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IMPREGNATING PROCESS FOR ELECTROLYTIC CONDENSERS

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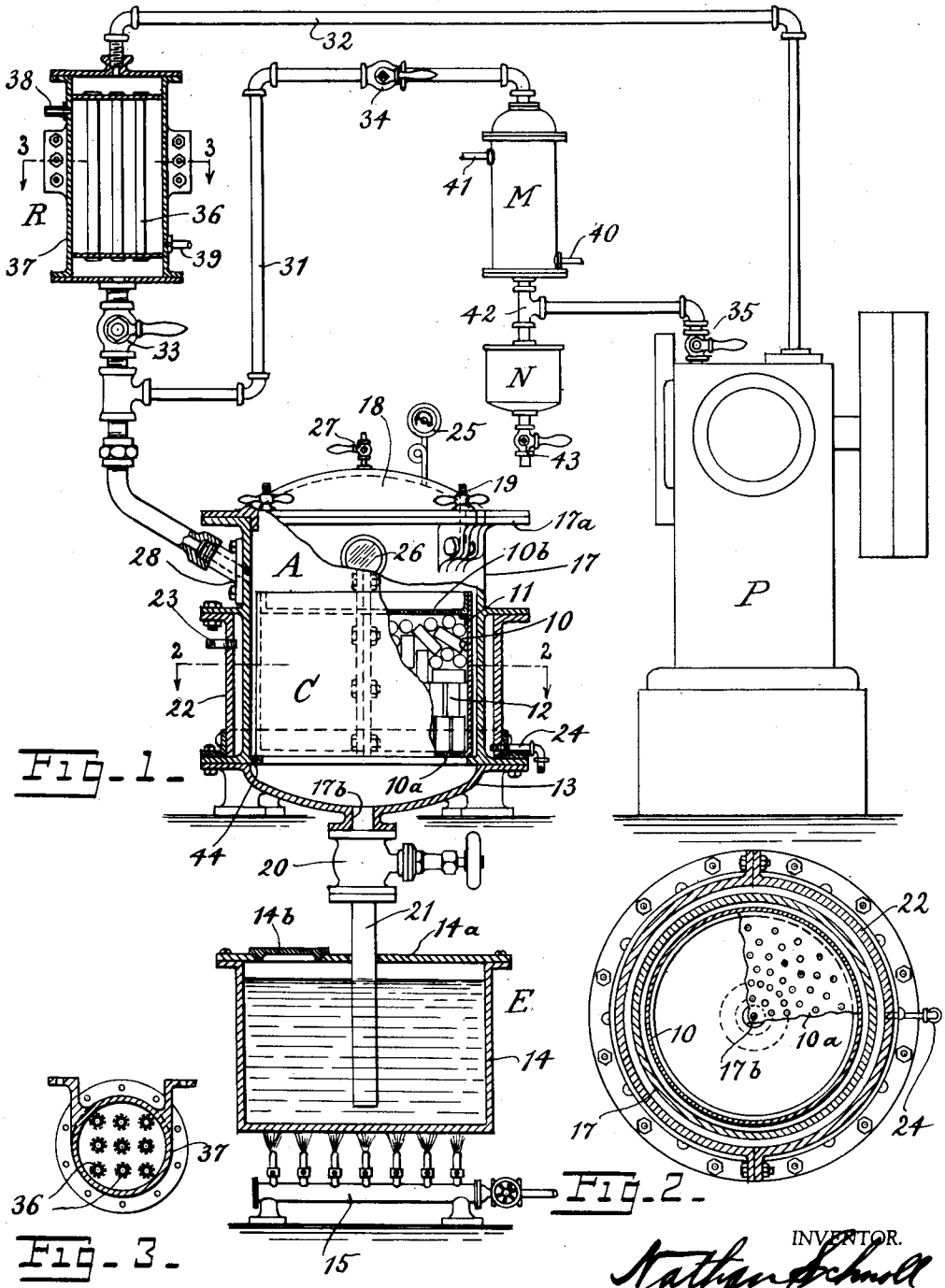


Fig-1-

Fig-2-

Fig-3-

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IMPREGNATING PROCESS FOR ELECTROLYTIC CONDENSERS

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3 Claims. (Cl. 91—68)

This invention relates broadly to improvements in the manufacture of electrolytic condensers of the dry and semi-dry type, and in particular to that phase of the manufacturing process which concerns the impregnation of the foil electrodes in assembled form with an electrolytic medium. Electrolytic condensers of the character herein referred to, viz: dry or semi-dry electrolytic condensers of fixed capacity, always comprise three main elements: The electrolyte, which is originally more or less liquid and consists mostly, though not necessarily, of a diluted borax or boric acid solution to which certain glutinous and coagulating ingredients are admixed, and two kinds of electrodes in sheet or foil form, imbedded in the electrolytic paste, one of which at least must possess a "film-forming unidirectional quality". Generally these electrodes are two strips of aluminum, one of which, the anode, is covered with an oxide film, permitting the passing of the current in one direction and obstructing its passage in the opposite direction, while the other electrode, the cathode, is, under ordinary conditions, not film-forming. It may or may not be provided with special means to prevent the incidental formation of an oxide film on the cathode surface, and in certain cases, especially when the condensers are used for A. C. current, the electrodes alternate their functions and are then both film-forming.

It is however not so much this quality of the electrodes which is important in regard to the present invention, but another peculiarity which will be found in spirally wound aluminum condensers of recent date, viz: that one or both electrode foils may have an etched surface. This etching of the surface, preparatory to the assembling and pre-filming of the condensers, serves two purposes. First, it artificially increases the operative area of the electrode and therewith the capacity of the condenser, and secondly, in the case of the cathode being etched, it is one of the best preventatives for the formation of a film by the so-called ripple current which involves a reversal of polarity of very short duration and small voltage. It is well known that a certain current density per unit of area is required, before formation of an electrolytic film can take place and therefore this artificial increase of the foil surface by etching acts as a safeguard against such occurrence. The etching process is described in detail in my copending application filed September 20, 1935, under Ser. No. 41,412. But while this etching of the surface area has the aforementioned beneficial results, it introduces at the same time also a drawback which becomes especially apparent in the case of electrolytes of a semi-dry or pasty consistency. This is the difficulty to secure an intimate low resistance contact of the electrolyte with the complete surface area of the etched anode or cathode, on account of the many gaps and crevices presented by the wrinkled and pitted surface which, as a view through a microscope will reveal, often shows undercut furrows and cavities which, in case of so-called dry or semi-dry condensers, prepared by hand or dipped into a cold or even molten, heated solution, are not completely filled by the paste. Now interstices between the electrolyte and electrodes, filled by air in small layers or in bubbles, greatly reduce the effective area and thereby the capacity and also increase the effective resistance of the condenser. This difficulty is overcome by the present invention which involves a novel impregnating process under vacuum whereby a maximum effective contact of electrolyte with the available area of both electrodes is obtained and any air bubbles, interstices between adjacent surfaces or fissures in the non-conductive interlays of either spirally wound or stacked condensers are eliminated.

In connection with the vacuum treatment, the new process employs also a special preparation of an electrolytic impregnating medium which is fluid when applied hot and congeals to a rather solid but still humid paste when properly cooled.

The principle of impregnation under vacuum is in itself not new and it has even been applied before, if not to electrolytic condensers of the described or any other kind, at least to paper wound condensers, using molten paraffin or halowax as the impregnating medium. Although the treatment to be described was specifically developed to impregnate etched foil condensers, as before mentioned, it is equally effective to impregnate any kind of dry and semi-dry condensers, be they of the electrolytic class, having plain preformed or unformed electrodes, whether etched, plated or unetched and polished, or whether they are plain paper wound or stacked plate condensers to be impregnated with molten paraffin, halowax or any non-conductive paste having no electrolytic or film-forming properties.

But as far as the application of electrolytic impregnants is concerned, the process to be presently described also embodies a special valuable feature in that it tends to retain, recover and more economically utilize the volatile ingredients contained in the new electrolytic impregnant and by constantly and immediately returning the

condensed vapors escaping from the solution under vacuum to the impregnating bath renders the process continuous and prevents losses of costly ingredients. Moreover, means are provided whereby vacuum may be maintained in the impregnating chamber without loss of volatile ingredients and consequent change in the characteristics of the electrolyte. At the same time means are provided for the removal of occluded air from the condenser windings prior to and during impregnation.

Itemizing therefore the various features of the inventive concept, the separate objects contemplated are the following:

The first object of the invention is to devise a novel process of impregnating the interlays between adjacent electrodes of spirally wound or stacked condensers of fixed capacity with a suitable fluid medium under vacuum.

Another object is to devise a vacuum impregnating process, applicable to electrolytic condensers of the dry and semi-dry type.

A further object of my invention is to provide a vacuum impregnating process, applicable to electrolytic dry or semi-dry condensers employing etched electrode foils, and adapted to more thoroughly impregnate them than is possible by manual or mechanical methods under ordinary atmospheric pressure.

Another object in compass with the aforesaid objects is to provide a suitable electrolytic impregnating medium which, while possessing and retaining the required film-forming qualities, is fluid when heated to sufficient temperature and congeals to a rather solid and yet humid paste when cooled.

A further object is to provide suitable apparatus of the simplest kind for carrying out the process as described.

A further object is to provide means which will automatically draw the molten fluid impregnating medium into every empty space and interstice in the assembled condensers, as soon as they are completely evacuated and dried out, and tend to permanently keep the impregnating medium therein.

Another object, in conjunction with this impregnation process under vacuum, is to provide means which will take care of the gaseous volatile ingredients contained in the solution drawn in by vacuum and condense them as soon as they have escaped under the lowered surface tension of the vacuum tank.

Another object is to provide means to return the condensate from such gaseous constituents immediately into the impregnating bath.

A further object of my invention is to keep the vacuum above the impregnated condensers in spite of the volatilization of a portion of the solution as high as possible during the saturating action, so that any remnant gases as well as excess moisture may be eliminated and no voids, due to imperfect contact between electrolyte and foil, may develop.

Other objects will become apparent from a detailed description of the successive steps of the process as such and an embodiment of apparatus for carrying out said process, as illustrated by the accompanying drawing. It is to be understood, however, that the method described hereafter, is not confined to the few mechanical and chemical agents listed, but that the process itself as well as the appliances used may be modified or their sequence changed without necessarily departing from the underlying principles set forth and that many changes within the scope of the invention are possible and applicable.

Reference may be had to the following figures, of which—

Fig. 1 is an elevation of a plant for carrying out the claimed impregnating process, shown in rather diagrammatic fashion;

Fig. 2 is a horizontal cross section along the line 2—2 of Fig. 1, looking in the direction of the arrows, cutting through the container in which the condensers are piled up, and the steam jacket of the vacuum tank. The condensers themselves which are indicated in the tank, shown partly broken in Fig. 1 are omitted in Fig. 2, and only a portion of the perforated container bottom is shown, revealing thereby the ledge or inner flange of the vacuum tank on which the container is seated.

Fig. 3 is a horizontal cross section along the line 3—3 of Fig. 1 through the reflux condenser in which the volatile constituents of the impregnating solution are caught and collected to flow back into the vacuum tank.

Similar reference numerals denote similar parts throughout the several views.

Referring more in detail to the drawing, A designates the vacuum or impregnating tank, into which the container C, holding the batch of condensers to be impregnated, is placed; E is the storage tank from which the electrolyte solution is drawn; R is the reflux condenser, P is the vacuum pump, M is the absorber in which the moisture coming from the unimpregnated condensers during the initial evacuation, is condensed, and N the trap in which such condensed moisture can eventually collect.

The assembled condenser rolls, ready to be impregnated, are stacked loosely in the container C, shown partly in section in Figs. 1 and 2. This container consists of a simple round can 10 with perforated bottom 10*a* and when it is filled to within about an inch from the top rim a sieve-like dished lid 10*b*, perforated similarly to the bottom and with upturned flange is inserted into the mouth of the container, so that it rests on top of the irregularly packed condenser rolls or preferably upon a few bracket-like ledges 11, provided on the inside wall of the container, so as to leave a little clearance on top of the condensers.

The condenser coils 12 are wound and prepared in a dry condition without any application of electrolytic paste or fluid, either manually or by use of mechanically driven bobbins upon which the foils, i. e. the anode strip, etched and provided with a preformed unidirectional oxide film, and the cathode strip, etched or unetched, and both separated by a non-conductive gauze and a thin absorptive paper layer, are spirally wound up and preserved in a closed form by rubber bands or other preliminary means. In addition thereto the tightly wound rolls are provided with well insulated terminal wires, preferredly attached to opposite ends of the electrode foils and protruding from opposite ends of the assembled condenser rolls. All further details of the preparation and assembly of these condenser rolls are explicitly given in my copending application on improvements in Electrolytic condensers, filed September 11, 1935, under Serial No. 40,058.

When the container 10 is filled with the unimpregnated condenser rolls 12 and the lid is inserted, the vacuum tank is opened and the container is lowered into it so that it rests upon the annular ledge 13 in the bottom of the tank. The container does not necessarily have the form described but may also consist of an open rack on

which the condenser rolls can be stacked in upright or prostrate positions in one or several tiers as practical experience or demands see fit, provided only that the rolls are accessible to the impregnating medium and that the whole batch of condensers can be inserted into or lifted out of the tank together.

The electrolyte solution,—or for a more general application of the process—any other impregnating solution selected, for example, molten paraffin or halowax, is contained in the storage tank 14, advantageously covered by a lid 14a, which may have a smaller cover 14b for replenishing the contents, so that volatilization of the ingredients is restricted. This storage tank can be heated in any convenient way, either by a steam jacket or electric heater (not illustrated), or, as shown, by a multiple gas jet 15 underneath the bottom.

A suitable recipe for the electrolyte solution is the following:

Boric acid	grams	2000
Ammonium hydroxide (28% NH_3)	ccm	400
Ethylene glycol	ccm	1200

This solution should be raised to a temperature of about 100° C., before being applied.

The vacuum tank A can have different constructions and the one shown in Fig. 1 is therefore only an illustrative embodiment out of many. It consists essentially of a round tank 17 which is closed by a removable lid 18, hermetically clamped down upon the top flange 17a by a number of hinged bolts 19. The bottom portion of the tank is provided with an inner flange or ledge 13 which supports the perforated receptacle 10 for the condenser coils, as before mentioned. To the inlet opening 17b of the rounded tank bottom is attached the inlet valve 20 to which is attached the suction pipe 21 reaching nearly to the bottom at the storage tank 14.

The lower portion of the vacuum tank, as far as it surrounds the receptacle 10, is encased in a steam jacket 22, provided with a live steam inlet 23 and an exhaust outlet 24, for heating up the contents of the vacuum tank. The tank is furthermore provided with the necessary service appliances, for instance, a vacuum indicator 25, a glazed inspection window 26, an air inlet 27 for breaking the vacuum, a thermometer (not shown) etc. On the side of the tank, well above the top rim of the receptacle 10 is a flanged outlet 28, leading to the reflux condenser R (to be described later) and to the vacuum or exhaust duct 31, leading through the moisture absorber M to the vacuum pump P.

As can be perceived from Fig. 1, the latter has two separate exhaust ducts towards the vacuum tank A, one 32, leading through the reflux condenser R which can be closed by cock 33, and the other 31, which may be closed by cocks 34 and 35.

The so-called reflux condenser R is a common surface condenser containing a number of vapor ducts 36 (see also Fig. 3) which are cooled by an outer water jacket 37, surrounding them and provided with the service water inlet 38 and the discharge outlet 39. The moisture absorber M is a condenser of similar construction, provided with water inlet 40 and outlet 41. Attached to the bottom of said absorber is a moisture trap or receiver N, directly connected to the absorber by a T 42 with a side outlet leading to the cock 35 on top of the pump P. The trap can be emptied by the bottom cock 43.

Operation of the vacuum treatment

As soon as the dry condensers, stacked in container C, are placed inside the vacuum tank A, the lid 18 is closed tightly, valve 20 and cocks 33 and 43 are kept shut and vacuum is applied through pump P, cocks 34 and 35 being opened. At the same time heat is applied through the steam jacket, bringing the temperature inside the tank A and the container C up to 100° C. and keeping it thereabout with a vacuum of 29 inches for at least half an hour. This treatment not only frees the contents of the tank of most of the surrounding air and that inclosed between the adjacent layers of foil, but also of any moisture held by the fibers of the interlay or clinging to the film or the pitted and etched surfaces of the foils. Any moisture exhausted will con[illegible] in the absorber M and be precipitated into the trap N.

At the end of this drying and heating period, cocks 34 and 35 are closed and valve 20 is opened. The electrolyte solution will consequently rush into the vacuum and will gradually rise until it reaches a level, a little above the perforated upper lid sheet 10b, which can be verified by inspection through the glass window 26. An electrolyte solution of the composition specified will somewhat differ in its behavior from a molten wax or paraffin solution on account of the volatile ingredients it contains. On account of the diminished atmospheric pressure and low vapor tension, the volatile constituents of the electrolyte, chiefly water and ethylene glycol, are released and rising from the surface tend to diminish the vacuum before it has exerted its full sucking power upon the impregnating medium.

As soon as the rising impregnating solution appears above the perforated sheet 10b, the valve 20 is closed, and cock 33 is opened while the heat is still applied to keep the contents at about 100° C. and the vacuum pump is kept going. If it should appear that the level of the impregnating solution is still too low, cock 20 may be then opened for a moment until the solution reaches the desired level.

While the vacuum is applied anew and the solution in the tank and on top of the electrolytic condensers is vigorously boiling, moisture and vapors are exhausted from the solution and from the space above the receptacle 10. They do not however reach the pump in any substantial quantity but are condensed in the reflux condenser R which is operated preferredly with cold water of zero temperature, so that most of the condensate immediately drops back into the vacuum tank, mixing with the remaining electrolyte and keeping its composition substantially constant throughout the vacuum cycle. Circulation of the electrolyte within the vacuum chamber is facilitated by openings 44 in flange 13.

When the vacuum has been reapplied for about 30 minutes to one hour with the temperature kept around 100°, the heat is shut off together with the vacuum pump and the air cock 27 together with valve 20 is opened. All the impregnating solution which is not absorbed by the condensers, will then drain back into the storage tank E. Then the receptacle together with the impregnated condenser rolls is lifted out of the tank and permitted to cool off.

The final treatments, as for example, the dipping in wax of higher melting point, and encasing in containers, etc. are not part of the impregnating process claimed and may be

learned in detail from my copending application, Ser. No. 40,058, filed September 11, 1935, mentioned before.

If a reflux condenser is installed in the manner shown and the volatile ingredients are recovered by the direct backflow of the condensate, as described, it will be found that the actual loss, or change of composition, of impregnating solution by volatilization is negligible. Moreover the effective trapping and condensation of the ammoniacal vapors as well as of any acid anhydride (boracic acid becomes itself partly volatile when in contact with another volatile ingredient) before it reaches the vacuum pump, is important also, because their action upon the pump fittings, gaskets, packings, etc. would be injurious in the end. The recovery of these volatile ingredients therefore is a necessary feature of the impregnation with electrolyte which is unnecessary when molten wax or paraffin only is used.

It will be evident that all the objects of the invention aforementioned have been attained in a simple, efficient and novel way, but it should be understood that the invention is not confined to the particular form shown and described, the same being merely illustrative, and that the invention can be carried out in other ways without departing from the spirit of my invention, and therefore, I claim broadly the right to employ all equivalent instrumentalities coming within the scope of the appended claims, and by means of which objects of my invention are attained and new results accomplished, as it is obvious that the particular embodiments herein shown and described are only some of many that can be employed to attain these objects and accomplish these results.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:

1. A process for impregnating electrical condensers and maintaining the composition of the impregnant substantially constant throughout the entire impregnating cycle, which consists in heating and drying said condensers under vacuum, impregnating them under vacuum with a heated impregnant containing volatile ingredients, and recovering the volatile ingredients evaporated during the impregnating cycle by condensation, and continuously returning them to the impregnant throughout the impregnating cycle.

2. A process for impregnating electrical condensers and maintaining the composition of the impregnant substantially constant throughout the entire impregnating cycle, which consists in heating and drying said condensers under vacuum, impregnating them under vacuum with a heated impregnant containing boric acid, ammonia and ethylene glycol, and recovering the volatile ingredients evaporated during the impregnating cycle by condensation, and continuously returning them to the impregnant throughout the impregnating cycle.

3. A process for impregnating electrical condensers and maintaining the composition of the impregnant substantially constant throughout the entire impregnating cycle, which consists in heating and drying said condensers under vacuum, impregnating them under vacuum with a heated impregnant containing volatile ingredients, recovering the volatile ingredients evaporated during the impregnating cycle by condensation and continuously returning them to the impregnant throughout the impregnating cycle, and thereafter cooling the impregnated electrical condensers before removing them.

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