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METHOD OF PREPARING AND COMPOSITION OF RODS OF HARD FACING MATERIAL

Clifton Taylor, Pittsburgh, Pa., and Joseph A. Weiger and George N. Sieger, Indianapolis, Ind.

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This invention relates to compositions adapted for applying a hard facing material to metal elements which are subject to abrasion and wear, and the process of making rods of such material, and has for general objects the provision of a composition of hard facing material which is substantially homogeneous, tough and hard and possesses great wear and abrasion resisting properties and which when applied to metal elements will remain well bonded thereto under severe conditions of use; the provision of a composition from which rods for application of hard facing material by welding may be readily formed with minimum expense and without any appreciable scrap loss; and an efficient and practicable process for forming such rods in desired sizes.

A more specific object of the invention is the provision of such hard facing composition formed from a mixture of readily obtainable commercial forms of tungsten, molybdenum, chromium, nickel, carbon and iron in finely divided states which can readily be formed into rods suitable for application by welding, either by the gas torch, or by the electric arc with direct or reverse polarity to deposit on metallic bases a tenaciously clinging facing of substantially homogeneous hard and tough, wear and abrasion resisting material.

A further object of the invention is the provision of a process whereby mixtures of such ingredients in finely divided states may be cheaply and readily formed into rods substantially without loss of material and heat treated to obtain a composition of relatively uniform character.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the product possessing the features, properties, and the relation of constituents, which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

In accordance with the present invention commercial compositions and forms of tungsten, molybdenum, chromium, nickel, carbon and iron in finely divided form are mixed together, pressed in molds and subjected to heat to form hard facing rods. Preferably, ferro alloys of tungsten, molybdenum and chromium and cast iron of relatively high carbon content are used.

The hard facing material composition in its preferred forms contains between about 30 per cent and 65 per cent iron; between about 2 per cent and 5 per cent nickel; between about 2 per cent and 30 per cent tungsten; chromium and molybdenum in amounts to cause the amount of tungsten, chromium and molybdenum when taken together to vary between about 25 per cent and 60 per cent, with the ratio of molybdenum to chromium being between about 1:2 and 2:3; and between about 3.5 per cent and 6.5 per cent carbon, all percentages being by weight.

Most commercial ferro alloys contain carbon as does cast iron. The ferro alloys of tungsten, molybdenum and chromium, the cast iron, and tungsten carbide when used, constitute the major sources of carbon, although some carbon, preferably in the form of lamp black, is usually added sufficient in amount to bring the carbon content up to the desired percentage. When ferro alloys of tungsten, molybdenum and chromium are used those with relatively high carbon content are preferably selected to keep to a minimum the amount of added carbon since it has been found that the carbon is more uniformly incorporated in the composition when some combined form is used.

Slight amounts of other substances will be found to be present in the compositions due to their presence in the commercial compositions and forms of the ingredients used. For example, silicon may be present in an amount between about 2 per cent and 3 per cent, and small amounts or traces of manganese, sulphur, and phosphorus may also be present.

The following hard facing material compositions are given by way of example:

	Parts by weight
I. Nickel	3.00
Ferro-chrome	27.50
Ferro-molybdenum	15.00
Ferro-tungsten	2.67
Carbon	1.00
Cast iron	51.00
II. Nickel	3.00
Ferro-chrome	27.50
Ferro-molybdenum	15.00
Ferro-tungsten	2.67
Carbon	1.00
Cast iron	51.00
Tungsten carbide	25.00

In the above examples relatively high carbon content ferro alloys, cast iron having a carbon content of about 3 per cent and tungsten carbide having a carbon content of about 6 per cent are preferably used, the added carbon preferably being in the form of lamp black.

The foregoing examples are given as embodiments of the preferred form of the invention but hard facing compositions can be produced in accordance with the present invention by other mixtures within the ranges given, the particular mixture chosen being relatively dependent upon the properties desired for the particular use to which the hard facing composition is to be put.

When desired an amount of the order of .2 per cent of material commercially known as calcium boride is mixed with the other ingredients of the composition prior to the formation of rods therefrom. The rods may also be provided with composition coatings if desired.

To form hard facing rods from such compositions the ingredients in finely divided form are thoroughly mixed, pressed into shape and subjected to heat at about the incipient fusion temperature. In accordance with the preferred method the various ingredients are ball milled for about three hours and about 2 per cent paraffin is then added as a binder. The mixture is then pressed in dies at a pressure of about 20 tons per square inch to form shaped rods, the pressed rods then being dried to evaporate any moisture present and subsequently stoked through a hydrogen furnace at the rate of about 1 inch per minute, a 30 inch muffle heated to a temperature of about 1200° C. preferably being used. The pressed rods are passed twice through the heat zone of such muffle. Temperatures other than that indicated have been found to be suitable but the time duration of the subjection to heat has been found to bear a relationship to the temperature used, for example, at a temperature of 1150° C. the pressed rods are subjected to the heat treatment for about three hours, at about 1200° C. for about one hour, and at about 1250° C. for about one-half hour, the 1200° C. heat treatment for about one hour being preferred since there appears to be less tendency for the cast iron to flow away from the other ingredients.

Rods formed by the outlined method have been used to deposit hard facing material on various metallic elements including cast iron elements by the gas torch and by the electric arc. With the electric arc either direct or reverse polarity may be used though reverse polarity is preferred. Hard facing material can be deposited from such a rod $\frac{5}{16}$ inch in diameter by the electric arc with a current of about 200 amperes at 30 volts, and without any interruption of the arc. The hard facings obtained are found to be efficiently wear and acid resistant, tenacious, of uniform composition, evenly deposited and relatively free from oxides and other imperfections.

By the method disclosed difficulties and material losses attendant upon melting and casting are eliminated. Rods are produced which are substantially uniform in composition throughout due to the limitation of the problems which arise when metals of high and low melting points and widely different vapor pressures and slagging materials are brought together in the molten state and cast in commercial sizes.

It will thus be seen that the present invention efficiently attains the objects set forth above and since certain changes in carrying out the above process, and certain modifications in the composition which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense and to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described.

Having described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. A sintered hard facing rod of a composition comprising nickel, carbon, iron, and ferro-alloys of chromium, molybdenum and tungsten, the major portion of said ingredients being in the form of small bodies homogeneously distributed throughout, the rod composition containing an amount by weight of iron varying between the limits of about 30 per cent and about 65 per cent, an amount by weight of nickel varying between the limits of about 2 per cent and about 5 per cent, the amount by weight of tungsten varying between about 2 per cent and about 30 per cent, with the ratio of molybdenum to chromium being between about 1:2 and 2:3.

2. A sintered hard facing rod of a composition comprising nickel, carbon, calcium boride, and commercial compositions of chromium, molybdenum, tungsten and iron containing carbon, the major portion of said ingredients being in the form of small bodies homogeneously distributed throughout, said commercial compositions of chromium, molybdenum and tungsten being ferro-alloys thereof, the rod composition containing the iron in an amount by weight varying between the limits of about 30 per cent and about 65 per cent, the nickel in an amount by weight varying between the limits of about 2 per cent and about 5 per cent, the tungsten in an amount by weight varying between about 2 per cent and about 30 per cent, with the ratio of molybdenum to the chromium being between about 1:2 and 2:3.

3. A sintered hard facing rod of a composition comprising cast iron, nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon and calcium boride homogeneously distributed throughout in the form of small particles, the amount of calcium boride being of the order of about .2 per cent, the rod composition containing an amount by weight of iron varying between the limits of about 30 per cent and about 65 per cent, an amount by weight of nickel varying between the limits of about 2 per cent and about 5 per cent, the amount by weight of tungsten varying between about 2 per cent and about 30 per cent, with the ratio of molybdenum to chromium being between about 1:2 and 2:3, and an amount by weight of carbon varying between the limits of about 3.5 per cent and about 6.5 per cent, the iron content including that in the cast iron and ferro-alloys ingredients and the carbon content including that in the cast iron and ferro-alloys ingredients.

4. A sintered hard facing rod of a composition comprising cast iron, nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon and tungsten carbide, said ingredients being in the form of small bodies homogeneously distributed throughout, the rod composition containing an amount by weight of iron varying between the limits of about 30 per cent and about 65 per cent, an amount by weight of nickel varying between the limits of about 2 per cent and about 5 per cent, the amount by weight of tungsten varying between about 2 per cent and about 30 per cent, with the ratio of molybdenum to chromium being between about 1:2 and 2:3, and an amount by weight of carbon varying between the limits of about 3.5 per cent and about 6.5 per cent, the iron content including that in the cast iron and ferro-alloys ingredients and the carbon content includ-

ing that in the cast iron, ferro-alloys and carbide ingredients.

5. A sintered hard facing rod of a composition comprising nickel, carbon, iron, and ferro-alloys of chromium, molybdenum and tungsten, the major portion of said ingredients being in the form of small bodies homogeneously distributed throughout, the rod composition containing an amount by weight of iron varying between the limits of about 30 per cent and about 65 per cent, an amount by weight of nickel varying between the limits of about 2 per cent and about 5 per cent, an amount by weight of carbon varying between the limits of about 3.5 per cent and about 6.5 per cent, an amount by weight of tungsten varying between about 2 per cent and about 30 per cent, with the ratio of molybdenum to chromium being between about 1:2 and 2:3, and the amount by weight of chromium, molybdenum and tungsten taken together varying between about 25 per cent and about 60 per cent.

6. A sintered hard facing composition comprising nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon and cast iron, said constituents being in the form of small bodies homogeneously distributed throughout the composition and being separately incorporated in amounts within reasonable variations of a few parts and fractional parts by weight from the proportions 3 parts by weight of nickel, 27.5 parts by weight of ferro-chrome, 15 parts by weight of ferro-molybdenum, 2.67 parts by weight of ferro-tungsten and 1 part by weight of carbon, with their relative proportions remaining substantially the same and with said iron ingredient making up the major portion of the remainder of said composition.

7. A sintered hard facing composition comprising nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon, tungsten carbide, and cast iron, said constituents being in the form of small bodies homogeneously distributed throughout the composition and being separately incorporated in amounts within reasonable variations of a few parts and fractional parts by weight from the proportions 3 parts by weight of nickel, 27.5 parts by weight of ferro-chrome, 15 parts by weight of ferro-molybdenum, 2.67 parts by weight of ferro-tungsten and 1 part by weight of carbon, with their relative proportions remaining substantially the same, the tungsten carbide constituting not more than about 25 parts by weight and as low as about 5 parts by weight, and the iron ingredient making up the major portion of the remainder of said composition, the total carbon content including that separately incorporated, that in the carbide and that in the ferro-alloys constituting from about 3.5 per cent to about 6.5 per cent by weight of the whole composition.

8. A sintered hard facing composition comprising about 3 parts by weight nickel, about 27.5 parts by weight ferro-chrome, about 15 parts by weight ferro-molybdenum, about 2.67 parts by weight ferro-tungsten, about 1 part by weight carbon, and iron varying in amounts between about 35 and 51 parts by weight.

9. A sintered hard facing composition comprising about 3 parts by weight nickel, about 27.5 parts by weight ferro-chrome, about 15 parts by weight ferro-molybdenum, about 2.67 parts by weight ferro-tungsten, about 1 part by weight carbon, about 25 parts by weight tungsten carbide, and iron varying in amounts between about 35 and 51 parts by weight.

10. The method of forming hard facing rods comprising mixing together nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon and iron all in finely divided form, pressing such mixture into the shape of rods, and subjecting such rods to a temperature between about 1150° C. and 1250° C. for a definite period of time bearing a relationship to the chosen temperature of the order of three hours at 1150° C., one hour at 1200° C., and one-half hour at 1250° C., to obtain incipient fusion of the ingredients.

11. The method of forming hard facing rods comprising ball milling together finely divided nickel, ferro-chrome, ferro-molybdenum, ferro-tungsten, carbon and cast iron, adding a small amount of paraffin as a binder, pressing the resultant mixture into rods at a pressure of about 20 tons per square inch, and heat treating such rods in a hydrogen furnace at a temperature of about 1200° C. for about one hour.

12. A sintered hard facing rod of a composition having the ingredients in the form of small bodies homogeneously distributed throughout and comprising carbon not more than about 6.5 parts by weight, iron from about 30 to 65 parts by weight, tungsten from about 2 to 30 parts by weight, molybdenum from about 7 to 23 parts by weight and chromium from about 14 to 39 parts by weight with the ratio of molybdenum to chromium being between about 1:2 to 2:3, said iron, tungsten, molybdenum and chromium being incorporated as commercial compositions thereof with at least some of the three latter as ferro-alloys.

CLIFTON TAYLOR.
JOSEPH A. WEIGER.
GEORGE N. SIEGER.