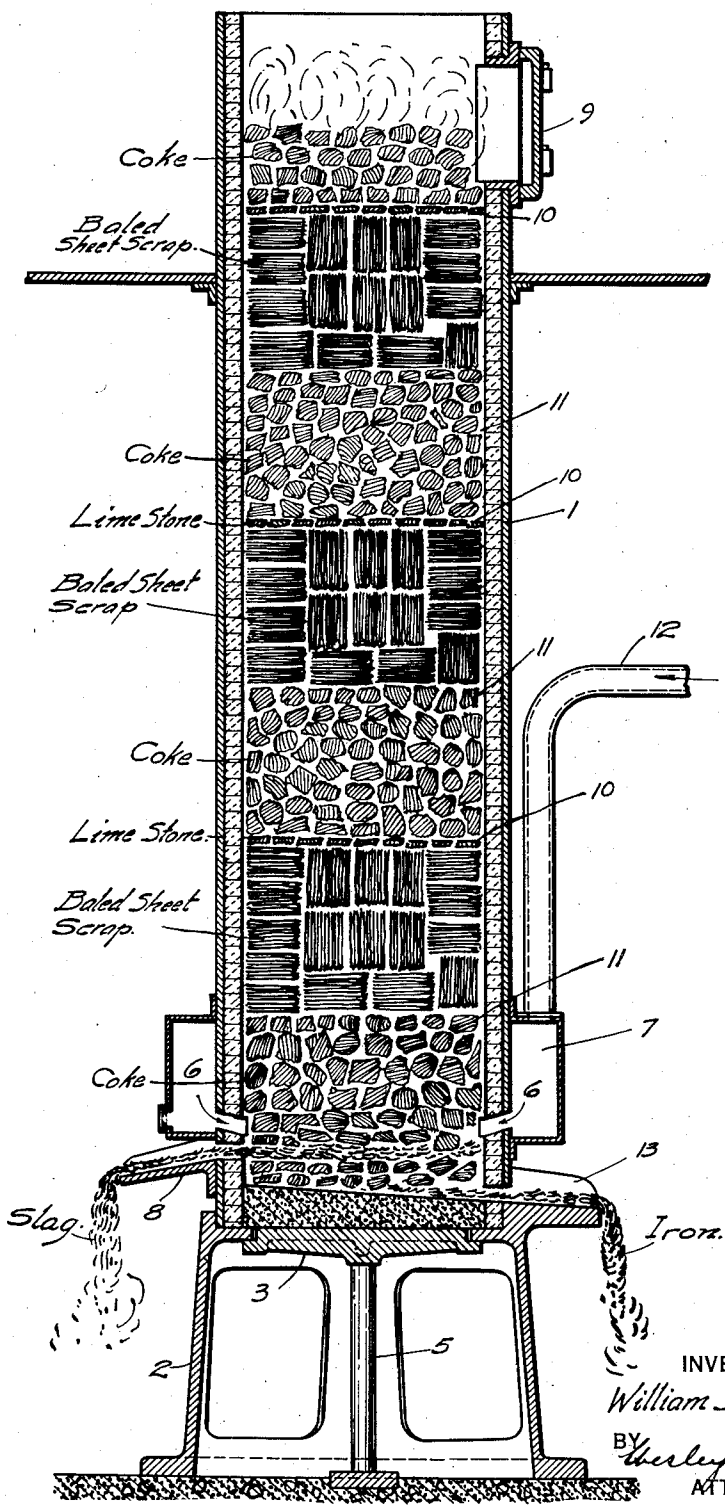
March 15, 1932. W. J. MERTEN 1,849,502

GRAY CAST IRON AND METHOD OF PRODUCING THE SAME FROM IRON SILICON ALLOYS

Filed April 16, 1928



INVENTOR
William J. Merten.
BY Harley E. Barr
ATTORNEY

Patented Mar. 15, 1932 1,849,502

UNITED STATES PATENT OFFICE

WILLIAM J. MERTEN, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

GRAY CAST IRON AND METHOD OF PRODUCING THE SAME FROM IRON-SILICON ALLOYS

Application filed April 16, 1928. Serial No. 270,204.

My invention relates to the preparation of synthetic iron from sheet-scrap punchings or stampings of iron-silicon alloys by the cupola process that has characteristics which render it suitable for gray-iron castings having special requirements.

The principal object of my invention is to provide a process of producing an iron from sheet scrap resulting from various cuttings and punchings of iron-silicon alloys that is suitable for preparing gray-iron castings of special characteristics, including high magnetic permeability and physical strength, combined with good machining qualities and a fair degree of ductility.

Another object of my invention is to provide a process of economically producing a high-grade iron from the sheet scrap resulting from the punchings or stampings of iron-silicon alloys which consists essentially in baling the scrap, mixing it with a small quantity of ferro-manganese, and melting the mixture in a cupola furnace, the quantity of sheet scrap and the amount of coke or other fuel utilized for melting it being so proportioned that the iron-silicon alloy will be melted and converted into an iron having characteristics which render it especially suitable for making castings and particularly those utilized in electrical apparatus, such as motors.

A further object of my invention is to provide gray-iron castings that have greater physical strength and better magnetic properties than castings formerly produced from iron prepared by the cupola process and in which the amount of chemical components and impurities, such as carbon, phosphorus, manganese and sulphur are of a selective value, or are considerably lower, and the amount of silicon is as high, or higher, than in castings usually produced from iron prepared by the cupola process.

A still further object of my invention is to provide gray-iron castings from sheet scrap resulting from the stamping or punching of an iron-silicon alloy which contains more than 2 per cent of silicon and in which the relation between the combined carbon and the graphitic carbon is such that the castings will have unusual hardness and strength, combined with good machining qualities.

Heretofore, the sheet scrap, resulting from the stampings or punchings of high-grade iron-silicon alloys utilized in transformers and other electrical apparatus, has been disposed of by adding it to molten pig iron or other furnace charge in a steel-making furnace. This method of utilizing the scrap was economically undesirable, because impurities, such as oxides or extraneous adhering materials, were often introduced into the melted furnace charge, and, when basic-lined furnaces were employed, the lining deteriorated rapidly. It was accordingly necessary to treat or refine the scrap, the same as any other inferior and impure material, which made the process expensive and this was especially so where the scrap consisted of stampings and cuttings made from specially prepared and purified material that involved a difficult and expensive process of preparation.

I have made the discovery that high-grade sheet scrap resulting from the punchings or stampings of iron-silicon alloys may be successfully remelted in a cupola furnace without introducing large amounts of impurities and that gray-iron castings may be prepared from the molten iron that will have high physical strength and good magnetic qualities.

My invention will be better understood when described with reference to the accompanying drawing, the single figure of which is a sectional view of a cupola or melting furnace.

The cupola or melting furnace, which is of the usual construction, comprises a refractory-lined shell 1, supported on legs 2, and a furnace bottom 3, also refractory lined, which is held closed by a support 5. A number of tuyères 6, leading from a common air chamber 7, are positioned in the furnace wall and extend into the furnace at some distance above the bottom. When the iron is melted, it may flow continuously out of the spout 13, or, if preferred, the outlet may be plugged and tapped at appropriate intervals.

In practicing my invention, a charge of bedding coke is placed in the furnace through the door 9. Because of the higher melting point of iron-silicon alloys, the amount of coke or other fuel required for melting the sheet scrap obtained therefrom is considerably more than the amount employed in the customary practice of melting pig iron. For a cupola having a diameter of 60 inches, I have found that the charge of coke should be such that the bed extends from the bottom of the furnace to approximately 36 inches above the tuyères. For a cupola of the size specified, approximately 3000 pounds is required for this charge. The bed is then ready to receive the charge of tightly bundled sheet scrap.

In accordance with my improved process, the charge of bundled scrap is obtained from the numerous cuttings or punchings of high grade silicon-iron alloy which is utilized in the manufacture of transformers and other electrical apparatus. This scrap material is composed of a silicon-iron alloy containing from 2.5 to 4.5 per cent of silicon and in which the total amount of impurities, such as carbon, sulphur, manganese and phosphorus, are not over .2 per cent. The scrap, however, may be slightly contaminated by a varnish or water glass with which the rolled sheets of the iron-silicon alloy are coated during the stamping or punching operations.

The sheet scrap, consisting of numerous cuttings or punchings of various thicknesses and shapes, are pressed and baled together as tightly as possible. I prefer to utilize bales having an approximate size of 6 x 6 x 20 inches, although I do not desire to be limited in this respect, as the size of the bales may be varied considerably without materially affecting the results. For a furnace of the size specified, the charge consists of about 3000 pounds of the baled iron-silicon scrap mixed with approximately 30 pounds of ferro-manganese.

The ferro-manganese is added to the charge of baled silicon-sheet scrap so that sufficient manganese will be introduced into the iron to counteract the effects of sulphur. When coke is utilized for the melting of the iron, it always contains a certain amount of sulphur, as an impurity, some of which combines with the iron to form iron sulphide. The sulphur, in the form of iron sulphide, causes "red shortness" and is also a powerful agent in increasing the chilling effect which makes the iron hard and difficult to machine. When manganese, however, is present, it combines with the sulphur, to form manganese sulphide in which form the sulphur is not such a potent agent in increasing the chilling effect. It will, therefore, be seen that the introduction of manganese may actually increase the ductility of the castings when sulphur is present.

The melting of the silicon-steel scrap in the cupola is similar to the usual practice. The charge of the baled sheet scrap mixed with the ferro-manganese, and a layer of limestone 10, which serves as a fluxing agent, rests upon the bed of coke 11. Air is blown through the blast pipe 12, wind box 7 and tuyères 6. The oxygen unites with the carbon to form carbon monoxide and carbon dioxide, and the hot gases, as they pass upward, carburize and melt the iron. As the iron is melted, the fuel is also consumed and a new layer of coke and baled sheet scrap, to which ferro-manganese has been added, will take the place of the previous layers in the melting zone of the furnace. The melted iron and slag collect in the crucible zone of the furnace and may be allowed to run out continuously, or, if preferred, the furnace may be tapped close to the hearth and the molten iron allowed to flow out of the cupola into a ladle at appropriate intervals. The iron may then be poured from the ladle into said molds having oven-dried cores to obtain castings of the desired shape.

Various iron castings prepared in the manner specified contained from 2.31 to 3.60% silicon, from .07 to .188% sulphur, from .20 to .80% manganese, from .02 to .06% phosphorus and from 2 to 3% carbon, of which from .20 to 1.5% was combined carbon and the remainder graphitic carbon. By proper annealing, however, the amount of combined carbon may be substantially reduced or changed entirely into graphitic carbon. When it is desired to produce castings having a high permeability, it is essential that the amount of combined carbon be low. Castings prepared from the iron have a gray fracture, machine well, and have 50 to 70 per cent better magnetic properties than iron castings ordinarily produced from iron prepared by the cupola process. The tensile strength of such iron castings is between 35,000 to 40,000 pounds per square inch. Under a load of from 3700 to 5000 pounds at the middle of a bar 18 inches long and 1⅛ inches in diameter, which was supported at the ends, there was a deflection of .15 to .2 of an inch.

As a specific illustration, a gray-iron casting prepared in the manner described contained 2.5% carbon, of which .7% was combined carbon and 1.8% carbon in the graphitic form. The amount of silicon was 2.75% and sulphur, manganese and phosphorus were present in the amounts of .1%, .75% and .03%, respectively.

Bars of my improved cast gray iron, when annealed at 900° C. and permitted to cool in the annealing furnace, had a magnetic induction of from 6000 to 8500 at 10 gilberts per centimeter and 9500 to 11000 gausses at 50 gilberts per centimeter, the corresponding ranges in permeability being 600 to 800 and 190 to 220, respectively.

The high magnetic induction of the castings results from the comparatively high

amount of silicon and the small amount of other chemical components and impurities contained in the iron, the amounts of carbon, sulphur, manganese and phosphorus being substantially less than in ordinary cast iron produced by the cupola process.

Gray cast iron produced by ordinary processes has a magnetic induction of from 2500 to 4500 gausses at 10 gilberts per centimeter and 5000 to 7500 at 50 gilberts per centimeter, the corresponding permeability being 250 to 450 and 100 to 150, respectively. It will, therefore, be seen that, for the magnetizing forces specified, the induction for ordinary cast iron is only 50% to 60% of annealed iron produced by my process.

My process of treating sheet silicon scrap to produce a high-grade cast iron is of especial importance because I am not only able to produce an iron that is superior to iron ordinarily produced by the cupola process, but my method provides an outlet for the high-grade sheet scrap of iron-silicon alloys for which no market has been available except at a great sacrifice of its potential value.

While I have described a specific form of my invention, it will be understood that the charges of the respective materials in the cupola will vary considerably and that the proportions given are to be considered illustrative and not as a limitation of my invention. When coke is utilized as a fuel, it should be of a high quality and should not contain more than 1 per cent of sulphur. The amount of ferro-manganese added will be in proportion to the amount of sulphur present in the coke and the speed of melting as the manganese combines with sulphur, forming manganese sulphide which counteracts the detrimental effects of sulphur.

Good castings have been produced without the use of ferro-manganese, providing the amount of sulphur in the fuel is small. I do not desire, therefore, to be limited to the use of ferro-manganese in my process, although it is a desirable ingredient and is essential when the amount of sulphur in the coke is high. It will also be understood that, for different sized cupolas, the respective charges will be correspondingly varied. As in ordinary cupola practice, however, there must be sufficient coke or other fuel present to melt the baled sheet scrap and carburize the iron, but for economical operation of the furnace, too much should not be added.

Other modifications of my invention will become apparent to those skilled in the art and I desire, therefore, that only such limitations shall be placed upon my invention as are required by the prior art and the appended claims.

I claim as my invention:

1. The process of producing iron castings from baled scrap of iron-silicon alloys in which the carbon content is not more than .2% which comprises melting the baled scrap in a cupola furnace and casting the molten iron in molds of the desired shape.

2. The process of producing iron castings from the sheet scrap of iron-silicon alloys containing not more than .2% carbon, which comprises mixing tightly baled silicon-sheet scrap with a small quantity of ferro-manganese, melting the same in a cupola furnace, and casting the iron in molds of the desired shape.

3. In the process of producing iron castings from the sheet-steel scrap of iron-silicon alloys containing not more than .2% carbon the steps which comprise charging a quantity of coke in a cupola furnace, adding a charge of baled silicon-steel scrap mixed with a small amount of ferro-manganese and a quantity of lime as a fluxing agent and melting the charge, the amount of coke being sufficient to melt the silicon-steel scrap and the amount of ferro-manganese adding being in proportion to the amount of sulphur in the coke.

4. In the process of producing iron castings from the sheet scrap of iron-silicon alloys containing not more than .2% carbon, the step which comprises melting a mixture of tightly bound silicon-steel scrap and a small quantity of ferro-manganese in a cupola furnace.

5. The process of producing iron castings from iron-silicon alloys containing not more than .2% carbon which comprises melting a charge consisting of at least 95% of the iron-silicon alloy in a cupola furnace and casting the iron in molds of the desired shape.

In testimony whereof, I have hereunto subscribed my name this 12th day of April, 1928.

WILLIAM J. MERTEN.