May 26, 1931. S. BOYER 1,807,375

ELECTRIC CONDENSER AND METHOD OF REMOVING IMPURITIES FROM THE ELEMENTS OF OR FOR SUCH CONDENSERS

Filed June 27, 1927 2 Sheets-Sheet 1

Fig. 2.

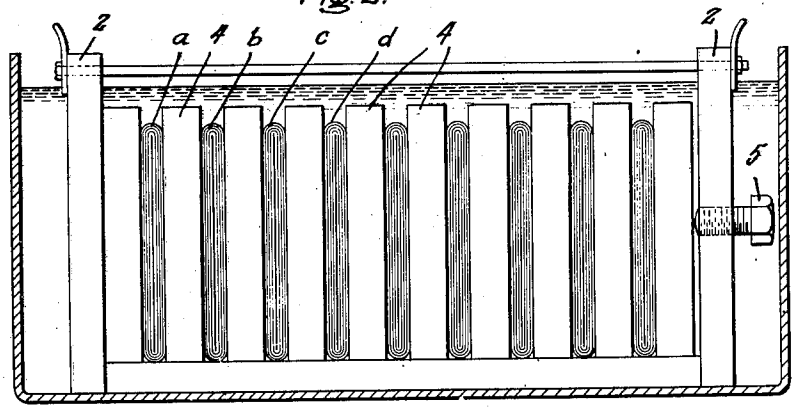


Fig. 4.

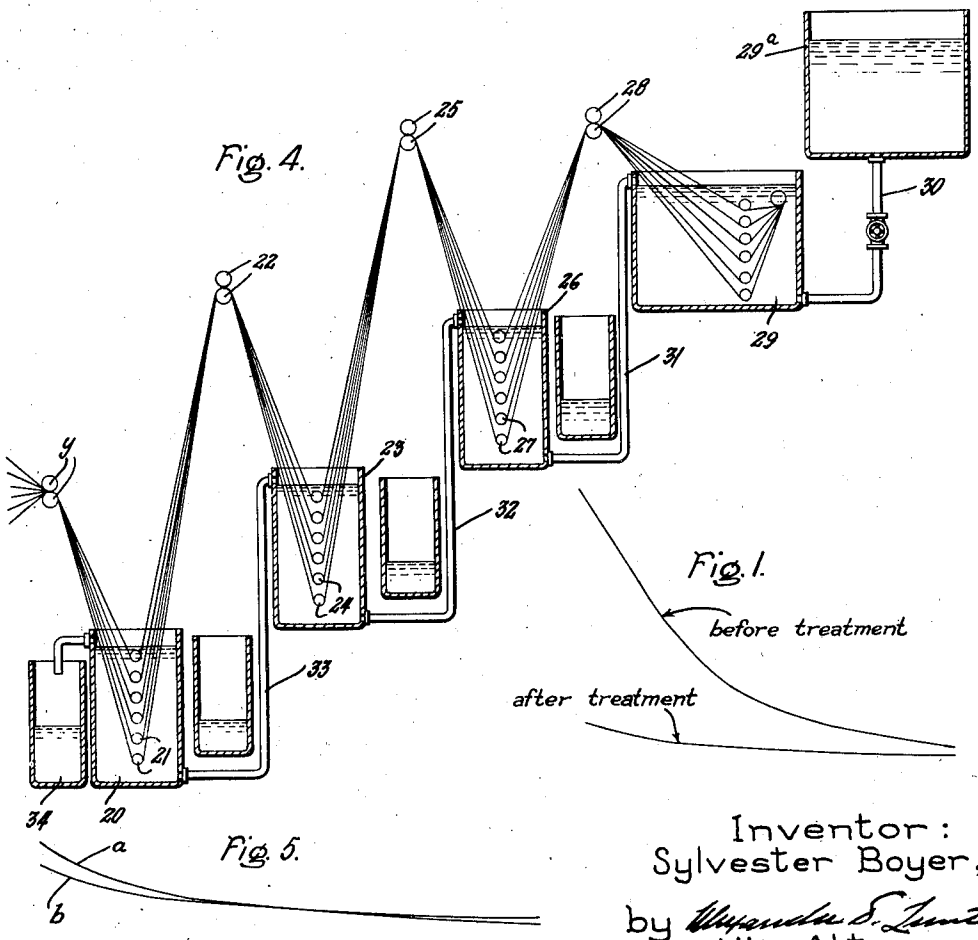


Fig. 1.

Fig. 5.

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Fig. 5.

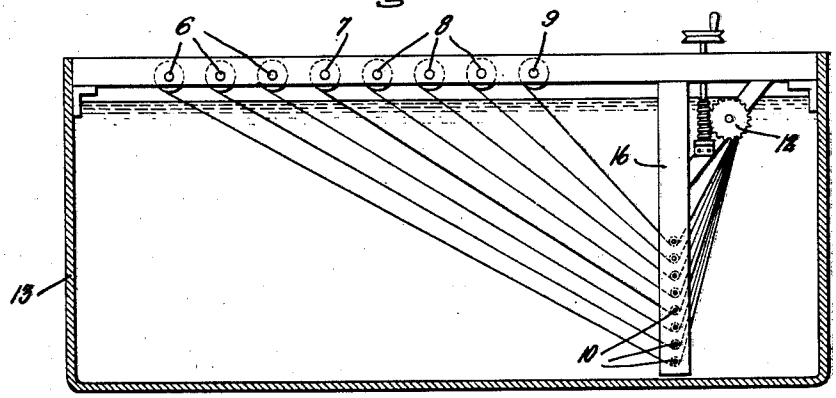


Fig. 6.

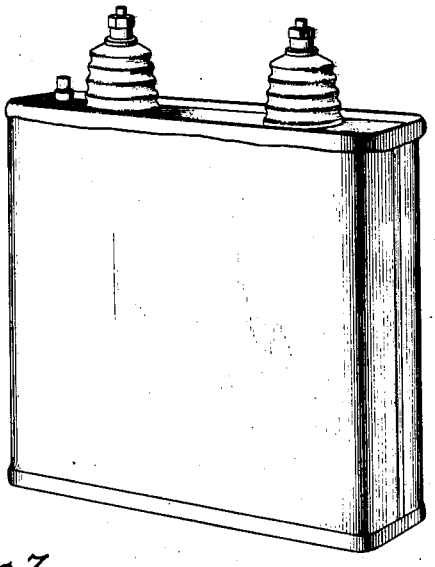
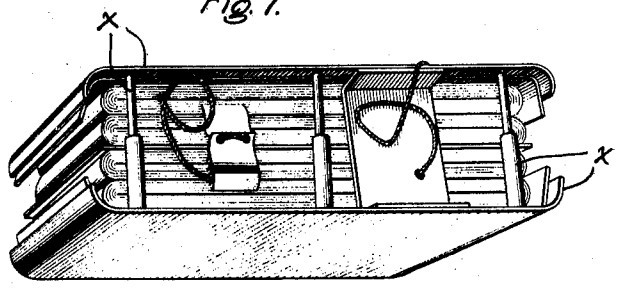


Fig. 7.



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Patented May 26, 1931

1,807,375

UNITED STATES PATENT OFFICE

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ELECTRIC CONDENSER AND METHOD OF REMOVING IMPURITIES FROM THE ELEMENTS OF OR FOR SUCH CONDENSERS

Application filed June 27, 1927. Serial No. 201,766.

My invention relates to electric condensers of the type in which the elements thereof are impregnated with dielectric material such as transformer oil, nitro-benzine, nitro-toluene, wax, or other such dielectric. More particularly the invention relates to condensers of the above character from which, or from the elements of which, impurities have been removed by the process of washing in dielectric materials such as molten wax, oil, nitro-benzine, nitro-toluene, and the like. It is an object of my invention to use washing material for such condensers and their elements having a high specific inductive capacity, or permittivity such as nitro-benzene or nitro-toluene, which are fluid at normal temperature and which have been purified to a point at which the resistivity is of the order of 1.4×10^{10} ohms centimeter cube and over and which have high dielectric strength. The method of producing such dielectric material is the subject of United States Patent No. 1,769,874, granted July 1, 1930.

Electric condensers as they have been constructed prior to my invention have had the objection that the power factor has been higher than it should be, and it is the object of my invention to reduce this power factor in such condensers by washing such condensers or their elements.

My invention will be more readily understood from the following specification and the accompanying drawings, in which Fig. 1 shows power factor curves of an assembled condenser unit before and after voltage treatment. The curve showing the greater power factor represents an unwashed condenser before voltage treatment. Fig. 2 shows apparatus for the washing of condenser units. Fig. 3 shows a device for washing the paper and foil elements of a condenser before they are wound up to form a condenser unit. Fig. 4 shows another form of device for washing the elements of the condenser. Fig. 5 represents another condenser which has been washed. Curve (*a*) in Fig. 5 shows the power factor before voltage application and curve (*b*) represents the power factor after voltage treatment, thus showing that in the case of the washed unit there is little change in power factor with voltage treatment while with the unwashed unit as represented in Fig. 1 there is a marked lowering in power factor with voltage treatment. Fig. 6 shows a condenser of the invention in finished form in its casing. Fig. 7 shows the condenser with the casing removed.

The method that I have found successful in the removal of impurities from assembled condensers is as follows:

I take an assembled condenser such as the condenser Fig. 7 at that stage of the manufacture in which it is to be impregnated with transformer oil, that is, at the stage when it is ready to be put in the vacuum tank to be vacuum and heat treated. The condenser at that stage of its manufacture is under the pressure of clamps X. I release the clamps and place the condenser with or without clamps in a nitro-benzene tank in a basket 2, as indicated in Fig. 2. The clamps are loosened in the tank sufficiently to allow the nitro-benzene to have free access to the elements of the condenser, that is, to their foil and paper. In the basket I place one or more condensers, such as condensers *a*, *b*, *c*, etc., so as to fill the basket. Between each of the condensers *a*, *b*, *c*, etc., a spacer 4 is interposed. At the end of an interval of time, as for example at the end of a half hour or an hour, pressure is applied to the condensers in the basket, for example by means of the screw 5. The result is that the condenser elements are again put under pressure and the nitro-benzene squeezed out. The screw 5 is then released and the elements are allowed to expand once more. After an interval of time

pressure is again applied and then released. This operation is carried on a number of times thereby insuring a thorough washing of the elements of the condensers by the nitro-benzene with the result that the objectionable impurities are removed from the elements. I have found that these impurities are in the form of water soluble salts which are commonly present in paper and also impurities consisting of resins which are also commonly present in paper. There may also be other impurities which are removed by the same operation.

After the condensers have been washed the basket 2 is removed from the nitro-benzene bath. Care should be taken that the screw 5 holds the condensers under pressure at this stage of the operation. If the clamps X are retained during the process the clamps of each condenser should be again tightened before the basket is removed from the nitro-benzene bath in which case it makes no difference whether the screw 5 is tightened or not.

As indicated in Fig. 2 the condensers are placed in the basket on end. I find that this is the preferable position. However, I have found that good results may also be obtained by placing the condensers in the bath in a flat or horizontal position.

After the condensers are removed from the bath they are immediately transferred to the vacuum and heat treating tank. By this method I find that the water impurities of the condenser elements can be removed in a fraction of the time that it takes to remove such impurities when the condenser is treated dry. In the process of heating and vacuum treating the condensers after they have been transferred to the vacuum tank care should be taken that after the nitro-benzene has all been removed the temperature of the condenser should not be raised too high inasmuch as there is danger that the texture of the paper may be damaged. I find that good results are obtained when the temperature of the condenser under vacuum is maintained in the neighborhood of about 90° C. After the condensers have been thoroughly dried nitro-benzene that has been separately vacuum and heat treated is allowed to pass into the vacuum tank containing the condensers for the purpose of resaturating the condensers. This method is the same as that usually practiced in connection with oil filled condensers.

Another method of preparing the condensers is by washing the elements of the condensers before they are wound. In Fig. 3 I have shown diagrammatically a form of device which may be used for washing the condenser elements before they are wound. In this device the rolls of paper and metal, which is aluminum, are mounted on the arbors 6, 7, 8 and 9. The arbors 6 and 8 will hold rolls of paper while the arbors 7 and 9 will hold aluminum foil. The sheets of paper and foil are brought down so as to pass between the idlers 10. After passing these idlers the elements of the condenser pass between separators (not shown) and are then wound into the form of a condenser on the arbor (not shown) behind the gear 12. After the condenser has been wound to the proper size it is removed from the arbor 12 and transferred to the vacuum and heat treating tank. After the moisture and nitro-benzene has been removed, separately vacuum and heat treated nitro-benzene is allowed to pass into the tank in which the condenser is located and allowed to become saturated in the usual manner after which the condenser is removed and sealed in its final container.

Referring to the apparatus in Fig. 3, I find that it is desirable to have the nitro-benzene flow into the tank 13 through one pipe while being withdrawn from the same tank by way of an outlet pipe at the opposite end of the tank neither of which are shown. By this method I insure pure nitro-benzene in contact with the elements of the condenser just before they pass on to the arbor behind the gear 12. I find it advantageous, for example, to put in a partition 16 between the rolls on arbors 6, 7, 8 and 9 and the gear 12. This partition tends to prevent the purer nitro-benzene as it comes in at the right from readily mixing with the comparatively impure nitro-benzene toward the left.

In the foregoing I have stated that the nitro-benzene is heated and vacuum treated before it is allowed to pass into the tank in which the condenser is being heated and vacuum treated. However, I find that this need not be done if the nitro-benzene is used for this purpose shortly after it has been purified and distilled. I do find, however, that it is advantageous that the nitro-benzene should be allowed to pass into the condenser vacuum tank at a temperature in the neighborhood of about 55° C.

In Fig. 4 I have illustrated diagrammatically another device for washing the elements of the condenser. In this device the paper and foil 18 are shown entering between rolls Y at the lower left hand side of the drawing. From this point the elements of the condenser are caused to pass through a container 20 having nitro-benzene. The elements of the condenser are allowed to pass under idlers or rolls 21. From this point the elements of the condenser are carried upward and allowed to pass between pressure rolls 22 thence through another tank 23 of nitro-benzene, under idlers or rolls 24 and once again through pressure rolls 25, through a third nitro-benzene tank 26, under idlers or rolls 27 and again through

pressure rolls 28 and through a fourth tank of nitro-benzene 29, within which tank the elements of the condenser are wound into the form of a condenser just as in Fig. 3. It will be seen that it is possible to carry on the washing operation, assembling the condenser in its final form and omitting the vacuum treatment process, especially if the condenser has been washed in hot nitro-benzene sufficiently to extract all the water but .05%. As indicated in Fig. 4 I provide a fifth tank 29ª in which pure nitro-benzene is contained. From this tank the insulating fluid is allowed to pass by way of conduit 30 into the tank 29. From the tank 29 it passes by way of conduit 31 into tank 26, and by way of conduit 32 into tank 23, and by way of conduit 33 into tank 20 from which it is drained off into a final tank 34. By this method it will be seen that as the condenser elements pass from tank to tank they continually meet oil which is more pure than that contained in the preceding tank.

It will be understood, of course, that the number of rolls of material may be varied depending upon the size and capacity of the condenser and also the number of tanks may be varied depending upon the result desired. Furthermore the rate of flow of the insulating fluid from tank to tank may be regulated depending upon conditions. The insulating fluid may be heated or it may be used at ordinary room temperature.

By either one of the methods described I find that washed condensers may be produced in which the power factor is substantially reduced and in which the power factor remains substantially constant even after the condenser goes into service. This is indicated by the curves in Fig. 5 in which the curve (*a*) represents the condenser power factor before it goes into service, and (*b*) the condenser power factor after it has been in service for some time.

I have already indicated that when the condenser is vacuum treated and heated after it has been washed, the presence of the nitro-benzene accelerates the drying process. I find that this is beneficial inasmuch as I find that better results are obtained with the condensers when the heating process under vacuum treatment is reduced to a minimum.

It will be understood that the washing operation may be conducted with any of the materials with which condensers have heretofore been impregnated. Preferably, of course, this material should be of a high degree of purity and in the case of nitro-benzene, nitro-toluene and benzene I prefer to use these materials after they have been purified by filtering through fuller's earth and aluminum oxide and distilling, this treatment being carried on until the specific resistivity of the material reaches a high stage. While I have described the washing process as being used in connection with the completed condenser, or as applied directly to the elements of the condenser before the condenser is wound, the principles of my invention are not limited to this extent, inasmuch as the washing process may be carried on in connection with the paper pulp before the paper is formed, or it may be carried on in connection with the crude materials from which the paper pulp is made. In fact I find that by the method that I have described the water soluble impurities of paper or paper making ingredients may be removed, also the resinous ingredients of fibrous material are likewise removed with the result that a product which is highly free from objectionable impurities results, and from which condensers may be made having much lower power factors than in the case of condensers as heretofore manufactured.

In the process of removing the undesirable impurities from the fibrous materials before paper is made, it will be understood that the object is to remove the objectionable resins and the water soluble impurities. After these have been removed then the ingredients for making paper may be dried so as to remove the nitro-benzene, after which distilled water may be used for the purpose of preparing the pulp in the process of the formation of the paper itself.

It will be understood that whereas I have made reference to specific devices and specific ingredients and specific steps in connection with my invention, I do not wish to be limited to these inasmuch as in view of the disclosure, variations and modifications may the resorted to without departing from the spirit of the invention as described herein or from the scope of the claims herein contained.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of removing impurities from the elements of an electric condenser which consists in washing the condenser in a dielectric fluid by compressing and releasing the elements of the condenser in the fluid.

2. The method of removing impurities from theelements of an electric condenser which consists in washing the condenser in a dielectric fluid by compressing and releasing the elements of the condenser in the fluid and subjecting the washed condenser to a vacuum and heat treatment.

3. The method of removing impurities from the elements of an electric condenser which consists in washing the condenser by compressing and releasing the elements of the condenser in nitrobenzene of high resistivity.

4. The method of removing resinous im-

purities from the solid elements of an electric condenser which consists in washing said elements in a solvent for resins by compressing and releasing the elements of the condenser in said solvent, and saturating the said solid elements with a dielectric of the same kind free from said impurities, said dielectric having high permittivity and high resistivity.

In witness whereof, I have hereunto set my hand this 24th day of June, 1927.

SYLVESTER BOYER.