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(54) NODULARIZING AGENT FOR CAST IRON AND METHOD OF MAKING SAME

(71) We FORD MOTOR COMPANY LIMITED, of Eagle Way, Brentwood, Essex CM13 3BW, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a nodularizing agent and to a method of making the agent.

The ability to nodularize cast iron was significantly advanced some 27 years ago when it became known that magnesium, rare earth metals, calcium or their alloys (hereinafter referred to as the alloy), will reliably condition a molten iron charged to form nodular graphite upon solidification. Since that time, the art has moved progressively from (a) adding the alloy to the molten iron charge in the ladle by such methods as plunging, immersion or the sandwich technique to (b) adding the alloy to the molten charge in a stream immediately before entering the mold, and finally to (c) adding the alloy into a portion of the gating system within the mold.

The earliest use of adding the alloy to a portion of the gating system in the mold was developed particularly with respect to inoculation, a form of cast iron and nodular iron conditioning which not only heralded the way but proved that total nodularization can be carried out within the mold. All of the in-the-mold techniques have possessed one common characteristic, namely: the alloy has been introduced in a particulate or powdered form or a compact made of these. The particulate alloy was (1) introduced in measured scoops spilled into a reaction chamber defined in a sand mold or (2) the alloy was premolded in particulate form within a foam suspension defining the gating system, or (3) a precompacted or extruded shape of particulate magnesium alloy was placed in the gating system contacting only one supporting surface. The latter has only been conceptually brought forth; it has not been used in a practical manner to date.

This progression of technology has resulted in a more matched use of magnesium or other nodularizing agent with the needs of the specific casting, it has eliminated fading effects associated with the use of the alloy, eliminated flare and other environmental problems, and has aided in reducing costs. Nonetheless, there still remains the likelihood of (a) defects in the casting resulting from undissolved or nonuniformly mixed particulate nodularizing agent which has floated or has been carried into the cavity, (b) variable segregation of the alloy or a variable solubility rate causing a metallurgical variation in the casting, (c) unnecessary waste resulting from expansion of the volume of the gating system to accommodate the particulate matter, (d) the inability to closely target the minimum amount of magnesium to obtain complete or partial nodularization, (e) slag defects in the casting resulting from the greater surface oxidation of the selected nodularizing agent used in particulate form, (f) the inability to remove the alloy from unpoured molds, thus deteriorating the molding properties of the sand mixture in said unpoured molds.

Even if the nodularizing agent was used in a very elemental cast form, prior to its being ground and sized into a particulate or powder form, such cast form would not achieve the objects of this invention because (a) it is not in a condition which will fit the variety of sizes and quantities required of different casting applications without special tailoring a specific such application, (b) the cast form usually is not made and therefore cannot be later converted to an angular form which may be required for a predetermined solution rate, and (c) the cast form generally has not be able to be made in thicknesses greater than 1.25 inches without

encountering significant segregation within the interior of the cast form.

A primary object of this invention is to provide an improved form of nodularizing agent for making spheroidal graphite cast iron.

The nodularization agents of the invention, which is defined in claim 1, are in a module form so that key may be manually broken into any desired block configuration constituting one or more of said modules and thereby facilitate meeting the needs of a variety of different casting applications without the necessity for tailoring the specific nodularizing agents for each individual application.

The invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a sectional elevational view of a mold useful for producing the nodularizing agent of this invention; and

Figure 2 is a plan view of the mold shown in Figure 1.

As shown in Figures 1 and 2, a preferred construction of a mold useful in making a nodularizing agent sheet is comprised of a shallow pan-like molding base (drag 10) and a flat cover (cope 11) adapted to fit so as to close off the interior of the pan. The cope and drag are each constituted of metal and have a sufficient thickness to provide a predetermined rate of cooling for the molten charge to be introduced into the covered mold. The interior 20 of the drag is defined by a flat bottom surface 13 and a continuous upright peripheral surface 14. The surface 14 may have a slight taper to accommodate stripping of the cast agent from the drag, preferably in the range of 3-8°. The cope has a flat interior surface 15 substantially parallel to the bottom surface 13 of the drag when the cover is in the closed condition, as shown in Figure 1. The interior surface 15 is interrupted by a plurality of depending ribs 16 which are arranged in a predetermined pattern as best illustrated in Figure 2. The ribs each have slanted sides 16*b* meeting at an apex 16*a*; the apex penetrates or projects into the interior of the cavity defined by the drag to a distance roughly half the depth defined by the cavity in the closed condition. The projection or penetrating distance 18 of each of the ribs is designed to imprint a groove line into the resulting cast nodularizing agent sheet so that the sheet product may be broken into a desired number of modules constituting said pattern. The module is determined by the spacing between the ribs in either direction of the cast product. The module is preferentially selected to have a dimension which is substantially square. The module is designed to accommodate the smallest or minimum casting charge with which the nodularizing agent is to be used. As a practical application, the distance 19 between the apices 16*a* of ribs, taken in one direction, is about 2 inches. The thickness of height 17 of the cast product is preferentially in the range of .5-4.0 inches, this being considerably greater than the thickness range capable of being cast by the prior art techniques without encountering significant segregation in the interior of the cast product.

A mouth 21 in the cover through which a molten charge of the nodularizing agent may be poured is provided. The nodularizing agent with which this invention is concerned, is comprised of a nodularizing element selected from the group consisting of magnesium, cerium, calcium and rare earth metals, said selected element being alloyed with iron and silicon in a homogeneous form substantially devoid of segregation and oxides on the interior thereof. The oxides are substantially eliminated by maintaining the product in the as-cast form since the covered mold system therefore eliminates contact with oxygen during the solidification process and there is no crushing involved.

The as-cast product is thus formed of a solid impervious brittle body comprised of an iron and silicon base alloyed with a suitable element to effect nodularization. Preferably, the body has a width of about 9 feet and a length of approximately 18 feet, whereas the thickness varies preferentially from .5-4.0 inches. The as-cast sheet or product has premolded portions of reduced thickness along at least one surface thereof as shown in Figure 2. Such portions of reduced thickness are preferably at least 80% of the thickness of the remainder of the body. In certain applications, the depending ribs may project from both the interior of the cover as well as from the interior of the bottom drag or pan. Thus, the spacing from the apices of opposed ribs will reduce the smallest thickness of the as-cast product. With the ribs in both surfaces of the mold and having slanted sides 16*b*, as shown in Figure 1, the product will be reduced in thickness at corresponding locations from both sides and can be manually broken to provide modules with tapered upper and lower sides which facilitates control of the solution rate in certain instances where a variable flow rate is encountered during the molding or pouring operation in which the agent is used.

When the agent is particularly comprised of magnesium ferrosilicon, such molding technique as disclosed herein will provide less than 0.20% impurities within the interior of the as-cast sheet and the magnesium may generally be concentrated in the range of 5-15%.

The agent of the invention may be manu-

ally broken about the portions of reduced thickness to provide modules of desired shape and size. Preferably, such modules are used for conditioning cast iron by the method disclosed and claimed in our copending application No. 30545/76 (Serial No. 1559584) the module being chosen to fit within a recess in a conduit leading to a mould cavity.

WHAT WE CLAIM IS:-

1. A nodularizing agent comprising a substantially planar solid impervious brittle cast body composed of iron and silicon alloyed with one or more of magnesium, cerium, calcium and rare earth metals, said body being formed with a plurality of portions of reduced thickness forming lines of weakness along which the body may be broken into pieces of predetermined size.

2. An agent as claimed in claim 1, in which the body has a thickness in the range 0.5 - 4.0 inches and is substantially devoid of segregation or oxides.

3. An agent as claimed in claim 1 or claim 2, in which said portions of reduced thickness have a thickness at least 80% of the thickness of the remainder of the body.

4. An agent as claimed in any preceding claim, which is constituted of magnesium ferrosilicon having less than 0.2% impurities and containing 5 - 15% magnesium.

5. A nodularizing agent substantially as herein described.

6. A method of making the nodularizing agent of any preceding claim, in which a charge of molten alloy is cast in a mold cavity defined by a drag having a flat bottom and a peripheral side wall and a cope carrying a grid pattern of depending ribs, said alloy comprising iron and silicon and one or more of magnesium, cerium, calcium and rare earth metals.

7. A method as claimed in claim 6, in which said alloy is magnesium ferrosilicon.

8. A method of making the nodularizing agent of any of claims 1 to 5, substantially as herein described with reference to the drawings.

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1559585 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale

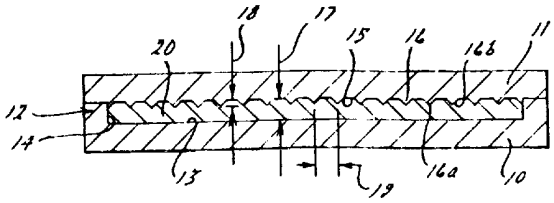

Fig. 1.

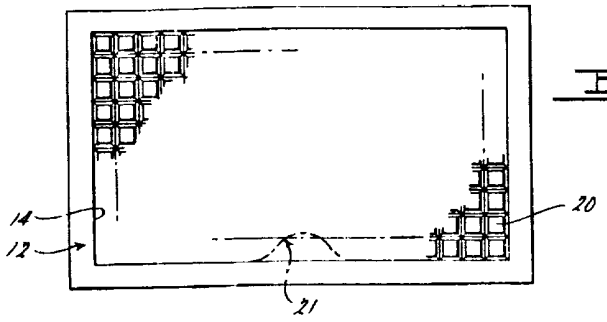

Fig. 2.