

April 9, 1935.

H. E. RHODES
ELECTROLYTIC CONDENSER
Filed Oct. 18, 1934

1,997,562

Fig. 1.

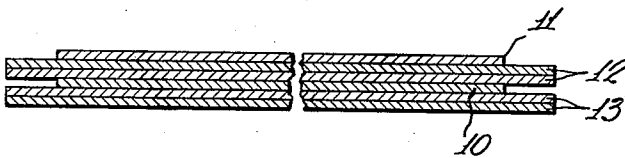


Fig. 2.

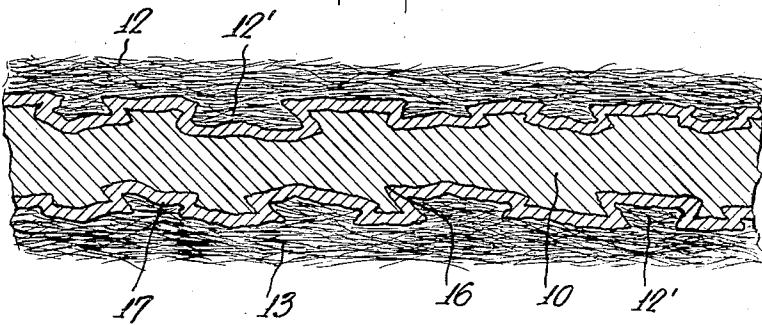
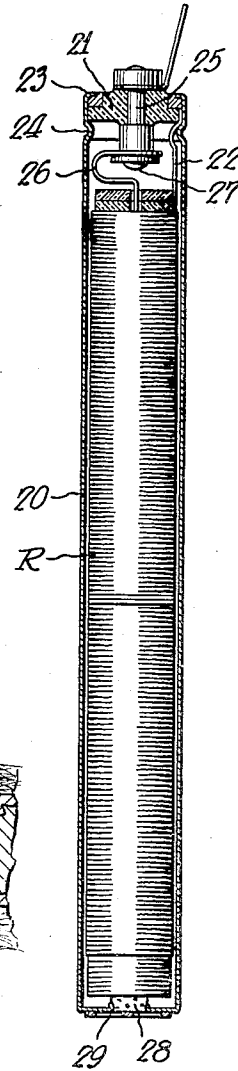


Fig. 3.



INVENTOR
Howard E. Rhodes
BY
Dean, Tribbitt, Hirsch & Foster
ATTORNEYS

UNITED STATES PATENT OFFICE

1,997,562

ELECTROLYTIC CONDENSER

Howard E. Rhodes, Floral Park, N. Y., assignor
to Aerovox Corporation, Brooklyn, N. Y., a corporation of New York

Application October 18, 1934, Serial No. 748,801

8 Claims. (Cl. 175—315)

My present invention relates to electrolytic cells, more especially to electrolytic condensers.

Among the objects of the invention is to provide an electrolytic condenser of extraordinarily small bulk per unit of capacity, which shall be of low cost, in embodiments suitable for various voltage and capacity requirements substantially throughout the range in which such condensers are now used for radio, power factor correction, motor starting and the like.

Another object is to provide a condenser of the above type in which an engagement is effected between the formed foil area and the absorbent interspacer which is so intimate as substantially to reduce or eliminate the usual small gaps which commonly give rise to a poor power factor.

In the accompanying drawing, in which are shown one or more of various possible embodiments of the several features of this invention,

Fig. 1 is a transverse sectional view on an enlarged scale, of the superposed elements from which the condenser is made,

Fig. 2 is a transverse sectional view on a greatly enlarged scale through a formed foil and the absorbent material between which it is sandwiched, and,

Fig. 3 is a transverse sectional view showing one embodiment of the completed condenser.

Referring now to the drawing, there is shown in Fig. 1, the general more or less conventional construction of an electrolytic condenser including an anode foil 10 sandwiched between paper spacers 12 and 13, over one of which is superposed the cathode foil 11. Said condenser may be flat as shown or enrolled in conventional manner as shown in Fig. 3, as hereinafter described.

Fig. 2 discloses on a greatly enlarged scale approximately as viewed through a microscope, but not to scale, the cross-sectional view of the anode foil with the contiguous paper sheets between which it is sandwiched. The foil is prepared according to the teachings of the copending application of Herbert Waterman, Serial No. 745,535, filed September 26th, 1934.

As set forth in that application, annealed aluminum foil prepared with crystals of size between .001 and .00001 inch is subjected to a controlled etching process by which undercut depressions 16 are eroded into the surface of the foil, said erosion being probably the consequence of the removal in the etching operation from the surfaces, of a large proportion of those crystals that have a greater amount of impurity than the body of the foil, which is preferably of purity less than 100 per cent and ordinarily not less than 99.6 per cent. The etched foil after removal therefrom of all foreign matter due to the etching operation is subjected to a film forming operation resulting in a thin di-electric film

17 closely adhering to the superficial area including the various undercut depressions of the foil.

The spacers 12 and 13 according to the present invention are of paper differing materially from that commonly used in wax condensers.

Paper of cotton fibre, manila rope, or alpha cellulose is desirable, provided it combines the required characteristics of high absorbency, tensile strength and a rough fibrous surface resembling a nap of felt. The paper is preferably between .001 and .005 inch thick, is devoid of sizing, uncalendered and very soft. The paper should also be pure, especially in freedom from inorganic salts, such as chlorides, sulphates or nitrates. The paper should also have tensile strength sufficient to permit winding of condensers without tearing under the tension imposed by automatic winding machines, even though the paper be wet by electrolyte. The fibre of the paper should be relatively long, not less than 2.5 mm, to afford a considerable nap. Such fibre will become sufficiently closely intermatted to afford the requisite tensile strength, and without resort to any considerable hydration or beating which would destroy the nap and render the surface too smooth for my purpose.

One, two, three or more sheets of the paper may be used between the two foils depending on the voltage for which the condenser is intended. The condenser even though tightly rolled into a small volume, admits of being readily impregnated by immersion in hot liquid electrolyte, which readily soaks up into the very porous paper and completely permeates the latter. Of course, the electrolyte may be incorporated in the paper beforehand, or, if desired, in the course of winding the condenser.

While marked improvements in the operation of condensers are attained by the use of the new paper interspacer with conventional foil, the use of the etched foil and the new paper interspacer in combination results in advantages considerably greater than those due to the additive advantages of the said individual elements.

Apparently, the protruding nap or fibers 12' of the special paper used, enter the undercut depressions 16 and come into intimate contact with the film lining said depressions and thereby bring the electrolyte permeating said spacer into such effective engagement with the film that minute gaps are avoided, thereby obviating any fortuitous increase in resistance due to air gaps either originally present or consequent upon expansion in operation. Accordingly the power factor is kept low and the tendency to break down and to other difficulties is minimized whether the electrolyte be in fluid or in paste condition.

By reason of the thinness of the paper, as compared to gauze, further reduction in the physical

size of the condensers is attained and, of course, there is economy of cost, since the paper is cheaper than gauze.

Aside from these characteristics and due to its continuous structure as compared to open mesh gauze, the closely matted paper will withstand a higher voltage, particularly much higher transient surge voltages, generally encountered in radio sets and other electrical devices when first set into operation.

It is understood that after the condenser has been rolled as set forth, it is subjected to a forming operation, either before or after sealing in the final container or both before and after sealing.

Where, as is preferable, the cathode also is pre-formed in the manner above set forth, the condenser will readily build up on the cathode thereof to operate on reverse polarity, should such reversal accidentally occur. It is also understood that both foils can be formed, in which case, the condenser is especially useful for alternating current service.

The enrolled condenser unit may be encased and provided with terminal facilities in any of a wide variety of possible ways. The assembly of Fig. 3 which is the invention of Samuel I. Cole, and covered in application, Serial No. 631,459, filed September 12, 1932, is a preferred embodiment. The condenser unit R. rolled reasonably tightly from the assembly of Fig. 1, is enclosed with some clearance in an aluminum can 20 having an insulating cover button 21, the periphery of which clamps the cathode tab 22 against the rim of the can, which rim is rolled over at 23 to effect a closure, the cover button resting upon the intumed bead 24 of the can. The button 21 also has a positive terminal 25 about which it is molded and to the under face of which is riveted at 27 the anode terminal 26. A vent in the form of a cork plug 28 is retained in the corresponding aperture 29 in the bottom of the can.

It will thus be seen that there is herein described apparatus in which the several features of this invention are embodied, and which apparatus in its action attains the various objects of the invention and is well suited to meet the requirements of practical use.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An electrolytic condenser comprising aluminum foils, intervening thin, soft, matted, napped absorbent interlay, in intimate contact therewith and impregnated with electrolyte, each of the electrodes presenting a multiplicity of minute depressions greatly to increase the effective superficial area of the foil.

2. An electrolytic condenser comprising two foil electrodes, an intervening thin, soft, napped layer of absorbent material carrying electrolyte, one of said electrodes having minute depressions, removed from its otherwise substantially flat surface to greatly increase the effective area thereof.

3. An electrolytic condenser comprising two

electrodes of thin aluminum foil, each of said electrodes having a multiplicity of minute depressions therein, greatly to increase the effective area of said foils, each of said foils having a film electrolytically pre-formed thereon to facilitate further formation, and a closely matted, soft, thin, napped absorbent spacer between said electrodes, impregnated with electrolyte.

4. An electrolytic condenser comprising two electrodes of thin aluminum foil, each of said electrodes having a multiplicity of minute depressions therein, greatly to enhance the effective area thereof, each of said foils having a dielectric film, the completed condenser including an inter-spacer of one or more layers of thin, soft, matted, napped absorbent material intervening therebetween and soaked with electrolyte.

5. An electrolytic condenser comprising thin aluminum foils, each of said foils having its surface eroded at a multiplicity of minute regions distributed throughout the foil area, the entire surface being preconditioned for facility of electrolytic formation, the two foils having therebetween a spacer of matted, napped, soft, long-fiber paper of highly absorbent character, the foils with the interleaved paper being closely enrolled, the paper interlay being impregnated with electrolyte, one of the foils having a further film formation, constituting the product of electrolytic action thereon by the electrolyte in the spacer.

6. An electrolytic condenser including annealed aluminum foil having minute surface irregularities substantially exposing crystalline faces of the grain of the foil structure, and a loosely mated absorbent interspacer, presenting relatively long fibers and a nap, the latter substantially entering said various irregularities and electrolyte retained by said interspacer and the nap thereof.

7. An electrolytic condenser including electrode foils and an electrolyte carrying absorbent interspacer therebetween, one of said foils of annealed aluminum presenting a structure, the crystalline grains of which are of length between .001 inch and .00001 inch and having said crystalline faces substantially exposed at the surface, with minute irregularities between crystalline faces, from which the crystals are absent, said interspacer comprising matted cellulosic absorbent fiber presenting a substantial nap entering into intimate contact with said irregularities in the foil surface, whereby to cause electrolyte incorporated in said interspacer to enter and remain in intimate contact with substantially the entire surface area of the foil.

8. An electrolytic condenser including electrode foils and an electrolyte carrying absorbent interspacer therebetween, one of said foils of annealed aluminum presenting a structure having crystals with faces substantially exposed at the surface and presenting minute depressions between contiguous crystal faces, from which certain crystals of conventional foil are absent, said interspacer comprising matted cellulosic absorbent fiber in excess of 2.5 mm. in length, presenting a substantial nap entering into intimate contact with said irregularities in the foil surface, whereby to cause electrolyte incorporated in said interspacer to enter and to remain in intimate contact with substantially the entire surface of the foil.

HOWARD E. RHODES.