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J. J. LANDER

2,516,058

APPARATUS FOR PLATING OF METALS

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FIG. 2.

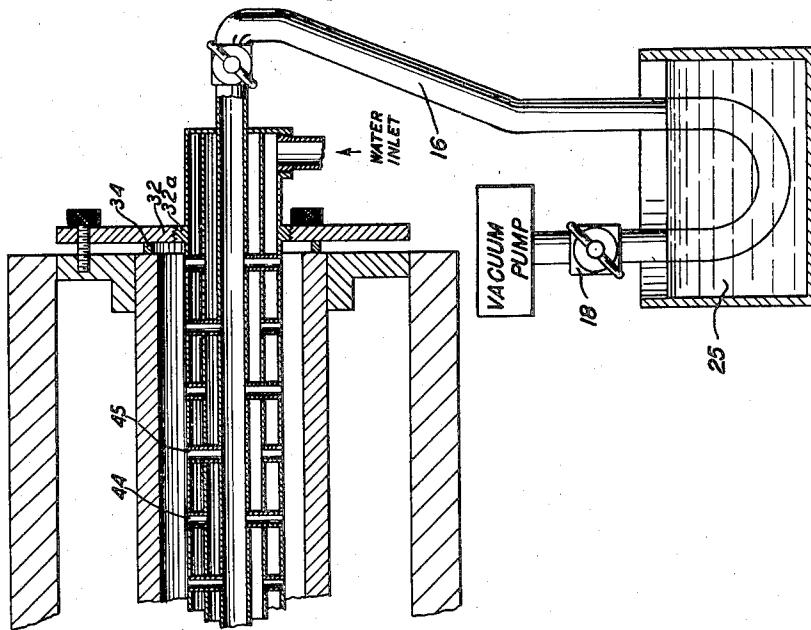
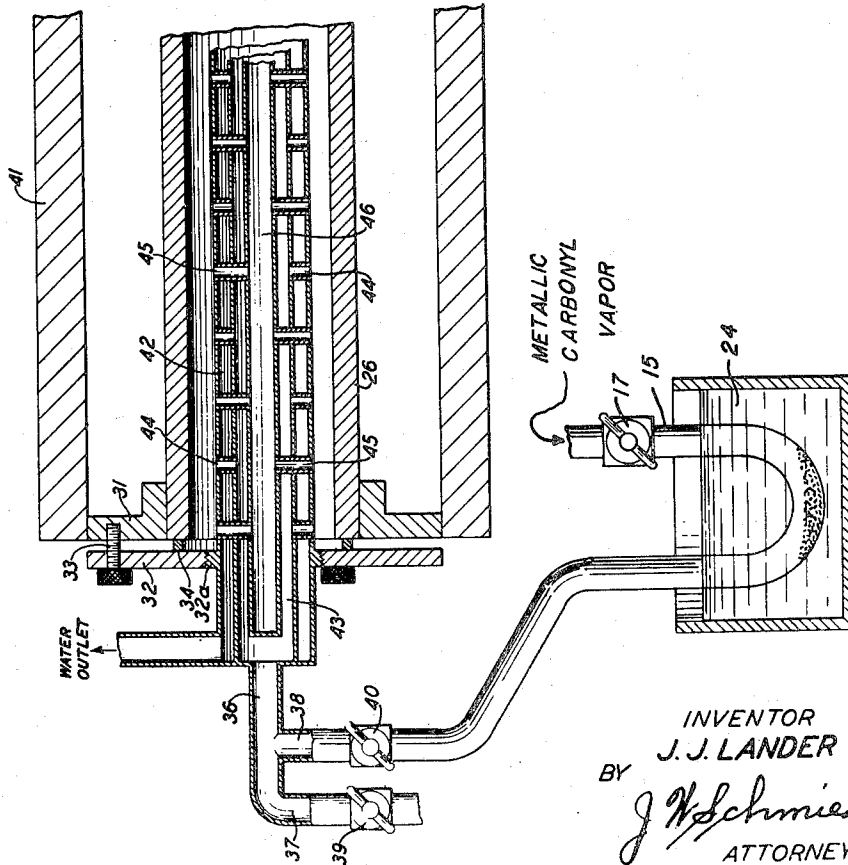


FIG. 1.



INVENTOR
J. J. LANDER
BY *J. H. Schmied*
ATTORNEY

UNITED STATES PATENT OFFICE

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APPARATUS FOR PLATING OF METALS

James J. Lander, Murray Hill, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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1 Claim. (Cl. 91—12.2)

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This invention relates to apparatus for coating metals, such as iron, steel, nickel or other metals, including those hereinafter mentioned, with chromium, tungsten or molybdenum.

Plating of objects which have internal surfaces, under-cut surfaces, depressions or grooves is often difficult because of the difficulty of depositing the plated metal upon the internal surfaces, the recesses, or in the bottom of grooves.

An object of the present invention is to provide apparatus for coating metal surfaces with tungsten, chromium or molybdenum more especially internal surfaces of hollow cylinders and similar objects.

Another object is to provide apparatus for supplying uniform and adherent coatings of tungsten, chromium or molybdenum or alloys of any two or all three of these metals to any desired portion of or to the whole of the interior or internal surfaces of metallic objects such as hollow cylinders.

A special feature of the invention consists in the use of a low pressure in the plating chamber.

Another special feature of the invention is the provision of means for varying the hardness of the applied metallic plating.

The invention may be practiced by causing the coating of metal to be applied by decomposition of tungsten, chromium and molybdenum carbonyls at the surface of the metal to be coated, the surface being maintained in suitable condition to cause the decomposition of the carbonyl and deposition of the metal upon the surface. The plating process is accomplished in an enclosed space under a reduced pressure maintained by a vacuum pump.

The surface to be plated may be treated preliminarily to the introduction of the carbonyl gas by heating it to relatively high temperatures such as 600° C. in a vacuum which is maintained by operating a vacuum pump. This tends to clean the surface.

However, hydrogen may be admitted to the plating vessel prior to, or during the plating operation, or both, and such uses of hydrogen may result in one or more of several kinds of beneficial effects; for best results the hydrogen should be purified and for this purpose known methods may be employed.

In the first place, the surface to be plated may be further or more effectively cleaned, with the result of a more perfectly adhering plate, by admitting hydrogen to come into contact with the surface to be plated either immediately or after the object has been subjected to vacuum

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for a period of time. The hydrogen is admitted from a suitable inlet and removed by a vacuum pump from a suitable outlet and during the time the surface to be plated is exposed to the hydrogen the temperature of the object having the surface to be plated may be raised as high as 600° C. or upward with the result that oxides and other substances upon the surface are removed.

The admission of hydrogen during the plating operation along with the carbonyl vapor may be through either the same inlet which supplies the carbonyl vapor or through a separate inlet. In either case an effect of the hydrogen is to produce an effect analogous to that which in electrolytic plating is sometimes styled "throwing power" which signifies that plating in crevices, grooves or depressions is more effectively accomplished and the metal plate is applied more uniformly over the surface to be plated.

Pressures of from $\frac{1}{16}$ to $\frac{1}{100}$ millimeter of mercury may be maintained in the plating vessel during plating; but the specification of these values is illustrative rather than limiting and with different metals or under different conditions with the same metal best results may be secured with some particular pressure. A suitable device to continuously indicate the pressure is not illustrated in the drawings described hereinafter but the method of application of such a device is considered obvious.

Apparatus illustrative of the apparatus used in practicing the invention and the method or mode of its employment is further described in connection with the accompanying drawing in which:

Fig. 1 illustrates the inlet end of an arrangement for delivering carbonyl gas more uniformly along the bore of a hollow tube to be plated and also removing CO gas, hydrogen and impurities from along the entire length thereof; and

Fig. 2 illustrates the outlet end of the apparatus of Fig. 1.

The hollow cylinder 26 may consist of iron, nickel, any type of steel or ferrous, cobaltous or nickelous alloy known to the art as well as metals or alloys of the metals tungsten, vanadium, titanium, molybdenum, tantalum, copper, or stainless steel, gun metal, cutlery steel, brass, bronze or any other metal of properties similar to these. It may be plated to produce a hard surface resistant to abrasion or a surface resistant to chemicals in gaseous or liquid form.

In connection with Figs. 1 and 2 it is contemplated that the member 32 should be sealed to the end of the gun barrel or other hollow tube

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to be plated. Before and after sealing as aforesaid carbonyl powder is placed in one of the U-shaped tubes, for example, the tube 15. At this time the tube 15 may be maintained cold by being immersed in brine, ice water, solid CO₂, or in any other suitable manner. If valves 17 and 40 are closed the tube 15 need not be cooled at this time. Permanently or separably mounted and sealed in the member 32 is a glass, vitreous, or metallic tube structure which includes or is connected to an inlet pipe 36 and other pipes and valves 37, 38, 39 and 40 in the same manner as in Fig. 3. Gaskets 34 and screws 33 provide a gas-tight seal. After the sealing operation is performed the tube 16 is connected to a vacuum pump and the valve 18 opened to thoroughly exhaust air from the interior of the sealed-in space enclosed by the hollow cylinder 26 and the end pieces 32.

As a preliminary operation after sealing the end pieces to the member 26, the carbonyl may be purified by placing it either in the tube 15 or 16, exhausting the vessel, warming the tube in which the carbonyl is placed, chilling the other tube, and distilling the metallic carbonyl from one tube 15 or 16 to the other, the valves 39, 17 and 18 being closed and valve 40 being open. This operation may be repeated one or more times or its equivalent may be performed in a separate vessel before placing the powdered carbonyl in the apparatus illustrated. The advantage of doing it in the same apparatus lies in the certainty with which recontamination of the material is prevented. For this purpose the media 24 and 25 may be alternately chilled or heated or replaced by media of suitable temperatures. We may assume that this step has been performed, if necessary, and the metallic carbonyl powder is in the tube 15 for the beginning of the plating operation and that the interior of the member 26 to be plated has been thoroughly exhausted of air. After the exhaustion or during the exhaustion hydrogen may be admitted through tube 37 in a slow stream until substantially the entire gas content of the tube consists of hydrogen and at any stage after the exhaustion, upon the admission of hydrogen or afterward, heat is applied by means of the furnace 41 or other suitable means to the cylinder 26. The plates 32, their sealing gaskets, and the entire structure 42, 43, 44, 45, 46 is kept cool by circulation of water through the water jacket 42 from the water inlet to the water outlet. The interior surface of the element 26 thus becomes heated and all oxides and other reducible foreign substances are removed from its internal surface by the combined effect of the heat and hydrogen gas. The element 26 is then adjusted in temperature, if necessary, to a suitable plating temperature and the valve 40 opened to admit vaporized metallic carbonyl. At this time the tube 15 may be heated by heating the medium 24 in which it is immersed, or otherwise, to a suitable temperature. The valve 18 is open and the operation of the vacuum pump connected to the tube 16 is continued to maintain a suitable degree of vacuum in the enclosed space in the interior of the tube 26. Hydrogen may be admitted through the valve 39 from a suitable source. The amount of hydrogen used may vary from none to several hundred or even several thousand molecules of H₂ per molecule of carbonyl; hydrogen equal to 100 molecules of H₂ per molecule of carbonyl produces good results. Suitable temperatures, depending upon the nature of the plate to be deposited, in the case of the carbonyls mentioned, may be in the range of 350° C. to 600° C.

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Medium 25 may be of low temperature to chill and condense metallic carbonyl during the plating operation and prevent waste thereof. The tube structure is provided with a water jacket 42 through which water is circulated to keep it cool. The carbonyl and hydrogen gases are supplied to an annular pipe 43 and pass out through any number of tubes 44 where they are exposed to the surface of the tubular member 26 to be plated. These outlets 44 may be of any desired size and any desired number and may be distributed uniformly or otherwise, both circumferentially and axially over the whole length of the structure. The outlet gases pass through other openings 45 to an interior tube 46 which is connected at the outlet end through a structure similar to the inlet end and to a vacuum pump. At the outlet end the member 32 may be screwed into place upon a flange 32a and further screwed down upon the gasket by screws 33, if necessary; the water inlet pipe and the tube 16 may be detachable and screwed or otherwise fastened into place for each operation. As stated above, the structure 42, 43, 44, 45, 46 may consist of glass, plastic, or vitreous material but it may equally well and preferably consist of metal. This metallic structure may be mounted to have the tube to be plated placed over it and fastened into position for the plating operation or the metallic structure may be thrust in the tube to be plated, which in such case would be preliminarily mounted in an oven 41 (diagrammatically indicated) or otherwise prepared to be heated to the desired degree. Owing to the fact that the carbonyl gas is supplied in a distributed manner over the entire inner surface, the plating may be made as uniform as desired by providing a suitable number and distribution of openings 44 and 46. The method and equipment may be adapted to tubes of very small diameter or large diameter or small length or great length by making the apparatus in a suitable size proportionate to the dimensions of the element to be plated upon its inner surface.

What is claimed is:

Apparatus for plating the interior of a hollow tube with metal comprising an elongated structure introducible into the hollow tube and extending substantially the entire length thereof, means for circulating a cooling fluid through the structure, means for supplying gas including gas of a metallic carbonyl into the structure, said structure comprising a plurality of outlet means distributed over substantially the entire length thereof for supplying the gas supplied thereto to the interior surface of the metallic tube to be plated, and a plurality of outlet means distributed over substantially the entire length thereof and leading to an outlet passage for removing said gas from the interior surface of the tube to be plated, a vacuum pump attached to said outlet passage, said structure when introduced into the hollow tube to be plated being sealed thereto to exclude all gases except those introduced intentionally along with the metallic carbonyl vapor.

JAMES J. LANDER.

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