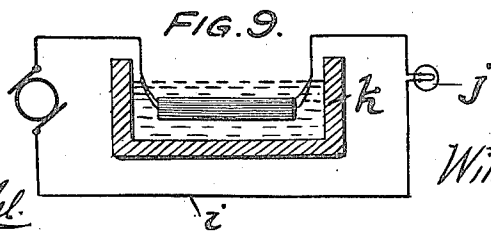
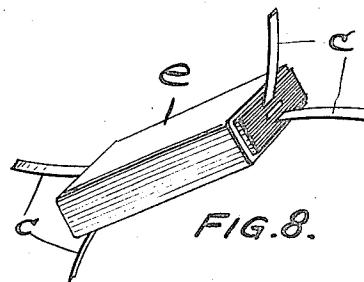
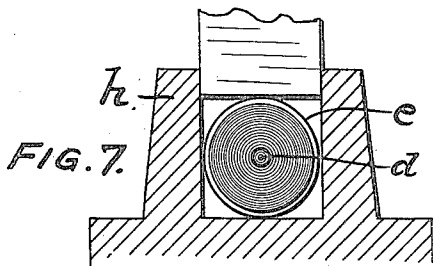
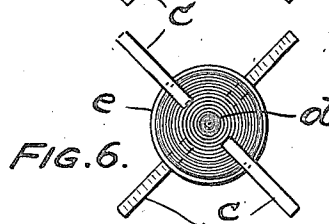
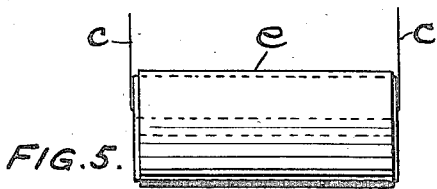
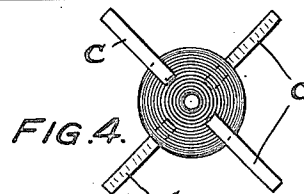
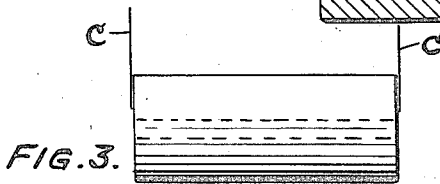
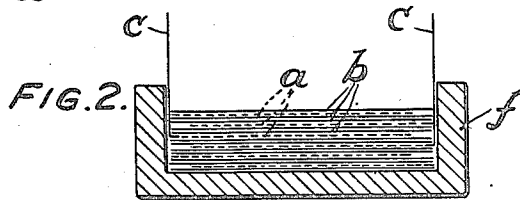
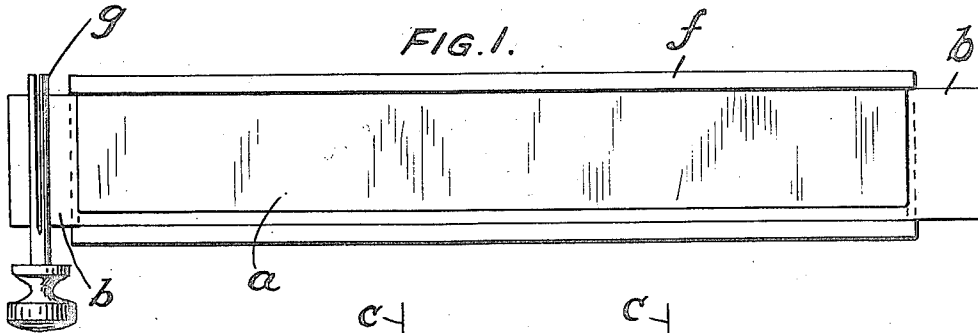


W. C. BRINTON, JR.
 PROCESS OF MAKING ELECTRICAL CONDENSERS.
 APPLICATION FILED JULY 20, 1917.

1,307,341.

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PROCESS OF MAKING ELECTRICAL CONDENSERS.

1,307,341.

Specification of Letters Patent. Patented June 24, 1919.

Application filed July 20, 1917. Serial No. 181,735.

To all whom it may concern:

Be it known that I, WILLIAM C. BRINTON, Jr., a citizen of the United States, residing at Kennett Square, county of Chester, and State of Pennsylvania, have invented a new and useful Improvement in Processes of Making Electrical Condensers, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

The object of my invention is to provide a new and simple process for making electrical condensers, which will be extremely economical, and at the same time produce condensers of uniform and maximum efficiency.

One of the most serious difficulties in the manufacture of condensers is the effectual elimination and permanent exclusion of moisture. In the process of manufacture, as ordinarily carried on, the paper or other dielectric material to be embodied in the condenser is thoroughly dried to expel the normally contained moisture. The layers of dielectric material and conducting material are then arranged in a pile or wound into a spiral and, by prolonged boiling, are impregnated with wax, olive oil, or other dielectric material. The layers are then consolidated by pressure. A casing is usually applied to the condenser after consolidation, although it may be applied before, as in the patent issued to me August 14, 1917, No. 1,237,015. This process involves considerable labor and expense. The drying and impregnating steps require some hours of time. The compressing operation, involving the expulsion of wax in the die, is uncleanly and involves danger of burning of the operative. The process must be continuous, to prevent reabsorption by the paper of moisture and cooling of the impregnating wax before compression. The complete expulsion of moisture is impossible, while in most condensers the interstices in the final product are not so effectually closed as to

prevent the entrance of moisture, so that the condenser is apt to be relatively short-lived. The preliminary drying of the paper materially weakens its strength and the leads are apt to cut into the paper in the compressing operation.

A large proportion of the condensers, after completion, are found to be too inefficient for use, and waste is therefore a serious factor.

Specifically my object is to overcome all these difficulties and eliminate all these objections. I entirely avoid the preliminary drying of the paper, reduce the period of impregnation from hours to minutes, enable the compression of the layers to be conducted in a cleanly manner and with relatively small application of power, avoid the necessity of carrying on the different steps of the process continuously, absolutely eliminate moisture and prevent its subsequent reëntry, maintain the original strength of the paper until after compression of the layers, insure a uniform and certain product, avoid waste, and enable the condenser to be tested in the process of manufacture, thereby dispensing with the necessity of subsequent testing.

In the preferred way of carrying out my improved process, I arrange alternate layers of dielectric and conducting material (say paper, preferably not preliminarily dried, and aluminum foil) in a pile of long strips, position the leads, wind the strip on a mandrel into a cylindrical shape, withdraw the cylindrical condenser body, insert it into a tubular casing of drawn steel, and, without intermediate treatment, subject the whole to pressure to convert the cylindrical incased condenser into a condenser of oblong shape in cross section and of considerably reduced volume, thereby consolidating the layers of the condenser body and pressing the latter into intimate contact with its casing. The condenser is then immersed in a body of dielectric impregnating liquid, such as wax or olive oil, preferably heated; wax, or similar

material, being necessarily heated to maintain it fluid. Simultaneously an electric alternating current is passed through the condenser. This results in the conversion
5 of the contained water into steam at a high pressure, the escape of the steam, and the replacement of the displaced water by the impregnating dielectric liquid.

In describing my process more in detail,
10 I shall refer to the accompanying drawings, wherein—

Figure 1 is a plan view of the apparatus employed in making the original cylindrical condenser body and also a plan view of
15 the strips of foil and paper before they are wound.

Fig. 2 is a cross-section through Fig. 1.

Fig. 3 is a side view of the uncovered spirally wound condenser body.

20 Fig. 4 is an end view of Fig. 3.

Fig. 5 is a side view of the condenser body inserted in its casing.

Fig. 6 is an end view of Fig. 5.

Fig. 7 is a cross-sectional view of the die,
25 with the condenser in place before compression.

Fig. 8 is a perspective view of the mechanically-completed condenser.

Fig. 9 is a diagram of the moisture-expelling and dielectric-impregnating apparatus.
30

It will be understood that the specific process about to be described is merely preferable, and that it involves steps some of which are in substance known in the art.
35 Further, the ultimate structure of the condenser, aside from the more complete exclusion of moisture and air and its more complete impregnation with dielectric liquid, is substantially the same as that disclosed in
40 my prior application hereinbefore mentioned.

I first lay, in a suitable trough *f*, as shown in Figs. 1 and 2, alternate layers of aluminum foil *a* and paper *b*. Each layer of
45 paper is preferably composed of two separate sheets or strips. The paper extends entirely across the trough, while the foil strips are of narrower width, alternate foil strips being flush with opposite longitudinal
50 edges of the paper, in the known manner. Leads *c* are inserted between adjacent layers of paper and foil as the latter are built up, these leads being L-shaped to adapt their projecting ends to the side walls of the
55 trough. Preferably the paper at one end projects beyond the foil and is wrapped around a mandrel *g* after the building-up operation is completed. The mandrel is then rotated, widening the foil and paper
60 spirally thereon, the resultant condenser body being shown in Figs. 3 and 4. The mandrel is then withdrawn.

Within the hollow center of the condenser body is inserted a spirally wound strip of

paper or other filler *d*. The condenser body 65 is slipped into a deformable casing *e*, as shown in Figs. 5 and 6. The armored condenser is then placed in a die *h*, shown in Fig. 7, and pressed into the form shown in Fig. 8. This operation presses the paper
70 and foil into close contact, which relationship is maintained by the rigid metal casing, which itself is in intimate contact with the periphery of the condenser body.

The leads of the condenser are connected 75 to an electric circuit *i* (in which is placed a lamp *j* in series with the condenser) and immersed in a bath *k* of wax, olive oil or other impregnating dielectric substance. See Fig. 9. The current should be an alternating
80 one. If wax is used it should be heated at least to the temperature required to make it highly fluid. I prefer to heat it to a temperature of from 250 to 300 degrees Fahrenheit. If an impregnating substance, such as
85 olive oil, is used which is fluid at ordinary temperatures, its artificial heating is not imperative but is desirable. The strength of the electric current may vary with the temperature of the impregnating bath. Thus,
90 with wax heated to the temperature above mentioned, I have successfully used a 110 volt 60 cycle circuit, which should be an alternating one.

As soon as the condenser, so placed in the 95 electric circuit, is immersed in the bath, the circuit is closed. There is sufficient moisture in the paper to generate a considerable volume of vapor, which acts as a good conductor, the result being that a gradually increasing quantity of current leaks through
100 the condenser, as is evidenced by the fact that the lamp in the circuit, shortly after immersion, begins to faintly glow, the light increasing in intensity, until, after the lapse of
105 a minute or so, it glows with a brightness not so far below that which is exhibited if the resistance of the condenser should be entirely cut out. At this time the generation
110 of vapor is at its maximum and the wax has scarcely begun to permeate the interstices of the condenser. The lamp gives its maximum light for but a fraction of a minute and then the light diminishes, at first slowly and then very rapidly. This indicates that the
115 wax has entered the body of the condenser, replacing the displaced moisture and vastly reducing the conductivity of the condenser. The wax apparently penetrates not only any fine interstices between the paper and foil,
120 but also the pores of the paper, rendering it completely dielectric. The time elapsing between the first glow of the lamp and its final dying out is about two minutes or so. The condenser has not yet, however, been
125 perfectly impregnated, as is evidenced by the continual "boiling" at the ends of the condenser. The operation is therefore con-

tinued until all boiling practically ceases. This may not be until after the lapse of (say) ten minutes.

It is probable that the pressure of steam within the condenser, during the conversion thereof of the water, is close to 100 pounds to the square inch, this high pressure insuring complete conversion and expulsion of moisture and, as a result, complete impregnation with wax. After the removal of the condenser from the bath, its exposed ends are coated with shellac or other protective covering.

The presence of the lamp in the circuit is advisable in that its action indicates to the operative that the operation is proceeding successfully; and indeed it is found that it dispenses with the necessity of any subsequent testing. Such testing of completed condensers has heretofore been imperative, because, notwithstanding the exercise of great care in their manufacture, the proportion of inefficient condensers, produced by ordinary processes, is very large. Condensers made by my process, however, when tested in the usual way, not only exhibit maximum efficiency, but also uniform efficiency, the percentage of inefficient condensers being zero.

It is obvious that with the great saving of labor and time achieved by the use of my process, and with the elimination of the serious factor of waste arising from the rejection of inefficient condensers, the use of my process is highly economical. Further, owing to the complete expulsion of moisture, the reduction to a minimum of the interstices within the condenser body, the complete impregnation of any interstices that exist and of the pores of the paper, the resultant permanent exclusion of moisture, and the fact that the condenser will not bleed or sweat at high temperature, the life of the condenser is greatly prolonged.

While the specific process herein described is the best way now known to me of practicing my improved process, I have succeeded in making condensers of a somewhat inferior, but yet of a very high, grade, by taking the incased and compressed condenser and passing through it, without immersing it in an impregnating material, an alternating 110 volt 60 cycle current for a period of about fourteen minutes with the lamp in circuit as described, and then dipping the ends in shellac. The observed phenomena, however, differed from that above described in that the lamp glowed brightly for a period of approximately ten minutes.

An operative and efficient condenser can also be made if the preferred process is modified by omitting the preliminary compression and condensation of the layers of dielectric and conducting material, whether the condenser is or is not incased.

The success of the process seems to be attributable to the fact that the electric current produces an internal heat which is sufficient in intensity to convert all the moisture into vapor within a much shorter period of time than is possible if reliance be had solely upon the heat imparted to the impregnating material, the temperature being sufficiently high to carbonize—and therefore functionally destroy—the dielectric material if such temperature were maintained a substantial length of time. Thus, if reliance be placed solely on the heat imparted to the impregnating material, and such material be heated up to a temperature corresponding to that which is produced internally by the electric current, the paper will char before the moisture is expelled and before there is an approach to thorough impregnation. With an electric current of predetermined strength depended upon to produce the high heat required, destruction of the condenser is impossible, because, before the paper starts to burn, the moisture is expelled, and then the leakage of current through the condenser necessarily ceases, the internal temperature dropping to the temperature of the impregnating material.

It will be understood that while the presence of a lamp in circuit is unnecessary to the execution of the process, the voltage is substantially reduced by the presence of the lamp, and if the lamp is cut out of the circuit, great care is required in carrying on the process. Indeed, it may be questioned whether the carrying out of the process, without some resistance in circuit, would not be attended with serious difficulty, as the presence of such resistance prevents internal overheating, the result of which would be the burning of the dielectric layers.

While in the above description I have explained the operation of the process on the theory that the contained moisture is converted into vapor during the passage of the electric current, it is quite possible, if not probable, that what actually occurs is an electrolytic action, whereby the moisture and air contained in the condenser body is ionized, that is, converted into its original elements. The precise theory by which to account for the results secured, is, however, of little importance, the fact being that the finished condenser has in the highest degree the qualities attributed to it and that the recited difficulties of manufacture are entirely overcome.

Having now fully described my invention, what I desire to claim and protect by Letters Patent is:

1. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and then passing through

the condenser body an electric current of a strength sufficient to raise the internal temperature of the condenser to the point required to expel the moisture without destruction of the dielectric material.

2. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and then passing through the condenser body an electric current of a strength sufficient to effect the expulsion of contained moisture, thereby facilitating the passage of current therethrough, and interposing a resistance in the circuit to limit the passage of current, and consequently the internal temperature, until the conductivity of the condenser is substantially reduced by the expulsion of moisture.

3. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and immersing the same in an impregnating dielectric substance in a liquid condition and while the same is so immersed passing through the condenser an electric current, thereby expelling the contained moisture and causing the dielectric substance to permeate the interstices of the condenser.

4. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and immersing the same in an impregnating dielectric substance in a heated and liquid condition and while the same is so immersed passing through the condenser an electric current.

5. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and immersing the same in an impregnating dielectric substance in a liquid condition and while the same is so immersed passing through the condenser an electric circuit until the resistance of the condenser, by reason of the replacement of a large part of the originally contained moisture by the impregnating substance, approaches its maximum, and thereafter continuing the passage of the current until the remaining moisture is substantially eliminated.

6. The process of making electrical condensers which consists in arranging layers of conducting and dielectric material to form a condenser body, and immersing the same in an impregnating dielectric substance in a liquid condition under atmospheric pressure, and while the same is so immersed passing through the condenser an electric current.

7. The process of making electrical condensers which consists in first consolidating by pressure layers of conducting and dielectric material to form the condenser body, and then passing through the condenser body

an electric current of a strength sufficient to expel the contained moisture and raise the internal temperature of the condenser to the point required to so expel the moisture without destruction of the dielectric material.

8. The process of making electrical condensers which consists in consolidating layers of conducting and dielectric material to form a compressed condenser body, immersing the condenser body in an impregnating dielectric substance in a liquid condition, and while the same is so immersed passing through the condenser an electric current.

9. The process of making incased electrical condensers which consists in arranging layers of conducting material and dielectric material to form the condenser body, applying thereto a casing of deformable material conforming in shape to the condenser body, subjecting the casing to pressure to effect a substantial reduction in its volume, thereby consolidating the layers and pressing the casing and its contents closely together, and then passing through the condenser body an electric current of a strength sufficient to raise the internal temperature of the condenser to the point required to expel the moisture without destruction of the dielectric material.

10. The process of making incased electrical condensers which consists in arranging layers of conducting material and dielectric material to form the condenser body, applying thereto a casing of deformable material conforming in shape to the condenser body, subjecting the casing to pressure to effect a substantial reduction in its volume, thereby consolidating the layers and pressing the casing and its contents closely together, immersing the incased compressed condenser in an impregnating dielectric substance in a liquid condition and while the same is so immersed passing through the condenser an electric current.

11. The process of making incased electrical condensers which consists in arranging layers of conducting and dielectric material and winding them in circular form to form a cylindrical condenser body, applying thereto a cylindrical casing of deformable material, subjecting the casing to pressure along radial lines to convert the cylindrical condenser into a polygonal condenser having a substantially decreased volume, immersing the incased compressed condenser in an impregnating dielectric substance in a liquid condition and while the same is so immersed passing through the condenser an electric current.

12. The process of making incased electrical condensers which consists in arranging layers of conducting material and dielectric material to form the condenser body, applying thereto a casing of deformable material conforming in shape to the condenser

body, subjecting the casing to pressure to effect a substantial reduction in its volume, thereby consolidating the layers and pressing the casing and its contents closely together to form a mechanically complete, but
5 moisture-containing and non-impregnated, structure, and afterward displacing the

moisture by a dielectric impregnating substance in a liquid condition.

In testimony of which invention I have 10 hereunto set my hand, at Philadelphia, Pa., on this 16th day of July, 1917.

WILLIAM C. BRINTON, JR.