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CHROMIUM PLATING PROCESS

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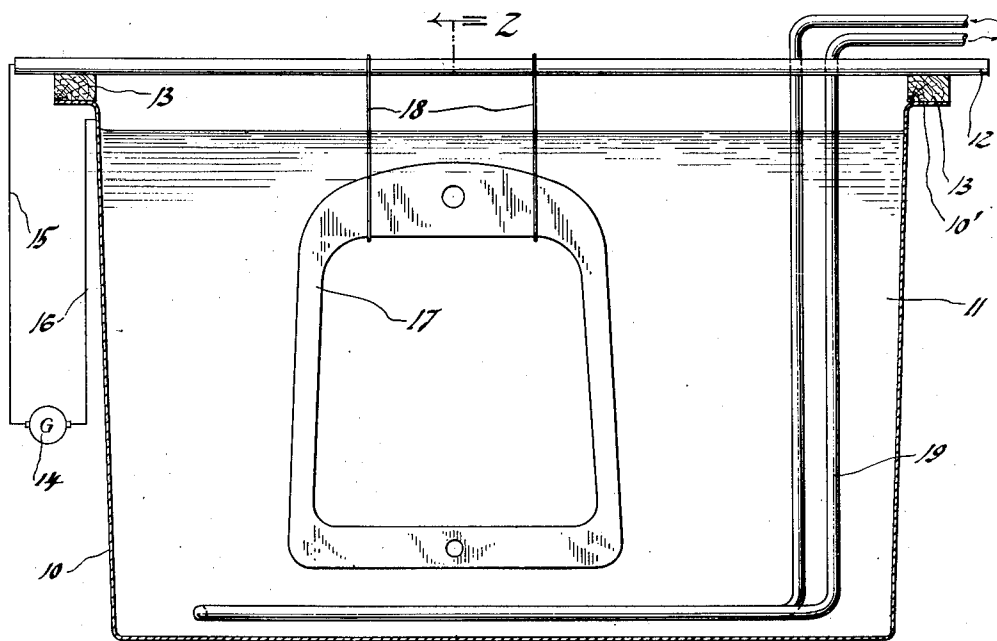


Fig. 1

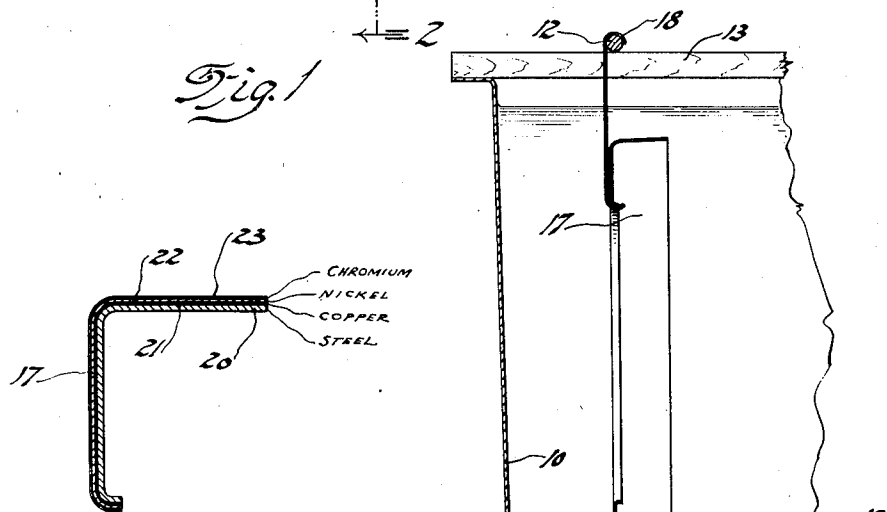


Fig. 3

Fig. 2

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CHROMIUM PLATING PROCESS

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The invention relates to electro-deposition of metallic chromium especially for the production upon conducting surfaces of a chromium plating for protective or decorative purposes. The effect of a layer of chromium in resisting corrosion and in protecting metals coated therewith when exposed to atmospheric and other corrosive agencies is well known, also its hardness and resistance to wear. The principal object of the invention, therefore, is to provide means whereby chromium plating may be carried on commercially with a high degree of uniformity in results and excellence in the product, both in appearance and in utilization of the desirable properties of chromium plate. To this end the invention comprises novel features in the treatment of the plating bath and of the articles to be plated, together with other details, all as hereinafter described and set forth in the appended claims.

In the accompanying drawing, Figure 1 is a vertical sectional view partly diagrammatic showing a plating apparatus which may be used in practicing the processes of the invention.

Fig. 2 is a section on line 2—2 of Figure 1, and

Fig. 3 is an enlarged sectional view through a portion of a radiator shell for automobiles showing the arrangement of coatings on a typical commercial article.

Referring to the drawing, 10 indicates a tank which is preferably formed of sheet steel and in which is a plating bath 11. The tank is shown as provided with flanges 10' at its upper edge on which is supported a bus bar 12 insulated from the tank by non-conducting blocks 13. Current may be supplied from any suitable source, as generator 14 connected to the bus bar and tank respectively by conductors 15, 16. An article to be plated, as an automobile radiator shell 17, may be suspended in the bath by conducting hooks 18 engaging the bus bar. A coil 19, through which heating or cooling medium may be circulated, may be provided for maintaining the desired temperature of the bath.

The chromium deposit can be applied to various conducting surfaces upon which the

chromium surface may give beneficial results as to appearance or durability, as upon the surface of articles of iron or steel, nickel, brass, copper, etc. When a bright surface finish of the chromium coating is desired the surface to which it is applied may first be polished or buffed. A bright coating of chromium can then be deposited which requires no buffing. By this means a brilliant chromium surface may be produced without any finishing step after the chromium plating except merely to wash the plated article and wipe same to remove any salts deposited by rinse water. In the production of coatings designed to protect iron or steel from corrosive effects of atmospheric agencies or the like excellent results have been obtained by first applying copper and nickel to the ferrous articles and depositing chromium over the copper-nickel coating.

As shown in the drawing, the radiator shell 17 is composed of a pressed steel body portion 20 upon which are deposited successive layers 21, 22, 23 of copper, nickel and chromium, respectively.

The preferred procedure is as follows:

The steel is first coated with copper and nickel in the usual manner. The nickel is buffed as usual and then cleaned, preferably in an electrolytic alkaline bath in which the work is made the negative electrode. It is then rinsed in water and dipped in an acid such as dilute sulphuric or muriatic, rinsed in water and transferred to the chromium plating bath. The acid treatment removes an almost infinitesimal alkaline film, which, if allowed to remain, often produces a cloudy effect in the chromium plate. The work is left in the chromium plating bath for a short time, preferably 1 to 5 minutes, and is then removed and washed in water. By this means a naturally lustrous coating is produced which needs no buffing or polishing during its life, and which protects the underlying metals from corrosion.

As shown, the tank 10 serves both as a container for the bath and as an anode for the supply of current. A material predominantly of ferrous metal, for example ordinary low carbon steel, is especially suitable for the ma-

material of the tank, as it is substantially unaffected by the ingredients of the bath which I employ for chromium plating and the tank or anode may be readily formed from sheet material.

The bath comprises soluble compounds of chromium principally chromic acid, CrO_3 , together with a relatively small amount of chromium sulphate, $\text{Cr}_2(\text{SO}_4)_3$, and preferably a small quantity of a compound containing the boric acid radical, for example, of boric acid. The proportions of the ingredients may be given as approximately 200 gr. of chromic acid, 1 to $12\frac{1}{2}$ gr. of chromium sulphate and 1 to $12\frac{1}{2}$ gr. of boric acid per liter of water.

The chromic acid of the bath serves as a reservoir for the supply of the chromium which is deposited electrolytically at the cathode. It is necessary, therefore, to replenish the chromic acid at intervals in order to maintain the original concentration. The preferred composition of a freshly prepared bath may be given as follows:

- 200-240 grams per liter of chromic acid, i. e., CrO_3
- 3-6 grams per liter of chromium sulphate, i. e., $\text{Cr}_2(\text{SO}_4)_3$
- 8 grams per liter of boric acid, i. e., H_3BO_3

It is important, for satisfactory operation of the bath, to restrict the total content of sulphates, including chromium sulphate, to that given, viz., not more than $12\frac{1}{2}$ gr. per liter, and preferably, for most uniform results, not more than approximately 6 gr. per liter. Since commercial grades of chromic acid usually contain some sulphates (including sulphuric acid) as impurities it will be obvious that the sulphate content of the bath will tend to increase with successive additions of chromic acid containing such impurities. It is essential therefore that the sulphate content of the chromic acid employed be limited to that which will not raise the total sulphate content beyond the desired range. A relatively small sulphate content in the acid is not objectionable since it serves to replenish the sulphates in the bath which are removed by loss of solution.

It is also important that the content in the bath of ingredients tending to corrode the ferrous metal of the container or anode preferably employed shall be restricted to an amount incapable of effecting undesirable corrosion. The ingredients specified for the bath have been found to have substantially no effect on the metal, but certain impurities usually present in commercial chromic acid, especially chlorides (including hydrochloric acid) tend to attack iron. It is desirable therefore, to restrict the content of such impurities in the chromic acid employed to the extent necessary to avoid their accumulation beyond a safe limit.

It will be understood that the loss of solution by "drag-out", i. e. by removal of solution adhering to the plated articles, and by spray, etc., will tend to keep down the undue accumulation of impurities. I have found it possible therefore to operate very successfully with chromic acid of ordinary commercial grade with a specified purity of at least 98%. I prefer, however, to limit the content of sulphates and of chlorides in the acid to approximately 0.5% of each. Such degree of purity has been found wholly satisfactory in factory production, although it will be understood that slight variations may be desirable above or below the limits set due to the fact that the percentage of loss of solution will vary somewhat depending upon the character of the articles being plated and with the amount of chromium applied thereto.

In order for the deposition of metallic chromium to take place it is necessary that chromium in reduced form, such as compounds which can be identified by analysis for Cr_2O_3 , be present in the bath, as it appears that deposition will not proceed satisfactorily when the chromium is present only as chromic acid and chromium sulphate. Therefore it may be desirable to treat a freshly prepared bath by passing current there-through for a short time before attempting to deposit chromium. This action causes reduction of sufficient chromium to provide for subsequent electrolytic deposition. The reduction, however, begins immediately with the flow of current when the anode area is greater than the cathode area, so that I have found it possible to begin plating as soon as the bath is prepared.

Since the reduction of chromium from the chromic acid continues during the deposition of metallic chromium there is a tendency for the bath to become continually richer in compounds of reduced chromium. In practice it is found advantageous for the Cr_2O_3 content to be kept below a value of approximately 25 gr. per liter. A certain degree of concentration may be reached in the normal operation of the bath at which an apparent state of approximate equilibrium occurs. At any time, however, when it is desirable to lower the proportion of reduced compounds it is only necessary to reverse the process by which the reduction is effected by substituting for the article being plated an anode of relatively small area of sheet lead, for example, and passing current through the bath in a direction the reverse of that used during deposition of metal and at a current density below that necessary for deposition of metal, thus reoxidizing a portion of the reduced chromium.

The bath is preferably maintained at a relatively high temperature during the plating operation as a much closer control of

current density must be maintained if the temperature is low. In practice a temperature of 105°-140° F. is most satisfactory. The current density is also kept at a relatively high point, the best results being secured with a current density of 100 to 200 amperes per square foot at the cathode.

It will be understood that slight variations in the details set forth may be made by one skilled in the art without departing from the scope of the invention and therefore I do not wish to be restricted to the specific features except as required by the language of the appended claims in view of the prior art.

I claim:

1. The process of depositing chromium electrolytically comprising passing electric current through a bath containing chromic acid with the use of a ferrous metal anode under conditions tending to produce in the bath an excessive amount of reduced chromium, and at intervals electrolyzing the bath with another anode of different material and under conditions adapted to lessen the excess of reduced chromium.

2. The process of treating a bath for depositing chromium electrolytically, said bath containing chromic acid and a compound recoverable upon analysis in the form of Cr_2O_3 , and in which bath is employed an iron or steel anode, comprising passing current through the bath in a direction opposite to that employed for depositing chromium, the iron or steel anode becoming cathode and another anode being used with such relation to the cathode as to oxidize the reduced chromium.

In testimony whereof I affix my signature.
WILLIAM M. PHILLIPS.