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COMPOSITION OF METAL

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This invention relates to new compositions of matter, to new and improved electrical contact materials, and more particularly to improved electrical contact materials of superior merit and durability when employed for periodically interrupting relatively small electrical currents at a relatively high rate, as in telegraph relays and the like.

An object of the invention is to provide a new electrical contact medium for the purposes stated which will have a longer useful life than known materials when similarly employed; which will function satisfactorily and without failure as an electrical current interrupting medium in telegraph relays and the like for considerably longer intervals than existing materials; which will thereby increase the dependability and continuity of operation of electrical circuit interrupting equipment of the character referred to; which in consequence thereof will minimize the frequency of electrical contact replacements and thus introduce economies in operation and maintenance; and which will permit of circuit interrupting operations under conditions and at periodicities such as are now impracticable because of a too rapid deterioration of known materials in use.

In certain types of telegraph relays, the movable contact has a clearance on open circuit of but a few thousandths of an inch from the associated fixed contact. Proper operation necessitates that this clearance be maintained within rather close limits in service, and that the contacting surfaces remain conducting and relatively smooth or flat.

These requirements call for a contact material which will wear away but slowly in service, which is relatively free from surface oxidation or other contamination, which in process of erosion does not form a film or deposit to such extent as will tend to insulate the contacts from each other, and which, on the other hand, does not produce metallic particles or accretions on the contacts thereby to reduce the contact clearance in operation resulting temporarily or permanently in a bridging of the gap and a condition of short circuit.

The refractory platinum metals and particularly alloys thereof, such as platinum-iridium, on the one hand, and a tungsten carbide-cobalt composition, such as is used in cutting tools, on the other hand, have been used in an attempt to meet the requirements above enumerated. Contacts made of the platinum metals have a very low surface resistance and remain free of oxide deposits. They have, however, a strong tendency to stick

or partially weld together in service in such circuits.

This sticking or welding is less pronounced in alloys of the platinum metals with tungsten or molybdenum; but the formation of insulating films on these contacts renders them unsuitable.

Contacts made of the tungsten carbide-cobalt composition show practically no tendency to stick or weld together in operation. They possess, however, an undesirably high contact surface resistance, which, moreover, keeps increasing in use due to the formation of a partly oxidized and uneven surface. This tendency makes them unsatisfactory for use in instruments having low contact pressures, or operating at low voltages.

Contacts made of pure tungsten carbide, or of related metal carbides, though not subject to oxidation to the same extent as the tungsten carbide-cobalt composition, erode much more rapidly and if used in telegraph instruments require frequent replacement.

We have discovered that an electrical contact material of superior durability and performance, free from the defects described above, is provided by an intimately associated and thoroughly dispersed solid composition of one or several carbides of tungsten or other elements of the tungsten sub-group (chromium, molybdenum, tungsten, and uranium) of the 6th group of the Mendelejeff periodic table, singly or in combination, with one or several of the platinum metals (ruthenium, rhodium, palladium, osmium, iridium, platinum), singly or in combination. These compositions are new so far as we are aware, and their use as electrical contact materials is likewise new.

We have discovered, moreover, that the proportions in which the constituents are combined in the new compositions of our discovery, have a marked influence on their durability and performance when employed as electrical contact materials. We have found, for example, that the carbon should be present in the proportion of not less than 3% to about 8% and preferably about 6% of the tungsten carbide, and that the platinum metal or metals should occur in percentages not exceeding about 20% by weight of the entire composition with a preferred range of from about 1% to about 12% by weight of the composition. Preferably all of the carbon should be present in chemical union with the refractory metal or metals to form pure carbides with no excess of free carbon.

The following examples are illustrative of particular compositions in accordance with our in-

vention, wherein in each instance the carbon content is about 6% of the carbide.

	Percent
Example I.—Iridium.....	7
5 Tungsten carbide.....	93
Example II.—Osmium.....	3.5
Tungsten carbide.....	96.5
Example III.—Rhodium.....	2.3
Osmium.....	4.7
10 Tungsten carbide.....	93.0

In the manufacture of compositions in accordance with our invention, we start out with a finely powdered carbide of tungsten or another element of the tungsten sub-group of the 6th group of the Mendelejeff periodic table, or two or more of them, and one or more of finely powdered platinum metals, mix them in the proportions desired, as by ball milling, press the mixture to the desired shape in a suitable die, and sinter at a temperature appropriate for the mixture. The pressure may vary from 5–80 tons per square inch, and the sintering temperature from about 2500° F. to about 3500° F., depending on the mixture; pressures of 10–30 tons per square inch and sintering temperature of 2800° or 3300° F. are, however, the ones most frequently useful. The sintering should be carried out in a reducing or neutral atmosphere; compositions embodying palladium are preferably sintered in vacuo. When the mixture is heated to the sintering temperature, boundary reactions appear to take place between the refractory carbide particles and the almost equally refractory particles of the platinum metals, causing the body to become coherent and to acquire substantial strength.

The procedure above outlined is convenient and satisfactory; it may, however, be varied as by pulverizing and mixing the ingredients, placing them into a suitable mold and sintering under pressure; or by fusing the ingredients together and casting the resulting alloy into the desired shape; or by fusing the ingredients together, allowing the mass to solidify, pulverizing, and then pressing and sintering, or sintering under pressure, the powder thus obtained.

In the application of the principles of the invention in actual practice, we have found that the specific composition to be adopted will vary somewhat with the nature of the service that it is to perform. Thus, for use in telegraph relays, in which the current flowing is small and the circuit interruptions take place at a high rate, a composition containing one or more of the carbides referred to, and particularly tungsten carbide, combined with osmium or ruthenium is most satisfactory, if only a single metal of the platinum group is to be employed. A typical composition of this sort is that given in Example II, and in such a composition, osmium and ruthenium are substantially equivalent. If a combination of metals of the platinum group is used, it is preferable that either osmium or ruthenium or a combination of those metals be used, together with one or more of the remaining metals of the platinum group, namely, rhodium, iridium, platinum, and palladium, Example III above given being typical of such a composition. For other purposes, other combinations may be employed, such as tungsten carbide together with one or more of the platinum metals exclusive of osmium and ruthenium, Example I being typical of the compositions referred to.

In the preferred forms of the new composition, tungsten carbide is employed, but it is to be understood that for most purposes the carbides of the other metals of the tungsten sub-group are the equivalent of tungsten carbide and may be substituted therefor either wholly or in part. Similarly, in the new composition, the platinum metals are equivalent for many purposes and may be substituted for one another either wholly or in part, although for special purposes, it is preferred as indicated above to use specific platinum metals or combinations thereof.

We claim:

1. As a new material: an intimately associated, thoroughly intermixed, and dispersed solid composition consisting of tungsten carbide containing from slightly in excess of 3 percent to about 8 percent of carbon, and at least one of the metals of the group consisting of osmium and ruthenium in an amount from about one percent to about 20 percent of said composition.

2. As a new material: an intimately associated, thoroughly intermixed, and dispersed solid composition consisting of tungsten carbide containing from slightly in excess of 3 percent to about 8 percent of carbon, and osmium in an amount ranging from 1 to 20 percent of said composition.

3. As a new material: an intimately associated, thoroughly intermixed, and dispersed solid composition consisting of tungsten carbide containing about 6 percent of carbon and osmium in an amount ranging from about 1 to 10 percent of said composition.

4. As a new material: an intimately associated, thoroughly intermixed, and dispersed solid composition consisting of tungsten carbide containing from slightly in excess of 3 percent to about 8 percent of carbon, at least one of the metals of the class consisting of osmium and ruthenium, and at least one of the metals of the class consisting of rhodium, iridium, platinum, and palladium, the total amount of said metals of said classes ranging from about 1 percent to about 20 percent of said composition.

5. As a new material: an intimately associated, thoroughly intermixed, and dispersed solid composition consisting of tungsten carbide containing from slightly in excess of 3 percent to about 8 percent of carbon, and at least one metal of the group made up of rhodium, iridium, platinum, and palladium, the total amount of such metal ranging from about 1 to about 20 percent of the composition.

6. A hard material which consists of tungsten carbide containing from slightly in excess of 3 percent to about 8 percent of carbon, and at least one of the metals of the group consisting of platinum, iridium, osmium, palladium, rhodium, and ruthenium, present in an amount ranging from about 1 percent to about 20 percent of the composition, said ingredients being intimately associated and thoroughly intermixed with and dispersed through one another.

7. A hard material which consists of tungsten carbide containing about 6 percent of carbon, and at least one of the metals of the group consisting of osmium and ruthenium in an amount ranging from about 1 percent to about 20 percent of the total.

8. A hard material which consists of tungsten carbide containing about 6 percent of carbon, at least one of the metals of the class consisting of osmium and ruthenium, and at least one of the metals of the class consisting of rhodium,

iridium, platinum, and palladium, the total amount of the metals of said classes ranging from about 1 percent to about 20 percent of the total.

- 5 9. As a new material: an intimately associated, thoroughly intermixed, and dispersed mass consisting of tungsten carbide containing about 6 percent of carbon, and at least one metal of the group made up of rhodium, iridium, platinum, and palladium, the total amount of such metal
10 ranging from about 1 percent to about 20 percent of the composition.

10. An electrical contact, which consists of tungsten carbide containing about 6 percent of carbon, and at least one of the metals of the group consisting of platinum, iridium, osmium, palladium, rhodium, and ruthenium, present in
5 an amount ranging from about 1 percent to about 20 percent of the total.

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