Aug. 28, 1956 M. CERESA 2,760,928

APPARATUS FOR ELECTROPLATING STUDIES

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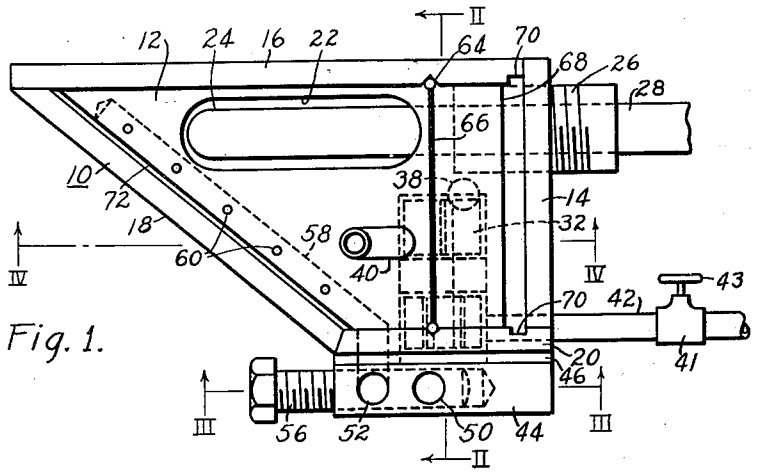


Fig. 1.

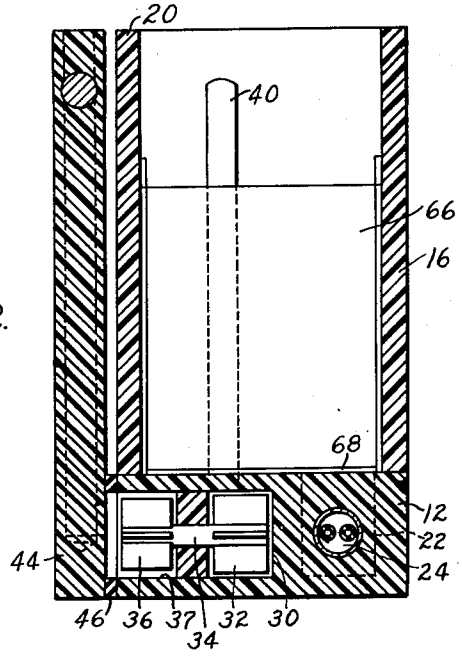


Fig. 2.

INVENTOR

Myron Ceresa

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Fig. 3.

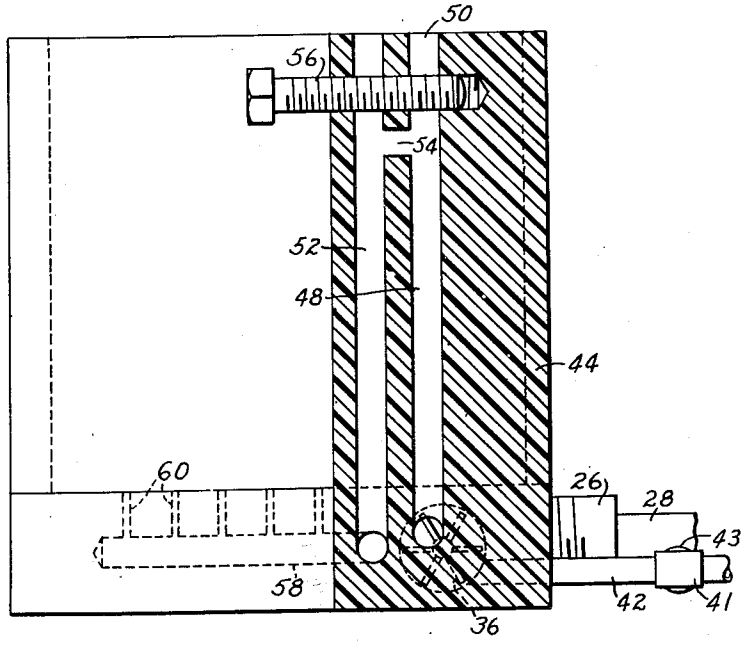
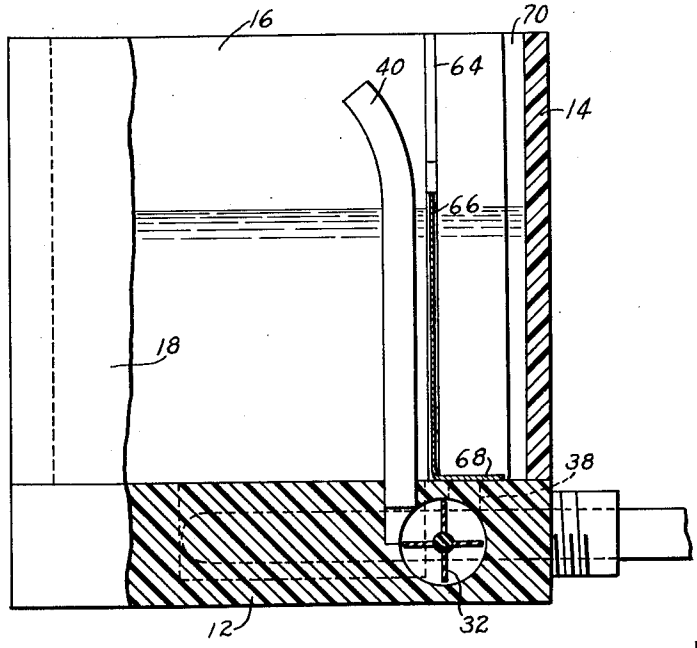


Fig. 4.



INVENTOR

Myron Ceresa

United States Patent Office 2,760,928 Patented Aug. 28, 1956

2,760,928

APPARATUS FOR ELECTROPLATING STUDIES

Myron Ceresa, Pittsburgh, Pa.

Application May 1, 1952, Serial No. 285,496

5 Claims. (Cl. 204—195)

This invention relates to improved apparatus and processes for evaluating and studying electro-deposition.

R. O. Hull Patent 2,149,344 discloses an apparatus for the study of electroplating. However, the apparatus disclosed therein contains no means for controlling certain variables such as temperature of electrolyte, agitation and other factors. In modern electroplating all variables must be kept under strict control if any tests made are to have proper significance.

The object of this invention is to provide an improved apparatus for testing electroplating processes wherein temperature, agitation and circulation of electrolyte are maintained under control.

Another object of the invention is to provide an apparatus in which tests may be performed on a small scale by means of an apparatus wherein the circulation of electrolyte and air agitation may be varied.

Another object of the invention is to provide an apparatus for conducting tests of electroplating processes wherein means are provided for diaphragming.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description and drawing wherein,

Figure 1 is a top plan view of an electroplating cell constructed in accordance with the invention,

Fig. 2 is a vertical cross section along line II—II of Fig. 1,

Fig. 3 is a vertical cross section along line III—III of Fig. 1, and

Fig. 4 is a vertical section along line IV—IV of Fig. 1.

In accordance with the present invention, I have produced a novel electroplating cell for testing electroplating electrolytes and electroplating processes. Briefly, my cell comprises a compartment for containing an electroplating electrolyte with means for disposing an anode and cathode member of predetermined cross sectional area so arranged that the distance between the anode and the cathode surface progressively increases as a line perpendicular to the surface of the anode travels from one side of the anode to the other side. The theory and value of such construction has been set forth in Hull Patent 2,149,344, and this feature is not my invention. The cell is provided with means for applying a predetermined temperature to the electrolyte within the cell without interfering or modifying the plating process or the flow of electrical current from the anode to the cathode. My cell is also provided with means for circulating the electrolyte at any predetermined rate. Furthermore, I have provided means for agitating the electrolyte at a controllable rate by forcing air through the electrolyte in the vicinity of the cathode member. Furthermore, I have provided a diaphragm in the cell so located as to prevent the circulation of impurities against the cathode.

Referring to Fig. 1 of the drawing, there is illustrated an improved cell **10** containing the hereinbefore mentioned features. The cell comprises a base **12** to which

are vertically fixed a side wall **14**, a back wall **16**, a diagonally disposed wall **18** and a front wall **20**. The base and vertically affixed walls are preferably prepared from some transparent insulating material such as resin or glass. I have secured good results by employing polymethyl methacrylate resin. Of course, it will be understood that nontransparent materials may be employed though it is an advantage to employ a transparent material in order to observe the plating operations carried out in the cell.

The bottom wall **12** of the cell is provided with a hollow or depression **22** which is open to the electrolyte disposed within the cell and in this depression is located a heating element **24** preferably comprising a resistance wire which contains a thermostatic element for controlling the flow of electrical current thereto. Heating elements per se are well known, and thermostatic controls therefor are similarly well known and it is believed unnecessary to describe the details thereof. The heating element **24** is kept in place by a packing nut **26** applied about a conductor lead **28**. As illustrated the nut **26** is threaded to cooperate with the latching thread in the base **12**.

In practice I have controlled current flow to the heating element **24** by means of a variable resistance. A thermometer may be immersed in the electrolyte from time to time in order to determine the temperature with a view of determining whether the current input need be changed and to what extent. Temperatures can be readily maintained within a few degrees of a given temperature by this means.

By disposing the heating element **24** within the depression **22** electrolyte heated thereby will circulate upwardly by reason of thermal convection currents and the entire electrolyte in the cell **10** will be warmed uniformly and rapidly. Inasmuch as the element **24** is disposed below the level of the upper surface of the base **12**, the flow of electrical current within the cell is not materially affected, as is the case when immersion heaters are disposed within the electrolyte in known fashion.

As best illustrated in Fig. 2 of the drawing, the base **12** is provided with a hollow chamber **30** containing a liquid circulating pump **32** mounted on a shaft **34** which is driven by an air motor **36** disposed in a cavity **37** also in the base **12**. As shown in Figs. 1 and 4 an opening **38** admits electrolyte to the pump **32** and the liquid is expelled through a vertically disposed nozzle **40**. The nozzle **40** is optional.

The air motor **36** is supplied with compressed air by a conduit **42**, the flow of compressed air being controlled by a valve **41** which is operated by a handwheel **43**. The handwheel may be manually rotated to open or close the valve **41** to any selected rate of flow of air. The compressed air from the conduit **42** impinges on the air motor **36** and then is exhausted to an air manifold **44**. A gasket **46** and suitable fastening means are employed to maintain the manifold **44** in airtight relation to the chamber **37**.

The details of the air manifold **44** are shown most clearly in Fig. 3 of the drawing. Air exhausting from the motor **36** enters a vertical channel **48** and if unrestricted would escape to the atmosphere through the exit **50**. Parallelling the channel **48** is another channel **52** cross connected thereto by a bypass **54**. A threaded screw **56** is disposed to traverse the channels **48** and **52**. By manipulating the screw **56**, the channel **48** may be opened entirely at exit **50** or the flow of air may be restricted to any desired extent. When restricted by the screw **56** air will tend to be driven down the channel **52** and thence into a distribution channel **58** into which are drilled a plurality of small air holes **60** distributed along the diagonal side wall **18**. It should be understood that the screw member **56** may be replaced by any suitable valve or plunger mechanism that will function to control the flow of air from the channel **48** to the exhaust **50**. In this

way, all of the air from the air motor may be vented to the atmosphere or any portion thereof may be shunted into into the distribution conduit 58 and thence to be bubbled to the electrolyte within the cell through air holes 69. A groove 70 is disposed in the back wall 16 and front wall 20 to provide for disposing an anode in the electrolyte in the cell. At a distance removed from the side wall 14 beyond the opening 38 are two grooves 64 for receiving a diaphragm member 66. The diaphragm member 66 may comprise canvas or any other suitable porous liquid penetrable material. It is desirable that the diaphragm 66 have a flap 68 disposed to cover the opening 38 to filter out any solids and prevent their entering the pump and thereby circulation of such solids is avoided.

In the base 12 a groove 72 is provided adjacent the diagonal wall 18 so that a cathode member may be retained in position by reason of both the groove 72 and the vertically disposed acute angle between the back wall 16 and the diagonal wall 18.

If it is desired to employ only an agitation and no circulation of electrolyte, the air motor 36 may be removed and air passed directly to the distribution conduit 58. Alternatively, the distribution conduit may be connected directly to a separate source of air supply so that the air motor 36 functions only to operate pump 32 and its exhaust be vented to the outside air.

In carrying out tests with the electroplating cell of this invention, a cathode member as long as groove 72 is disposed therein, and an anode member is disposed between grooves 70. A diaphragm 66 of 6 ounce duck is, for instance, placed in grooves 64, preferably with a flap over the opening 38. The electrolyte to be experimented with is then introduced into the cell to cover the anode and cathode members, but not higher than the top of the diaphragm 66. The heating element 24 is supplied with current to cause the electrolyte to reach a selected temperature. The handwheel 43 of valve 41 is manipulated to cause air to pass along conduit 42 and thereby operate the air motor 36. The air motor rotates the pump 32 and draws in electrolyte from the anode side of the diaphragm and expels the electrolyte on the other side of the diaphragm. The screw 58 is turned to obstruct flow of air exhausting from the air motor in channel 48 until there is secured the required degree of agitation by air passing through holes 69 along the face of the cathode member. The controls may be varied as desired during the plating operation. Plating current is applied to the cathode and anode when the temperature, electrolyte circulation and air agitation are at the desired values.

It will be appreciated that obvious changes may be made in the above apparatus without departing from the scope of the invention.

I claim as my invention:

1. In an electroplating apparatus to be employed as a Hull cell a flat base and side walls vertically affixed to the base to form a cell for containing an electrolyte, the base and side walls being made of a resin, at least the side walls being transparent, means in the side walls and base for holding a rectangular flat plate anode member and a rectangular flat plate cathode member vertically in the cell, the bottom edges of the anode member and cathode member being disposable substantially on the flat base, the one vertical edge of the cathode member being substantially nearer to one vertical edge of the anode member than the distance from the other vertical edge of the cathode member to the other vertical edge of the anode member, an open depression in the flat face of the base and a heating element disposed completely within the depression, the electrolyte having free access to the depression whereby on being heated by the heating element the electrolyte circulates throughout the cell volume by convection current flow.

2. In an electroplating apparatus to be employed as a Hull cell a flat base and side walls vertically affixed to the base to form a cell for containing an electrolyte, the base and side walls being made of a transparent resin, means in the walls and base for holding a rectangular flat plate anode member and rectangular flat plate cathode member vertically in the cell, the bottom edges of the anode member and cathode member being disposable substantially on the flat base, the one vertical edge of the cathode member being substantially nearer to one vertical edge of the anode member than the distance from the other vertical edge of the cathode member to the other vertical edge of the anode member, an open depression in the flat face of the base, a heating element disposed completely within the depression, the electrolyte having free access to the depression whereby on being heated by the heating element the electrolyte circulates throughout the cell volume by convection current flow, means on the side walls for receiving a diaphragm to divide the cell into a compartment containing the anode member and another compartment containing the cathode member, and a pump for withdrawing electrolyte from the anode compartment and ejecting the electrolyte into the cathode compartment.

3. In an electroplating apparatus to be employed as a Hull cell a flat base and side walls vertically affixed to the base to form a cell for containing an electrolyte, the base and side walls being made of a resin, at least the side walls being transparent, means in the walls and base for holding a rectangular flat plate anode member and rectangular flat plate cathode member vertically in the cell, the bottom edges of the anode member and cathode member being disposable substantially on the flat base, the one vertical edge of the cathode member being substantially nearer to one vertical edge of the anode member than the distance from the other vertical edge of the cathode member to the other vertical edge of the anode member, an open depression in the flat face of the base, a heating element disposed completely within the depression, the electrolyte having free access to the depression whereby on being heated by the heating element the electrolyte circulates throughout the cell volume by convection current flow, means on the side walls for receiving a diaphragm to divide the cell into a compartment containing the anode member and another compartment containing the cathode member, a pump for withdrawing electrolyte from the anode compartment and ejecting the electrolyte into the cathode compartment, an air motor for driving the pump, and means for passing the exhaust from the air motor into the electrolyte to provide for air agitation of the electrolyte immediately adjacent to the entire cathode member.

4. In an electroplating apparatus to be employed as a Hull cell a flat base and side walls vertically affixed to the base to form a cell for containing an electrolyte, the side walls being made of a transparent resin, means in the side walls and base for holding a rectangular flat plate anode member and a rectangular flat plate cathode member vertically in the cell, the bottom edges of the anode member and cathode member being disposable substantially on the flat base, the one vertical edge of the cathode member being substantially nearer to one vertical edge of the anode member than the distance from the other vertical edge of the cathode member to the other vertical edge of the anode member, an open depression in the flat face of the base, a heating element disposed completely within the depression, the electrolyte having free access to the depression whereby on being heated by the heating element the electrolyte circulates throughout the cell volume by convection current flow, a diaphragm in grooves in the side walls to divide the cell into one compartment containing the anode member and the other the cathode member, the base containing a pump, the base having an opening in the anode compartment for conveying electrolyte to the pump, a portion of the diaphragm arranged to cover the opening to filter the electrolyte, the outlet from the pump leading to an exit opening in the base in the cathode compartment, an air motor in the base con-

nected to the pump, an air inlet in the base for conveying compressed air to the air motor, a manifold member attached to the side wall to receive the exhaust from the air motor, the manifold having a conduit leading the exhaust air to an outlet to the atmosphere, means for selectively opening and closing the outlet, a second conduit connected to the first conduit to receive exhaust air and leading to a distributing conduit in the base parallel to cathode member, and the base having a plurality of fine apertures open to the electrolyte and connected to the distributing conduit for bubbling exhaust air adjacent the face of the cathode member as the means for selectively opening and closing is manipulated to restrict the flow of exhaust air to the outlet to the atmosphere, whereby to agitate the electrolyte immediately adjacent to and in contact with the entire cathode member, and at least a part of the exhaust air is forced to flow through the second conduit and the distributing conduit.

5. In an electroplating apparatus to be employed as a Hull cell a flat base and side walls vertically affixed to the base to form a cell for containing an electrolyte, the base and side walls being made of a resin, at least the side walls being transparent, means in the side walls and base for holding a rectangular flat plate anode member and a rectangular flat plate cathode member vertically in the cell, the bottom edges of the anode member and cathode member being disposable substantially on the flat base, the one vertical edge of the cathode member being substantially nearer to one vertical edge of the anode member than the distance from the other vertical edge of the cathode member to the other vertical edge of the anode member, an open depression in the flat face of the base, a heating element disposed completely within the depression, the electrolyte having free access to the depression whereby on being heated by the heating element the electrolyte circulates throughout the cell volume by convection current flow, means on the side walls to receive a diaphragm to divide the cell into one compartment containing the anode member and another compartment containing the cathode member, an air distributing conduit in the base, the base having a plurality of fine apertures along the entire bottom edge of the cathode member open to the electrolyte and connected to the distributing conduit, and means for conveying compressed air to the distributing conduit whereby such compressed air passes through the fine apertures and agitates the electrolyte immediately adjacent to and in contact with the face of the entire cathode member.

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