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ELECTRICAL CONTACT TERMINAL

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This invention relates to terminal members of electric conductors whether known as switch points, welding jaws, electrodes, or by other specific names; and the objects of the invention are the provision of a composition of matter which shall combine in itself the properties of a fairly low electrical resistance, a high degree of rigidity and tensile strength even when hot, a freedom from tendency to oxidize or disintegrate at high temperature, ease of fabrication, and low intrinsic value. In developing this article I have also discovered as I believe a new and valuable metallic composition comprising an alloy of tungsten or molybdenum with silicon and copper.

It has heretofore been suggested to impregnate a compressed mass of tungsten or molybdenum with a molten noble metal such as platinum. The resulting substance is too expensive for general use and further involves difficulties in practical manufacture. It has also been proposed to employ for the purpose above described a mixture of tungsten and copper wherein tungsten constitutes the skeleton and the copper acts as a binder and electrical conductor. The difficulty of this is that copper does not alloy with tungsten, and the articles made therefrom are fragile, brittle, and unreliable. Microscopic analysis shows them to be full of flaws and of areas where the copper has not flowed.

I have discovered that silicon acts as a mutual solvent for copper and tungsten, and enables the production of a hard, dense, strong, homogeneous, electric-conducting alloy; and that said alloy when made into the form of welding jaws, spot-welding electrodes, or electric current terminals of any kind, resists the heat, retains its strength even when hot and conducts electricity readily. Furthermore the articles made therefrom can be readily turned, planed, bored, filed, threaded, forged, and otherwise manipulated. The following compositions comprise my alloy:

Ingredients	Successful proportions		Preferred composition
Tungsten (or molybdenum)	95%	to 50%	82
Silicon	0.2%	to 5.0%	2
Copper	5%	to 50%	16
or			
W or Mo	90	to 50	70–75
Si	0.2	to 5	1–2
Cu	5	to 45	15–25
Ag	5	to 25	5–10
or			
W or Mo	90	to 50	70–75
Si	0.2	to 5	1–2
Cu	5	to 45	15–25
Ag	0	to 25	5–10
Iron group metal	0.5	to 2	1

In the production of my improved alloy I preferably start with the powdered or granular metallic tungsten or molybdenum as the same is reduced by hydrogen from its oxide. The resulting metallic substance is first compacted by pressure into a block or mass of the requisite size after which the copper is introduced; the only requirement being that the silicon be added at least as early as the copper and to this end the following variations are possible:

I have found it entirely feasible to mix powdered metallic silicon with the tungsten or molybdenum before pressing; or to mix pulverized carborundum with the tungsten or molybdenum which becomes decomposed during the subsequent heating of the mass; or I may mix copper and silicon together and fuse them simultaneously into the compacted tungsten or molybdenum; or I may take an alloy of silicon and copper containing the proper relative proportions, and fuse the necessary quantity thereof into a previously compacted block of tungsten or molybdenum. My tests appear to indicate that the silicon makes a true alloy with the other ingredients, yet a very small proportion of silicon serves to enable the successful alloying of the copper with the high-melting point ingredients, pro-

vided that the silicon is sufficiently uniformly disseminated throughout the whole to produce the observed effect of enabling a true solution between the tungsten and the copper.

One mode which I have successfully employed for securing this dissemination is as follows:

Supposing it be desired to produce a tungsten-silicon-copper alloy, I take a solution of sodium tungstate and mix therewith a solution of sodium silicate using such quantities of the two as shall produce the desired relation of tungsten and silicon. I then add sufficient hydrochloric acid to the solution to precipitate all the tungsten and all the silicon, which come down together in the form of WO_3, plus SiO_2, the two precipitates being intermixed with most extreme completeness. I next dry this precipitate and heat the same in a current of hydrogen until the tungsten is substantially completely reduced; I do not raise the question as to whether complete reduction by hydrogen is possible, but merely carry the same as far as is commercially practical.

I then cool the granular mass obtained which is of course an intimate mixture of metallic tungsten and amorphous silica mixed probably with a small amount of tungstic oxide, and mix the same intimately with a small amount of magnesium powder, afterwards heating the whole to a reacting temperature in a hydrogen or neutral atmosphere whereupon the magnesium reduces the silica to metallic silicon with the production of magnesium oxide. I next dissolve out the magnesium oxide with hydrochloric acid, wash out the resulting magnesium chloride with water, dry the resulting mass, and again reduce with hydrogen in order to remove the last traces of oxygen from the tungsten which would otherwise be found thereon as a result of the treatment with hydrochloric acid. The result of the foregoing process is to produce a mass of finely divided metal in which the admixture of the silicon and tungsten is so thorough that even a small fraction of 1% of silicon will be efficacious throughout the entire mass. This mass is then compacted together, and laid in an electric furnace in contact with metallic copper and heated in a neutral or reducing temperature until the copper melts and soaks into the same with which it rapidly combines in such a thorough manner as apparently to produce a homogeneous alloy.

It is possible and in fact advantageous to add certain other metallic ingredients for the purpose of hardening the alloy. Of such added ingredients the most useful is silver which has the property of hardening the alloy without unduly increasing the brittleness or the electrical resistance. Silver can be substituted for the copper in any proportion but economic considerations limit it to about 25% of the alloy, above which proportion its use shows no substantial benefit over copper. Other possible additional substances are the iron group metals, any of which can be used although the permissible percentage is comparatively small owing to the large hardening effect.

It is possible sometimes, particularly when plain shapes are desired, to form these shapes by the original pressing of the tungsten or molybdenum; but in view of the ready machining, forging, etc. this is not really necessary. My experiments further show that the resulting alloy can probably be melted and cast by the employment of a sufficiently high temperature although I prefer to work at lower temperatures and avoid the contamination practically inseparable from all casting methods.

Owing to the similarity in physical and chemical properties between tungsten and molybdenum, I consider either interchangeable with the other either in whole or in part within the purview of the present invention and have drawn my claims accordingly. I have found nothing in the behavior of tungsten or molybdenum which would prevent the reduction of their proportions below 50%, but have found no advantage in small proportions since the resulting alloy becomes unduly soft for most of the purposes in view and partakes too much of the properties of copper which is the reason that I prefer to employ a preponderance of the high melting point metals.

Having thus described my invention what I claim is:

1. An electrical contact terminal containing 50% to 95% of metal from the group consisting of tungsten and molybdenum together with both copper and .2% to 5% of silicon.

2. An electrical contact terminal containing 50% to 95% of metal from the group consisting of tungsten and molybdenum together with both copper and .2% to 5% of silicon, the high-melting point ingredient being preponderant.

3. As a new composition of matter an alloy containing: Metal from the group consisting of tungsten and molybdenum, 95% to 50%, copper 5 to 50%, silicon 0.2% to 5%.

4. As a new composition of matter an alloy consisting essentially of: Metal from the group consisting of tungsten and molybdenum 70 to 90%, copper 10 to 30%, silicon .5% to 3%.

5. The process of making an electrical contact terminal which contains the steps of producing a porous block of compact tungsten or molybdenum and metallic silicon and afterward impregnating the same with molten copper.

6. The process of making an alloy containing chiefly copper and tungsten or molybdenum which contains the steps of first prepar-

ing an intimate mixture of granular tungsten or molybdenum with metallic silicon, and afterward heating such mixture in a non-oxidizing atmosphere in contact with copper to a temperature above the melting point of copper.

7. The process of making an alloy containing chiefly copper and tungsten or molybdenum which contains the steps of first preparing an intimate mixture of granular tungsten or molybdenum with metallic silicon, compacting said mixture by pressure, placing metallic copper in contact with the compacted mass, and heating said mass in a non-oxidizing atmosphere until the copper is absorbed.

8. An electrical contact terminal containing copper 5% to 45%, silver 5% to 25%, and silicon .2% to 5%, together with 50% to 89% of metal from the group consisting of tungsten and molybdenum.

9. An electrical contact terminal containing 50% to 89% of metal from the group consisting of tungsten and molybdenum together with above 5% of silver, above 5% of copper, and not over 5% of silicon, the last named ingredient being present to the extent of at least .2%.

10. As a new composition of matter, an alloy containing: Metal from the group consisting of tungsten and molybdenum 90% to 50%, copper 5% to 45%, silver 5% to 25%, silicon 0.2% to 5%.

11. As a new composition of matter, an alloy containing: Metal from the group consisting of tungsten and molybdenum 60% to 90%, copper 10% to 25%, silver 5% to 20%, silicon .5% to 3%.

12. The process of making an electrical contact terminal which contains the steps of producing a porous block of compact tungsten or molybdenum and metallic silicon and afterward impregnating the same with a molten alloy of copper and silver.

13. The process of making an alloy containing chiefly copper and tungsten or molybdenum which contains the steps of first preparing an intimate mixture of granular tungsten or molybdenum with metallic silicon, compacting said mixture by pressure, and placing an alloy of copper and silver in contact with the compacted mass and heating said mass in a non-oxidizing atmosphere until said alloy is absorbed.

In testimony whereof I affix my signature.

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