F. F. FARNHAM.

PROCESS AND APPARATUS FOR ELECTROLYTIC RECOVERY OF WASTE LIQUOR.

APPLICATION FILED AUG. 11, 1911.

1,006,836. **Patented Oct. 24, 1911.**

2 SHEETS—SHEET 1.

Fig. 1.

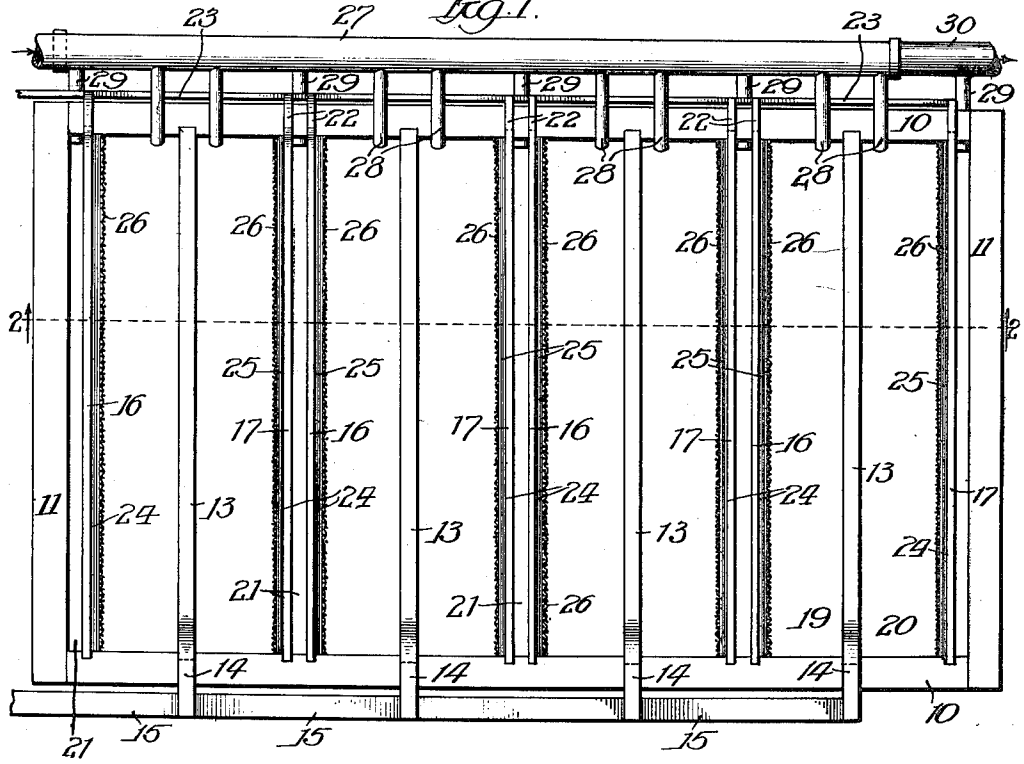
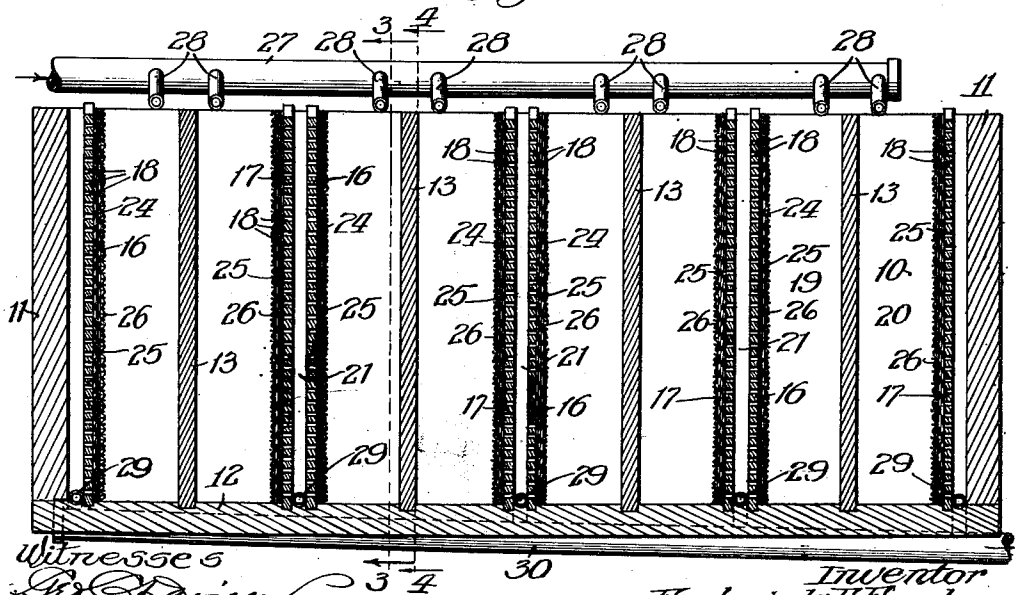


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

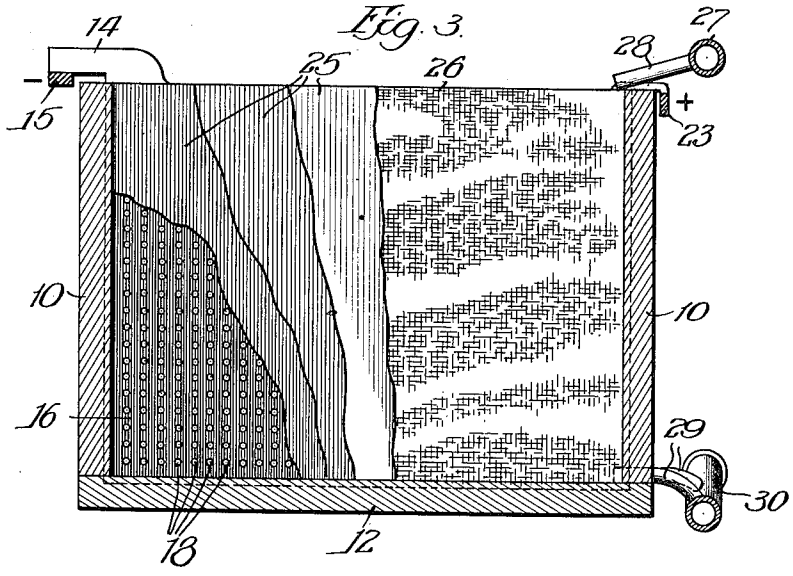
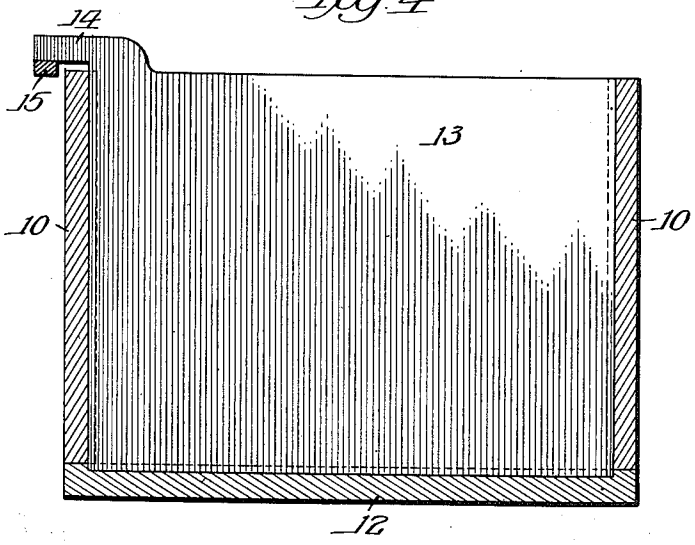


Fig. 4.



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UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR ELECTROLYTIC RECOVERY OF WASTE LIQUOR.

1,006,836. Specification of Letters Patent. Patented Oct. 24, 1911.

Application filed August 11, 1911. Serial No. 643,541.

To all whom it may concern:

Be it known that I, FREDERICK F. FARNHAM, a citizen of the United States, residing at McKeesport, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Processes and Apparatus for Electrolytic Recovery of Waste Liquor, of which the following is a specification.

My invention relates to a process and apparatus for the electrolytic recovery of waste liquor, and refers particularly to the recovery of iron and sulfuric acid from solutions of ferrous sulfate.

I am aware that processes have heretofore been used for the recovery of waste liquor, as shown, for example, in Patent 984,703, issued February 21, 1911, to Alexander S. Ramage. The process used in the patent just mentioned consists in introducing the waste liquor into a cathode chamber, diaphragms being placed between the cathode in the center of this chamber and anodes located at the sides thereof. As the electrolytic process progresses iron is deposited on the cathode, while a solution richer in sulfuric acid than that adjacent to the cathode accumulates at the anodes. A series of chambers are preferably used, all of the anode chambers being connected by suitable pipes and all of the cathode chambers being similarly connected.

One of the great disadvantages of the process and apparatus described in the Ramage patent consists in the fact that the diaphragms are fragile and quickly disintegrate, while, on the other hand, the solution coming from the anode chambers contains a large proportion of ferrous sulfate.

In my invention I have found that much superior results may be obtained by constructing a diaphragm intimately in contact with the anodes, which are preferably perforated. During the process of electrolysis sulfuric acid accumulates at the anodes and iron is deposited on the cathode. The electrolyte gradually seeps or filters through each of the diaphragms and its associated anode, and on account of the fact that all of the electrolyte passing through the perforations of the anodes has come into intimate contact with the latter, a solution rich in sulfuric acid is formed which is immediately drawn off from the anode chambers. On account of the fact that the diaphragms, preferably consisting of asbestos and burlap or the like, are fastened to the anodes, there is but little danger of disintegration of the diaphragms, and their life is almost indefinite. These and other advantages of my invention will be more readily understood by reference to the accompanying drawings, which show a preferred method of carrying out my process and the apparatus therefor, and in which—

Figure 1 is a plan of the electrolytic tank and associated parts; Fig. 2 is a vertical longitudinal section on the line 2—2 of Fig. 1; Fig. 3 is a transverse section on the line 3—3 of Fig. 2, the various layers of the diaphragm attached to one of the anodes being shown; and, Fig. 4 is a transverse section on the line 4—4 of Fig. 2, one of the cathodes being shown in elevation.

The tank in which my process is carried out is preferably built of wood, and consists of the sides 10, the ends 11, and the bottom 12. The cathodes 13, preferably of iron, are inserted in suitable slots in the sides 10 so that they are firmly held in position, the lower edges of these cathodes also preferably fitting in suitable grooves in the bottom 12.

As clearly shown in Fig. 4, each cathode is provided with a terminal 14, which forms electrical connection with the negative bus bar 15, which is connected with the negative pole of a generator or other suitable source of current. Pairs of anodes 16 and 17 are inserted in suitable slots in the sides 10 and the bottom 12, each pair of anodes being located between adjacent cathodes 13, except that at one end of the tank is a single anode 17, while at the opposite end there is a single anode 16. Each of these anodes is preferably made of lead, and has the perforations 18 extending therethrough. It will be apparent that between each cathode 13 and the adjacent anodes 16 and 17 are formed the cathode chambers 19 and 20, while between adjacent anodes 16 and 17 and between the anodes 16 and 17 and the ends 11 of the tank are formed the anode chambers 21.

Each of the anodes 16 and 17 is provided with a terminal 22, which is suitably connected with the bus bar 23, which, in turn, has electrical connection with the positive pole of the source of current. Each anode

16 and 17 on its face toward the adjacent cathode 13 is provided with a diaphragm, represented as a whole by 24, this diaphragm preferably consisting of several layers of asbestos 25 and an outer layer of burlap 26, this burlap being riveted, sewed, or otherwise suitably fastened to the anode so that the layers of asbestos are securely held in contact with the anode.

The inlet pipe 27 extends along one side of the tank on a slightly higher level than the top of the latter, and is provided with the spouts 28 through which the waste liquor flowing into the inlet pipe 27 is introduced into the cathode chambers 19 and 20. In the bottom of each anode chamber 21 is placed an outlet 29, these outlets all being connected with the main outlet pipe 30, which preferably has a slight pitch, as indicated in Fig. 2, so that the solution entering the pipe may be readily carried off.

Having thus described the apparatus which I employ, my process may now be readily understood: The ferrous sulfate waste liquor, which is the product obtained in cleaning iron or steel by means of sulfuric acid, entering the pipe 27, flows through the spouts 28 into the cathode chambers 19 and 20, as previously explained. The electric current flows from each of the anodes 16 and 17 through the waste liquor or electrolyte in the cathode chambers 19 and 20 to the cathodes 13 on which iron is deposited. At the same time sulfur dioxid is formed at the anodes, with the consequent formation of sulfurous acid, which is immediately oxidized to sulfuric acid, the reactions being—

$$SO_2+H_2O=H_2SO_3 \text{ and } 2H_2SO_3+O_2=2H_2SO_4.$$

The electrolyte within the cathode chambers 19 and 20 gradually seeps through the diaphragms 24, during which the formation of sulfuric acid results according to the reactions just given. This sulfuric acid passes through the perforations 18 of the anodes 16 and 17 into the anode chambers 21, from which it immediately passes off through the outlets 29 into the outlet pipe 30. The sulfuric acid flowing through the pipe 30 may be concentrated if desired, and used for any suitable commercial purposes. When the accumulation of iron on the cathodes 13 has become excessive, the latter may be removed, the iron melted or otherwise suitably treated, and new cathodes substituted.

It will be evident that my process is a continuous one, since the waste liquor constantly flows into the cathode chambers 19 and 20, while the sulfuric acid constantly flows away through the anode chambers 21.

It will be apparent that many changes could be made in the exact process and apparatus which I have described without departing from either the spirit or scope of my invention.

What I claim is:

1. The process of electrolytically treating solutions of metals, which consists in subjecting said solution to the action of an electric current passing from an anode through a diaphragm to a cathode, thereby depositing metal on said cathode and subjecting said solution to chemical reactions at said anode, and passing said solution through said diaphragm and into an anode chamber, whereby that portion of the solution which has been subjected to said chemical reactions is separated from the balance of said solution, substantially as described.

2. The process of treating solutions of sulfate of iron, which consists in subjecting said solution to the action of an electric current passing from an anode through a diaphragm to a cathode, thereby depositing iron on said cathode and forming sulfuric acid at said anode, and passing said solution through said diaphragm and perforations in said anode, substantially as described.

3. The process of treating solutions of sulfate of iron, which consists in subjecting said solution to the action of an electric current passing from an anode through a diaphragm to a cathode, thereby depositing iron on said cathode and forming sulfuric acid at said anode, passing said solution through said diaphragm and perforations in said anode, and drawing off the solution passing through said anode, substantially as described.

4. In an apparatus for treating solutions of metals, the combination of a tank having an anode and a cathode therein, means connecting said anode and cathode with a source of electric current, and a diaphragm fastened to said anode, whereby metal is deposited on said cathode and an acid is formed at said anode, substantially as described.

5. In an apparatus for treating solutions of metals, the combination of a tank having a perforated anode and a cathode therein, means connecting said anode and cathode with a source of electric current, and a diaphragm fastened to said anode, whereby metal is deposited on said cathode and an acid is formed at said anode as said solution passes through the latter, substantially as described.

6. In an apparatus for treating a solution of sulfate of iron, the combination of a tank having a perforated anode and a cathode therein, means connecting said anode and said cathode with a source of electric current, a diaphragm fastened to said anode, and means for withdrawing the solution after its passage through said anode, substantially as described.

7. In an apparatus for treating a solution of sulfate of iron, the combination of a tank having an anode and a cathode therein, means connecting said anode and cathode with a source of electric current, a diaphragm fastened to said anode, said diaphragm comprising a layer of asbestos and a layer of burlap, means for introducing the solution into the cathode chamber between said cathode and said anode, and means for withdrawing the solution as it passes beyond the face of said anode away from said cathode, substantially as described.

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