To all whom it may concern:

Be it known that I, RALPH D. MERSHON, a citizen of the United States of America, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Electrolytic Apparatus Having Filmed Electrodes, of which the following is a full, clear, and exact description.

In electrolytic apparatus such as condensers, rectifiers, and lightning arresters, the operation of the device depends upon the dielectric film which is formed upon the electrodes (usually composed of aluminum) when current is impressed thereon, and the continuance of high efficiency in the performance of the apparatus depends largely upon the preservation of the film substantially unimpaired. Moreover, unchecked impairment of the film at any point results in more or less rapid corrosion, and ultimate destruction, of the underlying electrode, and it has been found that at the boundaries of areas where the film is not in contact with the electrolyte the film deteriorates, with accompanying loss of efficiency and corrosion of the electrodes. Consequently any devices employed to support the electrodes (or anodes, as they may be conveniently termed) should be rounded, pointed or knife-edged so as to reduce to the minimum the areas of contact with the film, as explained in the prior patent of John S. Riddle and myself, No. 1,385,305. Even the presence of a bubble of air or gas adhering to the submerged film is sufficient to permit the film and the electrode to be attacked at the edge of the comparatively small area covered by the bubble. Bubbles thus become an important factor in the operation of the apparatus, in addition to the fact that they increase the internal resistance. It is therefore desirable to have the electrolyte in a state of motion or agitation to detach the bubbles and permit them to rise to the surface, as explained in my co-pending application, Serial No. 324,518; filed September 18, 1919; and when the anodes are deeply crimped or corrugated the movement or agitation should extend well into the folds of the anode since in these spaces the bubbles cover larger areas of the filmed surface and are therefore more injurious and are more difficult to dislodge.

My present invention relates to the above features, and its chief object is to provide an electrolytic apparatus in which the anodes are supported and spaced apart, with line or point contact, by devices which hold the anodes effectively and also fill the spaces between the same so that, without materially it at all obstructing the flow of current through the electrolyte, the liquid can easily be circulated or agitated in the folds or crimps of the anodes. To this and other ends the invention consists in the novel features and combinations hereinafter described.

In carrying out the invention in the preferred manner, I provide a rectangular frame or cage having horizontal members embracing the anodes on four sides, and transverse upper and lower members engaging the anodes at their top and bottom edges. These members have knife-edge or rounded ribs so that such contact as they have with the anodes will be along narrow lines or points. Between the anodes, to space them apart, I employ means which may take a great variety of forms. For instance, I may use plates of glass or other suitable non-conducting or insulating material unattacked by the electrolyte, as hard rubber, lavite, etc., having numerous slits or other perforations to permit flow of current therethrough; or sheets of woven fabric, preferably mineral in character, as glass cloth, or I may use solid rods, or tubes or beads strung on wires. An excellent method is to embed the entire “assembly” of anodes, supporting cage and all, in a loose mass of small cylinders or balls, or cylindrical or spherical beads, large enough to prevent entrance into the folds or crimps of the anodes. A still better method is to use apertured discs or “washers”. The latter devices preferably have flat surfaces, so that they will at most make line contact with the rounded bends of the folds or crimps.

Referring to the accompanying drawings:

Fig. 1 is a perspective view, partly in section, showing the preferred form of anode. This type is claimed separately in my co-pending application, Serial No. 158,146, now Patent No. 1,326,134.

Fig. 2 is a perspective view, partly in section, showing the preferred form of supporting cage.

Fig. 3 is a vertical section across the supporting cage, showing anodes spaced apart by means of rings, flat discs, or “washers.”
Fig. 4 is a section on line 4-4 of Fig. 3. Fig. 5 is a horizontal section on line 5-5 of Fig. 3.

Fig. 6 is a longitudinal vertical section of a condenser in which the anodes and supporting cage are embedded in small balls or beads.

Fig. 7 is a detail section showing the anodes spaced apart by beads strung on wires and by tubes and rods.

Fig. 8 is a detail sectional view showing beads strung on a wire to serve as a spacing device.

Fig. 9 is a detail sectional view showing perforated plates and sheets of woven fabric as separating devices.

Fig. 10 is a sectional view, somewhat diagrammatic in character, illustrating a simple pump as the preferred means for producing the desired movement or circulation of the electrolyte.

Fig. 11 is a diagrammatic sectional view illustrating means for injecting air into the electrolyte to produce the effect of boiling.

Fig. 12 is a diagram showing the preferred method of exciting the condenser by means of uni-directional current.

The electrode or anode illustrated in Fig. 1 comprises a sheet or strip of thin sheet metal, usually aluminum, which is folded or crimped to form deep corrugations or folds. The walls of the folds are parallel to each other, but the ends are rounded, as clearly shown in Fig. 5. At top and bottom the plate is grooved across the folds to receive the upper and lower stiffening members 11, 12, connected at their ends to vertical angle members 13, also preferably of aluminum. The two vertical and the two horizontal members thus constitute a frame which serves to give the crimped plate the necessary mechanical strength. The lower member or stiffener is preferably L-shaped in cross section, and the upper may also but is preferably shaped as illustrated. The bends of the sheet metal preferably have perforations or slits, as indicated at 10. It will be understood that for the best results the anodes should be arranged with their folds or crimps vertical. The crimped or corrugated plates preferably have welded connection with the upper members 11, as described in my Patent No. 1,326,134, before mentioned, to which reference may be had for a complete explanation.

For use in an electrolytic condenser any suitable number of anodes are arranged side by side. To confine them in position, I provide a frame or cage, preferably such as is shown in Fig. 2, composed, for example, of vertical members 15, horizontal end or transverse members 16 and longitudinal or side members 17, and transverse upper and lower members 18, 19. The members 16, 17, 18 and 19 are faced on the inside with strips of glass, hard rubber, lavite or other suitable insulating material, provided with rounded ribs, as indicated at 20, so that they will touch the anodes in lines or points, as illustrated in Fig. 3. It will of course be understood that upper members 18 are not put in place and fastened to the uprights 15 until the anodes are loaded in the frame.

For spacing the anodes apart I prefer to use flat insulating rings or "washers" 21, 22, 23, 41, 45, 46, in which case the anodes are assembled as follows: the frame or cage is placed on its side and an anode is laid in position. The surface of the anode is then covered with washers, and on top of these is laid another anode, followed by another layer of washers, and so on until the cage is full. The cage can then be righted and the top members 18 fastened in place. Preferably the flanges on the lower and side stiffeners 12, 13, are wide enough to overhang the crimped plates by an amount equal to the thickness of the washers, as clearly indicated in Figs. 3, 4 and 5, in which case each layer of washers is boxed in or confined at the sides and bottom at least so that none can be displaced.

Instead of rings or washers various other means can be used for holding the anodes apart. For example, I may use tubes 22, or solid rods 23, Fig. 7, or beads 24 strung on wire 25, Figs. 7 and 8. In these cases the cage can be loaded in the manner described in connection with the washers. If long rods or tubes are used, some or all of them should be bent or curved to provide spaces for the flow of current through the electrolyte. Still another method of spacing the anodes is to embed the whole assembly (by which I mean anodes and the cage confining the same) in insulating balls or beads. In this method the anodes are spaced apart temporarily by means of narrow strips (not shown) and the loaded cage is then placed in the vessel, as 26, Fig. 6, which is to contain the electrolyte. The beads or balls 27 are then sifted into the vessel until the spaces, between the anodes and around and inside the cage, are filled, after which the temporary spacing strips can be drawn out and the electrolyte (not shown) can be poured in.

Still another method is to use perforated plates of suitable insulating material, preferably glass, as 28, Fig. 9, or sheets of woven glass fabric, as 29.

In all the above cases the confining and separating devices have only point or line contact with the anodes and the spaces between the latter are filled with bodies which obstruct upward movement of the electrolyte in such spaces and hence compel the movement or flow to take place in the folds of the anodes. This movement of the liquid can be produced in various ways. For ex-
ample, the heat resulting from losses in the apparatus may produce more or less vigorous convection currents or may even be allowed to boil the liquid, or a pump may be used for the purpose. In the latter case the tank may be provided with a well 30, Fig. 10, having a discharge opening 31 at the bottom and an intake opening 32 at the top. An impeller 33 in the well, driven by any suitable means, not shown, drives the water downwardly through the well or passage and up through the anode-assembly (represented by the broken lines at 34) as indicated by the arrows. It is also possible to produce the desired circulation by the "thermo-siphon" principle, especially if the descending leg of the siphon be kept cool, so as to increase the temperature differential. To increase the agitation, air may be introduced into the current, as by means of a pipe 35. The air thus drawn in by the suction of the flowing liquid breaks up into bubbles which produce the effect of ebullition, and coming in contact with gas or air bubbles on the anodes tend to coalesce therewith and drag them off or make them large enough to float off. Another method is to inject air under pressure into the liquid at the bottom of the tank. For this purpose a series of horizontal discharge pipes 36, Fig. 11, perforated along their tops and connected to a manifold 37 may be provided, the manifold being connected with any suitable source of air under sufficient pressure.

If the condenser is to be excited by unidirectional current the exciting current may be led in by a suitable cathode, as 38, Fig. 2, composed of carbon, nickel, or other conducting material, which does not take on a dielectric film when current is impressed on the apparatus. The exciting system is preferably arranged as indicated diagrammatically in Fig. 12, in which 39 designates a condenser having anodes 40 connected to terminals 41 for connection with the external circuit. The cathode 38 is connected to the negative pole of a source of direct current 42 of which the positive pole is connected to the neutral point of a balance coil or auto-transformer 43 across the main leads. The connection of the source 42 to the balance coil may be shifted, as explained in my co-pending application, Serial No. 328,467, filed October 4, 1919, if due to any unbalancing of the condenser the position of the neutral point be changed.

It is to be understood that the invention is not limited to the specific construction illustrated and described but can be embodied in other forms without departure from its spirit.

I claim:

1. In an electrolytic apparatus of the kind described, a plurality of filmed anodes arranged side by side, a supporting cage enclosing the anodes and having supporting members of insulating material constructed and arranged to engage the anodes at points of small area, and a plurality of relatively small devices of insulating material loosely held between the anodes to space the same apart and adapted to touch the filmed surfaces of the anodes on small areas only.

2. In an electrolytic apparatus of the kind described, a plurality of filmed anodes arranged side by side, each comprising a crimped or corrugated plate or sheet and a rigid supporting frame within which the plate or sheet is mounted; a supporting cage enclosing the anodes and engaging only the supporting frames thereof; and a plurality of relatively small devices of insulating material loosely held between the anodes to space the same apart and adapted to touch the filmed surfaces of the anodes on small areas only.

3. In an electrolytic apparatus of the kind described, a plurality of filmed anodes each composed of a crimped or corrugated plate of thin sheet metal and a rigid supporting frame within which the plate is mounted, said frame having members provided with flanges extending over the spaces between the anodes; supporting means enclosing the plurality of anodes; and relatively small devices of insulating material loosely held between the anodes to space the same apart and retained between the anodes by the flanges of the anode-supporting frames.

4. In an electrolytic apparatus of the kind described, a plurality of filmed anodes arranged side by side, each composed of a crimped or corrugated plate or sheet and a rigid supporting frame within which the plate or sheet is mounted; supporting means enclosing the plurality of anodes; and a plurality of apertured discs or washers of insulating material, loosely held between the anodes to space the same apart in said supporting means.

5. In an electrolytic apparatus of the kind described, a plurality of filmed anodes each composed of a crimped or corrugated plate or sheet and a rigid supporting frame within which the plate or sheet is mounted, said frame having members provided with flanges extending over the spaces between the anodes; supporting means enclosing the plurality of anodes; and a plurality of apertured discs or washers of insulating material between the anodes to space the same apart and retained between the same by the flanges of the anode-supporting frames.

6. In an electrolytic apparatus of the kind described, a plurality of filmed anodes each composed of a crimped or corrugated plate or sheet and a rigid supporting frame within which the plate or sheet is mounted; rigid supporting means enclosing the plurality of anodes; and a plurality of rela-
tively small devices of insulating material loosely held between the anodes to space the same apart and touching the filmed surfaces thereof on small areas only.

7. In an electrolytic apparatus of the kind described, a plurality of filmed anodes comprising crimped or corrugated plates or sheets; supporting means enclosing the plurality of anodes; and devices of insulating material arranged between the anodes to space the same apart, and substantially filling the spaces between the anodes whereby liquid currents in the electrolyte parallel to the folds or crimps of the anodes are compelled to flow in the folds or crimps.

8. In an electrolytic apparatus of the kind described, a plurality of filmed anodes each comprising a crimped or corrugated plate or sheet, and devices of insulating material arranged between the anodes to space the same apart and substantially filling the spaces between the same but having openings for the flow of current from anode to anode through the electrolyte and leaving the spaces between the folds of the anodes unobstructed.

9. In an electrolytic apparatus of the kind described, a plurality of filmed anodes arranged side by side; a supporting cage enclosing the plurality of anodes, composed of horizontal and vertical members and strips of insulating material carried thereby, having ribs adapted to engage the anodes on small areas; and spacing devices between the anodes and within said supporting frame, said devices substantially filling the spaces between the anodes but having openings for the flow of current from anode to anode through the electrolyte and leaving the spaces between the folds of the anodes unobstructed.

10. In an electrolytic apparatus of the kind described, a plurality of filmed anodes, means for supporting the same in an electrolyte, and devices between the anodes substantially filling the spaces between the same whereby liquid currents in the electrolyte are kept close to the surface of the anodes.

11. In an electrolytic apparatus of the kind described, a plurality of filmed anodes arranged side by side but spaced apart, each comprising a crimped or corrugated plate of sheet metal; and a plurality of apertured discs or washers loosely held between the anodes to hold the same apart and substantially filling the spaces between the anodes.

In testimony whereof I hereunto affix my signature.

RALPH D. MERSHON.