Patented Nov. 7, 1944

2,362,310

UNITED STATES PATENT OFFICE

2,362,310

METALLIC BLASTING AND ABRASIVE MATERIAL

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No Drawing. Application December 29, 1942, Serial No. 470,517

6 Claims. (Cl. 51—309)

The present invention relates to metallic blasting and abrasive material used in processes where the blasting material is thrown at high velocities against an object by air or other gas pressure or by mechanical force to clean the object or to obtain an abrading effect, and more particularly to cast iron shot and the like to be used in its cast or spherical form in such processes.

It has been proposed to make shot and the like to be used directly, i. e., not crushed and used as grit, of hard white cast iron or of soft malleabilized cast iron, but such blasting and abrasive material was not completely satisfactory in actual commercial practice. Unalloyed white iron shot possessed high hardness, but lacked the desired toughness and shattered on impact. Some modified compositions exhibited moderate improvement in toughness, but shot having such compositions still suffered from the disadvantage of shattering upon impact with the material being shot blasted and of having relatively short service life. Malleabilized cast iron shot had a microstructure containing principally ferrite and temper carbon and possessed higher toughness than white iron shot, but its hardness and wear resistance was at a much lower level. Although many attempts were made to remedy this and other shortcomings, none, as far as I am aware, was entirely successful when carried into practice commercially.

I have discovered that an improved combination of properties, including high toughness, can be obtained by using a special composition for metallic blasting and abrasive material to be used in its cast or substantially spherical form.

It is an object of the present invention to provide a chilled shot having an improved combination of properties.

It is another object of the invention to provide a metallic blasting and abrasive material having a high degree of toughness at intermediate hardness levels.

It is a further object of the invention to provide a metallic blasting and abrasive material having increased service life.

It is still another object of the invention to provide an improved austenitic-carbidic alloy cast iron shot which has adequate hardness combined with high toughness and decreased tendency to shatter in use.

It is also an object of the invention to provide an improved cast iron shot having a simple composition.

Other objects and advantages of the invention will become apparent from the following description.

Generally speaking, the present invention provides an alloyed cast iron shot and the like to be used directly, i. e., not crushed and used as grit, made of cast iron containing about 2% to 4% carbon, about 0.2% to 1.5% manganese, about 0.5% to 6% nickel, and at least about 0.2% but less than 1.5% silicon. Manganese in amounts exceeding the amount required because of its effect on sulfur, which is usually about 0.2% to 0.5% manganese, promotes austenite formation and may be desirable in certain instances. Silicon contents within the range of about 0.5% to 1.2% have given satisfactory results. In addition to the foregoing elements, the cast iron of the present invention may contain up to about 2% chromium, e. g., about 0.1% to 1.5% chromium, but the presence of chromium is not essential to obtain the improved combination of properties, particularly toughness and hardness, which characterizes the cast iron shot provided by the present invention. Chromium, e. g., about 0.25%, may be beneficial, particularly when the nickel is less than about 2%, in promoting austenite formation. In actual practice, it is preferred to maintain the nickel within the range of about 3.5% to 5% and to maintain the silicon within the range of about 0.5% to 1%. The shot of the present invention may also contain small amounts of incidental or minor constituents and impurities added for known purposes or present as the result of commercial practice, e. g., sulfur, phosphorus, titanium, etc. Thus, the cast iron shot may contain about 0.02% to 0.2% of sulfur, about 0.03% to 1% of phosphorus, about 0.01% to 0.05% of titanium, etc. It is to be understood that when the term "balance substantially all iron" is used herein, it is not desired to exclude incidental or minor constituents or impurities, including chromium, molybdenum, sulfur, phosphorus, etc. which may be present in such amounts as occur in commercial products or in amounts not adversely affecting the desired properties of the cast iron shot.

It is a critical feature of the improved shot that a balanced composition be maintained within the ranges set forth hereinbefore. If the silicon content exceeds the amounts set forth, the high toughness of the shot provided by the invention is no longer obtained. Thus, a cast iron shot containing about 3.23% total carbon, about 1.53% silicon, about 0.36% manganese, and about 2.34% nickel had a Vickers hardness number of about 831 to 804 and an impact value of about

2.9 to 3.5 inch pounds measured as set forth hereinafter by a drop test, and was harder and much less tough than the shot provided by the present invention. It has been found that the effect of silicon in cast iron shot is not the same as in ordinary cast iron castings. Low silicon contents in shot apparently promote increased toughness and decreased hardness and favor austenite formation, whereas in ordinary castings low silicon contents promote high hardness and brittleness and favor chill formation. Nickel in the amounts set forth hereinbefore is also essential to obtain the desired high toughness combined with satisfactory hardness to give good wear resistance and service life.

The improved cast iron shot provided by the invention contains a large proportion of austenite and has a microstructure constituted substantially entirely of carbide, i. e., cementite, and austenite. Martensite or other austenite decomposition products are usually absent and should not be present in more than small amounts, e. g., about 15% of the matrix. The grain size of the cast iron in the shot is markedly decreased compared to other cast iron shot. The carbide net work is markedly refined to produce a cell structure apparently of finely divided carbides surrounded by austenite rather than a structure containing the more massive carbides usually found in plain unalloyed cast iron shot.

In order that those skilled in the art may have a better understanding of the present invention, illustrative examples are given in the following table of the carbon, silicon and nickel contents of cast iron shot produced in accordance with the present invention. The Vickers hardness number and the relative impact strength in inch pounds determined by single blow drop tests are also set forth in the following table:

Shot No.	Per cent C	Per cent Si	Per cent Ni	V. H. N.	Impact
1	2.9	1.0	0.8	458	4.9
2	2.9	1.0	1.3	458	4.9
3	3.0	1.1	2.3	432	5.5
4	3.0	1.1	3.5	426	6.1
5	2.95	1.2	5.0	434	7.4
6	3.0	0.9	4.2	420	7.0

Impact values were obtained by dropping from a given height a weight of 0.6 pound that struck a shot specimen of about 0.075 inch diameter which was placed on a flat hard base. The weight was dropped from various heights, each time onto a new specimen, until one level was found from which the weight would fracture the shot with a single blow. If dropping the weight from one inch lower failed to fracture the shot, the impact strength was taken as the product of the weight and the distance it fell to produce fracture. Similar tests on shot having a diameter of about 0.105 inch confirmed in general the high toughness indicated by the impact values set forth in the table which were obtained on shot having a diameter of 0.075 inch. In some instances, for example in shot No. 1 and shot No. 4, improvements in toughness markedly exceeding the general trend were obtained in the 0.105 inch diameter shot. In measuring the hardness of various sizes of shot it was found that the hardness of shot of a given composition was about the same regardless of the size. The toughness of the 0.075 inch diameter shot increases progressively as the nickel content increases and this increased toughness is accompanied by a relatively slight decrease in the hardness. For example, a plain unalloyed iron containing 2.9% total carbon and 1.0% silicon had a Vickers hardness of 461. With a nickel content as high as about 5%, the Vickers hardness was 434 and at these hardness levels the slight decrease in hardness of the much tougher nickel-containing shot over that of unalloyed cast iron shot apparently does not have a detrimental effect. Comparison of the shot of the present invention with a commercial malleabilized shot showed that the toughness of the higher nickel content shot was substantially the same as that of the malleabilized shot, but all the shot made in accordance with the invention had much higher hardness. For example, a malleabilized shot had an average Vickers hardness of 162 and an impact strength of 7.4 inch pounds as compared to a much higher Vickers hardness of 434 in combination with a similar impact strength of 7.4 inch pounds for shot No. 5 set forth in the table.

The present invention is applicable to the production of metallic blasting and abrasive material, particularly to the production of tough shot which is to be used directly in its cast substantially spherical form, i. e., not crushed and used as grit, and where shattering is undesirable. A brief description of some blast cleaning processes, apparatus, and illustrations of the differences in surfaces cleaned by shot and by grit may be found in Metals Handbook, 1939 Edition, pages 1142 and 1143. The use of shot blasting for purposes other than cleaning are also well known to those skilled in the art, e. g., for scale and metal removal, work hardening of steel, raising the fatigue life of springs and other parts subjected to vibratory stresses, cutting, polishing and grinding in the stone industry, etc.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such variations and modifications are considered to be within the purview and scope of the invention and the appended claims.

I claim:

1. Metallic abrasive and blasting material made of substantially spherical cast iron particles having a microstructure comprised substantially entirely of carbide and austenite, and containing about 2% to 4% carbon, 0.2% to 1.5% manganese, 0.2% to 1% silicon, 0.5% to 6% nickel and the balance substantially all iron.

2. Metallic abrasive and blasting material made of substantially spherical cast iron particles having a microstructure comprised substantially entirely of carbide and austenite, and containing about 2% to 4% carbon, 0.2% to 1.5% manganese, 0.2% to 1% silicon, 3.5% to 5% nickel and the balance substantially all iron.

3. As an article of manufacture, a cast iron particle of substantially spherical form and of a size suitable for shot blasting and the like made of cast iron having a microstructure comprised substantially entirely of carbide and austenite, and comprising about 2% to 4% carbon, about 0.2% to 1.5% manganese, about 0.2% to 1.2% silicon, about 3.5% to 6% nickel, and the balance substantially all iron.

4. As an article of manufacture, a cast iron particle of substantially spherical form and of size suitable for shot blasting and the like made of cast iron having a microstructure comprised

substantially entirely of carbide and austenite, and comprising about 2% to 4% carbon, about 0.2% to 1.5% manganese, about 0.5% to 1% silicon, about 3.5% to 5% nickel, and the balance substantially all iron.

5. As an article of manufacture, cast iron shot suitable for shot blasting made of cast iron having a microstructure comprised substantially entirely of carbide and austenite, and containing about 2% to 4% carbon, about 0.2% to 1.5% manganese, about 0.5% to 1.2% silicon, about 0.5% to 6% nickel and the balance substantially all iron.

6. Metallic cast iron chilled shot having a microstructure comprised substantially all of carbide and austenite, and containing about 2% to 4% carbon, 0.2% to 1.5% manganese, 0.2% to 1.2% silicon, 0.5% to 6% nickel and the balance substantially all iron.

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