Dec. 30, 1941. J. B. BRENNAN 2,267,717

ELECTROLYTIC DEVICE AND METHOD OF MAKING SAME

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Fig. 1.

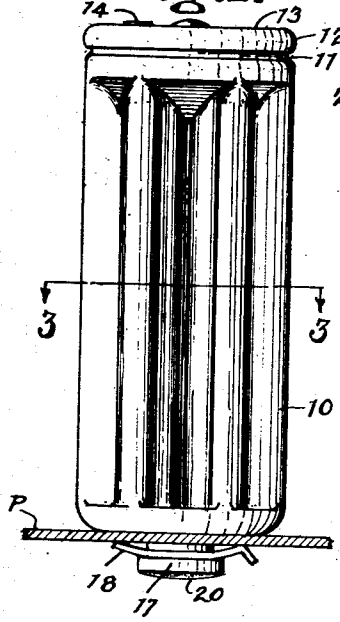


Fig. 2.

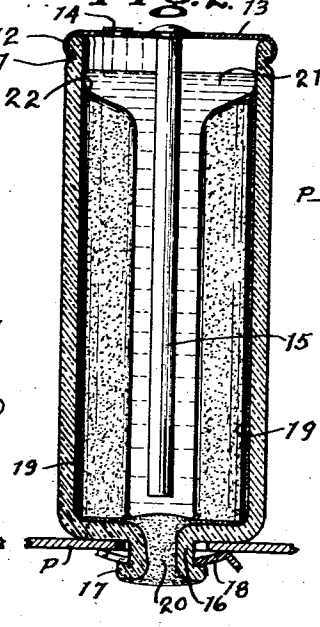


Fig. 3.

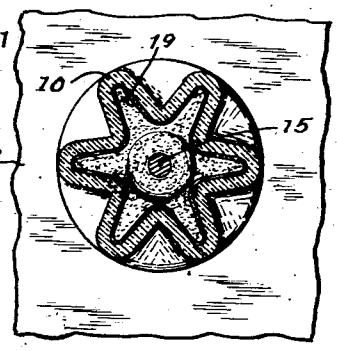


Fig. 4.

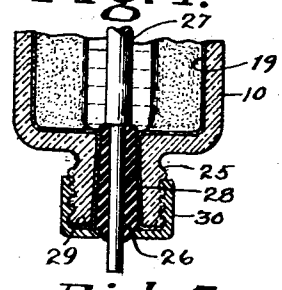


Fig. 8.

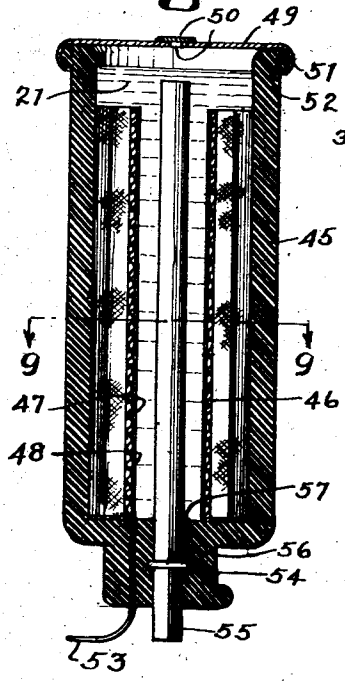


Fig. 6.

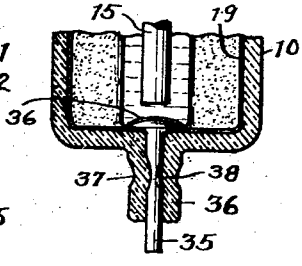


Fig. 5.

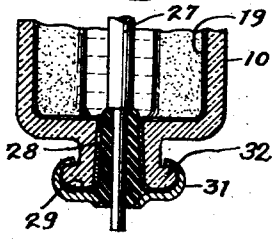


Fig. 9.

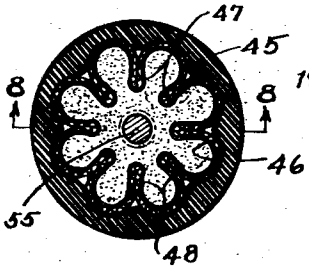
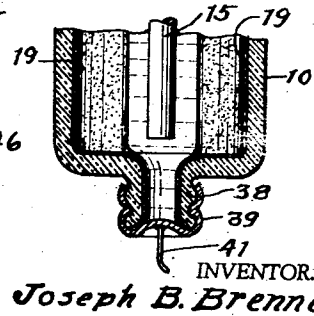


Fig. 7.



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Fig. 10.

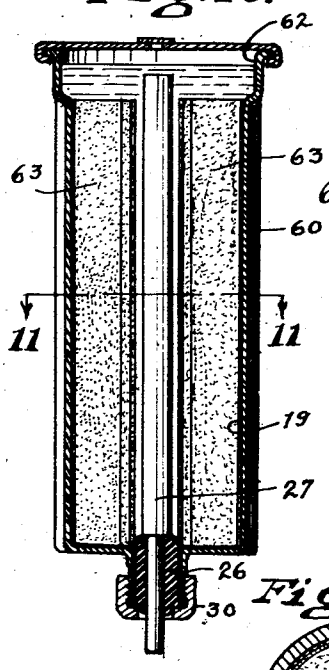


Fig. 11.

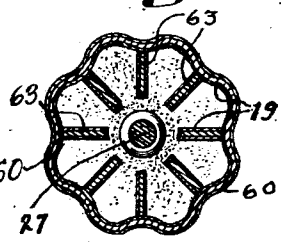


Fig. 12.

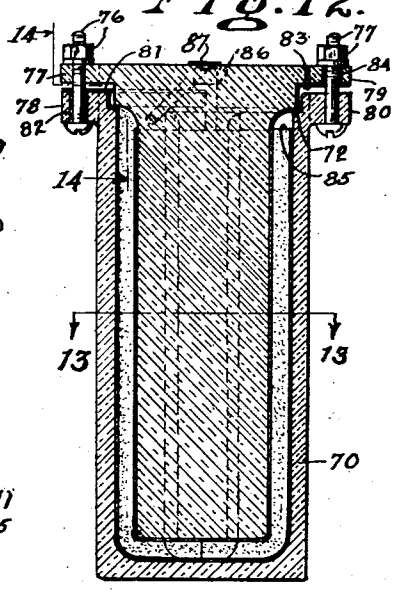


Fig. 13.

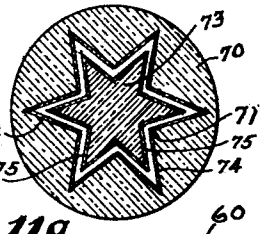


Fig. 11a.

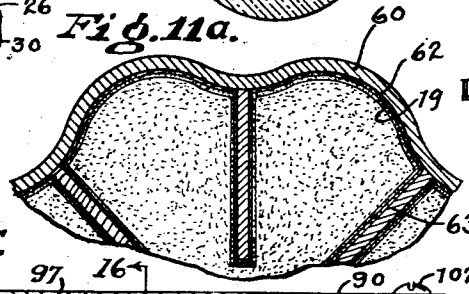


Fig. 14.

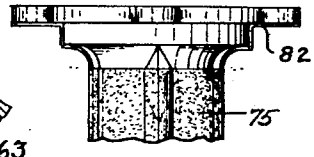


Fig. 15.

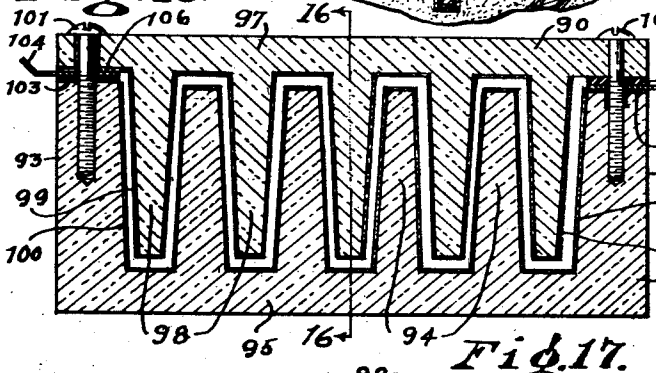


Fig. 16.

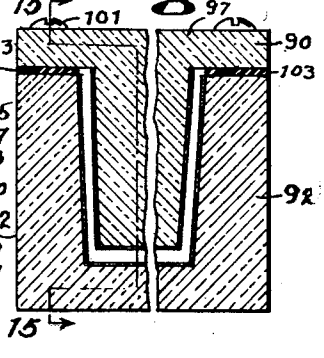
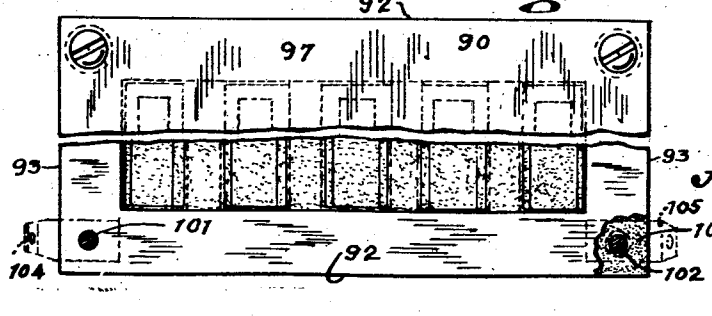


Fig. 17.



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Fig. 18.

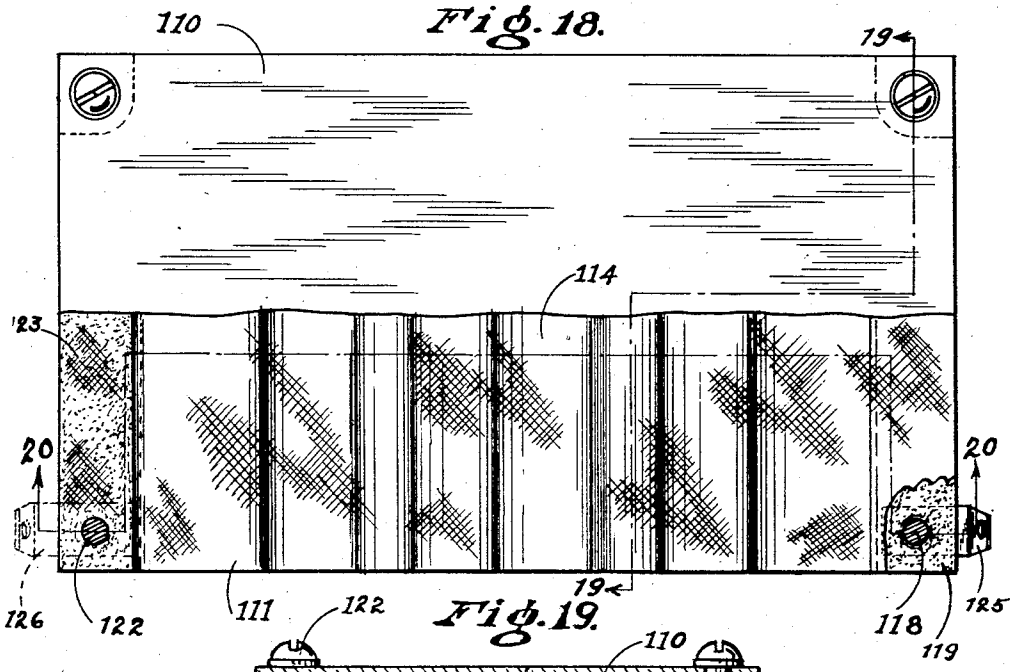


Fig. 19.

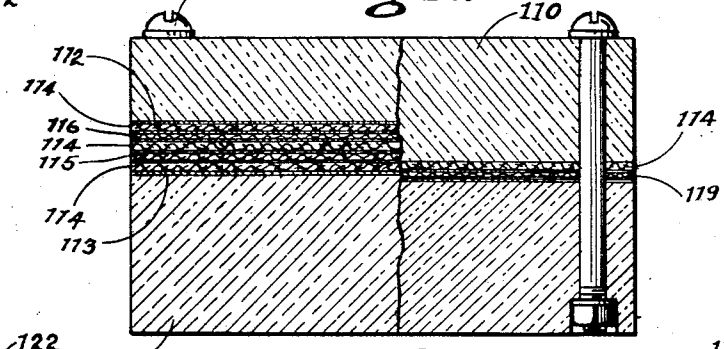
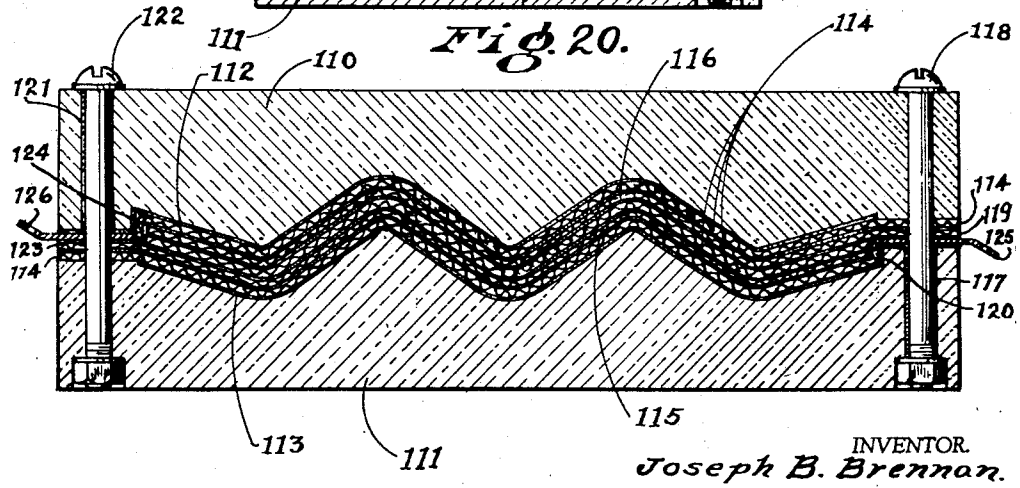


Fig. 20.



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Patented Dec. 30, 1941 2,267,717

UNITED STATES PATENT OFFICE

2,267,717

ELECTROLYTIC DEVICE AND METHOD OF MAKING SAME

Joseph B. Brennan, Euclid, Ohio

Application July 13, 1938, Serial No. 218,910

17 Claims. (Cl. 175—315)

This invention relates to electrolytic devices and methods of making same and more particularly to devices such as electrolytic condensers, lightning arresters and rectifiers embodying at least one film anode.

It is among the objects of my invention to provide efficient, durable and economical electrolytic condensers, lightning arresters, rectifiers and the like. Another object of my invention is to provide an economical and convenient method of manufacturing such devices. A further object of my invention is to provide an electrolytic condenser in which the container for the electrolyte, which also constitutes one of the electrodes, is made of inexpensive insulating material which is not corrodible by the electrolyte. Another object is to provide an electrolytic condenser which will have a high capacity in proportion to its size. Another object of my invention is to provide an electrolytic condenser or similar device in which the inner surface of the container for the electrolyte constitutes the anode of the device. A further object is to provide such a device wherein the effective area of the anode is greatly increased as compared to the plane or directly measurable area thereof.

Briefly a preferred form of my invention as applied to an electrolytic condenser contemplates a condenser in which the container for electrolyte is provided with an inner coating of aluminum or other suitable filming material which is formed with a dielectric film if it is to constitute the anode of the condenser. Preferably the surface of the film forming material is produced by spraying molten metal on the inner surface of the container for electrolyte by the method described and claimed in my Patent No. 2,104,018 issued January 4, 1938. The container for electrolyte in which the film forming material is deposited may be made of any suitable material, such as aluminum for example, but preferably the container is made of an inexpensive insulating material which is not corrodible by the electrolyte. For example, I have found glass, porcelain, or hard rubber to be very satisfactory. The cathode of the condenser may take various forms, for example a suitable conducting rod suspended within the electrolyte and preferably disposed centrally of the container may be employed.

Further objects and advantages of my invention will become apparent from the following description of various preferred and modified forms thereof, reference being made to the accompanying drawings, in which:

Figure 1 is an elevation of a wet type of condenser made in accordance with the preferred form of my invention; Figure 2 is a vertical section through the condenser illustrated in Figure 1; Figure 3 is a transverse section as indicated by line 3—3 of Figure 1; Figures 4, 5, 6 and 7 are fragmentary vertical sections through condensers of the same general type as that indicated in Figures 1 to 3 but showing modified forms of supports for the cathode and modified methods of sealing the containers; Figure 8 is a transverse section, as indicated by line 8—8 of Figure 9, through another form of condenser made according to my invention in which the container is made of hard rubber; Figure 9 is a section taken along line 9—9 of Figure 8; Figure 10 illustrates still another modification of my invention as applied to a wet type of condenser; Figure 11 is a section taken along the line 11—11 of Figure 10; Figure 12 is a further modification showing the type of condenser in which both anode and cathode are formed by spraying metal on fluted or corrugated forms made of glass or other insulating material; Figure 13 is a section taken along line 13—13 of Figure 12; Figure 14 is a section taken along line 14—14 of Figure 12; Figure 15 is a vertical section through a further modification of my invention, the section being indicated by line 15—15 on Figure 16; Figure 16 is a section taken at right angles to Figure 15 as indicated by line 16—16 on Figure 15; Figure 17 is a top plan view of the condenser illustrated in Figure 15 with part of the upper member removed for convenience of illustration; Figure 18 is a plan view of still another modification adapted particularly for dry type condensers and having part of the upper member of the condenser broken away for convenience of illustration; Figure 19 is a section taken along the line 19—19 of Figure 18; and Figure 20 is a section taken along line 20—20 of Figure 18.

Referring to Figures 1 to 3 of the drawings in which I have illustrated a preferred form of my invention, it will be seen that the condenser comprises a fluted or corrugated hollow container 10 formed in one piece of glass or other suitable insulating material such as porcelain or other ceramic material, synthetic resins, or the like. The upper end of the container may be provided with a groove as at 11 to receive the inwardly deformed flange 12 of the closure or cap 13, the cap being provided with any suitable vent 14 to permit the escape of gases generated within the condenser during operation, and also functioning to support the cathode rod 15, which is preferably formed of copper.

At its lower end the condenser is provided with a neck portion 16 of reduced diameter having a flanged end 17. The assembly may be supported in an apertured plate P by engagement of the resilient clip between the plate and the flange.

To form the anode of the condenser I preferably coat the inner surface of the container 10 with finely divided cohering particles of aluminum or other suitable film forming material as indicated at 19. Preferably the coating is produced by atomizing a molten metal and spraying the atomized metal in finely divided condition upon the inner surface of the container. The metal may be atomized by means of a spray gun in which a wire is melted as by an oxy-acetylene flame and atomized by a blast of compressed air or other gas, or the metal may be fused in a furnace and fed from the furnace, by gravity, suction or pressure to a spray nozzle where it is atomized by compressed air or other gas. In either case, the spray nozzle or gun is preferably held from two to ten inches from the surface being sprayed.

This operation, as described in greater detail in my prior Patent No. 2,104,018, produces a layer of finely divided metallic particles which adhere to the inner surface of the piece and cohere to each other to form a conductive layer which is of a porous, roughened, or honey-combed nature when viewed with the aid of a microscope. The irregularity of the surface produced by the spraying operation increases the effective area of the metallic surface many times (in practice, from 10 to 50 times) as compared with the area of the inner surface of the container. As described in my patent above referred to, when such a coating of aluminum for example is provided with a dielectric film, preferably by subjecting the coating to electrolysis as an anode in a solution of, for example, borax and boric acid circulating the electrolyte within the container, and continuing the formation until the desired voltage is reached and the leakage drops to the required value, the film conforms to the irregularities of the surface of the minute particles and thus the area of the film and the capacity of the condenser are increased in proportion to the increase in the effective area of the filming metal. Therefore by employing such a surface I am able to produce a condenser having a high capacity with relation to its size or volume and because of the reduction in size and the economy of the materials, my condensers can be produced at low cost.

To make external contact with the layer 19 constituting the anode of the condenser and also to seal the passageway through the neck 16, the sprayed layer is preferably continued through the neck, sufficient material being deposited as indicated at 20 to completely fill and seal the neck and provide an external terminal for connecting the anode surface to an external circuit, since the sprayed material within the neck is continuous with the sprayed layer within the container and in contact with the electrolyte 21.

It will be noted that the upper boundary 22 of the sprayed layer 19 is below the level of the electrolyte 21. By this type of construction the corrosion of the anode which ordinarily takes place at the surface of the electrolyte is eliminated, as the anode is totally submerged. Thus the durability of the anode is increased and the leakage losses of the condenser are reduced.

Figure 4 of the drawings illustrates a condenser generally similar to that illustrated in Figures 1 to 3 but modified with respect to the manner in which the cathode is supported and the container sealed. In this modification the lower portion of the container 10 is provided with a threaded neck portion 25, the opening through the neck being sealed by a rubber plug or grommet 26 which also functions to support the cathode rod 27. The interior of the container is provided with a sprayed layer 19 as before which is extended through the neck as shown at 28 and around the bottom surfaces of the neck as at 29. An aluminum cap 30 engaging the threads on the neck 25 functions to compress the grommet 26 to retain it in position and also makes contact with the sprayed material at 29. In this type of condenser the upper portion of the container may be closed by a cap similar to the cap 13 shown in Figures 1 and 2 but without the cathode secured thereto.

In the modification shown in Figure 5 the construction is similar to that shown in Figure 4 except that a cap 31 is spun into engagement with a flange 32 on the neck portion of the container 10, the sprayed layer 19 being carried through the neck and around the lower surface of the flange 32 as before and as indicated at 28 and 29, respectively. In the modification shown in Figures 4 and 5, the sprayed material is preferably burnished where it extends through the neck of the container, so that it will make a better seal with the grommet, and to prevent seepage of electrolyte through the sprayed layer.

Figure 6 illustrates a different method of sealing the bottom of a condenser otherwise similar in all material respects to the condenser shown in Figures 1 to 3, inclusive, and including a container 10, a sprayed surface 19 constituting the anode and a cathode rod 15 supported from the upper closure cap. In this modification the anode terminal is formed by an aluminum riser 35 having a head portion 36 which engages the sprayed surface 19, the spray extending over the surface of the head. The container is sealed by heating the neck portion 36 thereof until it is soft and then pinching in the neck into sealing engagement with the riser as shown at 37. Preferably the riser is indented as at 38 to form a better seal between the aluminum and the glass.

Figure 7 also illustrates a condenser in which the cathode 15 is supported from a cap similar to cap 13 secured to the upper part of a container 10, the container being provided with an internal sprayed surface 19 as before and having a threaded neck portion 36 closed by an aluminum cap 39 which functions as the anode terminal as it contacts with the sprayed surface which is continued through the neck and around the exterior of the end of the neck 36 as at 40. The cap 39, and similarly the cap 30 and 31 may be provided with terminal wires 41, if desired.

In Figures 8 and 9 I have illustrated a form of my invention in which the container 45 is preferably formed of molded hard rubber or of various moldable synthetic resins such as urea formaldehyde resins. Other readily moldable insulating materials can be employed so long as they are inert to the electrolyte. If hard rubber is used it should have a low sulphur content. In this modification the anode surface area is greatly increased by employing an insert 46 of cloth or aluminum wire gauze provided with a plurality of inwardly extending fins 47 as illustrated particularly in Figure 9. This insert is placed within a container 45 and then sprayed with molten aluminum or film forming material to form the

anode surfaces 48, the sprayed aluminum also functioning to hold the fabric in place within the container and to stiffen the fabric so that it will retain its shape in use. The upper end of the container is closed by a cap 49 provided with a suitable vent 50 and having a flange portion spun downwardly as at 51 into engagement with the beaded upper edge 52 of the container, this being the type of cap preferably employed with the modifications of my invention shown in Figures 4 and 5. In this form the terminal for the sprayed anode surfaces 48 preferably consists of a wire 53 molded into the neck portion 54 of the container and extending into contact with the sprayed areas 48 while the cathode may comprise a rod 55 provided with an enlarged portion 56 and also molded into the neck 54. The enlarged portion serves to prevent the cathode from being displaced with relation to the neck 54 and also assists in preventing leakage of the electrolyte around the cathode. As before, the sprayed surfaces terminate preferably below the level of the electrolyte 21, and also the central portion 57 of the lower surface of the container is not sprayed so that there will be no possibility of a short circuit taking place between the cathode and the anode.

In Figures 10 and 11 the container 60 for the electrolyte is formed of steel or other ferrous material, the entire inner surface of the container and the neck portion 61 thereof being coated with porcelain enamel or other suitable vitreous insulating material to prevent contact between the electrolyte and the metal of the container. Thereafter the inner surface of the container is provided with the sprayed metallic surface 19 constituting the anode. The layer of enamel 62 and the sprayed layer 19 are indicated on an enlarged scale and with the thickness of the layers greatly exaggerated in Figure 11a.

In this modification the container 60 may be corrugated as shown particularly in Figure 11 in order to increase its area and to obtain a further increase in anode area, steel fins 63 may be welded to the interior surface thereof, the fins being enamelled and then sprayed with the anode layer 19. The neck portion 61 may be sealed in the manner described with relation to Figure 4; that is a rubber grommet 26 may be inserted within the neck to support the cathode 27 and may be retained in position by the aluminum cap 30 threaded onto the neck 61 and making contact with the sprayed surface which is continued through the neck and around to the radial end surfaces of the neck as at 64.

In the modification illustrated in Figures 12, 13 and 14, the anode and cathode both are formed of molded insulating material, preferably a ceramic material such as porcelain, or rubber or various synthetic resins. In this form of my invention the container for electrolyte comprises a molded female member 70 having inwardly extending projections 71 to increase the internal area thereof and having a flanged and shouldered upper portion 72. The container receives a similarly shaped male member 73 which extends downwardly therein in such a manner that the surfaces of the members 70 and 73 are closely spaced but do not touch. The adjacent surfaces of both members are sprayed as at 74 and 75 preferably with aluminum to form the anode and cathode. Ordinarily the male member will constitute the cathode but if desired the surfaces of the male member may be formed with a dielectric film and the male member may be employed as the anode. If the condenser is intended for use in an alternating current circuit both sprayed surfaces 74 and 75 may be provided with dielectric films. The spaces between the electrode surfaces 74 and 75 may be filled with any suitable electrolyte of either the liquid or paste type.

The two members may be retained in position by screws 76 and 77 engaging lugs 77, 78, 79, and 80 formed in the male and female members, respectively. To provide terminals for connecting the sprayed surfaces to external electrical circuits the sprayed surface 74 on the female member may be continued upwardly adjacent the screw 76 as indicated at 81 the sprayed material preferably being carried through the opening through which the screw passes and under the head of the screw as indicated at 82. As shown in Figure 14 the sprayed surface 75 on the male member 73 is stopped adjacent the sprayed area 78 but is carried upwardly as at 82 adjacent the opposite screw 77 and this sprayed surface is continued through the opening in the lug 77 and extended to beneath the securing nut as indicated at 83. On this side the sprayed area of the female member 70 is terminated at 85 to prevent short circuits from occurring. By this construction the effective areas of both the anode and cathode of the condenser may be made very large and thus a very efficient and compact condenser is obtained. If a liquid electrolyte is employed a vent may be formed by a passageway 86 extending from a point above the level of the electrolyte to the upper surface of the male member 73 and there provided with any suitable vent 87.

The modification shown in Figures 15, 16 and 17 also embodies male and female forms 90 and 91 respectively, preferably made of ceramic material or other suitable insulating material. The female form is preferably generally rectangular in shape and has side walls 92 and end walls 93 and a plurality of tapered fins 94 projecting upwardly from the base 95 and extending between the side walls 92. The male member 90 which forms a closure for the female member has a flat upper portion 97 and downwardly projecting fins 98 which extend between the fins 94 of the member 91. The adjacent surfaces of both members are spaced apart as shown and the surfaces of the male and female members are provided with sprayed coatings 99 and 100, respectively. In conjunction with this type of condenser a paste electrolyte is preferably used, the porous sprayed surfaces being impregnated with the electrolyte. A very satisfactory electrolyte is disclosed in my prior Patent No. 2,095,966 patented October 19, 1937.

The male and female members may be held together by screws 101 and 102, a rubber sealing gasket 103 being disposed between the adjacent flat surfaces of the members. These screws may be employed as terminals or if desired the connections from the anode and cathode may be made by means of tabs 104 and 105. In either event the sprayed surface on the member 90 is preferably extended to the region adjacent the screw 101 as indicated at 106 while the sprayed surface on the female member 91 is stopped short in this area. At the other end of the condenser the sprayed surface on the female member is extended as at 107 while the adjacent area of the male member is not sprayed. Contact is made between the sprayed areas 106, 107, the screws 101, 102 and tabs 104 and 105, respectively. The

condenser may be completely sealed and is of rigid construction so that no case or cover is required. In this type of condenser either the male or female member may be the anode the other member serving as the cathode in case of a condenser intended for service on direct current or if the condenser is intended for alternating current service, both sprayed surfaces may be formed with dielectric films in the manner described with reference to Figures 1 to 3.

In Figures 18, 19 and 20 I have illustrated another paste type condenser in which the surfaces of the electrodes are formed by spray deposited material on forms of porcelain or other insulating material preferably with interleaved sprayed cloth electrodes disposed between the forms. The condenser may comprise two generally similar porcelain forms 110 and 111 having their adjacent surfaces corrugated as shown at 112 and 113, respectively, in order to increase the area thereof. These surfaces are sprayed with aluminum or other suitable film forming material and constitute the electrodes of the condenser. Disposed between the sprayed surfaces 112 and 113 are interleaved condenser elements comprising spacer members 114 and further electrode elements 115 and 116. The elements 115 and 116 preferably consist of cloth sprayed with molten aluminum in the manner disclosed and claimed in my copending application Serial No. 158,105 filed August 9, 1937, the member 115 being of the same polarity as the sprayed surfaces formed on member 110 while the elements 116 is of the same polarity as the sprayed surfaces formed on member 111. This produces a construction in which condenser plates of opposite polarity are interleaved and separated by insulating spacers.

The terminal connections may be made by extending the sprayed surface 113 to the region 117 adjacent the screw 118 and similarly extending the sprayed cloth 116 to the region adjacent the screw as at 119. The spacers are stopped short adjacent shoulder 120 and the sprayed area 112 is also being stopped to prevent short circuits from occurring. At the other end of the condenser the sprayed surface 112 is extended as indicated at 121 to the region adjacent screw 122 while the sprayed cloth 115 is similarly extended as indicated at 123, the remaining condenser elements are stopped adjacent the shoulder 124 of the member 110. Connections may be made to external circuits either through screws 118 or 122 or by tabs 125 and 126 which are clamped into engagement with the adjacent sprayed surfaces by the screws 118 and 122.

This type of condenser may be impregnated with a suitable paste type of electrolyte such as that described in my patent above referred to, the electrolyte permeating the interstices of the porous spaced material surfaces so that a very great capacity can be obtained in a compact condenser. After the formation of the dielectric film has been completed and after the condenser has been impregnated with electrolyte it may be sealed merely by dipping the assembled elements in a suitable wax composition, rubber or other synthetic resins.

In every modification, I preferably circulate the electrolyte during the operation of forming the dielectric films on the sprayed surfaces to insure proper formation of the film throughout the area of the sprayed particles. Also, in each example, the electrolyte used in the condensers permeates and impregnates the sprayed surfaces so that the effective anode area, and correspondingly the capacity of the condensers is very large as compared to the size of the electrodes. By reason of the great capacity per unit of urea of my anodes, my condensers can be made in very compact form thus reducing the resistance and power factor losses of the condensers. The various material of which the condensers are preferably made are very inexpensive. Relatively small quantities of aluminum or other film forming materials are required and the manufacturing operations are very simple. Therefore condensers made according to my invention can be manufactured at very low cost.

In the foregoing specification I have described the several forms of my invention particularly as applied to electrolytic condensers. Various changes and modifications of my invention will be apparent to those skilled in the art and it will be evident that my invention can be adapted to other types of electrolytic devices all without departing from the teachings thereof. Therefore it is to be understood that my patent is not limited to the forms of my invention described herein or in any manner other than by the scope of the appended claims.

I claim:

1. In an electrolytic condenser, a closed container formed of insulating material and having an electrolytic solution therein, said container having its inner surface coated with a material forming a filming anode, a terminal fixed in one end of said container and in connection with said coating, the other end of said container including a conductor of electricity insulated from said coating, and a cathode extending from said conductor of electricity into said container.

2. An electrolytic condenser, comprising, a container formed of glass and having its internal surface coated with a film of material forming an anode, said container having an electrolyte therein, and a cathode supported in said electrolyte and insulated from said film of material.

3. In an electrolytic condenser, a container formed of insulating material and having a roughened inner surface and coated with a material forming an anode, said container having an electrolyte therein, and a cathode in said container insulated from said coating.

4. In an electrolytic condenser, a sealed container formed of glass or the like and having an electrolyte therein and having its inner surface coated with aluminum, a cathode suspended in said electrolyte and insulated from said coating.

5. An electrolytic condenser, comprising, a container formed of insulating material and having a plurality of corrugations in its walls providing increased internal and external area, the inner surface of said container coated with a film of material forming an anode, said container having an electrolyte therein, a cathode mounted in said container, and means for closing said container.

6. An electrolytic condenser, comprising, a container for an electrolyte formed of insulating material, having a multiplicity of fins formed on its inner surface for providing greater area therefor, said inner surface coated with a film of material forming an anode, and a cathode mounted adjacent said film.

7. An electrolytic condenser, comprising, a container formed of insulating material having a coating on its inner wall formed of a material constituting an anode, said container having an electrolyte therein and having a cap closing said open end, a cathode suspended from said cap

within said container and spaced therefrom, and an electrical connection to said coating at the closed end of said container.

8. An electrolytic condenser, comprising a molded container formed of insulating material and having a closed end and having a film of material on its inner surface forming an anode, a terminal molded in said closed end in engagement with said film, and a cathode disposed in said container having an electrical connection thereto, said container having an electrolyte therein.

9. An electrolytic condenser, comprising, a cylindrical container formed of insulating material closed at its ends and having an electrolyte solution therein, the internal wall of said container being coated with material forming a filming anode, one end of said container having a terminal projecting therefrom having engagement with said coating, and a cathode extended from the other end of said container into the container, said coating terminating short of the end of the container from which the cathode projects.

10. An electrolytic device comprising a container for electrolyte formed of insulating material and having an internal conductive surface of finely divided cohering metallic particles constituting one electrode of the device and provided with a dielectric film, an electrolyte within the container and in contact with said surface and another electrode insulated from said surface and immersed in said electrolyte.

11. An electrolytic device comprising a container for electrolyte having an internal surface composed of minute cohering particles of film forming material constituting the anode of the device and having a dielectric film formed on the surface of the particles and conforming thereto, an electrolyte within the container and a cathode supported within said container and insulated from said internal surface.

12. An electrolytic device comprising a container for electrolyte formed of insulating material having deposited on the internal surface thereof a great number of minute particles of film forming material cohering to each other to form a porous conductive layer constituting the anode of the device and having a dielectric film formed thereon coextensive with the irregularities of the porous surface thereof whereby the conductive surface area of the film is many times more than the internal area of said container, and another electrode insulated from said surface and supported within said container.

13. An electrolytic device comprising a container for electrolyte formed of insulating material and having an internal surface composed of a great number of minute particles of film forming material deposited thereon to form a porous layer, said surface being conductive throughout its area and extending to the exterior of the container to provide an electrical connection with an external circuit, an electrolyte within the container and in contact with said surface and another electrode insulated from the surfaces and immersed in said electrolyte.

14. An electrolytic condenser comprising a container for electrolyte formed of ferrous material having its interior surfaces coated with an insulating layer of vitreous material fused thereon, and at least part of the area of said layer being provided with a conductive metallic surface constituting one electrode of the condenser.

15. An electrolytic condenser comprising a container for electrolyte formed of ferrous material and having a plurality of inwardly extending fins secured within the container, the inner surfaces of the container and the surfaces of said fins being coated with an insulating layer of fused vitreous material, and a conductive layer of finely divided particles of film forming material deposited on said layer of vitreous material covering the greater portion of the area thereof and constituting the anode of the condenser.

16. An electrolytic condenser comprising a female member having an internal surface of insulating material provided with a conductive layer of finely divided metallic particles adhering thereto and constituting one electrode of the condenser, a male member extending within the female member and having an external surface of insulating material and having a conductive layer of finely divided metallic particles adhering thereto and constituting another electrode, said layers being spaced apart, and at least one of said layers being composed of film forming material and formed with a dielectric film.

17. An electrolytic condenser comprising two complementary forms of ceramic material having spaced, juxtaposed surfaces coated with conductive layers of finely divided particles of film forming material, at least one of said layers being formed with a dielectric film, and a film maintaining electrolyte disposed in the space between said surfaces and in contact with said layers.

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