

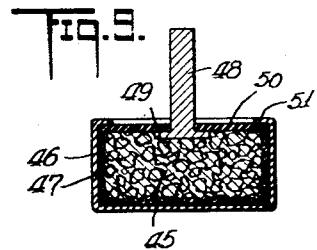
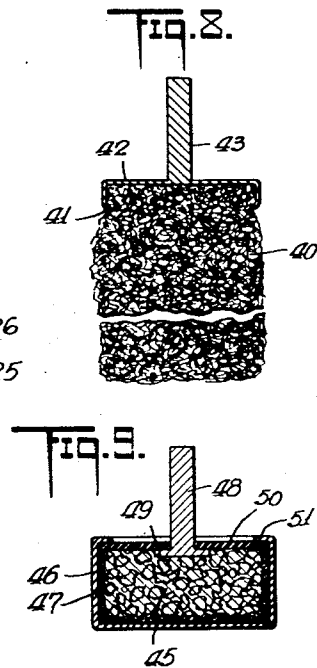
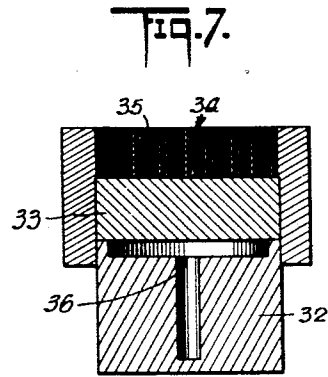
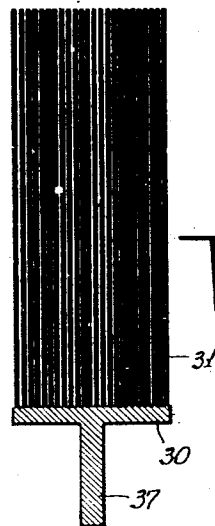
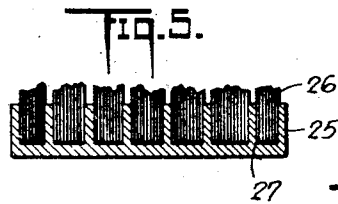
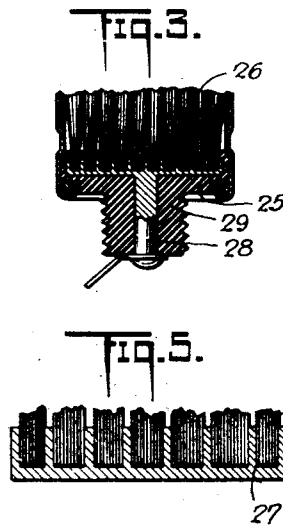
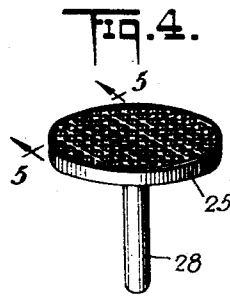
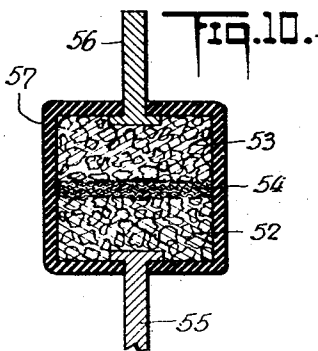
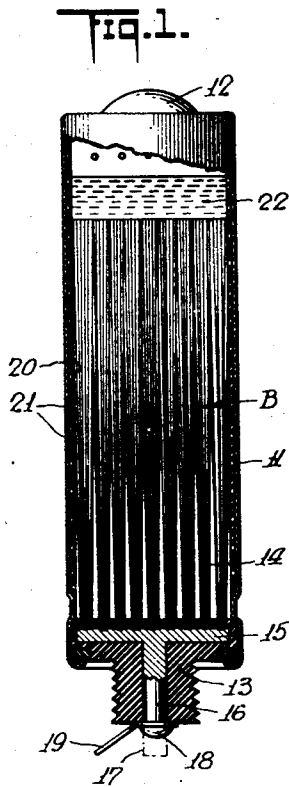
Oct. 20, 1942.

H. WATERMAN

2,299,667

ELECTROLIC CELL

Filed Oct. 25, 1939



INVENTOR  
Herbert Waterman  
BY  
Dean Fairbank & Hirsch  
ATTORNEYS

## UNITED STATES PATENT OFFICE

2,299,667

## ELECTROLYTIC CELL

Herbert Waterman, New Bedford, Mass., assignor  
to Aerovox Corporation, New Bedford, Mass., a  
corporation of New York

Application October 25, 1939, Serial No. 301,181

2 Claims. (Cl. 175—315)

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

Among the objects of the invention are to provide an electrolytic condenser of compact and rugged structure and yet obviating the use of the relatively expensive, refined aluminum foil and the processing of such foil for increased surface area.

According to the invention the structure of the formed electrode or electrodes is a capillary body of film forming metal ordinarily of aluminum, which presents a tremendous internal capillary area that is film formed and also readily impregnated with electrolyte.

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

Fig. 1 is a view in longitudinal cross-section of one embodiment of the invention,

Fig. 2 is a perspective view of the riser head with the wires therein,

Fig. 3 is a fragmentary view in longitudinal cross-section indicating an alternative structure of anode mount,

Fig. 4 is a perspective view of the riser of Fig. 3 prior to application of the wire structure,

Fig. 5 is a fragmentary sectional view on a greatly enlarged scale illustrating the method of connection of the wires to the riser head in the embodiment of Fig. 3, and taken on line 5—5 of Fig. 4,

Fig. 6 is a side elevation of the anode and riser structure of a further embodiment.

Fig. 7 is a more or less diagrammatic cross-sectional view illustrating the method of producing the anode structure shown in the embodiment of Fig. 6,

Fig. 8 is a view in longitudinal cross-section of a further construction of anode,

Fig. 9 is a view in longitudinal cross-section of an alternative form of condenser structure, and

Fig. 10 is a view similar to Fig. 9 of another embodiment thereof.

Referring now to Figs. 1 and 2 of the drawing there is shown an electrolytic condenser of the wet type illustratively comprising a cylindrical can 11 with a suitably vented closure 12 of any appropriate construction at one end thereof and an insulating mounting structure, illustratively with a screw nipple 13 at the opposite end. The condenser can and its mount are not per se claimed herein. Any known construction illus-

tratively that of the prior patent to H. E. Rhodes No. 2,163,262, of June 20, 1939, will serve.

The invention in the aspect pertinent to the present embodiment is concerned with the anode structure. In the embodiment shown, the anode consists of a capillary structure, in this particular embodiment a bundle B of fine generally parallel wires 14 of film forming metal, ordinarily aluminum. The wire bundle and its constituent wires are film-formed. The area of film is the combined surface area of the multiplicity of wires making up the bundle B. The film is thus of tremendous area for a given volume and therefore affords a correspondingly tremendous capacity. The individual wires 14 in the present embodiment are desirably aluminum, soldered to an aluminum riser plate 15, the rod-like end 16 of which extends through the closure plug 13 for terminal connection.

Preferably a body of molded resin such as "Bakelite," completely embeds the riser plate 15 and the associated ends of the wires 14 and desirably also is molded as a unit with the screw mount 13 as shown in the drawings. Ordinarily the end of the riser rod 16 will be permitted to protrude from the molded plug 13 as shown in dash lines at 17 and is subsequently headed over as at 18 for attachment of the terminal lug 19. Desirably an insulating liner sleeve 20 perforated as at 21 is disposed within the can and prevents any short circuiting tendency.

The electrolyte 22 may be of type conventional in so-called wet electrolytic condensers, ordinarily an aqueous solution of boric acid and sodium borate and it completely submerges the anode wire bundle B as shown. The capillary nature of the wire unit permits the electrolyte readily to impregnate the brush structure thereof and to come into intimate engagement with the surfaces of the individual bristles or wires, so that the full capacity comes into play. If desired the can 11 which serves as a cathode may be of etched material for enhanced cathode surface.

By reason of the very high capacity per unit volume attained with the use of the anode structure set forth, it will be seen that for a condenser of given capacity and given length the diameter may be reduced as compared with conventional constructions. Accordingly the distance from a wire at the center of the bundle to the inner surface of the can is not more than and in fact slightly less than half the internal diameter of the can. The major portion of the formed wire surface is near the outer periphery of the

bundle and is therefore much nearer to the surface of the can. The mean distance between formed anode surface and interior cathode surface is probably in the order of less than 10% of the can diameter. As a consequence the condenser, with the use of a given electrolyte has a better power factor than a corresponding condenser of larger diameter and in which the mean distance of anode from can is absolutely and relatively considerably greater than in to the present construction.

In the embodiments of Figs. 3 to 5, the anode riser has a deeply gridded head 25 lodging the ends of the individual bundles 26 of aluminum wires the said riser head being swaged together for securely retaining such wires in mechanical and electrical contact with the plate. As best shown in the exaggerated view of Fig. 5, the grid end of the riser head has a multiplicity of relatively deep sockets 27 in each of which a small bundle 26 of the wires is mounted and affixed, by swaging the head. As shown in this embodiment the riser head is provided with the unitary rod 28 about which is slipped and affixed in conventional manner the insulating mounting plug 29.

In the embodiment of Fig. 6 the anode is shown with an aluminum riser head 30 having as integral parts thereof, the bundle 31 of substantially parallel aluminum wires. The anode of Fig. 6 is made by the method diagrammatically indicated in Fig. 7. As shown in this embodiment a plunger 32 mounting a slug 33 of aluminum of thickness greater than the riser head pushes the latter through a hardened die 34 having minute perforations 35 therethrough of diameter corresponding to that of the wire to be extruded. The plunger 32 has a depression 36 corresponding to the head 30 and associated riser rod 37. Accordingly, under hydraulic pressure a part of the thickness of the slug 33 will be extruded to form the wires 31 and the residual slug will be shaped to form the head 30 and rod 37.

In the embodiment of Fig. 8, aluminum wool of the character described in Ohmann Berichte, volume 45, page 2973 (1912), is employed. This wool is in physical appearance generally similar to steel wool which is a familiar article of commerce. The aluminum wool is of relatively fine texture and is packed into a bundle 40 retained by the inwardly crimped rim 41 of a cup-shaped clamp 42 formed integral with the riser rod 43. The wire wool is film formed and may be used in place of the structures shown in Figs. 1 to 6 inclusive.

In Figs. 9 and 10 are shown embodiments in which instead of resort to filaments of metal for building up the capillary electrode structure, the film forming metal is in the form of a block of sponge aluminum or other film forming metal. Sponge aluminum may be produced by any of a variety of familiar procedures known to those skilled in the art. Among the methods of producing it are the absorption of large volumes of gas under pressure by liquefied aluminum followed by the sudden release of pressure just prior to solidification. Alternatively aluminum gran-

ulated by any well known method may be sintered together. Other suitable methods of producing sponge aluminum are disclosed in British Patent 217,465 to Kalsamori, accepted August 13, 1923.

The block of sponge aluminum made by any of the various known methods presents a large internal capillary surface area which may be readily film formed. Desirably electrolyte may be forced under high pressure to course as a stream through the sponge aluminum, completely to impregnate the interstices thereof and to eject any air therefrom.

In the embodiment of Fig. 9 the sponge aluminum block 45 made by any of the methods disclosed, is lodged with little or no clearance in a metal container 46 preferably lined as at 47 in manner similar to the showing of Fig. 1. A terminal stud 48 at the otherwise free surface of the anode block is in effective contact therewith as for instance by a head 49 and protrudes through the insulating cover 50, over which the rim 51 of the container 46 is crimped. The anode block impregnated with electrolyte as described substantially fills the container 46 all of the interstices of which are desirably charged with electrolyte.

The embodiment of Fig. 10 is particularly suitable on alternating current. Here both electrodes 52 and 53 are formed blocks of capillary aluminum such as shown in Fig. 9. Interposed between these blocks is a layer 54 of porous insulating material which is impregnated with electrolyte as are the two aluminum blocks. Terminals 55 and 56 are connected to the respective blocks and protrude through an insulating casing 57 preferably molded about the contents.

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 of the claims, 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 is:

1. An anode unit for an electrolytic cell comprising a multiplicity of substantially parallel fine aluminum wires, presenting a capillary bundle, each wire having a film coating thereon, an aluminum riser head to which electrical contact with one end of the bundle is made, and a molded resin block embedding the contiguous ends of the wire bundle and the head.

2. An anode for electrolytic condensers comprising a riser head of aluminum with a grid bottom, a bundle of fine aluminum wire, the ends of which are lodged and swaged in the depressions making up said grid for secure mechanical and electrical connection with the riser, the individual wires having film formation thereon and the bundle presenting a capillary structure and being adapted to be impregnated by electrolyte.

HERBERT WATERMAN.