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THERMOCHEMICAL LANCING AND CUTTING POWDERS AND METHOD OF PREPARING SAME FOR USE IN OXYGEN SUSPENSION

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This invention relates to a new and improved mixture of metal powders for use in cutting high heat, refractory materials, such as, chrome and nickel alloys, cast iron, and all manner of non-metallic, refractory materials, such as, fire brick, magnesite brick, aluminum, chrome, slag, concrete rock, and to a method of preparing the same in a form well adapted to be suspended in an oxygen reacting stream during its passage through a cutting torch or lance.

It has long been known that steel, when raised to the ignition temperature, can rapidly be cut with a stream of oxygen. The conventional cutting torch, therefore, consists of an oxy-fuel gas flame, to raise the temperature of the steel to the ignition point and a secondary means of directing a stream of oxygen on to the preheated steel to accomplish the cutting action. Such a procedure however, is ineffective for the cutting of the refractory materials above enumerated.

In torch cutting or lancing refractory materials it is well-known to direct streams of iron powder and oxygen into the reaction zone to permit a continuous cutting action, due to the thermochemical fluxing reaction so produced. Because of its relatively low ignition temperature, the iron powder is normally conveyed to the cutting torch or lance by a relatively inert gas stream. This gas acts as a diluent for the products of combustion and carries heat away from the reaction zone. This reduces the effective temperature in the reaction zone, whereas, higher temperatures are desired to increase the rate of cutting or fluxing or for other purposes.

The heat value of iron oxidized to ferric oxide is only slightly over 3,000 B.t.u. per pound, but when iron powder is oxidized or burned in pure oxygen, the temperature produced is well above the melting points of alloy steels, due to the fact that the oxygen is absorbed into the molten iron oxide and no heat is carried away from the torch flame by inert gas. The molten iron oxide fluxes and thereby cuts into refractory metals and materials such as cast iron, alloy steel, firebrick, slag, concrete, etc.

Attempts have been made to convey iron powder to the torch or lance with oxygen to avoid the use of air or inert gas, in order further to increase the temperature and rate of cutting, but these have not proven successful, due to undue heating of the torch or lance and consequent flashbacks in the torch or lance. Serious explosions have resulted from conveying iron powder and mixtures of iron powder and aluminum powder in oxygen. It will be recognized that a lance is a metal pipe or tube used to convey the powder and oxygen. It may be as long as 20 feet. Its free end gets quite hot and heat is transmitted backwards into the pipe.

Commercially available iron powders will ignite in oxygen at low temperatures, such as a low red heat, and some types ignite spontaneously when exposed to oxygen or even to air at ordinary temperatures. Commercial iron powder containing less than 0.2% each of carbon and silicon, which has been sintered in a reducing atmosphere of about 1,800° F. passing through a standard

Tyler screen of 325 mesh will ignite in oxygen at 700° F. whereas particles of the same powder larger than 100 mesh ignite only at 860° F. in oxygen and mixtures of these sizes ignite at the lower temperature of 700° F. A powder having an ignition point of 700° F. has been found too unsafe for use in an oxygen stream. I have found that any inert, powdered, non-metallic material, such as powdered magnesia, added to iron powder will raise its ignition point by simple dilution, but such material is objectionable since it lowers the ultimate temperature developed by the combustion of the iron.

The object of the present invention is to provide a metallic powder which has the thermochemical properties which permit its successful and safe use in a cutting torch or lance with oxygen. More specifically, the invention contemplates a metal powder composition for the purpose described, which has a safe ignition temperature, which may be safely conveyed with oxygen through the torch or lance, and which at the same time will develop the desired high temperature and thermochemical fluxing action.

The invention also contemplates a method of making such powder in the form of a mixture of metallic particles, which insures provision of the thermochemical properties described.

The metallic cutting and lancing powder of the invention consists essentially of a mixture of finely divided iron powder, having a relatively low ignition temperature in oxygen, with a finely divided iron alloy powder, refractory toward oxygen while in the solid state but reacting rapidly with oxygen when molten, in such proportions that the mixture may be safely conveyed in oxygen through a torch or lance for ignition at the surface to be cut away. That is to say, the mixture is composed of iron powder which ignites in oxygen at temperatures of about 700° F. and a powder of an alloy of iron, having a higher heat of oxidation than iron, which ignites in oxygen at a temperature of not less than 1700° F. in such proportions that the mixture will ignite in oxygen only at a temperature in excess of 700° F., and below 1200° F., that is to say, between a low red heat and a bright red heat.

According to the invention, the ferrous alloy powder of the mixture comprises ferro-aluminum, to provide in the mixture 10% or more aluminum. In this connection, it is to be observed the heats of oxidation of the two metals of which the mixture is composed are: Fe to Fe_2O_3, 3,175 B.t.u. per pound, Al to Al_2O_3 13,218 B.t.u. per pound.

The mixture should not contain substantially less than 33⅓% nor substantially more than 80% of free iron powder and the balance the alloy powder, the proportions varying according to the specific use, and thus the range of temperatures and degree of fluxing action desired. Such mixtures will not ignite in an oxygen stream in passing through the lance or torch, but will develop higher temperatures than iron alone upon combustion. At the lower free iron content, the mixture will ignite at a temperature about 1050° F., and at the higher free iron content at approximately 800° F. The maximum permissible alloy content is preferred for reasons of safety.

It has been found that the ferrous alloy powder used alone in oxygen cannot be ignited at the start of the cutting operation without an excessively hot ignition source on the surface to be cut and, even when ignited, it does not burn as fast as the iron powder alone, or as fast as the mixture of the free iron powder and the ferrous alloy. It has been found impracticable to use alloy powder alone for this purpose, due to the well-known resistance of such alloys to oxidation, except in the molten state. The alloy powder, therefore, behaves as a diluent of the iron pow-

der during its passage through the lance and does not burn until molten. Thereby, it functions to prevent ignition of the powder in passage through the torch or lance.

The alloy powder of the mixture preferably contains about equal proportions of iron and aluminum. The alloys may be readily made in an electric furnace. These proportions are preferred, because they provide the most brittle alloy, which is readily converted to powder, and they provide the mixture with a large proportion of the high heat value of aluminum. Moreover, the density of the alloy is so close to that of the iron powder that segregation of the constituents of the mixture does not readily occur.

In producing the mixture the iron and the ferro-alloy are each produced in the form of fine powders preferably passing 60 mesh, with a proportion up to 30% passing 325 mesh, with intermediate distribution of sizes. These powders are then mixed or blended together to form a composition containing not substantially less than one-third, nor substantially more than four-fifths of the free iron powder. The preferred mixture for general use contains substantially one-third free iron, one-third combined iron and one-third aluminum, but these proportions may vary widely, according to specific use and material being fluxed. The powder should preferably pass through 60 mesh Tyler screen, and may be finer than this; for example, it may all pass through a 100 mesh screen, but a minimum of particles passing through 325 mesh is preferred, as the finer fractions do not flow easily and have a tendency in the iron fractions to pre-ignite. Mixtures 100% passing 100 mesh with 30% passing 325 mesh are successfully used.

Thus when here and elsewhere in this specification and claims, I use the term "finely divided" it is to be understood as being in the range of from 100% through 60 mesh and up to 30% through 325 mesh.

It is found that, when such mixtures are burned in an adequate supply of oxygen, the iron content ignites first at the heated surface above a visible red heat of brick, slag, metal or other refractory which is to be cut, forming immediately iron oxide in highly fluid condition with which the alloy content reacts rapidly in the molten state, forming extremely hot and fluid mixtures of iron oxide, aluminum oxide, which rapidly melt and flux away the surface upon which the flame is impinged.

It will be seen, therefore, that while it has previously been proposed to utilize mixtures of iron powder and aluminum or other metal powders, said mixtures must be handled in air or an inert gas stream, which is inconvenient and reduces the temperature. The essence of this invention lies in providing a mixture of free iron and refractory iron alloy powders in which the ignition temperature in oxygen is raised by simple dilution to a point at which the powder safely may be carried in oxygen at temperature up to a low red heat but which, when ignited at higher temperature, will react rapidly with oxygen to develop molten oxide mixtures having higher temperature and having fluxing properties superior to those obtained with iron alone. By these means, by raising the heat value of the metal powder and making it possible to convey it safely in oxygen, it has been found possible to cut refractory materials with ease and rapidity.

Another advantage of the composition of this invention, as compared with simple mechanical mixtures of iron powder and aluminum powder, or other metal powders, lies in the tendency of the elemental powders, by virtue of their differences in specific gravity, to separate in handling and transportation, whereas, the powders of this invention are of closer specific gravity and, therefore, not subject to gravity separation, such as by vibration during transportation. It is obvious that, for uniform continuity of safe operation, such separation must be avoided.

I am aware that, in the past, some users have mixed elemental iron powder and elemental aluminum powder immediately prior to use for cutting and lancing. Such procedure is attended by hazard in the mixing operation and, more particularly, by hazard in the use of such a mechanical mixture, due to the well-known tendencies of these finely divided metals to pre-ignite, which hazards are overcome by this invention.

Mechanical mixtures of some elemental metal powders, such as iron and aluminum or magnesium, are subject to spontaneous combustion and to deterioration by slow oxidation by air, oxygen, moisture, or other gases, which render them hazardous in preparation, storage and use, and slow deterioration detracts from their ultimate usefulness. The compositions of this invention are not subject to such spontaneous combustion or deterioration.

The invention has been described with reference to preferred embodiments in which specific alloys, quantities and proportions are given. It is to be understood that these specific alloys, quantities and proportions are merely exemplary of the invention and should not be construed as limitations. Such embodiments of the invention as come within the scope and purview of the appended claims are to be considered as part of this disclosure.

What is claimed is:

1. A thermochemical metal mixture for safe torch cutting and lancing with oxygen, consisting essentially of a mixture of iron powder having a relatively low ignition temperature and a binary alloy powder consisting essentially of substantially equal parts of iron and aluminum having a relatively high ignition temperature, the mixture containing not more than 75 parts of said iron powder and the balance being powder derived from said binary alloy, whereby the ignition temperature of the mixture is controlled to prevent ignition of the mixture in transit with oxygen to the discharge end of the torch or lance.

2. A mixture as claimed in claim 1 wherein the iron powder has an ignition point in oxygen about 700° F. and said alloy powder has an ignition point in oxygen of at least 1700° F.

3. A mixture as claimed in claim 1 wherein the iron powder has an ignition point in oxygen about 700° F. and said alloy powder has an ignition point in oxygen of at least 1700° F. and wherein said iron powder and said iron alloying powder are combined in such proportions that the ignition point of the mixture in oxygen is between about 800° F. and about 1050° F.

4. A mixture as claimed in claim 1, in which the free iron content forms at least one-third of the mixture and the balance being alloy powder, said alloy powder being refractory to oxygen while in the solid state, but capable of rapid oxidation while in the molten state, thereby generating higher temperature than the oxidation of iron powder alone.

5. A mixture as claimed in claim 1 and wherein said mixture comprises between 33⅓% and 80% by weight of iron powder and the remainder iron-aluminum alloy powder, said alloy being such as to provide at least 10% by weight of aluminum in the total mixture.

6. A process of producing ferrous metal powders for torch cutting with oxygen which comprises mixing finely divided iron, having a low ignition temperature in oxygen, with finely divided binary alloy consisting essentially of substantially equal parts of iron and aluminum, said alloy having a high ignition temperature in oxygen, the iron powder constituting at least 30% of the mixture and the balance being powder derived from said binary alloy, whereby the ignition temperature of the mixture is raised substantially above that to which the mixture is subjected in passing in suspension in oxygen to the nozzle of the torch or lance.

7. A process of producing a thermochemical powder for torch cutting with oxygen which comprises crushing to powder form ferro-aluminum having substantially equal

proportions of iron and aluminum and having an ignition point in oxygen of at least 1700° F., and mixing with the alloy powder finely divided iron to reduce the ignition point of the mixture to not substantially less than 800° F. and thus provide a safe torch or lance cutting mixture having an enhanced heat value and fluxing action.

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