May 4, 1926.

1,583,704

S. E. SHEPPARD ET AL

ELECTRODEPOSITION OF RUBBER UNDER GAS REMOVING CONDITIONS

Filed June 8, 1925

FIG. 1.

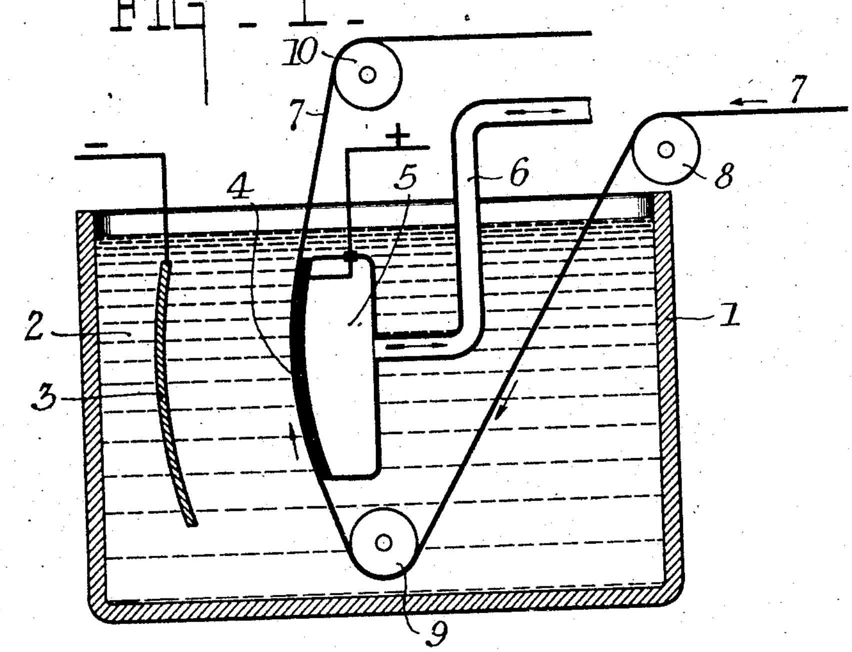
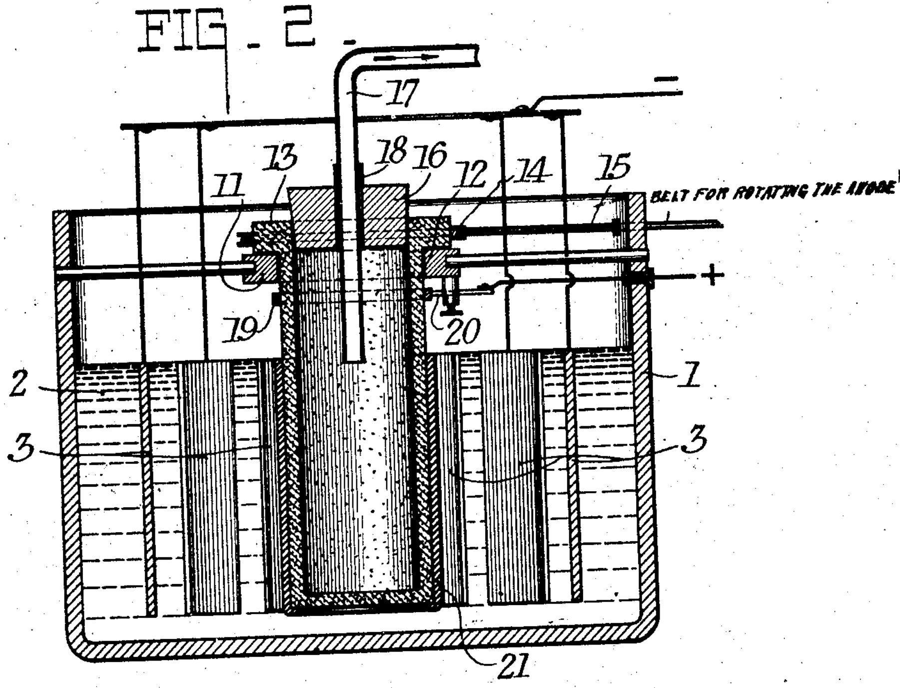


FIG. 2.



INVENTOR.
Samuel E. Sheppard & Leon W. Eberlin,
BY R. L. Stinchfield
ATTORNEY

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UNITED STATES PATENT OFFICE.

SAMUEL E. SHEPPARD AND LEON W. EBERLIN, OF ROCHESTER, NEW YORK, ASSIGNORS TO EASTMAN KODAK COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

ELECTRODEPOSITION OF RUBBER UNDER GAS-REMOVING CONDITIONS.

Application filed June 8, 1925. Serial No. 35,612.

To all whom it may concern:

Be it known that we, SAMUEL E. SHEPPARD and LEON W. EBERLIN, subject of the King of Great Britain, and a citizen of the United States of America, respectively, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Electrodeposition of Rubber under Gas-Removing Conditions, of which the following is a full, clear, and exact specification.

This invention relates to processes and apparatus for electrodepositing organic material, such as rubber for example, under such conditions that evolved gas is removed from the anode.

One object of the invention is to provide a process of electrodepositing such material in a way that will remove gases evolved at the anode from the zone of electrodeposition before they produce deleterious effects. Another object of the invention is to provide such a process in which the gases, generated at the anode surface, are removed rearwardly from the zone of electrodeposition so as not to interfere with the movement of the material to the zone of electrodeposition and so as not to form pits or weak spots in the deposited coating. Another object of the invention is to provide such a process in which the evolved gases may be removed mechanically, either with or without the assistance of chemical gas-removing expedients. Still a further object of the invention is to provide an apparatus in which such gas-removal is readily effected. Still another object is to provide a porous anode through which the gases may be drawn away from the active anode surface. Other objects will hereinafter appear.

In the accompanying drawing, Fig. 1 is a diagrammatic cross section upon an exaggerated scale of an apparatus embodying certain features of our invention and in which our process may be conveniently carried out.

Fig. 2 is a diagrammatic cross section upon an exaggerated scale of a different apparatus embodying our invention and by means of which our process may be carried out, a moving anode surface being illustrated.

This invention is an improvement upon and an outgrowth of the process and apparatus illustrated in our prior Patent No. 1,476,374, December 4, 1923, for electrodeposition of rubber coatings. When rubber or equivalent organic material is deposited from an electroconducting aqueous emulsion thereof upon an unattackable anode, the deposition may be speeded by employing relatively high current densities. Under such circumstances gas, like oxygen, may be liberated at the anode and bubbles of the gas may interfere with the passage of the rubber particles to the anode surface and with the formation of a coherent uniform coating. Weak spots and pits may be formed in the coating where bubbles of evolved gas have prevented the building up of a proper electrodeposited layer.

We have found that the trouble due to this evolved gas may be wholly or substantially avoided by mechanically removing the gas from the anode zone. Preferably this removal is rearward from the anode surface, that is, the gas passes away from the anode surface on the side of the latter opposite to that from which the rubber particles come. The result is especially useful when the electrodeposited rubber is to be stripped from the anode surface as a smooth sheet of suitable continuity and uniformity.

We have found that a vacuum is the best means for removing the gas mechanically and we prefer to carry out this removal by means of a porous anode, to the rear side of which a vacuum is applied. Stated differently, the porous anode is connected at its rear with a chamber, the pressure in which is kept materially below the pressure in the active electrolyte.

The porosity of the electroconducting anodes may obviously be varied considerably to suit different conditions, and such anodes may be formed of different materials. We have found that wire cloth or perforated sheet metal may be used, but in the preferred form of our invention we employ porous carbon. Of course, we do not wish to be limited to these examples, except as indicated in the appended claims, since the principles of our invention may be applied in many different ways. Where metallic wire cloth is used we can employ one of a highly resistant metal having a mesh of from 200 to 300 or higher per inch. It is preferable to roll such a cloth to a comparatively smooth sheet without, however, eliminating the numerous tiny apertures which render it porous. Nickel wire cloth, or cloth made from a nickel copper alloy, like "Monel" metal, is useful. This cloth may contain porous strands of a non-conductor, such as asbestos wound in it.

The preferred material for our anodes is porous carbon similar to that used in the plates of batteries, such as dry cells. We have used successfully plates of carbon of ⅛ to ¼ inch thickness, there being 25% pore space therein; but we, of course, do not wish to be limited to these characteristics, since the porosity and thickness may vary widely without interfering with the effectiveness of our invention.

Referring to Fig. 1 of the drawing, 1 represents a container in which is located an electroconducting aqueous emulsion 2 and a cathode 3. 4 represents the porous anode of the type described above. Obviously the anodes may have any suitable shape,—straight, curved or irregular. In Fig. 1 it is shown as slightly curved so that a fabric 7 drawn across it will move smoothly and yet make good contact therewith.

The anode 4 is located in one end of chamber 5 of any suitable or preferred resistant gas-tight material. Chamber 5 is connected by pipe 6 with any suitable vacuum source, such as a pump or aspirator (not shown).

The electrodeposition may be made directly upon the anode 4, or a fabric 7 may be drawn through the electrolyte over the surface of anode 4 and in good contact therewith, say over suitable rolls, such as 8, 9 and 10, the latter being preferably driven. Of course, the movement may be continuous or intermittent. When the rubber is deposited upon the anode 4 directly, it may be stripped therefrom, as a coherent uniform sheet after washing and drying as indicated in our prior patent. When the cloth is drawn slowly across the surface, the rubber is electrodeposited in the meshes of the cloth in intimate relation to the fibers so as to impregnate it.

The degree of vacuum can be varied greatly, without interfering with the practice of our invention. In fact, it is preferable to increase it with higher current densities, and to decrease it with lower current densities,—in other words, to vary it in proportion to the gas evolution. The gases move in Fig. 1 from the outer surface of anode 4 through the pores in the anode into chamber 5 and thence through pipe 6 to the evacuating apparatus. If some liquid is drawn through the spaces of the anode 4 into the chamber 5 it may be removed by draining away under vacuum or any other suitable expedient. Usually there is no trouble from such liquid. The current densities and voltages are preferably of the order of magnitude of those indicated in our prior patent cited above. The nature of the current (continuous, pulsating, etc.) may also be varied so long as it is effectively unidirectional,—even an unbalanced A. C. current may be useful.

Where the electrodeposition of rubber takes place into the fabric 7 the action is of the kind described in our above cited prior patent where non-conducting objects were rendered suitable for receiving the deposition by impregnating them with solutions of electrolytes. The emulsion with which the fabric is wetted or saturated performs this function. It will be noted that the action of the vacuum tends not only to remove the gases rearwardly from the anode zone but likewise may tend to some extent to maintain the sheet 7 in contact with the anode 4.

In Fig. 2 a different form is shown. The vessel 1 contains one or more cathodes 3 preferably surrounding the anode on all sides. In a stationary bearing 11 of any suitable type, preferably above the level of the emulsion 4, is located rotatable anode 12, say in the form of a hollow cylinder having a collar 13 at the top which bears upon the bearing 11. This collar may be provided with means for actuating it, such as a pulley surface 14 operated through belt 15. In the top of the anode 12 is a closure 16 through which enters a pipe 17 by means of a stuffing box 18. The pipe 17 can remain stationary, while the anode 12 and closure 16 rotate, yet stuffing box 18 maintains a sufficiently gas-tight connection permitting vacuum to be maintained in the hollow anode 12. The pipe 17 is connected with any suitable evacuating apparatus.

Electric contact with the anode 12 is maintained by any suitable means, such as a metallic conducting ring 19 mounted thereon, against which bears a brush 20 mounted on the lower face of bearing 11.

The emulsion 4, such as one of those described in our above cited patent, or a natural or modified latex, is located around the anode to the desired level. The current is then started, the vacuum being created in the anode 12 at about the same time that the electrodeposition starts, or even before it. The plating practice preferably follows that described in our above cited patent. When a deposit of rubber 21 has formed to a suitable thickness, it may be treated in the usual manner, such as by stripping it off and vulcanizing it or vulcanizing in situ and then removing it.

Obviously a fabric, to be impregnated with rubber, may be drawn across the rotating anode in timed relation to its movement, this operation being similar to that described and illustrated in connection with Fig. 1, suitable rolls being used.

The removal of the gas mechanically may be supplemented by the use of chemical deoxidizing materials in the electrolyte. Thus we may add to the rubber emulsion sodium or ammonium sulfite or thiosulfate. Sodium hydrosulfite is also very useful. The concentration of these bodies will vary in accordance with the difficulty in combating the evolved gas. It is a simple adjustment for any workman, to supply sufficient reducing agents for each particular case. These reducing agents, which are preferably sulfo-bodies, form on electrolytic oxidation, polythionates which assist in maintaining dispersion of colloidal sulfur and may assist in the vulcanization process itself.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. The process of depositing organic material on a gas-permeable anode surface, which comprises bringing said surface into contact with an electroconducting aqueous suspension of said material, passing a depositing electric current through said surface and suspension, the current density being such that gas is evolved adjacent said surface, and removing said gas rearwardly from said surface.

2. The process of depositing rubber on a gas-permeable anode surface which comprises bringing said surface into contact with an electroconducting aqueous emulsion of said material, passing a depositing electric current through said surface and emulsion, the current density being such that gas is evolved at the anode, and removing said gas rearwardly from said surface.

3. The process of depositing organic material on a gas-permeable anode surface, which comprises moving said surface while in contact with an electroconducting aqueous emulsion of said material, relative to said emulsion, passing a depositing electric current through said surface and emulsion during said movement, the current density being such that gas is evolved adjacent said surface, and removing said gas rearwardly from said surface during said movement.

4. The process of depositing organic material in a fabric which comprises locating said fabric on a gas-permeable anode in contact with aqueous electroconducting emulsion of said material, passing a depositing electric current through said surface and emulsion, and removing gas liberated at the anode rearwardly from said surface away from said fabric.

5. The process of depositing rubber in a fabric which comprises moving said fabric across a gas-permeable anode in contact with an aqueous electroconducting rubber emulsion, passing a depositing electric current through said anode and emulsion, and removing any gas evolved at the anode rearwardly through the latter and away from said fabric.

6. The process of depositing organic material on a gas-permeable anode surface, which comprises bringing said surface into contact with an electroconducting aqueous emulsion of said material, which emulsion contains a reducing agent, passing a depositing electric current through said surface and emulsion, and removing any gas evolved at said surface which is not acted upon by said reducing agent, rearwardly from said surface.

7. In an electrodeposition apparatus for use with an electro-conducting aqueous suspension of organic material, a gas-permeable anode, and means for withdrawing gas rearwardly from the surface of said anode.

8. In an electrodeposition apparatus for use with an aqueous electroconducting emulsion of rubber particles movable toward the anode, a porous anode, and a vacuum chamber connected to the rear of said anode.

9. In an electrodeposition apparatus for use with an aqueous electroconducting emulsion of organic material, a gas-permeable anode, means for removing gas rearwardly from the active face of said anode, and means for holding a fabric adjacent said anode.

10. In an electrodeposition apparatus for use with an aqueous electroconducting emulsion of organic material, a gas-permeable anode, means for moving said anode during electrodeposition, and means for withdrawing gas from said anode during said movement.

11. In an electrodeposition apparatus, a gas-permeable anode, said anode including a cylindrical portion rotatable about its axis, and means for withdrawing gas from the interior of said cylindrical portion during rotation of the latter.

Signed at Rochester, New York, this 2nd day of June, 1925.

SAMUEL E. SHEPPARD.
LEON W. EBERLIN.