Patented Feb. 11, 1936 2,030,229

UNITED STATES PATENT OFFICE

2,030,229

PROCESS OF MAKING COMPOUND STRUCTURAL MATERIAL AND SHAPED ARTICLES THEREOF

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No Drawing. Application February 19, 1932, Serial No. 594,154. In Germany November 28, 1931

5 Claims. (Cl. 75—1)

This invention relates to a new process of manufacturing structural material adapted more particularly for electrical purposes, without, however, being limited to this use.

Attempts have already been made to unite hard metals, such as, tungsten, or molybdenum, with softer metals, such as, copper, silver and so forth. A cohesive sponge-like body was made from the hard metals and the fluid soft metals were allowed to be absorbed therein by infiltration.

The present invention comprises a process for making composite structural material, and shaped articles thereof, which consists principally of tungsten and molybdenum while two or more of the following substances also may be present: titanium, vanadium, zirconium, tantalum, silver, gold, aluminium, cobalt, chromium, copper, nickel, platinum, tin, zinc or iron, which are chosen so that at least two of them form at the most only a superficial, alloy or solid solution or penetration while heated with or without pressure during the compounding. More particularly the invention consists in a composite structural material which comprises at least one from the group of the following harder substances: molybdenum, titanium, vanadium, tungsten, tantalum, zirconium and at least one from the group of the following softer substances: silver, gold, aluminium, cobalt, chromium, copper, nickel, platinum, tin, zinc, iron. Titanium can be present either in the first group, or preferably, in the second group. In the present case, therefore, at least one harder or higher melting substance of the first group is present in the structural material and at least one softer or low-melting substance of the second group.

According to the invention also the substances are so chosen that at least one of them maintains its state of aggregation during the compounding in the hot state and/or under pressure.

According to the present invention, the procedure is advantageously such that one or several of the here enumerated harder metals are consolidated in a suitable manner from the metal powders, oxides or other compounds by melting or highly sintering, if desired also thoroughly worked mechanically, by hammering and rolling, and then comminuting, preferably to the finest powder possible. The melt, however, can also be granulated. The powder thus obtained is uniformly and finely crystalline and has then one or more soft metals above mentioned poured thereover either singly or in admixture. The choice of both the hard and the soft metals must be made bearing in mind the properties it is desired to impart to the body finally obtained, i. e. whether its hardness or its softness and shaping capability is to preponderate, or whether value is laid on small density, great conductivity or great resistance to attack by atmospheric influences.

There is also the choice of the quantity of hard and soft metal. It may be sufficient for the soft metal to comprise only 3 to 6% of the total quantity of the structural material. Consequently it will act only as a binding agent, for which purpose regular quantities of this order of magnitude up to about 15% are sufficient. In other cases, however, the soft metal acts not only as a binding agent, but represents the structural material in the main, which is improved in its surface quality of hardness by the addition of the hard metals; the quantity of soft metals can then be chosen equal to, or greater than, that of the hard metals. The amount of the latter may thus be limited to 20, 10 and even lower percentage.

The following examples of binary composite bodies corresponding to the invention may be given:—

(1) Molybdenum-silver; molybdenum-chromium; molybdenum-copper; molybdenum-tin; molybdenum-zinc.

(2) Vanadium-silver; vanadium-copper.

(3) Tungsten-silver; tungsten-chromium; tungsten-copper; tungsten-tin; tungsten-zinc.

The following examples of ternary structural composite materials may be given:—

(4) Molybdenum-silver-zirconium; molybdenum-silver-chromium; molybdenum-silver-titanium; molybdenum-chromium-titanium; molybdenum-chromium-copper; molybdenum-chromium-tin; molybdenum-chromium-zinc; molybdenum-copper-titanium; molybdenum-nickel-copper.

(5) Vanadium-silver-zirconium; vanadium-silver-chromium; vanadium-copper-titanium; vanadium-copper-chromium; vanadium-copper-zirconium; vanadium-silver-copper.

(6) Tungsten-silver-zirconium; tungsten-chromium-zirconium, tungsten - copper - zirconium; tungsten-silver-titanium; tungsten - chromium - titanium; tungsten-copper-titanium; tungsten-tin-titanium; tungsten-zinc-titanium; tungsten-silver-chromium; tungsten - copper - chromium; tungsten-tin-chromium; tungsten-zinc-chromium; tungsten-silver-vanadium; tungsten-copper-vanadium; tungsten-chromium-vanadium; tungsten-vanadium-titanium; tungsten-nickel-copper.

For making the structural material the proce-

dure may be to pour the liquid soft metal over the compact hard metal powder. However, parts of the soft metal in solid form, more particularly in the form of powder, may be added to and intimately admixed with the powdered hard metal, and the whole may then be cast over with the remainder of the soft metal, which, however, is fused. In this case the whole is preferably maintained at a temperature such that the admixed soft metal powder melts as well and becomes incorporated with the soft metal which is cast on.

Finally, the procedure may also be such that both the hard and soft metals are comminuted, mixed and the whole thereupon heated to such an extent that at least the soft metal melts and incorporates the hard metal on cooling, which latter will become uniformly distributed in the cold soft metal.

In these ways in the first place whole blocks or bars can be obtained of any shape or size, which are homogeneous throughout and from which the desired article can finally be made by heat treatment, e. g. recasting, or by mechanical working in the hot or cold, such as hammering, rolling, drawing, cutting.

It is also possible to obtain the desired article direct by inserting the metal powder mixture into a suitable mould and bringing at least the soft metal portion in it to fusion or softening it to such an extent that it takes up the hard metal part during cooling and imparts great homogeneity and uniform density to the body being made.

Frequently, however, it is desired to make only certain parts of the body according to the invention, i. e. to make a composite body, such as, making a contact pin in which case only the outer contact surface is to be both hard and readily capable of being worked and resistant to oxidation, whilst the remaining part may not have the same resistance capability as the contact surface. In such a case the procedure is preferably such that, a mould open at the top is used, the lowest part of which is adapted to the contact surface, on which the hard metal powder is applied in sufficient layers, after which the soft metal is poured or fused thereon, care naturally being taken that no air bubbles are entrained and consequently the casting is preferably carried out in a mould with discard head and in such a way that slow cooling which progresses from the bottom to the top is effected. A contact is then obtained which contains the hard metals at the contact surface and which possesses the desired general properties.

Similar results can also be attained by choosing the hard metals according to their density and taking care that the metal bath in which the soft metals are fluid and the hard metals are solid, remains in the hot liquid state for a certain time, as a result of which the heavy hard metal powder can slowly move downwards and the bath is at least enriched in hard metals or metal powders in the lower part thereof, whereupon the bath is allowed to set.

Thus one is in a position to make both shaped and unshaped bodies of the desired property which, on account of their suitably chosen hard metal content possess the desired strength and on account of their suitably chosen soft metal content, have good conductivity and may be difficultly oxidizable and may be made with such properties far more economically and consequently more cheaply than this was hitherto possible with silver, gold-silver, platinum, and so forth, which metals, furthermore, are far too soft, are rapidly beaten out or changed in shape and consequently required frequent substitution.

The material according to the invention enables all the advantageous properties of the different materials to be mutually adapted to one another and consequently permits of the production of a structural material which, shows particularly high conductivity with sufficient hardness or particularly great hardness with sufficient conductivity and which always shows the desired mechanical, electrical and chemical stability.

It is always possible to add the hard metal not only in the form of ductile powder but also in other form as short or long wires which have been bundled or laid and which consequently have already been rendered compact and ductile during their preparation by hammering, drawing and so forth. These bodies can then be enclosed or melted round by the desired soft metals as a result of which a composite body is attained from which the desired articles can be made. Thus it is possible to cast a soft metal (or metal mixture) cylindrically around such a cable or the like of tungsten or molybdenum wire. This can be more particularly carried out in a continuous process, such as in machines for pressing the soft metal about the hard and then plates, or longer, somewhat cylindrical parts can be cut off from the cylindrical composite body which are used, as contact bodies. In these the wires of tungsten or molybdenum are then incorporated so that the electric current advantageously flows in the direction of the "fibre" of the wire.

When the composite body is made in the said manner in a machine for pressing one metal around the other, the soft metal is united to the harder metal in the hot liquid state or at least in a plastic state produced by heating. Production is effected, therefore, both in the hot state and under raised pressure which can be increased in individual cases to betweeen 25 atm. and 50 atm. and even above.

The finely crystalline structure of the composite body sets in of itself, the harder metal obtained by melting or highly sintering either already possessing such structure or else acquiring it subsequently by mechanical working. If necessary, however, a particularly desired finely crystalline structure may be obtained by thermal treatments such as known per se in the metal working art, thus, for example, by rapid cooling or chilling of the composite body during the manufacture or by subsequent heating of the ready made article or body and subsequent rapid cooling thereof.

The material according to the invention is not confined to any special purpose. Thus it can for instance be used as bearing, packing or stuffing box metal, particularly for steam turbines.

I claim:

1. A process for making an agglomerated structural material and shaped bodies thereof, containing at least one metal selected from a first group consisting of tungsten, molybdenum, and tantalum, and at least one metal selected from a second group, consisting of silver, nickel, cobalt, iron, said process consisting in first subjecting metal of the first group in the powdered form in which it is obtained from its compounds or ores, to a heat treatment at temperatures at least as high as sintering temperature, thereupon powdering the so compacted metal, thereupon mixing this powder with metal taken from

the second group and consolidating this mixture by heat treatment at temperatures below the sintering temperature of the metal of the first group.

2. In a process according to claim 1, taking metal from the first group amounting from about 10% up to about 94% of the mixture.

3. A process of manufacturing an agglomerated structural material and shaped bodies therefrom, containing at least one metal selected from a group consisting of tungsten, molybdenum and tantalum and at least one metal selected from a group consisting of silver, nickel, cobalt, iron, copper, said process consisting in first heat treating granular initial metal taken from the first group in the powdered form in which it is obtained from its compounds or ores at temperatures at least as high as sintering temperature, thereupon powdering the so-compacted metal, then mechanically working the compacted metal, then powdering the so compacted metal and mixing it with metal taken from the second group, thereupon heating this mixture at a temperature at least sufficiently high to melt the metal taken from the second group but below a temperature at which the structure of the metal of the first group is materially changed.

4. A process of manufacturing an agglomerated structural material and shaped bodies therefrom containing at least one metal selected from a group consisting of tungsten and molybdenum, and at least one metal selected from a group consisting of copper, silver, said process consisting in first heat treating granular initial metal taken from the first group in the powdered form in which it is obtained from its compounds or ores, said heat treatments to be effected at temperatures at least as high as sintering temperature of the metals taken, thereupon compacting the metal by allowing it to cool down, then mechanically working the compacted metal, then powdering the so compacted metal and mixing it with metal taken from the second group, thereupon heating the mixture at a temperature at least sufficiently high to melt the metal taken from the second group, but at a lower temperature than one at which the metal from the first group is materially changed.

5. A process of manufacturing an agglomerated structural material and shaped bodies therefrom containing at least one metal selected from a group consisting of tungsten and molybdenum, and at least one metal selected from a group consisting of copper, silver, nickel, said process consisting in first heat treating granular initial metal taken from the first group in the powdered form in which it is obtained from its compounds or ores, said heat treatments to be effected at temperatures at least as high as sintering temperature of the metals taken, thereupon compacting the metal by allowing it to cool down, then mechanically working the compacted metal, then powdering the so compacted metal and mixing it with metal taken from the second group, thereupon heating the mixture at a temperature at least sufficiently high to melt the metal taken from the second group, but at a lower temperature than one at which the metal from the first group is materially changed.

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