

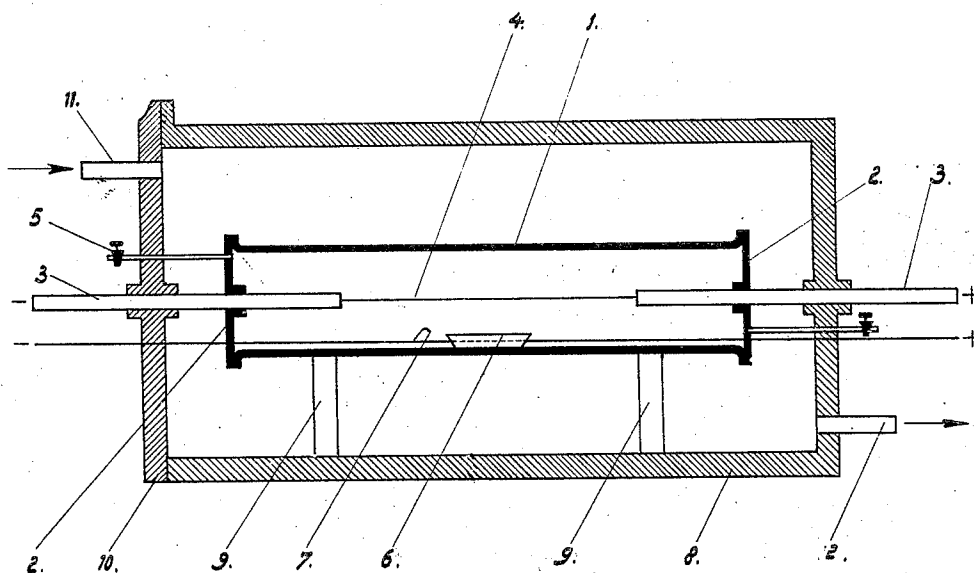
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MANUFACTURE OF BODIES FROM METALS HAVING A HIGH MELTING POINT

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UNITED STATES PATENT OFFICE.

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MANUFACTURE OF BODIES FROM METALS HAVING A HIGH MELTING POINT.

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This invention relates to an improved manufacture of ductile bodies of tungsten or other refractory metals and comprises heating a single crystal of metal in an atmosphere of a volatile and dissociable compound of a refractory metal at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal in such a way that the latter grows larger while retaining its single crystal structure. Single crystals of refractory metal hitherto known have a diameter not larger than about 0.1 millimeter, in any case less than 1 millimeter.

The dissociable compound of the refractory metal can be associated with small quantities of other substances which are adapted to form with the refractory metal a single crystal. The crystal to be treated can be placed in a continuous current of the vapor of the dissociable compound.

The cross-section of the crystal treated according to this invention increases in a very regular manner, till only practical considerations make it necessary to stop. The body obtained is so ductile that it may be immediately shaped into any desired form by mechanical operations such as hammering or rolling or drawing.

For manufacturing bodies of tungsten according to one embodiment of the invention, a tungsten crystal is heated in an atmosphere of chloride of tungsten to a temperature between 1200° and 2400° C. The metal dissociating from the chloride settles on the tungsten crystal, so that the latter increases in cross-section while remaining only a single crystal. For manufacturing wires, threads, ribbons or plates the original body is allowed to increase in size in the atmosphere of chloride to the extent desired. The body obtained in this way, may be given the desired shape by mechanical treatment. Thus wires for electric lamps may be manufactured directly from such ductile material and strong wires can be obtained after further mechanical treatment.

The original crystal instead of being a crystal of the same material as the final ductile body may be a crystal of another metal or a metal alloy, provided the crystal form of this metal or alloy is isomorphous with that of the material of the ductile body. In this case the core may be re-

moved in any known manner after the formation of the body.

It may be useful, in order to improve the properties of the final product, to add to the atmosphere in which the refractory metal such as tungsten is treated, small quantities of substances such as iron, nickel, phosphorous, or silicon. The additional substances must be such as can form a single crystal with the refractory metal, without disturbing the uniform crystallization. The substances are added by incorporating them in a volatile state in the atmosphere in which the crystal is heated.

In the accompanying drawing a device is diagrammatically represented by way of example for use in carrying out the process according to the invention.

In this drawing, 1 is a vessel in which an atmosphere of chloride of tungsten is provided. This vessel is closed by two covers 2. Through each of the covers a tungsten rod is inserted and these rods support at their ends a single tungsten crystal 4. The vessel 1 is provided with a conduit 5 through which it can be exhausted. The vessel rests on supports 9 in a furnace 8. The interior of the furnace is maintained at such a temperature that the chloride of tungsten does not condense on the walls of the vessel 1. The heating of the vessel may be effected by a hot current of air, entering through a conduit 11 and leaving through a conduit 12, but the furnace can be heated in any other suitable way.

A cup 6 filled with tungsten powder is placed in the vessel. The tungsten powder may contain some additional substance as hereinbefore mentioned.

After the vessel is exhausted and filled with vapour of chloride of tungsten, the body 4 is heated to about 1500° to 1600° C. by an electric current, whilst the powder in the cup 6 is heated in some way to a temperature of 300-500° C. According to the drawing the powder is electrically heated by means of a resistance-wire 7. The vapour then dissociates at the surface of the body 4 on which it deposits tungsten, while the liberated dissociation-products combine with the powder in the cup 6 to form new compounds capable of dissociation.

The way of heating the body 4 and the powder may be varied according to circumstances. It is not necessary that the powder

and the crystal should be enclosed in the same chamber but the vapour may be led from the powder to the crystal in a circulating process. Instead of tungsten powder it is possible to use tungsten in any other form (the temperature to which it is heated, being varied accordingly), while chloride of tungsten can be replaced by other volatile tungsten compounds, which are capable of dissociation.

It is to be understood, that although the process is particularly described for manufacturing bodies of tungsten, the invention is also practicable for other refractory metals, such as molybdenum, tantalum and the like, which are able to form compounds that are dissociable at a temperature below the melting point of the metal.

What I claim is:—

1. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in an atmosphere of a volatile and dissociable compound of the refractory metal at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal in such a way that the latter grows larger while retaining its single crystal structure.

2. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in an atmosphere of a volatile and dissociable compound of the refractory metal at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal, in such a way that the latter grows larger while retaining its single crystal structure, said volatile and dissociable compound being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated refractory metal and together constitute the grown single crystal.

3. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in a chamber through which passes a continuous flow of a volatilized dissociable compound of the refractory metal at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal in such a way that the latter grows larger while retaining its single crystal structure.

4. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in a chamber through which passes a continuous flow of a volatilized dissociable compound of the refractory metal at a temperature

which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal, in such a way that the latter grows larger while retaining its single crystal structure, said volatilized dissociable compound being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated refractory metal and together constitute the grown single crystal.

5. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in an atmosphere of a volatilized dissociable compound of the refractory metal and a non-metallic radical at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the latter grows larger while retaining its single crystal structure, and causing the non-metallic radical of the volatilized dissociable compound to pass in contact with a separate body of the refractory metal at a temperature at which new quantities of the dissociable compound are reformed for a repetition of the cycle.

6. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in a chamber through which passes a continuous flow of a volatilized dissociable compound of the refractory metal and a non-metallic radical at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the latter grows larger while retaining its single crystal structure, and causing the non-metallic radical of the volatilized dissociable compound to pass in contact with a separate body of the refractory metal at a temperature at which new quantities of the dissociable compound are reformed for a repetition of the cycle.

7. A process of manufacturing ductile bodies of refractory metal, which consists in heating a single crystal of a metal in a chamber through which passes a continuous flow of a volatilized dissociable compound of the refractory metal and a non-metallic radical at a temperature which is between that at which said compound dissociates and that at which the dissociated metal ceases to associate with the metal of said crystal, in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the latter grows

larger while retaining its single crystal structure, said volatilized dissociable compound being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated refractory metal and together constitute the grown single crystal, and causing the non-metallic radical of the volatilized dissociable compound to pass in contact with a separate body of the refractory metal at a temperature at which new quantities of the dissociable compound are reformed for a repetition of the cycle.

8. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in an atmosphere of a volatile and dissociable compound of tungsten at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the tungsten crystal, in such a way that the latter grows larger while retaining its single crystal structure.

9. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in an atmosphere of a volatile and dissociable compound of tungsten at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the tungsten crystal, in such a way that the latter grows larger while retaining its single crystal structure, said volatile and dissociable tungsten compound being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated tungsten and together constitute the grown single crystal.

10. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in a chamber through which passes a continuous flow of a volatilized dissociable compound of tungsten at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the tungsten crystal, in such a way that the latter grows larger while retaining its single crystal structure.

11. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in a chamber through which passes a continuous flow of a volatilized dissociable compound of tungsten at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the tungsten crystal, in such a way that the latter grows larger while retaining its single crystal structure, said volatilized dissociable compound of tungsten being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with

the dissociated tungsten and together form the grown single crystal.

12. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in a chamber through which passes a continuous flow of a volatilized dissociable compound of tungsten and a non-metallic radical at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the metal of said crystal, in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the latter grows larger while retaining its single crystal structure, and causing the non-metallic radical of the volatilized tungsten compound to pass in contact with a separate body of tungsten at a temperature at which new quantities of the dissociable tungsten compound are reformed for a repetition of the cycle.

13. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in a chamber through which passes a continuous flow of a volatilized dissociable compound of tungsten and a non-metallic radical at a temperature which is between that at which said compound dissociates and that at which the dissociated tungsten ceases to associate with the metal of said crystal, in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the latter grows larger while retaining its single crystal structure, said volatilized dissociable compound of tungsten being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the volatilized dissociated tungsten and together constitute the grown single crystal and causing the non-metallic radical of the volatilized dissociable compound to pass in contact with a separate body of tungsten at a temperature at which new quantities of the dissociable tungsten compound are reformed for a repetition of the cycle.

14. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in an atmosphere of tungsten chloride to a temperature between 1200° C. and 2400° C.

15. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in an atmosphere of tungsten chloride to a temperature between 1200° C. and 2400° C., the tungsten chloride being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated tungsten of the tungsten chloride and together constitute the grown single crystal.

16. A process of manufacturing ductile

tungsten, which consists in heating a single crystal of tungsten in an atmosphere of tungsten chloride to a temperature between 1200° C. and 2400° C., at which temperature

5 the tungsten chloride is dissociated, the chlorine of said chloride passing in contact with a separate body of tungsten at a temperature at which new quantities of the tungsten chloride are reformed for a repetition of the cycle.

10 17. A process of manufacturing ductile tungsten, which consists in heating a single crystal of tungsten in an atmosphere of tungsten chloride to a temperature between 1200° and 2400° C. in such a way that the compound breaks up and the refractory component is so deposited on the crystal that the crystal of tungsten grows larger while retaining its single crystal form, the tungsten chloride being associated with a small quantity of another volatile substance, at least one component of which substance will deposit with the dissociated tungsten of the tungsten chloride and together constitute the grown single crystal, and causing the chlorine of the dissociated chloride to pass in contact with a separate body of tungsten at a temperature at which new quantities of the tungsten chloride are reformed for a repetition of the cycle.

15 18. A single crystal of a refractory metal having a diameter larger than 1 millimeter.

19. A single crystal of tungsten having a diameter larger than 1 millimeter.

20 20. Ductile refractory metal consisting of a single crystal of said refractory metal having a diameter larger than 1 millimeter and mechanically shaped into a form different from that of the crystal.

21. Ductile tungsten consisting of a single

crystal of tungsten having a diameter larger than 1 millimeter and mechanically shaped into a form different from that of the crystal.

22. The process of increasing the size of a uniaxial metal body which consists in placing the body in a chamber containing a chemical in gaseous form and in placing in the same chamber a separate mass of the same metal, heating the said mass to a sufficient degree to cause the chemical to attack the said mass and form a gaseous compound with the metal and heating the uniaxial body to a degree sufficient to dissociate the metal from the chemical and to cause the dissociated metal to be deposited and added to the metal as a part of the uniaxial body and thus releasing the chemical for a repetition of the operation.

23. The process of causing the growth of a tungsten uniaxial crystal which consists in heating the uniaxial crystal to a temperature that will rob tungsten chloride of tungsten and liberate chlorine and in heating a mass of tungsten to a temperature that will cause the chlorine to unite with tungsten to form tungsten chloride and in enclosing the uniaxial crystal and the said mass in a vessel containing chlorine and subjecting the mass to the action of the chlorine to form chloride of tungsten and subjecting the formed chloride of tungsten to the action of the uniaxial crystal and to cause the deposit of tungsten upon the uniaxial crystal and cause the growth thereof, and subjecting the mass again to the liberated chlorine and repeating the cycle.

In testimony whereof I affix my signature.
ANTON EDUARD VAN ARKEL.