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F. W. DANE

ELECTRICAL CONDENSER

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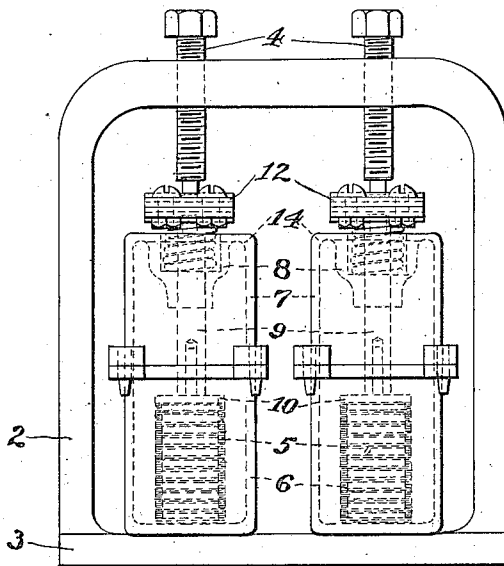


Fig. 1

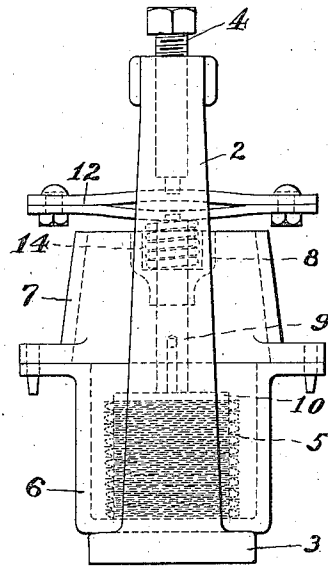


Fig. 2

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UNITED STATES PATENT OFFICE.

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ELECTRICAL CONDENSER.

Application filed April 3, 1920. Serial No. 371,153.

To all whom it may concern:

Be it known that I, FRANCIS W. DANE, a citizen of the United States, residing at Hamilton, in the county of Essex and State of Massachusetts, have invented certain Improvements in Electrical Condensers, of which the following description, in connection with the accompanying drawings, is a specification, like reference characters on the drawings indicating like parts in the several figures.

The usual method practised commercially of making electrical condensers consists in assembling alternate sheets of conducting and dielectric materials, the materials used in the better class of condensers consisting of mica and metal foil. The sheets of mica and foil are secured together by a suitable insulating material such as paraffin, adhesive varnish, or the like. It has been determined that the maximum capacity is produced when the insulating material between the foil and the mica is reduced to a minimum approaching the ideal case of molecular contact between the foil and the mica. It has likewise been determined that the condenser losses are less if the insulating filler between the foil and the mica is reduced to a minimum, since the dielectric losses in mica are smaller than the dielectric losses in the insulating materials. It has also been determined that the resistance of the condenser to breaking down either under test or while in use depends on reducing, so far as possible, the presence of anything between the conducting elements except the mica. In other words, the presence of air spaces, voids, blisters, or even of the insulating filler itself, is detrimental from an electrical standpoint. For instance, the presence of a void or bubble between a sheet of foil and the next adjacent sheet of mica is very liable to cause a brush discharge of sufficient intensity to substantially raise the temperature of the mica, thereby lowering its dielectric strength to such a point as to cause it to break down and thus short circuit the condenser.

With a view to avoiding, so far as possible, the presence or voids, bubbles, or an unnecessary thickness of insulating filler between the condenser elements, it has been proposed heretofore to apply pressure by means of a clamp to the condenser stack in such a direction as to force the sheets of mica and

foil into intimate contact with each other and to heat the stack while still in the clamp, the purpose being to squeeze out from between the sheets any surplus insulating filler and also any air or gas that might be pocketed between said sheets. This expedient reduces the liability of a break down due to the causes above mentioned. It does not, however, entirely eliminate trouble from these causes and the present invention is directed to the improvement of the processes of marking condensers with the object of effecting a further reduction in the defects of this character. In other words, the invention aims to improve the process of manufacturing condensers with a view particularly to reducing to a minimum the presence of voids, bubbles, or adhesive material between the layers of conducting and dielectric material that make up the condenser.

For the purpose of clearly disclosing the process of the present invention it will be herein described in connection with a novel form of apparatus which I have successfully used in practising the process.

Referring now to the drawings,

Figure 1 is a front elevation of the apparatus above mentioned showing two condensers mounted therein; and

Fig. 2 is a side elevation of the apparatus shown in Fig. 1.

The apparatus shown in the drawings comprises a clamp consisting of a frame 2 having a base 3 adapted to rest on a suitable support, and also having two bolts 4-4 threaded through the upper part thereof. The clamp is intended to accommodate two condensers at a time, as shown in Fig. 1, the particular condensers shown being of the wax (preferably paraffin) type, in which the insulating filler used between the sheets of mica and tin foil consists preferably of paraffin or wax. The invention may be applied, however, to condensers employing other forms of insulating filler, such as adhesive varnish.

At this point in the process of manufacture of the condenser, the condenser stack has been assembled and the condenser units connected together in the desired manner. The condenser stack 5 next may be mounted in the casing 6 in which it is to be permanently secured, and in the usual form of condenser in which one terminal is grounded to the casing, this terminal is then secured

at this point in the process to the casing. For the purpose of filling the casing with wax a false head 7 is fitted on the upper end of the casing. This false head is provided with a bridge piece 8 which is drilled to receive a plunger 9 carrying a pressure plate 10 at its lower end, the pressure plate resting on the upper end of the condenser stack 5 and, as illustrated, covering substantially the entire active area of the stack. Pressure is applied to this stack by means of the screw 4 and a double leaf spring 12 is interposed between the lower end of this screw and the upper end of the plunger 9 so that the pressure is resiliently applied to the condenser stack. A coiled spring 14 encircling the plunger 9 immediately below the leaf spring 12 is located in a counter bore in the bridge piece 8 and acts on the lower end of this counter bore to press the false head 7 firmly against the upper surface of the casing 6 and thus maintain a tight joint between these parts.

After the parts have been assembled in the manner illustrated, the casing 6 and false head 7 are substantially filled with wax sufficiently heated to be molten. The bolt or screw 4 is turned down until the leaf spring 12 is compressed to such a point that the desired degree of pressure is applied to the condenser stack, this pressure tending to force the sheets of mica and foil firmly into contact with each other. Any desired degree of pressure can be applied in this manner, that usually employed being about 2,000 pounds. While this pressure is maintained on the stack, heat is supplied to the casing until the fluid wax therein has been heated to a temperature of approximately 135° C. The wax is heated up slowly so that the temperature of the stack will rise substantially in unison with that of the wax. The heat supplied as above is specially desirable when the insulating material used is paraffin as preferred and when the molten paraffin in the casing has been cooled by its contact with the previously unheated stack, all in order that the wax between the sheets may be made sufficiently fluid to permit its being squeezed out.

It will readily be appreciated that the high temperature to which the stack is subjected will greatly expand any gas or vapor pocketed between the sheets of mica and foil that make up the stack and will also melt the wax between these sheets, while the heavy pressure applied to the stack will squeeze the gas or vapor and any surplus wax out from between the sheets. In other words, the effect will be to practically eliminate the presence of any gas or vapor from between the elements of the stack and to reduce to a minimum the film of wax still remaining between these elements.

I have discovered that this result is accom-

plished far more effectually when the pressure on the stack is resiliently applied and maintained during the heating and subsequent cooling of the stack, that is, when a spring or its equivalent is interposed between the pressure transmitting parts. The explanation appears to be that the height of the stack varies during the heating and subsequent cooling operations, due largely to the squeezing out of the gas, vapor, or excess wax from between the elements of the stack. If the pressure is rigidly applied when the apparatus is assembled a reduction in the height of the stack effects a corresponding reduction in the pressure maintained on the stack. The resilient application of this pressure ensures the maintenance of a substantially constant pressure on the stack during the entire heating and subsequent cooling operation notwithstanding any variation in the height of the stack that may occur during said operations. The result is a more thorough elimination of the gas, vapor, or excess insulating filler from between the elements of the stack.

After the stack has been heated up to the desired temperature, preferably approximately 135° to 145° C. the wax may be poured out of the casing. Usually it takes about twenty minutes to heat the wax to the desired temperature. The resilient pressure is maintained on the stack during the subsequent cooling operation, this embedding of the stack in its casing, which consists in filling the casing and head with molten wax and allowing it to cool and solidify, the head and surplus wax then being removed. The maintenance of the resilient pressure on the stack while it is cooling off, ensures that the alternate layers of mica and foil will be kept in intimate contact with each other while the wax is solidifying where it will serve to hold the condenser elements in this intimate relationship, if, during any subsequent step in the process of manufacture, it becomes necessary to remove the pressure from the stack.

While I have herein described the process of this invention in connection with a certain form of apparatus, it is obvious that the process is independent of any specific apparatus and that it may be practised with the aid of a great variety of forms of apparatus; and a great variety of accompanying process steps. Also, while mica and metal foils constitute the best form of condenser within the invention (the mica and foils both being substantially non-porous and substantially incompressible), the invention includes the substitution of sheets of equivalent material.

What is claimed as new is:

1. In the art of making electrical condenser stacks of sheets of substantially non-porous and incompressible dielectrics and conductors, the improvement in cleansing

the surfaces of the sheets in the stack by squeezing out a fluid insulating material from the thin spaces between the sheets lying face to face, which consists in initially
 5 applying a squeezing-out pressure to the stack in a resilient manner; and then for a substantial period of time, and during the presence of the fluid insulating material between the sheets, permitting the initial pressure to follow up with substantial constancy
 10 the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another by means of such constantly maintained pressure.

2. In electrical condensers comprising stacks of sheets of mica and metal foil, the improvement in excluding foreign matter
 20 from between the sheets lying face to face in the stack upon reduction of temperature and contraction of the length of the stack, which consists in initially and resiliently applying pressure across the ends of such a stack prior to such reduction of temperature and contraction of length; and thereafter, and during such cooling, permitting such pressure to follow with substantial constancy the variation of the length of the stack consequent upon such cooling.

3. In electrical condenser stacks of sheets of mica and metal foil, the improvement which consists in permitting the action on such stack of a resiliently applied pressure of the order of thousands of pounds while the stack is submerged in insulating material which is solid at ordinary temperatures but then is fluid at a temperature of the order of about one hundred and forty degrees centigrade.

4. In electrical condensers comprising stacks of sheets of mica and metal foil, the improvement in effecting and maintaining cleanliness of the surfaces of the sheets of the stack, by squeezing out from the thin spaces between the sheets lying face to face, an insulating material which is solid at ordinary temperatures but fluid at moderately high temperatures, and thereafter excluding such material from between the sheets, which consists in heating such a stack for a substantial period of time while such insulating material is present between the sheets; simultaneously with such heating
 55 permitting a resiliently applied squeezing-out pressure to follow up with substantial constancy the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid material from between the sheets and the gradual forcing of the sheets toward one another by means of such constantly applied pressure; and thereafter permitting the continuing action of said resiliently applied pressure during the cooling of the stack,

5. In the art of making electrical condenser stacks of sheets of mica and metal foil, the improvement in effecting and maintaining cleanliness of the surfaces of the sheets in the stack by squeezing out from the thin spaces between the sheets lying face to face, an insulating material which is solid at ordinary temperatures but fluid at moderately high temperatures, and thereafter excluding such material from entering between the sheets, such improvement consisting in submerging such a stack in such insulating material in hot fluid condition; supplying additional heat to the insulating material and the submerged stack for a substantial period of time; and in the presence of such insulating material in hot fluid condition between the sheets, permitting a resiliently applied pressure to follow up with substantial constancy the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another by such constantly applied pressure; and thereafter permitting the continuing action of said resiliently applied pressure during the cooling of the stack.

6. That improvement in the process of making electrical condensers of the type in which alternate sheets of metal foils and mica are assembled to form a stack with insulating material between the sheets which is solid at ordinary temperatures and fluid at moderately high temperatures, which process consists in heating the stack sufficiently to reduce said adhesive material to a more or less fluid condition, exerting a pressure resiliently on said stack in the direction of its height while the stack is hot, and maintaining said conditions of pressure and temperature on the stack for a sufficient length of time to squeeze out the insulating material and any other deleterious things from between the sheets of the stack and bring said sheets into intimate contact with each other.

7. That improvement in the process of making electrical condensers of the type in which alternate sheets of metal foils and mica are assembled to form a stack with insulating material between the sheets which is solid at ordinary temperatures and fluid at moderately high temperatures, which consists in heating the stack sufficiently to liquefy said insulating material, subjecting said stack to a heavy spring pressure while it is so heated, maintaining said conditions of temperature and pressure on the stack for a sufficient length of time to squeeze out the insulating material and any other deleterious things from between the elements of the stack and maintaining said resiliently applied pressure to act on the stack while it cools.

8. In the art of making electrical condenser stacks of sheets of mica and metal foil, the improvement in cleansing the surfaces of the sheets in the stack by squeezing out from the thin spaces between the sheets lying face to face, an insulating material which is solid at ordinary temperatures but fluid at moderately high temperatures, such improvement consisting in heating such a stack for a substantial period of time while such insulating material is present between the sheets and simultaneously with such heating permitting a resiliently applied squeezing-out pressure to follow up with substantial constancy the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another by means of such constantly applied pressure.

9. The herein-described method which consists in initially and resiliently applying a pressure across the ends of a condenser stack of sheets of mica and metal foil, at a time when the stack is at an ordinary temperature; and thereafter permitting such pressure gradually and with substantial constancy to follow up variations in length of the stack consequent upon changes in its temperature and thereby maintaining the sheets in such intimate relation to one another as to exclude everything deleterious from between them.

10. The combination of a condenser stack with sheets of metal foil and mica, of a pressure plate arranged to act over the active area of the sheets in said stack; and a spring clamp acting against said pressure plate and arranged to be free to exert substantially constant pressure on said stack via said pressure plate for all variations of length of the stack due to changes in its temperature.

11. The combination of a condenser stack comprising sheets of metal foil and mica surrounded with an insulating material which is solid at ordinary temperatures and fluid at moderately high temperatures, and a spring clamp therefor constructed and arranged to exert resiliently a distributed pressure over the active area of said sheets in the stack to follow up and yield to variations in length of the stack and maintain the pressure thereon substantially constant.

12. An apparatus adapted for use in the manufacture of a condenser stack in its permanent casing and comprising a head adapted to be mounted on the casing, means for permitting resilient pressure to act on the stack and a spring interposed between said pressure means and said head for holding said head on the casing.

13. The improvement in the process of making electrical condenser stacks of sheets of mica and metal foil, which consists in

surrounding the stack with hot fluid insulating material; and while the stack is thus submerged, holding the sheets in close relation to one another to exclude the surrounding insulating material from between them, by permitting the action on the stack of a resiliently applied spring pressure, thereby permitting the length of the stack to be varied without substantially varying said applied pressure.

14. In the art of making electrical condenser stacks of sheets of mica and metal foil, the improvement in excluding injurious things from between the sheets lying face to face in the stack, which consists in permitting a resiliently applied squeezing-out pressure to force the sheets toward one another in the presence, between the sheets and around the stack, of an insulating material in a fluid condition at a moderately high temperature but which is solid at ordinary temperatures; and permitting the continuing action of such resiliently applied pressure after it has resulted in the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another, and during the cooling of the insulating material surrounding the stack, the cooling of the stack itself, and the solidification of the insulating material around the stack as an embedment therefor.

15. That improvement in the process of making electrical condenser stacks of sheets of mica and metal foil treated with insulating material which consists in resiliently applying squeezing out pressure and heat to said stack to drive out the insulating material progressively from between the sheets, and surrounding said stack with fluid insulating material while permitting the continued action of said spring pressure, thereby permitting contraction of the stack without substantial alteration in pressure thereon.

16. That improvement in the process of making electrical condensers which consists in subjecting a stack of sheets of mica and metal foil to a bath of hot molten insulating material while compressed under spring pressure, and while under said pressure surrounding said stack with hot molten insulating material solid at ordinary temperatures, providing a head of such material thereabove, and then cooling and solidifying said material while permitting the continued action of said spring pressure.

17. In the art of making electrical condenser stacks of sheets of mica and metal foil, the improvement in cleansing the surfaces of the sheets in the stack by squeezing out from the thin spaces between the sheets lying face to face, a fluid insulating material at moderately high temperature which is solid at ordinary temperatures, such im-

provement consisting in submerging such a stack in such insulating material in hot fluid condition; supplying additional heat to the insulating material around the stack for a substantial period of time; and, in the presence of such insulating material in hot fluid condition between the sheets, permitting a resiliently applied squeezing-out pressure to follow up with substantial constancy the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another by such constantly applied pressure.

18. In the art of making electrical condenser stacks of sheets of mica and metal foil, the improvement in cleansing the sur-

faces of the sheets, which consists in forming a stack of such sheets with insulating material between them which is solid at ordinary temperatures but fluid at moderately high temperatures; applying heat to such stack for a substantial period of time; and, while the insulating material between the sheets is in fluid condition, permitting a resiliently applied pressure to follow up with substantial constancy the gradual contraction of the stack consequent upon the gradual squeezing out of the fluid insulating material from between the sheets and the gradual forcing of the sheets toward one another by such constantly applied pressure.

In testimony whereof I have signed my name to this specification.

FRANCIS W. DANE.