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MOLD CHILL

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This invention relates to the art of making molds, or parts thereof, of sand or similar material that will make a frangible mold or mold part, and it is especially concerned with providing chills for said molds or parts.

In making castings in sand molds or molds containing sand cores, it is well recognized that the molten metal freezes relatively slowly in such molds as compared to the rate of freezing in all metal molds. In making some castings the rate of freezing is important, and the slow freezing which normally occurs in a sand mold or in contact with a sand core must be increased in order to avoid shrinkage, reduce the grain size, and/or to increase the surface hardness of the casting. To thus hasten the freezing rate in portions of the mold, it has been a common practice to embed blocks of metal in the sand mold or core. Such blocks of metal are referred to in the art as chills. The quantity of heat that any chill will absorb and the rate at which the heat is absorbed constitute what is herein referred to as chilling effect. When castings are made that have a complicated shape and must be chilled in certain parts, it is frequently necessary to provide specially shaped chills to conform to the contour of the casting. Such special chills are obviously expensive to make and maintain, to say nothing of the labor involved in positioning them in the mold. In some cases where chills have been desired, it has been physically impossible to use blocks because of the size or location of the chill. This situation has led me to devise a new type of chill which can be molded to fit any desired contour or location as the mold or core is being made, the principal object of my invention being the provision of a chill which is not only initially moldable but which will provide a chill that performs the same function as the conventional type of metal block chills used heretofore. A particular object is to provide a moldable chill mixture for use in making baked sand cores to be employed in making light alloy castings.

My invention is predicated upon the discovery that a composition comprising an intimate mixture of small metal pellets, finely divided graphite, and a suitable binder is readily moldable, when properly tempered, prior to placement in a mold or core made of sand or similar material and yet can be hardened, if desired, at room temperature or at an elevated temperature, depending upon the character of the binder, with the result that a firm chill body is produced which will not crumble in contact with the molten metal in the mold and possesses a greater chilling effect than

the same mixture without graphite. By means of such a composition it is possible to use chills of varying size at any place in a sand mold or core, particularly in locations where block chills cannot be employed such as in thin sections or tortuous passages, and also to make the chill body conform to the shape of the casting to be made in the mold. In some instances it may even be desirable to make an entire core of the chill mixture. In no event, however, does molding sand form a part of the mixture because it reduces the chilling effect too greatly. The selection of the correct amount of chill for a given portion of a casting can be readily determined by the foundryman. After the casting has been formed in the mold, the chill, together with the sand, can be readily broken away in the usual manner. This is especially important in the removal of sand cores. The moldable mixture containing metal pellets, graphite, binder and tempering medium may be referred to for purposes of convenience as a green chill mixture while if the binder is of the hardening type, the resulting chill body may be referred to as a hardened chill mixture. The improved chill which I have devised may be said to be characterized by its initial moldability, i. e., its adaptability to being shaped during the usual molding operations, its capability of being hardened, if desired, and a chilling effect similar to that of the metal blocks heretofore employed, said chilling effect being greater than that of the same mixture without graphite.

By a chilling effect similar to that of metal block chills, I mean that the chill composition herein described and claimed reduces the grain size and shrinkage of the casting in the region where the chill is employed as compared to the condition prevailing when no chill is used. In some cases the chilling may also cause an increase in the surface hardness of the casting. The term, harden, as used herein refers to the loss of moldability and setting of a green chill mixture through evaporation of all or part of the tempering medium or through a change in the binder, or both, which occurs naturally on standing exposed to the atmosphere or by exposure to an elevated temperature prior to the time that the casting is poured in the mold. The expression, chill mixture, without reference to greenness or hardness covers the chill mixture in both conditions.

Although the chill mixture herein described is adapted for use in molds and cores employed in the casting of a large variety of metals and alloys, I have found it to be especially useful in making

castings of light metals, particularly those of magnesium and magnesium base alloys. In the last named instance I prefer to use a mixture of iron pellets, graphite, and a synthetic thermosetting resin binder for the hardening type of chill, and iron pellets, graphite and bentonite for a non-hardening chill. The molds and cores where the chill mixture is used are generally made of sand or similar material. The molds may be of either the green or dry type, but the cores are usually baked prior to use. The baked cores may be employed in so-called permanent molds as well as in sand molds, but use in a permanent mold does not eliminate the necessity for having chills in the cores in making certain castings. The term, sand, as used herein is intended to cover not only sand itself but also its equivalents.

The metal portion of the chill mixture should consist of metal pellets which will not fuse at the temperature of the molten metal being cast in the mold. A variety of metals may generally be so employed, but for practical purposes a cheap metal having a high and rapid heat absorbing capacity will generally be preferred, such as iron or copper. Another consideration which affects the selection of the kind of metal pellets employed in certain instances is the readiness with which the pellets will alloy with the molten metal in the mold if the two come into metal-to-metal contact. Such alloying is to be avoided or minimized. This condition rarely arises, however, where graphite is mixed with the pellets because of interference with metal-to-metal contact.

The metal portion of the chill mixture constitutes the largest part thereof, at least 75 per cent of the total weight being made up of metal pellets, but at least 90 per cent is employed in my preferred practice. The size of the metal pellets has an important bearing upon their utility. I have found that if the pellets are larger than 30 mesh that they are not satisfactorily held in place by the usual binders, and they also tend to produce a rough surface on the casting. On the other hand, if the pellets are smaller than 150 mesh, a large part of the chilling capacity of the chill is lost and the disadvantages of metal dust or powder are encountered. I have also found that the best results are obtained by using substantially spherically shaped bodies of metal. Pellets of the foregoing size and shape are frequently referred to as shot. The term, pellet, as herein employed, however, is intended to describe rounded and substantially spherical bodies and includes metal particles of 30 to 150 mesh size known in the trade as grit.

Although pellets of a single mesh size may be used in a chill, better results are obtained if two or more mesh sizes are employed. For example, a combination of 40 and 60 mesh pellets are better than 40 or 60 mesh pellets used separately. In some instances it is advantageous to use three mesh sizes of pellets, for example, 40, 60, and 90.

The graphite component of the mixture is unique in that it increases the chilling effect of the metal pellets. Although graphite by itself has a chilling effect greater than that of the usual molding sand, yet this effect is less than that of the common metals used for chilling purposes, namely, copper and iron. On the other hand, a given mass of metal pellets alone does not have the chilling effect of a mixture of graphite and metal pellets. The graphite appears to increase the rate at which heat is absorbed by the metal

pellets. Graphite is unique among the substances which I have examined in this respect. The combination of metal pellets and graphite produces a true synergetic result for neither component by itself is able to accomplish the effect produced by the combination. The increased chilling effect is manifested in the casting by a greater reduction in shrinkage, a finer grain size, and in some cases a harder surface than is found where graphite is omitted from the chill mixture.

In practice, from 1 to 10 per cent of finely divided graphite such as the flake or amorphous variety is added to the mass of pellets and the two are stirred together. A convenient means for mixing the two is a muller. In my preferred practice substantially all of the metal pellets are thus coated with some graphite, thus producing a mixture having a very uniform chilling effect. In making chills for casting light metals, especially magnesium alloys, I prefer to use from 1 to 5 per cent graphite with iron pellets.

In addition to promoting the chilling effect of the metal pellets described hereinabove, I have found that the graphite also serves as a green binder of the metal pellets, i. e., a binder which is operative in the chill mixture prior to drying. This effect of the graphite does not, however, obviate the necessity for using other binders mentioned hereinbelow.

The binder portion of the mixture may consist of any of the common green or dry binder materials on the market so long as the chill mixture has the desired degree of cohesion and resistance to crumbling when exposed to the molten metal in the mold. A further restriction on the choice of binder is that in cores it should not yield enough gas during the casting operation to form blow holes. Although thermosetting synthetic resins find some application in green sand molds, they are especially useful as binders in my chill mixture when used in baked sand cores because a smaller quantity is needed to hold the metal pellets in place than where other types of binders are employed, and they produce but a very small amount of gas in the mold. This relative freedom from gas production is highly important in making castings of metals which are sensitive to gas, for example, magnesium base alloys. In general, from 0.5 to 3 per cent by weight of the chill mixture may consist of the synthetic resin. Where other types of binders are used in either green sand molds or cores, from 0.5 to as much as 5 or 6 per cent may be required to obtain the necessity bond. For chills in green sand molds it is generally preferred to use a non-hardening binder of the bonding clay type such as bentonite.

A large number of thermosetting resins are on the market and are satisfactory for use as a binding material. It has been my experience that at least one substance of the group consisting of the urea formaldehyde and phenol formaldehyde types gives the best results.

In making up a green chill mixture it is advisable to first mix the pellets and graphite as mentioned hereinabove. The binder and tempering medium may then be added in proper proportion. Where a thermosetting resin is employed, the dry material may be added to the metal-graphite mixture and thoroughly mixed therewith, or the resin may be mixed with water or other tempering medium to produce a fluid and then the fluid mass is added to the dry metal-graphite mixture. Where the dry resin is first added to the metal-graphite mixture, the

water or other tempering medium is subsequently introduced and the whole mass then worked to the proper consistency. The amount of tempering medium employed is generally limited by the degree of plasticity desired in the green chill mixture, a large amount tending to produce a more fluid mass. The exact consistency to be used in any given case will be determined by the nature of the mold and the intricacy of the casting. Water or other aqueous or non-aqueous tempering media may be used, depending on the kind of binder and character of mold being used.

In making green chill mixtures containing iron pellets, it may be desirable to use certain solutions in place of water as a tempering medium to prevent rusting. Two such media are dilute aqueous solutions, containing 1 per cent of potassium dichromate or 1 per cent potassium permanganate. Other rust or corrosion inhibitors may be employed, of course, the choice in any case depending on the metal composing the pellets and the conditions favoring corrosion.

Once the green chill mixture has been prepared, it can be placed in the mold next to a pattern or in the core box, and the remaining sand which constitutes the mold or core can be placed behind the chill and the whole mass rammed in the usual manner. In cases where dried sand cores are to be made, the same molding procedure may be followed, but the green cores are baked in order to give them the required strength and freedom from moisture in the final mold. The hardenable chill mixture herein described has been found to be particularly useful in making dried sand cores for molds in which magnesium base alloys are cast. The reference herein to light alloys is intended to include both aluminum and magnesium and the alloys in which these metals predominate.

Minor amounts of other substances than those enumerated hereinabove may be present in the chill mixture either as impurities or as intentionally added components. For example, where magnesium alloys are being cast, especially when the chill is not baked, it is necessary to include such well known oxidation inhibitors as boric acid and/or diethylene glycol in the mixture in amounts, for example, of 0.5 to 3 per cent by weight of the mixture. The added components should not, in any event, materially reduce the chilling effect of the mixture, nor should they adversely affect the moldability of the green mixture. Molding sand, however, should be excluded from the chill mixture because of its adverse influence upon the chilling effect. In referring to the chill mixture in the appended claims as being substantially composed of metal pellets, graphite, a binder, and a tempering medium, it is intended that other substances of the kind just enumerated shall not be excluded so long as the essential characteristics of the mixture are retained.

An example of a chill mixture which gives satisfactory results in the casting of magnesium alloys is one consisting of 300 pounds of iron pellets of equal parts of 40, 60, and 90 mesh sizes, 1.75 pounds of urea formaldehyde resin, 1.75 pounds of phenol formaldehyde resin, 7 pounds of graphite, and enough 1 per cent potassium dichromate aqueous solution to temper the mass. Another example of a successful chill mixture is one wherein 3.5 pounds of phenol formaldehyde are used in place of the foregoing phenol formaldehyde-urea formaldehyde combination. In some cases where an exceptionally smooth sur-

face is required, the 40 mesh pellets should be replaced by an equal quantity of 90 mesh pellets. In both cases the iron pellets should be coated with graphite by mixing the two materials in a muller. Both mixtures are especially useful in making hardened chills for baked sand cores and have produced a chilling effect in practice which was adequate for the purpose, and was superior to that obtainable from chill mixtures containing no graphite.

An example of a suitable chill mixture for green sand molds is one consisting of 150 pounds of 60 mesh size iron pellets, 150 pounds of 90 mesh size iron pellets, 6 pounds of bentonite, 12 pounds of graphite, and enough 1 per cent potassium dichromate aqueous solution to temper the mass.

The effectiveness of the foregoing chill mixtures was gauged by their behavior in making commercial castings with respect to reducing grain size and shrinkage.

I claim:

1. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a binding material and a tempering medium, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

2. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a clay bonding material and a tempering medium, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

3. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a synthetic thermosetting resin and a tempering medium, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

4. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, at least one substance of the group consisting of the urea formaldehyde and phenol formaldehyde type of resins and a tempering medium, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

5. A chill mixture containing at least 75 per cent by weight of at least two different sized metal pellets within the range of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a binding material and a tempering medium, said mixture being characterized by

being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

6. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, said graphite coating substantially all of the metal pellets, a binding material and a tempering medium, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

7. A chill mixture containing at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a binding material and a tempering medium containing a corrosion inhibitor, said mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

8. In combination with a sand mold the chills comprising a mixture of at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a binding material and a tempering medium, said mixture being characterized by having a chilling effect sufficient to reduce the grain size and shrinkage in the casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

9. In combination with a mold, a core having chills therein comprising a mixture of at least 75 per cent by weight of 30 to 150 mesh size metal pellets, from 1 to 10 per cent of finely divided graphite, a binding material and a tempering medium, said mixture being characterized by having a chilling effect sufficient to reduce the grain size and shrinkage in the casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

10. A chill mixture for casting magnesium base alloys consisting of at least 75 per cent by weight of 30 to 150 mesh size iron pellets, from 1 to 10 per cent of finely divided graphite, from 0.5 to 3 per cent of a synthetic thermosetting resin, from 0.5 to 3 per cent of an oxidation inhibitor, and a tempering medium containing an iron rust inhibitor, said chill mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

11. A chill mixture consisting of at least 75 per cent by weight of at least two different sizes of 30 to 150 mesh size iron pellets, from 1 to 10 per cent of finely divided graphite, said graphite coating substantially all of the iron pellets, from 0.5 to 3 per cent of a synthetic thermosetting resin, and a tempering medium containing an iron rust inhibitor, said chill mixture being characterized by being moldable in its green condition, and having a chilling effect sufficient to reduce the grain size and shrinkage in a casting in the region of the chill as compared to the condition prevailing in the absence of said chill, said chilling effect being greater than the effect of the same mixture without graphite.

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