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STEEL SHOT FOR BLAST CLEANING, BLAST PEENING, AND THE LIKE

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The invention relates to metal shot or pellets of the type used for metal abrasive and blast cleaning, peening, polishing and the like, and more particularly to an improved composition of steel shot.

Prior to my invention, so far as I am aware, no one has been able to make, commercially, steel shot, although cast iron shot has been manufactured commercially for a great many years and is in wide use. Steel, because of its higher pouring temperature and higher viscosity, and because of the presence of various alloying ingredients, presents greatly increased difficulties when it is attempted to disintegrate the molten metal into shot by the usual disintegrating methods. Such methods consist, generally, in applying, to a stream of molten metal, a blast of break-up fluid, usually water, which causes the molten metal to be broken up into small liquid globules; these are caught as solid pellets in a bath of water.

The real difficulty I have encountered in the use of steel is to make good usable shot and to avoid making defective shot. Good usable shot has the important characteristics of roundness, solidity, proper micro-structure, freedom from cracks and strains, long life and hardenability. Defective shot may have one or more of the following defects: it may be hollow, it may be shredded, it may have dimples, it may have cracks, it may not be properly hardenable, or it may not have proper micro-structure or strength to resist fracture from impact or fatigue.

My present invention overcomes these difficulties by using steel alloys which are able to withstand the disintegrating treatment and yet produce the proper characteristics in the final product. The essential alloying elements in my steel, and the approximate percentages by weight within which they must be used to overcome the foregoing difficulties, are about as follows:

TABLE A

	Per cent
Carbon	.10 to 1.70
Silicon	.30 to 1.00
Manganese	.30 to 2.00
Iron	Balance

In addition to the foregoing, other elements may be incorporated, depending upon the properties desired in the finished product, as for example, chromium 0 to 5.00%; molybdenum 0 to 5.00%; vanadium 0 to .40%; nickel 0 to 2.50%, and copper 0 to 1.00%.

I have found by test that there are certain

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limits to the alloying ingredients. Good steel shot is very dependent upon proper silicon content. For example, if the silicon in the metal at the time of pouring for disintegration is above 1.00%, the particles formed after disintegration are apt to be shredded. In fact, except for pouring at exceptionally high temperatures, good roundness could not be obtained for silicon contents above 0.80%. Added silicon decreases fluidity and surface tension so that the steel does not draw itself into a round ball. On the other hand, a silicon content less than 0.30% gives a round but hollow shot, regardless of the percentages of the other alloying materials or deoxidizers used.

Carbon content is also effectual in producing round solid material. Carbon increases silicon tolerance. The higher the carbon, the more the fluidity obtainable at any certain temperature. Generally speaking, the higher the carbon content, the lower the pouring temperature necessary, as well as the greater amount of silicon that can be used and yet form round steel particles.

A number of specific examples of compositions following the teachings of my invention are given below. These examples may be conveniently classified according to carbon content, as high, low and intermediate. "High" is applied to steel shot having from 1.20 to 1.70% carbon. "Low" is applied to steel shot having from 0.15 to 0.30% carbon. "Intermediate" is applied to steel shot having from 0.30 to 1.20% carbon.

In the following tables the balance iron means substantially all iron except for the usual impurities in normal amounts.

Example No. 1 (shot with high carbon content)

Tests indicate that good shot having the desired properties of roundness, solidity, freedom from cracks or strains, and suitable micro-structure may be produced, having a high carbon content falling within the ranges shown in Table No. 1.

TABLE NO. 1

	Per cent
Carbon	1.20 to 1.70
Silicon	0.35 to 1.00
Manganese	0.30 to 1.50
Chromium	0 to 0.60
Molybdenum	0 to 1.60
Vanadium	0 to 0.30
Copper	0 to 1.00
Nickel	0 to 1.00
Iron	Balance

Specific examples of steel shot falling within the ranges of Table No. 1 are given in Tables Nos. 2, 3, 4, 5 and 6.

TABLE NO. 2

	Per cent
Carbon	1.35
Silicon	0.50
Manganese	0.70
Chromium	0.35
Molybdenum	1.50
Vanadium	0.20
Iron	Balance

TABLE NO. 3

	Per cent
Carbon	1.50
Silicon	0.50
Manganese	1.50
Iron	Balance

TABLE NO. 4

	Per cent
Carbon	1.39
Silicon	0.92
Manganese	0.61
Iron	Balance

TABLE NO. 5

	Per cent
Carbon	1.63
Silicon	.65
Manganese	.64
Copper	1.00
Iron	Balance

TABLE NO. 6

	Per cent
Carbon	1.32
Silicon	.87
Manganese	.67
Nickel	1.00
Iron	Balance

As an example of hardness obtained with the specific composition of Table No. 2, good usable shot was made having a hardness of 63 Rockwell "C."

Example No. 2 (shot with low carbon content)

Tests indicate that usable shot may be produced having a low carbon content. Such shot falls within the ranges shown in Table No. 7.

TABLE NO. 7

	Per cent
Carbon	.15 to .30
Silicon	.30 to .80
Manganese	.40 to 1.00
Nickel	.80 to 1.20
Iron	Balance

A specific example of steel shot falling within the ranges of Table No. 7 is given in Table No. 8.

TABLE NO. 8

	Per cent
Carbon	.21
Silicon	.48
Manganese	.94
Nickel	1.00
Iron	Balance

With the composition set forth in Table No. 8 good non-cracked material was produced but the material did not have as much hardenability as the material of Table No. 2. However, material was produced having a Rockwell "C" hardness of 45, with excellent breakdown characteristics.

Example No. 3 (shot with intermediate carbon content)

Steel shot with an intermediate carbon content was also produced. The composition and percentage range of such material is given in Table No. 9.

TABLE NO. 9

	Per cent
Carbon	.30 to 1.20
Silicon	.30 to 1.00
Manganese	.40 to 2.00
Nickel	0 to 1.00
Iron	Balance

The composition of Table No. 9 produced usable crackless material having a hardness range of from 48 to 65 Rockwell "C."

Specific examples of steel shot falling within the ranges of Table No. 9 produced and tested are given in Tables Nos. 10, 11 and 12.

TABLE NO. 10

	Per cent
Carbon	.53
Silicon	.50
Manganese	.60
Nickel	1.00
Iron	Balance

TABLE NO. 11

	Per cent
Carbon	1.00
Silicon	.50
Manganese	.60
Nickel	1.00
Iron	Balance

TABLE NO. 12

	Per cent
Carbon	.85
Silicon	.70
Manganese	.64
Iron	Balance

The following composition range in Table No. 13, falling within the range of Table No. 9, has produced excellent shot having the best all around characteristics. Such shot has a hardness range of from 48 to 52 Rockwell "C."

TABLE NO. 13

	Per cent
Carbon	.60 to .80
Silicon	.40 to .60
Manganese	.40 to .60
Iron	Balance

In all of the above tables, the pellets may be suitably heat treated to give proper strain relief, hardness and micro-structure. The stated hardness values are those obtained after such heat treatment.

Thus practical, usable shot is produced having the important characteristics of roundness, solidity, micro-structure, freedom from cracks and strains, long life and hardenability. The practice of the invention avoids forming the shot with dimples or cracks. It avoids producing shot which is either hollow or shredded. It produces the proper micro-structure to give proper hardness and longevity.

By the practice of this invention usable shot may be obtained ranging in size throughout the entire range of commercial sizes, for example, from shot as small as No. 100 (.0054 inch diameter) to as large as No. 10 (.156 inch diameter).

While certain novel features of the invention have been disclosed herein, and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Steel pellets such as used in blast cleaning, blast peening and the like, and of a size between

0.0054 to 0.156 inch diameter characterized by good roundness and solidity, freedom from dimples, and freedom from cracks and strains and having a hardness ranging between about 45 to about 65 Rockwell C classification, said pellets containing a plurality of ingredients of which the following, in the proportions stated, are the only elements necessary to obtain said characteristics: from about 0.35 up to about 1.20% carbon, from about 0.30 up to about 1.00% silicon, and suitable strengthening alloying metal selected from the group consisting of manganese 0.30 to about 2.00%, molybdenum 0.00 to about 5%, nickel from 0.0 to about 2.5%, copper from .0 to about 1.00%, and the balance iron.

2. Steel pellets such as used in blast cleaning, blast peening and the like, characterized by good roundness and solidity, freedom from cracks and strains, and by good hardenability, said pellets having a hardness ranging between 45 to about 65 Rockwell C classification containing a plurality of ingredients of which the following, in the proportions stated, are the only elements necessary to obtain said characteristics: from about 0.30 up to about 1.70% carbon, from about 0.30 up to about 1.00% silicon, from about 0.30 up to about 2.00% manganese, from zero up to about 5.00% chromium, from zero up to about 5.00% molybdenum, from zero up to about 0.40% vanadium, from zero up to about 2.50% nickel, from zero up to about 1.00% copper, and the balance iron.

3. Steel pellets such as used in blast cleaning, blast peening and the like, characterized by good roundness and solidity, freedom from dimples, freedom from cracks and strains, and by good hardenability, said pellets containing a plurality of ingredients of which the following, in the proportions stated, are the only elements necessary to obtain said characteristics: about 1.35% carbon, from about 0.35 up to about 1.00% silicon, about 0.70% manganese, about 0.35% chromium, about 1.50% molybdenum, about 0.20% vanadium, about 1.00% copper, from zero up to about 1.00% nickel, and the balance iron, said pellets having an average hardness ranging up to about 65 Rockwell C classification.

4. Steel pellets of a diameter less than about 0.15'' in diameter such as used in blast cleaning, blast peening and the like, characterized by good roundness and solidity, freedom from dimples, freedom from cracks and strains, and by good hardenability, said pellets containing a plurality of ingredients of which the following, in the proportions stated, are the only elements necessary to obtain said characteristics: from about 0.30 up to about 1.20% carbon, from about 0.30 up to about 1.00% silicon, from about 0.40 up to about 2.00% manganese, from zero up to about 1.00% nickel, and the balance iron, said pellets having a hardness ranging between about 45 to 65 Rockwell C classification.

5. Steel pellets such as used in blast cleaning, blast peening and the like, characterized by good roundness and solidity, relative freedom from dimples, relative freedom from cracks and strains, and by good hardenability, said pellets having a size less than about 0.1'' and containing a plurality of ingredients of which the following, in the proportions stated, are the only elements necessary to obtain said characteristics: about 0.80% carbon, about 0.60% silicon, about 0.60% manganese, and the balance iron, said pellets having a hardness ranging between about 45 to about 65 Rockwell C classification.

6. Steel shot for blast cleaning, blast peening and the like having the characteristics of roundness, relative freedom from dimples, solidity, proper microstructure, relative smoothness and uniformity of surface, hardenability and long life, a size between 0.0054 to 0.156 inch in diameter, a hardness ranging between about 45 to 65 Rockwell "C" classification, said shot having a composition substantially as follows: carbon 0.35 to 1.20 percent for good hardenability; silicon 0.30 to 1.00 percent; manganese 0.30 to 2.00 percent; a strengthening alloy element selected from the group consisting of: chromium 0 to 5.00 percent, copper 0 to 1.00 percent; molybdenum 0 to 5.0 percent; nickel 0 to 2.50 percent; and vanadium 0 to 0.40 percent; and the balance iron.

7. A steel shot for use in blast cleaning, blast peening and the like, said steel shot being solid, round pellets smaller in size than about 0.1'' diameter and having been produced directly from molten metal by shot disintegration methods, said steel shot having a chemical composition of about 0.35% to about 1.20% carbon content for good hardenability and about 0.30% to about 1.00% silicon content with the ratio of silicon to carbon being in a proportion between about 0.7 to about 1.0 and about 0.9 to about 1.0 for a round solid shot, and a suitable strengthening metal selected from the group consisting of 0.30–2.00% manganese, 0–5.00% chromium, 0–2.50% nickel, 0–5.00% molybdenum, and the balance substantially all iron.

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