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METALLIC ABRASIVE OR BLAST MATERIAL

John F. Ervin, Ann Arbor, Mich.

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This invention relates to metallic abrasive or blast materials, or to improvements therein, and more particularly to improvements in alloy compositions in or for the production of such materials, used as a medium for cleaning, polishing and cutting purposes. It constitutes a continuation in part of the invention disclosed in my U. S. Patent No. 2,145,747, dated January 31, 1939, and in my three still pending U. S. applications Serial Nos. 246,758, 246,759 and 246,760, filed respectively on December 19, 1938, as separate divisions hereof.

The object of the invention is to provide a further improved and more perfectly adapted alloy or material which will afford more efficient and satisfactory results from the standpoints of hardness, durability and resistance to "break-down" or disintegration under use. That is, it aims to produce an abrasive material having a high crushing strength and impact resistance.

Particlized or so-called "shotted" metal utilized as a blast under pressure or driven force is of course well-known as an abrasive for cleaning and cutting metal, stone and other hard objects. It is admirably suited to said purpose and has come into extensive use therefor in various ways. However, the peculiarly rigorous and destructive conditions to which it is subjected in use not only requires certain characteristics in the form and composition of the material, but also makes it difficult to attain satisfactory criteria concerning the same. For instance, hardness is one of the prime essentials, which may vary in degree for different purposes and for different materials or objects on which it is to operate. But hardness must be accompanied by a certain degree of resiliency and impact resistance or malleability to prevent it from fracturing or disintegrating into mere dust from the force of impact against hard objects. In the case of cutting steels, for example, where the material is impelled with tremendous velocity against the object, a very high degree of hardness is necessary as compared with the cutting or mere cleaning of limestone rock or the like which is much less resistant to the force of impact. But speaking generally, the higher the degree of hardness attainable, the better will be the product for most purposes, provided it is accompanied by a sufficient degree of toughness and impact resistance or crushing strength to retain its integrality and form. Ordinarily, a spherulate or globular form is preferred, inasmuch as this is less given to disintegration than mere lump or irregular forms.

It may assist understanding of the objective to here state that the life of an abrasive used in blasting for cleaning or cutting purposes is dependent entirely upon its resistance to breaking down under impact due to the exceedingly high velocities with which the material is necessarily projected to strike the object under treatment. Also, the life of such material is governed substantially by its resistance to wear or abrasion from the object on which it is operating.

In search of a material presenting a high impact resistance as well as a high crushing strength, various alloys or compositions have been proposed, founded upon different basic metals. For instance, tungsten carbide has been suggested as a suitable basic or primary component metal. But while this particular material is exceptionally hard, it is on the other hand extremely expensive. Furthermore, it is short-lived. Such a product is relatively brittle and under the terrific impacts involved in its use, will rapidly break down to a powdery form so that it is unsatisfactory for such reason. Other factors similarly come into play and the correlation and proportioning of various components to produce the physical characteristics desirable in the material is difficult to achieve. It has been found that iron is probably the most suitable and the best basic or principal metal for the purpose. To this basic metal various ingredients such as carbon, manganese, silicon, sulphur, phosphorus and other substances have been added in various combinations and proportions with various results and desirable improvements. This applicant has advanced these developments somewhat by adding chromium, molybdenum, vanadium and nickel in different proportions to such compositions, with improved results. But the perfect, or nearly perfect, composition has not yet been found and there is still much to be desired in a material of the kind. It should be observed that due to the nature of the use of the material, very large quantities are generally required and the price factor is therefore a very important further consideration.

As stated in my aforementioned prior Patent No. 2,145,747, I have discovered that a very effective abrasive or blasting material of this general type can be produced from the generally preferred iron as the basic metal, by alloying it with relatively minor amounts of certain alloying components found to advantageously modify its physical characteristics along the lines desired. Stated more specifically, I have found that minor additions of chromium and molybdenum or vanadium, and also nickel, to typical high carbon iron alloys, in place of or in addition to some of

the ingredients previously used, produces a very effective and satisfactory metallic blast material. These alloying components very markedly modify the impact resistance and crushing strength of the base alloy and produce a product possessing to a considerable extent those desirable characteristics which are essential to a superior product of the kind. An important factor is the marked modification of the basic or ferrous composition material by the addition of such relatively minor and hence inexpensive amounts of these alloying ingredients. As explained in said patent the additions of proportioned amounts of chromium and vanadium were found to greatly increase the impact resistance of the ferrous material. Similarly, the addition of properly proportioned amounts of molybdenum and nickel were found to appreciably improve the crushing strength of the iron, thus rendering the resulting alloy unusually effective as an abrasive material.

A composition producing an improved effective alloy by the use of chromium and molybdenum or vanadium and nickel in minor proportions as above described is illustrated by the following formula, which will aid understanding of the present invention in further development thereon, to wit:

	Per cent
Carbon	3.0
Manganese	0.5
Silicon	1.5
Sulphur	0.1
Phorphorus	0.4
Chromium	1.0
Molybdenum	0.2
Iron—the remainder or	93.3

In place of the molybdenum of the above formula, vanadium up to approximately 0.1% may be substituted, in which event the chromium content would be modified to from 0.25% to 3.0%. Or, together with the molybdenum, nickel from 0.1% to 3.0% might be added, in which case the molybdenum would be reduced to from 0.6% to 0.1% and the chromium content modified to from 0.1% to 1.5%. The predetermined quantities of chromium and molybdenum or vanadium and nickel with the other components may be added in the ladle to the iron-carbon alloy.

It will be appreciated that the above exemplified alloy of an improved type is merely illustrative and that the percentages of the beneficial alloying ingredients specified are not critical. Thus, the chromium content may be varied from approximately 0.25% to as much as 5.0% or more and the molybdenum addition may be correspondingly varied. The molybdenum is utilized in the approximate ratio of 1 part molybdenum to 5 parts of chromium and greatly improves or increases the crushing strength of the composition. The vanadium in combination with the chromium imparts improved impact resistance as well as crushing strength to the iron. It will be observed that the proportion of vanadium utilized is in the approximate ratio of only 1 part to 50 parts of chromium. Even in the small quantities thus employed, the effect on the final product is very marked. It will be appreciated of course that both vanadium and molybdenum may be used in the same composition by maintaining their approximate and stated ratio to the chromium addition. The crushing strength can similarly be improved by incorporating small amounts of the nickel in the alloy. When nickel is utilized, the amount of chromium may be somewhat reduced as has already been indicated above.

As the result of further experimentation upon these lines, I have discovered that a still more improved alloy for an abrasive or blast material can be produced by the use or addition of copper in a like relatively small proportion, such copper being substituted for the nickel where nickel might be used in connection with the foregoing illustrative formula. That is, copper is employed in combination with the chromium and molybdenum or vanadium and in substitution for the nickel used in some instances. As before, the molybdenum and vanadium have a relative action, and either may be used, together with the chromium to confer upon the ferrous base alloy the particularly desirable characteristics of high impact resistance and crushing strength, but this is greatly increased by the copper here proposed in combination therewith. To exemplify, the new and much improved alloy may be produced according to the following formula, viz:

	Per cent
Carbon	3.0
Manganese	0.5
Silicon	1.5
Sulphur	0.1
Phosphorus	0.4
Chromium	0.25 to 3.0
Molybdenum or Vanadium	0.1 to 0.6 / 0.05 to 0.1
Copper	0.25 to 5.0
Iron—the remainder or from approximately	85 to 94

As in the case of the first formula, the molybdenum is utilized in the approximate ratio of 1 part of molybdenum to 5 parts of chromium and when vanadium is employed in place of the molybdenum, it is utilized in the approximate ratio of 1 part to 50 parts of chromium. Also, the vanadium and molybdenum may be used in the same composition by maintaining their approximate and stated ratio to the chromium addition. The chromium content itself may be varied from approximately 0.25% to 3.0% or even more and the molybdenum addition may be correspondingly varied. As to the copper, approximate limits of variable content have been given for the purpose of covering its full beneficial range. While it contributes beneficially within these limits, it has been found to be most effective at approximately a 2% content. Its function or effect is two-fold and very definite. First, in combination with the iron it enters into solution and creates a more mobile liquid or mass; that is, it is more active in a molecular way and has the characteristic of forming a more perfect "shot" or discreted particle. Second, it combines with the other components and increases their hardening effect upon the alloyed mass so as to render the material harder and more greatly resistant to impact and crush when broken up or discreted into the particle form.

It will be understood, furthermore, as in the previous case, that this second formula is merely illustrative and representative. That is, the percentages of the beneficial alloying ingredients are not critical and may be varied within the limits named. For instance, the carbon content may be varied over a fairly wide range, the 3.0% composition stated being taken merely as indicating a relatively high carbon ferrous base alloy. The percentages of the manganese, silicon, sulphur and phosphorus are similarly susceptible of some variation. While an improved composition has

been described, it will be appreciated that the formula recited is merely an example by which to illustrate and explain the underlying principle of the invention and is not intended to limit the scope of the same to the particular composition designated. This is especially true with reference to those components other than copper, the proportions of which latter have been stated within definite limits.

The alloy thus produced is of course converted or reduced into particlized or "shotted" form in any suitable manner as by one of the well-known "shotting" methods. That is, said alloy as a molten metal is gravitated in a stream against which a stream of liquid or steam, or both, is projected to explode or disintegrate the same into particle or "shotted" form. These particles or "shots" are thereupon dropped into a liquid bath for cooling and hardening, after which they are removed and passed through a drying or combined drying and tempering treatment by which they are brought to commercial utility condition. The sizing of the particles of course depends upon the break-up or disintegrating operation.

The composition produced by this copper addition, in combination with the chromium and molybdenum or vanadium in an otherwise ordinary carbon ferrous alloy, has very superior characteristics admirably suited to abrasive or blast materials for the purposes described. Impact tests show that this improved material as compared with others, in the same size of "shotting," has an approximately 30% increased resistance to break-down and a corresponding greater life. Other tests show that after the equivalent of 25 hours service in blasting operation, an addition of only about 10% to the original supply is required at 5 hour intervals to keep the total weight of operating material constant, whereas the ordinary material without the copper component requires about a 35% addition in the same period of time to keep the total weight constant. Furthermore, it is found that this new and improved material is about 81% efficient while the ordinary material is only about 54% efficient in use. The advantages of the material made from this new alloy including copper in minor proportion with the other components of the same will therefore be appreciated.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An abrasive material characterized by a high crushing strength and impact resistance comprising a carbon-ferrous alloy composition consisting of iron in a substantial proportion of from approximately 85% to 94% and substantially 3% of carbon, including minor quantities of chromium and a metal chosen from the group consisting of molybdenum and vanadium, and having a copper content of from 0.25% to 5.0%.

2. An abrasive material characterized by a high crushing strength and impact resistance comprising a carbon-ferrous alloy composition consisting of iron in a proportion of from approximately 85% to 94% and substantially 3% of carbon, including chromium in from 0.25% to 3.0%, molybdenum in from 0.1% to 0.6%, and a content of copper in from 0.25% to 5.0%.

3. An abrasive material characterized by a high crushing strength and impact resistance comprising a carbon–ferrous alloy composition consisting mainly of iron in from approximately 85% to 94% and substantially 3% of carbon, having relatively small contents of manganese, silicon, sulphur and phosphorus, including chromium in a proportion of from 0.25% to 3.0%, vanadium in from 0.05% to 0.1%, and copper in a proportion of from 0.25% to 5.0%.

4. An abrasive material characterized by a high crushing strength and impact resistance comprising a carbon-ferrous alloy consisting of a substantial amount up to 5.0% of carbon, a substantial amount up to 3.0% of chromium, a substantial amount up to 0.6% of molybdenum, a substantial amount up to 5.0% of copper, together with small amounts of impurities, such as manganese, silicon, sulphur and phosphorus in insufficient quantities to alter the characteristics of the alloy, the remainder consisting of the iron in a proportion of approximately from 85% to 94%.

5. A metallic abrasive or blast material characterized by a high crushing strength and impact resistance, consisting of a carbon-ferrous alloy composition comprising a substantial amount of iron having substantially 3% of carbon, a substantial amount up to 3.0% of chromium, a substantial amount up to 0.1% of vanadium, a substantial amount up to 5.0% of copper, and the remainder consisting of small amounts of impurities, such as manganese, silicon, sulphur and phosphorus in insufficient quantities to alter the characteristics of the alloy, the iron content being in a proportion of from approximately 85% to 94%, and said composition being characterized in that the vanadium content is utilized in the approximate ratio of 1 part to 50 parts of the chromium.

6. A metallic abrasive or blast material, comprising shotted or discreted particles of an alloy characterized by a high degree of hardness having a high impact and crush resistance, said alloy consisting primarily of iron in a proportion of from approximately 85% to 94%, a relatively high proportion of carbon up to approximately 5.0%, manganese in the approximate proportion of 0.5%, silicon in the approximate proportion of 1.5%, sulphur in the approximate proportion of 0.1%, phosphorus in the approximate proportion of 0.4%, chromium in a relative proportion of from 0.25% to 3.0%, molybdenum in a proportion of from 0.1% to 0.6%, and a copper content of from 0.25% to 5.0%, the molybdenum being regulated in a ratio of approximately 1 part to 5 parts of the chromium.

JOHN F. ERVIN.