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METHOD FOR ELIMINATING HOT TEAR CRACKS IN CASTINGS

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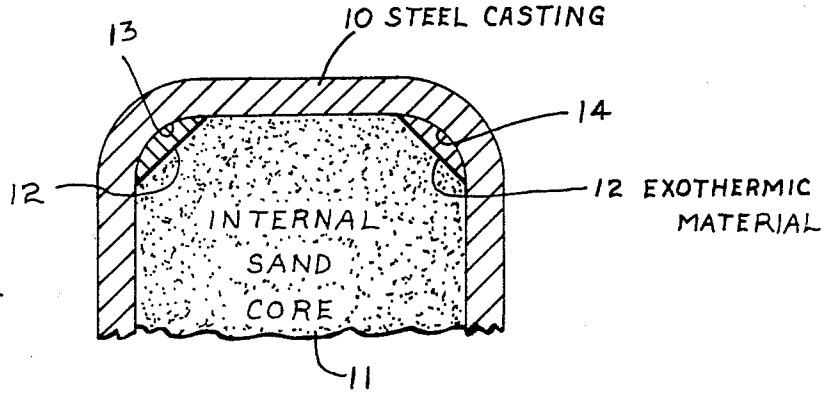


FIG. 1

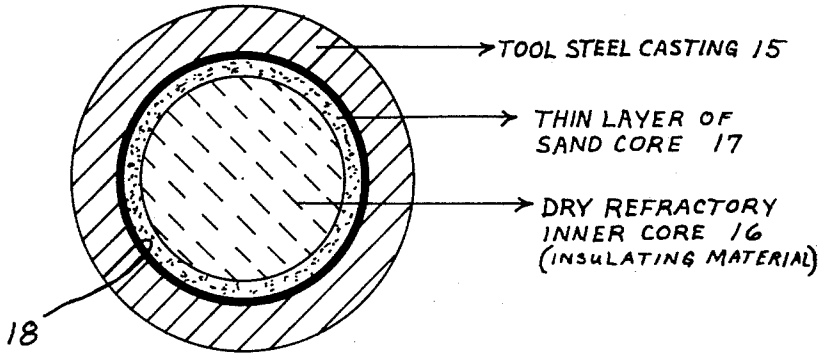


FIG. 2

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METHOD FOR ELIMINATING HOT TEAR CRACKS IN CASTINGS

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Int. Cl. B22d *19/00*

ABSTRACT OF THE DISCLOSURE

High quality castings having recessed portions cast about a core having means to maintain the recessed portions longer at a higher temperature than the balance of the castings by application of additional heat to such recessed portions, such heat being supplied by a layer of exothermic material on the surface of the core. Alternatively to addition of heat, the heat of the recessed portions of the castings is retained for a longer period of time than the heat of other portions of the castings by use of a heat insulating core.

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to the production of higher quality castings by eliminating a casting defect known as hot tear cracking a condition in which the surface of the casting splits or cracks leaving open grooves or furrows in the casting surface.

It is generally agreed that hot tear cracking occurs in the hotter, weaker areas of the casting and at a critical temperature depending on the chemistry and the stress imposed on the hotter, weaker areas by the other sections of the casting which are contracting during cooling; depending upon existing conditions of individual castings, this critical temperature usually occurs at the time of development of liquid film during the process of solidification.

The occurrence of hot tearing in castings has been a constant problem of foundries required to produce and deliver high quality crack-free castings. When hot tearing cannot be eliminated, it is generally removed by grinding and welding at a highr cost of foundry time.

It is therefore, the object of this invention to eliminate hot tear cracking in high quality castings with a substantial savings in cost and time.

This object is generally accomplished by control of metal temperature in the areas of the casting which are prone to hot tears, by keeping these areas well above the solidus temperature while the balance of the castings which imposes the stress is undergoing a high percentage of contraction. Specifically, the desired result is obtained by using an exothermic material or a refractory insulating material both designed to keep the so-called weaker area at a higher temperature during contraction and solidification of the balance of the casting and with no harmful effect to any part of the casting.

The application of this treatment is shown diagrammatically in the drawing in which:

FIGURE 1 is an illustration in cross section of the use of an exothermic material in the areas prone to hot tearing; and

FIGURE 2 is an illustration in cross section of the use of an insulating material as the inner core of the mold.

In the drawing, with particular reference to FIGURE 1, there is shown a steel casting **10**, an internal sand core **11** vented in the usual manner (not shown) with exothermic material **12** padding the corners **13** and **14** of the mold. The exothermic material is placed in the areas where hot tear cracking is most likely to occur and supplies the additional heat necessary to maintain these weaker areas above the solidus temperature while the balance of the casting is exerting a stress thereon during the solidification period. This exothermic padding material on contacting the molten metal is ignited and heats to a temperature greater than 3000° F. and this heat input to the adjacent metal keeps the temperature in the area or at the interface of the padding material above the critical temperature at which the hot tear occurs.

FIGURE 2 shows a tubular tool steel casting **15** having dry refractory insulating material **16** for an inner core with a thin layer sand core **17** therebetwen. In this casting the core would not be vented to carry off accumulated heat and the retention of heat by the insulating material is the means of supplying the heat necessary to keep the area prone to hot tear cracking, namely the inner periphery **18** of the tubular casting **15**, above the solidus temperature during the solidification and contraction of the balance of the casting in the cooling period.

There are castings of difficult shapes which are particularly conducive to hot tearing, such for example, as alloy steel cradles. Such a casting has internal angles which create natural hot spots the heat from which is normally rapidly dissipated through the adjacent core material. The thin walls required and the necessary large core provide casting configurations contributing to hot tearing due to core restraint. The reason for this is that the internal radii during cooling does no have sufficient ductility at higher temperatures to resist the strain imposed on it by the contracting metal of the balance of the casting and the large core hinders the required total contratcion of the cooling metal.

The treatment of this invention was applied to castings of a 350 lb. alloy steel cradle as follows:

The molds employed were of green sand, AFS fineness No. 60–70 and were well vented to assist in exhausting gases generated by the padding material which were not removed through the core vents; the basic core was a cold setting resin core mix which was hollowed out and filled with a weak bedding sand and properly vented; a one-eighth inch thickness of exothermic padding was placed in the radii area during the making of the basic core which was then baked at 400° F. (204.4° C.) for eight hours and after cooling was covered with two coats of a proprietary zircon wash; utilizing a 5500 lb. electric induction furnace charged with 75% cold scrap, when the contents were molten, a chemical analysis from a vacuum spectrometer determined the required amounts of pig, ferrochrome and ferromolybdenum to be added, to ensure a time boil; before tapping the furnace, ferromanganese and ferrosilicon were added; the contents of the furnace were tapped into a preheated ladle at 3075° F. (1691° C.) and deoxidized with .10% aluminum in the ladle; the molten material at a temperature of 2975° F. (1635° C.) was poured into six molds with the pouring time of one mold being 45 seconds; these cradle castings were heat treated by normalizing at 1650° F. (989.9° C.) for four hours, austenized at 1600° F. (871.1° C.) for three hours, quenched in oil and tempered to obtain the desired physical properties.

No evidence of hot tearing of these castings utilizing the exothermic padding material in the radii area could be detected by the magnaflux inspection.

Chemical analysis of the casting surface, to detect possible casting contamination from the exothermic material, revealed that there was no evidence of chemical pick-up from the padding material which would decrease the quality of the casting.

Physical properties were also tested from the radius area of a heat treated casting which employed a core with exothermic material and from other areas of the same casting which were not in contact with the padding mate-

rial, and there was no evidence of the physical properties of the casting being lowered by the use of the padding material.

The results from over 100 castings show that controlled use of exothermic material will definitely eliminate hot tearing and reduce excessive casting repair which averages six hours of foundry time per casting.

This procedure, which has been utilized to eliminate all external hot tearing in the radii of 350 lb. steel alloy cradle castings, has also been employed successfully on 1200 lb. alloy steel breech ring castings.

What is claimed is:

1. A method of eliminating hot tear cracks in castings having recessed portions comprising, casting a metal around a core padded with an exothermic material in areas prone to hot tear cracks and cooling said casting while said padded areas are maintained longer at a higher temperature than the balance of said casting by additional heat supplied by the ignited exothermic material whereby the solidified casting is entirely free of hot tear cracks.

2. A method of eliminating hot tear cracks in high quality castings having recessed portions comprising, casting a metal around a core padded on its exterior surface with an exothermic material in areas adjacent to portions of the castings which are prone to hot tear cracks and cooling said casting while said padded areas are maintained by the ignited exothermic material above the solidus temperature during the stress imposed by the contraction of the balance of the casting whereby the solidified casting is entirely free of hot tear cracks.

3. A method of eliminating hot tear cracks in high quality metal castings having recessed portions comprising, utilizing a sand core for a casting, padding the core on its exterior surface adjacent recessed areas of the casting prone to hot tear cracking with a thin layer of an exothermic material, casting the metal around the padded core and maintaining during cooling said prone areas above solidus temperature by additional heat supplied by contact of exothermic material with the cast metal during the contraction of the remainder of the casting whereby all areas of cast metal are entirely free of hot tear cracks.

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