

UNITED STATES PATENT OFFICE.

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MAKING MALLEABLE-IRON CASTINGS.

No Drawing. Application filed February 5, 1923, Serial No. 617,163. Renewed December 7, 1926.

In the manufacture of malleable iron castings it is customary to have silicon present in the iron before casting so that, in the subsequent malleabilizing operation, it may assist the decomposition or breaking up of the cementite in the iron. After casting and while the casting is cooling the presence of too much silicon, however, causes the precipitation, during or just after freezing, of a percentage of the carbon in the flaky form normally found in grey iron castings and renders the castings worthless for conversion into malleable iron, and owing to this action the amount of silicon present or to be added must be regulated with very great care. I have found that additions of small proportions of graphitization accelerators such as uranium and nickel, and particularly of titanium and aluminum, to iron containing an inappreciable percentage of silicon greatly accelerate the annealing cycle of malleable iron, acting in much the same way as larger amounts of silicon, but without the deleterious effects of silicon.

In carrying out my invention I have found that iron containing no substantial percentage of silicon and approximately .10-.15% of titanium or aluminum (these amounts being those contained in castings after they have been malleabilized) may be cast without precipitating the carbon, and when annealed graphitizes as completely and more satisfactorily than malleable iron of normal analysis which contains substantially .60-.75% of silicon and no titanium or aluminum. The addition of suitably larger amounts would still further promote ease of annealing. Similar additions in properly reduced amount can be made to metal having the silicon content usual in malleable iron. Such additions will similarly benefit the metal with respect to its annealing properties, resulting either in a marked reduction of the time required for an anneal or in a reduction (amounting to as much as 25% or more) in the amount of material requiring further treatment to remedy the defects of the first anneal.

The effect of silicon in iron for malleable castings is to raise the critical point above which carbon is soluble and to lower the solubility of free carbon in solid iron at all temperatures above the critical point

just mentioned. Silicon thus acts by decreasing the solubility of carbon in the iron and renders graphitization during annealing at a given temperature more rapid and complete, but by reason of its completeness there is danger of precipitation of carbon while cooling in the mold, which is ordinarily known as primary graphitization. Neither titanium nor aluminum, on the other hand, so far as I have observed, has any appreciable effect on the critical point of the alloy and each appears to increase instead of decrease the solubility of carbon.

So far as I have observed, other metals in addition to titanium and aluminum, such as nickel and uranium, have the power of increasing the rate of graphitization at annealing temperatures without so far lowering the solubility of carbon and increasing the rate of graphitization near the melting points as to produce precipitation of the carbon in the form of graphite flakes.

My invention is particularly adapted for use in making malleable castings with comparatively heavy sections, since the slow cooling of such castings in the casting operation, because of their thick sections, tends to permit the precipitation of the carbon in flaky form if the castings contain too high a percentage of silicon. A result of using such graphitization accelerators as titanium and aluminum is to shorten the annealing cycle and therefore decrease the time during which the surface of the castings is exposed to the decarbonizing effects of air or of the packing material which is in contact with such surface, so that the thickness of the ferrite skin on the castings formed by such exposure is lessened by the shortening of the time of exposure. As this ferrite skin is more difficult to machine than the material underneath, a definite improvement in machining qualities is thus achieved.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed, it being understood that by the use of the term "graphitization accel-

erators" I include such elements as assist in the graphitization of the metal during annealing.

What I claim is:

5 1. The process of making malleable iron castings containing an inappreciable percentage of silicon which comprises adding a graphitization accelerator to the iron, casting the metal without precipitating a substantial proportion of the carbon, annealing the casting and thereby precipitating the carbon, in the form of small particles.

10 2. The process of making malleable iron castings which comprises adding a graphitization accelerator other than silicon to the iron before casting, casting the metal without substantial precipitation of the carbon, annealing the casting and thereby precipitating substantially all of the carbon in the form of small particles.

15 3. The process of making malleable iron castings which comprises adding a graphitization accelerator to the iron, casting the metal and annealing the casting, the said accelerator having a neutral effect on the formation of graphite during casting but acting to accelerate the decomposition of the

grain structure of the metal and assist in the precipitation of the carbon into the form of small graphite particles during annealing. 30

4. The process of making malleable iron castings which comprises adding a graphitization accelerator to the iron without materially affecting the critical point of the metal and at the same time not materially affecting the solubility of the carbon, casting the metal without substantial precipitation of the carbon and annealing the casting, and thereby precipitating a substantial proportion of the carbon. 35 40

5. The process of making malleable iron castings which comprises adding a small percentage of titanium or aluminum to the iron, casting the metal and annealing the casting, and thereby effecting graphitization of the casting during annealing. 45

6. The process of making malleable iron castings which comprises adding from .10 to .15 per cent of titanium or aluminum to the iron, casting the metal and annealing the casting, and thereby effecting graphitization of the casting during annealing. 50

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