Nov. 7, 1950 A. LIECHTI 2,528,596
CONDENSER HAVING A LAMINATED DIELECTRIC
THICKENED AT ITS MARGINAL PORTIONS
Filed Feb. 11, 1948 4 Sheets-Sheet 1

Fig.1.

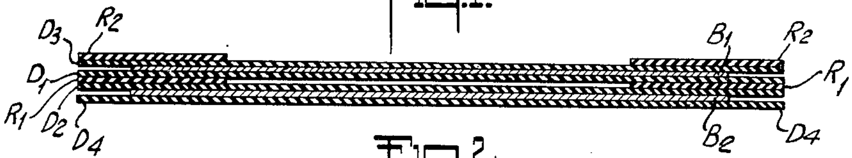


Fig.2.

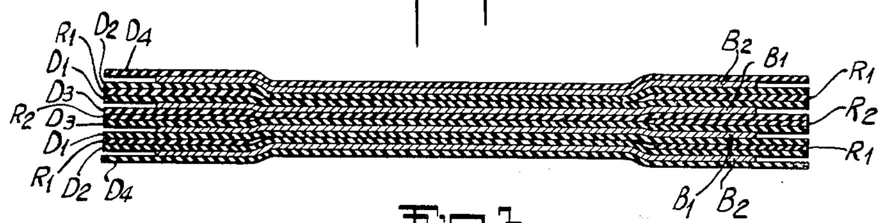


Fig.3.

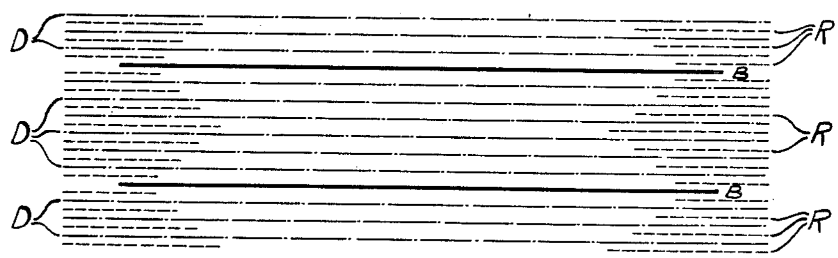


Fig.4.

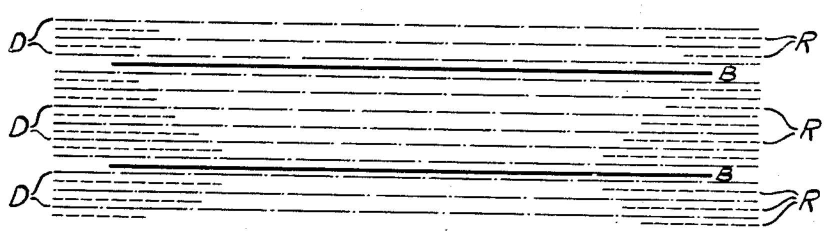
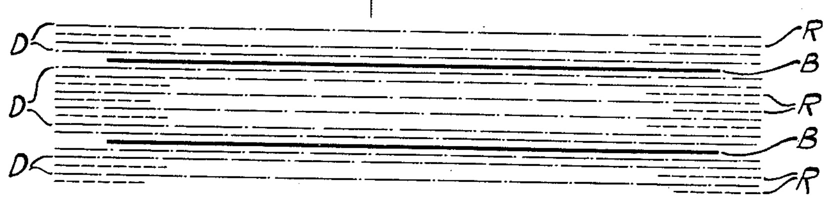


Fig.5.



INVENTOR
ALBERT LIECHTI.
BY K.A. Mayr
ATTORNEY

Nov. 7, 1950 A. LIECHTI 2,528,596

CONDENSER HAVING A LAMINATED DIELECTRIC THICKENED AT ITS MARGINAL PORTIONS

Filed Feb. 11, 1948 4 Sheets-Sheet 2

Fig. 6.

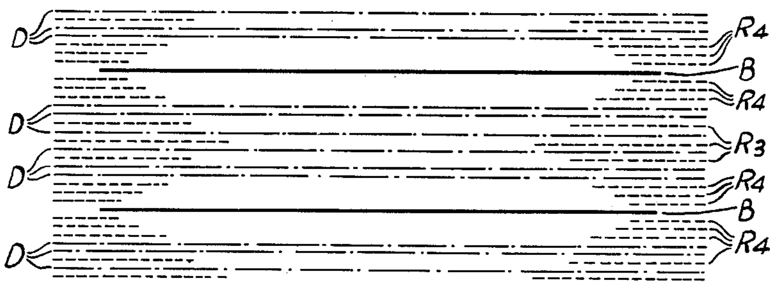


Fig. 7.

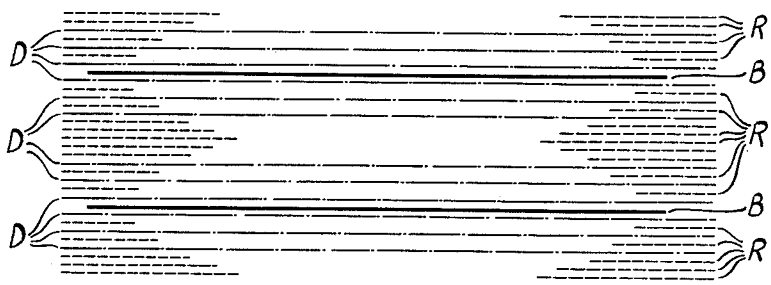
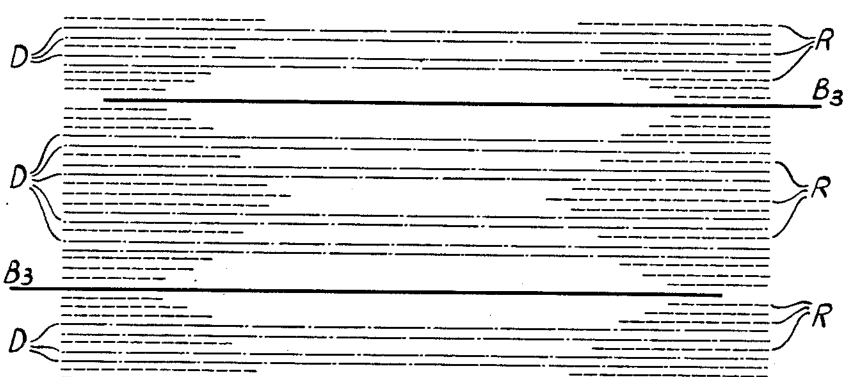


Fig. 8.



INVENTOR
ALBERT LIECHTI.
BY K. A. Mayr
ATTORNEY

Nov. 7, 1950

A. LIECHTI

CONDENSER HAVING A LAMINATED DIELECTRIC THICKENED AT ITS MARGINAL PORTIONS

2,528,596

Filed Feb. 11, 1948

4 Sheets-Sheet 3

Fig. 9.

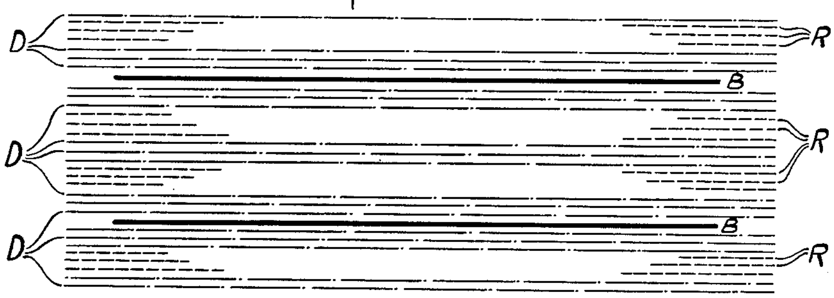


Fig. 10.

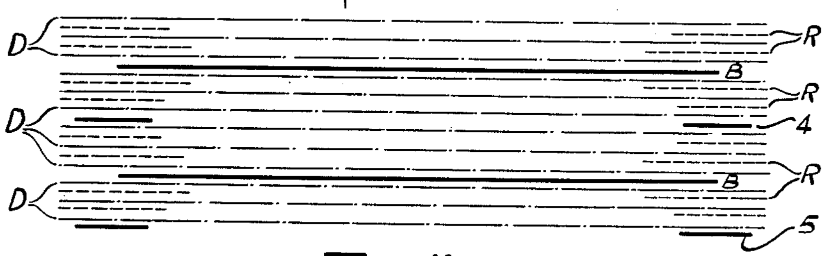


Fig. 11.

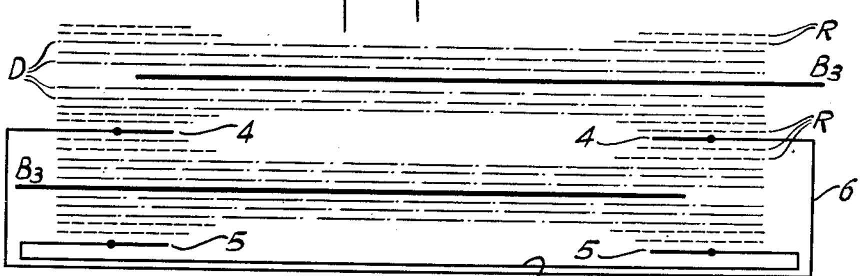
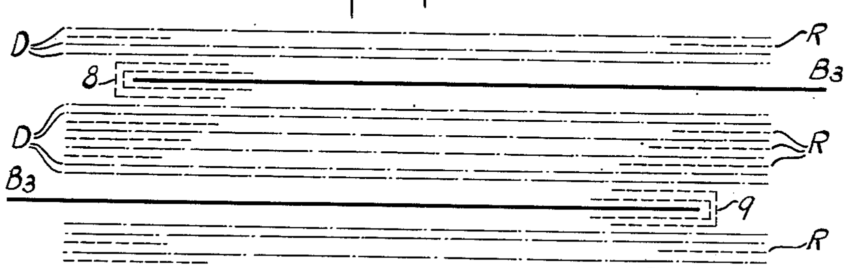


Fig. 12.



INVENTOR
ALBERT LIECHTI.
BY K. A. Mayr
ATTORNEY

Nov. 7, 1950 | A. LIECHTI | 2,528,596

CONDENSER HAVING A LAMINATED DIELECTRIC THICKENED AT ITS MARGINAL PORTIONS

Filed Feb. 11, 1948 | 4 Sheets-Sheet 4

Fig. 13.

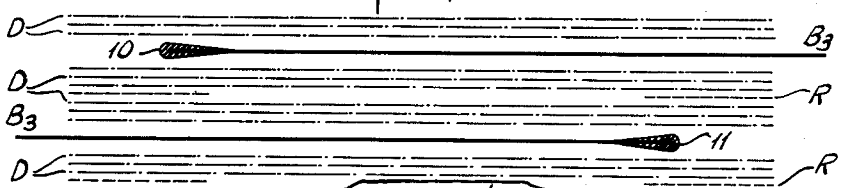


Fig. 14.

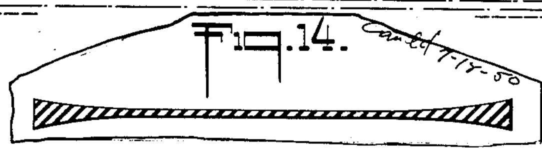


Fig. 14.

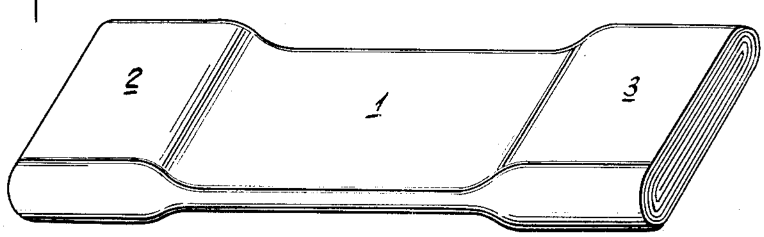


Fig. 15.

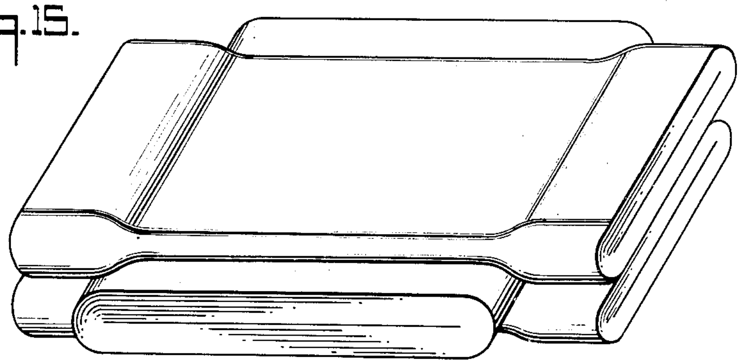
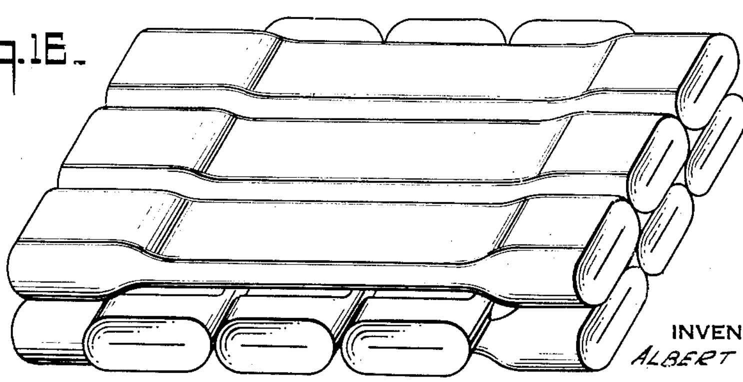


Fig. 16.



INVENTOR
ALBERT LIECHTI.
BY K. B. Mayr
ATTORNEY

Patented Nov. 7, 1950

2,528,596

UNITED STATES PATENT OFFICE

2,528,596

CONDENSER HAVING A LAMINATED DIELECTRIC THICKENED AT ITS MARGINAL PORTIONS

Albert Liechti, Zurich, Switzerland, assignor to Micafil A.-G., of Zurich-Altstetten, Switzerland, a corporation of Switzerland

Application February 11, 1948, Serial No. 7,608
In Switzerland February 19, 1947

10 Claims. (Cl. 175—41)

1

The present invention relates to an improved construction of electric condensers more particularly to condensers of the type made of strips of foil and dielectric by rolling them together.

An object of the invention is to provide an improved electric condenser having laminated dielectrics which are enlarged at their marginal portions.

According to the invention the marginal portions of the dielectric of condensers in which the dielectric consists of several layers of insulating material which is impregnated by an insulating agent, are made more effective relatively to the central portion of the dielectric by providing between the marginal portions of at least two full width layers within two metallic layers at least one narrow intermediary layer consisting of insulating material whereby, before rolling, the inserted layer is slidable on the adjacent layers.

Condensers having a dielectric built up of layers impregnated with oil tend to form gas at high dielectric loads which gas formation is due to glow phenomena whereby at certain voltages to which the condensers are subjected and known as ionization voltage the dielectric and thereby the whole condenser is destroyed.

There are conventional condensers in which on both surfaces of the metallic layers an insulating layer of very loose texture and rough surface is laid whereas the other insulating layers are of the usual dense material with smooth surfaces. It is also known to lay solely on the marginal portions of both surfaces of the metallic layers always one insulating layer of loose texture and rough surface. Gas formation has been somewhat reduced in such condensers and destruction is less likely than with condensers having smooth insulating layers only.

Tests on all conventional condensers have shown that the glow phenomena begin always at the marginal portions of the metallic layers and that therefore the great dielectric resistance of the central portions of the dielectric is never fully utilized.

It is known that the proportion of the field strength in two materials of different dielectric constants which are located between two plane electrodes is inversely proportional to the dielectric constants of said two materials. Since in an impregnated laminated dielectric the thickness of the impregnating medium is extremely small compared with that of the insulating material, the voltage to which the condenser is subjected may be increased at constant field strength in the impregnating material if, at the

2

same time, the dielectric constant of the insulating material is reduced. Also in this case a substantial increase of the ionization voltage is not possible and the interior portions are not fully used as compared with the marginal portions.

It has been found that the ionization voltage is proportional to the 0.45 to 0.5th power of the thickness of the dielectric. If the thickness of the dielectric between the metallic layers is increased at the marginal portions the ionization voltage can be increased without simultaneously considerably reducing the overall capacity of the condenser.

Depending on the thickness and number of the full width insulating layers already with a single intermediary layer disposed in the two marginal regions of the condenser between always two metallic layers, the marginal portions of the dielectric can be so strengthened as to increase the ionization voltage of the dielectric by at least 10%. Insertion of one or more intermediary layers is preferably done within the full width insulating layers whereby undesirable abrupt changes in the surfaces of the metallic layers at the transition from the interior region to the marginal regions are avoided.

According to the invention a substantial increase of the thickness of the condenser margin may be obtained by means of stacked, preferably graded intermediary layers or other suitably shaped bodies of insulating material which are inserted between the continuous insulating layers or adhere directly to the metallic layers and which are placed in the condenser rims together with the individual intermediary layers.

By insertion of additional metallic layers in the thickened border regions the dielectric of these regions may be subdivided in layers of smaller thickness whereby the ionization voltage may be increased still further.

The following example may serve for better understanding of the construction according to the invention:

A condenser is thickened at its rim to 1.4 times the original thickness, i. e. by 40%. Since the ionization voltage is proportional to the 0.45th to 0.5th power, i. e. the square root of the thickness of the dielectric, the thickened condenser may carry an ionization voltage of

$$U_2 \approx \sqrt{1.4} \times U_1 \approx 1.18 \ U_1$$

whereby U_1 is the ionization voltage of the unthickened condenser. If a metallic intermediary layer is inserted into the thickened border region, the distance between a full width layer and an intermediary layer in the border region is 0.7 times the distance between two layers in the original condenser. A voltage

$$U_3 \approx \sqrt{0.7} \times U_1 \approx 0.84 \times U_1$$

may then prevail between in intermediary and a full width layer and a voltage of $U_4 = 2 \times U_3 \approx 1.68 U_1$ may prevail between the two full width layers and on the condenser itself which amounts to an increase of 68% of the ionization voltage. By thickening of the marginal region 1.4 times and embedding of an intermediary metallic layer the power of the condenser may be increased by the square of the increase in voltage, i. e. by $1.68^2 = 2.8$. With the present invention condensers may be built which can carry a load 4 times as great as that of conventional condensers, at unchanged capacity, by doubling the thickness of the border regions and insertion of a metallic intermediary layer, as long as the dielectric resistance of the unthickened portions is sufficient. The increase of volume of the improved condenser amounts to not more than 1 to 2% at suitable piling of the individual condenser windings.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings which, by way of illustration, show what I now consider to be preferred embodiments of my invention.

In the drawings:

Fig. 1 is a cross sectional view of a condenser strip according to the invention suitable to be rolled to form a coil, and before it is compressed.

Fig. 2 is a cross sectional view of a condenser made up of a strip as illustrated in Fig. 1 and rolled over once and compressed.

Fig. 3 is a diagrammatic cross section of a modified condenser strip according to the invention before it is rolled and/or pressed.

Fig. 4 is a diagrammatic cross sectional view of another modification of layer arrangement in a condenser strip according to the invention suitable to be coiled.

Figs. 5 to 9 are diagrammatic showings of cross sections of further modifications of layer arrangements in a condenser according to the invention, before being rolled and/or pressed.

Figs. 10 and 11 are diagrammatic cross sectional views of modified layer arrangements according to the invention comprising narrow metallic intermediate layers in the thickened marginal regions.

Figs. 12 and 13 show cross sections through modified condensers according to the invention having the edges of metallic layers embedded in the dielectric, enveloped in supplemental insulating matter.

Fig. 14 is a perspective view of a flattened condenser roll according to the invention.

Fig. 15 is a perspective illustration of a stack of pressed condenser rolls according to the invention.

Fig. 16 is a perspective view of a modified stack of pressed condenser coils according to the invention.

Like parts are designated by like numerals and/or letters in all figures of the drawings.

Referring more particularly to Figures 1 to 13 of the drawings these illustrate cross sections through stacks of insulating and metallic layers arranged according to the invention, as they are used for winding condenser coils. In Figs. 1 and 2 actual sections of the individual layers are shown whereas Figures 3 to 13 are more dia-

grammatic and indicate the metallic layers by solid lines B, the impregnated layers of insulating material such as paper by dash-dot lines D and the narrow strips of intermediary layers on both marginal portions of the condenser by dotted lines R. The latter produce the thickening of the border regions which is an object of the invention.

Fig. 1 illustrates the simplest system of piling the layers of which the condenser is composed, according to the invention. There is only one intermediary layer R_1 inserted in the border regions of the condenser between full width layers D_1 and D_2 of insulating material between the metallic layers B_1 and B_2. Intermediary narrow layers R_2 must be provided on top of the dielectric layer D_3, as shown, or below layer D_4, to assure that, after winding of the layers to form a coil, an intermediary border layer according to the invention is between all windings of the metallic layers.

The number of full dielectric layers as well as the number of intermediary narrow dielectric layers may be increased as indicated in Figs. 3 to 5 to suit individual conditions.

After winding, the produced roll is preferably pressed to a configuration as shown in Fig. 14 and in such manner that there is a gradual increase of thickness between the central portion 1 and the border portions 2 and 3. The layers of the central portion and the layers of the border portions are closely adjacent after pressing. The transition of full dielectric layers and the metallic layers from the middle portion to the marginal portions is gradual to avoid sharp bending, cracking and breaking of the latter. For this purpose the intermediary dielectric strips are of different and graded width as shown in Fig. 3, for example.

Figures 3 to 5 illustrate diagrammatically various arrangements of intermediary layers for producing a graded transition from the middle portion to the border portions of the condenser. Narrow intermediary layers R may be arranged between all full dielectric layers D as in Figs. 3 and 4, or intermediary layers R may be omitted between layers D as in Fig. 5. A narrow intermediary layer R may be directly adjacent both surfaces of the metallic layers B, as in Fig. 3, or such layers may be omitted, as in Fig. 4.

A portion of the narrow intermediary layers, R_3, may alternate with the full layers D and another portion of the intermediary layers, R_4, may be arranged in stacks of three, adjacent metallic layers B, as illustrated in Fig. 6. The arrangement may be modified according to Fig. 7 where a stack of five narrow layers is placed between the centrally located full layers between two metallic layers and other narrow layers alternate with the full layers closer to the metallic layers. A further variation of the arrangement according to the invention is shown in Fig. 8 whereby a package of narrow dielectric layers is directly adjacent the metallic layers and another package is between the full layers in the middle between two metallic layers and the packages alternate with single narrow layers in the remaining spaces between the full layers.

It is also possible to arrange all packaged narrow layers between full layers, as in Fig. 9.

In the arrangements as per Figures 8, 11, 12 and 13 the metallic layers B_3 project laterally from the dielectric for better cooling of the condenser.

Figs. 10 and 11 illustrate arrangements according to the invention in which narrow metallic intermediary layers 4 and 5 are inserted in the lateral portions of the condenser. In the modification shown in Fig. 11 the intermediary narrow metallic layers inserted between the same dielectric layers, i. e. positioned at the same dielectric level are electrically conductively interconnected by conduits 6 and 7, respectively, disposed outside of the condenser. This assures equal voltage distribution throughout the body of the enlarged dielectric.

If conduits 6 and 7 are positioned inside the condenser special insulation of the conduits is essential.

The narrow intermediary metallic layers 4 and 5 may be individual foil material or applied to the dielectric layers by spraying, pressing, or steaming electrically conductive material thereon.

The local enlargement of the dielectric material may be produced in part by folding insulating layers 8 and 9 around the ends of the metallic layers which do not project from the condenser. The ends of layers 8 and 9 are of different length for assuring graded transition from the thin central portion to the thick marginal portions of the condenser. If the metallic layers do not project at all from the condenser both ends may be enveloped by or embedded in dielectric material such as 8 and 9.

The number of narrow intermediary dielectric layers in the embodiments of the invention according to Figs. 3 to 12 may be chosen to suit individual conditions. To obtain practical results at least two, preferably more intermediary narrow dielectric layers must be provided in the dielectric composed of six full layers as shown by way of example in these figures.

Fig. 13 illustrates a modification of the arrangement according to Fig. 12. The local enlargement of the dielectric mass is effected partly by applying insulating masses 10 and 11 of drop like cross section around the lateral edges of the metallic layers B_3 which do not project from the condenser.

The thickness of the individual full width and narrow insulating layers may be the same, or different, or may be different in groups to suit individual requirements. It is, however, important that there be a minimum of mechanical strain at the transition from the thin to the thick portions of the condenser and this is the case if the rules laid down above are followed.

Preferably the inserted narrow intermediary layers are made of dielectric material whose dielectric constant is smaller than that of the full layers. It is thereby made possible to reduce the field strength in the impregnating medium in the marginal portions since within the border regions the mean dielectric constant of all insulating layers is reduced with respect to the dielectric constant of the impregnating medium.

The dielectric constant of the individual layers forming the dielectric may be chosen freely to obtain desired conditions.

Fig. 14 illustrates a finished pressed condenser coil according to the invention, and Fig. 15 a stack of such coils which shows that a number of coils according to the invention require little more space than conventional coils of same thickness as the middle portions of the improved coils.

Fig. 16 illustrates a modified stacking method whereby the improved condensers require practically the same space as the same number of conventional condensers. With the new coils relative displacement of the individual condenser coils is impossible.

While I believe the above described embodiments of my invention to be preferred embodiments, I wish it to be understood that I do not desire to be limited to the exact details of method, design, and construction shown and described, for obvious modifications will occur to a person skilled in the art.

I claim:

1. In an electric roll condenser having more than two metallic layers and between each two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, at least one relatively narrow insulating layer inserted between two of said full width layers in each of said marginal portions.

2. In an electric roll condenser having more than two metallic layers and between each two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, a plurality of relatively narrow insulating layers disposed in said marginal portions between two metallic layers and relatively slidably interspersed between said full width insulating layers.

3. In an electric roll condenser having more than two metallic layers and between each two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, a plurality of relatively narrow insulating layers disposed in said marginal portions between two metallic layers and interspersed between said full width insulating layers, the width of said narrow layers being different and said narrow layers being disposed consecutively according to their width for obtaining a graded overall configuration.

4. In an electric condenser having between two metallic layers a dielectric composed of a plurality of full width layers and having a middle portion and marginal portions, a plurality of relatively narrow insulating layers alternating with said full width layers in a portion thereof and disposed in said marginal portions, and a plurality of adjacent narrow layers disposed in said marginal portions between other of said full width layers.

5. In an electric condenser having between two metallic layers a dielectric composed of a plurality of full width layers and having a middle portion and marginal portions, a plurality of said full width layers being adjacent to one another and forming packages which are adjacent to said metallic layers, and a plurality of relatively narrow insulating layers adjacent to one another and forming packages inserted in said marginal portions between other of said full width layers.

6. In an electric condenser having between two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, said metallic layers having lateral edges disposed within a marginal portion, and a plurality of relatively narrow insulating layers disposed in each of said marginal portions between said metallic layers, at least, one of said narrow layers surrounding a lateral edge of said metallic layers.

7. In an electric condenser having between two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, said metallic layers having lateral edges disposed within a mar-

ginal portion, and an insulating mass disposed on said edges and having greatest thickness at the outermost portion thereof and tapering toward the center of said metallic layers and the middle of the condenser.

8. An electric condenser as defined in claim 10, said narrow metallic layers pertaining to two different marginal portions being pairwise galvanically interconnected.

9. In an electric condenser having between two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, a plurality of relatively narrow insulating layers disposed in said marginal portions between two metallic layers and interspersed between said full width insulating layers, said metallic layers having edges disposed in said marginal portions, and an insulating mass surrounding said edges and being thickest thereat and tapering along the marginal portion of the metallic layer whose edge it surrounds toward the center of the condenser.

10. In an electric roll condenser having more than two metallic layers and between each two metallic layers a dielectric built up of a plurality of full width insulating layers and having a middle portion and marginal portions, the combination of a plurality of relatively narrow insulating layers disposed in said marginal portions between two metallic layers and interspersed between said full width insulating layers, and relatively narrow metallic layers imbedded in the so thickened marginal portions of said dielectric.

ALBERT LIECHTI.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
901,498	Thomson	Oct. 20, 1908
923,889	Pruessman	June 8, 1909
1,327,593	Dubilier	Jan. 6, 1920
1,391,672	Dubilier	Sept. 27, 1921

FOREIGN PATENTS

Number	Country	Date
351,366	Great Britain	June 25, 1931
670,494	Germany	Jan. 19, 1939