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(54) **Brake disc production method and products thereby obtained**

(57) The invention describes a brake disc production system and the products thereby obtained, featuring a cast iron melting phase and a subsequent plurality of phases in which a metal mould is made to rotate and is lined with a particular refractory material. There follows a phase in which the liquefied cast iron is removed from the furnace then poured into the rotating mould through a special opening.

At this point, the mould is cooled by means of nozzles

which spray water at the said mould's external surface, and the cylindrical element obtained at the end of the cooling phase is then extracted.

Finally, a shot blasting phase is carried out in which all the residues are cleaned off the cylindrical element, followed by a phase in which the structural and mechanical characteristics of the said element are checked. Finally, the cylindrical element is cut into "slices" to realise the single discs.

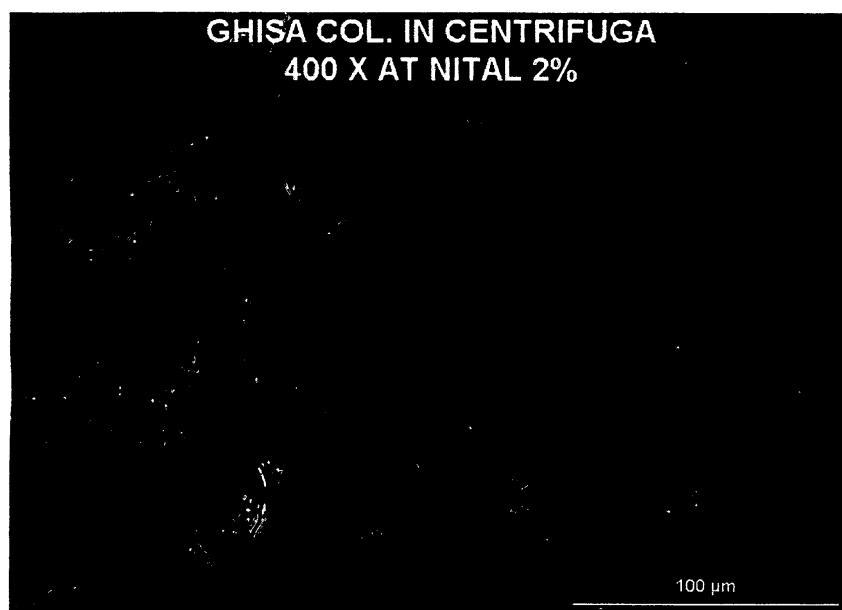


FIG. 3

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Description

[0001] The present invention refers to a brake disc production system and the products thereby obtained, recommended in particular for the realisation of brake discs for motorbikes.

[0002] As it is known, a brake is a device capable of countering the movement of a rotary or translational body where the operation is based on the friction that is generated between the two surfaces pressed against each other.

[0003] At present, brake discs for motorbikes that are realised in cast iron are obtained by casting, i.e. by filling previously prepared sand moulds with liquid metal.

[0004] In detail, to realise the discs in question, special siliceous sand moulds are prepared first of all into which are pressed the imprint of the castings (discs) to be obtained together with the feeding system constituted of a series of suitably-sized channels which allow the liquid metal to fill the mould.

[0005] The fusion of the cast iron can be brought about using different foundry systems: electric oxycombustion furnaces or with a cupola furnace (a particular shaft furnace designed for cast iron founding), by means of which pig iron is melted.

[0006] The liquid cast iron is brought up to temperature, removed from the furnace, then poured into the sand moulds and left to cool to a temperature of circa 300 °C.

[0007] The subsequent working phase consists in the spruing, in which the castings are separated from the feeding system metal, which is then remelted. More precisely, the channels and sprues are the parts which are discarded following casting and are not part of the disc.

[0008] The castings then undergo a shot blasting phase, during which operation, carried out in a special shot blasting machine, steel balls are blasted against the disc in order to remove the siliceous sand residues.

[0009] Lastly, the fettling is carried out, in which a grinding wheel is used to remove any flash. Finally, the discs are carefully checked to verify the material's characteristics.

[0010] Once approved, the discs are dispatched for a series of processes which allow the finished disc to be obtained. In fact, operations are envisaged in which the casting is turned, polished, lightened etc...

[0011] With the procedure just illustrated, a disc is obtained wherein the cast iron constituting it features mechanical characteristics that can prove substantially different from one zone to another, since there can be notable differences between the graphite present in proximity to the casting joint and that in the zone filled last.

[0012] In greater detail and as shown in figure 2, the graphite in the castings obtained through gravity casting features greater dimensions in proximity to the external diameter in the disc's casting joint zone, where superior mechanical characteristics are necessary.

[0013] These dimensional characteristics of the graphite, frequently, generate the occurrence of fire cracks

generally positioned in proximity to the disc lightening holes.

[0014] In addition to the faults already highlighted, the brake discs obtained through gravity casting have brought to light a plurality of drawbacks.

[0015] A first drawback derives from the fact that the discs mentioned earlier feature a master pattern, as shown in figure 1, which is not uniform or homogenous and has structural differences between the zone at which the casting starts and the last zone filled, which results in non-homogeneous mechanical characteristics.

[0016] A second drawback derives from the fact that in the structure of the discs obtained by gravity casting, the presence of ferrite may be found, this being a structural component with inferior mechanical characteristics which render the disc less resistant to load stresses.

[0017] A further drawback of the brake discs produced by gravity casting emerges from the fact that they are liable to have gas bubbles in their structure which render the said casting completely unusable, in addition to porosities which can also reduce the disc's mechanical characteristics and resistance, with the result that it must be discarded. In addition to what has been stated above, inclusions of sand and/or slag have been found to be present in the casting, thereby rendering it unusable also in this case.

[0018] In addition to all the points highlighted above, a further drawback found in the gravity casting production system derives from the fact that the forms used as moulds for the casting are rather laborious to prepare and can only be used once for the production of the discs, requiring substantial casting preparation times with consequent costs that influence production costs. In addition to the situation illustrated above, the castings formed have decidedly greater dimensions to those of the finished disc, in fact, the surface imperfections must be removed and a certain depth must be reached below the surface of the formed piece before finding metal with all the homogeneous characteristics required: hardness, composition and structure. The quantity of material removed is equal to about 25% of the weight of the blank with consequent costs in terms of both working and material.

[0019] The aim of the present invention is essentially to overcome the drawbacks of the commonly known technique resolving the aforesaid difficulties by means of a brake disc production system and the products thereby obtained, able to realise a material structure with better stress resistance characteristics.

[0020] A second aim of the present invention is to realise a brake disc production system and the products thereby obtained, able to feature uniform hardness in a circumferential manner and better material compactness.

[0021] A third aim of the present invention is to have a brake disc production system and the products thereby obtained, which is able to obtain special high-resistance iron castings with extremely high heat transfer coefficient.

cients and a higher workability index.

[0022] A still further aim of the present invention is to realise a production system which eliminates discards due to porosities, inclusions or gas bubbles.

[0023] A still further aim of the present invention is to realise a production system which enables brake discs to be obtained from different materials (for example, steel) without modifying the patterns or the feeding system.

[0024] A still further aim of the present invention is to have a brake disc production system which permits operation with low temperature casting, resulting in energy saving.

[0025] A further but not final aim of the present invention is to realise a brake disc production system which is simple to manufacture and works well.

[0026] These aims and others, which will better emerge over the course of the present description, are essentially achieved by a brake disc production system and the products thereby obtained, in accordance with the claims that follow.

[0027] Other characteristics and advantages will better emerge from the detailed description that follows of a brake disc production system and the products thereby obtained, in accordance with the present invention, provided below in the form of a non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 shows an enlarged view of a master pattern for gravity casting of iron;
- figure 2 shows the distribution of the graphite in gravity cast iron;
- figure 3 shows an enlarged view of cast iron master pattern produced with the system according to the present invention;
- figure 4 shows a picture of the distribution of the graphite in iron cast using the system in question.

[0028] The brake disc production system in question is essentially composed of a plurality of phases including, at first, the re-melting of the cast iron produced in the blast furnaces, which is brought to a liquid form in electric oxycombustion furnaces or cupola furnaces.

[0029] The production system according to the present invention envisages that a metal mould, called the chill mould, is made to rotate rapidly (depending on the diameter of the casting to be obtained) and is lined with a particular siliceous type of refractory material, of a commonly known kind, to prevent the metal subsequently adhering to the mould.

[0030] At this point the system envisages that the liquid iron is removed from the furnace and poured into the rotating chill mould through a special opening called tap. After the introduction of the liquid iron, a chill mould cooling cycle is initiated by means of nozzles which spray water at the chill mould's external surfaces.

[0031] The water flow can be modulated in order to obtain faster or slower cooling.

[0032] The cooling cycle terminates when the iron casting has reached a temperature of circa 500°C, which is followed by a phase in which the casting obtained is extracted, the said casting featuring an internally hollow cylindrical configuration. In greater detail, the casting obtained is essentially a tube. The tube then undergoes a shot blasting phase, in which all the silica residues are cleaned off.

[0033] The tube obtained is then checked and dispatched for a subsequent sequence of processes in which each tube is cut into "slices" thereby obtaining the single pieces, i.e. the single discs, which will then undergo mechanical working such as milling, turning and the formation of the lightening holes featured to enhance brake pad performance and eliminate the risk of the formation of a thin layer of water in the event of rain, all of which is realised according to commonly known techniques.

[0034] In accordance with the present invention, the brake disc obtained with the production system in question, that is to say, by means of spun casting, features a master pattern with an essentially homogenous conformation in which the graphite features a shorter, thinner configuration in the disc's external diameter, while in the disc's internal diameter the graphite is longer, this condition resulting in improved heat transfer, less disc wear and therefore superior performances.

[0035] Furthermore, the brake disc features a master pattern for the centrifugal casting with uniform and homogenous characteristics, without the structural differences, as shown in figure 3. In particular, the master pattern is more compact and completely devoid of porosities, inclusions, gas bubbles and ferrite.

[0036] In addition to what has been stated above, the disc in question features a uniform hardness in a circumferential manner, and a uniformly compact material. Furthermore, the cast iron of which the disc is comprised is highly resistant with a high heat transfer coefficient and a higher workability index.

[0037] After this predominantly structural description, the functioning of the invention in question will now be outlined.

[0038] When a cylinder must be prepared from which, later on, the "slices" that will constitute the brake discs will be obtained, it is sufficient to bring the cast iron to a liquefaction temperature of circa 1400°C, lower than the temperature usually necessary for gravity casting, which is around 1550°C.

[0039] Once the liquid iron has been poured into the chill mould, the cooling phase begins, which requires less time than cooling in the gravity casting mould, resulting in a reduction in the time the chill mould is occupied by the tube before it is extracted with respect to cooling in moulds. Furthermore, the chill mould is reused countless times.

[0040] The present invention thereby achieves the aims set.

[0041] In fact, the brake disc production system in

question is able to obtain a type A graphite which features better mechanical characteristics. In fact, the graphite found in the discs produced according to the system in the invention features a shorter, thinner configuration, as shown in figure 4, in particular, in the disc's external diameter, where superior mechanical characteristics are necessary, thereby dramatically reducing the possibility of the formation of fire cracks in proximity to the lightening holes since the graphite, which is an interruption in the master pattern, interferes less with the said master pattern, while in the disc's internal diameter the graphite is longer, this condition resulting in improved heat transfer, less disc wear and superior performances.

[0042] Advantageously, the graphite obtained with the system in question proves extremely homogenous around the disc's circumference.

[0043] Furthermore, the production system according to the present invention enables a master pattern to be obtained for the spun casting with uniform and homogeneous characteristics and without the structural differences caused by the perlite with varying degrees of cell openness located between the zone at which the casting starts and the last zone filled, as occurred with the commonly known technique.

[0044] Advantageously, the spun casting allows the presence of ferrite to be completely eliminated, this being a component which reduces the mechanical characteristics in general and in particular those related to traction.

[0045] In addition to all the points highlighted above, the master pattern for the spun casting enables all waste, gas bubbles and microinclusions to be eliminated since they are concentrated in the disc's internal diameter and will therefore be removed during the subsequent turning phase.

[0046] Finally, the master pattern is more compact, completely devoid of porosities, thus enabling an improvement of the mechanical characteristics which renders the disc more durable and more resistant to wear and, in certain sectors like, for example, in racing, it permits a reduction in the disc's dimensions and masses, consequentially making the vehicle lighter.

[0047] The production system according to the present invention has highlighted how controlled cooling and the casting type allow castings to be obtained with very different chemical analyses since the various characteristics can be optimised as desired.

[0048] In particular, special iron castings can be obtained, that is to say, with an extremely low presence of silicon, thus discs of this type feature an extremely high heat transfer coefficient, better mechanical characteristics with the same degree of hardness and a higher workability index than discs produced using the commonly known gravity casting technique.

[0049] Furthermore, the high castability of the spun castings permits the production of a range of cast irons with particular characteristics (resistance to heat, wear and corrosion) which are difficult to obtain with traditional, gravity castings.

[0050] In particular, with the system in question it is possible to obtain, without any problems or needing to modify the casting equipment: austenitic cast irons, which are highly resistant to heat; nodular cast irons, which feature superior mechanical characteristics, and aluminium-alloyed cast irons endowed with a low specific weight.

[0051] Finally, by means of the spun casting system, it is possible to cast - without worrying about shrinkage and shrinkage cavities - cast iron with a very low carbon equivalent which therefore has superior mechanical characteristics.

[0052] Advantageously, with the system in question there are no longer hidden flaws caused by gas bubbles, porosities and the presence of inclusions such as sand or slag as used to happen with the commonly known technique, thereby guaranteeing greater structural safety for the disc obtained and preventing the necessity for special checks, that is to say, radiographic structural checks, enabling savings in terms of time and production costs and reducing discards considerably.

[0053] In addition to what has been stated above, the production system proves extremely versatile and is able to offer a production with remedial mechanical characteristics since the hardness and mechanical characteristics are uniform in a circumferential manner. This condition allows greater hardness where it is required, unlike in the casting using the commonly known technique, where differences in hardness of up to 15% are noticeable in the same band and in particular in proximity to the casting joint zone.

[0054] Furthermore, with the same chemical analysis different characteristics can be obtained by altering the controllable cooling parameters (time, water flow, intervention time) and with the same hardness, a greater load can be obtained due to the compactness of the spun material.

[0055] Finally all the discs obtained from the cylinder have the same characteristics, while in gravity casting the castings poured at the end of the casting feature differences from the castings poured at the beginning (when the temperature of the casting is higher).

[0056] A further advantage of the present system derives from the fact that there is a reduction in the planarity defect of the casting, i.e. there are no more warped "saucer-shaped" discs.

[0057] In addition to what has been stated above, the production system eliminates all the taps and casting joints that constitute circa 15-30% of the discards in gravity founding and reduces the excess metal from working left on the casting, with a clear reduction in discards.

[0058] Furthermore, the system utilises a reduction in the casting temperature which consequently enables energy saving.

[0059] A further but not final advantage of the present invention is that it proves easy to use, simple to manufacture and works well.

[0060] Naturally, numerous modifications and variants

could be applied to the present invention, without falling outside the scope of the invention defining it.

Claims

1. A brake disc production system of the type comprising a fusion phase in which cast iron is brought to a liquid state in electric furnaces or cupola furnaces, **characterised by** the fact that the said system comprises the following phases:

- rotation of a metal mould, called the chill mould, at a speed that varies according to the diameter of the casting to be obtained,
- the lining of the said mould with a particular refractory material,
- the removal of the liquefied iron from the furnace followed by its pouring into the rotating chill mould through a special opening,
- the cooling of the said mould by means of nozzles which spray water at the said mould's external surface,
- the removal of the casting obtained at the end of the cooling, that is to say, when the temperature has reached circa 500°C,
- shot blasting, in which all the silica residues are cleaned off the casting,
- checking phase, in which the casting diameter is verified, together with the material characteristics (master pattern, graphite and hardness).

2. A brake disc production system according to claim 1, **characterised by** the fact that the said system comprises a cutting phase in which the said castings are cut into "slices", thereby obtaining the single pieces, i.e. the single discs.

3. A brake disc production system according to claim 1, **characterised by** the fact that the said casting features an internally hollow cylindrical configuration.

4. A brake disc production system according to claim 1, **characterised by** the fact that the single discs from each casting will undergo mechanical working such as milling, turning and the formation of lightening holes.

5. A brake disc **characterised by** the fact that the said disc is obtained by means of spun casting.

6. A brake disc according to claim 5, **characterised by** the fact that the said disc is obtained following the cutting of the said casting into "slices".

7. A brake disc according to claim 6, **characterised by** the fact that the said disc features a master pattern

for the spun casting with uniform and homogeneous characteristics and without the presence of structural differences.

8. A brake disc according to claim 6, **characterised by** the fact that the said master pattern is compact and completely devoid of porosities, inclusions, gas bubbles and ferrite.

9. A brake disc according to claim 6 **characterised by** the fact that the said disc is endowed with a master pattern with an essentially homogenous conformation in which the graphite features a shorter, thinner configuration in the disc's external diameter, while in the disc's internal diameter the graphite is longer, this condition resulting in improved heat transfer, less disc wear and therefore superior performances.

10. A brake disc according to claim 6, **characterised by** the fact that the said disc features uniform hardness in a circumferential manner and better compactness in terms of the material comprising the said disc.

11. A brake disc according to claim 6, **characterised by** the fact that the cast iron of which the said disc is comprised proves highly resistant and features a high heat transfer coefficient and a higher workability index.

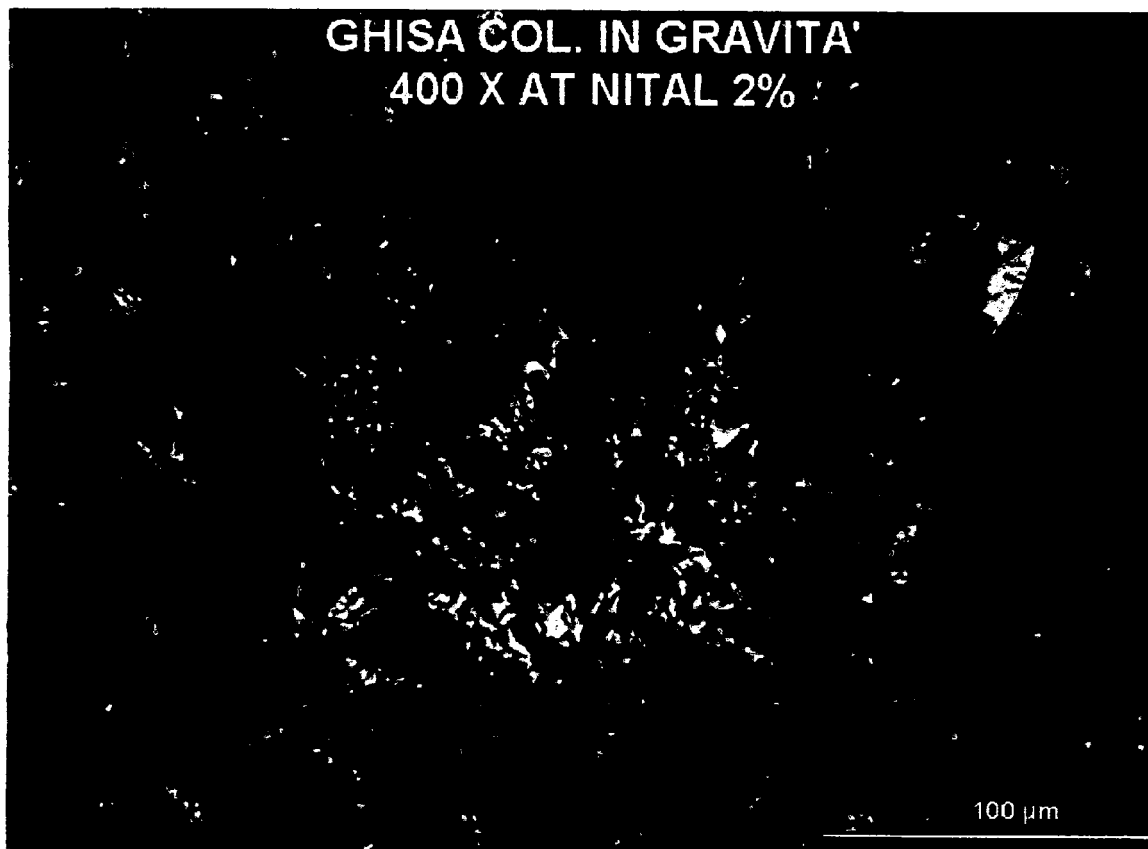


FIG. 1



FIG. 2



FIG. 3

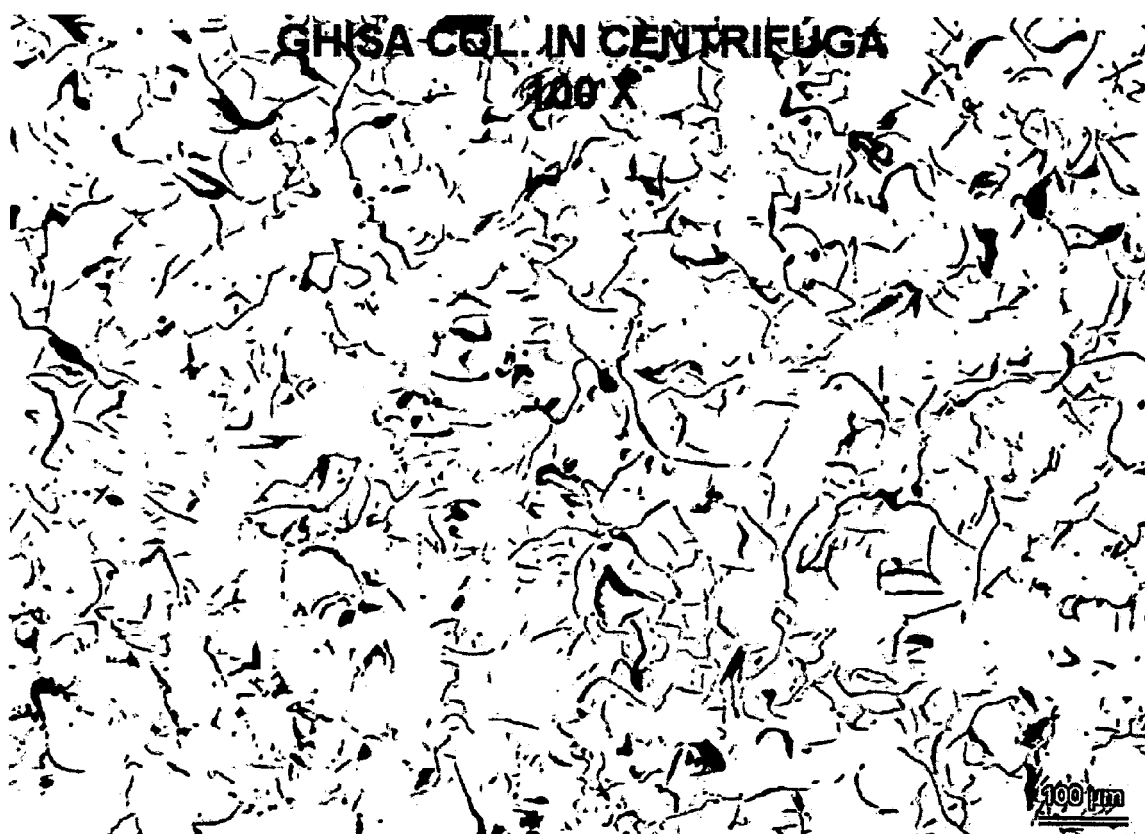


FIG. 4