projecting beyond the insulation material, the projecting portions of said second-mentioned set of plates being bent to overlap each other and said overlapping portions being soldered together.

7. In condenser construction, in combination,

a rod of circular cross-section having a slot extending lengthwise thereof, a set of condenser plates strung thereon and having tabs projecting into said slot, a second set of condenser plates strung onto said rod, the plates of said second set having an opening therein greater than the cross-section of said rod, and sheet-like insulating material interposed between the plates of said sets and having an opening therein great enough to receive said rod therethrough but smaller than the openings in the plates of said second set.

8. In condenser construction, in combination, a rod of circular cross-section having a slot extending lengthwise thereof, a set of condenser plates strung thereon and having tabs projecting into said slot, a second set of condenser plates strung onto said rod, the plates of said second set having an opening therein greater than the cross-section of said rod, the plates of said second set having over-all dimensions greater than the over-all dimensions of the plates of said first set, sheet material interposed between the plates of said sets and having over-all dimensions intermediate of those of the plates of said two sets so that the plates of said second set peripherally project thereover.

9. In condenser construction, in combination, a rod of round cross-section having a slot extending therealong, a plurality of alternated condenser plates strung thereon to form two sets of plates, all of the plates being annular in shape and the plates of one set having greater outside and inside diameters than the respective outside and inside diameters of the plates of the other set, and one set having tongue-like portions projecting into said groove.

10. In condenser construction, in combination, a rod of round cross-section having a slot extending therealong, a plurality of alternated condenser plates strung thereon to form two sets of plates, all of the plates being annular in shape and the plates of one set having greater outside and inside diameters than the respective outside and inside diameters of the plates of the other set, one set having tongue-like portions projecting into said groove, and solid dielectric material interposed between adjacent plates and being of annular shape and having an outside diameter intermediate of the outside diameters of the plates of said two sets.

11. In condenser construction, in combination, a casing having an insulating support adjacent its bottom, said insulating support carrying a conductive member projecting therefrom, a condenser unit having a plurality of supporting means adapted when inserted into said casing to be supported by said insulating support, one of said supporting means being in electrical connection with one electrical side of said condenser unit and contacting with said conductive member projecting from said insulating support.

12. In condenser construction, in combination, a casing having supporting means adjacent its bottom and carrying a plurality of connecting members insulated from each other, means for insulatingly making electrical connection from the exterior of said casing to said connecting members, a condenser unit adapted to be supported by said supporting means, and a plurality of connecting members in electrical connection with the terminals of said condenser unit for coacting respectively with said first-mentioned connecting members and to become interconnected therewith when said unit is put in place upon said support.

13. In condenser construction, in combination,

a casing having in one end thereof a support having a plurality of tapered studs projecting upwardly therefrom one of said studs being insulated from the rest and being provided with means for making an electrical connection thereto, a condenser having a plurality of means each provided with a tapered recess for respectively receiving the said tapered studs, the means that receive said insulated stud being in electrical connection with one side of said condenser, there being a space between the side of said condenser and the inside wall of said casing, means in mechanical connection with said condenser and projecting into said space, and means capable of manipulation through said space for forcing and holding said last-mentioned means and said support one toward the other and thereby to hold said tapered studs against egress from said tapered recesses.

14. In condenser construction, in combination, a casing having therein a support, a condenser unit, said parts being provided with interfitting tapered parts there being a space between said condenser wall and a wall of said casing; and means having an operable portion accessible by way of said space for drawing said condenser unit and support together.

15. In condenser construction, in combination, a casing having an opening therein, a sleeve-like metal bushing secured in said opening and having insulating means associated therewith exteriorly of said casing, conductive means passing through said insulating means and said bushing and into said casing, said bushing having a threaded portion accessible from the interior of said casing, and electrical apparatus within the latter and connected to said conductive means, and means in threaded connection with said bushing for positioning said apparatus.

16. In condenser construction, in combination, a casing having an opening therein, a sleeve-like metal bushing secured in said openings and having insulating means associated therewith exteriorly of said casing, conductive means passing through said insulating means and said bushing and into said casing, a support within said casing and secured to said bushing, a connecting member insulatingly carried by said support and in electrical connection with said conductive means, an electrical apparatus carried by said support, and a connecting member associated with said apparatus and connectible with or disconnectible from said first-mentioned connecting member upon respectively associating or disassociating said apparatus with respect to said support.

17. In electric condenser construction, in combination, a stack of condenser plates, upper and lower assembly plates for holding said stack of condenser plates assembled, said lower assembly plate having depending portions, and terminal connecting and supporting means for electrically and mechanically engaging said depending portions of said lower assembly plate.

18. In electrical condenser construction, in combination, a casing having therein a condenser construction comprising two sets of condenser plates alternated with each other, and insulation between adjacent plates, the plates of one set being of greater peripheral expanse than the plates of the other set, thereby to provide marginal portions, and said marginal portions being bent throughout their entire periphery in a direction generally lengthwise of the axis of said sets and being of sufficient extent so that said marginal portions successively overlap one

another, thereby forming a complete outer casing for said condenser, said condenser construction being dimensioned so that said last-mentioned casing is spaced inwardly from the walls of said first-mentioned casing, and a dielectric and cooling medium within said first-mentioned casing and in the space between said two casings for insulating the latter and for dissipating heat from said second-mentioned casing to said first-mentioned casing.

19. In electrical condenser construction, in combination, a casing having an opening therein and having mechanical supporting means therein, a condenser unit having supporting means adapted when inserted into said casing to engage said first-mentioned supporting means, said two supporting means having interfitting surfaces inclined with respect to one another, whereby said two supporting means are wedged one into the other.

20. In electrical condenser construction, in combination, a casing having an opening therein and having mechanical supporting means therein, a condenser unit having supporting means adapted when inserted into said casing to engage said first-mentioned supporting means, said two supporting means having interfitting surfaces inclined with respect to one another, said first-mentioned supporting means engaging said second-mentioned supporting means underneath the latter whereby the weight of said condenser unit coacts to wedge one of said supporting means into the other.

21. In electrical condenser construction, in combination, a casing having a supporting standard for holding the casing spaced from a supporting surface such as a floor, a relatively high voltage terminal bushing in the bottom of said casing for passing electrical conductor means from the exterior of said casing into the interior thereof, a condenser construction adapted to be let down into said casing, supporting means within the casing for supporting said condenser construction, and means in electrical connection with said condenser construction making electrical connection with said conductor means as said condenser construction is brought into supporting relation to said supporting means.

22. In electrical condenser construction, in combination, a casing having an insulating support adjacent its bottom, said insulating support carrying conductive means, insulated terminal means in a wall of said casing and in electrical connection with said conductive means, a condenser structure having at its bottom supporting means for coaction with said insulating support to transmit the weight of the condenser structure to said insulating support, said supporting means having conductive means in electrical connection with said condenser structure and mechanically and electrically engaged with said first-mentioned conductive means upon interrelation of said supporting means to said insulating support.

23. In construction of the class described, in combination, a casing having an opening therein, a sleeve-like bushing secured in said opening and having insulating means associated therewith exteriorly of said casing, a rod-like member within said casing and carrying and having related thereto capacitor means, means independent of said insulating means for connecting said rod-like member to said bushing to be supported thereby, and conductive means passing through said insulating means and said bushing

and into said casing and being in electrical connection with said capacitor means.

24. In construction of the class described, in combination, a casing having an opening therein, a sleeve-like bushing secured in said opening and having insulating means associated therewith exteriorly of said casing, a rod-like member within said casing and carrying and having related thereto capacitor means, a support mechanically connected to said bushing and carry-

ing insulated connecting means, conductive means passing through said insulating means and said bushing and into said casing and being in electrical connection with said connecting means carried by said support, and means mechanically connecting said rod-like member to said support and for making electrical connection between said capacitor means and the connecting means carried by said support. 5

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