COLD CAST MASS ELEMENT

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ABSTRACT
A cold cast mass element has solid metal particles of greater than 75% by volume and a binding agent of less than 25% by volume, with an outside surface. The binding agent is exposed on the outside surface and encapsulates the solid metal particles within the cold cast mass element. The mass element has an outside surface has a hardness of greater than durometer 70 Shore A and preferably has a hardness of above about 75 Shore A or above about 100 Shore D. The mass element has a binding agent which is an epoxy resin or thermosetting phenol formaldehyde resin. The metal particles can be iron of preferably 85% to 96% by volume with a binding agent 4% to 12% by volume. The mass element preferably has solid metal particles of greater than 85% by weight; and a binding agent of less than 15% by weight.
COLD CAST MASS ELEMENT
BACKGROUND OF THE INVENTION

[0001] Mass elements such as flywheels, exercise weights and heavy ballast for patio umbrella stands have traditionally been cast in iron and then coated with a powder coating or paint. The mass elements typically encompass inertial elements such as flywheels which need to have structural rigidity, and weights such as patio umbrella stands which need to be rigid and maintain wear resistance in outdoor environments. Unfortunately, the hot casting process which is a hot melting of iron requires heat and cannot be performed at room temperature or at temperature which does not require a heating element. The mass elements are sometimes coated with a plastic housing, which requires an extra step.

[0002] Cold casting methods for high molecular weight polymers have been described in the prior art such as in Johnson U.S. Pat. No. 5,602,197 issued Feb. 11, 1997. Johnson discloses in the abstract that thermoplastic binder compositions comprising a high molecular weight polymer component and a molten wax component are compounded with sinterable ceramic or other inorganic powders. Upon cooling, a thermally reversible gel is formed in the binder by the gelation of the polymer in the molten wax. Ceramic batches comprising these binders behave as shear-thinning and thermally reversible gels.

[0003] An example of a cold cast method is found in Cook U.S. Pat. No. 6,005,041 issued Dec. 21, 1999, the disclosure of which is incorporated herein by reference and provides for soft cold cast articles that have a soft rubbery consistency. Cook teaches that a variety of hard materials can be mixed into a resin for increasing its strength. Cook uses oils to make a reinforced thermoplastic elastomeric gel soft enough to be flexible for human wearing.

[0004] Bradshaw U.S. Pat. No. 5,446,085 issued Aug. 29, 1995 describes a composition comprising an inorganic filler and binder component containing a glassy polymer and a rubbery polymer is provided. The glassy polymer contacts and encapsulates the filler. The compositions are especially useful in the fabrication of flexible magnetic recording media and abrasive articles.


[0006] The processes currently used in the field of resin composition materials science provides methods of strengthening a resin with additives.

SUMMARY OF THE INVENTION

[0007] The present invention teaches certain benefits in construction and use which give rise to the objectives described below.

[0008] The present invention is a casting system or casting process to manufacture low tolerance parts without heating up the cast molds and thus at low cost. The material used to make parts using the cast molds is a mixture of ground iron powder and a resin to bond the iron powder together in a shape given in the cast molds. Depending on the mixture ratio of the iron powder and the resin, the mixture before curing could be as either a gel or dough. When the mixture is a gel, it could be injected into the mold through an injection hole. When the mixture is as dough, it could be poured into or dropped onto the cavity of the mold with the mold open. After the mixture is set inside the mold, it is taken out of the mold and set on a dry place to cure and harden. Because the process and the mixture require almost no heating either on the mold or on the part material before injection, the part cost is significantly lower than the traditional casting processes, and the molding process is simplified.

[0009] The process is for creating rigid articles, and is specifically well-suited for nonstructural weights or mass or inertial elements such as plate or dumbbell weights of diameter 70 Shore A and above to about 75 Shore A or 100 Shore D. The process is also well suited for creating flywheels for apparatus such as exercise machines. It is preferred to use the process to make nonstructural weights or mass or inertial elements.

[0010] A cold cast mass element has solid metal particles of greater than 75% by volume and a binding agent of less than 25% by volume, with an outside surface. The binding agent is exposed on the outside surface and encapsulates the solid metal particles within the cold cast mass element. The may have an outside surface has a hardness of greater than durometer 70 Shore A and preferably has a hardness of above about 75 Shore A or above about 100 Shore D. The mass element has a binding agent which is an epoxy resin or thermosetting phenol formaldehyde resin. The metal particles can be grinded iron of preferably 85% to 96% by volume with a binding agent 4% to 12% by volume. The mass element preferably has solid metal particles of greater than 85% by weight; and a binding agent of less than 15% by weight.

[0011] A primary objective of the present invention is to provide a system having advantages not taught by the prior art. Another objective is to provide such a process system that helps reduce manufacturing cost by eliminating heating process in the casting process. Another objective is to provide such a casting process system that accommodates a low-pressure injection or forming to reduce wear and tear on the tooling. Another objective is to provide such a system that eliminates a finishing process such as painting after the part is formed and dried.

[0012] Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWING

[0013] The accompanying drawings illustrate the present invention. In such drawings:

[0014] FIG. 1 is a perspective view of a first apparatus embodiment for a cold casting process.

[0015] FIG. 2 is a second perspective view of the first embodiment.

[0016] FIG. 3 is a perspective view of a second apparatus embodiment for cold casting process.

[0017] FIG. 4 is another perspective view of the second embodiment.

[0018] The following call out list of elements are used consistently herein.

[0019] 10 Cold Cast Apparatus

[0020] 12 First Cast

[0021] 14 First Cast Block

[0022] 16 First Cast Cavity Surface

[0023] 18 First Cast Injection Channel

[0024] 40 Second Cast

[0025] 42 Second Cast Block
The above described drawings FIGS. 1 and 4 illustrate the invention, a cold cast apparatus 10 employing a cold casting or molding process, comprising a first cast 12, a second cast 40, and a part 100 made from the casting process. First cast 12 and second cast 40 are half sides of the cast block as shown in FIGS. 1 and 2, but they can also be parts of multi-side molds that have more than two cast blocks to create an enclosure for cavity space for a part shape. First cast 12 comprises a first cast block 14, a first cast cavity surface 16 on first cast block 14, and a first cast injection channel 18. Since the cold casting process does not require a high pressure to mold the parts, first cast block 14 and other mating cast blocks may not have to be of high strength tool steel, but could be low cost material such as regular steel and aluminum for relatively high volume productions, and clay or hardened gypsum powder for low volume productions. On first block 14, first cast cavity surface is formed to match the shape of the part on the side, as shown in FIG. 1, and first cast injection channel 18 is placed to direct a mixture material from outside the casting block into the cavity area of the cold cast apparatus.

Second cast 40 resembles first cast 12 in its features and comprises a second cast block 42, a second cast cavity surface, and a second cast injection channel. Second cast block 42 is usually made of the same material as that of first cast block 14 but block 42 could be of a different material. In FIGS. 1 and 2, second cast block 42 is made to mate with first cast block 14 to create a complete cavity surface or space to make a part, however the mold may comprise more than two cast blocks and inserts to complete the cavity surface or space in other instances and applications. Second cast cavity surface 44 forms the shape of the part on the corresponding side and is a surface area or surface of the space formed on second cast block 42. Second cast injection channel 46 is also formed on second cast block 42 to put the mixture material into the cavity area for forming the part. In the apparatus shown in FIGS. 1 and 2, both first cast injection channel 18 and second cast injection channel 46 come together, when both first cast block 14 and second cast block 42 comes together closing the cavity, to form a hole for the material injection. Usually, the air inside the enclosed cavity leaks out through the parting line between the cast blocks as the mixture material is pushed into the cavity area, but to help the air to escape completely, vent holes 48 are placed at selective places around the mold to make sure there is no trapped air inside the cavity while the mixture material fills the area or space. The markings left on the part as the result of the vent holes or parting line can be cleaned after the casting process.

The mixture material for a part 100 is made of iron powder and a resin for bonding the iron powder. The iron powder is preferably from 300 micron to 1000 micron, but the process also works for smaller sized particles as small as sub micron diameter. Depending on the ratio of the mixture between the iron powder and the resin, the mixture may come out more as a thick gel or dough. When the mixture is a thick gel, it may be injected through cast injection channels 18, 46 to the cavity to form part 100. When the mixture is dough, it may be put into the cavity with the mold open, and closing the mold forms the part. In this case of using dough-like mixture, cast injection channels 18, 46 may be omitted from cast blocks 14, 42. Because cold casting process does not require heating up the castings to sinter or to melt the material, it takes at least a few minutes to cure the part. Some heat, not as much as that for sintering or melting, may help to speed solidifying the part inside the castings before it is taken out of the mold. The parts are usually taken out of the mold for complete curing.

Main ingredient for the mixture for the part is powdery metal, such as iron powder, that can be easily made without melting process from scrap metals, such as iron or steel scraps, and even ores. The adhesive binding agent mixed with the powered metal can be epoxy resin or thermosetting phenol formaldehyde resin with its proportion range from 4% to 12%, which would mean that the powdered metal percentage is preferably in the proportion range of 88% to 96% by volume. The percentage of metal by volume can also be as low as 75%. Also other adhesive types may also be used to hold the metal particles in the shape formed by the casting. If calculating the amount of iron by weight, it would be approximately at least 89% by weight in the preferred range. The present method is also effective for iron particles of 85% or more by weight.

FIGS. 3 and 4 show a second casting apparatus that is similar to the first casting apparatus in terms of making the part pattern but has a slightly different structure such that it is possible to open the cast and directly pour the material into the cavity and close the cast rather than pushing the mixture through an injection hole. The second casting apparatus comprises a mandrel assembly 60 comprising a mandrel base 62 to support a first mandrel 64, a second mandrel 66, and a center mandrel 68. The mandrels are basically long shafts extended out from mandrel base 62 to put through cast blocks and the part to form the holes of the mandrel shapes in the part as shown in FIGS. 3 and 4. Second cast block 42 having the shape pattern of one side of the part is put through mandrel assembly 60 with its pattern side facing away from mandrel base 62. And both mandrel assembly 60 and second cast block 42 are inserted into a cast housing 80 that provides, in this apparatus, a sidewall pattern for the part. The mixture for the part is then poured over the second cast block, and the cast can now be closed with first cast block 14 inserted into cast housing 80 with its patterned side facing toward the mixture. With some pressure over the first cast block, the mixture is formed to the shape of the cavity created by the cast blocks, the mandrel shafts, and the cast housing. A great advantage of this casting system is that the amount of the mixture poured into the cast does not have to be exact. The cast blocks naturally accommodate different amounts of the mixture that means without using different tooling, the parts of different thickness can be manufactured in a single setup.

The second casting apparatus shown in FIGS. 3 and 4 further comprises a cast base 90 supporting cast housing 80
and mandrel assembly 60. Cast base 90 comprises a base plate 92 that is basically a flat structure, a base plate slots 96 that is a set of slot holes on base plate 92 to clamp down and position cast housing 80 on base plate 92, and a base plate holes that a number of holes in base plate 92 to insert pins to help ejecting mandrel assembly 60 from cast housing 80. Also mandrel assembly 60 further comprises a mandrel base holes 70 that is a set of holes on mandrel base 62 for the pins to go through to eject cast blocks 14, 42 with or without part 100.

[0047] Even though a low pressure to merely to force the mixture into the shape of the casting is sufficient to produce the part without causing too much wear and tear on the tooling, but a relatively high pressure, near 500 kilogram per square millimeter, may be applied to make the part more dense by squeezing out all the air bubbles in the mixture. Alternatively, no pressure which is very light hand pressure can be applied in instances where a bubble formation is not a problem.

[0048] The process through the first apparatus and second apparatus is ideal for producing parts that are structurally non-critical and low tolerance and that need some mass built in and be formed to particular shapes quickly. One such part is a barbell weight plate as part 100 as shown in FIGS. 1 and 2. Traditionally barbell weights are made from casting using iron powder sintered or molten iron poured into the casting. The parts such as barbell weights produced in the traditional casting process comprise nearly all iron as their material yield a good weight density for weight lifting exercises. Since cold casting process requires the resin as the bonding material for the iron powder in the mixture, the weight density for the parts made from cold casting is not quite as heavy as the weight parts made from the traditional casting process. However, cold casting process cuts or takes out the significant amount of heat from the traditional casting process and thus saves the heating cost from the casting process. Also the parts made from cold casting are naturally glossed gray in color on the exterior eliminating the process of rust proofing or painting the part after the casting process. Since the process cuts both significant amount of heating during the casting process and applying finishing on the part after curing, it is an environmentally friendly process.

[0049] The process is preferably completed at room temperature, or whatever temperature the workspace is. If the end product is heated after molding, the end product can be cured faster, however it is preferred to have the entire process completed at room temperature. After the end product is completed, it would have hardness of a tofu or gelatin desert. In about 15 minutes, the resin outside of the product cures and the product is relatively rigid. The hardness of the final article outside surface is preferably about durometer 5 Shore A and above to about 75 Shore A or 100 Shore D. The outside surface is protected by and preferably encapsulated by the binding agent which is exposed on the outside surface so that it covers the solid metal particles within the cold cast mass element.

[0050] Although the invention has been disclosed in detail with reference only to the embodiments shown above, those skilled in the art will appreciate that various other embodiments can be provided without departing from the scope of the invention. Accordingly, the invention defined only by the claims set forth below.