Feb. 3, 1948. H. S. HATFIELD 2,435,273

METHOD OF COATING WITH TUNGSTEN CARBIDE

Filed July 14, 1942

Fig. 1.

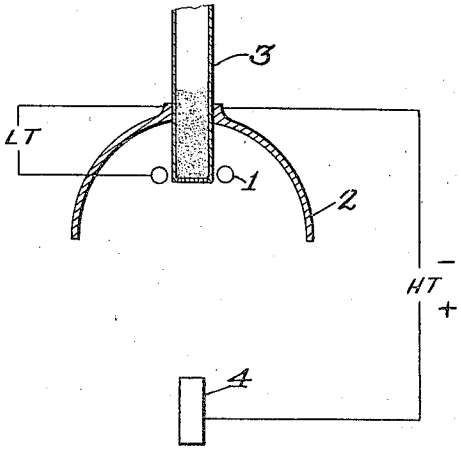
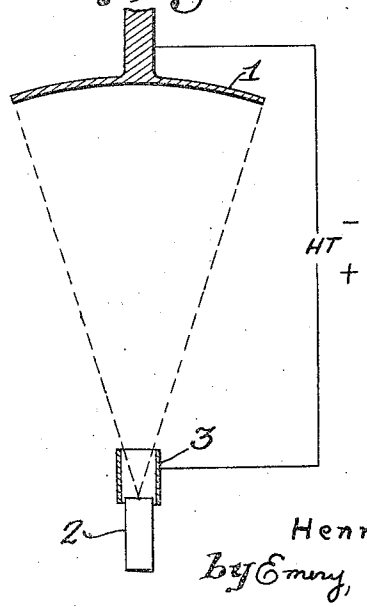


Fig. 2.



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2,435,273

METHOD OF COATING WITH TUNGSTEN CARBIDE

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6 Claims. (Cl. 117—93)

1

This invention relates to means for coating, treating, or otherwise changing the surface of solid bodies, and according to it, the surface of the body is heated to a high temperature for a very short time by exposure to a beam of high-velocity particles such as cathode, or positive, rays. The process is particularly applicable to the incorporation with the surface of a very thin layer of another material having special properties, such for example as great hardness, resistance to corrosion or abrasion, electrically important properties such as photo-electric or secondary electron emission, and the like. The beam of rays, focussed on the surface, heats it and the coating material (supplied before or during the application of the rays, very rapidly to the point at which they fuse together. Such material may first be applied to the surface by any suitable means in the form of a coating, and then be incorporated by exposure to the rays. Or it may be injected in the form of a fine powder into the beam of rays, or be evaporated by suitable means so as to be deposited on the surface. It is a common practice to fuse a thin layer of material onto the surface of a body by means of a blowpipe, the material being previously applied to the surface, or fed to it simultaneously with the flame. This invention consists essentially in the use as a new sort of blowpipe of focussed electric rays. This allows a very high temperature to be attained so quickly that amalgamation of the coating with the surface occurs before the heat penetrates.

For example, hard steel parts may be coated with very finely powdered tungsten or other hard metal carbide, and exposed to the beam. Alternatively, the finely powdered carbide may be fed mechanically into the beam as it is made to impinge on the surface. The metal may also be coated with tungsten, or may contain it in the form of an alloy, and the carbide be afterwards formed from carbon powder applied under the heat of the beam.

I will describe two ways in which the standard forms of apparatus used for producing X-rays by the action of a beam of cathode rays upon a target, may be adapted with little change to serve the purposes of this invention. Figure 1 of the accompanying drawing represents in section the manner of using a "hot-cathode" apparatus, Figure 2 the adaptation of a cold-cathode apparatus, such as was in general use for generating X-rays before the invention of the hot cathode. Each has its advantages for the purpose of this invention, for the following reasons:

2

In the hot cathode tube, the electrons escape from the cathode into an electrostatic field which extends to the anode, the applied high voltage being distributed over this space, so that it is necessary for the target to be situated near the cathode, and to be the anode. There is therefore a very strong electric field at the surface of the target, which tends to cause any loosely adherent matter to be thrown off. In the cold cathode arrangement, the applied high potential results in a strong field very close to the surface of the cathode, and the electrons emitted from the latter are therefore given a very high velocity in a direction at right angles to the surface of the cathode, flying to a focus at the target, which may be at any desired distance from the cathode. In the cold cathode tube, the presence of gas is necessary; 0.001 mm. of hydrogen gas is usually chosen. This is an advantage in that a very high vacuum is not necessary; on the other hand, the pressure of the gas has a great effect upon the amount and velocity of the electrons emitted. Since in carrying out this invention we are necessarily working with "demountable" apparatus, that is, apparatus in which the vacuum has to be broken from time to time, there is no difficulty, with modern pumps and appliances, in adjusting the gas pressure as required. In the cold cathode tube, there is only a small electrostatic field near the surface of the target, and this may be almost abolished by a suitable screen.

A hot-cathode arrangement suitable for coating small steel parts, such as the working faces of limit gauges, with tungsten carbide, is shown in Fig. 1. The cathode filament 1 is enclosed in a metal bell 2, open below, and having in its centre a small vessel 3, made of tungsten or molybdenum. This vessel has a perforated bottom, and contains tungsten carbide powder, which passes through the perforations at the bottom when the apparatus is subjected to vibration, at a rate dependent upon the intensity of the vibration. 4 is the part to be coated, such as a small cylinder of steel intended for a limit gauge. It is connected to the positive end of the high tension supply, which is of any standard form as used for X-ray work. The apparatus used for producing vibration may also be of any standard type used for causing powders to pass through screens.

The waste heat from the cathode serves to heat the tungsten powder; the target may also be heated in the manner familiar in the degassing of vacuum tubes, by subjecting it to a high-frequency field. Preheating shortens the period of

exposure necessary to cause the powder to amalgamate with the surface of the target.

The apparatus is enclosed in a suitable vacuum chamber. This is of sufficient size to permit of the parts to be treated to be set ready on a turntable or belt, so that they can be treated one after the other without breaking the vacuum.

Fig. 2 shows a cold-cathode arrangement. The cathode 1 is of the usual concave form, which leads to a focus of the rays on the target 2. This is surrounded by a metal tube 3, in electrical connection with it. This practically abolishes any electrostatic field at the surface to be coated, and allows the powder to be used as coating to be applied with little or no adhesive. I have found that an even coating, sufficiently adherent, may be made by mixing the powder with a little toluol or other volatile hydrocarbon.

Particularly with the longer beam of rays produced by the cold cathode, it is easy to use a magnetic field, in the well known manner, to adjust the position of the focus of the rays. Furthermore, this position may be made to "scan" the surface of the object to be coated, in the manner familiar in the case of the television cathode ray tube, so as to cover, step by step, a larger area. It is obvious that this invention lends itself to automatic operation, since the heat applied, the time of its application, and the area to which it is applied, can all be determined with great nicety.

I have described the invention in connection with one application only, and using only one sort of rays. I do not wish myself to be limited to this. The method of heating a surface to a very high temperature by the impact of particle rays, unlike any other method, allows the temperature to be attained so quickly that the penetration of it below the surface is reduced to a minimum. This enables closely dimensioned parts to be treated without serious disturbance of the worked surface.

I claim:

1. The method of coating a metallic surface which comprises applying to said surface powdered tungsten carbide and simultaneously subjecting said surface as it is contacted with said carbide to a focussed beam of cathode rays for a time sufficient to amalgamate said metallic surface and said carbide, said metallic surface comprising the anode relative to the source of cathode rays.

2. The method of coating a metallic surface which comprises directing a stream of powdered tungsten carbide through a cathode zone on to said metallic surface comprising the anode, thereby preheating said carbide, and simultaneously focussing cathode rays on to said anodic metallic surface at the area of contact with said carbide for a time sufficient to amalgamate said anode surface and said powdered tungsten carbide.

3. The method of coating a steel surface which comprises applying to said surface powdered tungsten carbide and simultaneously subjecting said surface as it is contacted with said carbide to a focussed beam of cathode rays for a time sufficient to amalgamate and coat said surface with said carbide, said surface being the anode relative to the source of cathode rays.

4. The method of coating a metallic surface which comprises applying to said surface powdered tungsten carbide, subjecting said surface together with said carbide to a focused beam of cathode rays for a time sufficient to amalgamate said metallic surface and said carbide.

5. The method of coating a metallic surface which comprises applying to said surface powdered tungsten, contacting said tungsten on said surface with powdered carbon, and simultaneously subjecting said surface together with the powdered material thereon to a focused beam of cathode rays for a time sufficient to form tungsten carbide and to amalgamate said metallic surface with said carbide, said metallic surface being the anode relative to the source of cathode rays.

6. The method of coating a metallic surface which comprises applying thereto a powdered tungsten carbide, subjecting said surface together with said carbide to a focused electron ray bombardment for a time sufficient to amalgamate said metallic surface with said carbide, said metallic surface comprising the anode relative to the source of cathode rays and being substantially free from any electrostatic field, and regulating the position of the focus of said rays relative to a predetermined surface area and for scanning.

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