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MIXTURE FOR THE PRODUCTION OF MALLEABLE IRON

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This invention relates to improvements in mixture and method for the production of malleable iron, and it consists of the matters hereinafter described and more particularly pointed out in the appended claims.

It is an object of my present invention to provide a mixture for use in the production of malleable iron, which will produce a malleable metal having high tensile strength and yield point and which will machine easily and be of a uniform quality throughout.

In general, the invention is directed primarily to a particular relationship of carbon and silicon, the other ingredients being present to give particular characteristics for particular purposes or merely as impurities. In this respect, the particular range of manganese recited is not essential to the invention in its broadest sense, but said range is the preferable one and could be varied or altered without departing from the spirit of the invention.

The object of my invention is attained by proportioning the various ingredients charged into the furnace, or by varying the melting practice employed in fusing, or both, to obtain a ferrous metal with ingredients as follows:

	Per cent
Carbon	1 –1.8
Silicon	.9 –2
Manganese	.05–1.4
Phosphorus	.01– .20
Sulphur	.01– .35

I have found that variations in the melting temperature used will produce varying qualities in the resulting malleable metal. However, my invention has been found to give an improved malleable iron at all of the usual temperature ranges. I do not, therefore, desire to be limited to any specific temperature requirements for the manufacture of malleable metal using my invention.

I have found that a most desirable malleable metal as a substitute for ordinary malleable iron is produced by the use of the above-mentioned ingredients in the following proportions:

	Per cent
Carbon	1.35
Silicon	1.60
Manganese	.30
Phosphorus	.04
Sulphur	.03

The mixture will provide, when annealed, a black, easily machined structure, a yield point at approximately 55,000 lbs. per square inch, an ultimate tensile strength of approximately 75,000 lbs. per square inch, an elongation of from 5% to 14% in two inches, and a superior and uniform wearing surface. This mixture is capable of being completely annealed in twelve hours without resorting to abnormal temperatures when compared to the usual temperature range for commercial malleable iron annealing. Ordinary malleable iron would require at least 60 hours at the same temperatures.

Another mixture which provides a greater yield point and ultimate tensile strength is obtained by lowering the carbon and silicon proportions and raising the manganese. This is:

	Per cent
Carbon	1.15
Silicon	1.25
Manganese	.85
Phosphorus	.08
Sulphur	.05

This mixture anneals to a gray pearlitic structure not as dark as ordinary malleable iron, and though the Brinell reading is approximately 180 at 300 kilograms, the metal machines more easily than this reading would indicate due to the exceptionally even distribution of the nodular carbon, said distribution provided by the combined action of the constituents of the balance.

It is found that in malleable metal made in accordance with my invention, the carbides resulting from the use of carbon in the foregoing relative proportions are evenly distributed throughout the entire mass of metal.

A most important characteristic of a metal made in accordance with my invention is that it may be poured in the ordinary green sand mould, the same as ordinary malleable iron without causing an undesirable precipitation of the carbides contained in the metal. Such precipitation as is obtained is in the form of a nodular or spheroidal carbon, or both, (when the carbon content is below 1.7%)

I have found that a variation of the carbon and silicon content to the extent of disturbing the foregoing relative balance between the two ingredients, results in undesirable changes in the physical properties of the resulting malleable metal.

By the use of the proportions embodying my invention, I have found that the resulting malleable metal is relatively free from shrinks and blow holes, and with proper handling makes a smooth, well-run casting. Likewise, the resulting malleable metal in a hard or unannealed frac-

ture shows a fine, dense, nondendritic structure. In the use of the foregoing proportions of ingredients, it will be seen that a radical invasion has been made into the dead limits of both known malleable irons and steels. The malleable metal thus produced has the following characteristics:

Its ultimate tensile strength is 65,000 lbs. to 110,000 lbs. per square inch, and has an elongation upon special annealing of as high as 22% and an average elongation with ordinary annealing of from 5% to 14%.

Its yield point is approximately 14,000 to 24,000 lbs. below its ultimate tensile strength as above given. It is to be understood that these figures will vary if a special treatment is given the metal to secure added elongation.

It machines like ordinary malleable iron except where given special heat treatment to increase its tensile properties, in which case it machines slightly harder than gray iron. In addition, this metal can be worked hot either in its hard or annealed state. Likewise, it can be hammered, forged, rolled or punched while hot, in temperatures lower than those required in the working of steel by these methods. It has been found that hot working of the metal serves to increase its physical strength due to a refining and closing of the grain by such working, and the ability to be hot worked is one of the significant and valuable features of this metal.

In hardness it shows a Brinell reading of from 140 to 300 depending again on the heat treatment used on the iron.

Its annealed appearance is substantially the same as ordinary malleable iron except where oxidation throws the proportion out of balance, in which case the resulting iron has a mottled appearance which, however, may be remedied by additional heat treatment. When hard fractured the malleable metal using my invention shows few similarities either to ordinary malleable iron or to steel, and is characterized by being very close grained and non-dendritic in its formation.

Malleable metal using my invention anneals at lower temperatures and more quickly than ordinary malleable iron and thus effects a considerable saving in the annealing process.

From the foregoing it will be apparent that malleable metal produced using my invention is a different metal from the ordinary malleable iron produced by ordinary methods. The mixture most generally used in the production of ordinary malleable iron is as follows:

	Percent
Carbon	2.20–2.60
Silicon	.75–1.05
Manganese	.22– .37
Phosphorus	.09– .20

In using a mixture made up in the foregoing proportions for ordinary malleable iron, the manganese acts as a sulphur neutralizer and deoxidizer, and the silicon provides a carbon precipitator and a deoxidizer and provides additional fluidity to the mass.

In the mixture made in accordance with my invention, the fusing of the elements in these proportions shows that the manganese acts also as a primary graphite retarder, grain refiner, and carbon distributor, while the silicon adds to its reactions by checking the dendrites, raising the yield, and acting with the manganese to form a fine carbon flake or grain, which is evenly distributed and easily annealed.

The use of the ordinary mixtures in the production of ordinary malleable iron produces a malleable iron having an ultimate tensile strength of from 45,000 to 55,000 lbs. per square inch, as compared to the greatly increased ultimate tensile strength which malleable metal using my invention shows. The yield point of malleable iron made in the ordinary method is from 30,000 to 37,000 lbs. per square inch, as compared to the yield point of from 50,000 to 108,000 lbs. per square inch using my invention.

It is to be understood that the phosphorus content is to be held to as low a percentage as is possible in maintaining fluidity in order to avoid the objectionable features of this element when alloyed to excess in iron. It is also to be understood that although sulphur has not been mentioned in the specification heretofore, it is assumed that this element is presented in all commercial ferrous metals. Also, under certain conditions, this element can be so balanced as to increase the ductility and machineability. In such cases, it is sometimes expedient to add this element in an advantageous form to the metal. I, therefore, wish to avail myself of the scope as listed in the disclosure.

I have found that under usual circumstances, and melting conditions, a preferable manganese range is from .4%–1.4%, since its addition in these percentages expedites consistent commercial melting practice and increases the tensile properties. However, under favorable conditions the use of this element in percentages lower than .4% is sometimes of value since manganese has a tendency to retard the annealing or heat treating process, and also tends in appreciable amount to decrease the machineability of the metal, particularly when out of balance with the silicon and carbon proportions.

It is also to be understood that due to the nature of my invention large quantities of scrap metal can be included in the furnace charge and in this scrap, various elements other than those above enumerated may be found which will be considered as impurities to the iron.

While I have given a range of percentages, and the percentages of ingredients which I have found to be the most satisfactory for general use, I do not desire to limit the scope of my invention, but desire to avail myself of all changes within the scope of the appended claims.

This application is a continuation in part of my earlier applications Serial No. 500,670, filed December 6, 1930, and 678,199, filed June 29, 1933.

I claim as my invention:—

1. A malleablized cast ferrous alloy comprising 1% to 1.8% carbon, 1.5% to less than 2% silicon, effective amounts up to not over 1.4% manganese and the balance substantially all iron.

2. A malleablized cast ferrous alloy comprising 1%–1.7% carbon, silicon less than 2% and more than 1%, effective amounts up to not over 1.4% manganese and the balance substantially all iron.

3. As a new article of manufacture, a high strength, hot workable, easily machineable, malleablized iron containing as essential elements, carbon about 1.35%, silicon about 1.60%, effective amounts up to not over 1.4% manganese, phosphorus about .04%, sulphur about .03%, and the balance substantially iron.

4. An alloy for the production of malleable iron comprising a given quantity of iron, carbon not less than 1% or more than 1.8%, silicon not less than .9% or more than 2%, the aggregate

combined amount of carbon and silicon in substantially equal proportions not less than 1.9% by weight of the mixture; effective amounts up to not over 1.4% manganese, by weight of the mixture; phosphorus not less than .01% or more than .27% by weight of the mixture; and sufficient commercial iron and its characteristic impurities and contaminations to constitute the balance of 100%.

5. An alloy containing as essential elements, carbon 1% to 1.80%, silicon .90% to 1.95%, manganese .4% to 1.4%, phosphorus .01% to .15%, sulphur .01% to .35%, the carbon and silicon being in approximately equal proportions and the remainder substantially iron.

6. A malleablized alloy containing as essential elements: carbon 1% to 1.80%, silicon .90% to 1.95%, manganese .4% to 1.4%, phosphorus .01% to .14%, sulphur .01% to .35%, the carbon and silicon being in approximately equal proportions and the remainder substantially iron.

7. A ferrous alloy comprising 1.2% to 1.6% carbon, .46% to .5% manganese, 1.5% to 2% silicon, and the balance substantially all iron.

8. A malleablized ferrous alloy casting comprising 1.2% to 1.6% carbon, .46% to .5% manganese, 1.5% to 2% silicon, and the balance substantially all iron.

9. As a new article of manufacture, a high strength, hot workable, easily machineable, malleablized iron containing as essential elements: carbon about 1.5%, silicon about 1.38%, manganese about .75%, phosphorus about .17%, and the balance substantially iron.

10. An alloy for the production of malleable iron comprising a given quantity of iron, carbon not less than 1% or more than 1.8%, silicon not less than .9% or more than 2%, the aggregate combined amount of carbon and silicon in substantially equal proportions not less than 1.9% nor more than 3.8% by weight of the mixture; manganese not less than .4% and not more than 1.4% by weight of the mixture; phosphorus not less than .15% or more than .27% by weight of the mixture; and sufficient commercial iron and its characteristic impurities and contaminations to constitute the balance of 100%.

11. A ferrous alloy graphitizable to increase its malleability and capable upon cooling to normal temperatures in an ordinary green sand mold of forming an alloy substantially free from primary cementite and which, upon annealing, will give an alloy having a Brinell hardness of about 140 to 300, said alloy comprising 1 to 1.7% carbon, .9 to 2% silicon, effective amounts up to not over 1.4% manganese, and the remainder mainly iron.

12. A ferrous alloy as defined in claim 11 including .4 to 1.4% manganese.

13. A malleablized cast ferrous alloy as defined in claim 1 including .4 to 1.4% manganese.

14. A malleablized cast ferrous alloy as defined in claim 1 which is hot workable and contains about .01 to .35% sulphur.

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