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(54) **PLASMA-ELECTROLYTIC POLISHING OF
METALS PRODUCTS**

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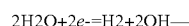
(57) **ABSTRACT**

Plasma-electrolytic polishing (PEP) of titanium alloy and
other metals where plasma effect takes place when voltage
does not exceed 80V DC.

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PLASMA-ELECTROLYTIC POLISHING OF METALS PRODUCTS

[0001] Plasma-electrolytic polishing (PEP) of metal products was discovered in 1986 [1]. The process is based on the smoothing of micro-roughness surfaces in a passage of current through ionized layer separating the electrolyte from the surface of the metal, with the application between a sufficiently high voltage (from 90 to 290 v). The voltage applied to the piece (+) and electronic conductor (cathode) immersed in the electrolyte (-). Steam layer is formed as a result of overheating electrolyte in contact with the surface of the product, above the point of boiling, Joule heat and abundant gas (the cathode), caused by the electrolysis of water. At the auxiliary electrode (cathode), which has a surface much more than surface processed products, ionized layer of steam is not occurs and the surface of the cathode in contact with the electrolyte. On boundary of the cathode to the electrolyte flow electrochemical reactions generally—the restoration of water to hydrogen gas:



[0002] Later it was suggested to use more high voltage (200-400 V) for the sustainable maintenance of steam layer and its ionization [2]. EPA has a significant advantage over the conventional process electrolytic polishing (EP), is the ability to use as the electrolyte harmless to human health, cheap and environmentally friendly solutions of low-concentration salts. The disadvantages of EPA are:

[0003] a) high energy, ten times more than energy PE; b) the high cost of equipment. The high cost of equipment due to high power PEP power supply and the need to ensure reliable electrical safety at high DC voltages.

[0004] Studies of the EPA showed that in order to maintain stable Ionized steam layer (plasma) is needed some thermal power per unit area of treated surface WS.

[0005] This power can be roughly estimated by the formula:

$$W_s = i * U \quad (1)$$

where i —current density on the treated surface, U —voltage between the product and the cathode. Formula (1) is approximate because the majority (80-90%) of voltage is lost by passing electrical current through the steam layer. The value of W_s depends on the composition of the material products of the electrolyte temperature and other factors, but remained within the 100-300 Wt/cm². With increasing current density-voltage, under with the formula (1), decreases:

$$i = W_s / U \quad (2)$$

[0006] On the other hand, the polishing rate is proportional to the current density, as well as removal of metal in the PEP, as well as in PE is proportional to current density.

[0007] Time t_p , inversely proportional to the speed of removing the metal and is directly proportional to voltage:

$$t_p = k * (U / W_s) \quad (3)$$

[0008] Total Energy E is equal to multiplication of W_s by timing t_p and is proportional to voltage U :

$$E = t_p * W_s = kU \quad (4)$$

[0009] Thus, to reduce the energy consumption of the process, it is necessary to reduce the operating voltage. This current density will grow in accordance with the formula (3).

[0010] At the same time, reducing the voltage from hundreds of volts to values below 80V, sharply reduces the chance of injury of personnel of electric shocks and allows to simplify and reduce the price of equipment. Experience shows that the way to improve the PEP real, and the PEP at 80 and below can be practically implemented, which can be confirmed by a number of examples.

EXAMPLE NUMBER 1

[0011] Stainless steel type 400 and 300 may be polished in the electrolyte consisting of 70% solution of phosphoric acid in water 75 C temperature, voltage 48 V, current density 2-3 A/cm². Polishing time 15-45 sec.

EXAMPLE NUMBER 2

[0012] Copper can be polished in a solution: 57% sodium phosphate (NaH₂PO₄)+9% H₃PO₄ (phosphoric acid) at a temperature of 70 C, with a voltage of 35 V, current density 8-9 A/cm². Time polishing 2-10 sec.

EXAMPLE NUMBER 3

[0013] Products made of titanium alloy Ti, 6% Al, 4% V can be polished in the electrolyte consisting of 50% phosphoric acid, 10% Sodium perchlorate, 1% of hydrofluoric acid HF in the 75 C temperature, current density 1.5-2 A/cm². Time 30-60 sec.

EXAMPLE NUMBER 4

[0014] Products made of aluminum alloy Al, 4% Cu, 0.9% Mn can be polished in a solution containing 50% polypropylene-glycol, 39% water, 10% Sulfuric acid, 2.5% Ammonium Fluoride, at 80 C temperature, voltage 80 V, current density 1.2-1.5 A/cm². Polishing time 30-60 seconds.

LITERATURE.

[0015] 1. Patent of German Democratic Republic (DD) #238074 (A1), Class 25F3/16, published Aug. 6, 1986

[0016] 2. U.S. Pat. No. 5,028,304, Class B23H3/08, C25F3/16, C25F5/00, Published Feb. 7, 1991

What is claimed is:

1. method of plasma electrolytic polishing surface metal products, including immersion in electrolyte, processed products and electro-conducting auxiliary electrode (cathode) and the application of permanent tension between manufacturing and product support electrode, only difference is that in order to reduce energy consumption and to avoid the risk of destruction of people with electric shocks, DC voltage does not exceed 80 V.

2. The method of claim 1, characterized that as the electrolyte use water or water-organic solutions inorganic acids and their salts.

3. The method of claim 1, characterized that the temperature of the electrolyte is in the interval from 20 to 100 C, mostly from 70 to 100 C.

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