

UNITED STATES PATENT OFFICE

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COMPOSITION FOR ADDITION TO CAST
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8 Claims. (Cl. 75—122)

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This invention relates to a novel composition of matter for the control and improvement of the physical properties of cast iron and for other uses, such as the treatment of steel in the molten state.

The cast iron which is most used commercially for construction applications is gray iron, which term actually covers a wide range of compositions with correspondingly widely varying properties which depend to a great extent upon the forms in which the carbon exists, and their distribution.

While a part of the carbon present in gray iron may be combined as iron carbide, the greater amount is present in the elemental form as graphite. The relative amounts of free carbon and combined carbon, as well as the shape, size and distribution of the particles, are dependent upon such factors as the maximum temperature of the iron in the liquid state, rate of cooling during and after solidification, and types of heat treatment, if any, applied to the solidified casting.

It is known that magnesium and certain other elements introduced into iron which would otherwise cast gray or nearly so cause the graphite to change from flakes or plates into spheroids or nodules with simultaneous increase in the strength of the metal and production of some ductility. This ductility may be increased by annealing with relatively small sacrifice in the strength of the metal.

Serious difficulties have beset attempts to make this magnesium practice one that would provide with assurance successive reproduction in continuous manufacturing operations of iron articles of high strength or high strength and good ductility. The boiling point of magnesium being considerably below both the melting temperature of those metals or alloys with which it is preferably combined for making addition agents and below the temperatures at which cast iron is tapped and poured, causes extreme difficulty in controlling the overall recovery of magnesium from raw material to the finished cast iron product.

The boiling point of magnesium is about 2030° F., which results in very high losses due to vaporization of the magnesium when it is added to molten nickel which melts at about 2650° F. to

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form an alloy containing 20% magnesium and 80% nickel, and even when added to copper which melts at about 1980° F. to form an alloy containing 20% magnesium and 80% copper.

Further difficulty is presented when it is attempted to introduce iron into these nickel or copper base alloys. Iron is a very desirable carrier metal when magnesium is to be introduced into cast iron or steel.

This invention resides in the addition of one or more of the alkaline earth elements calcium, barium, strontium and lithium in certain critical proportions to a composition, preferably in alloy form, of magnesium, copper, silicon and iron, whereby improved results are obtained upon adding the alloy to molten cast iron for the purpose of causing the carbon in the solidified cast iron to assume the nodular form which results in high strength and considerable ductility, along with other advantages. Because of the inclusion of one or more alkaline earth elements in the new alloy, the magnesium content of the alloy can be somewhat lower than in alloys previously used but not containing an alkaline earth element. This lower magnesium content aids in reducing the losses of magnesium on addition of the alloy to molten cast iron. Moreover, the alkaline earth elements which are added to supplement the magnesium in producing the desired micro-structure, all have boiling points higher than that of magnesium, these being actually just in the range of or above the usual operating temperatures for molten cast iron (Ba, 2980° F., Ca, 2625° F., Sr, 2520° F., Li, 2500° F.). They are, therefore, volatilized to a minimum degree and to an extent substantially less than magnesium.

The alkaline earth elements combine readily with magnesium and with silicon so that in the manufacture of the new alloy the losses of magnesium are considerably less than in the manufacture of an alloy not containing alkaline earth elements. Furthermore, the alkaline earth elements are recovered almost completely in the manufacture of the alloy. Thus a significant improvement has been effected in the making of the alloy and also in using it to produce the desired type of cast iron.

In addition, the amount of the new alloy containing one or more alkaline earth elements, be-

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sides magnesium, silicon, copper and iron, which is required in order to produce the desired effect in gray iron, is less than in the case of the prior magnesium-silicon-copper-iron alloy. There is, therefore, the advantage of economy in use and less chilling of the molten iron when my new alloy is employed in treating cast iron. This refers not only to the gross weight of alloy added to cast iron but also to the total amount of magnesium in the alloy which is added to the cast iron.

The ranges of elements in my compositions are given in the following table:

Table

	Range, Percent.	Preferred Range, Percent.
Magnesium.....	2 to 20.....	3 to 12.
Calcium, barium, strontium or lithium.....	2 to 15.....	2 to 8.
Silicon.....	5 to 50.....	25 to 40.
Copper.....	3 to 50.....	3 to 20.
Iron.....	5 to 65.....	10 to 50.

The ranges of 2 to 15% and 2 to 8% given in the table refer to the sum of the calcium, barium, strontium and lithium if more than one of these alkaline earth metals is employed in the composition which is to be added to cast iron or steel. In addition to the elements listed in the table there are present the usual impurities such as carbon, phosphorus, sulphur, etc., which generally do not exceed a total of 4%.

Within the ranges of compositions given in the table, I prefer to restrict the relative proportions of the several elements in the following ways. The sum of the magnesium and calcium or other alkaline earth metal preferably is not over 25% and better still is not over 20%. Preferably the amount of magnesium is not less than $\frac{1}{3}$ of and not more than 3 times the amount of the alkaline earth elements. Preferably the amount of silicon is not less 2 times and not more than 6 times the sum of the amount of magnesium plus the amount of alkaline earth elements. Preferably the sum of the magnesium plus the amount of alkaline earth elements is not less than $\frac{1}{2}$ and not more than 4 times the amount of copper.

Two examples of alloys within the preferred limits of this invention are:

	A	B
Magnesium.....	8.42	6.77
Calcium.....	3.12	5.87
Silicon.....	28.75	38.20
Copper.....	5.26	6.14
Iron.....	Bal.	Bal.

The amount of alloy to be added to molten cast iron for casting into gray iron castings will vary with the nature of the iron, the maximum temperature attained by the molten iron, the temperature at which the addition is made, and perhaps other factors. In general, the addition approximates 0.08% to 0.15% of contained magnesium but this will vary with alloys of different alkaline earth metal contents.

The alloys of this invention may also be added to molten steel for lowering the sulphur content of the steel.

The invention is not limited to the preferred embodiment but may be otherwise embodied or

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practiced within the scope of the following claims.

I claim:

1. A composition of matter for addition to cast iron or steel, said composition comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50% copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%.

2. A composition of matter for addition to cast iron or steel, said composition comprising about 3 to 12% magnesium, 2 to 8% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 25 to 40% silicon, and 3 to 20% copper, the balance being substantially all iron, the iron being in an amount between 10 and 50%.

3. An alloy for addition to cast iron or steel, said alloy comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50% copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%.

4. An alloy for addition to cast iron or steel, said alloy comprising about 3 to 12% magnesium, 2 to 8% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 25 to 40% silicon, and 3 to 20% copper, the balance being substantially all iron, the iron being in an amount between 10 and 50%.

5. An alloy for addition to cast iron or steel, said alloy comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50% copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%, the amount of magnesium being not less than $\frac{1}{3}$ of and not more than 3 times the amount of elements selected from said class consisting of calcium, barium, strontium and lithium.

6. An alloy for addition to cast iron or steel, said alloy comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50% copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%, the amount of silicon being not less than 2 times and not more than 6 times the sum of the amount of magnesium plus the amount of elements selected from said class consisting of calcium, barium, strontium and lithium.

7. An alloy for addition to cast iron or steel, said alloy comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50% copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%, the sum of the magnesium plus the amount of elements selected from said class consisting of barium, calcium, strontium and lithium being not less than $\frac{1}{2}$ and not more than 4 times the amount of copper.

8. An alloy for addition to cast iron or steel, said alloy comprising about 2 to 20% magnesium, 2 to 15% of at least one element selected from the class consisting of calcium, barium, strontium and lithium, 5 to 50% silicon, and 3 to 50%

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copper, the balance being substantially all iron, the iron being in an amount between 5 and 65%, the amount of magnesium being not less than $\frac{1}{3}$ of and not more than 3 times the amount of elements selected from said class, the amount of silicon being not less than 2 times and not more than 6 times the sum of the amount of magnesium plus the amount of elements selected from said class, the sum of the magnesium plus the amount of elements selected from said class being not less than $\frac{1}{2}$ and not more than 4 times the amount of copper.

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