

Aug. 29, 1939.

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2,171,127

CONDENSER

Filed June 21, 1938

FIG. 1

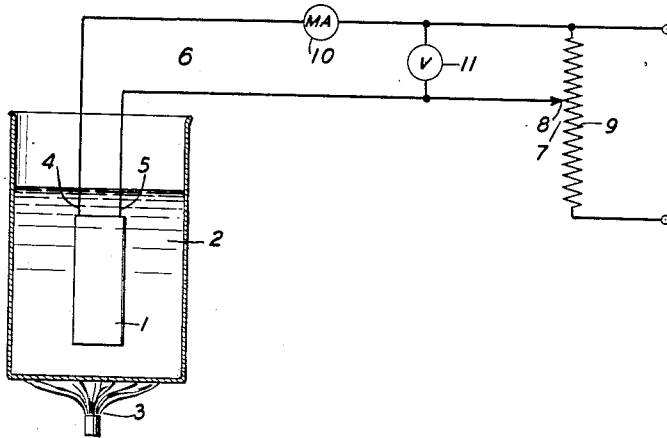


FIG. 2

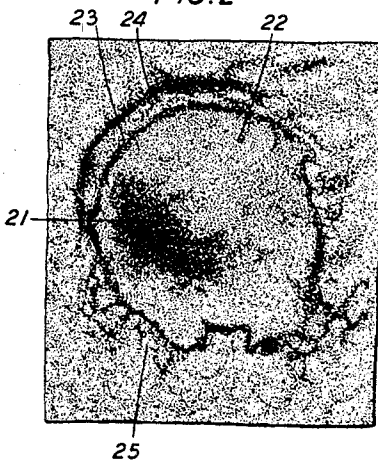


FIG. 4

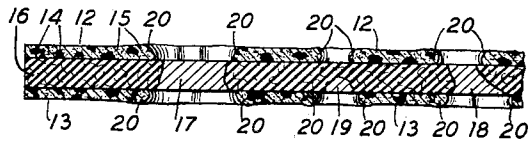


FIG. 3

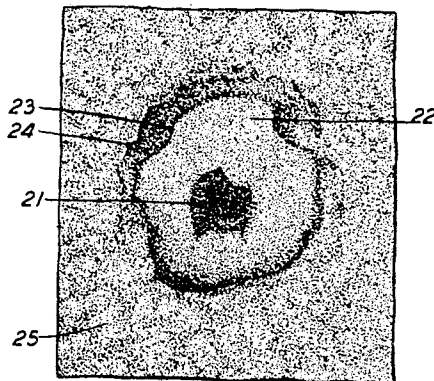
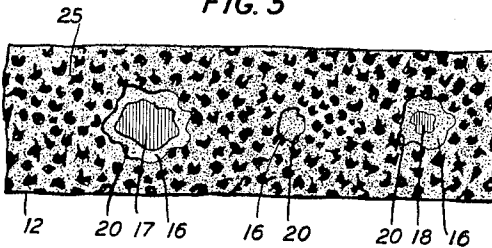


FIG. 5



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2,171,127

CONDENSER

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Application June 21, 1938, Serial No. 214,905

5 Claims. (Cl. 175-41)

This invention relates to condensers and more particularly to a method of manufacturing condensers.

5 The object of the invention is to produce fixed condensers much smaller and of greater capacity than are now available without changing the dimensions of the electrode plates.

10 The object above mentioned is attained by the use of a method of production whereby portions of conducting layers in the condenser are automatically changed to compensate for slight imperfections in layers of dielectric material.

In the drawing:

15 Fig. 1 is a view in schematic form of a condenser and apparatus for treating the condenser in accordance with this invention;

20 Fig. 2 is a greatly magnified view of a portion of a condenser showing a weak area in the dielectric isolated from the electrodes after treatment by my method;

25 Fig. 3 is a view similar to Fig. 2 but showing another weak area isolated from the electrodes;

30 Fig. 4 is a greatly magnified view in cross-section of portions of two electrode plates and an interposed sheet of dielectric material after treatment according to my method; and

35 Fig. 5 is a plan view of Fig. 4.

40 In making condensers comprising metal foil electrodes and interposed sheets of dielectric material, and particularly in making what are known as paper-filled condensers, it has been common practice to make the sheets of dielectric material in at least two-layer form. This practice has been found advisable due to the presence of imperfections in the dielectric sheet material. The imperfections may be, for instance, particles of foreign matter having a lower electrical resistance characteristic than the remaining material in the sheet or may be slight perforations in the sheet material. When the dielectric sheets are made in laminated form, the possibilities of low resistance paths existing through the dielectric sheet and between two electrode sheets separated thereby are materially reduced. The double layer sheet of dielectric material, however, increases the thickness of the condenser and decreases the capacity because of the necessary wider spacing of the electrodes. Efforts have been made to find dielectric sheet material free of relatively low electrical resistance particles and apertures in order that a single sheet of dielectric material may be used in place of the double-layer form. Dielectric sheet material free of the imperfections above mentioned, however, is not available in commercially produced paper.

This invention contemplates the use of commercially available single sheet dielectric material and layers of conducting material, the conducting material being preferably a low melting point metal or an alloy whose eutectic melts at a temperature low enough to permit partial melting of the electrode material without carbonizing the material of the dielectric sheet. In this invention a condenser, made up of single-layer dielectric sheets and sheets of conducting material alternated therewith, is subjected to a rather slowly increasing electrical potential while the condenser is being maintained at a temperature slightly below the melting point of the conducting material.

15 I have found that when a condenser comprising alternated layers of conducting material and dielectric material is subjected to a slowly increasing electrical potential while the condenser is maintained at a temperature slightly below the melting point of the conducting material, there is a sufficient increase in temperature at points in the conducting sheets lying adjacent points of imperfection in the dielectric sheet to so change the portions of the conducting sheets at such points as to destroy their conduction. For example, I have found that in a condenser having foil electrodes of a low melting point metal or alloy, a sheet of paper interposed between the foil electrodes and a minute particle of carbon in the sheet of paper, that the effect of this imperfection (particle of carbon) in the sheet of paper and hence in the condenser can be nullified by destroying the electrical conductivity of portions of the metal in the foil electrodes lying adjacent the point of imperfection in the sheet of paper and that such change will be obtained when the condenser is treated in the manner herein set forth.

40 Since such changes are accomplished by my method, it becomes practicable to make a condenser with a single-layer sheet of paper interposed between metal foil electrodes and thus obtain a relatively thinner condenser and a condenser having greater capacitance than would be the case were the condenser made of dielectric sheets and electrodes of the same plain surface areas but with laminated dielectric sheets.

50 Microscopic views taken of the condenser after being subjected to my method of treatment, show that portions of the metal foil electrodes lying adjacent the point of imperfection in the dielectric sheet have been changed so that the electrodes are no longer conductive at said point and in the immediate vicinity thereof. Several rea-

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sons may be advanced as to why the metal at such point changes its conductivity and why the conductivity decreases at such point. Although it is not necessary to fully understand and explain the reason for the change, it is submitted that probably one reason for the change is that when the temperature of the low melting metal or alloy is slowly raised from a point slightly below its melting point toward the melting point, the metal or alloy begins to melt and the softened portion of the metal to be attracted by skin tension away from the point of imperfection in the dielectric sheet thus insulating that portion of the electrode from the conducting path in the dielectric. If the defect in the dielectric sheet is a small aperture, the change occurring in the metal foil adjacent the aperture is substantially the same as occurs when the defect is a particle of some foreign substance having greater conductivity than that of the paper. When the defect in the dielectric sheet is compensated for by a change in the adjacent portion of the electrode material, the flow of current through this point is automatically reduced and the temperature at such point is correspondingly reduced. In the case where the defect is an aperture and a small electric arc is developed therethrough from one foil electrode to another, the arc may slightly burn away or char some of the paper in the vicinity of the aperture. The additional heating produced by the discharge and by the partially conducting carbonized path will cause the metal to melt in the vicinity of the conducting area and produce drawing away of the electrode metal adjacent the point of imperfection.

In cases where there are several defects in the sheet of dielectric material, the defects are compensated for in succession in the order of their conductivity and starting with the one having the greatest conductivity and running down to the one having the least. As each point of defect is compensated for, the temperature at that point is reduced and the temperature at the next point is increased upon increasing the voltage until it also is compensated for.

I have found that alloys such as those formed by tin and lead are suitable for the material of the electrode since such alloys have an eutectic sufficiently low to melt at a temperature which will not result in carbonization of a dielectric sheet. I have also found that commercially obtainable linen or kraft paper of four or five-tenths mil thickness is suitable for the dielectric sheet material and that when such material is used in single-layer form, any ordinary slight defects will be compensated for when the condenser is treated according to the method of my invention. It is understood, however, that the principle is applicable to thin sheets of any dielectric.

One form of applying my method of treatment to a condenser is shown in Fig. 1. In this case the condenser 1 is immersed in a bath of paraffin 2 maintained by means of a burner 3 at a temperature slightly below that of the melting point of the electrode material. The bath of paraffin may be subjected to the action of a suitable pump (not shown) to take off gases and moisture released and rising from the condenser and the paraffin bath. Electrode terminals 4-5 of the condenser are connected to a suitable source of electrical current supply in a circuit 6 provided with means 7 for slowly increasing the potential applied to the condenser. By slowly moving the movable contact 8 across the resistance coil 9 to decrease the resistance in the supply circuit

6, the potential applied to the condenser may be slowly increased. A milliammeter 10 and a voltmeter 11 suitably connected into the circuit 6 will show the current and voltage applied through the condenser 1.

Instead of having the condenser immersed in a bath of paraffin prior to and at the time the slowly increasing potential is applied, the condenser may be subjected to the heat treatment and slowly increasing potential in an unimpregnated condition and then immersed in the bath of paraffin or other impregnating compound.

The condenser 1 comprises sheets of metal foil alternated with sheets of paper, the sheets of paper being in single-layer form. In Fig. 4 portions of two sheets of metal foil and a portion of a sheet of paper interposed between the sheets of metal foil are shown in cross-section and greatly magnified. The sheets of foil 12 and 13 are represented as being composed of a binary alloy, for instance, that of tin and lead. The tin is represented in this case by the large dark blotches 14 and the lead by the relatively smaller dark spots 15. In the sheet of paper 16 there are particles of foreign matter represented at 17, 18 and 19. These particles of foreign matter may be, for instance, flakes of carbon or other substance more conductive than the paper and may extend from one face of the paper to the other or only partially through the paper sheet. The particle 17 is relatively large and extends from one face of the paper to the other. The particle 18 is smaller than 17 but also extends entirely through the paper sheet. The particle 19 is embedded in only one face of the paper. When the condenser is connected into the circuit 6 there is concentration of current at the particles 17, 18 and 19, the concentration depending on the size and character of the particle and the extent of passage through the paper. The concentration of current causes an increase in temperature at the points of imperfection residing in the particles 17, 18 and 19. The increased temperature results in melting a partial melting of the material of the foil electrodes 12 and 13 at portions lying adjacent the particles 17, 18 and 19 when the temperature is sufficiently high to cause such action. In this case the electrode material in the vicinity of the point of imperfection will melt, and due to the skin tension of the metal, be drawn away from the point of imperfection. As the metal draws away from the point of imperfection it makes this portion of the condenser less conductive than before. As the conductivity decreases there is a lessening of the flow of current and a corresponding decrease in temperature. With this decrease in temperature the drawing action of the metal stops. Fig. 4 shows the condition of the electrode material after the condenser has been treated in accordance with my method and with portions 20 of the electrodes adjacent the points of imperfection rolled back from the point of imperfection. Figs. 2 and 3 show magnifications of portions of a dielectric sheet and the foil electrodes after the treatment, the portions being the point of imperfection in the dielectric sheet 16 and in the vicinity thereof. In the magnifications shown in Figs. 2 and 3 the darkest spots 21 are where there is an entire absence of electrode material and where there is a point of imperfection in the dielectric sheet. Surrounding the spots 21 are areas 22 where there are no foreign particles in the paper but where there has been removal of the electrode material. The dark rings 23 and

24 are where the electrode material vacated from the areas 21 and 22 has rolled back into the main portion 25 of the electrode, the rolling back being accomplished by surface tension of the electrode material. Figs. 2 and 3 are drawn from actual microscopic photographs made of portions of a condenser after the condenser was subjected to the treatment above described. Fig. 5 shows a theoretical but still greater magnification than Figs. 2 and 3 of a portion of a condenser. The dark spots 17 and 18 represent the points of imperfection in the dielectric sheet. The dielectric sheet material left exposed but free of particles of foreign substance is indicated at 16. The irregular lines 20 indicate the rolled back electrode material drawn away from the vicinity of the points of imperfection. The unaffected portions of the electrode sheet and the material in its original condition are shown at 25 in Figs. 2, 3 and 5.

The novel method of making condensers as above described is not limited to making condensers of the particular structure set forth but may be used also in making condensers where conducting material is vaporized upon or otherwise applied to a sheet of dielectric material. For example, a low melting point metal or an alloy of low melting point metal may be applied in vaporized form to two sheets of paper or other dielectric, the two sheets so treated being placed together to obtain alternated layers of non-conducting and conducting film and then rolled into compact form with terminal strips laid in contact with portions of the conductive layers. When the method of treatment above described is applied to a condenser formed in this manner, the points of imperfection in the paper strips are automatically compensated for by a change in portions of the metal layers lying adjacent the points of imperfection in the paper strips.

The temperatures and potentials to be applied in carrying out my method of treatment will depend on the materials employed in the condenser structure.

In an experiment to determine the practicability of the method described, I used electrode material of lead-tin foil, having an eutectic melting at approximately 181° C. The dielectric material was .4 mil linen paper and the length of the foil was approximately 200 centimeters. The condenser was clamped tightly between brass plates and was immersed in Superla-wax at 180° C. and pumped at a pressure of less than 5 millimeters of mercury for approximately one-half hour. When a very low voltage was applied, the milliammeter indicated a flow of a large current for a short time and then fell to a very low value. As the potential was slowly increased, the milliammeter indicated numerous irregularities in the flow of current and a gradually increasing continuous flow. When the voltage was raised to approximately 50, breakdowns were faintly audible and each one was indicated by a sudden small deflection of the milliammeter. After each

breakdown the current fell to approximately the previous low value. The test circuit was broken after the voltage was raised to 120. The time taken for making the voltage changes was about one minute. When the condenser was examined after the treatment above described, it was found that sixty-two imperfections in the paper had been compensated for by changes in the electrode material at portions adjacent the points of imperfection. The points of imperfection ranged in size from those visible to the unaided eye to others requiring a magnification of fifty diameters before being visible.

What is claimed is:

1. A method of manufacturing a condenser having electrode layers and interposed layers of dielectric material, comprising applying a slowly increasing potential to the condenser while the condenser is maintained at a temperature slightly below the melting point of the electrode material.

2. A method of manufacturing a condenser having electrode layers and interposed layers of dielectric material, comprising maintaining the condenser at a temperature slightly below the melting point of the electrode material, and then slowly applying an increasing electrical potential to the condenser to raise the temperature of portions of the electrodes in the vicinity of points of imperfection in the dielectric material to cause melting of and consequent changes in the electrode material in the vicinity of the points of imperfection in the dielectric material.

3. A method of manufacturing a condenser having layers of metal composition having a relatively low melting temperature eutectic, and interposed layers of dielectric material, comprising maintaining the condenser at a temperature slightly below the eutectic of the metal composition layers and applying a slowly increasing electrical potential across the electrodes of the condenser.

4. In the manufacture of a paper filled condenser having metal foil electrodes and inherent slight imperfections in the paper filling, the method of treating said condenser comprising, maintaining the condenser at a temperature slightly below the melting point of the foil electrodes and applying a slowly increasing electrical potential to the electrodes to bring portions of the electrodes lying adjacent the points of imperfection to a fusible condition to change the metal of the electrodes at the points of imperfection to a condition of lower conductivity.

5. A method of manufacturing a condenser having electrode layers and interposed layers of dielectric material, comprising placing the condenser in a bath of insulating material, heating the bath to a temperature slightly below the melting point of the electrode material and then applying a slowly increasing electrical potential to the condenser while the bath is at such temperature.

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