

UNITED STATES PATENT OFFICE

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CASTING FREELY OXIDIZABLE METAL

No Drawing.

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While the present improvements relate more particularly to casting of magnesium and so-called light metal alloys, in which magnesium is the predominant constituent, it will be understood that the improved method and means involved may also be found adaptable for the casting of other similar readily oxidizable metals. Difficulties encountered in melting and handling, in molten state, magnesium or an alloy largely composed of this metal are well known, and those difficulties are still present when it is attempted to introduce such metal into a mold in any process of casting. For example, when green sand castings are made in the ordinary way by simply pouring the molten magnesium or light metal alloy into an untreated sand mold, not only is there a pronounced tendency for the metal to burn in the sprue, but the surface of the casting formed by contact with the complementary surface of the mold tends to become oxidized, pitted, or both, due to the formation of a powder (presumably an oxide or a nitride of the metal). Where the casting poured in this manner is of relatively heavy section, it either completely burns up or is badly damaged due presumably to the temperature of the metal cast remaining in the rapid oxidation range for a longer period of time than is the case with thin-section castings which chill promptly. Even if the impairment of the surface of such castings as can be made is not serious enough to prevent the cast article from being finished when removed from the mold, the casting has an unsightly appearance and a certain loss of metal is involved. It is to be noted, of course, that the cleaner the casting, the more easily may the subsequent finishing operations be carried out.

It has heretofore been proposed to overcome these difficulties, specifically in casting magnesium and alloys containing the same in dry sand molds, by dusting the mold with sulphur prior to casting the metal therein, the sulphur giving off in contact with the molten metal a vapor which is more easily oxidizable than magnesium. This procedure, however, has the objection that it is obviously difficult to correctly gauge the amount of sulphur thus used and particularly if an excess is applied to the surface, either of the mold proper or the core, so much vapor may be generated that some of it becomes entrapped during the period that the metal is solidifying, the result being blow-holes or surface shrinks in the casting.

More recently it has been proposed to avoid the difficulties encountered in casting magnesium and its alloys by using a molding composition consisting of pulverized carbon, pulverized soapstone, magnesium oxide and a light bodied mineral oil. I have found, however, that the use of magnesium oxide, which is commercially sold as a fine powder, is not only unnecessary but detrimental since it makes the mold less porous and thus tends to prevent the ready escape of gases generated during casting. This in itself is undesirable since it causes pitting, surface shrinks, and general surface injury to the casting. I have further found that the use of magnesium oxide in contact with hot magnesium and its alloys accelerates or promotes the oxidation of the metal. This discovery is incorporated in my copending Patent No. 1,871,315 wherein I have described and claimed the casting of readily oxidizable metals in a mold formed from pulverized carbon and oil with or without a plasticizer such as soapstone.

While working with molding compositions bound with non-aqueous liquids and consisting largely of pulverized or finely divided carbon, I discovered that still better results could be obtained in the way of producing castings of readily oxidizable metals, such as magnesium and its alloys, by incorporating in such molding compositions an oxidation inhibitor. The inhibitors used for this purpose may be admixed directly with the molding composition or may be applied in solution or suspension form. The materials that I have found best suited for the purpose at hand are boric acid, sulphur, ammonium compounds, such as ammonium chloride and ammonium sulphate, or mixtures of these.

Accordingly, among the objects of the present invention is the production of an improved molding composition suitable for use in casting readily oxidizable metals such as magnesium and its alloys, the use of such composition further permitting the production of castings having a good surface appearance. Other objects and advantages will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the method and product hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail means and modes of carrying out the invention, such disclosed means and modes illustrating, however, but several of the various ways in which the principle of the invention may be used.

I have discovered that, where pulverized or finely divided carbon is used instead of sand for forming a mold, such mold has a much higher heat conductivity than a similar sand mold. This increased heat conductivity causes the hot readily oxidizable metal being poured into the mold to chill promptly which not only decreases the period wherein rapid oxidation can take place but produces a fine grain structure in the casting which exhibits superior properties as compared with a like casting made in sand. In this connection it is to be noted that carbon is chemically and physically not an equivalent to sand since it is not an oxide; it is combustible and has a much higher heat conductivity than sand. I am aware that graphite, powdered coal, and lampblack have been used as facings and washes for molds used in the casting of iron and steel; however, the problem encountered there is in no way comparable with that encountered in the casting of an extremely readily oxidizable metal, such as magnesium and its alloys, which has to be handled and poured at a temperature whereat it readily ignites and burns.

My improved molding composition, consisting of pulverized carbon, a non-aqueous liquid binder, specifically mineral oil, with or without a plasticizing agent and having incorporated therein an oxidation inhibitor, may be used to form a mold to produce a casting of any desired shape or size, e. g. a crank case for an internal combustion engine or like article, and such mold, if desired, may have incorporated therein cores or metal parts as is well known to the art.

If, with the carbon base molding composition used in making such mold, approximately $\frac{1}{2}$ of 1 per cent to 10 per cent of the boric acid, ammonium compounds, sulphur, or a combination of these or other like oxidation inhibitors be intermixed, a very satisfactory result in the way of a casting is obtained upon pouring the metal into the

mold in the usual manner, it being noted of course that ordinarily unless the casting section is very thin an amount of the above noted agents greater than the minimum stated should be used. For general casting service with such compositions, I have found that 3 per cent of boric acid, or 4 per cent ammonium chloride, or 4 per cent of sulphur admixed therewith will produce castings of readily oxidizable metals that are substantially free from burning and exhibit an exceptionally good surface finish. The use of my present invention is concerned broadly with the treatment of non-aqueous bound molding compositions wherein pulverized or finely divided carbon is a major constituent. As specific examples of such mixtures may be noted the pulverized carbon-oil composition wherein the proportions by weight of the ingredients vary from 75 to 90 per cent for the carbon and 25 to 10 per cent for the oil. In like manner such pulverized carbon-oil composition may include a plasticizing agent (1 to 30 per cent) such as soapstone, or some other suitable silicate such as bentonite. Such pulverized carbon-oil-soapstone composition is equally applicable to treatment according to my invention as is the pulverized carbon-oil composition. While I have given percentage ranges and preferred amounts of oxidation inhibiting agents to be added to the pulverized carbon molding composition I do not wish to be strictly limited to those specific ranges since I have found that as high as 20 per cent by weight of the oxidation inhibiting agent or agents can be used with satisfactory results. I have further noted that where sulphur is used according to the method described as the percentage approaches 10 the casting produced takes on a dark appearance; however, when the percentage of sulphur is increased to 20 the dark appearance almost completely disappears. Even the dark castings, however, when pickled according to common practice exhibit an exceptionally good surface, which shows that the discoloration is not detrimental to the formation of good castings. The castings made with boric acid as the protective agent normally take on a beautiful iridescent color while the ammonium chloride protected castings normally assume a grayish appearance. These castings, however, when pickled or cleaned according to common practice exhibit sound castings having an exceptionally good surface. The following examples show in detail two preferred formulae for my improved molding composition.

Example 1

Where using pulverized carbon and oil alone with the oxidation inhibitor, I have found that very good castings can be made

by using the following composition:—18% medium body mineral oil, 3% of oxidation inhibitor (boric acid, ammonium chloride, ammonium sulphate, sulphur or a mixture of them), 79% carbon (pulverized coke) having the following sieve analysis.—

Percent- age	Mesh
33	40-100
47	100-200
20	Through 200

Example 2

Where using a plasticizer such as soapstone in addition to pulverized carbon and oil, I have found that the following composition produces very satisfactory castings:—13% medium body mineral oil, 10% finely powdered soapstone, 3% of oxidation inhibitor (boric acid, ammonium chloride, ammonium sulphate, sulphur, or a mixture of them), 74% carbon (pulverized coke) having the following sieve analysis.—

Percent- age	Mesh
33	40-100
47	100-200
20	Through 200

In using the above compositions I have found that the castings produced present a very good surface which is substantially free from oxidation, pitting and surface shrinks, and further I have found that the tensile properties, Brinell hardness, fatigue endurance and toughness of such castings are above the average of like articles cast in sand according to current practice.

In using my improved molding composition for casting, a small portion of the volatile liquid binder is gasified and driven off by the hot metal poured into the mold. Likewise a small amount of the oxidation inhibitor is driven off or otherwise lost during the casting operation. After the so poured casting has cooled to a point where it will not ignite or rapidly oxidize when exposed to air, it can be shaken out and the molding composition reconditioned by adding thereto sufficient of the oxidation inhibitor and non-aqueous volatile liquid binder to overcome the losses and place the composition in shape for reuse, it being noted that the other ingredients of the composition will be substantially unaffected by casting conditions. The volatile liquid binder, preferably mineral oil, acts substantially the same in making my improved molding composition "green" and moldable as does water in the conventional water bound green sand molds but without the bad effects encountered due to water or steam giving up oxygen to oxidize the metal.

While I have mentioned pulverized coke as the carbon material used in my improved molding composition I do not wish to be limited to that material since I have found that pulverized gas carbon, coal, and other similar hard high carbon materials can be used in like manner. The term "carbon" will accordingly be understood to broadly cover this class of materials unless otherwise specified. Further, I have found that the sieve analysis of the pulverized carbon may vary considerably from that specifically noted in the foregoing examples, the analysis used depending upon the permeability and bond strength desired.

Other modes of applying the principle of my invention may be employed instead of those explained, change being made as regards the method and product herein disclosed provided the method and product stated by any of the following claims or the equivalent thereof be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. A method of treating a non-aqueous liquid bound carbonaceous mold part to eliminate excessive burning of a readily oxidizable metal such as magnesium and its alloys when cast in contact therewith, which comprises incorporating in such mold part at least one of the materials, boric acid, ammonium salt, sulphur.

2. A method of treating a non-aqueous liquid bound carbonaceous mold part to eliminate excessive burning of a readily oxidizable metal such as magnesium and its alloys when cast in contact therewith, which comprises incorporating in such mold part at least one of the materials, boric acid, ammonium chloride, sulphur.

3. A method of treating a non-aqueous liquid bound carbonaceous mold part to eliminate excessive burning of a readily oxidizable metal such as magnesium and its alloys when cast in contact therewith, which comprises incorporating in such mold part boric acid.

4. A molding composition for casting readily oxidizable metals which comprises a mixture of pulverized carbon and at least one of the oxidation inhibitors, boric acid, ammonium salt, sulphur, and a binding agent consisting of oil.

5. A molding composition for casting readily oxidizable metals which comprises a mixture of pulverized carbon, boric acid, and a binding agent consisting of oil.

6. A molding composition for casting readily oxidizable metals which comprises a mixture of pulverized carbon, boric acid, and a medium body mineral oil binding agent.

7. A molding composition for casting a readily oxidizable metal such as magnesium and its alloys, which comprises a mixture of

pulverized carbon, a plasticizer, at least one of the oxidation inhibitors, boric acid, ammonium salt, sulphur, and a nonaqueous liquid binder.

- 5 8. A molding composition for casting a readily oxidizable metal such as magnesium and its alloys, which comprises a mixture of pulverized carbon, a plasticizer, at least one of the oxidation inhibitors, boric acid, ammonium salt, sulphur, and a binding agent consisting of oil.
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9. A molding composition for casting a readily oxidizable metal such as magnesium and its alloys which comprises a mixture of
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pulverized carbon, pulverized soapstone, at least one of the oxidation inhibitors, boric acid, ammonium salt, sulphur, and a binding agent consisting of a medium body mineral oil.

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10. A molding composition for casting a readily oxidizable metal such as magnesium and its alloys which consists of a mixture of pulverized carbon (74%), pulverized soapstone (10%), boric acid (3%), and a binding agent consisting of a medium body mineral oil (13%).
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