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ELECTROMETALLURGICAL PROCESS FOR MANUFACTURE OF DUCTILE BODIES OF HIGH FUSING METALS AND ALLOYS OF SAME

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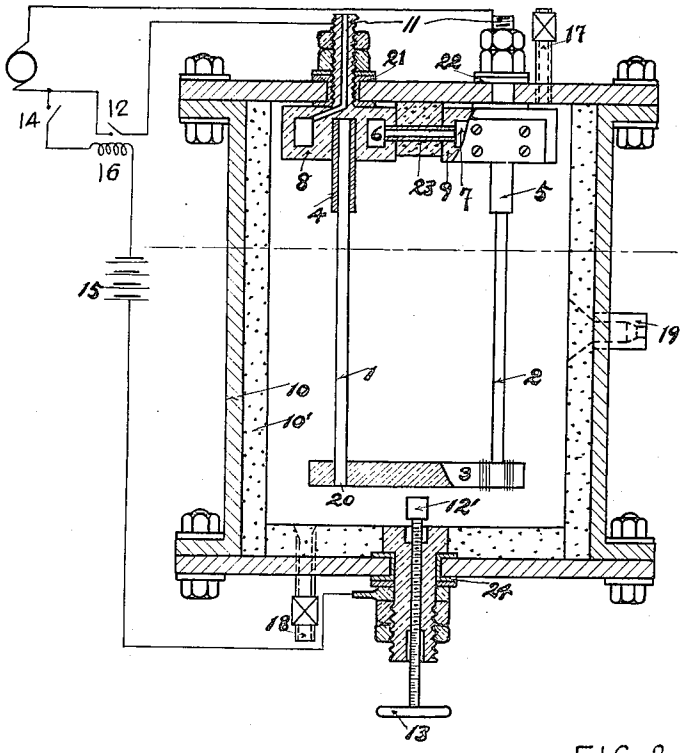
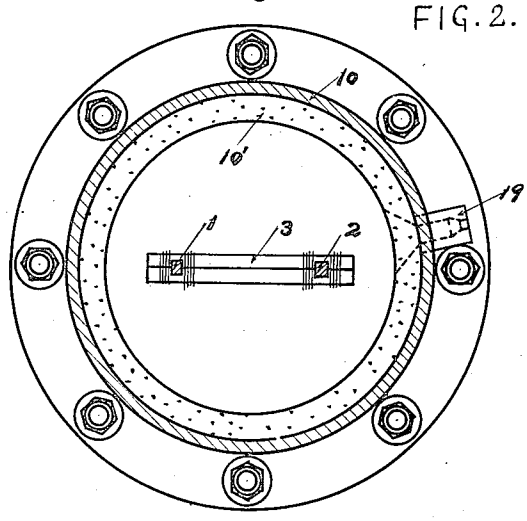


FIG. 1.

FIG. 2.



Inventor

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UNITED STATES PATENT OFFICE.

EIJI AOYAGI, OF KYOTO, JAPAN.

ELECTROMETALLURGICAL PROCESS FOR MANUFACTURE OF DUCTILE BODIES OF HIGH-FUSING METALS AND ALLOYS OF SAME.

Application filed June 17, 1920. Serial No. 389,694.

To all whom it may concern:

Be it known that EIJI AOYAGI, subject of the Empire of Japan, residing at No. 561 Karasumaru-Ichijo, Kyoto, Japan, has invented certain new and useful Improvements in Electrometallurgical Processes for Manufacture of Ductile Bodies of High-Fusing Metals and Alloys of Same, for which he has filed application in Japan, Sept. 26, 1918; and he does hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the process of giving ductility to brittle rods of high-fusing metals such as tungsten molybdenum, tantalum and similar high-fusing metals or alloys of the same, and has for its object to provide an improved process for conveniently and easily manufacturing bodies made of the above metals or their alloys which may be ultimately used in the manufacture of such articles as incandescent lamp filaments and anchors therefor, for example. The physical and chemical properties of these metals and their alloys make them especially suitable to be used for these and similar purposes.

The invented process consists of heating the brittle rods, hung in a vessel containing hydrogen or other inert gas, to their melting point and bringing them to a nearly molten state when the elongation of the rods automatically cuts off the heat supply.

Of the process involved in the present invention, the following statements give a precise explanation, reference being made to the accompanying drawings in which:—

Fig. 1 shows a sectional elevation of the apparatus, while

Fig. 2 shows its sectional plan.

An amount of tungsten powder is compressed in an iron mold under a very high pressure to form a brittle rod. The rod can be more or less increased in strength by heating it to a high temperature in an atmosphere of hydrogen. Hitherto the further heat treatment for such a rod has been to sinter it in an atmosphere of hydrogen or other inert gas by putting it vertically and passing heavy electric current through it. But the expansion of the rod, caused by heating, makes it necessary to provide a complex apparatus; moreover in such prior apparatus the temperature of the rod must generally be kept lower than the melting point of the material to avoid its melting, although its ductility is much more increased by heating to its melting point. I do not know of any previous device for keeping such a rod at its melting point for an extended period without its melting.

In my invention, the rod is held at its melting point for an extended period. After making the structure of the rod as compact as possible by pressure, the heating is stopped, before the rod breaks, and the rod is cooled.

Independent to the above method, I have devised a method to prevent vaporization of the material of the rod when heated and simultaneously to make the rod more compact by heating the rod up to its melting point in an enclosed chamber under high pressure of the enclosed gas. The high gas pressure to which the rod is subjected at its melting point is, however, not necessary to give ductility to the rod, it serves only to make the rod more compact.

The following describes accurately the necessary apparatus to carry out the present invention:—

Two tungsten rods of the same dimension are supported parallel to each other in vertical direction as 1 and 2 in the Fig. 1. The lower ends, 20, of the rods are connected by means of a horizontal tungsten rod 3 of proper length and greater cross sectional area than the said rods, to form a U-shape with the same. The shape is not limited to U-shape, and may be properly modified. Then two tungsten electrodes 4 and 5 of proper size are attached to the upper ends of the U-shape. These two tungsten electrodes are fixed to electrodes 8 and 9 respectively, having water chambers 6 and 7, said chambers being connected by way of a pipe, made of insulating material, 23. The latter electrodes with water chambers and the vessel 10 are insulated one from another by means of insulating pieces 21 and 22, and the tungsten rods are hung vertically in the vessel as shown in Fig. 1. The vessel is made of steel or cast-iron and is lined with refractory material 10′ to minimize heat loss and has a glass window 19 for inspection and temperature measurement. Each

of the two electrodes with a water chamber has a hollow metal rod 11 projecting out through the upper cover of the vessel. These two hollow rods serve as water passages to the water chambers and as terminals for connection to a source of electric current. The two openings 17 and 18 with stop cocks are inlets and outlets respectively for hydrogen or other inert gas.

After the air in the vessel 10 is replaced by hydrogen or other inert gas, the switch 12 is closed to let heavy electric current through the three tungsten rods, 1, 2 and 3, in series. The lower ends of the two rods 1 and 2 being free from the vessel, the change of length of these rods, due to heating, can take place very freely, while the pressure of the enclosed gas may be increased very easily by any convenient means.

When the temperature of the two rods 1 and 2 reaches their melting point, and the electric current through them is adjusted to supply heat a little more than to overcome their radiation loss, the rods gradually come to a molten state; and, after a certain elongation by their own weights and by that of the rod 3, they finally melt down. But if the current is cut off at a proper time before the melting down of the two rods 1 and 2 occurs, they cool and get greater ductility. Of course, the rods become more compact if high pressure is given to the gas enclosed in the vessel at the proper time before their melting down. The breaking of the electric circuit at the proper time is performed conveniently by making use of the elongation of the rods during their melting period. If the distance between the tungsten rod 3 and the auxiliary electrode 12′ is properly adjusted by means of the handle 13, the rod 3 and auxiliary electrode 12′ will touch each other at the proper instant and the local circuit with a source 15 connected to a switch 14 is closed to open the main switch 12 by the action of the trip coil 16 or to stop the main current by cutting off the exciting current of a generator which supplies the main current. Or, this action can be done by making use of the bulging out of the two vertical rods 1 and 2, due to electrodynamic action of the current through them when they are softened by heat. In the present invention, the heating method is not restricted to that by electric current through the rods; but they may be heated externally by an electric furnace or other heating devices. In such a case, the elongation of the rods due to heat may be adjusted by heat regulation. If the material of the rods consists of pure metal or a mixture of pure metals, a high pressure, if desired, may be applied to them from the beginning of heating. But if the material of the rods contains impurities, the rods are to be heated initially under an ordinary or reduced pressure to get rid of the impurities by vaporization and later a high pressure may be applied.

The electrode 12′ in its holder is insulated from the metallic walls of the vessel 10 by the insulating sleeve 24, as shown.

Having now particularly described and made clear the nature of my invention, and in what manner the process is to be performed, I declare that what I claim is:—

1. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in heating rods made of the said substances hung vertically in a vessel containing neutral or reducing gas to a nearly molten state and then stopping heating as soon as the rods elongate to a proper length.

2. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in heating rods made of the said material, hung vertically in a vessel containing neutral or reducing gas, by means of an electric furnace, to a nearly molten state and then stopping heating as soon as the elongation of the rods reaches a proper length.

3. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in heating rods made of the said substances, hung vertically in a vessel containing a neutral or reducing gas, by means of a heavy electric current passed through the rods to a nearly molten state and then stopping heating as soon as the elongation of the rods reaches a proper length.

4. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in suspending rods made of the said substances in a vessel containing neutral or reducing gas under high pressure, heating the rods to a nearly molten state, and then stopping heating as soon as the rods elongate to a proper length.

5. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in consolidating metallic powder into rods by application of pressure, suspending the rods so formed vertically in a vessel containing neutral or reducing gas, heating the rods to a nearly molten state, and then stopping heating as soon as the rods elongate to a proper length.

6. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said

metals and their compounds, which consists in consolidating metallic powder into rods by application of pressure, suspending the rods so formed vertically in a vessel containing neutral or reducing gas, heating the rods to a nearly molten state by means of an electric current passed through the rods and then stopping heating as soon as the rods elongate to a proper length.

7. A process for the manufacture of ductile rods from high-fusing metals, from their compounds or from a mixture of said metals and their compounds, which consists in consolidating metallic powder into rods by application of pressure, suspending the rods so formed vertically in a vessel containing neutral or reducing gas under high pressure, heating the rods to a nearly molten state by means of an electric current passed through the rods, and then stopping heating as soon as the rods elongate to a proper length.

8. A process for the manufacture of ductile rods from high-fusing metals, from their compounds, or from a mixture of said metals and their compounds, which consists in suspending rods made of the said substances in a vessel containing neutral or reducing gas, heating the rods to a nearly molten state, maintaining the rods in this state for a period of time sufficient to cause elongation of said rods by said heating and then stopping heating as soon as the rods elongate to a proper length.

9. A process for the manufacture of ductile rods from high-fusing metals, from their compounds, or from a mixture of said metals and their compounds, which consists in consolidating metallic powder into rods by application of pressure, suspending the rods so formed in a vessel containing neutral or reducing gas, heating the rods to a nearly molten state by means of an electric current passed through the rods, maintaining the rods in this state for a period of time sufficient to cause elongation of said rods by said heating, and then stopping heating as soon as the rods elongate to a proper length.

10. The process of providing a ductile metal body which comprises forming from divided metalliferous material a compact body, suspending and heating said body to its melting point, thereby producing elongation of said body and then stopping heating before actual melting takes place.

11. A process for the manufacture of ductile rods from high-fusing metals, from their compounds, or from a mixture of said metals and their compounds which consists in placing rods made of the said substances under tension, heating the rods while under tension up to the melting point, thereby producing elongation of said rods and then stopping heating before actual melting takes place.

12. A process for the manufacture of ductile rods from high-fusing metals, from their compounds, or from a mixture of said metals and their compounds which consists in placing rods made of the said substances under tension, heating the rods up to the melting point, maintaining the rods at this heat for a period of time sufficient to elongate said rods by said heat and then automatically stopping heating before actual melting takes place.

In testimony whereof he hereunto affixes his signature in the presence of two witnesses.

EIJI AOYAGI.

Witnesses:
KWANZI HIGNCHI,
TOKURO SHIBATA.