

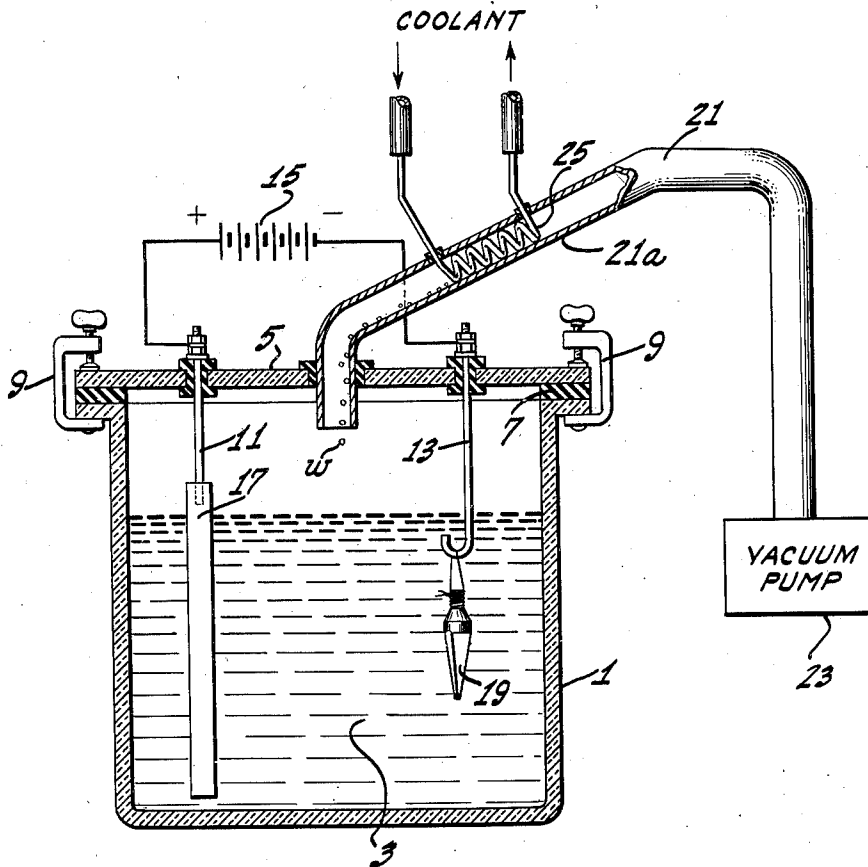
March 29, 1949.

L. PESSEL

2,465,747

APPARATUS FOR ELECTROPLATING METAL

Filed April 30, 1945



INVENTOR.
LEOPOLD PESSEL
BY *CD Muska*
ATTORNEY

UNITED STATES PATENT OFFICE

2,465,747

APPARATUS FOR ELECTROPLATING METAL

Leopold Pessel, Philadelphia, Pa., assignor to
Radio Corporation of America, a corporation
of Delaware

Application April 30, 1945, Serial No. 591,069

1 Claim. (Cl. 204-274)

1

This invention relates to the electrodeposition of metals, and more particularly to the electrodeposition of iron, manganese and other similar metals from aqueous solutions of salts thereof wherein said metals normally occur in a relatively lesser or lower valent form but tend to assume a higher valent form in the presence of oxygen.

There are many industrial and other applications where it has been found useful to coat various articles with iron and the like in order to increase the life and utility of such articles. For example, in the case of copper heating tips of soldering irons, the solder tinning compounds customarily used attack the copper and not only reduce the efficiency of the heating tips, but also cause them to wear out rapidly. It has therefore been found advantageous to coat such tips with iron which is not attacked by such tinning compounds. Again, in the case of printing plates, which are generally made of relatively soft material, it has been found advantageous to coat such plates with iron to provide a hard wearing surface therefor. Many other similar applications are well known.

Iron is usually applied to such articles by electrodeposition. In the electrodeposition of iron according to prior art methods, the formation of pits in the electroplated layers is frequently encountered. These pits are due to the adherence of gas bubbles to the surface of the electrodeposited metal. The gas bubbles shield the areas underneath them against further metal deposition, while the latter takes place in the area adjoining the bubbles. This phenomenon takes place in practically any type of iron bath and under nearly every operating condition known heretofore.

To remedy this, it has been proposed to impart movement to the cathode, where the electroplating takes place, or to stir the plating bath with sufficient violence to wash off the adhering gas bubbles. However, any movement of the electrode (particularly in the case of an iron bath) should be avoided because such motion causes accelerated oxidation of the bath from the lower valent condition of the metal to the higher valent condition thereof (that is, from the ferrous to the ferric state in the case of iron). Such oxidized baths must be subjected to a reducing treatment which is not only time and material consuming but, unless carried out with great care, may unbalance the composition of the bath. Similar conditions exist in the electrodeposition of other metals, especially manganese, from aqueous elec-

2

trolites containing salts thereof in which the metals appear in the lower valent form.

The primary object of my present invention is to provide an improved apparatus for electrodepositing iron, manganese, and other similar metals which will not be subject to the above noted limitations.

Another object of my present invention is to provide an improved apparatus for electroplating iron and the like which will result in smooth surfaces substantially free from pits and other similar irregularities.

It is also an object of my present invention to provide an improved apparatus for electroplating metals as aforesaid in which stirring of the electrolyte will be enhanced without the necessity of using mechanical devices for this purpose, as has been customary in the prior art.

A further object of my present invention is to provide an improved apparatus for electroplating metals as aforesaid in which the tendency for the plating metal in the electrolyte to oxidize is counteracted, if not even almost entirely eliminated.

Still a further object of my present invention is to provide an improved apparatus for electroplating as above set forth which will result in more uniform plating than has been achieved heretofore.

In accordance with my present invention, the adherence of gas bubbles and particles in the plating bath to the surface of the cathodic deposit is effectively prevented by substantially evacuating the air space above the plating bath and maintaining the electrolyte at a pressure below atmospheric pressure while electrodeposition takes place. In other words, I have found that pitting of the electrodeposited layer or coating can be effectively prevented by electrodepositing the metal in a substantial vacuum. I prefer to use a vacuum of the order of two to five millimeters of mercury, although higher or lower pressures may be employed. The choice of the pressure may be influenced by the vapor pressure of the bath which, in turn, is governed by the bath temperature. The complete electrolytic system or apparatus is, of course, substantially fluid- or air-tight.

An immediate effect of the reduction of the pressure under which the electrodeposition takes place to a point substantially below atmospheric pressure is increased gas evolution, especially at the cathode. However, the gas bubbles which are formed separate from the surface almost at once. An additional benefit results from this increased

3

gas evolution since it thoroughly stirs the electrolyte. This action tends to remove any foreign particles that may have settled on the cathode surface. A further benefit resulting from my present invention, especially in the case of an iron plating bath, is the decreased oxygen concentration both within the bath and in the gas space above the bath, that is, in the attenuated atmosphere filling the air-tight enclosure in which the electrolytic bath is contained, whereby the metal in the plating bath tends to remain in its lower valent form.

A specific application of the use of vacuum in electroplating according to my present invention is found in the deposition of iron on copper heating tips of soldering irons. When such tips are iron plated according to conventional plating methods, the iron coatings almost invariably contain pits and other porous areas due to the conditions described above, and these pits or the like decrease the effective heat conductivity through the plated iron. Hence, such tips operate at a relatively low efficiency. On the other hand, soldering tips plated with iron while kept under a vacuum of about five millimeters of mercury in accordance with my present invention have an extremely smooth surface coating free of pits and perform with much greater efficiency.

When electroplating under vacuum from an aqueous plating bath, evaporation of water is greatly accelerated, especially when the bath operates above room temperature. If the bath concentration is to be held constant, as is usually desirable, frequent replacement of the lost water becomes necessary. I prefer to do this automatically either by an automatic level control or by introducing a cooling unit into an evacuating duct connected to the plating tank. In the latter case, the larger part of the escaping water vapor condenses on the surface of the cooling unit and is reintroduced into the bath. The use of such a condenser is particularly desirable for the protection of the pump or other device that may be employed to evacuate the plating tank. By ordinarily maintaining a substantially uniform bath concentration, the quality of the metal deposition is also enhanced.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description, when read in connection with the accompanying drawing in which the single figure shows, by way of illustration, partly in section and partly diagrammatically, one form of apparatus which may be employed in accordance with my present invention.

Referring in greater detail to the drawing, there is shown a plating tank 1 containing a plating bath or electrolyte 3 and provided with a cover 5. The cover 5 may be held in air-tight relation with the tank 1 by means of an interposed gasket 7 and a plurality of C clamps 9.

Suspended from the cover 5 are a pair of spaced terminal elements 11 and 13 the former of which is connected to the positive terminal of a direct current source 15 to constitute an anode connection and the latter of which is connected to the negative terminal of the source 15 to constitute a cathode connection. An anode 17 which is supported by the anode terminal 11 is immersed in the electrolyte 3. An article 19 which is to be plated is suspended from the cathode terminal

4

13 within the electrolyte 3 and constitutes the cathode. In the illustrated embodiment, the cathode or article 19 comprises a heating unit or applicator of a soldering iron, the applicator being made of copper or other suitable material which has a higher heat conductivity than iron.

For the purpose of evacuating the air space within the tank 1 above the electrolyte 3, a suitable pipe or duct 21 is brought in through the top or cover 5 and is connected at its other end to a vacuum pump or the like 23. A condenser coil 25 through which a suitable coolant, such as brine, is fed serves to condense any water vapor that is evaporated from the electrolyte 3 and to condense the water. By inclining the portion 21a of the duct 21 at a suitable angle relative to the cover 5, the condensing water droplets W will automatically flow back into the tank and the quantity of the water in the plating bath or electrolyte 3 will remain substantially constant.

The electrolyte 3 is an aqueous solution of a suitable salt of the metal which is to be plated on the article 19. In the case of iron, the bath may be a solution of ferrous chloride, ferrous sulphate, ferrous fluo-borate, or of any other suitable divalent iron salt which, in the presence of oxygen, tends to oxidize to the trivalent or ferric state. If manganese is to be plated onto the article 19, the electrolyte may be an aqueous solution of divalent manganese sulphate, divalent manganese chloride, or any other similar divalent manganese salt which tends to assume the trivalent form in the presence of oxygen. These and similar electroplating baths are acidic in nature and usually have a pH value of from three to six, wherefore hydrogen is liberated in relatively great quantities during the plating process. The hydrogen gas bubbles and foreign particles which may be present in the plating bath 3 ordinarily accumulate on the article 19 and result in pits and other similar deformations or irregularities which not only produce a rough surface in the plated coating, but render the plated coating easily susceptible to chipping, fracture, and the like. By evacuating the air space above the plating bath 3, these bubbles and other foreign particles are quickly drawn off from the article being plated, and the result is a smooth, firmly adherent coating on the cathode.

While I have shown and described the present invention with particular reference to the plating of iron and manganese, it is apparent that the invention is applicable to the plating of other metals as well. For example, in plating tin from somewhat alkaline solutions of a stannous chloride, stannous sulphate or other stannous salts, my present invention may be used advantageously, notwithstanding the fact that such alkaline solutions, which usually have a pH value of from eight to twelve, liberate only small amounts of hydrogen during the plating operation. Thus, it is apparent that the effect of vacuum in preventing pits and rough deposits, in promoting a stirring of the electrolyte by the passage of the gas bubbles through the solution without the introduction of extraneous mechanical devices, and in counteracting oxidation is a general one. I therefore desire that my invention shall not be limited to any particular electroplating bath composition or operating condition but that it shall be limited only by the principles and spirit of the invention disclosed herein, by the prior art, and by the spirit of the appended claim.

I claim as my invention:

In electroplating apparatus for electrodeposit-

ing metal, the combination of a fluid tight receptacle containing an aqueous electroplating solution, an anode therein and a cathode therein to which the work to be plated is connected, means including a vacuum pump and a duct having an inclined portion connecting said pump to said receptacle for maintaining the interior of said receptacle at a pressure lower than atmospheric pressure whereby (a) to enhance removal from said work of any gas liberated from said electrolyte during the plating operation, and (b) incidentally to enhance evaporation of water from said electrolyte, and means within said duct for cooling said inclined portion of the duct for condensing the evaporated water in the duct and returning the condensed water flowing back through the inclined portion of the duct to said electrolyte whereby to maintain the quantity of water in said electrolyte substantially constant.

LEOPOLD PESSEL.

20

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

	Number	Name	Date
	692,688	Meslans	Feb. 4, 1902
	742,442	Mc A. Johnson	Oct. 27, 1903
5	1,597,231	Haynes	Aug. 24, 1926
10	1,838,666	Fink et al.	Dec. 29, 1931
	1,965,813	Stuart	July 10, 1934
	2,044,742	Armstrong et al.	June 16, 1936
	2,229,077	Hammond et al.	Jan. 21, 1941
15	2,439,491	Schiff	Apr. 13, 1948

FOREIGN PATENTS

	Number	Country	Date
	20,716	Great Britain	1906
	156,800	Germany	Aug. 25, 1939