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CAST IRON HEAT TREATMENT

Lucien Péras, Billancourt, France, assignor to Régie Nationale des Usines Renault, Billancourt, France

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The invention relates to improvements in the heat treatment of white cast iron parts which are graphitized by subsequent annealing. It relates more particularly to the process which consists of the following cycle of treatment comprising three phases:

(1) Austenitization followed by interrupted martensitic quenching;

(2) Tempering and nucleation of the graphite at a precise temperature of the order of 450° C., variable according to composition;

(3) Subsequent graphitisation at high temperature (generally between 800° C. and 950° C.).

This process leads to difficulties in the case of the treatment of heavy pieces whose diameters may be as much as and exceed 4 to 7 cm., such as crank-shafts for motor cars, due to the size of the salt baths which are necessary and the difficulty of obtaining an adequate cooling speed to obtain the quasimartensitic structure.

According to the invention it has been found that it is possible to obtain good results in the series production of such parts cast in the white state, even in core sand or in shells, without the risk of shrinkage cracks in spite of the size and shape of the parts, if, after the austenitization has taken place at a suitable temperature: between 780 and 880° C. during a period of time sufficient for the homogenisation of temperature and structural equilibrium to take place (20 minutes to 1 hour 30 minutes), the part is then subjected to a cooling operation in still air until the surface is lowered to a temperature of between 650° C. and 700° C. (or approximately 680° C. to 780° C. at the centre), before being immersed in the hot or cold oil or water quenching tank. This definition of intermediate cooling is characterised by the fact that in those regions of the part which have been cooled to the greatest extent the structure has remained austenitic and is yet able to be hardened by martensitic quenching by immersion in the quenching medium.

It should be noted that by using this delayed quenching with white cast iron parts, it is possible to prevent the formation of shrinkage cracks with perfect reliability.

This process applies particularly to the following cast iron:

C	Mn	Si	Cu	Ni	S	P	Zr	Ti	Al
2	1	1	1.35	0.75	0.05	0.05	0.15	0.03	0.05

Thus, for example, crank-shafts with a shaft line of 40 mm. in diameter are cast in core sand from white cast iron. These white castings are austenitized, for example, at 840° C. for one hour, then cooled in still air until the surface is between 650° C. and 700° C. depending on whether the relatively thin or the relatively thick regions are being considered, and then the parts are immersed in oil.

After quenching, these castings are subjected to nucleation tempering at 440° C. for 4 to 5 hours and then,

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with or without intermediate cooling, the castings are brought to 920° C. for 2 hours and are then cooled in still air.

The following features are thus obtained:

Total absence of primary cementite;
Number of graphite nodules per square millimetre: 2.000 to 6.000;

Traction characteristics: $R=80$ to 100 kg./mm.^2 , A percent=5 to 7% (according to the French norms for steels);

Endurance limit in rotary bending test: 36 kg./mm.^2 .

If necessary, after the graphitisation at 920° C., it is possible to carry out a partial or total graphitisation of the pearlite between 650° C. and 700° C. or to carry out a quality treatment comprising quenching and tempering or to carry out a surface hardening operation.

The process can also be applied to thin parts (i.e. less than 10 mm.) of complicated shape cast in chill moulds with or without pressure. It applies in this case more particularly to the following cast iron composition:

C	Mn	Si	Cu	S	P	Ti	Al
2	1	1.5	1.35	0.05	0.05	0.05	0.05

White castings of this composition are austenitized at 810° C., cooled in still air to a surface temperature of 700° C., then quenched in water or in oil without any risk of shrinkage cracks despite the angular parts. These parts are tempered for two hours at 440° C., and then brought to 885° C. for one hour and cooled in still air. 6.000 to 30.000 grains of graphite per square millimetre are thus obtained:

$R=80$ to 100 kg./mm.^2 ; A percent=5 to 7%

I claim:

1. A method of heat treating white iron castings which comprises subjecting a casting of said white iron to austenitization with heat at a temperature of approximately 840° C., cooling the casting in still air sufficiently for the surface temperature of the casting to cool to a temperature in the order of 650° C. to 700° C., quenching the casting to form martensite, subjecting the casting to nucleation tempering with heat at a temperature in the order of 450° C., subjecting the casting to graphitization with heat at a temperature between 800° C. to 950° C. for a period of time in the order of two hours.

2. A method of heat treating white iron castings which comprises subjecting a casting of said white iron to austenitization with heat at a temperature of approximately 840° C. for a period of time in the order of 20 minutes to 1 hour and 30 minutes, cooling the casting in still air sufficiently for the surface temperature of the casting to cool to a temperature in the order of 650° C. to 700° C., quenching the casting to form martensite, subjecting the casting to nucleation tempering with heat at a temperature of approximately 450° C., cooling the casting in still air, subjecting the casting to graphitization with heat at a temperature between 800° C. to 950° C. for a period of time in the order of two hours.

3. A method of heat treating white iron castings which comprises, subjecting a casting of said white iron to 1 austenitization of approximately 840° C. for approximately one hour, cooling the casting in still air sufficiently for the surface temperature of the casting to cool to a temperature in the order of 650° C. to 700° C., quenching the casting in oil to form martensite, subjecting the casting to nucleation tempering with heat at a temperature of substantially 440° C. for 4 to 5 hours, subjecting the casting to graphitization with heat at a temperature of about 920° C. for about two hours.

4. A process as defined in claim 3, wherein the cast iron has the composition: 2% C, 1% Mn, 1% Si, 1.35% Cu, 0.75% Ni, 0.05% S, 0.05% P, 0.15% Zr, 0.03% Ti, 0.06% Al, the balance being iron.

5. A method of heat treating white iron castings which comprises, subjecting a casting of said white iron to austenization of approximately 840° C. for less than one hour, cooling the casting in still air sufficiently for the surface temperature of the casting to cool to a temperature in the order of 650° C. to 700° C., quenching the casting in oil to form martensite, subjecting the casting to nucleation tempering with heat at a temperature of substantially 440° C. for 4 to 5 hours, subjecting the casting to graphitization with heat at a temperature of about 920° C. for about 2 hours, cooling the casting in still air.

6. A process as defined in claim 3, wherein the cast iron has the composition: 2% C, 1% Mn, 1.5% Si, 1.35%

Cu, 0.05% S, 0.05% P, 0.05% Ti, 0.05% Al, the balance being iron.

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