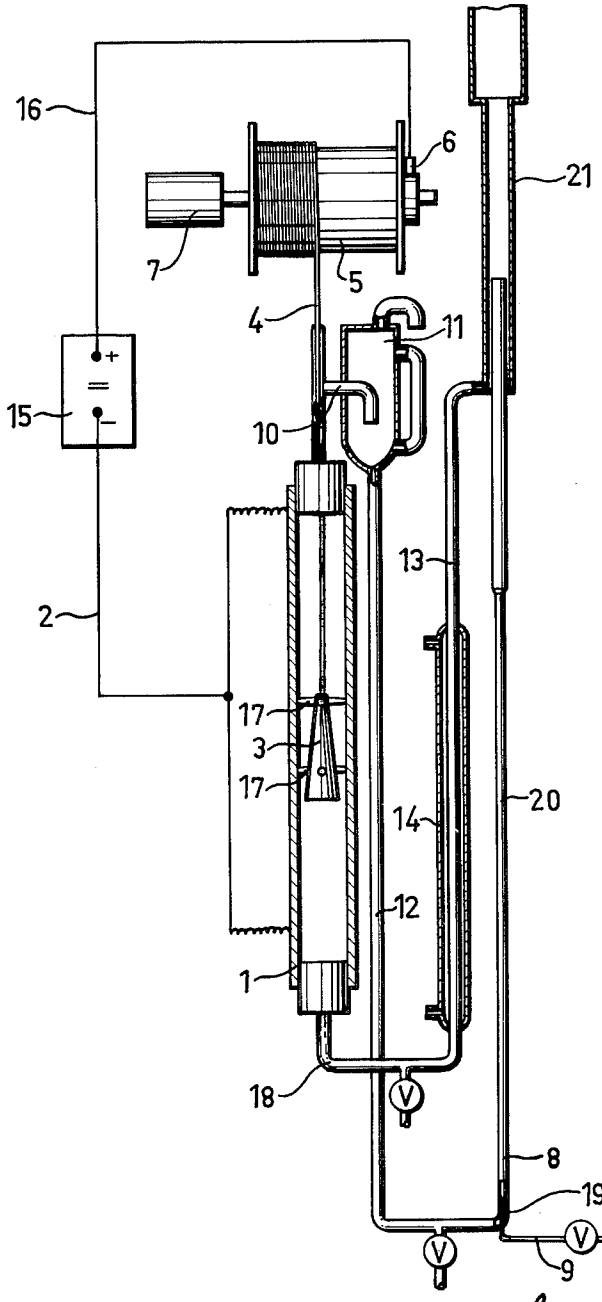
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METHOD OF ELECTROLYTIC METAL PLATING

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METHOD OF ELECTROLYTIC METAL PLATING

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1 Claim. (Cl. 204—26)

This invention relates to electrolytic surface treatment, and more particularly to depositing a metal such as chromium or nickel from an electrolyte upon a metallic surface. The object of the invention is to provide a method which produces a deposited metal layer which adheres firmly to the base, and which is not brittle or porous, and which has a smooth surface. The invention is primarily concerned with the treatment of the inner surface of tubes having a circular cross-sectional area, particularly very thin or slender tubes, but the invention can be applied in the internal or external treatment of tubes having other cross-sectional forms, and in the surface treatment of other metal objects, such as sheet metal.

The method of this invention is characterized in that the metal object coupled as a cathode and a body coupled as an anode are moved relative to each other and the electrolyte is directed to flow through the space between anode and cathode, and that the anode is so placed in relation to the cathode that the space between them widens in the direction of movement of the anode, and that the electrolyte is brought to flow in the direction of movement of the anode.

The positive result, which is achieved with the anode used as described in the invention, is probably due to the fact that the injurious effect of the gas bubbles formed during the depositing process is reduced. During the electrolytic treatment a large number of gas bubbles are formed and these disturb the passage of the current in the space between the cathode and anode and should therefore be removed from this space as quickly as possible. This takes place partly because of the flow of the electrolyte and partly because the gas bubbles tend to rise. The most favourable conditions for the removal of the gas bubbles are, therefore, obtained if the object to be treated is placed vertically and the anode body is moved upward and the electrolyte is made to flow upward in the space between the anode and the cathode. From the underside of the anode body, where the space is narrowest and the current density accordingly is greatest, there flows from below a gas-free electrolyte which quickly carries upward the gas bubbles that have formed in that zone. At the top of the anode body the space is widest and the current density accordingly at its lowest, and therefore the gas bubbles present in that zone do not have any particularly injurious effect on the process. When the anode body is moved upward during the treatment, the upper part will thus cause a preliminary treatment of the metal surface while the finishing deposition, which determines the surface quality, is dealt with by the lower part of the anode body which in fact operates free from the disturbing effect of gas bubbles.

The invention will be described more exactly below by reference to the accompanying drawing, which shows an arrangement for the internal plating of tubes and other hollow bodies.

According to the figure a tube **1** that is to be plated internally is by means of a lead **2** connected to the negative pole of a direct current source **15**. In the tube an anode body **3** is arranged in the form of a truncated cone supported by an insulated cable **4** which, since it also serves to convey the current, is preferably of copper. The

cable **4** is wound on a drum **5** which is driven by a motor **7**. By means of a sliding contact **6** and a lead **16**, the cable and thereby the anode body are connected to the positive pole of the direct current source **15**.

To ensure that the anode body **3** is held centrally in the tube **1**, it is equipped with projections **17** of a non-conducting substance such as hard rubber which rest against the inside wall of the tube.

During the operation the electrolyte is introduced into the lower end of the tube **1** through a conduit **18**. The electrolyte is led out of the upper end of the tube through a pipe **10** to a container **11** in which some of the gas bubbles formed during electrolysis are separated from the electrolyte. From the container **11** the electrolyte is conveyed through a conduit **12** to a circulating pump **8** which can, in principle, be of any type, but which is visualised in the illustrated arrangement as consisting of a jet **19** for the injection of a gas, such as air into the electrolyte. The gas draws the electrolyte fluid along with it, partly through the effect of the injector and partly through the so-called mammoth pump effect. The mixture of fluid and gas bubbles rises up through a stand pipe **20** to a larger pipe or container **21**, where the gas and fluid are separated and then the electrolyte, because of the force of gravity, runs through a conduit **13** to a heat exchanger **14** where it can be cooled or heated and then on through a conduit **18** to the bottom of the tube **1**.

The anode body, consisting of nickel, for instance, is made so that its upper end is only as thick as is necessary for the connection of the cable **4** carrying the current. The lower end of the cone should not be larger than required so that the space between the cone and the wall of the tube permits the passage of the desired amount of electrolyte. The length of the cathode body, that is to say the height of the cone, should be such that the surface of the cone corresponds to the desired current density.

Example

The apparatus illustrated in the figure was used for applying a nickel coating on the inner wall of a cylindrical body having a central boring of a diameter of 60 millimeters. The hollow body had a length of 400 millimeters and an outer diameter of 150 millimeters. It consisted of an austenitic stainless chromium-nickel steel.

The hollow cylindrical body was placed with the boring extending vertically, and was connected to the negative pole of the direct current source **15**. The voltage was so controlled that the average current density, based upon the entire wall of the anode body, was 6 amperes per square decimeter. The anode body consisted of nickel, and had the shape of a truncated cone having a height of 210 millimeters, an upper diameter of 22 millimeters and a bottom diameter of 52 millimeters. The anode body was lifted at such a rate that each point of the boring was exposed to the electric current for a period of 35 minutes.

The electrolyte was an electrolyte called Efco-Udulite 66H, containing a nickel salt in a concentration of 330 grams per liter. It was circulated by a stream of air through the pump **8**, and it was kept at a temperature of 60° C. during the process.

The process now described produced on the wall of the boring a nickel coating having a thickness of 40 microns. It was found that this nickel coating had an excellent quality; it adhered firmly to the base metal and it had a high ductility which showed that the absorption of hydrogen or other gases had been very low during the electrolytic treatment.

What is claimed is:

A method of electroplating a surface of a metal object which comprises arranging the metal object, coupled as a

cathode, and a metal body, coupled as an anode, generally vertically and separated from each other sufficiently to define between them a space for electrolyte; passing unidirectional direct current from anode to cathode through intervening electrolyte while upwardly moving the anode with respect to the cathode and as the anode passes each successive zone of said cathode surface progressively diminishing the distance between anode and cathode thereby initiating electrodeposition under relatively low-current density conditions and then progressively increasing current density to maximum, whereby each successive spot on the surface to be plated receives deposition under conditions of minimum current density followed by progressively increasing current density, and

simultaneously establishing and maintaining an upwardly flowing current of electrolyte through said space thereby sweeping upwardly out of said space any gas bubbles which may form on said surface.

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