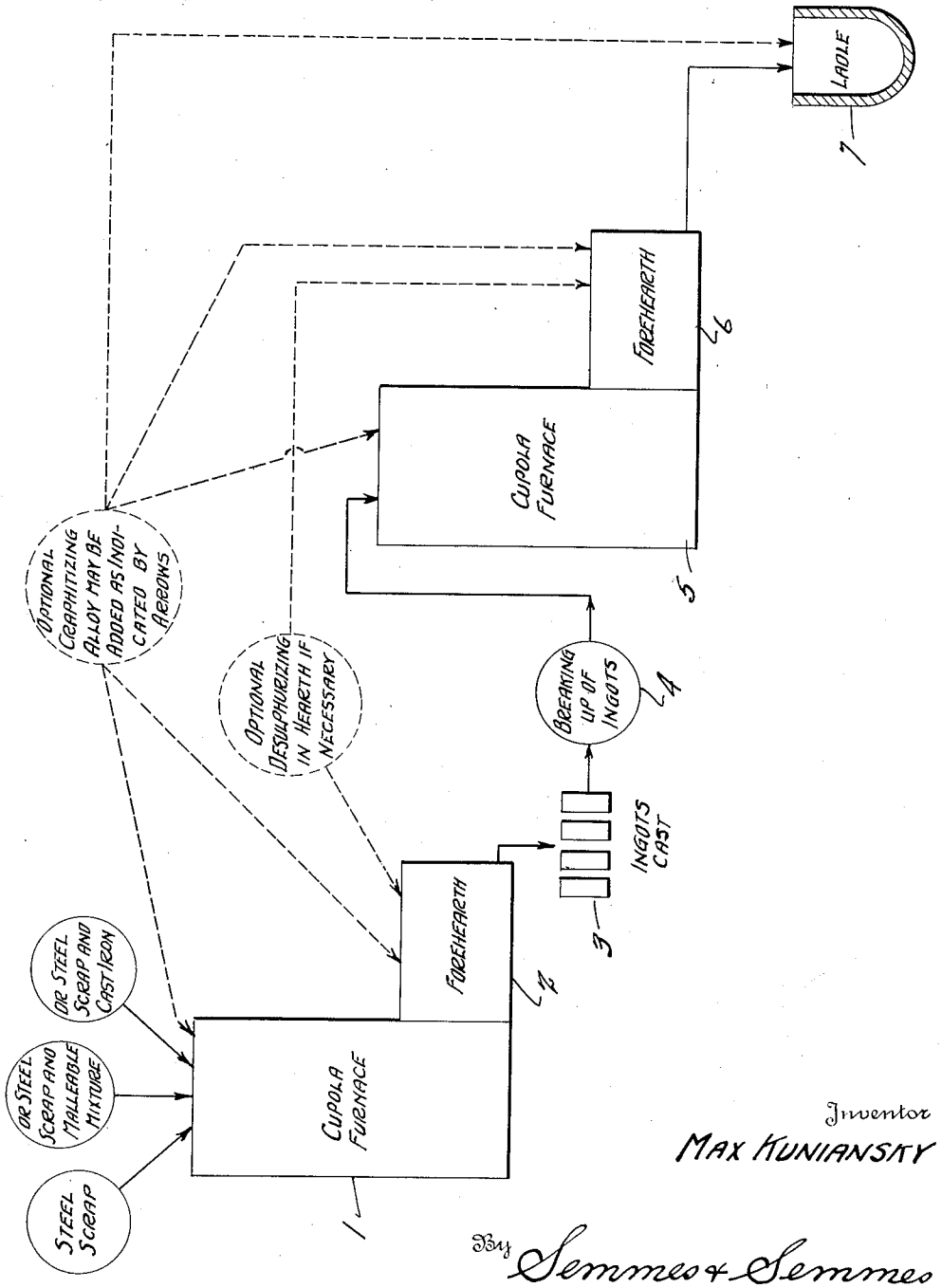
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METHOD OF MAKING CAST IRON

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METHOD OF MAKING CAST IRON

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11 Claims. (Cl. 75—130)

My invention relates to a process for making cast iron and to the product obtained by the process.

This application is a continuation in part of my copending application Serial No. 632,468, filed September 9, 1932, and of my copending application Serial No. 733,528, filed July 2, 1934.

Heretofore it has been usual in preparing iron castings to employ cast iron ingots. These cast iron ingots often differed largely as to the desirable constituents, and the result of using cast iron ingots was that the cast articles were non-uniform in composition and possessed various weaknesses in structure, some of which were apparent only upon continued use. More often, photomicrographs of the cast iron indicated that the structural arrangement of the compounds and elements in the product was such as to inherently result in undesirable qualities of the material.

Where cast iron is not used as the basis for forming iron castings, difficulty is encountered in obtaining the proper content of carbon and other desirable compounds and elements.

In general, I employ a material which is lacking in those compounds or elements which are desired in the final product. For instance, I may employ a steel scrap which is low in, say, carbon, and which will not ordinarily produce a desirable cast iron. I may employ also a malleable iron or mixture of malleable iron and steel scrap. Moreover, with either the malleable iron or steel, I may mix cast iron. It may be stated that I aim to employ materials which are low in content of the desirable compounds or elements.

Starting with this basic material, I subject the scrap or the mixtures, as set forth, to a melting and remelting operation in contact with carbon, and I have found that it is generally desirable to add a graphitizing agent preferably while the material is in the molten state in the remelting step.

The melting and remelting operation is preferably conducted in cupola furnaces where the material is in contact with the furnace coke and absorbs carbon to raise the carbon content.

It is an object of my invention to produce a good quality cast iron in the process of which I may employ scrap material.

Another object of my invention is to produce a good quality of cast iron economically and with simple and well known apparatus, in a process in which the control factors are easily regulated.

Referring to the drawing, I have shown diagrammatically the sequence of steps which I may employ in the preferred forms of my process. It is to be understood that the diagrammatic illustration is not limiting and that any one or more of the features of my process, either alone or in combination with other features, may be protected, if novel. Therefore, I wish to have my invention limited in its scope solely by the appended claims of this application and by the showing of the prior art.

In the drawing:

The single figure of the drawing diagrammatically illustrates some preferred embodiments of the process which I employ.

In the manufacture of cast iron according to my process, I may employ a material which is lacking in desired final constituents. Preferably I employ a material which is largely steel scrap, and which lacks the requisite high carbon content for cast iron. I may employ a malleable iron melt which also is low in carbon content in comparison to the requisite carbon content of the final cast iron product. Mixtures of material may be employed, such for instance as a mixture of steel scrap and malleable or wrought iron. In fact, I may employ a mixture, for instance, of steel scrap and cast iron.

By employing as a starting material a substance which lacks the requisite high percentage of some of the elements or compounds in the final product, I am enabled to carefully control the amount of such elements or compounds which may be added. Moreover, I have found that a very uniform finely grained cast iron can be obtained by my process. The gray iron which can be made by my process has high twistability, is tough, can be made of varying degrees of machinability. The white iron is very wear-resistant.

Some of the characteristics of the iron made by my process are predictable from photomicrographs of the material. Other characteristics which distinguish it from ordinary cast iron of either the gray or white variety are not detectable through a study of the photomicrographs, but appear readily under tests, such as hardness, twistability, abrasive tests, and so forth.

I prefer to employ cupola furnaces for melting the material, and I have found that by melting the material in a cupola furnace considerable economies can be effected over, for instance, a treatment in an electric furnace in contact with carbon. The cupola furnace treatment, while economical, also supplies the requisite carbon addition, which is desirable.

The starting material, which, as I have stated, may be steel scrap, malleable iron, or any of the mixtures specified, is charged into the top of the cupola furnace and allowed to pass through the furnace from top to bottom in contact with the coke in the furnace. The coke in this initial furnace may be a high carbon coke of low sulphur content or it may be ordinary coke of somewhat lower carbon and higher sulphur content. Sometimes it is possible to eliminate the desulphurizing step which may be employed after the

initial melting, if a high carbon-low sulphur coke is employed. The higher the carbon content of the coke employed, the greater will be the addition of carbon to the iron in this initial melt. Therefore, if it is desirable to have an iron of relatively high carbon content as a final product, one of the ways of insuring this desirable high carbon content is to use a high carbon coke in the first melt.

The melted material runs down into the forehearth of the furnace, where a soda ash desulphurization treatment may be employed, if it is desirable. Other desulphurizing agents than soda ash can be used, and I am not to be limited to this particular treatment. A compound or mixture comprising sodium carbonate or other suitable material is mixed with the molten material in the forehearth and the sulphur content of the melt is largely reduced.

The material is then run into ingots, and the ingots are cast. These ingots are broken up and charged to a second cupola furnace. The second cupola furnace may contain a high carbon coke with low sulphur content, or ordinary coke, and here again the desired characteristics of the final product determine the type of coke employed. If a very high carbon iron is desired, high carbon coke is employed. By high carbon coke I mean a coke having a fixed carbon content of over ninety percent. Moreover, if the sulphur content of the coke is low, the use of the soda ash or desulphurizing step may be eliminated. It is to be understood, however, that even where a high carbon-low sulphur coke is employed in either the first or the second melt, it may be desirable in my process, after the first melt or after the second melt, or after both melts, to employ a soda ash desulphurizing and purifying treatment.

In my process, therefore, I may pass the second melt to the forehearth of the furnace and desulphurize it with a soda ash or some other desulphurizing treatment. The material is then run to a ladle, and can be utilized in casting articles.

While the material is in the molten state, either in the remelting cupola or in the forehearth from the remelting cupola, or in the ladle which is filled from the remelting cupola, a graphitizing agent should be added. As a graphitizing agent I usually employ some of the zirconium alloys. Such alloys may contain a considerable amount of iron and other materials, and I preferably employ alloys which contain a considerable amount of iron in their composition, although this is not a necessity.

The alloys which I add to produce the graphitizing have a number of different compositions. It is not always necessary to use a zirconium alloy. For instance, I may employ an iron-silicon alloy in which I use 25% iron and 75% silicon. Another alloy which I may employ has the following composition:

	Per cent
Fe	35
Zr	15
Mn	10
Si	40

I can also employ calcium and silicon alloys, or calcium and titanium alloys. The calcium and titanium perform a function somewhat analogous to that of the zirconium, and though I have mentioned calcium silicide and titanium silicide as possible alloys that may be used, it must be realized that I can employ alloys embodying calcium or titanium which are more complex. Other alloys which may be used have approximately the following compositions:

Iron-silicon-zirconium

	Per cent
Zr	12–14
Si	40–42
Fe	41–42

Silicon-zirconium

	Per cent
Zr	36–38
Si	50–52
Fe	8–12
C	.25

Zirconium-manganese-silicon

	Per cent
Zr	20–24
Mn	10–12
Si	58–62
Fe	8–12
Al	.75
C	.03

Whether or not I add the material in the remelt cupola or in the forehearth of the remelt cupola, or in the ladle which is filled from tapping the forehearth of the remelt cupalo, is a matter of choice, depending upon the desirable characteristics of the final product and the nature of the initial charge.

In general, I employ as a base material about 85–100% steel scrap, the remainder being scrap iron. The amount of alloy which I add to the remelt material is from about 1% to 3% by weight of the molten material. In some instances I may exceed 3%, but ordinarily this is not desirable.

I find that there is great homogeneity in grey iron castings made from my iron. Photomicrographs show that there is relatively small difference between the structure of thin castings and thick castings. This desirable feature of my material distinguishes it from the usual gray iron. Though I have to date been unable to show from photomicrographs any easily discernible difference between my white iron and ordinary white iron, I do find that the resistance to abrasion or, as often stated, attrition, of my material is sometimes as high as 25% greater than is the case with ordinary white iron. This, though not readily explicable, from a study of the comparative photomicrographs of my white iron and ordinary white iron, is nevertheless an important distinguishing feature of my white iron and one which makes it of peculiar utility in uses where high resistance to abrasion is desirable, such as in the piping of abrasive materials.

As a variation of my process, I may add the graphitizing agent during or after the first melt and before remelting in any of the alternate forms of the process disclosed herein Again, I may add the graphitizing agent both before the casting of the ingots and during the remelt step, or in the forehearth of the remelt cupola, or in the ladle from the remelt step.

Referring to the single sheet of the drawing, I have diagrammatically illustrated the process. The charge is placed in a cupola furnace 1 and is melted, and flows to a forehearth 2. From the forehearth 2, the molten material is cast into ingots indicated at 3. The ingots are broken up, as indicated in the step 4.

The ingots when broken up are charged to a second cupola furnace 5, and the molten material

runs to a forehearth 6. From the forehearth 6 the molten material is tapped into a ladle 7.

The molten material in the first forehearth may be subjected to an optional desulphurization step. Likewise, the molten material in the forehearth 6 may be desulphurized. If necessary, desulphurization of the material in both the forehearth 2 and the forehearth 6 may be carried out. If the molten material is low in sulphur, the desulphurizing step after the melting operation of each cupola can be dispensed with. A graphitizing agent can be added in the cupola of the first furnace or in the forehearth of the first furnace. Some of the graphitizing agent may be placed in the cupola with the charge, and some of the graphitizing agent may be added in the forehearth 2.

The graphitizing agent may be postponed until the second melting, in which case the graphitizing alloy may be added to the second cupola furnace 5 or the graphitizing alloy can be placed in the melt in the forehearth 6 of the second cupola furnace, or the graphitizing agent can be added in the ladle 7. As a variation of the process, the graphitizing agent can be added at all of the places indicated by the dotted arrows in the single figure of the drawing, or in some of the places. The amount of graphitizing agent added, and the place or places of addition are matters which are determined by the operating characteristics of the apparatus, the type of coke used in the cupola furnace, the type of initial material, and the desired characteristics of the final product.

What has just been said in connection with the graphitizing agent is also true of the desulphurization steps. Desulphurizing at either or both of the places indicated on the drawing is to be controlled by the type of material treated, the characteristics of the coke used in the cupola furnaces, the time of operation, the proportions of coke and ingredients, and the desired characteristics of the final product. In fact, graphitizing and desulphurizing depend on the various complex factors of operation which can be determined by one skilled in the art. The graphitizing must occur at some one or more points in the process. The desulphurizing may be entirely dispensed with under certain conditions.

While I do not wish to be limited specifically to definite amounts of carbon addition in both the melting and remelting operations, in general I find that I may employ a process in which the carbon content of the material from the first melting operation runs from 2.7 to 3 percent, and in the remelting operation runs from 3.4 to 4 percent of the total weight of the material. It is understood that I may vary these limits just given as desired. My final product runs over 3 percent of total carbon.

By adding the carbon in the second melting, or remelting operation, much better control of the carbon content can be obtained than where the total carbon is sought to be added in the original melting.

For instance, as an example of my iron, I may desire 3.5 percent carbon. If all of this carbon is sought to be added in the original melting, which can only be done under extreme conditions where, for instance, pitch coke is used, it is practically impossible to obtain a definite carbon content. For instance, if the carbon is added only in the first melt and a total carbon of 3.5 is desired, it is just as possible that the total carbon obtained in the one melting operation will run from 3 percent to 3.7, whereas with the double melting operation and the addition of carbon in the second melting, the total carbon content of the final product can be controlled within a range of say 3.40 to 3.60 percent without difficulty. Moreover the final product is much better in many ways than where the carbon is added in a single melting operation. Tensile strengths are better; castings are more uniform in hardness throughout the cross section of large castings and the castings are sounder and have fewer flaws.

It is desired that I be limited solely by the appended claims and the showing of the prior art.

I claim:

1. A method of making cast iron having in excess of 3% by weight of carbon, comprising subjecting scrap predominantly of steel to a melting operation in a cupola furnace in contact with carbon, to add carbon to the molten material, casting this melt into ingots, and remelting the ingots again in contact with carbon, to add further carbon to the iron to produce an end product with a carbon content in excess of 3%.

2. A method of making cast iron having in excess of 3% by weight of carbon, comprising melting scrap predominantly of steel in a cupola furnace, to add carbon to the molten material, casting this melt into ingots, and remelting the ingots in a second cupola, to add further carbon to the iron, to produce an end product with a carbon content in excess of 3%.

3. A method of making cast iron having in excess of 3% by weight of carbon, comprising subjecting scrap predominantly of steel to a melting operation in a cupola furnace in contact with carbon, to add carbon to the molten material, casting this melt into ingots, remelting again in contact with carbon, to add further carbon to the iron to produce an end product with a carbon content in excess of 3%, and adding a graphitizing agent in a quantity not over three percent by weight.

4. A method of making cast iron having in excess of 3% by weight of carbon, comprising melting scrap predominantly of steel in a cupola furnace, to add carbon to the molten material, casting this melt into ingots, remelting the ingots in a second cupola, to add further carbon to the iron to produce an end product with a carbon content in excess of 3%, and adding a graphitizing agent in a quantity not over three percent by weight.

5. A method of making cast iron having in excess of 3% by weight of carbon, comprising subjecting scrap largely of steel to a melting and remelting operation in separate cupola furnaces in contact with carbon, to increase the carbon content in each melt to produce an end product with a carbon content in excess of 3%, and adding a zirconium-containing graphitizer to the molten material of the remelt.

6. A method of making cast iron having in excess of 3% by weight of carbon, comprising subjecting a mixture of cast iron and steel scrap to a melting operation in a cupola furnace, to add carbon to the molten material so that it has approximately 2.70 to 3% of carbon, casting this melt into ingots, remelting the ingots in a second cupola, to add further carbon to the iron, so that the final product has approximately 3.40 to 4% of carbon, and adding a graphitizing agent at some time during the process.

7. A process of making cast iron having in excess of 3% by weight of carbon, comprising subjecting scrap predominantly of steel to a melting step in a cupola furnace in contact with

high carbon coke, casting this melt and remelting the castings in a second cupola in contact with a high carbon coke, to increase the carbon content to produce an end product with a carbon content in excess of 3%.

8. The method of making a low phosphorus gray cast iron which consists in melting down scrap predominantly of steel in a cupola, casting the molten metal into ingots, remelting the ingots in a cupola to add carbon, adding to the molten metal an alloy of iron, manganese, zirconium, and silicon, the alloy forming not over three percent by weight of the molten metal, and casting the metal into molds.

9. The method of making a low phosphorus gray cast iron having in excess of 3% by weight of carbon, which consists in melting down scrap predominantly of steel in a cupola, casting the molten metal into ingots, remelting the ingots in a cupola to add carbon, to produce an end product with a carbon content in excess of 3%, adding to the molten metal a graphitizing agent not over three percent by weight, and casting the metal into molds.

10. The method of making a low phosphorus gray cast iron which consists in melting down scrap predominantly of steel in a cupola, casting the molten metal into ingots, remelting the ingots in a cupola to add carbon, and adding to the molten metal one percent to three percent of an alloy made up substantially as follows: iron 35%, zirconium 15%, manganese 10% and silicon 40%.

11. A method of making cast iron having in excess of 3% by weight of carbon, comprising subjecting starting material low in carbon selected from the group; malleable iron, and steel to a melting operation in a cupola furnace in contact with carbon, to add carbon to the molten material, casting this melt into ingots, and remelting the ingots again in contact with carbon, to add further carbon to the iron to produce an end product with a carbon content in excess of 3%.

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