

UNITED STATES PATENT OFFICE.

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MANUFACTURE OF MOLYBDENUM-TUNGSTEN ALLOY.

1,308,907.

Specification of Letters Patent.

Patented July 8, 1919.

No Drawing.

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To all whom it may concern:

Be it known that I, FREDERICK G. KEYES, a citizen of the United States, and resident of Hoboken, county of Hudson, State of New Jersey, have invented certain new and useful Improvements in the Manufacture of Molybdenum-Tungsten Alloy, of which the following is a specification.

The present invention relates to a new method of producing an alloy of tungsten and molybdenum containing any desired percentage of the last named element. Such an alloy may be used for a great variety of purposes and it is not my intention to describe it in such a way as to confine its use necessarily to any particular art. In order, however, to point out one important use of this alloy, I shall with the reservation above made, describe it as suited to the purposes of making lamp filaments or resistance wire for electric tube furnaces. For this purpose I have found that an alloy of pure tungsten with twenty per cent. of molybdenum, for example, is highly satisfactory. For other purposes and possibly also for the purpose of making a wire such as last described, other proportions of molybdenum and tungsten may be found usable. I may say that it appears to be only necessary that there should be enough of the molybdenum present, so that when the same is liquefied by a heating process, there shall be enough liquid present to pull together the particles of powdered tungsten which, as will appear, are mixed with the molybdenum oxid particles at the beginning of the process. The description herein will be concerned more particularly with the manufacture of an alloy of eighty per cent. tungsten and twenty per cent. molybdenum, although it is not intended to exclude other proportions of molybdenum in combination with tungsten, if manufactured in accordance with the process about to be described. It is known that molybdenum has a melting point lying approximately 500° C. below the melting point of tungsten. Now, when a bi-metallic mixture of fine particles of molybdenum and tungsten is gradually heated by any suitable means, preferably by passing an electric current through it, the lower melting constituent will melt first, and if it be present in sufficient quantity will, owing to its surface tension, tend to draw the mass of powdered material to-

gether into a coherent ingot. The following process is suited for producing conveniently an alloy of molybdenum and tungsten. By taking quantities of chemically pure MoO_3 and WO_3 and reducing the mixture to a metallic state, an alloy of the desired metallic Mo content will ultimately result, as will appear farther on. This content may be twenty per cent. molybdenum or any other percentage which is found preferable.

It is better to mix the oxids previously to reducing to the metallic state rather than to attempt to mix the metals after reduction, owing to the fact that a much more uniform mechanical mixture can be produced in this way, on account of their being soft and capable of being infinitely reduced by means of a pestle or other grinding agent.

It will be understood that the oxids are first thoroughly ground and mixed. Thereafter they are reduced either by means of dry CO or dry H_2 . When reducing with H_2 , the reduction should be carried slowly to completion at about 800° and finished at about 1000°. The coarseness of the mixture reduced by hydrogen depends on the speed of the gas stream. A very slow gas stream will require a longer time for the reduction and yield a coarser powder than a reduction carried out at the same temperature with a rapid stream of dry hydrogen. It would seem that the pressure of the water vapor which is not promptly carried off, as it would be with a vigorous stream of hydrogen, causes a growth of small particles to larger particles by some alternate reduction and oxidation action. For the purpose specially desired to be served by the present invention it is desirable to have fine and thoroughly reduced metal.

The metal, having been suitably reduced, is mixed with a little water and molded to a bar under pressure. During the drying of the molded bar the finer particles undoubtedly oxidize superficially. The dry bar is placed in a furnace maintained at about 1200° and through it a very slow stream of dry hydrogen is caused to pass. After about an hour heating, the bar may be allowed to cool in H_2 . The bar of metal so produced is sufficiently strong to permit of its being handled. The cohering appears to be due to the slow reduction of the superficially oxidized particles. The bar pro-

duced in the above manner when cooled, is further heated by the passage of the electric current until its temperature has attained the melting point of molybdenum.

5 At this temperature the molten molybdenum begins to alloy with the tungsten particles and, owing to the surface tension of the liquid molybdenum, the particles of tungsten are pulled together. In carrying out
10 this process it is essential to maintain the bar at the proper temperature until contraction ceases.

The bar thus produced may be rolled into sheets at 800 to 900° C. The material is
15 quite soft while hot and may be drawn into wire by the ordinary drawing process applied to most metals.

I prefer for many purposes, as has been stated, to make the proportions of molybdenum and tungsten respectively twenty per
20 cent. and eighty per cent.

An alloy produced in the manner described and drawn into wire by processes well-known in the art of working metals is

admirably suited to serve the purposes of a 25 filament for electric lamps and of resistance for electric furnaces and like purposes. Such a process is described, for example, in Staite's British Patent 12,212 of 1848.

I claim as my invention:

1. A ductile, malleable metallic alloy of 30 molybdenum and tungsten free from appreciable quantity of impurities.

2. A metallic alloy of tungsten and molybdenum in which alloy the molybdenum 35 constitutes approximately twenty per cent. of the entire content.

3. A metallic alloy of molybdenum and tungsten free from appreciable quantity of 40 impurities.

Signed at New York, in the county of New York and State of New York, this 15th day of October, A. D. 1915.

FREDERICK G. KEYES.

Witnesses:

HAROLD B. WOODWARD,
THOS. H. BROWN.