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CONDENSER CONSTRUCTION

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Fig. 1.

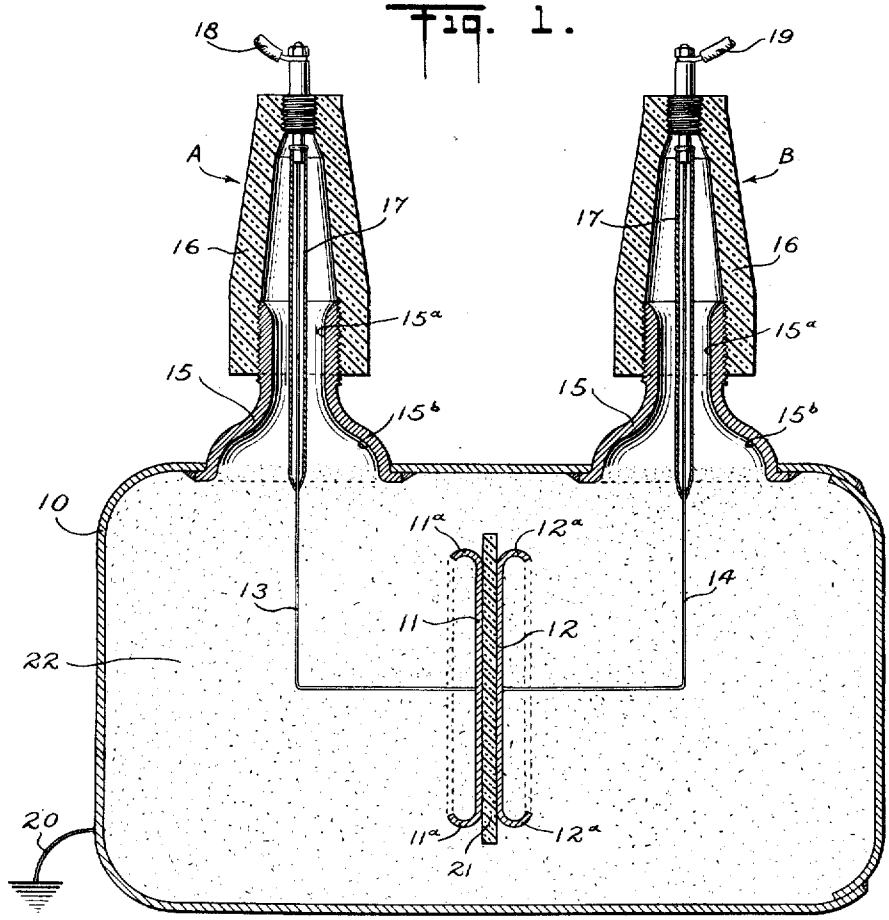
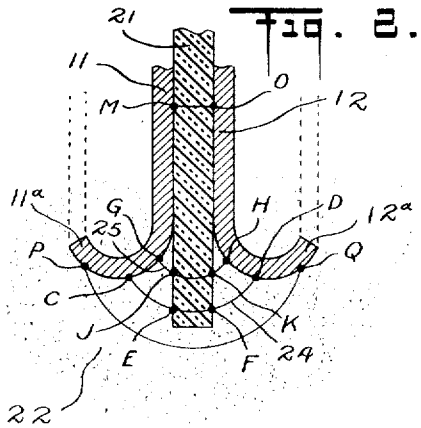


Fig. 2.



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CONDENSER CONSTRUCTION

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28 Claims. (Cl. 175—41)

This invention relates to electric condenser construction.

One of the objects of this invention is to provide a simple, practical and reliable condenser construction well adapted for operation at relatively high voltages. Another object is to provide a condenser construction that will be inexpensive and capable of ready and convenient embodiment in practical form. Another object is to provide a condenser construction in which dielectric losses, particularly at high frequencies, are minimized in a thoroughly efficient and practical manner. Another object is to provide an efficient, lasting and inexpensive insulating medium particularly adapted for use in high voltage condensers. Another object is to provide an electric condenser construction in which many of the desirable features of mica may be fully realized while at the same time the many disadvantages and detrimental effects and actions of mica as now employed are eliminated. Another object is to provide a simple and efficient method of achieving insulation of parts affected by relatively high differences of potential and, moreover, to provide a method of this character that may be inexpensively and dependably carried on in practice. 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 drawing in which I have shown one of various possible embodiments of the mechanical features of my invention,

Figure 1 is a vertical central sectional view of a high voltage condenser, and

Figure 2 is a fragmentary sectional view through the plate electrodes and insulating media on a greatly enlarged scale.

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

Referring now more particularly to Figure 1, I have indicated at 10 a container made of any suitable material, such as pressed steel, adapted to withstand high pressure. Container or tank 10 may conveniently be of cylindrical form and of any appropriate length in an axial direction, the sectional view of Figure 1 being taken through the axis of the casing 10. Within the casing 10 is an electric condenser construction which, for the sake of greater simplicity of illustration, I have shown in Figure 1 as comprising the two opposed plate electrodes 11 and 12 but which may include, it is to be distinctly understood, any number of suitably related plate or electrode members which may be mechanically supported within the casing 10 by any suitable means (not shown) if desired. Possible modes of support of the condenser construction within the container or tank 10 may take the form of those described, for example, in my co-pending applications Serial No. 539,810, filed May 25, 1931, or Serial No. 580,909, filed December 14, 1931.

The high tension conductors 13 and 14, connected respectively to the plates 11 and 12, are brought out through the walls of the casing 10 by means of suitable high voltage terminal constructions generally indicated at A and B, respectively; I prefer, however, to employ terminal constructions having certain features of construction which coact with certain other features of my invention and hence I construct these terminals substantially as indicated in Figure 1.

Inasmuch as both terminals A and B are preferably of the some construction, it will suffice to describe in detail only one of them. Considering now the construction of the device A, I associate with a suitable opening preferably in an end wall of the casing 10 a metallic bushing 15 which is externally threaded to receive a tapered tube-like housing 16 made of a suitable insulating material, preferably phenolic condensation product or bakelite, and of sufficient thickness to withstand the relatively great pressure of a gaseous dielectric which, as is more fully described hereinafter, is contained within the sealed casing 10. At its upper end housing 16 supports a cylindrical conductor 17 which is held coaxially with respect to both the housing 16 and the bushing 15, any suitable means being employed to insure that the connection between the conductor 17 and the upper end of the housing 16 is sealed and will withstand the high internal gas pressure. To the outer end of conductor 17 is secured one of the high voltage line wires 18 of the circuit to which the condenser is to be associated.

The radii of the conductor 17 and of the interior cylindrical surface 15a of bushing 15, the space between which is filled with the gaseous dielectric under pressure, are so proportioned as to provide a fast discharge gap across which

spark-over will occur without being preceded by corona. The critical voltage of this fast discharge gap is preferably of such a magnitude as is explained more clearly hereinafter.

As above noted, the construction of the high voltage terminal B is the same as that of terminal A, a similar fast discharge gap existing between the portion 15b of the bushing 15 and the conductor 17 of terminal B, the other line wire of the high voltage circuit being indicated at 19 and being thus connected to the other condenser plate 12. Preferably the tank 10 is grounded as is indicated at 20.

The condenser plate elements 11—12 may be of any suitable construction and as purely illustrative of a possible form which they may take, it may be assumed that they are made of a suitable sheet metal and that they may be of circular shape. Preferably, the peripheral portions 11a and 12a thereof are curved substantially as is indicated in Figure 1 and as is better shown in Figure 2, for a purpose to be more clearly described hereinafter.

With the above-described illustrative electrical arrangement, plate elements 11 and 12 have to be insulated from each other and also from the casing 10. In Figures 1 and 2 I have diagrammatically indicated at 21 a solid dielectric medium interposed between the plates 11 and 12.

Insofar as certain features of my invention are concerned, the member 21 is made up principally of mica.

Before considering in detail the physical structure of the mica insulating element 21, it might first be pointed out that mica in its natural state is neither flexible nor uniform and, moreover, permits of relatively large surface leakage. Commercially available mica for insulating purposes is available only in pieces of relatively small area and to obtain sheets of greater area it has to be reconstructed; in the course of this reconstruction, the high dielectric strength of the mica is largely lost. In reconstructing the mica for commercial purposes, flakes or small particles of natural mica are overlapped or staggered to form larger sheets of sizes suitable for commercial use and these flakes or particles are permanently held together by a suitable cementing material or binder, generally shellac. It is this binder and/or other cementing material that greatly lowers the dielectric strength of the resultant reconstructed mica and that also greatly increases the dielectric losses. Also, the binder or cementing material limits the temperature at which the reconstructed mica can be used. Thus, commercially available mica has numerous deficiencies, some of which have just been noted. Also, mica, as now used for insulating purposes, has a further defect, due to its naturally laminated form; this laminated form of the mica causes a further lowering of its dielectric strength. In between the laminations are layers of air at atmospheric pressure and hence of low dielectric strength. The permittivity of air is low, being on the order of unity, while the permittivity of mica is within a range of from 5 to 7. The dielectric stress to which the composite dielectric of mica and air is subjected is thus distributed across the laminations and the layers of air in proportions that are inverse to the permittivities thereof and directly as their thicknesses; hence, the minute layers of air are made to assume from 5 to 7 times the voltage gradient of the mica laminations with the result that these layers of air easily break down, causing failure of the insulation.

According to certain features of my invention, I eliminate such defects and disadvantages as the above and interpose between the parts to be insulated, such as the plates 11 and 12 of the condenser, a composite dielectric which embodies a sheet, indicated at 21, made up of scales of natural mica, the scales being superimposed upon each other and staggered so that they sufficiently overlap, and this process I carry on until I achieve a member 21 of sufficient thickness and of sufficient area. To make clearer what I mean by superimposing "scales of natural mica" I might at this point note that, as is also later hereinafter set forth, natural mica is obtainable in various sizes or areas of pieces, pieces that may be easily handled individually and may thus even by hand, if so desired, be laid down in superimposed layers, each layer made up of a sufficient number of pieces or small sheets of mica, but the pieces of mica in successive layers being staggered relative to the pieces in an adjacent layer so that they sufficiently overlap. Illustratively, but not by way of limitation, I may use "scales" (commercially termed "sheets") of natural mica whose area may be as small as one or two square inches or may be considerably greater than that, or even less. The greater the area of the sheet that I employ, the greater is the cost per sheet, but by reason of my invention, as will become clearer, I may use high grade natural mica in small pieces or sheets (thus far less costly) build them up into layers of large area, and thus avoid the expense and limitations as to size imposed by larger available natural-mica sheets. Preferably these scales or sheets of mica are built up directly upon the lower condenser plate 12, after the latter has been suitably placed in position, whereupon the other condenser plate 11 is placed upon the thus built-up mica member 21. Insofar as certain features of my invention are concerned, therefore, it will thus be seen that I make it possible to eliminate or to avoid the use of a binder or cementing material with its attendant defects, deficiencies, and disadvantages, some of which I have pointed out above. The mica member 21 thus also preferably fixes the spacing or distance between the plates of the condenser. The built-up character of the mica member 21 will thus be seen to be quite different from a single sheet of so-called "reconstructed" mica in which, as earlier above described, a binder or cement is used and whose detrimental effects upon the dielectric strength and dielectric losses are sufficiently above pointed out.

Disregarding for the moment certain other coacting features of my invention and which are more fully described below, I thereupon heat the resultant condenser construction to a suitable temperature, for example, a temperature on the order of 300° C., connecting the sealed tank 10 to a suitable exhausting apparatus so that the moisture in the built-up mica member 21 is driven off by the heat and pumped out of the apparatus by the exhausting apparatus. After the mica insulation has thus been thoroughly dried, I introduce into the sealed tank 10 a gas, preferably a chemically neutral gas like nitrogen, under a pressure on the order of 15 atmospheres per square inch.

Considering now the coaction of this gaseous dielectric under pressure with the built-up mica member 21, it might first be pointed out that

the gas under pressure penetrates the built-up mica member 21, entering in between the various superimposed scales or sheets, and also in between the laminations of the individual scales or sheets of which the member 21 is built up. This the gaseous dielectric under pressure may readily do and in fact does, thanks to the absence of the above-mentioned binder or cement. The resultant insulating medium between the plates 11 and 12 is thus made up of both mica and minute layers of gaseous dielectric under pressure; the latter has a very high dielectric strength and coacts with the laminations and scales of the built-up member 21 in a unique way. More specifically, though the permittivity of the gaseous dielectric under pressure is unity and though the dielectric stress to which the serially related layers or laminations of mica and of gas under pressure is sub-divided inversely in proportion to the permittivities of these two insulating media, the gaseous dielectric has such high dielectric strength that it does not break down even though it assumes four, five, six or seven times the voltage gradient that is assumed by the mica layers or laminations. With this composite dielectric, I am enabled vastly to improve the insulation between the high voltage parts, to increase the reliability of the resultant condenser, increase greatly the factor of safety by correspondingly increasing the break-down voltage, and to achieve such advantages as these with the use of less mica and at much lower expense than has heretofore been possible. Furthermore, the gaseous dielectric under pressure greatly increases the resistance of the mica to surface leakage and it dependably precludes the initiation of break-down in precluding surface leakage.

Furthermore, I am enabled to employ small pieces of high grade natural mica, such small pieces being obtainable at a much lower cost than large pieces. For example, the area of the insulating member 21, because of the area of the condenser plates, might conceivably be greater in excess of the area of the largest available natural-mica sheet and, in accordance with heretofore known practice, a reconstructed mica-sheet with its numerous deficiencies, some of which are pointed out above, would have to be employed, or the area of the plates reduced; I am enabled, however, to avoid these limitations with their attendant expense and other disadvantages for I may make the area of the plates and hence of the insulating member 21 as large as I may wish, without limitation, by making up each layer of the various layers that may be used to make up the member 21 of a suitable number of preferably small sheets or pieces of natural mica, sufficient in number to give the aggregate or total area desired. By making it possible to employ small pieces or sheets of mica, available at far less cost than large sheets of natural mica, I am, furthermore, enabled vastly to reduce first cost. The resultant composite dielectric has also a high impulse ratio and, as above pointed out, excellent and high dielectric strength. Also, because of the high permittivity of mica, I am enabled to dependably achieve a greater permittance for a given volume of condenser construction than would be the case if I employed gaseous dielectric under pressure alone.

Considering now certain other and coacting features of my invention, it is first to be noted, as is shown in Figures 1 and 2, that preferably the built-up mica insulating member 21 extends beyond the edges of the condenser plates 11—12 and in view of the mechanical interrelation of the sheets or pieces or "scales" of mica to make up the individual layers that may go to make up the member 21, it will now be clear that, once the thus built-up mica member 21 is interposed between the plates 10—11 and the parts mechanically held assembled in any suitable way (not shown, as above pointed out) or, for example, as indicated in my above-mentioned copending application, the member 21 has sufficient mechanical integrity at its periphery to sustain its projecting peripheral portions adequately; of course, and it may be needless to point out, one would not employ, at the peripheral portions of the layers of the member 21, such small pieces or sheets of mica as would not reach from the extreme peripheral edge to a point in between the plates 11—12, for then, quite obviously, the projecting peripheral portion or portions of the built-up member 21 might be free from inherent mechanical support and would require some other means for supporting it.

As above noted, the condenser plates are enlarged at their peripheral portions as by curving the latter upwardly at 11^a and 12^a, respectively; this construction aids somewhat in diminishing the concentration of stress at the edges of the condenser plates but, as is better shown in Figure 2, I arrange for dependably preventing the possibility of break-down at these edge portions. The solid dielectric member 21 is preferably extended beyond the edges of the condenser plates, as is better shown in Figure 2, and the spaces between the curved edge portions 11^a and 12^a of the plates and the insulating member 21 I fill up with a solid dielectric material in the form of ground fused quartz or ground pyrex glass; this granulated or powdered material is indicated by the stippling at 22. In Figure 1, I have shown this material 22 as being interposed also between the condenser plates 11—12 and the walls of the casing 10, from which the high voltage condenser plates 11—12 have to be insulated. The material 22 extends upwardly into the enlarged portions 15^b of the bushing 15 but not into the portions 15^a, for reasons more clearly set forth hereinafter.

The permittivity of ground fused quartz is 3 and, though it is preferably well packed into place, it is, nevertheless, intermingled with the gaseous dielectric under pressure and the latter fills the interstices betwen the particles of the material 22, resulting in a coaction of great practical advantage. To make this coaction clearer, particularly at the edge portions of the condenser plates 11—12, the electrical conditions may first be considered with the material 22 omitted in Figure 2. Let line 24 indicate a flux line of the dielectric field extending from point C in part 11^a of one condenser plate to point D in the other condenser plate. Let it be assumed that this flux line 24 enters the solid dielectric member 21 at E and leaves it at F.

The permittivity of ground fused quartz is 3 permittivity of the gaseous dielectric under pressure in series through which portions C—E and F—D of flux line 24 pass is unity, the gaseous dielectric under pressure tends to become overstressed. Now assume another flux line 25, passing from point G in one condenser plate to point H in the other, entering and leaving member 21 at points J and K. Along this flux line, a similar distribution of the total dielectric stress takes place. However, the maximum voltage gradient is greater along the portion G—J of flux line 25

than it is along the portion C—E of flux line 24, and due to such factors as these, accompanied by the additional fact that there is a concentration of dielectric stress at the edges of the plates anyway, it is possible to cause over-stressing of the gaseous dielectric under pressure and consequent breaking down thereof and of the insulation at the edge portions.

However, with the material 22 filled in as indicated by the stippling in Figure 2, and assuming that material to be ground fused quartz, whose permittivity is 3, the dielectric stress imposed upon the gaseous dielectric under pressure in such paths as path C—E or G—J, is greatly reduced; in fact, the dielectric stress along such paths as these is distributed between the ground material 22 and the gaseous dielectric under pressure in inverse proportion to their respective permittivities and directly as their dimensions. The gaseous dielectric assumes a stress three times as great as the stress imposed upon the particles of fused quartz, the total stress thus subdivided between the ground quartz 22 and the gaseous dielectric under pressure, both of which, already in series with each other, are in series with the dielectric member 21, is less than the total stress that would have to be assumed by the gaseous dielectric under pressure alone were the ground material omitted. Thus, I make certain that, particularly at the edge portions of the plates, the maximum voltage gradient to which the gaseous dielectric under pressure is subjected is at no time and at no place excessive and above that value which the gaseous dielectric under pressure can withstand with an ample factor of safety.

Where the member 21 takes the composite or built-up form as above described, the voltage gradient throughout those portions thereof that are contacted by the two opposed plates is uniform and the gaseous dielectric under pressure is in series with the mica; these relations hold true, for example, in the flux line or path indicated at M—O. The dielectric action has been described in detail above. In the flux line path P—Q which, it will be noted, does not pass through the member 21, the gaseous dielectric under pressure is in series with the ground quartz or like material 22, but in this path P—Q the voltage gradient is not uniform. But in this latter path excessive stressing of the gaseous dielectric is precluded because of the relative permittivities of the gaseous dielectric under pressure and of the fused quartz, these permittivities being 1 and 3, respectively. In the path P—Q, the gaseous dielectric under pressure is stressed no more than three times the stress assumed by the particles 22, thus leaving an ample margin of safety at points in the path P—Q where the voltage gradient, which, as above noted, is not uniform, may be greater than the voltage gradient in paths like the path M—O where the voltage gradient is uniform. The composite dielectrics effective in paths M—O and P—Q will be seen to be in parallel.

In a path like path C—D, the composite dielectric of gaseous dielectric under pressure and ground fused quartz (throughout the portion C—E) will be seen to be in series with the composite dielectric made up of gaseous dielectric under pressure and mica (in the portion E—F). These composite dielectrics, in paths where the voltage gradient is not uniform and where the maximum voltage gradient assumes an otherwise dangerous value, thus subdivide the total dielectric stress between them inversely in proportion to their respective effective permittivities, but within each composite dielectric a like subdivision of the stress assumed by each takes place, and by such features as these I am enabled to prevent over-stressing of the dielectrics or of any of them and thus to positively insure against break-down.

As above pointed out, the members 15—17 of the high voltage terminal constructions are proportioned to form a fast discharge gap having a certain critical voltage; either or both of these gaps has preferably a critical voltage such that break-down occurs at a voltage below that at which injury to the apparatus within the casing 10 takes place. Preferably this break-down occurs at a voltage below that at which over-stressing or break-down of the above-described dielectric media or any of them takes place. Abnormal voltages in the high tension line 18—19, due to transients, surges, or the like, are thus grounded or shunted away from the condenser construction and the latter and its component parts are thus dependably safeguarded against damage.

As above noted, where I employ the powdered solid dielectric material, the latter extends upwardly into the bushings 15 of the high voltage terminal constructions to an extent insufficient to cause it to bridge the fast gap-forming portion 15^a of the bushings; this because of the downwardly flared shape of the bushings 15 which thus present a relatively greatly enlarged radius throughout the portions 15^b thereof, a radius sufficiently great to prevent surface leakage from the high voltage conductors 17 along the upper surface of the insulating material 22 to the portions 15^b of the bushings. The coaction of the gaseous dielectric under pressure with the upper surface of the powdered material so greatly reduce surface leakage over the latter that even this enlarged radius of the portions 15^b can be made much smaller than would be the case if reliance were placed upon solid dielectric alone. Also, I insure that there is no interference with the intended action of the fast gaps whereby they break down without the break-down being preceded by corona.

Where the material 22 takes the form of powdered fused quartz, I preferably first wash it in hot hydrochloric acid in order to remove traces of iron; fused quartz has the lowest dielectric losses of any known solid dielectric material and by powdering it and washing, as above noted, I still further lessen the dielectric losses.

Where I employ the material 22, I subject the apparatus to the heating, to a temperature on the order of 300° C., all as above described, while having the sealed tank connected to the exhausting apparatus so that the heat drives off the moisture from or out of the powdered material so that it may be removed by the exhausting apparatus.

The apparatus is of high efficiency and is adapted for use in connection with high voltage circuits. More particularly, the condenser construction is admirably adapted for superimposing upon a high voltage transmission line a high frequency carrier current modulated for the transmission of intelligence. In such systems the frequency is very high compared to commercial power frequencies, a typical carrier current frequency being 150 kilocycles. In condenser constructions employed in such systems and subjected to such high frequency, the dielectric

losses must be maintained at the lowest possible minimum and the apparatus must safely withstand the high voltages used in high tension power transmission systems. The features of construction and action above-described dependably meet these requirements.

In these latter connections, it might be pointed out that there are but few solid dielectrics that have a low enough power factor to warrant their application in a high frequency condenser. Natural mica is one of these dielectrics but its power factor is so increased by the binding material or other cement that is employed in building it up in sheet form, as above pointed out, that this built-up mica is undersirable, to say nothing of its greatly diminished dielectric strength as described above. However, by causing it to coact with the gaseous dielectric under pressure, all as aobve described, I am enabled to employ natural mica with its power factor hence unimpaired.

Fused quartz likewise has an excellently low power factor but its physical shape, form, and other characteristics, as it is commercially available, preclude it from being satisfactorily or commercially used in condenser construction. But by reason of certain features of my invention and particularly by powdering it, I am enabled to bring its excellent power factor or phase angle characteristics into practical use in a thoroughly practical and inexpensive way.

This powdered solid dielectric, such as the powdered fused quartz or powdered pyrex glass, moreover will be seen to achieve in a thoroughly practical way the relieving of the gaseous dielectric under pressure at those points or places where it is subjected to the highest and possibly dangerous voltage gradient and I am thus enabled to employ commercially practical and inexpensive configurations of solid dielectric material (such as the mica) and of the condenser plates while retaining the many advantages and unique coactions of the gaseous dielectric under pressure, all without subjecting the gaseous dielectric under pressure to unsafe stresses.

It will thus be seen that there has been provided in this invention an insulating means and a condenser construction in which the several objects hereinbefore noted, together with many thoroughly practical advantages, are successfully achieved. The construction will be seen to be inexpensive, of a thoroughly practical nature, and well-adapted to meet the exigencies of practical use.

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 herein above set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In condenser construction, in combination, juxtaposed plate members and a composite dielectric insulating said members from each other, said dielectric including mica and a gaseous dielectric under pressure in series therewith at portions where the voltage gradient between said plates is substantially uniform and two composite dielectrics at portions where the voltage gradient is not uniform, said two composite dielectrics being arranged in series and each including two dielectrics of different permittivities in series with each other.

2. In condenser construction, in combination, juxtaposed plate members and a composite dielectric insulating said members from each other, said dielectric including mica and a gaseous dielectric under pressure in series therewith at portions where the voltage gradient between said plates is substantially uniform and two composite dielectrics at portions where the voltage gradient is not uniform, said two composite dielectrics being arranged in series, one of said two composite dielectrics including gaseous dielectric under pressure and mica in series and the other including a solid dielectric material having a lower permittivity than mica and a gaseous dielectric in series therewith.

3. In condenser construction, in combination, juxtaposed plate members and a composite dielectric insulating said members from each other, said dielectric including mica and a gaseous dielectric under pressure in series therewith at portions where the voltage gradient between said plates is substantially uniform and two composite dielectrics at portions where the voltage gradient is not uniform, said two composite dielectrics being arranged in series, one of said two composite dielectrics including gaseous dielectrics under pressure and mica in series and the other including a mass of small particles of solid dielectric material comingled with gaseous dielectric under pressure.

4. In condenser construction, in combination, juxtaposed plate members and a composite dielectric insulating said members from each other, said dielectric including mica and a gaseous dielectric under pressure in series therewith at portions where the voltage gradient between said plates is substantially uniform and two composite dielectrics at portions where the voltage gradient is not uniform, said two composite dielectrics being arranged in series, one of said two composite dielectrics including gaseous dielectrics under pressure and mica in series and the other including powdered fused silica and gaseous dielectric under pressure.

5. In condenser construction, in combination, juxtaposed plate members and a composite dielectric insulating said members from each other, said dielectric including mica and a gaseous dielectric under pressure in series therewith at portions where the voltage gradient between said plates is substantially uniform and two composite dielectrics at portions where the voltage gradient is not uniform, said two composite dielectrics being arranged in series, one of said two composite dielectrics including gaseous dielectrics under pressure and mica in series and the other including powdered glass and a gaseous dielectric under pressure.

6. In condenser construction, in combination, juxtaposed plates, and a layer made up of superimposed and staggered scales of mica interposed therebetween, the superimposed scales being in face to face contact with each other and the spaces between the scales being free from a binder and being filled with a gaseous dielectric under pressure, and a container forming a confining enclosure therefor.

7. In condenser construction, in combination, juxtaposed plates, natural mica interposed therebetween, the spaces between the laminations of said mica being free from a binder or filler, a gaseous dielectric under pressure filling the said spaces between the said laminations of said natural mica, and a container for enclosing said

plates and interposed natural mica and said gaseous dielectric under pressure.

8. In condenser construction, in combination, a sealed casing having therein a condenser construction comprising two plate elements, and means for insulating said plate elements, said means including a mass of freely contacting small particles of solid dielectric material, the spaces between said particles being free from a binder or filler, and a gaseous dielectric under pressure occupying the spaces between said particles.

9. In condenser construction, in combination, two plate elements, and means for insulating said plate elements, said means including two composite dielectrics in parallel, each dielectric comprising a gaseous dielectric under pressure and a solid dielectric, the solid dielectric component of one composite dielectric having a permittivity different from the solid dielectric component of the other composite dielectric.

10. In an electrical apparatus, the combination with a casing having therein two parts to be insulated from each other, of a solid dielectric interposed therebetween, said dielectric comprising natural mica whose scales or laminations have thin spaces therebetween which are free from a binder or filler, and a gaseous dielectric under pressure filling the said spaces between said scales or laminations of said natural mica.

11. In an electrical apparatus, the combination with two parts to be insulated from each other, of a mass of freely contacting particles of solid dielectric material interposed therebetween, there being minute spaces between said particles and said spaces being free from a binder or filler, and a gaseous dielectric under pressure filling said minute spaces between said particles.

12. In an electrical apparatus, the combination with two parts to be insulated from each other, of a mass of free particles of ground fused quartz interposed therebetween.

13. In an electrical apparatus, the combination with two parts to be insulated from each other, of a mass of free particles of ground glass interposed therebetween.

14. In an electrical apparatus, the combination with two parts to be insulated from each other, of two composite dielectrics interposed therebetween, each composite dielectric including a gaseous dielectric under pressure and a solid dielectric, the solid dielectric of one composite dielectric having a permittivity different from that of the solid dielectric of the other composite dielectric.

15. In an electrical apparatus, the combination with two parts to be insulated from each other, of two composite dielectrics interposed therebetween, each composite dielectric including a gaseous dielectric under pressure and a solid dielectric, the solid dielectric of one composite dielectric having a permittivity different from that of the solid dielectric of the other composite dielectric, said composite dielectrics being arranged in series.

16. In an electrical apparatus, the combination with two parts to be insulated from each other, of two composite dielectrics interposed therebetween, each composite dielectric including a gaseous dielectric under pressure and a solid dielectric, the solid dielectric of one composite dielectric having a permittivity different from that of the solid dielectric of the other composite dielectric, said composite dielectrics being arranged in parallel.

17. In an electrical apparatus, the combination with two parts to be insulated from each other, of two composite dielectrics interposed therebetween, each composite dielectric including a gaseous dielectric under pressure and a solid dielectric, the solid dielectric of one composite dielectric having a permittivity different from that of the solid dielectric of the other composite dielectric, said two composite dielectrics being arranged in series and also in parallel between said parts.

18. The herein described method of insulating two parts of an electrical apparatus which comprises superimposing directly upon one another and in staggered relation and in direct face to face contact with each other a suitable number of scales or sheets of mica, interrelating the resultant built-up mica and the parts to be insulated, and filling the interstices between the contacting faces of the scales of mica with a gaseous dielectric under pressure.

19. The herein described method of forming a composite dielectric adapted for insulating two parts of an electrical apparatus which comprises reducing fused quartz to small particles, dissolving out metallic impurities, and drying the resultant particles after interposing them between the parts to be insulated.

20. The herein described method of forming a composite dielectric adapted for insulating two parts of an electrical apparatus which comprises reducing fused quartz to small particles, dissolving out metallic impurities, drying the resultant particles after interposing them between the parts to be insulated, and filling the spaces between said particles with a gaseous dielectric under pressure.

21. The herein described method of forming a composite dielectric adapted for insulating two parts of an electrical apparatus which comprises superimposing sheet-like portions of natural mica directly one upon the other and free from an interposed binder, removing the moisture from the mica, and filling the interstices between the sheet-like portions of said natural mica with a gaseous dielectric under a pressure other than atmospheric and to give it high dielectric strength.

22. The herein described method of forming a composite dielectric adapted for insulating two parts of an electrical apparatus which comprises superimposing scales of natural mica one upon another and free from an interposed binder, and heating the mica under reduced pressure to remove moisture therefrom.

23. The herein described method of forming a composite dielectric adapted for insulating two parts of an electrical apparatus which comprises superimposing scales of natural mica one upon another and free from an interposed binder, heating the mica under reduced pressure to remove moisture therefrom, and filling the interstices between the scales of mica with a gaseous dielectric under a pressure other than atmospheric and to give it relatively high dielectric strength.

24. In electrical apparatus, the combination with a casing having therein two parts to be insulated from each other, of solid dielectric material interposed therebetween, said material including a layer of scales of mica resting directly one upon the other and free from a binder, and a gaseous dielectric under pressure filling the spaces between the said scales.

25. The herein described method of forming a composite dielectric adapted for insulating two

parts of an electrical apparatus which comprises building up a layer of freely contacting superimposed scales of mica by laying said scales one upon the other with their adjacent faces in free contact and filling the interstices between contacting faces of said scales with a gaseous dielectric under pressure.

26. The herein described method of insulating two parts of an electrical apparatus that are of substantial area which comprises placing on one of said parts a suitable number of relatively small sheets of natural mica in a single layer and sufficient in number to cover the desired area of said one part, placing upon the said layer a sufficient number of relatively small sheets of natural mica to form a second layer of substantially the same area but with the mica sheets of the second layer staggered relative to the sheets of the first layer, then relating the other of said parts face to face with said last-mentioned layer, and filling the interstices between contacting faces of the sheets in said two layers and the interstices between edges of the sheets in each of said layers with a gaseous dielectric under pressure.

27. The herein described method of insulating two parts of an electrical apparatus that are of substantial area which comprises placing on one of said parts a suitable number of relatively small sheets of natural mica in a single layer and sufficient in number to cover the desired area of said one part, placing upon the said layer a sufficient number of relatively small sheets of natural mica to form a second layer of substantially the same area but with the mica sheets of the second layer staggered relative to the sheets of the first layer, thus forming as many more layers of mica sheets in a similar manner until the required thickness of mica sheets is obtained, relating the other of said two parts face to face to the last of the layers thus formed, then filling the interstices between contacting faces of the sheets in adjacent layers and the interstices between adjacent edges of the sheets in each layer with a gaseous dielectric under pressure.

28. In electrical apparatus, the combination with a casing having therein two parts to be insulated from each other, of solid dielectric material interposed therebetween, said material including a plurality of individual layers of sheets of mica, each layer comprising a plurality of mica sheets arranged edge to edge, and the sheets of one layer being staggered relative to the sheets of the other layer, and a gaseous dielectric under pressure filling the interstices between contacting faces of the sheets of adjacent layers and filling the interstices between the adjacent edges of the sheets in each layer.

FRANKLIN S. SMITH.

CERTIFICATE OF CORRECTION.

Patent No. 2,079,231. May 4, 1937.

FRANKLIN S. SMITH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 64, for the words "The permittivity of ground fused quartz is 3" read If the permittivity of member 21 is 7 and the; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of July, A. D. 1937.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.

parts of an electrical apparatus which comprises building up a layer of freely contacting superimposed scales of mica by laying said scales one upon the other with their adjacent faces in free contact and filling the interstices between contacting faces of said scales with a gaseous dielectric under pressure.

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27. The herein described method of insulating two parts of an electrical apparatus that are of substantial area which comprises placing on one of said parts a suitable number of relatively small sheets of natural mica in a single layer and sufficient in number to cover the desired area of said one part, placing upon the said layer a sufficient number of relatively small sheets of natural mica to form a second layer of substantially the same area but with the mica sheets of the second layer staggered relative to the sheets of the first layer, thus forming as many more layers of mica sheets in a similar manner until the required thickness of mica sheets is obtained, relating the other of said two parts face to face to the last of the layers thus formed, then filling the interstices between contacting faces of the sheets in adjacent layers and the interstices between adjacent edges of the sheets in each layer with a gaseous dielectric under pressure.

28. In electrical apparatus, the combination with a casing having therein two parts to be insulated from each other, of solid dielectric material interposed therebetween, said material including a plurality of individual layers of sheets of mica, each layer comprising a plurality of mica sheets arranged edge to edge, and the sheets of one layer being staggered relative to the sheets of the other layer, and a gaseous dielectric under pressure filling the interstices between contacting faces of the sheets of adjacent layers and filling the interstices between the adjacent edges of the sheets in each layer.

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