March 6, 1934. J. T. CURTIS 1,950,352

CONDENSER

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Fig. 1

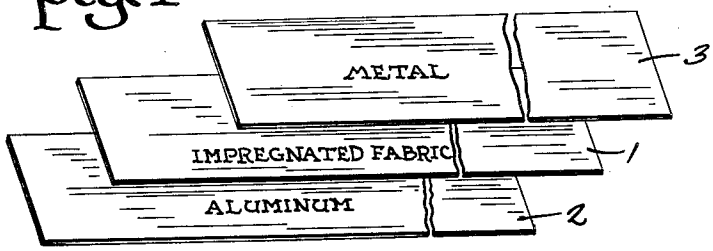
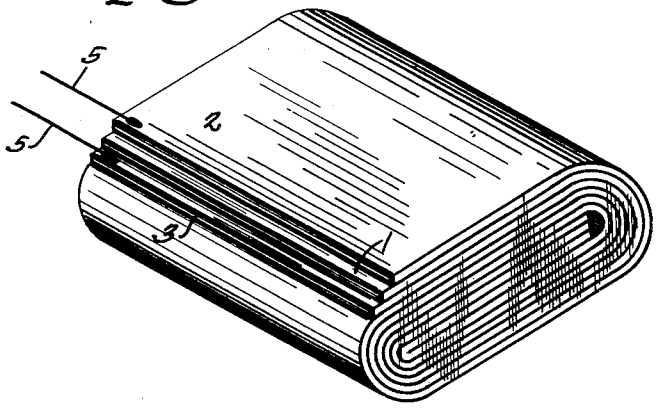


Fig. 2



Fig. 3



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CONDENSER

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7 Claims. (Cl. 175—315)

This invention relates to condensers as employed for example in radio, wireless, X-ray, telephony, and other arts. The objects of the invention are the provision of a condenser which shall be inexpensive to manufacture, shall possess high capacity, shall be very compact, and shall be devoid of free liquid. Other objects of the invention are the provision of a condenser which shall be self-healing in case of puncture by an accidental excess of potential; the provision of a chemical type condenser which shall be free from the defects of gas-evolution, bulging, corrosion, or production of fumes; while further objects and advantages of the invention will become apparent as the description proceeds.

In the performance of my said invention I employ plates of metal spaced apart by and immersed in or in contact with an electrolyte of the hereinafter-described composition. One of the plates is made of one of the metals aluminum or magnesium, or tantalum, aluminum being preferred both because of its cheapness and availability and because its behavior is superior to that of other metals.

The other plate may be of any one of these metals, or for most purposes of any other metal which does not react directly with the electrolyte. The electrolyte may include any soluble carbohydrate, a solvent and a soluble non-corrosive alkali carbonate such as ammonium carbonate, boric acid and a higher alcohol. One example of an electrolyte I have found efficient in use includes:

	Oz.
Granulated sugar	9
Water	7

The sugar is dissolved in the water and simmered gently for twenty minutes more or less to produce a clear, non-crystalline, syrup to which when nearly cool is added a soluble non-corrosive alkali carbonate such as ammonium carbonate, boric acid and glycerine in the substantial ratio of 1:1:2, respectively.

These ingredients should be incorporated thoroughly together and the mixture gently heated until all bubbles are expelled.

It is to be understood that the above ingredients specifically set forth and their proportions are merely illustrative of one specific embodiment of my invention and that, as stated herein, other ingredients of the general classes described may be employed and are intended to be within the scope of my invention. For instance I have stated that the organic solution may consist of any water soluble carbohydrate and that any higher alcohol may be used, such as glycerine. Furthermore any suitable soluble alkali compound such as a carbonate of ammonia may be advantageously employed in the mixture.

The plates are preferably separated by a non-metallic, non-conductive, spacing element or separator of some kind which may be paper or cloth or other fabric of a porous nature which shall not unduly increase the internal resistance of the condenser. In practice I employ very thin, coarse, tissue-paper soaked in the solution above described and interposed between the adjacent metal sheets.

The aluminum sheets employed in these condensers must, before the condenser is complete and operative, be provided with an adherent coating prepared electrolytically. This can be effected either before or after assembling. It is generally better and more convenient to effect this previous to the assembling, the sheets being suspended in a bath of the proper electrolyte and subjected to whatever current will flow therein at the voltage for which the condenser is designed. This can be effected either between two aluminum sheets, both of which are to be used in the manufacture of condensers, or by one aluminum sheet against a dummy anode. When alternating current is employed in this forming step the voltage employed should be at least double that for which the condenser is designed; when direct current is employed for this step the voltage employed should be at least the same as that for which the condenser is designed, the aluminum sheet in question being the anode in the forming bath. In either case the current though large while it lasts will be only momentary.

This forming bath may be the same as that above described, although I preferably employ a simpler bath consisting essentially of a solution of borax, generally intensified with a small proportion of potassium bichromate. The aluminum plate changes color according to the voltage employed in the forming thereof, becoming lighter as the voltage is increased.

In case the coating on the surface of the plate is to be built up after the condenser is assembled, this is effected by alternately charging and discharging the condenser while gradually raising the voltage until the desired rating is obtained, care being taken to do this sufficiently slowly to prevent any substantial temperature increase. A coating thus produced at a given voltage is successful with an over-voltage of only about ten volts, whereas the imposition of a higher voltage

than this is detrimental. Accordingly it is possible to build up the coating after assembling by alternately charging and discharging with constant increase in the potential by steps of ten volts.

In the accompanying drawing I have illustrated one of my improved condensers together with the mode of making the same. Fig. 1 is a perspective view of the mode of building up the condenser; Fig. 2 of the mode of rolling or folding the condenser, and Fig. 3 the completely assembled condenser.

Describing the parts by reference characters, 1 denotes a sheet of thin fabric such as paper which has been impregnated with the solution first above described. This is laid on top of a thin, flexible sheet of aluminum 2, and on it is laid another sheet of metal 3, which may either be aluminum or some other metal which is not readily corrodible and does not react with the liquid, e. g. tin. For small condensers such as are used in radio work the plate 2 is made of very thin sheet aluminum, and the plate 3 is preferably of the same material, although when tin is used it may be even thinner, namely: tin-foil. The sheet 3 is here shown as shorter than the other sheets, which are then folded over it as indicated at 4 in Fig. 2, after which the pile is further rolled or folded until a compact mass is produced as shown in Fig. 3. The wires 5—5 may be attached either before or after folding, and either to the inner or outer ends. The condenser may be compacted in a suitable press whereby all excessive liquid is expressed and is preferably finally wrapped in a close covering of paper or other fabric whereby it is kept air-tight. When both metal sheets are of aluminum the condenser had indifferent polarity; when only one plate is aluminum, that plate must always be the negative.

This condenser exhibits an extremely large ratio of capacity to size and weight. It exhibits no deterioration after long periods of use. It operates successfully with any voltage up to about ten volts above the potential at which the plates were formed and without heating. It can be formed and used successfully for any potential up to a total of several hundred volts. Furthermore if subjected to a sudden over potential the only injury is to cause a local breaking down of the di-electric, and upon turning off the current and waiting a short time the break is found to have healed itself. The condenser will operate indefinitely without heating if operated within the potential range for which it was designed.

I judge that the coating on the surface of the aluminum plates constitutes the true dielectric, and that the liquid constitutes merely an extension of the positive plate, since this liquid is highly conductive owing to the alkali compound and to the boracic acid content. I do not assert that the particular ingredients I have described are all necessary (since the glycerine can be omitted without serious detriment) or that equivalents may not be used; although it is important to avoid the presence of substances which are easily decomposed electrolytically or which will react with the metal plates. I do not find it possible to ascribe different functions to the different ingredients, since it seems to be important to have both boron and alkali present to secure a condenser which possesses the ability to stand any substantial potential, and especially to be self healing after an accidental puncture. The organic solution has the function of thickening the liquid and holding it in contact with the plates and the boracic acid has the second function of preventing its decomposition. The organic solution may consist of any water soluble carbohydrate.

The organic ingredient can be omitted without any substantial effect on the operation. For example, the liquid mixture can be prepared by working the boracic acid into a paste with the glycerine or other higher alcohol such as ethylene glycol and the alkali compound added without water and the mixture heated until the bubbles are expelled and a clear liquid obtained. This liquid is used in the manner heretofore described and appears to work perfectly well for a time, but the device is not so long lived at least in some climates owing to the lack of the binding and effect of the carbohydrate and its tendency to prevent separation or crystallization of the other ingredients.

When the two plates are made of certain dissimilar metals, as for example the one of aluminum and the other of tin, the device is operative as a condenser only in connection with a direct current system and then only when the tin plate is connected to the negative pole. If such a bimetallic device be employed with alternating current it operates as a rectifier and this with a large degree of success because of the large superficial area and the very small internal resistance which causes it to run without heating if not overloaded. It should be noted, however, that the current this device will handle continuously as a rectifier is smaller than that which it will handle as a condenser, and that as a rectifier this device is best used only for such small currents and intermittent periods as shall minimize the decomposition of the electrolyte. While I do not limit myself to these particular ingredients or steps except as hereinafter set forth in my claims, I have described in detail the best method I have so far devised for the practical use of my invention.

Having thus described my invention what I claim is:

1. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum, magnesium or tantalum and a liquid interposed between said plates and making contact with the faces thereof, said liquid containing a soluble carbohydrate of the type represented by the formula $C_mH_{2n}O_n$, a soluble alkali carbonate, which is non-corrosive to the plates, and boracic acid.

2. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum or magnesium or tantalum, and a liquid interposed between said plates and making contact with the faces thereof, said liquid containing a soluble carbohydrate of the type represented by the formula $C_mH_{2n}O_n$, a soluble non-corrosive alkali compound, a higher alcohol having substantially the viscosity of glycerine and boracic acid.

3. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum or magnesium or tantalum, and a liquid interposed between said plates and making contact with the faces thereof, said liquid containing a soluble carbohydrate, boracic acid, an alkali carbonate, and an alcohol having low hygroscopicity and of the class as represented by ethylene glycol.

4. An electric condenser characterized by a pair of metal plates and a porous non-metallic sepa-

rator between them impregnated with a solution containing a boron compound which is acidic in reaction, a soluble carbohydrate of the type represented by the formula $C_mH_{2n}O_n$, an alkali carbonate and a preservative compound characterized by the presence of the hydroxyl group, one at least of said plates being of aluminum and having thereon an adherent oxide coating.

5. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum, magnesium or tantalum and a liquid interposed between said plates and making contact with the faces thereof, said liquid containing a soluble carbohydrate of the type represented by the formula $C_mH_{2n}O_n$, a soluble alkali carbonate, which is non-corrosive to the plates, and boracic acid.

6. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum or magnesium or tantalum, and a liquid interposed between said plates and making contact with the faces thereof, said liquid containing a soluble carbohydrate of the type represented by the formula $C_mH_{2n}O_n$, a soluble non-corrosive alkali carbonate, glycerine and boracic acid.

7. An electric condenser characterized by possession of spaced metal plates one at least of which consists of one of the metals aluminum, magnesium or tantalum, and an electrolyte interposed between the said plates and in contact with the faces thereof, said electrolyte containing ammonium carbonate, boracic acid and an alcohol having low hygroscopicity and of the class as represented by ethylene glycol.

JESSE TEMPLE CURTIS.