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C. G. FINK

1,904,432

METHOD OF ELECTRODEPOSITING CHROMIUM

Filed July 27, 1926

Fig. 1.

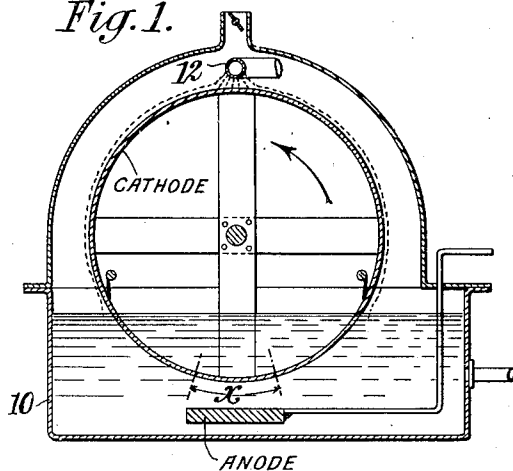


Fig. 2.

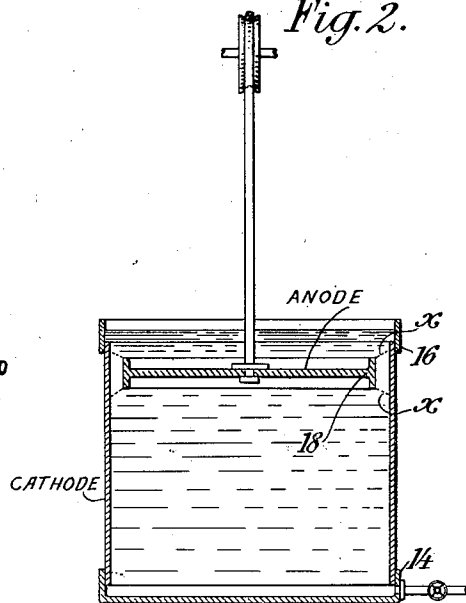


Fig. 3.

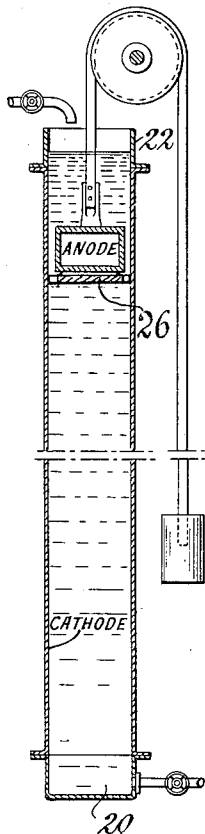


Fig. 4.

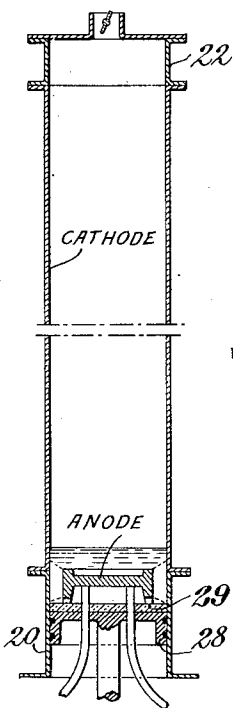
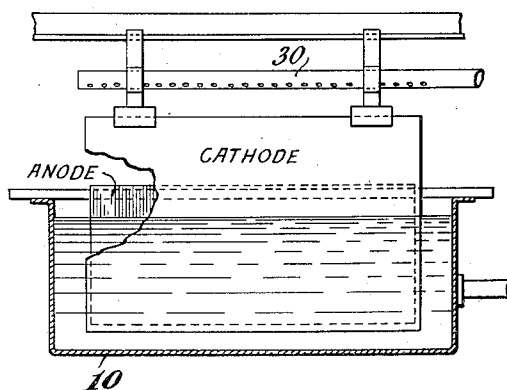


Fig. 5.



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UNITED STATES PATENT OFFICE

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METHOD OF ELECTRODEPOSITING CHROMIUM

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This invention relates to processes of chromium plating and more particularly to the plating of large objects and other objects where the conditions limit the current to or make desirable the use of current of a lesser amount than will furnish the required current density for plating over the entire surface to be plated. It further relates to chromium plated articles.

10 The invention provides a convenient, practical, and reliable process for chromium plating large objects and other objects of the character referred to above. It also provides a chromium plated article of the character requiring, or most conveniently formed by, plating successive areas, having the chromium plate integral and adherent there-
15 to.

20 The accompanying drawing illustrates several modes of procedure in carrying out, and applications of, the process.

Figure 1 illustrates the invention as applied to the plating of the exterior of large vessels, tubes, and the like.

25 Fig. 2 illustrates the invention as applied to the plating of the interior of large vessels, tubes and the like.

Fig. 3 illustrates the invention as applied to the plating of the interior of articles where the conditions limit the current to a lesser amount than will furnish the required current density for plating over the entire surface to be plated, the article being a long tube or pipe of relatively small diameter.
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35 Fig. 4 illustrates the plating of pipe or the like by a mode somewhat different from that illustrated in Fig. 3.

40 Fig. 5 illustrates the invention as applied to the plating of large articles of a sheet or disk-like nature.

Referring to said drawing, numeral 10 designates a suitable tank containing a chromium-plating bath or solution preferably such as disclosed in my Patent No. 1,581,188,
45 granted April 20, 1926, and others.

Large objects present difficulties and inconveniences in electro-depositing chromium thereon. There are difficulties in obtaining proper uniformity of current density over
50 the surface, of taking care of the excess hy-

drogen so as not to interfere with the plating, and of obtaining dynamos of sufficiently large ampere output, and inconveniences of excessively large tanks, anodes, and lead wires. Moreover in plating the interiors of certain
55 objects such as elongated tubes, pipes and the like, the amount of current which can be successfully or conveniently used is limited to an amount insufficient to furnish the required current density for plating over the
60 entire surface, because of the increasing concentration or quantity of hydrogen gas in the bath at and toward the exit or exits of the gas from the interior of the object, and also because of the heating effect of the current on
65 the bath. These same impediments are also likely to be met with in plating (interiorly or exteriorly) objects having a large vertical height in a bath. Moreover, some surfaces, notably surfaces of cast iron articles, have
70 variable characteristics as regards the flow of current to different portions thereof, due for example to the honeycomb structure extending below the surface plane of cast iron
75 structures.

According to the present invention, I pass current from an anode to a portion of the surface of objects (cathode) such as described above, at a sufficient current density to electro-deposit chromium on such por-
80 tion. Current densities vary with temperature, concentration of bath, and quantity of catalyst (usually a sulphate radical), and the proper limits of current densities under any given condition of temperature, con-
85 centration of bath and quantity of catalyst may be found by following directions contained in my aforesaid Patent No. 1,581,188. Usual current densities are from $\frac{1}{2}$ to $1\frac{1}{2}$
90 amperes per square inch. It will be understood that in such process, below certain minimum current-densities, no chromium will be deposited, only hydrogen being gen-
erated.

In order to protect the unplated portions
95 of the surface of the object from oxidation (or other deleterious action) so as to receive an adherent plate of chromium when a current of proper current density is applied to such unplated portions, I protect from, or
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prevent, such oxidation in a suitable manner. This protection is conveniently provided by covering, wetting, or keeping covered such unplated portions with the bath solution, or by hydrogen, which latter is available from the process itself.

Current at the proper current density is successively passed to the protected portion or to portions of such portion until the entire surface is coated with chromium. Such objects have an integral and adherent chromium plate over their entire surface.

Referring to the illustrated examples of the process; and first to Fig. 1, the object to be plated is a tube or ring of large diameter. It is made cathode. It is partially immersed in the bath, and current is passed from an anode facing said object over a portion of its surface. Current is passed from this anode at a sufficient current density to deposit chromium over a portion of such object surface, as for example the portion comprised within the arc $x-x$. A cover of the bath solution is maintained over the unplated portions of the surface. Part of such unplated surface is below the level of the bath solution, and over the other part a cover may be maintained by flow of bath solution from "rose" 12 or the like. Or the hydrogen released from the bath may be used to cover the unplated surface, by surrounding the object by a hood and catching the hydrogen in such hood. Or a cover of both bath solution and hydrogen may be maintained over the unplated portion, as illustrated.

Referring to Fig. 2, the object to be plated is a large tube or vessel, and a plate is to be applied on its inner sides. The lower open end is conveniently closed (if open) as indicated at 14, and the object used as a receptacle for the bath. An extension 16 is preferably placed around the upper edge (to insure good plating on the end and edges of the object). The interior of the object is conveniently filled with the bath, to a level above its upper edge. Current at a proper density for electro-depositing chromium is passed from an anode to such object, as cathode. The anode for large objects is conveniently a ring 18 from which current at the proper density for depositing the chromium flows to a portion of the inner surface, as the portion comprised between the lines $x-x$, Fig. 2. The plating is preferably begun from the top. As the anode is lowered, the upper inside portion is left coated with chromium, and if desired, the solution level may be lowered successively to a level above the successive positions of the anode, the plated upper part no longer requiring protection. The unplated portions are protected from oxidation by the solution or by hydrogen held therein.

Referring to Fig. 3, the object to be plated is a long pipe of relatively small diameter.

A closure 20 is conveniently placed over the bottom and the plating bath introduced into the pipe. An extension 22 is preferably placed at the upper edge portion, and the level of the solution is preferably above the upper edge of the pipe. In order to avoid excessive concentration of hydrogen gas at and near the upper end of the pipe (and also excessive heat) the quantity of current passed from the anode to the pipe (cathode) is so limited that current at the required density for electrodepositing chromium only flows to a part of said pipe. The anode, as here shown, may be a short tubular anode, and an insulating guide 26 (of glass or porcelain for example) may be attached to said guide to keep it centered. It is so attached to the anode to permit free passage of hydrogen from the plating area. As here shown, it is placed below the plating area. After one portion is plated, the anode may be moved opposite other portions, the unplated portions being meanwhile protected from oxidation by the solution, or by hydrogen held therein. When plating is begun at the upper part, the solution level may be lowered as the anode is lowered.

Referring to Fig. 4, the article to be plated is also shown as a pipe or tube. It is likewise preferably provided with extensions 20 and 22. A piston or sliding dam 28 is placed therein, above which is mounted an annular anode. The plating is preferably begun at the bottom, and the piston pushed upward as the plating progresses. The solution may only partially fill the tube to a slight distance above the piston, the portions above the piston being preferably wetted, and protection maintained by hydrogen evolved during the plating. The piston 28 is preferably separated and insulated from the anode by a glass plate 29 or the like. The plating is carried on progressively in strips, as heretofore described.

Referring to Fig. 5, the object to be plated is a large sheet. It is partially immersed in a bath, and current at the required density for electrodepositing chromium passed from the anode to the submerged part, or parts of the sheet (cathode). The unplated portion above the solution level is protected from oxidation conveniently by flushing it with the bath solution discharged thereon from a perforated pipe 30, or other suitable means. After the submerged portion is plated, the plate is quickly inverted, and the upper unplated portion placed beneath the level of the bath, and then plated by passing current of the required density to it. The upper part above the bath level being now plated with chromium, protection from oxidation of the part projecting beyond the bath level is no longer required.

Difficulties are frequently met with in plating some surfaces, due to variable charac-

teristics as regards flow of current thereto. With cast-iron articles it is apparently explained by the fact that the surface portion beneath the surface plane (as seen under the microscope) is of a "honeycomb" or "spongy" structure, thereby presenting a greater real surface to the current than the area of the surface plane. Moreover, this honeycomb structure varies over the surface, so that not only more current than computed for the area of the surface plane is required, but variable amounts thereof per unit of plane area. Therefore an amount of current is passed to such articles based on the "honeycomb" or "spongy" sub-surface area. This cannot readily be computed, but runs up to two or three times the current density required by computation for the plane area unit. Moreover, plating of such surfaces, because of the variations, is best effected by plating portion by portion, or strip by strip (particularly where the surface or object is large), as there are less extremes of variation in the current flowing to different parts of a portion only of the surface than there would be in attempting to plate at once over the entire surface. As the chromium will not deposit below a determined current density for a given concentration, temperature, etc., excess of the minimum current density is best secured by plating portions at a time, as just explained. If the cathode articles shown in Figs. 1 and 2 were of cast iron, or are large (as indicated), it would be desirable to plate them in strips, if for no other reason, because of the variations of the current flow to different portions of such surface.

Moreover, by arranging the anode in the bath in such manner that current may pass therefrom to portions of the cathode surface adjacent the portion being plated at the time, at current densities which will release hydrogen (without being high enough to deposit chromium) an electrolytic cleaning of the surfaces of the cathode adjacent the successive portions of the surface being plated, will be effected, thereby greatly facilitating the obtaining of a good adherent deposit when such cleaned surface is subsequently covered with an electrodeposit. In Figs. 1 to 4, inclusive, current will pass from the anodes to the cathode surfaces adjacent the areas at which plating is indicated, the density of the current being such that hydrogen will be released without deposition of chromium, and thus electrolytic cleaning of such adjacent surfaces of the cathode effected.

The same process may be applied for plating from solutions containing other metals where similar conditions of hydrogen evolution, relatively high minimum current densities, etc. obtain.

The process may be carried out by other

modes of procedure than those herein specifically described.

What is claimed is:—

1. A method of chromium plating large objects and other objects where the conditions limit the current to a lesser amount than will furnish the required current-density for plating over the entire surface to be plated, comprising bringing such object into contact with a chromium plating bath for which a relatively large minimum current-density is required to effect deposition of the chromium, and passing a current from an anode to a portion of the surface of said object (cathode) at a current-density at or above the aforementioned minimum current-density to thereby plate chromium on said portion, maintaining the portion of the surface not being plated at the time, wet, and successively passing a current at or above the aforesaid minimum current-density to effect plating of chromium on successive unplated wetted portions of said object, while maintaining the portions of the surface of said object on which the plating is incomplete, wet.

2. A method of chromium plating according to claim 1, wherein the portion of the surface not being plated while another portion is being plated, is maintained wetted by bath solution.

3. A method of chromium plating according to claim 1, wherein the portion of the surface not being plated while another portion is being plated, is maintained wetted by bath solution carried by bubbles of hydrogen escaping from the bath solution.

4. A method of chromium plating interiors of tubular, or like objects, comprising introducing into said object a chromium plating solution of the type for which a relatively large minimum current-density is required to effect deposition of the chromium and from which bath during plating a relatively large volume of gas is evolved, passing a current from an anode to a portion of the surface of said object (cathode) at a current-density at or above the aforementioned minimum current-density to thereby deposit chromium on said portion, allowing free escape of the hydrogen from the area being plated, maintaining the portion of the surface not being plated at the time, wet, and successively passing a current at or above the aforesaid minimum to effect plating of chromium on successive unplated wetted portions of said object, while maintaining the portions of the surface of said object on which the plating is incomplete, wet.

5. A method of chromium plating interiors of tubular, or like objects, comprising introducing into said object a chromium plating solution, and passing a current from an anode to a portion of the surface of said object (cathode) at a sufficient current-density to electro-deposit chromium on such portion, al-

lowing free escape of hydrogen from the area being plated, beginning the plating at the upper end or part of said object, proceeding to deposit successively toward the bottom, and reducing the level of the solution in the object as the zone of plating proceeds downwardly.

6. A method of chromium plating the interior of hollow objects, comprising placing an extension on such objects exposing the interior edge portion of such object to the bath solution and to the flow of plating current, filling the object with solution above the upper edge of such object, and passing current to such object as cathode including the interior edge portion, at a current-density at or above the minimum current-density required to deposit chromium.

7. A method of chromium plating tubular objects comprising stopping the lower end of said object with a movable piston, introducing into said tubular object a quantity of plating solution considerably less than the capacity of said tubular object, placing an anode above said piston in said plating solution, passing a current from said anode to said object through said solution to deposit chromium on a portion of said object at a time, and advancing said piston and the solution in said object to cover fresh portions of the surface of said object and passing current through said solution in the successively advanced positions of said piston to deposit chromium on successive portions of said object.

In witness whereof, I have hereunto signed my name.

COLIN G. FINK.

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