

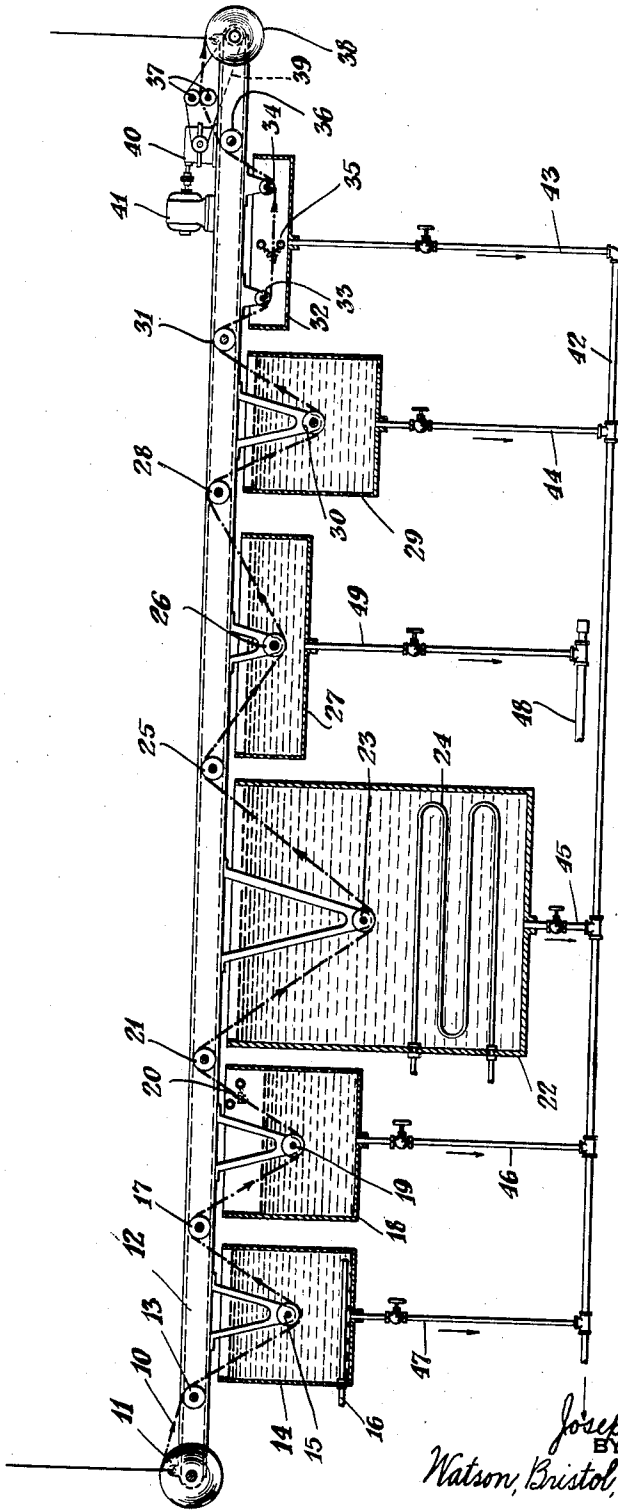
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CONDENSER AND METHOD OF PRODUCING SAME

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CONDENSER AND METHOD OF PRODUCING
SAME

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This invention relates to electrolytic apparatus, such as condensers, rectifiers, lightning arresters, and other devices, in which electrodes of aluminum or other filming metal are immersed in a suitable electrolyte, as for example, an aqueous solution of borax and boric acid. More particularly, the invention relates to an improved anode for electrolytic condensers of both the so-called "dry" and "wet" types and a method of producing same.

A general object of the invention is the provision of an improved electrolytic condenser featured by an anode which has been chemically etched in a manner greatly to increase the capacity of the condenser and to improve its efficiency, and an improved method of producing such an anode which allows efficient factory control.

More specific objects of the invention are the provisions of such a condenser having an anode chemically etched by an aqueous solution of copper chloride whereby the operating characteristics thereof are improved and a new and novel method of cleaning, etching and treating such anodes which results in substantially uniform production thereof.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, the apparatus embodying features of construction, combination and arrangement of parts, adapted to effect such steps, and the article which possesses the characteristics, properties and relation of elements, all as exemplified in the detailed disclosure hereinafter set forth, and the scope of the invention will be indicated in the claims.

Inasmuch as the electrode constructed in accordance with the invention is adapted for use in electrolytic apparatus, and particularly electrolytic condensers having a dielectric film thereupon, the invention, except insofar as it relates to the novel anode surface, may be considered as an improved preliminary treatment for dielectric film carrying aluminum anodes which are to be later subjected to one of the prior art dielectric film-forming operations. As examples of two dielectric film forming methods which are now in extensive use, attention is directed to United States Patents, Number 1,012,889, issued December 26, 1911 and Number 1,065,704, issued June 24, 1913, to Ralph D. Mershon.

The methods described in the above patents, and many others, are old and well known to those skilled in the art and a description thereof is believed unnecessary. It will suffice to say that in the methods disclosed the electrode is subjected to electrolytic action in a suitable electrolyte until a film of sufficient thickness and di-

electric strength is produced upon the surface of the electrode. Electrodes treated in this manner are referred to in the art as formed electrodes.

The present invention described in this application, which is a continuation in part of my prior application Serial Number 697,700, filed November 11, 1933, is particularly well adapted to electrolytic condensers and is based upon the discovery that the capacity of an electrolytic condenser may be increased at least three fold and more if the dielectric film on the anode is formed upon an etched surface.

In practice it has been found that a condenser having a formed anode prepared in accordance with this disclosure actually has at least three or more times as much capacity as a similar condenser not so treated. To what extent the etching of the electrode contributes to the increase in capacity obtained by this invention has not been definitely determined. One possible theory, which may be advanced, is that the etching of the anode provides more anode surface to be filmed, and while this theory may be correct, it is believed that the preliminary and subsequent treatments of the electrode also contribute to and account for some of the increase in capacity obtained by forming the condenser electrode in accordance with this disclosure.

The etching of the electrode may be accomplished in a number of different ways, but the preferred method consists in first cleaning the electrode, which in the present instance will be assumed to be of aluminum, in a five per cent (5%) solution of sodium hydroxide (NaOH) for about fifteen (15) seconds. This produces a chemically clean surface. The electrode is then placed in a water solution of copper chloride (CuCl_2) for about thirty (30) seconds. The concentration of the copper chloride solution may vary, but should preferably be about four and one half (4.5) to seven (7) per cent. After the etching process is completed the electrode is immersed in concentrated nitric acid (HNO_3) for about fifteen (15) to thirty (30) seconds and then washed off in water.

The preferred method which allows efficient factory control consists of the following detailed steps:

1. Cleaning the aluminum anode in a five per cent (5%) aqueous solution of sodium hydroxide (NaOH) for about fifteen (15) seconds at a temperature of about seventy (70) to seventy-five (75) degrees C. For dry electrolytic condensers the maximum amount of anode foil per gallon of solution is to be limited to about sixty (60) square feet. Similar precautions are to be taken in cleaning anodes for wet electrolytic condensers.

2. Rinsing in tap water until all traces of the

sodium hydroxide solution have been removed from the anodes.

3. Etching the cleaned anodes in a four and one half per cent (4.5%) solution of copper chloride (CuCl_2) in distilled water by immersion for a period of about thirty (30) seconds at a temperature of about thirty-two (32) to thirty-four (34) degrees C. For dry electrolytic condensers the maximum amount of anode foil per gallon of solution is to be limited to about six (6) square feet. The solution should not be used more than twenty-four (24) hours before replacement and the concentration should be controlled between about thirty-eight (38) and forty-five (45) grams of copper chloride per litre of solution, using any suitable method for determining the concentration. Similar precautions are to be taken in etching anodes for wet electrolytic condensers.

4. Treating the etched anodes in concentrated nitric acid having a specific gravity of about 1.42 for about fifteen (15) to thirty (30) seconds, using the acid until it fails to remove visual traces of copper on the anodes.

5. Rinsing the treated anodes in cold tap water until all traces of nitric acid have been removed.

6. Drying in currents of warm air.

7. Boiling in distilled water for a minimum time of ten (10) minutes to remove impurities that may be present. This last step should be practiced in lieu of any cleaning operation using acid or alkaline cleaners which have a tendency to attack aluminum anodes to such an extent as to render the surfaces or effective capacities thereof non-uniform.

The immersion of the aluminum anode in concentrated nitric acid, after the etching, is believed to remove any copper and/or other impurities from the anode. However, it is possible that, in addition to cleaning the anode in the above manner, the concentrated nitric acid may also form a very thin film of aluminum oxide (Al_2O_3) which will protect the etched surface and, in conjunction with the later electrolytic formation of the anode, account for the improved results obtained.

The aluminum anodes of dry electrolytic condensers of the type contemplated by this invention are at the present time formed of sheet aluminum foil which is obtainable in long ribbon like strips. Therefore, in practice the above operations can be carried out in a continuous manner by feeding the strips of aluminum foil successively through containers in which the several solutions are placed. If this is done water washes, in the form of sprays or baths, may be provided between the containers for preventing the solution of one container being carried over with the foil and into the next container.

A preferred series of steps for a continuous operation, as outlined above, is to run the foil first through a container filled with the sodium hydroxide solution, then through a tank of water and/or through a water spray, next through the copper chloride etching solution, followed by a wash, and into the concentrated nitric acid bath, after which it will be finally washed with water. As additional adjuncts rubber rollers, for squeezing the solutions and water off the aluminum strip, may be interposed between the several steps. After the final washing the aluminum foil may, if desired, be passed through a drying oven.

For a fuller understanding of the nature and objects of the invention reference should be had

to the following detailed description taken in connection with the accompanying drawing, in which:

The figure is a vertical elevational view with parts in section showing a suitable mechanism for carrying out a preferred form of the continuous process of the present invention.

The foil 10 supplied from a reel 11 mounted on a roll-supporting frame 12 passes over a hard rubber roll 13 into a tank 14 containing the caustic soda bath. In tank 14 is mounted a glass roll 15 under which the foil 10 passes. A coil 16, for heating or cooling the caustic solution bath, is preferably mounted in the bottom of the tank 14.

Foil 10 then passes out of the tank 14, over a hard rubber roll 17, into a tank 18 containing water, under a hard rubber roll 19 and between water sprays 20 in the tank 18, out of the tank 18 over a hard rubber roll 21 and into a lead lined wooden tank 22 containing the copper chloride etching solution. In tank 22 is mounted a glass roll 23 under which the foil 10 passes. A coil or coils 24 for heating or cooling the copper chloride solution is, or are, preferably mounted in the bottom of the tank 22.

The foil 10 then passes out of the tank 22, over a hard rubber roll 25, and under a glass roll 26 in an asphalt lined wooden tank 27 containing the nitric acid solution. The foil 10 then passes out of the tank 27 over a hard rubber roll 28, into a tank 29 containing a water bath, under a hard rubber roll 30 in tank 29, out of the tank 29 over a hard rubber roll 31 and into a pan 32. In the pan 32 the foil 10 passes under a pair of spaced apart rubber rolls 33 and 34 and between water sprays 35 located between the rolls 33 and 34.

Foil 10 then passes out of the pan 32 over a hard rubber roll 36, between a pair of soft rubber rolls 37, 37 to act as a wringer for squeezing the liquid off the foil, and to a winding reel 38.

The winding reel 38 is supplied with motive power to pull the foil through the solutions and baths, preferably by means of a belt 39 from a speed reducer 40 geared to a motor 41. As shown one of the wringer rolls 37, 37 is also rotated by the belt 39.

All of the hard rubber rolls 13, 17, 21, 25, 28, 31, and 36, and the supply and winding reels 11 and 38 are rotatably mounted on the supporting frame 12 with their axes disposed substantially horizontally. The rolls 15, 19, 23, 26, 30, 33, and 34, in the tanks 14, 18, 22, 27, 29, and 32 are also rotatably mounted on supports fixed to the frame 12 with their axes disposed substantially horizontally. The roll supports in the caustic soda tank 14, copper chloride tank 22 and nitric acid tank 27 are formed from suitable material or suitably protected to prevent attack by the solutions.

The pan 32 and the tanks 29, 22, 18, and 16 are respectively connected to a common sewer or drain pipe 42 by means of valve controlled lines 43, 44, 45, 46, and 47. The nitric acid tank 27 is connected to a separate drain 48 by means of a valve controlled line 49.

While the above outlined method has been found to be most satisfactory, particularly for efficient factory production, it is to be understood that other chemicals may be used and that variations in the time indicated may be made without departing from the spirit of this invention. The etching action of the copper chloride may be accelerated by passing an electric current through the copper chloride solution during the etching operation. As a substi-

tute for sodium hydroxide in the cleaning step, it has been found that hydrofluoric acid or nitric acid may be used. The electrodes must be chemically clean when exposed to the etching solution and, therefore, a cleaning of the electrode in the sodium hydroxide solution or some other cleansing agency is necessary in order to obtain proper results.

Since certain changes may be made in carrying out the above process and in the article, and modifications effected in the apparatus for practicing the principle thereof, without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

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

1. In the method of producing an aluminum electrode for electrolytic condensers the step of subjecting the electrode to the etching action of an aqueous solution of copper chloride.

2. A method of producing an aluminum electrode for electrolytic condensers which comprises subjecting the electrode to the etching action of an aqueous solution of copper chloride and treating with nitric acid.

3. The method of producing an aluminum electrode for electrolytic condensers which comprises cleaning the electrode surface, subjecting it to the etching action of an aqueous solution of copper chloride, and treating with nitric acid.

4. The method of producing a dielectric film carrying aluminum electrode for electrolytic condensers which comprises subjecting the electrode to the etching action of an aqueous solution of copper chloride, and stopping the etching action by immersing the electrode in nitric acid.

5. The method of producing a dielectric film carrying aluminum anode for electrolytic condensers, which comprises subjecting the anode to the etching action of an aqueous solution of copper chloride, and cleaning the anode to remove any deposited copper.

6. The method of increasing the capacity of an electrolytic condenser having an aluminum anode, which comprises subjecting the anode to the action of an aqueous solution of copper chloride for the purpose of etching the surface thereof, and finally immersing the anode in concentrated nitric acid to stop the etching action.

7. The method of producing a high capacity aluminum anode for an electrolytic condenser, which comprises cleaning the anode with sodium hydroxide, etching the surface thereof with an aqueous solution of copper chloride, and treating the etched surface with concentrated nitric acid.

8. A treatment for an electrolytic condenser aluminum electrode, preliminary to the formation of a dielectric film thereon, which consists in first washing the electrode in a solution of sodium hydroxide, immersing the electrode in an aqueous solution of copper chloride, subjecting the electrode to the action of concentrated nitric acid, and finally washing the electrode in distilled water.

9. The method of producing an aluminum electrode for electrolytic condensers which consists in cleaning the electrode surface with a solution of sodium hydroxide, subjecting it to the action of an aqueous solution of copper chloride, treat-

ing with concentrated nitric acid, and boiling in distilled water.

10. A preliminary treatment for an aluminum condenser anode of the type having an electrolytically formed dielectric film thereupon, which consists in washing the anode with a five per cent solution of sodium hydroxide for approximately fifteen seconds, immersing the anode in an aqueous solution of copper chloride for approximately thirty seconds, subjecting the anode to the action of concentrated nitric acid for about fifteen to thirty seconds, and finally washing the anode in distilled water.

11. The method of producing an aluminum anode for electrolytic condensers which comprises, washing the anode in a five per cent solution of sodium hydroxide for about fifteen seconds, immersing the anode in an aqueous solution of copper chloride of a concentration of about four and one half to seven per cent for approximately thirty seconds, subjecting the anode to the action of concentrated nitric acid for about fifteen to thirty seconds, and boiling the anode in distilled water.

12. The method of producing an aluminum anode for electrolytic condensers, which comprises cleaning the anode surface with a solution of sodium hydroxide, rinsing in tap water, etching in an aqueous solution of copper chloride, treating with nitric acid, rinsing in cold tap water, and boiling in distilled water.

13. The method of producing an aluminum anode for electrolytic condensers, which comprises cleaning the anode surface in a five per cent solution of sodium hydroxide for about fifteen seconds at a temperature of about 70 to 75° C., rinsing in tap water to remove all traces of sodium hydroxide solution, etching in an aqueous solution of copper chloride of about four and one half per cent concentration for about thirty seconds at a temperature of about 32 to 34° C., treating with concentrated nitric acid for about fifteen to thirty seconds, rinsing in cold tap water until all traces of nitric acid have been removed, and boiling in distilled water for at least ten minutes.

14. The method of producing an aluminum anode for electrolytic condensers, which comprises cleaning the anode surface in a five per cent aqueous solution of sodium hydroxide for about fifteen seconds at a temperature of about 70 to 75° C., at least a gallon of cleaning solution being used for sixty square feet of anode surface, rinsing in tap water to remove all traces of sodium hydroxide solution, etching in a distilled water solution of copper chloride of about four and one half per cent concentration for about thirty seconds at a temperature of about 32 to 34° C., at least a gallon of etching solution being used for six square feet of anode surface, treating with concentrated nitric acid for about fifteen to thirty seconds, rinsing in cold tap water until all traces of nitric acid have been removed, drying, and boiling in distilled water for at least ten minutes.

15. In the manufacture of electrolytic condensers, the steps which comprise cleaning a film-forming aluminum electrode in a solution of a hydroxide of an alkali metal, and etching said cleaned electrode in an aqueous solution of copper chloride and increasing the active surface area of the electrode more than two-fold.

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