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PRESSURE CHILL-CASTINGS OF IRON

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5 Claims. (Cl. 148—3)

The invention relates to improvements to the method of treating pressure-chill castings of iron made according to the Leon Saines co-pending patent application Serial No. 336,188, filed February 10, 1953, and applicant's co-pending patent application Serial No. 555,285, filed December 27, 1955.

Thus, as stated in said application Serial No. 336,188 the combination of the processes of chill-casting, die-casting, and graphitization with pretreatment for the nuclear formation, leads industrially to new products of high quality, high output of mass-produced parts, precision and good surface qualities on the castings, high strength of the cast iron and regularity of production.

In fact, the die-casting of iron in chill-molds is greatly facilitated, compared with steel, by the great stability of the metal bath in the storage furnace, by the lowering of the casting temperature, and by the considerable reduction in the effects of hot erosion on the chill-mold.

Thus, white iron can be cast without micro-shrinkage-cracks or blow-holes, thanks to the pressure exerted during the solidification. Cracks are avoided by stripping immediately after the solidification is finished.

Due to the chill-casting, the iron can have a relatively high silicon content which lowers the tapping temperature while preserving a white structure in the rough-cast pieces. Thus the normal contents in malleable cast irons can be considerably exceeded, reaching values of between 1.5 and 2%. Moreover, higher carbon contents of 2.6 to 3% can be allowed for the same reasons.

In order to obtain the optimum effect, it is preferable, according to the invention, to use irons containing copper though without that being an absolute necessity. Copper acts as a constituent to improve the casting qualities, as an agent for the nuclear formation of the graphite, and as an additive with a view to suitability for the hardening and tempering heat-treatment.

In order for the process to have its full effect, it is necessary, according to the invention, to carry out the triple treatment of hardening, nuclear formation and graphitization. The hardening treatment can be carried out, starting from the casting heat, by stripping fairly hot, above 810° and quenching directly in a salt-bath, for example at 180° for 1 minute, then cooling in still air, which makes it possible to obtain chilled castings without the risk of cracks or shrinkage cracks. If the casting comprises narrow parts which have been over-cooled, it can, after being stripped, be immersed in a stabilizing bath at 810° one minute, after being salt-hardened at 180°. The casting is then subjected to nuclear formation treatment, for example 48 hours at 450°, then, with or without intermediate cooling, the casting is subjected to graphitization of the primary cementite; in order for the graphitization to be absolutely complete; it is necessary to maintain it at 875° for 2 to 6 hours, but this time can be reduced to between 40 minutes and two hours by annealing at 900°.

The following table gives the number N per mm.² of fine spherules of graphite having an average diameter of

2 to 6 microns obtained by this process. In these tests, the chill-casting was 14 mm. thick; stripping was done at more than 820° and the piece was hardened directly in salt at 180°. The annealing comprised a first cycle of 48 hours at 450°, and a second: 3 hours at 875°.

No. of Casting	C per-cent	Si	Mn	Cu	N/mm.²
2163	2.40	1.58	0.61	0.40	12,000
2162	2.42	1.56	0.62	0.20	14,000
2164	2.46	1.51	0.60	1.84	15,000

In order for the process to attain its full effectiveness, it is preferable to allow the piece to cool on leaving the matrix and to reheat it for austenization at 810° for 30 minutes, for example, and hardening in stages, at 180° for 1 minute for example. The castings are then subjected to nuclear formation treatment, for example 48 hours at 450°, cooled then reheated to 875° for example, just long enough for the graphitization of the primary cementite, then cooled in still air, failing which, if the time taken is too long, the graphite undergoes a coalescence with a reduction in the number of spherules and lowering of the mechanical properties. This is shown by the following table which gives the number of spherules of graphite per mm.² having a diameter of less than 2 microns;

No. of Casting		2163	2162	2164
Cu, percent		0.4	1.2	1.84
Time at 875°	1 hour	32,000	40,000	26,000
	3 hours	30,000	35,000	23,000
	6 hours	16,000	23,000	14,000

In each case, the quantity of cementite is nil, so that the annealing for 1 hours at 875° is sufficient. It will be seen that here the best result is obtained with the cast iron containing 1.2% copper, which has 40,000 spherules of graphite per mm.².

These chill-cast irons, reheated 810°/30 minutes, hardened in salt at 180° for 1 minute, cooled in still air, reheated to 450° for 48 hours, cooled in still air then reheated at 875° for 1 hour, and cooled in still air, are lamellar pearlitic and have the following characteristics in test-pieces 4 mm. in diameter, machined from pieces 20 mm. thick:

No. of Casting	Cu, Per-cent	E Kg./mm.²	R Kg./mm.²	A, Per-cent
2163	0.4	59	70	3
2162	1.2	47	72	4.8
2164	1.84	57	79	4.2

After this treatment, a piece of casting 2162 was reheated to 835°, hardened in oil, tempered at 700°; it then showed: E=80, R=82, A=2.5% in a machined test-piece 4 mm. in diameter.

It is also possible, after this last tempering at 700°, to stop this by oil-hardening and temper it for 2 hours at 500° to induce the structural hardening of the copper.

Finally, it is possible to modify the compositions and properties of these cast irons by alloys such as: Ni, Mo, Ti, Al, Zr and the like. The machinability, after graphitization, with or without hardening and tempering, is particularly easy, due to the graphite.

According to the two aforesaid patent applications, white iron castings are obtained by chill casting predetermined compositions under pressure in suitably deter-

mined casting conditions. These castings are subjected to a graphitisation treatment comprising three phases:

(1) Bainite or rather martensite staged prequench;

(2) Germination of the graphite at temperatures contained between 400 and 500° and for periods contained between 5 and 100 hours;

(3) Graphitisation of the primary cementite at temperatures contained between 850 and 900° and for periods contained between 10 minutes and 12 hours.

Recent progress has rendered it possible to reduce the period of the germination treatment, as disclosed in the aforesaid co-pending application Serial No. 336,188 appreciably. This application relates to this latter improvement.

Said treatment may be reduced to periods varying between a few minutes and 5 hours if the castings:

(*a*) Are thin (less than about 10 m.);

(*b*) Contain elements favouring the martensite quench, such as Ni (0.4 to 2%), Mn (brought to 1.5%), or favouring the formation of germs of graphite, such as Al (between 0.03% to 0.05%).

With these special provisions (thin castings, elements favouring the martensite quench), the reduction of the period of the germination treatment in relation to that indicated in the patent application Serial No. 336,188 is not accompanied by any reduction in the exceptional mechanical properties which the method of treatment in three phases enables there to be obtained.

I claim:

1. A method of obtaining malleable iron of pearlitic structure containing diffused fine particles of graphite which comprises die casting in a chill mold an iron suitable for the formation of pearlitic malleable iron, stripping the casting from the mold while hot, and above 810° C., quenching the casting in a salt bath at a temperature of about 180° C. for about 1 minute, cooling the casting in still air, subjecting the casting to a temperature between 400° to 500° C. for a period of time up to 5 hours, sufficient for effecting formation of graphite nuclei, subjecting the casting to graphitization of the primary cementite with heat at a temperature between 850° and 900° C. for 2 to 6 hours.

2. A method of obtaining malleable iron of pearlitic structure containing diffused fine particles of graphite which comprises die casting in a chill mold an iron suitable for the formation of pearlitic malleable iron, stripping the casting from the mold while hot, and above 810° C., quenching the casting in a salt bath at a temperature of about 180° C. for about 1 minute, cooling the casting in still air, subjecting the casting to a temperature between 400° to 500° C. for a period of time up to 5 hours, sufficient for effecting formation of graphite nuclei, cooling the casting in still air, subjecting the casting to graphitization of the primary cementite with heat at a temperature between 850° and 900° C. for 2 to 6 hours.

3. A method as defined in claim 1, wherein the iron treated contains 0.4% to 2% nickel and 1.5% manganese.

4. A method as defined in claim 2, wherein the iron treated contains 0.4% to 2% nickel and 1.5% manganese.

5. A method as defined in claim 1, wherein the iron treated contains a small amount of aluminum.

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