

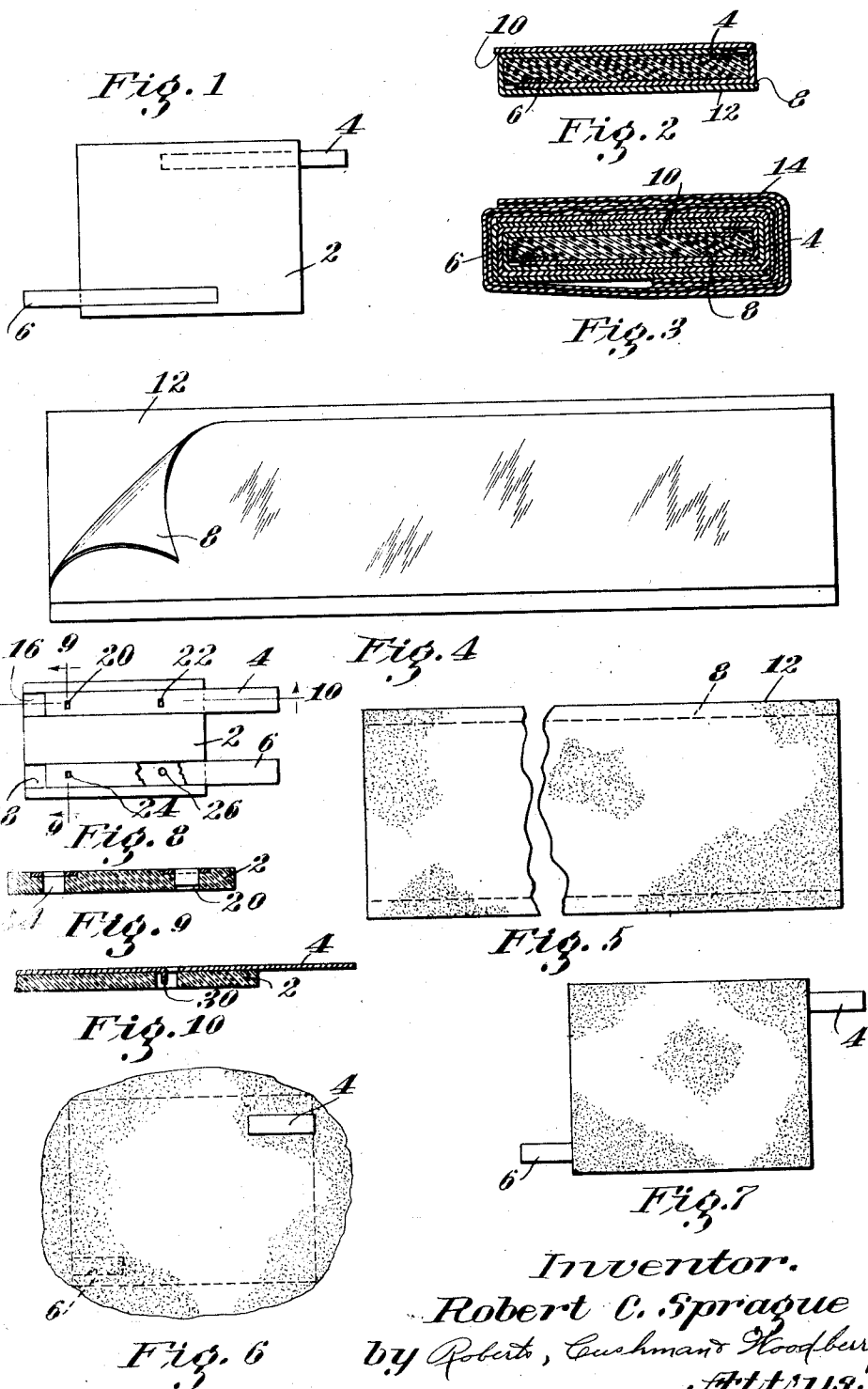
June 24, 1930.

R. C. SPRAGUE

1,767,412

ELECTRICAL CONDENSER AND METHOD OF MAKING THE SAME

Filed Sept. 14, 1926



# UNITED STATES PATENT OFFICE

ROBERT C. SPRAGUE, OF QUINCY, MASSACHUSETTS, ASSIGNOR TO SPRAGUE SPECIAL-  
TIES CO., OF QUINCY, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

## ELECTRICAL CONDENSER AND METHOD OF MAKING THE SAME

Application filed September 14, 1926. Serial No. 135,342.

The present invention relates to electrical condensers and more particularly to a new and improved form of electrical condenser having a high capacity and which is particularly adapted for use in small apparatus.

One form of condenser which is in common use comprises two sets of interlaid layers of tin foil separated by sheets of paper coated with paraffin or shellac. The alternate layers of tin foil are connected to each other, and two common terminals are thus formed. When these terminals are connected to a source of high electromotive force the plates become charged, and a discharge occurs thereafter when a suitable path is afforded for neutralizing the charges between the plates. In this form of condenser the capacity is comparatively low and the apparatus as ordinarily constructed is bulky.

Condensers have heretofore been made by forming the condenser in a mold in which paraffin is employed to impregnate the condenser, and in which pressure is applied to attain the desired compactness of the condenser body. This process requires the expenditure of comparatively long periods of time for the reason that the condensers can not be removed from the molds until the molds have cooled and the paraffin has completely solidified. By the process of my invention the use of molds is entirely obviated and the product of my invention may be made in considerably less time than condensers heretofore produced. Furthermore, heretofore only a single condenser could be made in a mold while by my process a large number of condensers may be made simultaneously without the corresponding use of molds, the use of which involves considerable expense.

It is a primary object of the present invention to provide a condenser which shall be moisture proof, which will occupy but small space and which has a high capacity so as to be adapted for radio work and other uses for which a small sized apparatus is particularly desired.

Another object of the invention is to provide a condenser of a form so that it is not easily broken and in which the capacity will

remain substantially constant throughout the life of the condenser.

Another object of the invention is to provide a method of manufacturing a condenser of the form above described which shall be rapid and efficient and by means of which the condenser may be produced at a very low cost.

With these and other objects in view the invention comprises the various features hereinafter more fully described and particularly defined in the claims.

The various features of the invention are illustrated in the accompanying drawings, which show a preferred embodiment of the invention, in which,

Fig. 1 is a plan view of the base material showing terminals or leads connected thereto;

Fig. 2 is a vertical sectional view of the portion of the device shown in Fig. 1, to which sheets of foil and insulating material, such as tissue paper, have been added;

Fig. 3 is a vertical sectional view of the portion shown in Fig. 2, to which an insulating wrapping material has been added;

Fig. 4 is a plan view of a section of tissue paper with the foil placed thereon, one corner of which is shown removed from the tissue;

Fig. 5 is a plan view of the tissue and foil shown in Fig. 4, after paraffin or other suitable insulating binding material has been applied thereto;

Fig. 6 is a plan view of a condenser showing the appearance thereof during the stage of manufacture after a pressing operation, in which excess paraffin and asphalt have been squeezed out or extruded from the body of the condenser;

Fig. 7 is a view of the condenser in finished form;

Fig. 8 is a plan view of the base material to which the leads or terminals are connected in a modified way;

Fig. 9 is a transverse sectional view taken on the line 9—9 of Fig. 8; and

Fig. 10 is a longitudinal sectional view taken on the line 10—10 of Fig. 8.

Referring more in detail to the drawings the numeral 2 designates a base material of suitable dimensions, upon which the condens-

er is formed or built up. The base is preferably thin and of extended area such as in the form of a rectangle for example, although obviously any suitable shape may be used. I may employ a base one-sixteenth of an inch in thickness and about one inch wide by one and one-half inches long for example which I have found suitable for radio work. The base material is preferably composed of an insulating material, such as fiber or press board, although other materials may be employed which have a sufficiently high dielectric strength and which are preferably more or less flexible so as not to become broken during use, or in the manufacture of the condenser.

Connected to the base or fiber board 2 are leads 4, 6 which may be of copper or other suitable conducting material. These leads are preferably pressed into the surface of the base 2 by means of pressure in any suitable way so as to be more or less firmly held in place during the process of manufacturing the condenser, or until the leads are otherwise more firmly held as will be hereinafter more fully described.

After the leads have been attached or embedded in place in the surface of the base 2, a sheet of metal foil, such as aluminum foil or tin foil 8, is attached to each of the leads by means of adhesive material and the foil is then wound around the base with insulating material between the adjacent coils so as to provide condenser plates separated by a suitable dielectric medium. In order to accomplish this result I first attach a sheet or strip of foil 8 to the base 2 in contact with one of the leads, such as the lead 4, for example, by means of mending tissue. I then attach another or second sheet or strip of foil 10 to the other side of base 2 in contact with the other lead such as lead 6, by means of adhesive or mending tissue in a similar manner, and then I roll or wind the sheets around the base material in the same direction with an intervening layer of insulating material between the sheets. The most satisfactory way which I have found for putting the metal sheets or foil in place around the base material so as to provide intervening layers of insulating material between the coils or folds of metal foil, comprises uniting the sheets of foil with the insulating material, such as tissue paper, before the foil strips are attached to the leads. This may be readily accomplished by dipping the foil in roll form, with tissue paper separating the coils of the foil, in a suitable adhesive material which will serve as a binding medium between the foil and separating medium, and which will serve also to permit, when desired, the separation of the foil from the tissue or other separating medium. For this purpose I preferably employ paraffin which may be readily melted and maintained at a temperature

above its melting point. The bath is preferably maintained at a temperature of about 280° F. and the roll is preferably immersed therein from a period of 10 to 20 minutes so as to obtain substantially complete penetration of the melted paraffin into the roll. After the roll has been withdrawn from the bath and allowed to cool the strips of foil may be removed therefrom as required for use combined with the tissue paper or separating medium.

In order to obtain good conductivity between the metal foil and the leads when the foil strips are attached thereto, I may remove the paraffin from the portion of the foil to be connected to the leads by means of petroleic ether, for example, in which paraffin is soluble, but the foil strips may be united to the leads so as to attain good conductivity by pressure contact, the pressure being applied after the parts have been assembled, as will be hereinafter more fully described, whereby satisfactory contact may be attained, the sheared edges of the leads apparently assisting in making good contact. By means of mending tissue or other adhesive material a good contact may then be obtained between the metal foil and the leads through the binding action thereof. After the end of the strip of foil 8 has been attached to the lead 4 and the strip 10 has been connected with the corresponding lead 6, preferably with the tissue or other separating medium for the foil connected to or attached to the foil by means of paraffin in the manner above described, the strips are then wound around the base preferably in a counterclockwise direction as shown in Fig. 2 of the drawings, in which the foil 8 passes from the lead 4 over the upper surface of the base 2, in direct contact therewith, whereas the foil strip 10 passes from the lead 6 under the base material in contact with its surface. The strips or sheets of foil 8 and 10 being wound on the base 2 with the insulating material or tissue paper 12 as a dielectric medium between the coils thereof, a condenser of high capacity is produced, the capacity depending upon the size and number of windings of the foil. After the metal foil together with the tissue or insulating medium attached thereto, has been wound around the base material to the desired thickness, an insulating covering 14, such as a waterproofed paper wrapping, is placed over the foil, the paper being preferably wound around the base material and foil to attain the desired waterproofing effect. I preferably employ for this purpose an asphalt paper or tar paper which has been made by joining two sheets of paper with asphalt or tar on one side of the paper, so that the waterproofing layer lies between the sheets of paper.

After the asphalt paper as been put in place over the base material and foil as above

described, and as shown in Fig. 3, this material is then dipped in a heated bath of insulating binding material to unite or bind the parts of the condenser and also to drive out air bubbles and moisture therefrom. I preferably employ a bath of paraffin which has been heated to a temperature of about 280° F., so that when the body is immersed therein the thin liquid paraffin will rapidly penetrate the voids between the parts of the body or assemblage and drive out substantially all of the air and moisture therein. The heated paraffin mixes also with the asphalt in the covering or wrapper and causes also some of the asphalt in the wrapper to flow out and mix with the paraffin in the assemblage.

After the desired penetration of paraffin into the assemblage has taken place, which will generally require in the neighborhood of from fifteen to twenty minutes, the bath may be cooled without removing the condenser body, the bath being cooled to a temperature such that the paraffin will not run out when the body is removed from the bath, but at a temperature such that the paraffin remains liquid. The cooling of the bath to this temperature requires considerable time and furthermore involves a loss of heat, which however may be avoided by the use of a second bath maintained at the aforesaid lower temperature into which the condenser may be plunged directly from the bath maintained at the higher temperature. In removing the condenser from the first bath and immersing it directly in the bath at the lower temperature the time interval for the operation is insufficient for any material cooling of the condenser to take place, and the heated paraffin within the condenser body does not escape therefore but remains therein. When the body comes into contact with the cooler body of paraffin the condenser body is cooled thereby to the same temperature, and after the desired lower temperature is reached the condenser body is removed from the second bath, the paraffin therein being viscous at that temperature so that it will not run out. By impregnating the condenser body with paraffin in accordance with the above process the use of molds in the making of condensers may be entirely avoided, the condenser body being merely pressed after the paraffin impregnation by means of any suitable form of press.

After the condenser body is withdrawn from the bath or, if desired, before the condenser body is dipped, the metal terminals 4, 6 are preferably folded over the body of the condenser as indicated in Fig. 6 and the condenser is then rapidly pressed to a uniform thickness so as to obtain substantially uniform capacity of the condenser and to remove excess paraffin together with any remaining air bubbles between the coils of the condenser. During the pressing operation more or less

paraffin and asphalt material exudes from the edges of the condenser. This material which is pressed out is then removed by means of a knife or a trimmer of any suitable form so as to attain a uniform size of condenser. After the trimming operation the terminals 4, 6 may be bent outwardly, and the condenser may be put in any suitable casing for use, such as a metallic casing, for example, in which one of the terminals may be connected to the casing and the other terminal may be connected to a binding post or other similar means whereby it may be connected into a circuit.

The aluminum or lead foil which is employed is preferably of a thickness of about .0002 of an inch and the tissue paper, or insulating medium between the coils of the foil, may have a thickness of about .0005 of an inch, although the thickness of both foil and paper may be varied as may be desired.

In the modified method of making the condenser illustrated in Figs. 8, 9 and 10, the base material 2 is preferably pressed by means of a suitable form of press so as to form two grooves 16, 18, for the leads in the surface of the base material and preferably perforate the base in the groove portions, as at 20, 22 and 24, 26 to serve for connecting or attaching the leads to the base portion, the leads having corresponding projections fitting into the openings so as to hold the leads in place. By embedding the leads in the grooves in the base material in this manner, heavier leads may be employed without danger of breaking the paper insulation during the pressing operation by which the condenser is compacted and the excess paraffin removed. In place of perforations extending through the base material I may employ indentations or openings extending into the base material without extending there-through, the projections upon the leads being made correspondingly shorter whereby the leads may be firmly held in position. The projections on the leads may be made in any suitable manner, although I preferably punch openings therein and bend over a portion of the metal as shown more particularly in Figs. 9 and 10.

In place of attaching the metal foil to the leads in the manner which has been set forth, the combined paper and foil strips of the kind heretofore described may be attached to the form of base member shown in Figs. 8, 9 and 10 by laying the said strips on the base member so that the paper side of the strip will be in contact with the base member, and thereafter pressing the lead or leads having one or more prongs or projections thereon into contact with the sheet or strip so that the prongs engage the sides of the openings in the base member, thus firmly attaching the combined strip and lead thereto. By this means

the use of adhesive material may be entirely avoided.

One or more prongs or projecting portions may be employed on each lead, although I preferably employ two such projections as shown in Fig. 8, the corresponding openings in the base member being formed therein so as to register with the projections. The leads and prongs thereon are preferably of copper, the prongs being preferably V-shaped so that when the prongs are pressed into the openings in the base the upper edges of the wedge-shaped prongs become firmly held by the sides of the openings, the wedges apparently cutting slightly into the openings and the edges of the wedges being slightly bent against the sides thereof, thus firmly holding the leads and the strips in place. The prongs or projections assist furthermore in forming a good electrical contact between the metallic foil and the corresponding lead.

The leads may be pressed into engagement with the base member by hand, or by means of a pressing or stamping operation as may be found most desirable, and the leads may be seated in grooves in the base member similar to the grooves 16, 18 as shown in Fig. 8, although they are preferably made slightly larger so that when the combined strip of foil and paper is pressed into the groove by the lead a suitable fit will be obtained.

It is obvious that the leads may be both attached on one side of the base member as shown in Fig. 8, extending outwardly therefrom in the same direction or in opposite directions; or the leads may be attached on opposite sides of the base members as shown in Fig. 1, extending in the same or in the opposite direction therefrom. It is to be understood also that in place of employing openings in the base member into which the prongs of the leads are pressed I might use a softer base material or leads of a harder composition so that the prongs may be forced directly into the body of the base member.

After the leads have been put in place the condenser is formed in the manner above explained by winding the strips around the base material in the same direction so as to form coils of the foil having the paper or other insulating material between the adjacent coils. In this way the outside layer which is formed will be the metal foil, which is then covered preferably by means of asphalt impregnated paper in the manner described and is thereafter coated and impregnated with paraffin.

The condenser which is formed by the process above described has a high capacity relative to its size and is particularly adapted for radio work and similar uses requiring a small and highly efficient condenser. It is to be understood that the method and product above described may be varied as will be apparent to those skilled in the art without de-

parting from the spirit or scope of the invention as defined in the claims.

I claim:

1. A method of manufacturing electrical condensers which comprises forming from fiber board a thin base of extended area, pressing portions of two separate metallic leads into a surface of said base so as to cling thereto, attaching the foil side of a strip of combined paper and foil to each of said leads, winding the strips around the base material in the same direction so as to form continuous coils of the foil having paper between the adjacent metallic coils to serve as a dielectric medium and leaving portions of said leads exposed, immersing the body in paraffin above its melting point, and removing excess paraffin from the said body.

2. The method of making electrical condensers which comprises assembling alternate layers of conductors and non-conductors, thoroughly impregnating the assemblage in high temperature liquid, then immersing the assemblage in low temperature liquid until the mass has cooled approximately to the solidifying temperature of the impregnating material, and then compressing the assemblage to squeeze out excess impregnating material.

3. The method of making electrical condensers which comprises assembling alternate layers of foil and paper, wrapping the layers with a wrapper containing asphalt, impregnating the assemblage in paraffin sufficiently hot to cause some of the asphalt to flow out of said wrapper and mix with the paraffin in the assemblage, and subsequently solidifying the mixed paraffin and asphalt on the assemblage.

4. In a method of manufacturing electrical condensers the steps which comprise forming grooves in a base member with openings therein, applying leads having projections therein to the base material so that the projections extend into said openings, connecting a strip of metal foil to each of the said leads and insulating each lead and foil connected therewith from the other, then winding the insulated foil around the base member over said leads, and applying an insulating covering to the resulting body.

5. The method of making electrical condensers which comprises pressing grooves into an insulating base member, attaching a metallic lead in each of said grooves, attaching the metal side of a combined strip of metal foil and paper to each of said leads and winding the combined strips around said base member so as to leave a portion of each of said leads exposed, covering the resulting body with insulating material, immersing the body in a melted paraffin bath at a high temperature so as to thoroughly impregnate the body, thereafter immersing the body in a melted

paraffin bath at a low temperature and cooling it therein to a point where the paraffin will not run out when the body is removed from the bath, and finally compressing the body.

5 6. An electrical condenser comprising two strips of coiled metal foil each connected by means of a relatively soft insulating binding medium to thin paper strips so as to form alternate layers of metal foil and insulation, a thin base material at the center of the coils, metallic leads mounted on said base and contacting with said foil strips, respectively, an asphalt impregnated paper surrounding said coils, and a soft insulating binding material distributed through the whole to attain a relatively thin compact condenser.

7. In a method of manufacturing electrical condensers, the steps which comprise laying a sheet of metal foil and insulating material on a base member having an opening therein so that said material is in contact with the base member and fastening the said sheet to the base member by means of a metallic lead having a projecting portion adapted to perforate the sheet at the said opening, and then winding said sheet around said base member over said metallic lead.

8. In a method of manufacturing electrical condensers, the steps which comprise placing a combined strip of metal foil and insulating material on an insulating base member so that the foil side of said strip is uppermost and attaching the said strip thereto by means of a conducting member having a sharp projection thereon adapted to perforate the said sheet and become firmly attached to said base member, and then winding said strip around the base member over said conducting member.

9. An electrical condenser comprising a base, layers of insulating and conducting material wound around the base, and terminals mounted on the exterior of the base inside said layers.

10. An electrical condenser comprising a base having recesses in its outer surface, layers of insulating and conducting material wound around the base, and terminals mounted in said recesses inside said layers.

11. An electrical condenser comprising a base, having a recess on the outside thereof, strips of insulating and conducting material wound around the base, a terminal in face contact with the inner end of the conducting strip and having a projection extending through the strip into said recess, said strips being wound over said terminal.

12. An electrical condenser comprising a base having a recess on the outside thereof, superposed strips of insulating and conducting material wound around said base, a terminal member mounted in said recess over the inner end of said conducting strip, said strips being wound over said terminals.

13. An electrical condenser comprising a base having a recessed surface, superposed strips of metal foil and paper wound on said base, adhesive binding material joining said strips as an integral unit but permitting the strips to be peeled apart, and a terminal mounted in the recess of the base in contact with said foil to anchor said strips to the base.

14. The method of manufacturing electrical condensers which comprises forming a thin insulation base of extended area with recesses therein, pressing into said recesses respectively separate strips each formed of metal foil and a dielectric, mounting a terminal in each recess in contact with the foil of the corresponding strip, and subsequently winding said strips around the base over the terminals to form a continuous coil condenser.

Signed by me at Boston, Massachusetts, this 23rd day of August, 1926.

ROBERT C. SPRAGUE.