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METALLIC REFRACTORY MATERIAL

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This invention relates to a new and novel article of manufacture which has the characteristic of resisting high heat and resisting oxidization at high heat and therefore may be substituted for refractory material, and which has the added characteristic of having mechanical strength greater than that of the ordinary vitreous refractory materials. This strength is apparent whether the article is in a hot or cold state.

In somewhat more detail, the invention pertains to a new metallic alloy which is capable of withstanding high temperatures and mechanical strains thus making it exceptionally satisfactory in supplanting vitreous refractory materials. This alloy also possesses the further characteristics of resisting the actions of acids as well as having the further attribute of great hardness. Also, this novel alloy is exceptionally resistant to oxidation at high heat, and resists the fluxing action of slags and molten metals.

It has long been the practice where refractory materials are required, to employ clay and fire brick or the like. The main characteristic of such vitreous material is that it is highly resistant to high temperatures, but it has the distinct disadvantage of having no particular mechanical strength, therefore, it is not satisfactory to maintain mechanical loads while it is resisting high temperatures. It, therefore, becomes of great value to provide a new article of manufacture which will satisfactorily resist high temperatures and which will withstand mechanical strains and stresses.

This particular metallic alloy as herein disclosed has shown among some of its characteristics a high melting point; resistance to oxidation, whether in a hot or a cold state; resistance to the solution action of molten iron or molten iron oxide, or other fluxes; highly resistant to the destructive action of acids; possessing such hardness that it is resistant to wear by mechanical abrasion, whether it is in a hot or a cold state; and possessing a mechanical strength which is greater than that of the ordinary commercial vitreous refractory material.

It will be understood that this metallic alloy is capable of being used for many different purposes, among which is that of constructing safes or vaults.

The preferred alloy is a combination of tungsten and silicon, preferably with the tungsten being of a materially higher percentage than that of silicon. It is, of course desired to employ these constituents in their purest form in forming the alloy, but it is found that the alloying may be obtained while reducing the ores thereof. It is to be understood, however, that should separate reductions produce the constituents in their pure form that the alloy of these pure constituents is within the scope of this invention.

The alloying of the constituents may be accomplished in any suitable way such for instance as in an electric furnace. It is desirable to mold the inner lining of the furnace of graphite to a form approximating the form of the article or plate desired to be cast. If an article or plate of large size is desired then the alloy is made and cast and later broken up by heavy stamps into pulverulent condition and then placed in molds which may be passed into a high frequency induction type furnace and remelted to the form of those molds.

From experience it is well understood that certain metals of approximately the same melting point may be readily alloyed together. It is also understood that it is difficult to alloy two or more metals whose melting points vary materially, especially if such metals are in their substantially pure state. In alloying two or more metals of materially different melting points it has usually been the practice to employ a bridge, i. e., use a metal or material which has an affinity for both of the metals.

In producing the new and improved alloy herein of tungsten and silicon it is found that they may be combined through a relatively wide range of percentages, and that generally speaking, the higher the tungsten content the higher will be the melting point of the alloy. One of the most satisfactory alloys produced under this combination for the purposes above outlined gives the maxi-

mum content limit of tungsten as about 95%, and the silicon content appeared as approximately .58%. Some of the alloys under this combination of tungsten and silicon show that the tungsten content may be 48% and the silicon content at 45%. It will, therefore, be seen that there may be a considerable range of percentages in combining these constituents.

In alloying the tungsten and silicon we have found that successful results have been obtained without using a bridge but we prefer, in order to accomplish the result more easily and quickly, to employ a bridge. Such a bridge may be nickel. In producing this alloy we have found that tungsten itself oxidizes at high temperature and in order to eliminate this disadvantage silicon is added. It is particularly desirable to form an alloy of the tungsten and silicon as the alloy is not readily soluble in molten iron or molten iron oxide. When the nickel is used as a bridge it is found that the resistance of the alloy to molten iron or molten iron oxide is reduced a little, and thus it is preferred to use a small amount of nickel. By using only the smallest amount of the nickel to give satisfactory and quick alloying results, the melting point of the alloy is maintained at a high point as well as maintaining a high insolubility of the alloy in the molten iron oxide. Such an alloy of high melting point and of high resistance to molten iron oxide is of considerable value in the construction of safes and vaults, and also for other purposes.

It will also be understood that additional constituents may be added to the tungsten and silicon for the purposes of varying the hardness and toughness of the alloy. For instance, the addition of carbon tends to render the metal alloy much harder. Also, molybdenum, nickel, chromium or vanadium may be added for increasing the toughness. These additional elements may be varied when the ranges of the tungsten and silicon vary.

A typical analysis of one of the alloys with a high tungsten content is as follows:—

	Per cent
W	95
Si	.58
Mo	.32
C	4.6

A typical analysis of an alloy having a low tungsten content is as follows:—

	Per cent
W	48
Si	45
Mo	1.17
C	5.83

In all of the alloys, it is possible to reduce the amount of silicon and substitute for the quantity reduced an equal amount of nickel, depending upon the type of alloy desired. It is to be understood, however, that the nickel does not spoil the non-oxidizable properties of the final alloy but adds to this property or characteristic. As previously stated, the function of the molybdenum is to make the alloy tougher, but it is possible, however, to omit the molybdenum and substitute therefor an equal amount of chromium, vanadium or nickel in making this alloy.

An example, and without in any way limiting ourselves, of a typical charge for the furnace may be as follows:—

Tungsten concentrates (Wo_3)	10 lbs.	
Molybdenite (MoS_2)	1 lb.	
Nickel (Ni)	1 lb.	
Coke	1 lb.	5 oz.
Silicon (Si)	1 lb.	
Calcium sulphate ($CaSO_4$)		14 oz.

In reducing this charge it is preferable to continue the operation of the furnace until the white smoke is no longer given off, and to discontinue entirely the heating when a green flame appears. It has been found satisfactory in practicing our invention to add one half of the silicon content at the beginning of the reaction and the balance of that content when the white smoke ceases. We do not, however, bind ourselves in this respect. Another form for satisfactorily obtaining the alloy is to heat the silicon and to then add the tungsten in comminuted form and to add such other elements or constituents as desired and at such times and under such conditions as will give satisfactory results.

From the foregoing description it will be seen that a new and improved refractory material has been produced, and that this new material is capable of satisfactorily supplanting vitreous materials and at the same time sustain mechanical loads. This metal alloy, in addition to its characteristic of being resistant to high temperatures and its capability of sustaining mechanical loads, possesses desirable characteristics which make it particularly advantageous for other uses, whether these other uses require the alloy to be raised to a high temperature or to be used in a cold state. For instance, it has been found when the alloy has been employed in safe and vault constructions it is resistant to the solution action of molten iron or molten iron oxide or other fluxes. The alloy, therefore, while performing its mechanical duties, resists the actions of the blow torch and the fluxes employed therewith. In using this alloy in safe and vault constructions it may be, if desired, encompassed within another metal.

It will be understood that while we have herein described in detail a particular embodiment of our invention for purposes of

full disclosure, and some detailed features which we are specifically claiming for a special advantage, many changes and modifications may be made without departing from the broad scope of our invention which is outlined in the appended claims.

We claim:

1. An alloy including tungsten in amount between 95–48%, silicon .5–45%, and nickel between 1–5%, the nickel content being substituted for an equal amount of the silicon.

2. An alloy including 95–48% tungsten, .5–45% silicon, .3–5% molybdenum, 2–10% nickel, and 2–5% carbon.

3. An alloy including 90% tungsten, 3% silicon, 1% molybdenum, 2% nickel, and 4% carbon.

4. As an improved article of manufacture, a heat-resistant, non-vitreous safe and vault member including 95–48% tungsten, .5–45% silicon, .3–5% molybdenum, 2–10% nickel, and 2–5% carbon.

5. As an improved article of manufacture, a high-melting, non-vitreous safe and vault member including 95–48% tungsten, .5–45% silicon, .3–5% molybdenum, 1–5% nickel, and 2–5% carbon.

6. An improved metallic refractory as an article of manufacture, characterized by a melting point of substantially 2800–3000° C., and high strength and abrasion resistance at high temperatures below the melting point, said refractory including 90% tungsten, 3% silicon, 1% molybdenum, 2% nickel, and 4% carbon.

This specification signed this 16 day of December, 1926.

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