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ELECTRO-CLEANING OF VANADIUM

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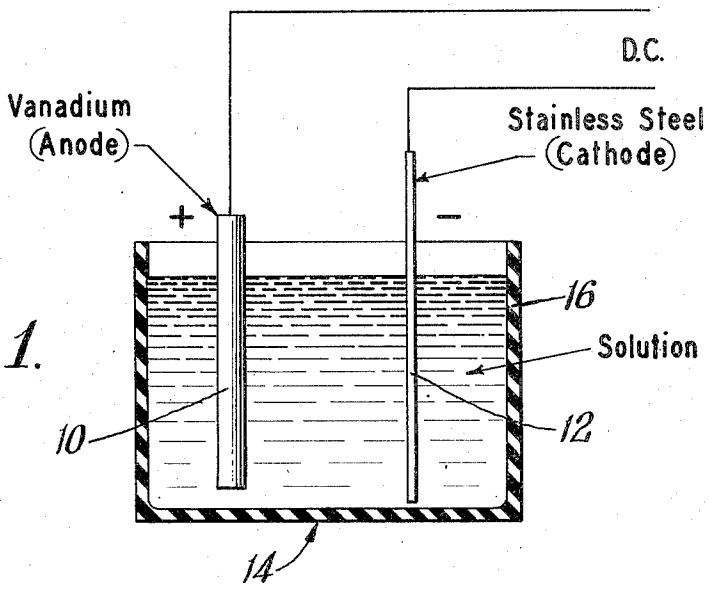



Fig. 1.

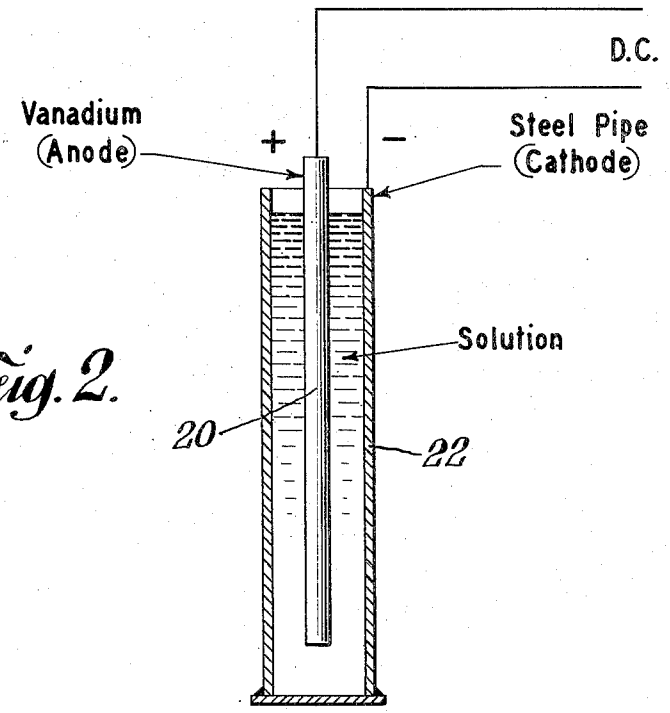



Fig. 2.

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# ELECTRO-CLEANING OF VANADIUM

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12 Claims. (Cl. 204—141)

This invention pertains to vanadium, and more specifically relates to a method of electro-cleaning this metal in preparation for its cold working and to apparatus for doing the same.

Because of its high affinity for oxygen, vanadium acquires a hard and brittle skin surface when it is hot worked. Since oxygen dissolves in the vanadium to a high weight content during this process, no protective oxide coating forms on the metallic surface, but rather there is formed a brittle layer beneath the oxide surface of the metal. When vanadium is cold worked in this condition, or if an attempt is made to straighten distorted bars of this metal, the oxygen-bearing surface metal cracks.

In the past, vanadium metal bars and rods having a diameter greater than ½ inch have been finished by machining from hot rolled stock. Similar sizes were prepared by cold swaging ½ inch diameter machined parts. Machining the hard surface of vanadium is, however, a difficult as well as a wasteful practice since special rests and set-ups are necessary in the machining of long lengths of hot rolled bars, and since the ductile vanadium rising along the irregular metallic surface is thereby lost.

It is, therefore, the primary object of this invention to electrically clean vanadium metal so as to enable it to be cold worked without surface cracking, and simultaneously obtain a maximum recovery of ductile vanadium by eliminating the necessity of surface machining of the hot worked metal.

It is another object of this invention to provide an inexpensive and safe electrolyte which will electro-clean vanadium without pitting its surface, and which does not require critical current densities.

These objects are attained in the practice of this invention, which comprises using vanadium metal as the anode of an electrolytic cell having a suitable cathode, an aqueous alkali metal carbonate or bicarbonate electrolyte, applying direct current of a predetermined voltage and suitable current density, and allowing electrolytic action to proceed until the hard, brittle metallic layer on the vanadium metal is removed.

In the drawings:

Fig. 1 represents a convenient embodiment of this invention; and

Fig. 2 represents a further refinement of the invention.

Sodium carbonate is the preferred electrolyte for this process, for in addition to being inexpensive, safe and easy to handle, it effectively electro-cleans vanadium without pitting. With many other electrolytes, if current density is not properly adjusted, metal is removed, but the metallic surface is adversely affected. With sodium carbonate, current density is not critical in this respect.

An aqueous sodium carbonate solution ranging from 10% to 15% by weight is preferred, but concentrated solutions having as much as 35% sodium carbonate, the solubility limit of this compound in hot water, or as little as 5%, are also suitable in the practice of this invention.

Other electrolytes having carbonate ions such as potassium carbonate, ammonium carbonate and the like may also be used in this method in equivalent concentrations up to their saturation points as may also sodium bicarbonate, potassium bicarbonate and other similar electrolytes capable of providing bicarbonate ions.



Current density values may vary between 0.26 and 1.2 amperes per square inch. In particular cases, current densities as high as 6 amperes per square inch may be used. The lower values indicated, however, are preferred, as they permit the exercise of better control over the cleaning operation, and avoid possible excessive loss of sound metal.

Quality control of the electro-cleaned vanadium metal is accomplished by hardness tests taken periodically during the electrolytic process. The electrolysis is preferably continued to a point at which the vanadium plate has a maximum of Rockwell B75 to B85 since this figure is sufficiently low to allow its cold working. These figures are not in any way critical, however. What is important is that excessively hard and contaminated outer layers of metal should be removed until a uniform base metal hardness is reached.

As an example of the practice of this invention, a vanadium plate measuring ⅜ inch x 3½ inches x 13 inches was formed by hot rolling at 1150° C. This plate was prepared for electro-cleaning by sand blasting its surface to remove the heavy oxide film which covered it. The plate **10** then served as the anode and a stainless steel strip **12** as the cathode of an electrolytic cell **14** consisting of a hard rubber vat **16** filled with a 10% solution of sodium carbonate. A current of 20 amperes was applied for 22 hours, during which time periodic hardness tests were made on the vanadium plate. It was found after the complete treatment that the smooth and polished surface of the plate was completely free of its hard surface layer. During this process the plate thickness was reduced from 0.365 inch to 0.280 inch. It was subsequently cold rolled without any difficulty to 0.030 inch.

As a further example of the practice of this invention, a hot worked vanadium rod, **20**, 0.550 inch in diameter by 36 inches in length was immersed in a steel pipe **22**, which in addition to being the cell cathode, also served as the electrolytic cell, as shown in Fig. 2. A 20% solution of sodium carbonate was supplied to this pipe, and a direct current of 15 amperes was applied for 4½ hours. The original diameter of the bar, 0.550 inch, was reduced to 0.440 inch. By the use of this modification of the invention, the brittle surface of the bar was cleaned equally on all sides. The electro-cleaned bar was then easily conventionally swaged to ⅜ inch in diameter. Round rods treated in this manner were cut to size with regular cutting tools instead of requiring carbide tools as is the case where the hard surface is not removed.

It is thus seen that the shape and size of the electrolytic cells employed in the practice of this invention are not at all critical, but may be varied within wide limits in order to accommodate anodes of various shapes and sizes.

In both examples given above, the recovery of vanadium in cold rolled bars or sheets after the electrolytic step is above 80%, as opposed to below 50% as occurs when the hot worked vanadium is machined prior to cold rolling.

The present invention makes possible the removal of the contaminated outside layer of vanadium of high oxygen content resulting from the hot working process, by electro-cleaning, using carbonate or bicarbonate solutions as the electrolyte, thereby eliminating the machining step for rods to be cold swaged to sizes smaller than ½ inch, or for cold rolling vanadium plates to thin sheets.

What is claimed is:

1. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous electrolyte consisting of ions selected from the group consisting of the alkali metal carbonates and alkali metal bicarbonates, applying a direct current of pre-determined voltage and continuing electrolytic action until the brittle layer of the vanadium metal has been removed.

2. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell, using an aqueous electrolyte consisting of alkali metal carbonate ions at a concentration range between 5% and 35%, and continuing electrolysis until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

3. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous electrolyte consisting of alkali metal carbonate ions, applying a direct current having a density between 0.2 and 6.0 amperes per square inch and continuing electrolytic action until the brittle layer of the vanadium metal has been removed.

4. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell using an aqueous sodium carbonate electrolyte having a concentration range between 5% and 35%, and continuing electrolysis until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

5. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell, using an aqueous sodium carbonate electrolyte having a concentration of about 10%, and continuing electrolysis under a current density ranging between 0.2 and 1.2 amperes per square inch until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

6. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous potassium carbonate electrolyte, and continuing electrolysis until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

7. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an ammonium carbonate electrolyte at a concentration range between 5% and saturation, and continuing electrolysis until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.



8. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell using a potassium carbonate electrolyte at a concentration range between 5% and saturation, and continuing electrolysis under a current density ranging between 0.2 and 6.0 amperes per square inch until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

9. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell using an ammonium carbonate electrolyte at a concentration range between 5% and saturation, and continuing electrolysis under a current density ranging between 0.2 and 6.0 amperes per square inch until the said vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform hardness is obtained.

10. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous electrolyte consisting of bicarbonate ions, applying a direct current of predetermined voltage, and continuing electolytic action until the brittle layer of the vanadium metal has been removed.

11. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous sodium bicarbonate electrolyte at a concentration range between 5% and saturation, and continuing electrolysis until the vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform thickness is obtained.

12. The method of electrically removing the contaminated, high oxygen-containing surface layer of vanadium metal which comprises making the metal to be treated the anode of an electrolytic cell having an aqueous potassium bicarbonate electrolyte at a concentration range between 5% and saturation, and continuing electrolysis until the vanadium metal has been freed from the hard contaminated outer layers, and base metal of uniform thickness is obtained.

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