

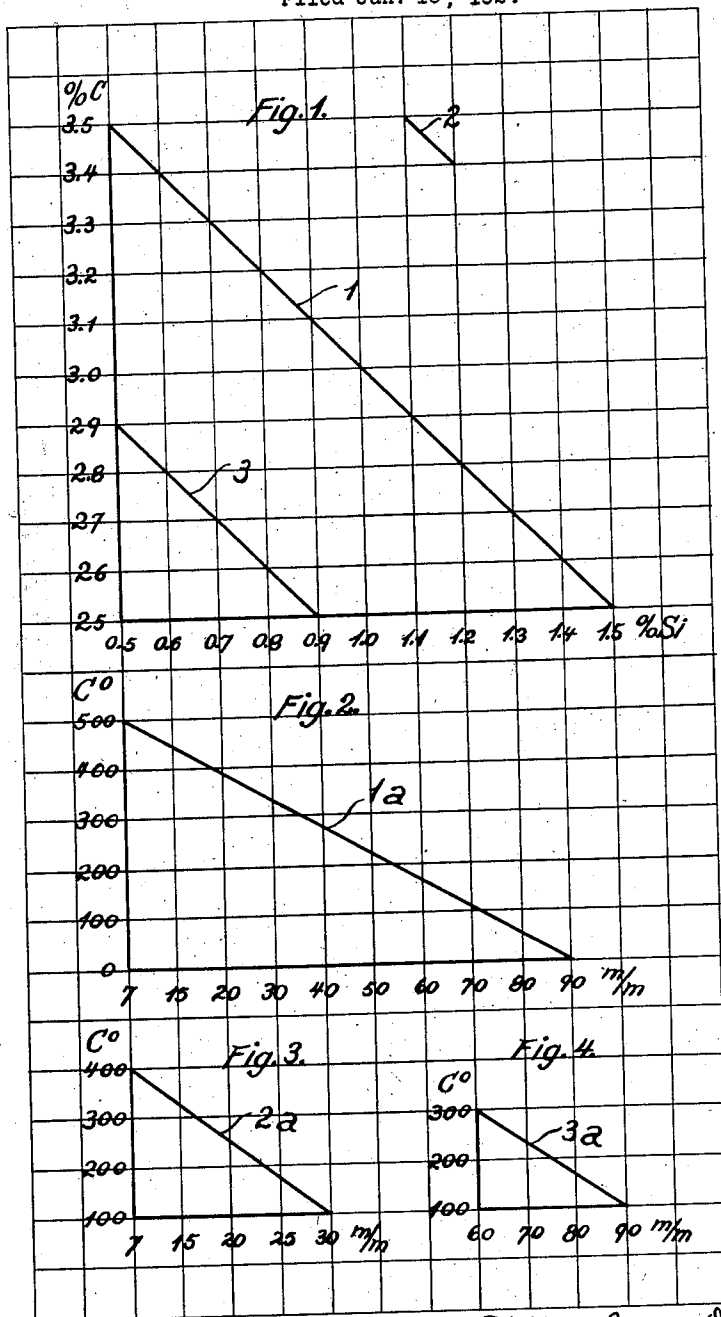
July 7, 1925.

1,544,562

P. A. DIFENTHÄLER ET AL

PRODUCTION OF CAST IRON

Filed Jan. 15, 1924



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Patented July 7, 1925.

1,544,562

UNITED STATES PATENT OFFICE.

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PRODUCTION OF CAST IRON.

Application filed January 15, 1924. Serial No. 686,284.

To all whom it may concern:

Be it known that we, PHILIPP AUGUST DIEFENTHÄLER and KARL SIPP, both citizens of the Republic of Germany, and residents, respectively, of Heidelberg and of Mannheim, Baden, Germany, have invented certain new and useful Improvements in the Production of Cast Iron, of which the following is a specification.

10 This invention relates to the production of gray cast iron, and has for its object the production of castings in which great strength is combined with moderate (about 1.65–1.75) Brinell hardness.

15 In an earlier application, Serial No. 458,049, filed on April 2, 1921, by Philipp August Diefenthäler as sole inventor, there is disclosed a process for producing gray cast iron which is characterized by a predominantly lamellar pearlite structure, with moderate graphite veinings and little if any free ferrite, by using for the castings an iron composition with a low content of carbon and of silicon and in retarding their cooling in the moulds according to temperature curves, based upon the heating of the casting moulds to a temperature varying according to the particular composition and the sectional thickness of the casting, adapted to permit the pearlite structure to develop and to limit the formation of free ferrite. The instructions therein contained are amply sufficient to enable those skilled in the art to produce castings possessing the structural characteristics disclosed and the properties resulting therefrom, namely, great strength and a high resistivity to frictional wear. But, while obtaining castings relatively high in the scale of strength, it has been found in practice that there is always a tendency to a return to toughness and an increase of the Brinell hardness, which has rendered the castings extremely difficult to machine or otherwise finish.

45 As the result of technical investigations and after exhaustive experiments we have discovered that, with iron compositions in which the sum of the carbon and silicon content (that of one varying inversely as that of the other) remains constant, the curve of the temperature required for heating the moulds to suitably retard the cooling therein of castings of different wall thicknesses or cross-sections, the higher tem-

peratures being required for castings of the smaller sections, is constant and approximates closely to a straight line, and, further, that the temperature curve will be lower the higher (within limits) the combined carbon and silicon content of the mixture, and vice versa; and we have worked out, within the scope of the earlier broad invention and by way of an improvement thereon, exact data by means of which we are able to produce castings of widely varying cross-sections having uniformly high physical and mechanical properties—castings which considerably excel the castings heretofore obtained not only as regards bending and tensile strength but also with respect to flexion and pre-eminently as regards resistance to shock while at the same time standing no higher in the Brinell scale of hardness than previous castings of average strength.

This data is set forth graphically in the accompanying drawing, wherein are shown, in Fig. 1, the curves of the carbon plus silicon content of what may be called our normal mixture and of two modifications thereof, and, in Figs. 2, 3 and 4, the three temperature curves for the heating of the moulds applicable respectively to the three different mixtures.

Thus, we use, and recommend, for the normal mixture, the formula $C+Si=4$ per cent, represented by the curve 1 (Fig. 1)—a mixture in which the sum of the constituents carbon and silicon equals 4 per cent of the mixture, the carbon content varying from 3.5 to 2.5 per cent and the silicon content from 0.5 to 1.5 per cent. The temperature or cooling curve for castings made from this mixture—that is to say, the temperature curve according to which the moulds should be heated for different sections of castings in order to suitably retard their cooling—is shown in Fig. 2 by the curve 1^a, approximately a straight line, wherein for castings decreasing in thickness from 90 to 7 millimeters the temperature required for the moulds rises from 0° to 500° C.

It is apparent from an inspection of the drawing that, for castings of more than 90 millimeters in cross-section, the curve 1^a will extend below the zero line, or, in other words, that the moulds must be cooled be-

fore the casting. In practice, however, this, as well as the heating of the moulds to temperatures of 500° C. and higher for castings of small cross-sections, presents, as will readily be understood, certain technical difficulties. Hence, to obviate such difficulties, we modify the carbon plus silicon content of the mixture and thereby raise or lower the cooling curve as desired, selecting for castings of small cross sections a softer mixture wherein the carbon plus silicon content is somewhat greater than 4 per cent, and a harder mixture, with carbon plus silicon content less than 4 per cent, for the thicker castings.

The soft mixture will have for its limit a carbon plus silicon content of 4.6 per cent—represented, in the same way as in the case of the normal mixture, by the curve 2, Fig. 1—, with a maximum of 3.5 per cent of carbon and 1.2 per cent of silicon, since, as is known, a higher silicon content will affect the structural properties of the castings under the higher working temperatures, as in motor cylinders. For the hard mixture, the theoretical limit of the carbon content will be 2.2 per cent; but it has been found in actual practice that a mixture wherein the carbon plus silicon content is constant and equals 3.4 per cent—represented by the curve 3, Fig. 1—, with a minimum of 2.5 per cent of carbon and a maximum of 0.9 per cent of silicon, may be used satisfactorily for all the thicker sections of castings usually required.

With these modified mixtures, or with mixtures lying between the normal mixture and the two extremes given, the temperature curve for the heating of the moulds may be lowered, in the case of thin castings, to the curve 2^a, Fig. 3, wherein for thicknesses ranging from 30 to 7 millimeters the heating required for the moulds rises from 100° to 400° C., and, for castings of from 90 to 60 millimeters in thickness, may be raised, as shown by the curve 3^a, Fig. 4, so as to extend from 100° up to 300° C.

From the detailed information hereinabove set forth, every skilled foundryman will be able, according to the mixtures and heating possibilities available, to produce castings of any desired cross-section and of uniformly high physical and mechanical properties.

It is to be understood that the temperature curves shown and described are based upon casting operations conducted at 1350° C. in normal cupola practice and in the sand-moulds regularly used in the production of gray cast iron. Should the casting be done at higher temperatures, as, for example, in an electric furnace, the temperature specified will of course be correspondingly lowered. If moulds other than the regular moulds are used, the required modi-

fications of the temperature curves can readily be calculated—for instance, if the moulds have particularly thick walls and it is found that the casting obtained has an appreciable ferrite content the temperatures must be slightly raised so that the preheating will penetrate farther into the mould.

It is also to be understood that the specific mixture and temperature curves herein set forth can be varied somewhat without essentially affecting either the process or the properties of the castings.

What we claim as new, and desire to secure by Letters Patent, is—

1. The process for producing iron castings of great strength with moderate Brinell hardness which comprises using for the castings mixtures having a low carbon and silicon content and cooling them in moulds preheated according to a temperature curve which with all mixtures having a constant carbon plus silicon content rises in approximately a straight line as the wall thicknesses of the casting gradually decrease.

2. The process for producing iron castings of great strength with moderate Brinell hardness which comprises starting with mixtures having a low content of carbon and of silicon and cooling the castings in moulds preheated according to a temperature curve which for mixtures having a constant carbon plus silicon content of approximately 4 per cent rises in approximately a straight line from 0° to 500° C. as the wall thickness of the castings decreases from 90 to 7 millimeters.

3. The process for producing iron castings of great strength with moderate Brinell hardness which comprises using for the castings mixtures with a carbon plus silicon content of not much if any more than 4.6 and not substantially less than 3.4 per cent and preheating the moulds, to retard the cooling of the castings therein, according to a temperature curve which for all mixtures having a constant carbon plus silicon content rises in approximately a straight line as the wall thicknesses of the castings gradually decrease and which is based upon a curve rising from 0° to 500° C. for castings from mixtures having a 4 per cent carbon plus silicon content and with wall thicknesses decreasing from 90 to 7 millimeters.

4. The process for producing iron castings of great strength with moderate Brinell hardness which comprises using mixtures having a carbon plus silicon content of substantially 4 per cent for castings of medium cross-section, of a higher carbon plus silicon content not much if any exceeding 4.6 per cent for castings of the smaller cross-sections, and of a lower carbon plus silicon content not substantially below 3.4 per cent for castings of the larger cross-sections, and retarding the cooling of the castings in ac-

cordance with a law based upon the preheating of the casting moulds according to a temperature curve which, approximating a straight line with all mixtures whose carbon plus silicon content is constant, rises as the cross-sections of the castings decrease—from substantially 0° to 500° C. for castings from the 4 per cent carbon plus silicon mixtures varying from 90 to 7 millimeters in thickness, and is correspondingly lower for the smaller cross-sections with the raised, and higher for the larger cross-sections with the reduced, carbon plus silicon content.

5. The process for producing iron castings of great strength with moderate Brinell hardness which comprises using for castings of medium wall thicknesses mixtures having a carbon plus silicon content of about 4 per cent and retarding their cooling in the casting moulds by heating the moulds according to a temperature curve which, the carbon plus silicon content remaining constant, rises in approximately a straight line from 0° to 500° C. for castings gradually decreasing from 90 to 7 millimeters in thickness, and for castings both of thin and of thick

sections modifying the temperature curve for the heating of the moulds by modifications of the mixtures used, lowering such curve in case of thin castings by using therefor mixtures with a higher carbon plus silicon content not much if any exceeding 4.6 per cent and raising it in case of thick castings by using therefor mixtures with a lower carbon plus silicon content but not substantially less than 3.4 per cent.

6. Gray cast iron which throughout is predominantly of pearlite structure and is characterized by great strength combined with a moderate Brinell hardness.

7. A casting of gray cast iron which is characterized structurally by a well-developed and uniformly distributed pearlite formation and in physical properties by great strength and the capability of being readily machined.

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Witnesses:

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