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PROCESS AND COMPOSITION OF MATTER FOR INCREASING THE FLUIDITY OF MOLTEN METAL

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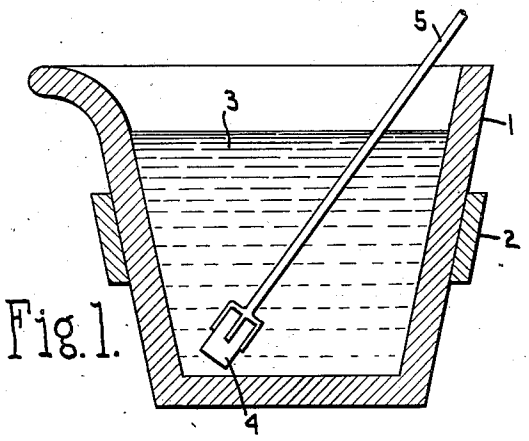


Fig. 1.

Fig. 2.

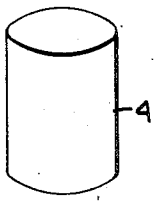


Fig. 3.

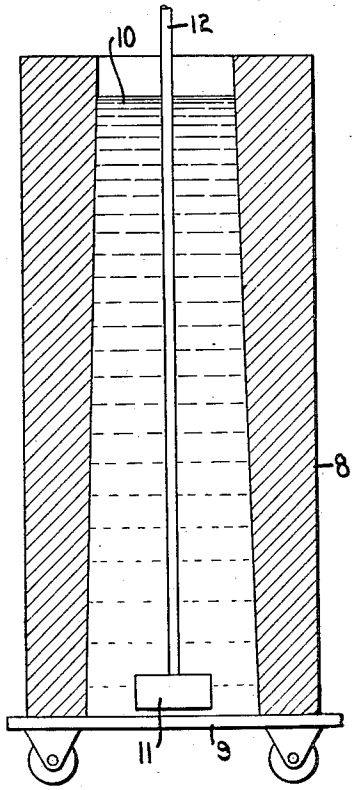


Fig. 4.

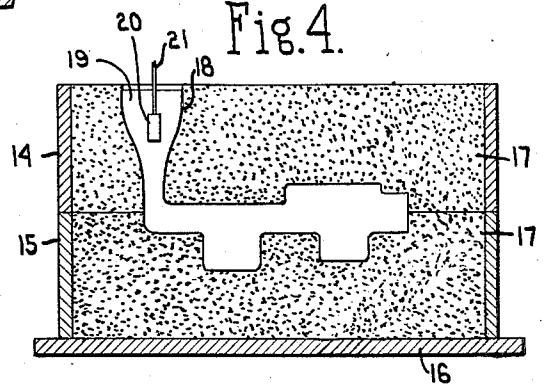
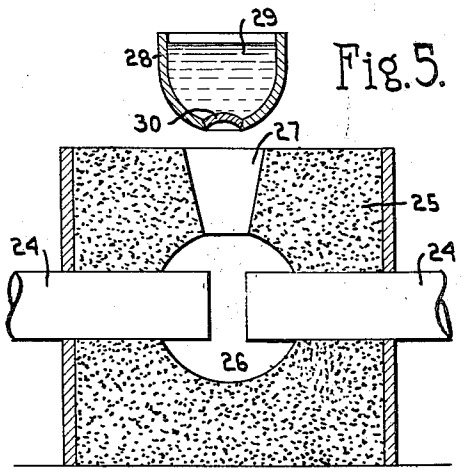


Fig. 5.



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PROCESS AND COMPOSITION OF MATTER FOR INCREASING THE FLUIDITY OF MOLTEN METAL.

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This invention relates to the preparation and casting of metals and alloys and has for its object the improvement of the metals in point of fluidity whereby the casting is facilitated and of physical properties whereby the resulting article is rendered more valuable. For example in the casting of iron and steel it sometimes happens that the metal becomes unduly cool before the pouring is completed, in technical language it becomes "dull." This may occur by reason of delays in pouring the metal from the ladles or may occur in the pouring basins or risers of the molds themselves, particularly where the molds are large and a considerable quantity of metal is required to compensate for the cooling shrinkage which always occurs prior to solidification. One object of my invention is the provision of means to secure a local heating of the metal if and when required and this not only without injuring the properties of the metal but with a positive benefit thereto; other objects are the provision of these means in a convenient and inexpensive form; the provision of means for producing alloys of the kind described in small quantities and without special preparations even where the heating effect is not required; while further objects and advantages of my invention will become apparent as this description proceeds.

The essence of my invention consists in producing inside the molten metal an exothermic chemical reaction whose products melt at such a temperature as not to detract from the fluidity. In practice I preferably utilize the alumino-thermic reaction wherein the heat is generated by the reaction of metallic aluminum on the oxides of metals which are reduced thereby under the surrounding temperature conditions; and I incorporate with this mixture a metal or compound of a metal of such nature as will reduce the melting point of the resulting product to whatever degree may be desired, or will have the desired effect upon its physical properties.

For example in connection with the casting of iron or steel in ordinary foundry practice the alumino-thermic reaction above mentioned is best obtained by inserting into the ladle or pouring basin or riser an iron can containing a mixture of iron oxide and aluminum powder in the desired proportions, together with an igniting charge, in case the temperature of the metal be not great enough to start the reaction. If these materials alone be used, the resulting product, being almost pure iron, will have a very high melting point which will largely offset the advantages of the heat evolved. Therefore I add to this can or charge a metal or metal-compound which will combine with this liberated iron to reduce its melting point. This substance can be either a metal, or an alloy, or a compound which will be reduced to metallic form as a part of the reaction. I prefer boric anhydride for this purpose because this is reduced by the aluminum with evolution of heat and the liberated boron unites with the liberated iron producing an alloy of remarkably high tensile strength and percentage elongation and of remarkably low melting point. Thus the tensile strength of an alloy of iron with 3 per cent of boron and less than ½ per cent of carbon exceeds 50,000 pounds per square inch and its melting point approximates that of cast iron. Smaller proportions of boron produce smaller depressions of the melting point but assist to that extent in connection with cast iron and conform more closely to the conditions encountered in casting steel.

It is not necessary that the boron be added in the oxide form as it can also be used in the previously alloyed condition, for example ferro-boron powdered and incorporated with the mixture. This modification of the procedure is entirely operative but I consider it slightly less advantageous practically for the reason that the ferro-boron is more expensive than the boracic anhydride and the melting of the same abstracts a part of the heat produced by the reaction while the reduction of the boracic anhydride adds heat to the reaction.

Also this invention is not confined to boron alone since any other substance can be employed which will lower the melting point of iron, for example manganese, which, as before, can be used either in the oxide form or as ferro-manganese. However, boron appears to have a larger depressing effect on the melting point of iron than any other material outside of carbon.

This process is not restricted to situations wherein the main consideration is the evolution of heat, but it may be used where a modification of the metal itself is desired.

Thus it is easy with this process to modify a single ladle of molten steel to some special alloy merely by adding to the can or package of active ingredients some other metal or compound such as chromium, chromium-oxide, or ferro-chrome; nickel, nickle-oxide, or ferro-nickel; or any other substance which is to be combined therewith; in all these cases I find it advantageous to employ a proportion of boron in order to reduce the melting point or improve the physical properties.

My invention is also advantageous in cases wherein the alumino-thermic reaction is employed for welding parts together, in order to secure a better correspondence between the melting point and physical properties of the original metal. Thus when two cast iron parts are attempted to be welded together by the use of a mixture of iron oxide and aluminum powder, the solidifying point of the pure iron produced by the reaction is some 300° above the melting point of the cast iron to be welded, which is very likely to result in a poor contact at each side of the weld, added to which the physical properties of the pure iron differ greatly from those of the cast iron. I have discovered that by mixing the alumino-thermic ingredients with boron in a reacting condition as hereinbefore described, the welding operation is facilitated because of the close correspondence in melting points and the ultimate strength of the work is increased because of the close agreement in physical properties.

Neither is this process restricted to use with an alumino-thermic mixture upon an iron base but may be used to advantage with iron-free materials. Thus in the manufacture of "stellite" consisting of cobalt, chromium and tungsten or molybdenum, or of "nichrome" containing only nickel and chromium, or of "Monel metal" consisting of nickel and copper, I find it advantageous to use an alumino-thermic mixture based upon one of the ingredients of the alloy in question together with a proportion of boron either elemental or in a reacting condition, which has the same effect in reducing the melting point as in the case of iron and appears to have no injurious chemical action. In such cases the can is made of a metal which will not injure the bath.

In the preparation of this mixture it is important to use water-free ingredients and while this can be done in many ways I prefer when using boracic anhydride to heat it with the iron oxide thereby simultaneously driving off the water of crystallization, and mixing the ingredients closely together. This produces in effect a very brittle glass which is easily powdered and mixed with the powdered aluminum. The amount of boron or other ingredients employed depends upon the purpose and upon the composition of the surrounding substances. Thus for use with cast iron I prefer to use an amount of boracic anhydride as will afford an amount of boron equal to about three percent of the iron content of the iron oxide, since this affords a eutectic of minimum melting point and very high strength. For use with steel one can use less boron since reduction in melting point is not so important, but at least about ½ of 1 percent is good practice since even this small amount has a material effect in improving the physical properties of the reduced iron. In case it be desired to mix the boron throughout the mass of the surrounding metal a larger proportion should be used, although large improvements in physical properties of steel, and especially such alloy steels as those of nickel or chromium, are obtained with as little boron as $\frac{1}{10}$ percent of the whole. It is used in approximately the same proportion in company with nickel, chromium, etc.

In the drawings acompanying and forming a part of this application I have illustrated diagrammatically certain of the uses of my invention and the steps in its performance. In this drawing Fig. 1 is a sectional view of a ladle showing the mode of treating the same when the metal becomes chilled or "dull"; Fig. 2 is a view of a simple can or package of my improved material; Fig. 3 illustrates the mode of making alloy steel in an ingot mold by the use of my improvements; Fig. 4 illustrates the mode of employing my invention for keeping the metal liquid in a mold riser; and Fig. 5 illustrates one mode of employing my invention in connection with welding two parts together.

In Fig. 1, 1 represents the body of a ladle which may be of any suitable size, and 2 the metal support by which it is carried. 3 represents the molten metal inside the ladle, 4 a metal container (preferably of the same composition as the predominant metal in the ladle) and containing my improved mixture, and 5 represents a metal rod by means of which the container is introduced into the molten bath and held there until the reaction is complete or at least well started. For example, in connection with the casting of iron, the rod is made of steel or wrought iron, and the container 4 is a sheet iron can.

In Fig. 3, 8 represents the side wall and 9 the bottom of an ingot mold filled with molten metal 10, and 11 represents the canister of ingredients which is introduced and held down by the rod 12. When the metal is steel, this rod is usually melted off during the reaction.

In Fig. 4, 14 represents the cope, 15 the drag, and 16 the base-board of a common sand-mold whose parts are represented at

17—17. 18 represents the sprue or riser which is hollowed out at the upper end to form a pouring basin of sufficient size to hold a considerable amount of molten metal 19. 20 represents a small can of my improved material introduced therein by means of a rod 21 for the purpose of heating this metal locally, and keeping the same fluid so it can flow into the mold as the metal therein contracts.

In Fig. 5, 24—24 represents two metal-members which are to be welded together. 25 represents the mold formed there around and providing a cavity 26 having a pouring hole 27, and 28 represents a crucible supported there above for the reception of the reacting mixture 29, the crucible having a tapping hole 30 at the bottom which is broken open at the proper time to permit the discharge of its contents into the mold space.

It will be understood that my invention comprehends the introduction of my temperature modifying material into the reacting mixture, regardless as to whether the reaction itself is to occur inside of a molten body of metal as shown in Figs. 1, 3, and 4 or in a separate container which is discharged into the point of use as in Fig. 5; and also regardless whether it is employed for reheating uniformly a mass of metal as in Fig. 1, or heating locally a portion of the mass of metal as in Fig. 4, or modifying the characteristics of a mass of metal regardless of the heating effect as in Fig. 3, or for any other purpose to which the same may be applicable. It will also be understood that whereas it is best to employ such an amount of the added material as will cause the melting point of the evolved metal to conform closely to that of the metal with which it is used, whether the same be already molten as shown in Fig. 4 or already solid as shown in Fig. 5, I do not limit myself thereto since some benefit is obtained by even smaller depressions of the melting point, and certain advantages are also obtainable by over-depression of the melting point. Accordingly I limit myself in no wise except as recited in the claims hereto annexed or required by the prior state of the art.

Having thus described my invention, what I claim is:

1. A composition of matter for the purpose described containing powdered aluminum, an oxygen compound of boron, and the oxide of a metal which is reduced by aluminum and which also alloys with boron.

2. A composition of matter for the purpose described containing powdered aluminum, the oxide of one or more metals capable of being reduced by aluminum, and boracic anhydride.

3. A composition of matter for the purpose described containing powdered aluminum mixed with the oxides of iron and boron.

4. A composition of matter for the purpose described containing powdered aluminum, an oxide of a metal which is reduced by aluminum and a compound of boron containing an amount of boron amounting to between about ½ percent and 4 percent of that of the metal to be reduced.

5. The process of increasing the fluidity of molten metal which consists in introducing therein a mixture of aluminum powder and an oxide of the first mentioned metal, together with the oxide of boron to form a eutectic therewith.

6. In the art of casting, the improvement which consists in increasing the fluidity of the metal in the pouring basin by introducing therein a mixture of the oxide of that metal with boracic anhydride and enough powdered aluminum to reduce both oxides.

7. The process of improving the properties of ferrous metal which consists of introducing into the same when molten a mixture of powdered aluminum and the oxide of such metal together with oxide of boron.

8. The process of reviving of dull melts of ferrous metal which consists of introducing therein an intimate mixture containing powdered aluminum and an oxide of a metal which is reduced by aluminum, and a compound of boron in a reacting condition, whereby the heat evolved may increase the temperature and the eutectic iron-boron alloy may increase the fluidity.

9. The process of producing ferrous metal castings which contains the steps of first making an intimate mixture of powdered aluminum, an oxide of a metal which is reduced by aluminum, and boric anhydride, second melting the ferrous metal and third introducing said mixture therein.

In testimony whereof, I hereunto affix my signature.

ALADAR PACZ.