Dec. 13, 1927. 1,652,212

W. H. PRIESS

ELECTRICAL CONDENSER AND METHOD OF MAKING IT

Filed March 30. 1921 4 Sheets-Sheet 1

Fig. 1.

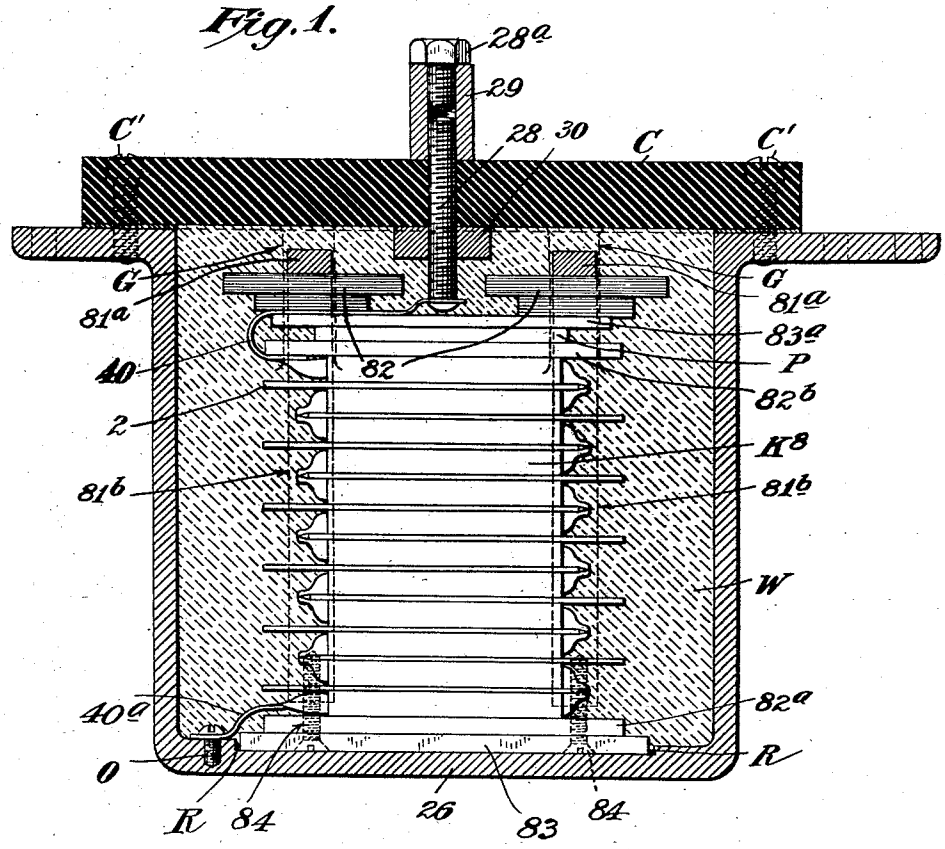
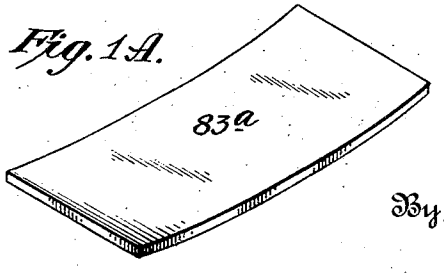


Fig. 1A.



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ELECTRICAL CONDENSER AND METHOD OF MAKING IT

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Fig. 2.

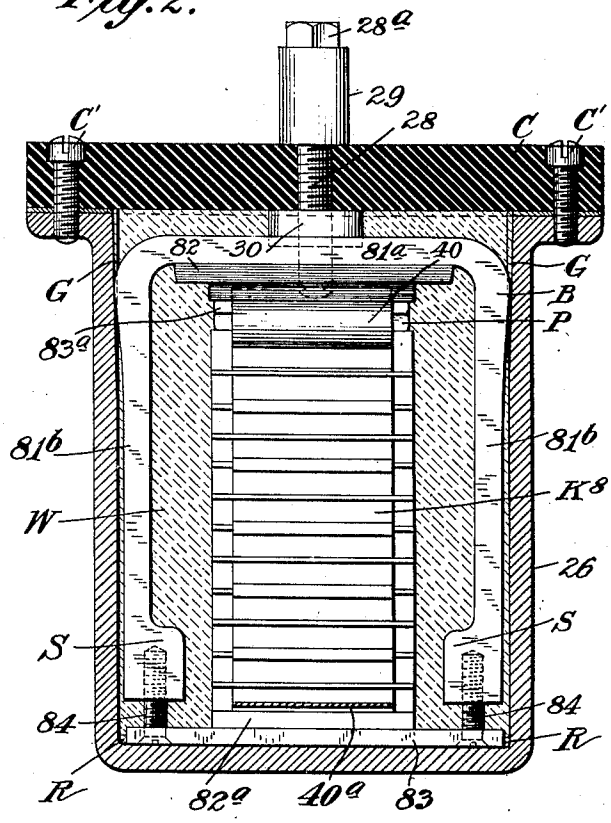
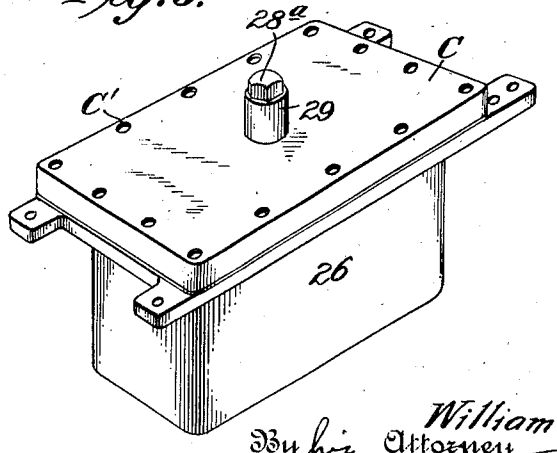


Fig. 3.



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ELECTRICAL CONDENSER AND METHOD OF MAKING IT

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Fig. 4.

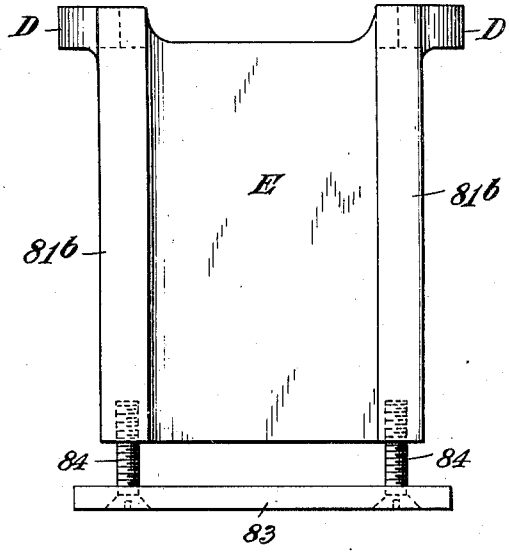
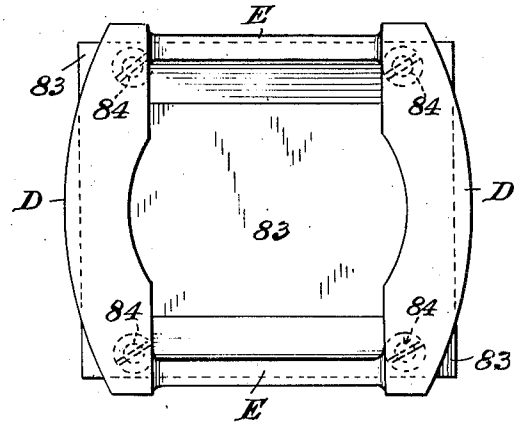


Fig. 5.



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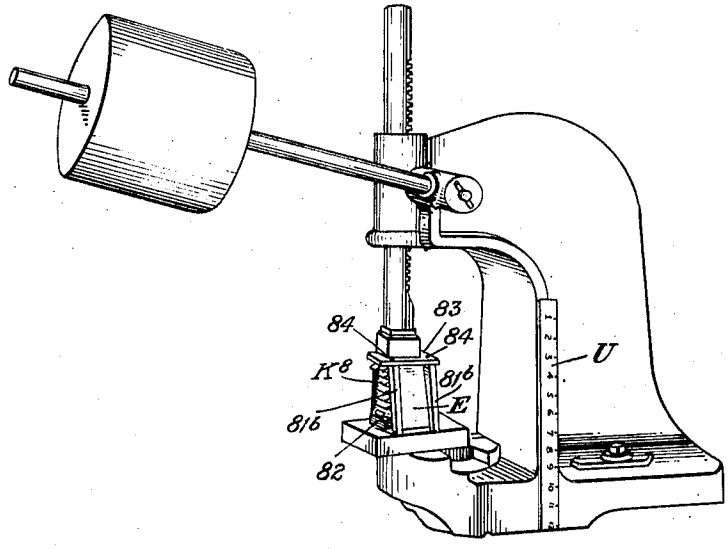
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ELECTRICAL CONDENSER AND METHOD OF MAKING IT

Filed March 30, 1921 4 Sheets-Sheet 4

Fig. 6.



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Patented Dec. 13, 1927. 1,652,212

UNITED STATES PATENT OFFICE.

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ELECTRICAL CONDENSER AND METHOD OF MAKING IT.

Application filed March 30, 1921. Serial No. 456,903.

This invention relates to electrical condensers and methods of making them. The invention is applicable to condensers of many types, for adaptation to high potential use, and specifically includes condensers of the sheet type for use in radio communication circuits, electric power circuits and the like.

The principal object of the invention is to provide a condenser adapted mechanically and electrically to preserve during service the high pressure initiated upon the condenser stack during the process of manufacture and consequent greatest practicable closeness of contact of surfaces of dielectric and conducting sheets, all under conditions of compactness and lightness; the construction being adapted for use not only in service but during the process of manufacturing the condenser stack itself.

The present application constitutes a continuation in part of my co-pending application, Serial No. 332,421, filed 22 October, 1919, and of my co-pending application for Patent 1,553,549 dated Sept. 15, 1925.

The invention consists of the features described in detail hereafter and illustrated in the best form in the drawings of which Figures 1, 1^A, 2, 4 and 5 are to scale and Figs. 3 and 6 are reduced.

Figure 1 is a longitudinal section of the casing or box and its cover for the condenser stack which is embedded or cast in wax, or immersed in oil in the casing, the stack being shown in elevation, and the clamping means in place around the stack.

Fig. 1^A is a perspective view of the spring plate used in the condenser.

Fig. 2 is a transverse section of the casing and cover showing the stack and its clamping means in elevation.

Fig. 3 is a perspective showing, in reduced scale, of the completed and enclosed condenser ready for service, the casing being oblong in correspondence with the like shape of the sheets of the condenser stack, the length being indicated in Fig. 1 and the width in Fig. 2.

Fig. 4 is a side elevation of an embodiment of a stack-clamping member alone, the view being taken as in Fig. 1, but the construction being specifically different from the clamping construction of Fig. 1 in that the two clamping members of Fig. 1 are joined together in Fig. 4 by two (Fig. 5) integrally cast webs E.

Fig. 5 is a plan view of the form shown in Fig. 4.

Fig. 6 is a view of the condenser stack with clamping means of Figs. 4 and 5, the whole inverted for compression in the common arbor press shown, as a part of the process of treating the condenser stack.

The clamping means of this invention has several functions, although simple in appearance; and it is used to participate in a very refined process of manufacture, in addition to being designed to remain permanently with the condenser stack as a functional part of the condenser for service conditions. The construction will be described first, that to be followed by the points which are now considered to be the most important ones in connection with the construction of the condenser, with the method or process of treatment of the condenser stack as involved with the use of the apparatus in connection with the method; and in connection therewith the operation in service of the condenser and its clamping means.

The condenser stack is at K^s of Figs. 1 and 2. The clamping means also shown in said figures comprises the parts which, with the stack, are permanently embedded or immersed in the solidified paraffin wax or oil W indicated by broken lines within the casing 26, which is usually but not necessarily of metal. The clamping member is of metal, and by reason of its design it permits maintenance of the required high mechanical pressure on the stack under conditions of greatly reduced space, the clamping means being very small relative to the high duty performed by it. The cover C (since it has no clamping function) may be of insulating material such as bakelite, mica moulded compositions or the like, secured to casing 26 by screws C′ (Fig. 3). When of insulating material, the cover provides for bringing out a condenser terminal or terminals. The clamp is especially designed, as to its mechanical and electrical features.

for use with condenser stacks which themselves are designed and processed to be adapted for high potential service; for example, the series sectional condenser disclosed in Figs. 1 and 2 is adapted to stand a voltage of approximately 20,000 volts or more at radio frequencies; although, of course, modifications of the clamp shown in Figs. 1, 2, 4 and 5 may be made to suit it for condensers of various operating frequency, current, voltage, capacity and consequent physical size. In high potential condensers it is desirable that the stack, both in process of manufacture and in service, be subjected to continuous high mechanical pressure which approximates a thousand pounds per square inch of active area of a condenser sheet which in this particular case is approximately a ton on the ends of the stack. The dielectric sheets of the stack are preferably of mica of approximately 3 mils thickness (the useful range for condenser mica being from one to five mils thick). The conducting sheets are of soft metal foil, preferably lead foil. The upper limit of pressure initiated during the process of manufacture and maintained during service is that which will not cause such deformation of the soft foil as the undue spreading thereof. Hence the pressures used are those which are the highest practicable to be used without injuring the condenser. The object of such highest practicable mechanical compression during process and service is to eliminate and keep out of the interior of the stack all foreign materials (such as air, moisture and wax or oil filler) to the greatest possible extent, so that the stack will consist so far as possible of nothing but the mica dielectric and conducting sheets, the surfaces of which are in intimate contact with one another to the greatest possible extent. In my above-mentioned co-pending application, Serial No. 332,421, filed 22 October, 1919, I have described the advantages and reasons for the intimate contact above referred to. By this means (other things remaining equal), a condenser is constituted which will have a maximum di-electric strength and a minimum effective series resistance which will best withstand without injury the high voltages and currents to which it is subjected in the class of service for which it is designed.

The clamping means about to be described is a solution for a high potential, high frequency, condenser having a means that will apply a pressure sufficient to force the surfaces of the sheets of the stack into and maintain them in intimate contact with one another, both during process and service conditions, producing a condenser having a minimum of loss and also having a minimum bulk.

In Figs. 1 and 2 are shown duplicate U-shaped metal clamping members or yokes 81^b not connected together save via the metal base plate 83 to which their free ends are secured by pressure-retaining screws 84 extending through base plate 83 into lugs or enlargements S on the lower ends of yokes 81^b; but it is preferable, as shown in Figs. 4 and 5, that said two yokes 81^b be joined by some such means as webs E cast integrally with the yokes, to prevent displacement of the individual yokes relatively to each other at their upper ends, and provide a path of maximum thermo conductivity from the stack to the casing, via the filler.

The stack K^s of desired construction and not necessarily as shown (Figs. 1 and 2 showing a series sectional arrangement long known as suitable for high potential service) rests on metal base-plate 83 from which the lower end of the stack may be separated and insulated if desired by a sheet of mica 82^a (thickness being shown exaggerated). Base-plate 83 rests in a recess R in the bottom of casing 26 which serves to hold the stack in central position in the casing, in co-operation with the upper parts of yokes 81^b which may bulge as at B (Fig. 2) to fit in vertical grooves G in the upper portions of opposite interior walls of the casing and extending from the top of the casing downwardly, having a decreasing depth, and serving to guide the stack into recess R which receives base plate 83.

In the construction illustrated in Fig. 2, the vertical portions of the clamping members 81^b are shown spaced from the adjacent sides of the stack, providing insulation clearances sufficient to prevent brushing or discharges from the stack to the clamping members 81^b, the clamping members 81^b being at the potential of the lowermost section of the stack and the potential in the stack increasing from section to section towards the top. The casing 26 is of metal and constitutes (or may constitute) one terminal of the condenser, being electrically connected to the lowermost section and at the potential of the clamping members 81^b. It is preferable and possible to have the casing 26 closely fit the clamping means whereby the size of the condenser for given electrical clearances is a minimum. Owing to the greater difference of potential between the upper portion of the stack and clamp, the clamp requires more clearance at the top. The grooves G allow this increased separation between the stack and clamp at the top without increasing the size of casing 26.

On top of the stack K^s and covering substantially the entire area thereof is (Fig. 1) the steel pressure plate P, and there may be a sheet of mica 82^b between the stack and the pressure plate P, serving to insulate the stack K^s from the pressure plate P resting

on said insulation 82^b. (Sheet 82^b is illustrated exaggerated in thickness.) The parts at this location are not so clearly shown in Fig. 2, being obscured by the copper strip lead 40 to an upper terminal, Fig. 2 being taken from the left of Fig. 1 where strip lead 40 extends upwardly from the uppermost section of the condenser, its upper end being free and flexible and soldered and riveted to screw 28 passing through nut 30 (a rubber washer not shown) and insulating cover C to external threaded sleeve 29 in which is screwed the terminal binding screw 28^a. The parts 30, 28 and 29 are held together and to the cover C, and constitute the other terminal of the condenser (the high-potential terminal). A copper strip lead 40^a is electrically connected to the lowermost section of stack K^s, which might be connected to the outside in any desired way; but when casing 26 is of metal as shown is connected to the casing by the screw O as shown, whereby casing 26 constitutes the low potential terminal.

Pressure plate P is preferably at least of sufficient area to cover the active area of the stack sheets, i. e., the area of the meeting surfaces of the dielectric and conducting sheets. Thereby the pressure of the clamping yokes 81^b is uniformly distributed over the entire area of the mica and foil sheets.

On top of pressure plate P is a spring which in the present embodiment of the invention is a metal spring plate 83^a which, when not under stress due to the high service pressure, is substantially curved as shown in Fig. 1^A. This spring plate 83^a is preferably made of special high grade material such as vanadium steel, the clamping yokes 81^b being preferably of cast steel.

In addition to all the precautions taken to make this clamping means perfect both electrically and mechanically, the surfaces of the steel yokes 81^b, base 83 and the pressure-plate P are copper-plated in order to reduce electrical losses by eddy currents, hysteresis and the like.

By the clamping means disclosed, approximately a ton load is permitted on the stack. The spring pressure to be more fully described is permitted by the spring plate 83^a to work over a change of stack length in service of about one-eighth inch, service changes of length being only of the magnitude of a few thousandths of an inch.

In service the spring 83^a shown in Fig. 1^A is usually compressed until it is flat as shown in Fig. 1, although under some conditions of service it need not be completely flattened. In constructing the spring plates 83^a, they are designed to require a pressure of approximately 1,000 lbs. per square inch of active stack area to flatten them out, and hence in constructing a condenser, the condition of the spring while under pressure is an index of the pressure applied and the builder will know that sufficient pressure has been applied when the spring is flattened.

For the purpose of transmitting the high pressure suitably to pressure-plate P, via floating spring-plate 83^a which is separate from clamping members 81^b, the clamping yokes 81^b via upper spaced U-ends 81^a or D (Figs. 4 and 5) are provided in duplicate, one at each end of the spring plate 83^a; but in order to provide ample insulation between the metal parts, the clamping members 81^a being at the potential of the lower end of the stack and the spring plate 83^a being at the potential of the upper end of the stack, a pair of spaced insulating members 82, preferably of mica sheets or other insulating material, are interposed between the ends of spring plate 83^a and the upper or U-ends 81^a of yokes 81^b, the pressure being transmitted from said clamping yokes 81^b to pressure-plate P via these insulating members 82, under compression, and the spring plate 83^a by compression of the same by the yokes 81^b. The insulators 82 are preferably constructed as shown to provide a long leakage path between the metal parts at a difference of potential. By providing the spaced cross parts 81^a of the clamping members 81^b and the spaced insulators 82, sufficient space is provided between them for locating the lower end of terminal screw 28 above the stack, and at the same time insulating the screw from the members 81^a. The lead 40 is passed between one of the insulators 82 and the top of the stack and connected to the screw 28, insulating it from the clamp. The above construction provides a minimum of height for the condenser for given electrical clearances. The above is the preferred specific arrangement for a stack as disclosed which has its opposite ends of opposite polarity, all so that the upper electrical end of the stack (which may be the high potential end) may be adequately insulated from the metal clamping yokes 81^b and the base plate 83 of the clamping means, which are in electrical connection with the lower electrical end of the stack. In practice, the upper end of the stack is usually the high potential end, the casing when of metal as shown constituting the low potential terminal.

The insulating arrangements above described are ample for instances when there are differences of many thousands of volts between the two ends of the stack.

The lower or free ends of the clamping yokes 81^b are connected to the clamping plate 83, i. e., the base member of the clamps, by screws 84. In a construction involving a light mechanical system, the stated high mechanical pressure cannot be attained initially by these screws, if the screws are designed solely for retaining tension loads, for turning them in an attempt to obtain such

pressures would be liable to introduce torsion strains that might twist off the screws or result in stripping the threads. The process to be described provides a means for overcoming this obstacle.

The construction and arrangement of the metal steel yokes 81^b and insulating members 82 is such that the insulation 82 is subjected to compression as distinguished from tensile strain. With the arrangement disclosed, a small bulk of insulating material is required for mechanical and electrical reasons and almost any solid insulating material of low electric loss such as crystal quartz or the stack of mica sheets 82, will be suitable to transmit by compression the pressure of the strong clamping yokes 81^b to the stack K^8.

The employment of spring-plate 83^a, in addition to pressure-plate P, although not absolutely necessary in all cases, is usually preferred as being superior to non-elastic clamping means which is liable to receive a set upon the cooling and contraction of the stack after heating and expansion under service conditions, so that a release of pressure on the stack would result. The more refined and painstaking the process of treatment of the stack, pursuant to the process now to be described, the less variation there will be in the length of the stack in service.

Following is a description of the method or process, illustrating how the clamping means and the casing 26 participate in the process in addition to remaining with the stack as permanent parts of the completed condenser, and maintaining permanently and preferably resiliently the high pressure initiated during the processing.

Prior to the process, the lead foil sheets are rolled perfectly flat, and the mica sheets are measured for thickness, electrically tested, thoroughly dried, and placed for storage in air-tight containers.

My process is an improvement upon those claimed in the applications of Pickard, S. N. 380,919, filed 12 May 1920, and Macpherson, S. N. 384,501, filed 26 May 1920; and to the degree that my process is similar to those I may employ in the execution of my process, the apparatus disclosed in said applications and in the manner therein described.

First. Each sheet of mica and foil is separately coated with hot fluid or semi fluid insulating material such as molten paraffin, this wax being intended only as a temporary coating and serving as a detergent or agent for washing out air and moisture from between the stack-sheets. Preferably each sheet is coated just before it is put in place on top of another sheet in the building process. This coating preferably is effected by dipping the sheet in a bath of warm molten paraffin. (But my improvements in processing may be applied to a stack built up of dry [non-waxed] sheets.)

Second. A stack of such coated sheets is built up of alternate sheets of dielectric such as mica and foil (the wax-coatings being preferably warm and fluid as they are put in place and throughout the stack-building operation), and section separators or markers (temporary metal plates if so desired) are at this time interposed between the stack sections to serve as markers for the purpose hereinafter described. In this building operation, additional sheets of mica and foil are used preferably for each section above the number calculated to be proper for a given desired capacity for a "run" of the thickest mica, so that later on, after capacity test, sheets of mica and foil can be removed if the capacity be too high.

Third. A stack built as above is thoroughly heated by immersion in a bath of fluid insulating material such as the molten paraffin, until the insulating coating is so fluid that it can be the more readily squeezed out later, and after remaining long enough in the bath to remove the moisture from the stack; then the latter is removed and cooled under the highest practicable pressure, the pressure being applied during the bath, or just after the bath while the stack is hot, all for the purpose of squeezing out the paraffin, contained air, etc. This pressure at this stage can be applied either by way of any suitable temporary clamp such as a powerful C clamp or an arbor press as in Fig. 6, directly applied, the compression means being tightened as the stack cools to maintain the pressure. The heating of the stack of such sections as described (when the stack is sectionalized) in the paraffin bath, is preferable, although each section could be thus heated separately. The heating of an entire stack of such sections reduces the necessary number of compression clamps, and the heating of the stack of sections is simpler and easier.

Fourth. The material stack after cooling is now split up, where the temporary separators are inserted, into sections to be used in making a series section condenser stack or to make condenser stacks of other types. The capacity of each section is now measured, and if too high as shown by measurement, surplus mica and foil sheets are removed, as proposed above under "second" to bring the section to the right capacity. Each section is also tested for voltage breakdown. In case of a breakdown of any of the sections, each bad section is split into halves and each half tested to determine which is good. The bad half is then split into quarters and each quarter tested for the same purpose. The good halves are assembled to form a good section and likewise the good quarters, eighths, etc. The method above described is a very economical way of salvaging broken-down sections.

Fifth. When it is desired to make a final

condenser stack, the good sections are then assembled, preferably with insulating separators 2 as shown in Fig. 1, consisting of mica sheets when the stack is a series sectional one, and the terminals of the sections soldered together as shown.

Sixth. The assembled stack is then put (when cold, i. e., without pre-heating as a direct preliminary to this step) in an arbor press (like that of Fig. 6 which is employed in the process). (If the condenser is not a sectional condenser, the above steps in so far as they pertain to treatment of sectional condensers may be omitted.) The pressure of the arbor press is then applied to the stack, the capacity of the stack is measured while under such pressure, and the pressure is released. Then on the rare occasions when necessity for adjustment of the capacity of the stack is shown, such adjustment is effected by removal or addition of sheets of mica and foil.

Seventh. The stack then has applied to it the permanent small spring clamp shown in the drawings, the clamp being applied at this time either very tightly or under only small pressure, this application of the clamp being when the stack is cold. At this stage, when the stack is cold (i. e., before being subjected to the next heating operation), the stack is put under the high compression which was applied to it when or just after it was subjected to the above paraffin heating bath ("third" supra), this compression being applied by the arbor press (Fig. 6) to the stack through the clamp, the screws 84 being tightened up for the purpose of retaining this pressure before removal of the stack from the press. As shown in Fig. 6, the clamped condenser is inverted, baseplate 83 being on top, thereby exposing screws 83 to convenient access for tightening while the condenser is held under compression in the jaws of the press. The foot-rule U shows the actual dimensions of all the apparatus.

Eighth. The stack with its clamp is then thoroughly heated by immersion in a bath of hot paraffin or of other hot insulating fluid and then re-transferred to the arbor press while hot, where it is again subjected to the highest practicable spring compression applied through the clamp parts (which is, so far as is necessary, the final compressing operation); and if this results in any decrease in length (as from any further squeezing out of hot paraffin, etc.), the screws 84 are further tightened up while the stack is yet under the heavy compression of the press. (Usually this operation is performed by setting up the spring plate 83^a to a final given deflection. This spring plate is calculated and designed for a desired final pressure at a desired final deflection. Final condenser pressures are thereby rendered inherent with final deflection and are therefore rendered independent of an operator's judgment.) This compression may be while the stack is in the heating bath or just after it is taken out of the heating bath (as in "third" supra). [If the pressure is applied while in the bath (enough presses being available for this purpose), then the subsequent preheating step before embedment in the insulating filler W (Fig. 1) in casing 26 is unnecessary (referred to in "ninth", infra), because in such case the stack is not allowed time to be cooled by treatment in the arbor press during the period of time intervening between the paraffin bath and the embedding operation,—in other words, the above paraffin bath preliminary to the above final compressing may thus itself be the heating bath just preliminary to the embedding.] This final compression results in a final washing out of the interior of the hot stack, thereby producing a stack having its interior as nearly as possible absolutely free of paraffin or other insulating material, air and moisture, and the mica and foil sheets in the closest and most intimate contact possible.

Ninth. The completed stack with its spring clamp in permanent condition is now placed in the permanent casing 26, the casing when of metal being thereby adapted to receive a fluid insulating filler such as molten paraffin and permanently retain therein the filler when cooled against expansion by heating during service. (As to centralizing, see description above of casing recess B, casing-grooves G and clamp-bulges B). The stack and clamp, and also the casing, are then pre-heated (see "eighth" supra) by temporarily filling the casing with fluid insulating material such as molten paraffin; and the temporarily-filled casing may be further heated by applying the flame of a Bunsen burner to the exterior of the casing. Thereupon the pre-heating bath in the casing is poured out of the casing from around the hot highly-compressed stack. Thereupon the hot stack in casing 26 is subjected to vacuum, and during this condition the hot molten paraffin or other fluid filler for permanent embedding is poured in the casing around the condenser, after which the vacuum is discontinued. By fluid insulating material or fluid filler is meant any material which during the application of the process is fluid or semi-fluid or plastic, whether maintained in that condition by heat or not and irrespective of whether or not such material or filler is solid or semi solid at ordinary temperatures.

Thereupon the stack with its permanently-applied spring clamp is left in the permanent embedding filler in the permanent casing 26; and the embedment is solidified in cases where the filler is solid at ordinary

temperatures. If desired, and preferably, the embedding filler is cooled and solidified in such wise as to cause it to be free from cracks or voids, i. e., to be holosteric, this being effected by the application of a temporary waxing head (preferably as shown in said application of Macpherson) to the top of the permanent casing immediately after the clamped stack is placed in the casing 26. Then when the fluid embedding filler W is poured into the casing, sufficient is poured in to fill up the temporary waxing head also, so that during the cooling and solidification of the wax in the casing there is a head of wax in the waxing head on top of the wax W in the casing around the stack. Thereupon the wax in casing and head is cooled gradually as by the abstraction of heat from the lower part of such wax, i. e., in the casing, and the supply of heat to the upper part of the body of wax, i. e., in the waxing head, so that the formation of cracks and voids is obviated in the wax in the casing and limited to the wax in the temporary waxing head. When the wax has thus cooled so that all cracks or voids exist only in the head of wax, and not at all in the embedding wax W in the casing, the temporary waxing head and the paraffin therein are removed, leaving the embedding wax W flush with the top of the casing (Fig. 1); and thereupon the rubber gasket Y and the insulating cover C are put in place.

Referring to Fig. 1, it is to be noted that before the stack K^8 is put in the casing 26, the screw 28 has its lower end soldered and riveted to the free end of the broad copper strip lead 40. Also the nut 30 is moved on screw 28 to the level which will permit said nut to lie against the lower surface of cover C when finally the latter is put down into place, when screw 28 passes through an unthreaded hole in the cover. A rubber washer (not shown) is placed on top of nut 30 before cover C is applied over it. After cover C is applied, internally threaded sleeve 29 may be screwed down on screw 28; and finally binding screw 28^a is screwed into sleeve 29.

Herein "mica" means mica or its substantial equivalent; and so with lead foil, as other preferably soft metal foils may be used; and so with paraffin, as other waxes, oils or insulating cleaning and filler agents may be employed.

Since I have succeeded in separating the electrical functions of the cover and its mechanical function with respect to the maintenance of stack pressure, I may use for the cover, materials of very fine electrical properties irrespective of their mechanical strength. For example, a mica sheet or a mica sheet and mica insulator may be used and advantage obtained, especially at high potential and high frequency alternating currents due to the relatively low dielectric loss of mica and its superior dielectric strength and surface creepage properties. A quartz sheet or a thin porcelain sheet might likewise be used as a cover material, inasmuch as they have no mechanical function other than that of simple cover for the support of the high tension terminal. These materials, especially if thin, would have a low dielectric loss and have very fine creepage values.

It is to be understood that the invention is not limited to the embodiments and features specifically shown and described herein, but that such embodiments and features are subject to changes and modifications without any departure from the spirit of the invention.

I claim:—

1. In an electrical condenser, a stack of dielectric and conducting sheets; clamping means comprising a U-shaped yoke extending from one end of the stack to the other; and means connected thereto to maintain the successive sheets of the stack in intimate contact, and a casing surrounding the clamped stack, said casing being provided with grooves in its interior opposite walls arranged to receive and guide the sides of said clamping yoke.

2. In an electrical condenser, a stack of dielectric and conducting sheets; clamping means comprising a U-shaped yoke extending from one end of the stack to the other and means connected thereto to maintain pressure on the stack, a casing open at one end to receive the clamped stack and being formed upon opposite inner sides with grooves in which lateral upper portions of said yoke enter as the clamped stack is introduced into the casing; and means at the bottom of the casing to receive the bottom of the clamped stack and to co-operate with said grooves to center the clamped stack within the casing.

3. In an electrical condenser of the series section sheet type, the improvement in means for holding the stack under high compression, which comprises two metal parts, one of which is a base-plate for engagement with one end of the stack of sheets, and the other of which is a U-shaped member having wide opposite sides for facing opposite sides of the stack, the inner walls of said wide sides having inclined surfaces providing for wider spacing from the higher potential portion of the two sides of the stack which it faces, said U-shaped member at its intermediate portion adjacent the other end of the condenser from the base-plate being formed in two portions separated from one another for clamping that end of the stack and means for securing together the base plate and U-shaped member.

4. An electrical condenser which com

prises a stack of dielectric and conducting sheets compressed together to be held in intimate contact with one another, and clamping means constructed to maintain such compression and including parts consisting of a metal such as steel having high specific resistance and magnetic permeability, said metal parts being provided with a coating of copper to reduce losses from eddy currents.

5. In an electrical condenser, a stack of sections connected in series and comprising alternate sheets of foil and dielectric, the opposite ends of the stack being at a difference of potential, a metal clamping member for said stack and permissively at the potential of one end thereof and insulated from the opposite end thereof and spaced from the lateral portions of the stack to provide insulation clearance, a metal casing surrounding said stack and clamping member, permissively at the potential of the clamping member, and provided with grooves upon its inner surfaces adjacent to the lateral portions of the clamping member into which grooves the clamping member fits.

6. In an electrical condenser, a stack of dielectric and conducting sheets divided into series-connected sections and having high potential difference across its ends; an all-metal clamping means extending from end to end of the stack and tending to pull said ends together, said clamping means being permissively at the potential of the lower end of the stack and insulated from the opposite end and sides thereof; a metal casing enclosing the clamped stack and on the bottom of which it is supported; said casing engaging said clamping means at the sides and bottom and permissively at the potential of the clamping means; a cover of insulating material for said casing, the clamping means being functionally independent of the casing and cover; a condenser terminal located above the stack and mounted in the casing-cover; and a conducting lead extending from the uppermost section of the stack to said terminal.

7. In an electrical condenser, a stack of sections connected in series and having its opposite ends at a difference of potential, a base plate on which the stack rests, U-shaped metal clamping means secured at its ends to said base plate and extending across the opposite end of the stack in two spaced parts at opposite sides of said opposite end, spaced insulating members interposed between the said opposite end of the stack and the crossing parts of said clamping means, said clamping means and base plate being permissively at the potential of the lower end of the stack, a metal casing receiving said stack and clamp and being at the potential of the clamping means and provided with a cover of insulating material, a terminal in said cover located between the crossing parts of said clamping means and above said stack, and a lead from an adjacent end section extending between one of said insulating members and the top of the stack and connected to said terminal.

8. In an electrical condenser, a stack of sections connected in series and comprising sheets of foil and dielectric, said stack having its ends at a difference of potential, a clamping means including a base plate on which the stack rests, a pressure plate at the opposite end of the stack, insulating members upon the pressure plate at opposite sides thereof and spaced from each other and a metal clamping member connected to said base plate and extending along opposite sides of the stack and having two spaced parts extending over said insulating members whereby the sheets of the stack are maintained in intimate contact, said clamping member being permissively at the potential of the lower end of the stack, a metal casing enclosing said stack and clamping means and permissively at the potential of the lower end of the stack, a cover of insulating material, a terminal located in said cover over the end of the stack and between said insulating members, a conducting lead from an adjacent end section extending between the end of the stack and one of said insulating members and connected to said terminal, and an insulating filler in said casing surrounding the stack.

9. In an electrical condenser of the type comprising a stack of conducting and dielectric sheets electrically divided into series-connected sections whereby in service a high difference of potential may be applied across the two ends of the stack, the combination with such stack, of clamping means extending from end to end of the stack to pull said ends toward one another, and including a resilient element allowing variations of length of the stack under service conditions; and an insulating member arranged at one end of the stack to be held under compression by the clamping means and acting to prevent the stack from being short-circuited by the metal of the clamping means.

10. In an electrical condenser of the type comprising a stack of dielectric and conducting sheets in intimate contact with one another; rigid all-metal clamping means for maintaining such intimate contact and extending from one end of the stack to the other and constructed to tend to pull the ends of the stack together; and a spring interposed between one end of the stack and the corresponding end of said clamping means.

11. In an electrical condenser of the type comprising a stock of dielectric and conducting sheets in intimate contact with one an-

other, of means for maintaining such contact which includes metal plates facing and acting against the opposite ends of the stack, and rigid metallic means extending from end to end of the stack along opposite sides thereof and constructed to tend to draw said plates toward one another; and a spring interposed between said metallic means and one of said metal plates; said metallic means acting through said spring and on the metal plate at the other end of the stack to hold the spring under strain and hold the metal plates in positions to maintain said intimate contact.

12. In an electrical condenser, a stack of sections connected in series and comprising dielectric and conducting sheets; a pressure plate facing and acting against one end of the stack; a spring plate facing and acting against said pressure plate; a casing enclosing said parts and including a cover; an all-metal clamp supported within and by said casing and functioning independently of the casing and cover, said clamp being constructed to extend from end to end of and exterior to the stack and to act on said pressure plate and spring plate to tend to pull them toward the opposite end of the stack; and insulating material located between the all-metal clamp and one end of the stack, held under the compression of said clamp, and preventing short-circuiting the stack by said metal clamp.

13. In an electrical condenser, a stack of sections connected in series and comprising alternate sheets of foil and dielectric, the opposite ends of the said stack being at a difference of potential, and clamping means for exerting pressure over opposite ends of the stack, and including insulation under compression insulating the opposite ends of the stack from each other, and including also a spring plate under stress whereby said pressure is maintained resiliently.

14. In an electrical condenser of the type comprising a stack of dielectric and conducting sheets, a metal pressure plate facing and acting against one end of the stack; a metal spring plate facing and acting against said pressure plate; and a metallic clamp extending rigidly alongside the stack and from end to end thereof and constructed to tend to pull said pressure plate and spring plate toward the opposite end of the stack.

15. The herein-described method of making a sheet-stack of an electrical condenser, which consists in building up a stack of wax-coated sheets of dielectric and conducting material, highly compressing such stack at room temperature, maintaining such compression by tightening a permanent clamping device around the ends of the stack; heating the then highly compressed stack by a hot insulating fluid; further compressing the then hot stack to an extent greater than is practical by said permanent clamping means; and then maintaining such increased compression by further tightening said clamping means.

16. An electrical condenser comprising a stack of sheets constructed to have a difference of potential between its opposite ends; clamping means for the ends thereof consisting of a spring metal clamping plate extending over one end of the stack; a metallic clamping yoke looped over the stack end; metallic adjusting means co-operating with said yoke to flex the spring metal clamping plate; and insulating material held under compression between one end of the stack and said clamping means.

17. The herein-described method of making condensers which consists in building a stack of sheets of foil and dielectric, treating said stack to a bath of hot insulating fluid, applying permanent high spring pressure to said stack to squeeze out the insulating fluid and bring the sheets into intimate contact, subjecting said stack while under said spring pressure to a bath of hot insulating fluid, and then permanently surrounding said stack with an insulating fluid while under said spring pressure, substantially as described.

18. The herein-described method of making condensers which consists in building a stack of sheets of foil and dielectric, treating said stack to a bath of hot insulating fluid, applying permanent high spring pressure to said stack to squeeze out the fluid and bring the sheets into intimate contact, temporarily heating said stack with hot insulating fluid while maintaining said spring pressure, applying vacuum to the stack while hot and under said spring pressure and then permanently surrounding the warm stack while under said pressure and vacuum with an insulating fluid, substantially as described.

19. The herein-described method of making a condenser which consists in building a material stack of alternate sheets of foil and dielectric and applying hot fluid insulating material, squeezing out the air and moisture with the insulating material by the application of high pressure, cooling said material stack while under pressure, separating the material stack into sections and connecting such sections together to form a condenser stack, again treating the sectional stack with hot fluid insulating material and applying permanent high spring pressure to bring the sheets into permanent intimate contact, heating the stack while under the spring pressure by a temporary wash of hot fluid insulating material, applying a vacuum while the stack is hot and under said spring pressure, and finally surrounding the hot stack while under vacuum and said pressure with fluid insulating material.

20. The herein-described method of building a condenser, which consists in separately coating sheets of dielectric with insulating material and building a material stack of alternate sheets of foil and such coated sheets, washing out air and moisture from the inside of the material stack by heating the stack and squeezing out the insulating material by pressure, then allowing the material stack to cool while under pressure; separating the material stack into sections, assembling a number of sections into a condenser stack and connecting the sections and inserting insulating sheets between them; reheating the stack in a bath of insulating material and applying spring pressure of the order of a thousand pounds per square inch to the stack; preheating the stack while maintaining the spring pressure of the order specified by temporarily washing the stack with hot insulating fluid; subjecting the hot stack while under the spring pressure of the order specified to a vacuum and while in vacuum surrounding the stack with fluid insulating material, and solidifying the embedding insulating material by gradually cooling from the bottom upwardly, the spring compression being maintained on the condenser throughout cooling and in service substantially as described.

21. The herein-described method of building a condenser, which consists in coating sheets of dielectric with an insulating fluid, then building a material stack of the temporarily-coated sheets and foil, washing out the air and moisture from the inside of the material stack by heating the stack and applying pressure squeezing out the insulating fluid with the air and moisture, and then cooling the stack while under high mechanical compression; separating the material stack into sections, adjusting the capacity of each section, and testing for breakdown; assembling a number of sections to make a condenser by connecting them; measuring the stack capacity under compression and correcting it, if necessary; applying permanent spring pressure of the order of a thousand pounds per square inch to the stack to maintain the sheets in intimate contact; heating the stack in hot insulating fluid while the spring pressure is being applied; preheating the stack by means of a temporary wash of hot insulating fluid; subjecting the stack to vacuum while maintaining the stack under the spring pressure of the order of magnitude specified; then while in vacuum and under the spring pressure specified surrounding the stack with hot insulating embedding fluid while maintaining the spring pressure of the order specified, and finally solidifying the embedding fluid by gradually cooling from the bottom upwardly while maintaining the spring pressure of the order specified, substantially as described.

22. The herein-described method of making a condenser which consists in building a stack of alternate sheets of foil and dielectric, applying permanent spring pressure to said stack, temporarily heating said stack while under the spring pressure, subjecting said stack while hot and under the said spring pressure to a vacuum, and finally surrounding said stack while under the spring pressure and vacuum with fluid insulating material.

23. In an electrical condenser having a stack of dielectric and conducting sheets, a clamp having a metal base-plate facing one end of the stack, and two U-shaped metal members comprising two spaced portions extending across the opposite end of the stack, said U-shaped members being joined together by wide sides consisting of integral webs adjoining opposite sides of the stack, and the lower ends of said sides of the U-shaped member being adjustably secured to said metal base-plate.

24. In an electrical condenser of the type having a stack of series-connected sections with high potential across its ends, the combination with a metal casing enclosing such stack and a cover therefor, the stack being arranged to have its low potential end near the bottom of the casing; a metal base-plate at the bottom of the casing and supporting the stack; a metal U clamp secured at its lower and free ends to said metal base plate and extending up over the sides of the stack and having two separated top portions extending over the top or high potential end of the stack; insulating material held under compression of the clamp between said two separated portions of the clamp and the stack; and a high potential connection extending from a top section of the stack to an open side of the U clamp, under the insulating material lying beneath one of said top portions of the clamp, and out beyond the end of the stack from between said top separated portions of the clamp.

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