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ELECTROPOLISHING OF TITANIUM BASE ALLOYS

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This invention relates to an electropolishing solution and to a method for electropolishing titanium base alloys.

During the fabrication of structural elements composed of titanium base alloys, it often becomes necessary to polish the surfaces of such elements and convert them to a high luster. In general, polished surfaces are obtained by buffing, mechanical polishing, electroplating or electropolishing. Electropolishing has been found to be very desirable because it is economical and provides a bright and highly lustrous surface on most metals and their alloys. Electropolishing, as a process, generally comprises the steps of immersing a metal object to be polished, as an anode, in an electrolytic solution and passing a current through the solution between the metal object being polished and another object referred to as the cathode. The electrolytic solutions employed heretofore in the electropolishing of metals and their alloys are aqueous acid solutions generally containing perchloric or hydrofluoric acid as their principal constituent. However, such solutions are highly corrosive in character and are potentially explosive. They are difficult to handle and oftentimes violent in action. In addition, the use of these solutions often produced semi-polished areas as well as undesirable pits in the surface areas. A further problem resides in the fact that titanium base alloys themselves are difficult to electropolish because of their inability to pass current as an anode in most aqueous electrolytes.

In accordance with this invention, however, it has been found that the surface of titanium base alloys can be successfully polished to a smooth bright lustre by employing an electrolytic solution which contains ammonium bifluoride, fluoboric acid, hydrochloric acid and formamide. This solution is relatively economical in use and produces a highly effective solvent action on the surface of titanium base alloys. The potential explosiveness and highly corrosive nature of prior art solutions are eliminated, thereby contributing to the ease with which the solutions of the present invention are handled.

Accordingly, it is an object of the present invention to provide a method and a solution for electropolishing the surface areas of titanium base alloys.

Another object of the present invention is to provide a method and solution for electropolishing titanium base alloys which obviates the use of highly corrosive and potentially explosive acid solutions.

A further object of this invention is to provide a method and solution for electropolishing which is effective in producing pit-free areas of high lustre on the surfaces of titanium base alloys.

The above and still further objects, advantages, and features of the present invention will become readily apparent upon consideration of the following detailed disclosure thereof.

In practicing the process of this invention, an electrolytic solution is placed in a suitable container and a titanium base alloy, to be polished, is immersed therein. This solution, which will be described in greater detail hereinafter, is heated to a temperature of from about 88° F. to 96° F. The particular titanium alloy employed is composed of 7 percent aluminum, 4 percent molybdenum, with the balance being substantially all titanium.

The titanium alloy which is to be polished is connected to a copper wire or some other metal wire sufficiently resistant to attack by the electrolyte and is immersed in the electrolytic bath to serve as the anode. Carbon, or some other material suitable for use as a cathode, is likewise connected to the copper wire and immersed in the electrolyte.

A suitable source of electric power is connected to the anode and cathode by means of the copper wire in order to complete the circuit. An electric current is passed through the circuit at an anodic current density sufficient to produce a highly polished area on the surfaces of the titanium alloy anode. It has been found that current densities of from about 3 to 5 amperes per square inch are highly successful and provide a surface removal rate of about 0.001 inch per minute. An ammeter and a resistance rheostat may be included in the circuit as a means of controlling the anodic current density of the electrolytic bath.

With the foregoing discussion in mind there is presented herewith a detailed specific example of the electrolytic solution of this invention However, the invention is not intended to be limited thereby. The composition was prepared by mixing together the following ingredients per liter of solution.

Ammonium bifluoride	grams	22 to 28
Fluoboric acid	ml.	14
Hydrochloric acid	ml.	441
Formamide	ml.	532

The above solution, when heated to a temperature of from about 88° F. to 96° F., successfully electropolishes the surface of a titanium base alloy at an anodic current density of from about 3 to 5 amperes per square inch in accordance with the method of this invention discussed in detail hereinbefore. The titanium alloy anode dissolves and loses metal from its surface at the rate of about 0.001 inch per minute. The anode surface is evenly attacked by the electrolytic solution of this invention and provides a bright and lustrous surface thereon. The electropolishing action extends to all surfaces of the alloy in a uniform manner with no undesirable pitting. Fairly low voltages are employed with the current densities discussed heretofore. The use of higher current densities result in shorter polishing times and may be employed if desired. However, uneven polishing and pitting are likely to result. The time required by this invention to effectuate electropolishing of a titanium alloy is not critical. However, excellent results have been obtained on the specific titanium alloy discussed heretofore when it was immersed in the electrolytic solution of this invention for a period of from about 5 to 10 minutes.

The present application has described a bath type process such as is employed with metal sheets or plates. However, it is to be understood that various modifications could be employed for effectuating the continuous treatment of strip-like metals.

It is to be further understood that although this invention has been described with reference to specific embodiments, various modifications and alterations can be made by those skiled in the art without departing from the spirit and scope of the invention, and that all such modifications as fall within the scope of the appended claims are intended to be included therein.

What is claimed is:

1. An electropolishing solution for treating the surfaces of a titanium base alloy consisting essentially of 22 to 28 grams of ammonium bifluoride, 14 ml of fluoboric acid, 441 ml. of hydrochloric acid, and 532 ml. of formamide per liter of solution.

2. A process for electropolishing a titanium base alloy which comprises the steps of immersing said alloy in an

electrolytic solution, said electrolytic solution consisting essentially of about 22 to 28 grams of ammonium bifluoride, about 14 ml. of fluoboric acid, about 441 ml. of hydrochloric acid and about 532 ml. of formamide per liter of said solution; making said alloy the anode in an electrolytic circuit which includes said electrolytic solution, a cathode, and a suitable source of electric power; heating said electrolytic solution to an elevated temperature of from about 88° F. to 96° F.; and passing an electric current through said circuit at a current density of about 3 to 5 amperes per square inch for a time period of from about 5 to 10 minutes.

References Cited in the file of this patent

UNITED STATES PATENTS

2,711,364	Beach	June 21, 1955
2,742,416	Jenny	Apr. 17, 1956
2,936,270	Webster	May 10, 1960
2,997,429	Rohrer	Aug. 22, 1961

OTHER REFERENCES

ASTM Standards, 1942, Part I, pages 1493–1496.

Jacquet: Metal Treatment and Drop Forging, April 1951, page 176.