

# UNITED STATES PATENT OFFICE.

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PROCESS OF RECOVERING MOLYBDENUM FROM MOLYBDENITE.

1,401,927.

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No Drawing.

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*To all whom it may concern:*

Be it known that we, GEORGE W. SARGENT, a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, and JOSEPH W. WEITZENKORN, a resident of Washington, in the county of Washington and State of Pennsylvania, have invented a new and useful Improvement in Processes of Recovering Molybdenum from Molybdenite, of which the following is a specification.

The invention relates to the recovery from molybdenite of molybdenum either in substantially pure form or as a ferro-molybdenum alloy.

Until recently molybdenum has been classed as a rare or semi-rare metal, and its use has been limited to products in which, for the most part, the cost of manufacture is not the controlling or prime factor. Chiefly because the metal was rare and its use so limited, the processes heretofore developed for its recovery from molybdenite, that is to say molybdenum sulfid ore, are not such as may be used to economically recover the metal in large quantities.

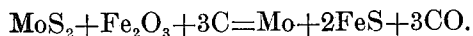
Of late years large deposits of molybdenite have been discovered, so that there are now available sources of molybdenum of such extent that the metal may, if economically recovered from the ore, be extensively used in large quantities for various purposes, as for example in the manufacture of ferrous alloys such as steel and iron.

Accordingly, it is the object of the invention to provide a method whereby molybdenum, substantially free from sulfur, may be economically recovered from molybdenite, and also to provide a method for economically producing directly from molybdenite a ferro-molybdenum alloy suitable for the manufacture of molybdenum steel alloys, and the like.

The invention, as far as concerns its broader aspects, is predicated upon our discovery that molybdenite readily combines with an oxid of iron in an exothermic reaction which evolves almost sufficient heat to render the continued reaction self sustaining after the molybdenite and the iron oxid have been heated to the reaction temperature. In the practice of the invention for recovering substantially pure molybdenum, molybdenite is caused to combine with iron oxid in the presence of a reducing agent such as carbon, the reaction being carried

on at an elevated temperature in any well known or desired type of furnace or crucible. However, the process may be, and preferably is, practised in an electric furnace of the resistor arc or semi-arc resistor type.

Prior to its being charged into the furnace, the molybdenite, crushed or otherwise reduced to substantially a powder state, is mixed with powdered iron oxid, as for example, hammer scale, and a suitable reducing agent, such as carbon in the form of charcoal, coke and the like. When the proper proportions of these materials are used it has been found that at a temperature of about 2000° F. the following reaction takes place:—



It is believed that in the first step in this reaction the iron dioxid combines exothermically with the molybdenite to form a ferro-molybdenum-sulfid compound, which is thereafter reduced by the carbon. Whatever the steps in the reaction may be, it has been found that carbon dioxid passes off as a gas, that substantially pure molybdenum settles to the bottom of the furnace, and that a low melting point fluid slag of ferro-sulfid separates from, and floats upon, the molybdenum.

After the materials have been heated to the temperature required for starting the reaction, the exothermic character of the reaction makes it necessary to apply little if any additional heat. Before tapping the furnace for final cleaning, the molten mass may be cleaned up by the addition of carbon or other suitable material, if it is found necessary to do so. However, it has been found that, if the mixture is properly proportioned at the beginning, little if any cleaning up is required, the condition of the slag under proper mix proportions being such that the slag readily throws out the metallic molybdenum, retaining little if any of the molybdenum.

If it is desired to recover the molybdenum in the form of a ferro-alloy for subsequent use in the manufacture of alloy steel and iron, an excess of iron oxid and reducing agent may be placed in the mix, the amount of iron oxid thus added depending upon the proportion of iron and molybdenum desired in the ferro-molybdenum. The excess of iron oxid becomes reduced by the excess of

carbon and together with the molybdenum is thrown down to form a ferro-molybdenum alloy. As a modification of thus combining iron with molybdenum simultaneously with the recovery of molybdenum from molybdenite, iron in the form of filings, turnings, etc., may be placed in the mix, the iron being rendered molten by the heat of the batch. In either case the molten iron readily mixes or alloys with the molten molybdenum forming a ferro-molybdenum alloy of predetermined proportions. The process for forming such alloy may be otherwise practised as previously described.

As thus far described, the process has been explained solely with reference to the use of iron oxid and carbon as the materials to be combined with molybdenite in the initial mix. The invention also contemplates, as a step in the process, the combining of an oxid of iron and molybdenite without carbon. By forming a mix of these two materials and heating it in the manner described, there is eliminated a large portion of the sulfur in the form of sulfur dioxid, and a ferro-molybdenum-sulfid compound is formed, which can be further reduced to metallic molybdenum by the addition of carbon, or which may be used as a starting point to make other molybdenum compounds.

In practising the invention it has been found that molybdenum and ferro-molybdenum may be readily produced having low sulfur contents. The materials utilized in the process are abundant and cheap, and the heat required for carrying out the process is very small due to the exothermic character of the reaction. All of these considerations contribute to the practical and economic

character of the process, by which large quantities of molybdenum may be recovered for the rapidly increasing use to which it is being put.

We claim:

1. A step in the process of recovering molybdenum from molybdenite, which consists in causing iron oxid to react with molybdenite.

2. The process of recovering molybdenum from molybdenite, which consists in causing iron oxid to react with molybdenite in the presence of a reducing agent.

3. The process of producing ferro-molybdenum directly from molybdenite, which consists in causing iron oxid to react with molybdenite in the presence of a reducing agent, and simultaneously combining iron with the molybdenum.

4. The process of producing ferro-molybdenum directly from molybdenite, which consists in simultaneously reducing iron oxid and causing iron oxid to react with molybdenite in the presence of a reducing agent.

5. The process of producing ferro-molybdenum directly from molybdenite, which consists in heating a mixture of molybdenite, iron oxid and a reducing agent, the iron oxid and reducing agent being in excess of that required to recover substantially pure molybdenum from the molybdenite.

In testimony whereof, we have hereunto set our hands.

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Witnesses:

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