Dec. 5, 1933. P. ROBINSON 1,938,464

ELECTROLYTIC DEVICE

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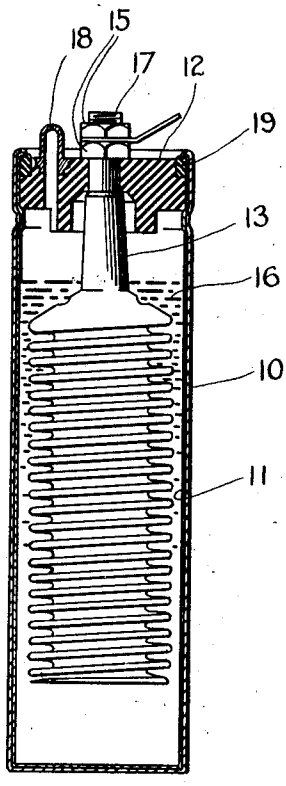
Fig. 1.



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ELECTROLYTIC DEVICE

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19 Claims. (Cl. 175—315)

My invention relates to electrolytic devices, such as electrolytic condensers, rectifiers or the like, comprising film-forming electrodes.

In such devices, use is made of the film-forming effect exhibited by certain metals as aluminum, tantalum, etc., which, when placed in suitable electrolytes, upon application of the proper voltage, are covered with a film. Such films consist of partially hydrated aluminum oxide and are of a unidirectional character.

I shall describe my invention in its application to electrolytic condensers and more particularly to condensers having aluminum electrodes and being used in filter circuits to eliminate the alternating current ripples from rectified currents. However, it should be well understood that my invention is not limited to such devices and applications.

When electrolytic condensers are used for the above stated purpose, only one of the electrodes, namely, the anode, is required to be of film-forming metal. The cathode which, as a rule, also forms the container of the condenser is usually made of a metal which does not exhibit film-formation, or at least not to a marked extent. Such metals—for instance—copper or nickel, are as a rule referred to as non-filming metals.

For economical reasons, especially if the cathode is to form the container, aluminum is a more desirable cathode material than copper or nickel, as it can be easier subjected to mechanical operations. Aluminum has therefore been used to some extent for such cathodes, but condensers incorporating same have shown to be inferior to condensers using non-filming cathodes in respect to their initial characteristics and, in addition, show a very pronounced deterioration in use.

Such is evidenced by a smaller initial capacity and larger power factor than obtainable with non-filming cathodes and by a pronounced decrease in capacity and increase in power factor in use.

I have found that the above is due to the formation of films on the cathode for the following three reasons:

The first reason is due to the fact that when the condenser is used, the alternating current ripples passing through the condenser, if of sufficient magnitude, are gradually building up a film on the cathode, through the electrolytic action of the current flowing at times in a direction opposed to that of the direct current component of the rectified current. The same applies when the condenser discharges upon the source of current being switched off. The film thus formed on the cathode represents a capacity which is in series with the capacity of the film on the anode and this series combination of the two capacities reduces the total capacity of the condensers. As long as the voltage of the ripples is small compared with the voltage of the direct current component, film-formation due to the ripples is negligible.

The second reason for film-formation is due to the chemical oxidization or corrosion of the aluminum in air, especially if wet.

The third reason is due to oxidization of the aluminum in the operation of the condenser, even when the condenser is sealed, due to the oxygen liberated at the anode which attacks the aluminum in the same way as the oxygen in the air.

The oxide film formed through the just referred to chemical action of the oxygen in air or oxygen liberated in the operation of the condenser is similar to the film formed through electrolytic action and represents a capacity in series with the capacity of the anode film reducing the total capacity of the condenser. Furthermore, the power factor of such chemically built-up film is much larger than the power factor of an electrolytically formed film of the same thickness. The deleterious effect of such chemically built-up film is well illustrated by the results of the following tests: Taking two identical cathode-containers and cleaning them in an alkali solvent in the presence of an inhibitive agent by one of the methods described in the co-pending application of P. Robinson and J. L. Collins, Serial No. 526,118 filed March 28, 1931, and assembling immediately one container in a condenser, while leaving the other container exposed to air for half an hour before its assembly, the first condenser showed an initial power factor of 20 per cent and the second of 40 per cent.

Similar increase in power factor with aluminum cathodes occurs in operation, due to the film-formation by the liberated oxygen.

I have found that to obtain aluminum cathode condensers of high quality and not subject to deterioration, film-formation caused by alternating current ripples, as well as by the oxygen of the air and the oxygen liberated in operation has to be prevented.

In my above referred to application I have disclosed processes to safeguard aluminum electrodes against oxidization prior to their assembly in condensers, as for instance by cleaning the electrodes in an alkaline solution and assembling

them immediately after their cleaning. However, this process does not preclude oxidization of the cathode in the operation of the condenser, nor does it prevent film-formation due to the alternating current ripples.

Oxidization of the aluminum cathode both in air and in operation is prevented by the use of aluminum of a much higher purity than is that of the commercial grade "A" aluminum. Grade "A" aluminum contains 99.5 to 99.7 per cent aluminum and is subject to corrosion both in air and in operation when used as a cathode. However, an aluminum of a purity of 99.9 per cent is not subject to corrosion, either in air or operation. However, film-formation due to the ripples is not prevented, and while this as a rule is not very pronounced and therefore not a serious objection, the use of such high purity aluminum is not a commercially satisfactory solution because of the present high price of such aluminum.

I have found that by providing aluminum with a suitable coating or plating both electroyltic film-formation and corrosion can be prevented in an economical way. Plating of aluminum and other film-forming metals has been attempted in the past but without marked success because film-formation due to oxidization in air prevented a coherent plating of the metal. However, when the oxide is removed by a cleaning process, as described in the above referred to application of Robinson and Collins, the metal may be readily plated.

While there are several metals with which aluminum thus cleaned can be plated, I have found that chromium, vanadium and manganese are the most suitable for such plating, and particularly chromium, both for the reasons that aluminum can be economically plated with these metals and also because such plating will exhibit neither film-formation nor corrosion.

While it is possible to obtain a practically non-porous chromium plating on the aluminum, non-porous plating is not altogether required. For instance, if 95 per cent of the aluminum surface is covered with chromium, only 5 per cent of the surface exposed to the electrolyte is subject to film-formation and corrosion and consequently only 5 per cent of the total surface would be subject to the deleterious influences previously explained.

In the drawing forming part of this specification the single figure is a partly sectionized side view of an electrolytic condenser embodying my invention.

The container 10 forms one of the electrodes of the condenser and is of aluminum or other suitable film-forming metal. The container 10 is provided with a non-film-forming and non-corrosive coating 11, preferably with a plating of one of the metals chromium, vanadium or manganese. As shown, the whole inside of the container 10 is thus covered with a plating, however, it is sufficient to cover such portions of the container which may come in contact with the electrolyte. If desired, the outside of the container may also be plated. The plating on the aluminum is not required to be perfectly non-porous for reasons previously set forth. The electrolyte 16 is indicated as being liquid, although it may have a reduced fluidity.

Immersed in the electrolyte 16 is a second electrode 13 of film-forming metal, for instance of aluminum, shown here as a corrugated tube, although other forms of electrodes may be used. The container is closed by a cover 12 of insulating material through which projects a threaded extension 17 of the electrode 13, said extension being provided with nuts 15—15 to form one of the outside terminals of the condenser, the container forming the other terminal.

The cover is provided with a vent 18 and a peripheral gasket 19 around which the free ends of the container 10 are crimped. Preferably sealing means (not shown) are also provided between the protruding end of the electrode 13 and the cover 12.

While I have described my invention in connection with a specific device, specific metals and in a specific application, I do not wish it to be limited to such devices, metals and applications, but desire the appended claims to be construed as broad as permissible in view of the prior art.

What I claim therefore to be new and desire to secure by Letters Patent is:

1. In an electrolytic device an electrode having a base of film-forming metal provided with chromium plating.

2. In an electrolytic device a container having a base of film-forming metal provided with chromium plating.

3. In an electrolytic device two electrodes of film-forming metal, one of the electrodes being provided with chromium plating.

4. In an electrolytic condenser a container having a base of film-forming metal provided with chromium plating, said container forming the cathode of the condenser.

5. In an electrolytic condenser an electrolyte, an anode of film-forming metal and a cathode of film-forming metal, said cathode being provided with chromium plating on its surface contacting with the electrolyte.

6. In an electrolytic condenser an electrolyte, an anode of film-forming metal and a container forming the cathode, said container having a base of film-forming metal and being provided with a plating of chromium on its surface contacting with the electrolyte.

7. An electrolytic condenser comprising a cathode of aluminum, said cathode being provided with chromium plating.

8. An electrolytic condenser having two aluminum electrodes and an electrolyte, one aluminum electrode being provided with chromium plating on its surface contacting with the electrolyte.

9. A cathode for electrolytic condensers having a base of film-forming metal and a plating of non-filming metal.

10. In an electrolytic device two aluminum electrodes and an electrolyte, one of the electrodes being provided with a non-corrosive and non-filming coating on its surface contacting with the electrolyte.

11. A cathode for an electrolytic condenser comprising a base of film-forming metal and a non-corrosive and non-filming plating on the surface of said base.

12. In an electrolytic condenser an electrolyte, an aluminum anode and a cathode having an aluminum base provided with a non-corrosive and non-filming plating on its surface contacting with the electrolyte.

13. In an electrolytic device an electrolyte, an aluminum electrode and a container having a base of aluminum provided with a non-corrosive and non-filming coating on its surface contact-

ing with electrolyte, said container forming the cathode of the condenser.

14. In an electrolytic device an electrode of film-forming metal and a second electrode having a base of film-forming metal provided with a coating of vanadium.

15. In an electrolytic condenser an aluminum electrode provided with a coating of vanadium.

16. In an electrolytic device an electrode of filming metal provided with a coating of manganese.

17. In an electrolytic condenser an electrolyte, an aluminum anode and a container having an aluminum base provided with a manganese coating, said container forming the cathode of the condenser the electrolyte being non-corrosive in its action on the manganese coating.

18. In an electrolytic device an electrolyte and an electrode being of chromium on its surface accessible to the electrolyte the electrolyte being non-corrosive in its action on the chromium.

19. In an electrolytic condenser an electrolyte and a film-forming anode and a cathode being of chromium on its surface contacting with the electrolyte the electrolyte being non-corrosive in its action on the chromium.

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