

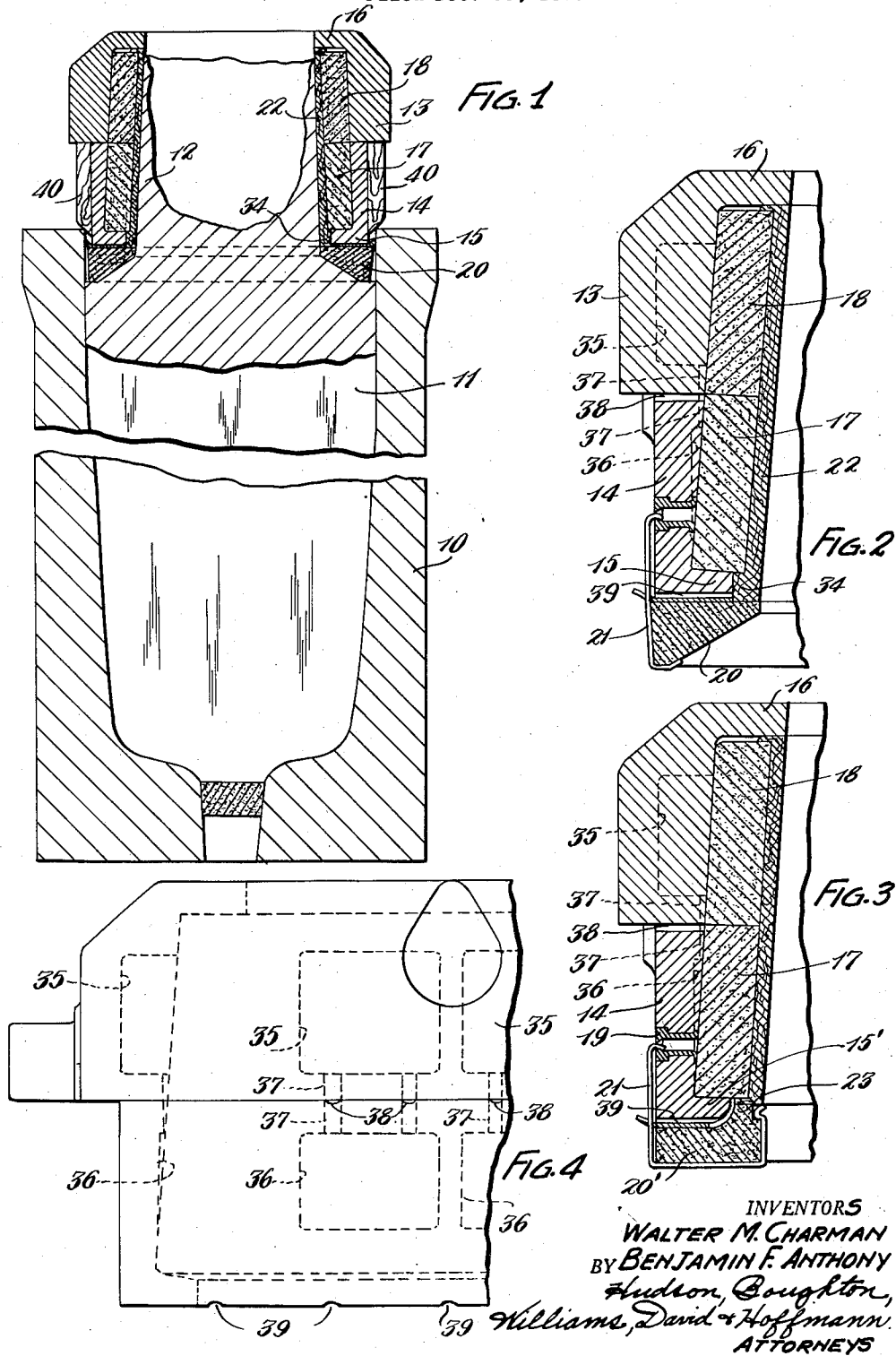
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HOT TOP FOR INGOT MOLDS

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HOT TOP FOR INGOT MOLDS

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This invention relates to improvements in hot tops for ingot molds, and has reference particularly to a method and means for hot topping in a highly efficient manner in order to reduce to a minimum the percentage of waste metal in the sinkhead as compared to that of good metal in the ingot proper.

The conventional composite hot top comprises a cast iron casing lined with first quality fire brick blocks. Such bricks have a higher softening temperature than the temperature at which molten steels are poured, namely 2700° F. to 2950° F. They possess thermal shock resistance of an acceptable order to withstand, first, the considerable shock attendant upon filling the hot top when molten steel comes into intimate contact with the relatively cold brick lining and second, when the hot top, the face of whose brick lining may be at a temperature as high as 2400° F., is stripped off the sinkhead and cold air rushes up through it to wipe these very hot surfaces. These brick also possess good mechanical strength to withstand the abuse given a hot top upon stripping and handling. When a crane pulls a hot top off a sinkhead it is rare that a straight up axial lift is achieved, consequently any cocking action must be resisted by the brick lining.

The heat losses for a hot top employing fire bricks of the first quality grade are considerable due to their high thermal conductivity and their high heat capacity. These high losses must be supplied by enough molten steel to insure adequate feeding of the molten metal needed for the shrinkage cavity of the solidifying ingot. Depending on the type of steel, its pouring temperature and several other factors, a hot top must have a capacity approximating 15 percent of that of the combined mold and hot top volumes. Only about 4 to 6 percent of the combined volumes is necessary to feed and insure ingot soundness. Hence the balance of 9 to 11 percent represents waste, loss or scrap and is an item which every steel plant is trying to reduce. Any reduction so accomplished is the equivalent of adding additional steel manufacturing capacity which today is of utmost importance to our military and civilian economies.

Various expedients have been devised to reduce the amount of steel necessary to produce a sound ingot and to keep the reduced amount molten for satisfactory feeding. These include playing gas flames or electric arcs on the top surface of the ingot, exothermic reactions in the hot top, special hot top constructions and special refractory materials. The benefits attendant upon these expedients have been limited by operating and economic considerations, and as a result the great bulk of hot topping is being done today as it was twenty years ago.

In this invention we substitute for the conventional fire brick linings a lining composed of insulating fire brick. These brick depend for their insulating qualities upon high porosity caused by burn-out material incorporated in the mix and burning upon firing of the brick. They are light in weight and quite fragile. They are also

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more expensive than first quality fire brick. They are made in various grades, those having the best insulating qualities being adapted for use at top service temperatures very much less than the pouring temperature of steel. Such brick will not withstand the mechanical abuse nor the penetration of their porous structure by liquid metal or slag phases as will the usual lining of first quality fire brick. Protective washes have proved ineffective because such protection hardens to greater strength than the brick structure and then upon rapid heating and cooling, differential dimensional movements will shear through the weaker structure of the porous insulating fire brick.

We have found that by providing a single use protective veneer of the proper thickness we are enabled to employ insulating fire brick as a semipermanent lining for hot tops with good life characteristics. We prefer to employ an intermediate grade of insulating fire brick having better strength than the maximum insulating grade, but with heat conductivity about one-third of that of first quality fire brick. By the use of such insulating brick, protected in accordance with our invention, the amount of steel poured in the hot top in excess of the amount necessary to feed piping of the solidifying ingot can be cut by one-third.

The thickness of the protective veneer is such that the temperature gradient across it will prevent the temperature of the internal face of the insulating fire brick from going above its rated maximum. Such thickness is of the order of one-half inch, that is to say on hot tops of average size under normal conditions for best results a one-half inch veneer is required. For large hot tops a somewhat greater thickness of veneer is desirable. Furthermore the veneer thickness will necessarily vary somewhat in different parts of the same hot top because of the human element of the workman or the inexactness of the action of the mechanical equipment employed for the purpose of applying the veneer. Also the safe working temperature of the particular brick used in the semipermanent lining (which is to be protected), is a factor which affects the selection of veneer thickness.

Due to the falling temperature gradient across the protective veneer, a grade of insulating brick can be selected whose service temperature limit is below the pouring temperature of the steel and hence make use of the added insulating properties and lower heat capacity without sacrificing life of the brick. Veneer of this thickness is more than sufficient to prevent molten steel from contacting the insulating fire brick, and is of such nature as to permit easy stripping of the hot top from the sinkhead. Furthermore, it easily absorbs any mechanical forces imposed by misaligned stripping.

One of the objects of the invention is the provision of a method and means for hot topping which shall reduce the amount of the metal of the sinkhead and correspondingly increase the percentage of good ingot metal in proportion to the total metal poured.

Another object is the provision of a hot top in which insulating fire brick are employed but are protected in such a way against thermal shock and mechanical shock that their life compares favorably with the life of conventional fire brick linings.

A further object is the provision of means for exhausting through the casing wall gases and water vapors generated in the veneer covering and passing through the pores of the insulating fire brick lining.

Other objects and features of novelty will appear as we proceed with the description of those embodiments of the invention which, for the purposes of the present application, we have illustrated in the accompanying drawing, in which

Fig. 1 is a vertical sectional view through an ingot and ingot mold and a hot top embodying our invention, and showing a sinkhead with a relatively thin shell, such as results from the practice of the invention.

Fig. 2 is a fragmental vertical sectional view of the hot top on a larger scale.

Fig. 3 is a view similar to that of Fig. 2 showing a modified form of hot top, and

Fig. 4 is a fragmental external elevational view of the hot top casing.

In the drawing we have illustrated at 10 a big end up mold for the casting of killed steel ingots. The figure shows an ingot 11 therein, having a sinkhead 12 of relatively low mass such as results from the practice of the invention. The hot top comprises a casing of cast iron or the like which may be cast in one or a plurality of sections, upper and lower sections 13 and 14 being illustrated. Any suitable means for holding the sections together may be employed.

Casing section 14 has an inturned bottom ledge 15 extending entirely around the hot top, and section 13 has an upper inturned rim 16 also extending entirely around the hot top. A semipermanent lining is supported on the ledge 15 and extends upwardly to a point just beneath the overhanging rim 16. This lining as illustrated in Fig. 1 consists of a lower course of insulating fire brick 17 and an upper course of insulating fire brick 18. These bricks are designed and made to fit the inner surfaces of the casing walls. The inner faces of the bricks are inclined inwardly and upwardly in planes meeting the rim 16 of the casing somewhat back from the edge of the rim, the distance being preferably of the order of one-half inch in the case of hot tops of average size.

Beneath the ledge 15 of the casing there is a refractory bottom ring 20 intended for a single use, this ring being flat on its upper surface and preferably having an inclined lower surface as shown in Figs. 1 and 2. Such a ring is known as a tapered ring and has advantages in that it forms a tapered shoulder on the ingot. A somewhat different bottom ring such, for example, as that shown in Fig. 3 at 20', may be employed however without departing from the spirit of the invention. The ring 20 or 20' extends inwardly beyond the ledge as illustrated in the drawing. It is supported by means adapted to fail when the hot metal is poured or when the hot top is stripped from the ingot. Such means may consist of a plurality of wire clips 21 having lower bent ends gripping the ring and upper hooks engaged in replaceable socket members 19 mounted in the casing section 14. When the hot top is stripped from the ingot the clips 21 break or pull out of the sockets 19 and the ring 20 or 20' remains behind on the ingot.

In preparing the hot top for use the casing with its lining blocks 17 and 18 is placed in a suitable cradle and inverted. Ring 20 or 20' is put in place and fastened with the clips 21. Then a moldable refractory veneer 22 is applied to the lining. This veneer should have low heat conductivity. It may have a siliceous base and may contain organic particles such as sawdust which add to its insulating qualities, and a binder. Exothermic materials may also be included. This veneer is of such physical characteristics that it has a single heat life, this phrase as hereinafter employed signifying that it cannot withstand exposure to the heat of more than a single pouring of molten metal, that degree of heat causing cracking, crumbling and breakage of the veneer with the result that when the hot top is stripped from the ingot at least a portion of the veneer falls away and must be renewed before the next heat. The inner edge of the ring 20 or 20' and the inner edge of the rim 16 may be used as guides to gauge the thickness of the veneer upon its application.

When the veneer has been applied it must be dried before the hot top can be used. Drying can be accomplished preferably by subjecting the veneer or the entire

assembly to the action of hot air, the dried veneer, in place in the hot top, when subject to the thermal and mechanical shock imparted by the molten steel, becomes quite frangible.

The thickness of the veneer must be such that the temperature gradient through it will give a lining face temperature not exceeding the maximum safe operating temperature of the insulating fire brick used. A thickness of one-half inch or more is suitable. The veneer need not be very hard and in fact a relatively soft veneer has some advantages in that it permits easy stripping of the hot top from the sinkhead, because it will absorb any force imposed by misaligned stripping. The veneer 22 of course follows the contour of the lining bricks 17 and 18 although if desired the thickness of the veneer at the top may be somewhat less than that at the bottom because the temperature and mechanical stresses at the top are not so severe as at the bottom.

In Fig. 3 we have shown the invention in connection with a form of bottom ring 20' which has been conventional up to the present time. It comprises a portion 23 which extends upwardly on the inner side of the bottom ledge 15' of the casing.

In both forms of the invention illustrated the ledge 15 or 15' extends inwardly a distance less than the bottom ring 20 or 20' and somewhat less than the lower inner edge of the semipermanent lining. The resulting space in the case of the form of Figs. 1 and 2 is filled with the veneer material, as indicated at 34. In the Fig. 3 construction such space is substantially eliminated and consequently only a very small amount of veneer material is required to fill the joint.

In the casing 13, 14 there are cored weight saving pockets 35 and 36 which are joined by passages 37 to grooves 38. In the bottom of the casing there are grooves 39. These grooves 38 and 39 conduct away or vent any gases or vapor generated when the molten steel strikes the veneer, the gases and vapor then passing through the porous insulating fire brick into the pockets 35 and 36. Some gases and vapor escape along the inner wall of the hot top, but the greater amount vents through the porous lining and escapes by way of the cored pockets 35 and 36, the vents 37 and the grooves 38. Gases generated around the thick portions 34 of the veneer escape through the grooves 39.

The hot top may be supported upon the mold temporarily during pouring of the hot metal by wooden blocks 40 or other means. When the metal has been poured into the hot top to the correct level, these blocks may be knocked out. After pouring and solidification of the ingot the hot top is stripped from the sinkhead. Some of the veneer will remain on the sinkhead and some will adhere to the hot top. In preparing the hot top for the next heat, loose veneer is removed, new blocks, wiper strips, ring and clips are put in place and a fresh veneer applied.

Having thus described our invention, we claim:

1. A high efficiency hot top, comprising a metal casing, a low heat capacity, low heat conductivity, semipermanent porous insulating lining for said casing and a refractory veneer of a thickness about one-half inch and of fragile nature when subjected to contact by molten steel in direct contact with the inner surface of said lining, whereby said semipermanent lining is protected from thermal shock and mechanical blows, said hot top being dimensioned to provide a sinkhead cavity of relatively low volume.

2. A hot top as defined in claim 1, wherein said casing is provided with pockets behind said semipermanent lining and with vents to atmosphere from said pockets, whereby gases or vapor generated in said veneer when contacted by hot metal may escape through said porous lining, said pockets and said vents.

3. In a high efficiency hot top, a metal casing, a porous refractory semipermanent lining therefor having a ca-

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capacity for withstanding temperatures of approximately 2600° F. without appreciable deterioration and having low heat capacity and conductivity, and a refractory veneer approximately one half inch in thickness of low heat conductivity and of fragile nature when subjected to contact by molten steel covering completely the inner surface of said lining, said veneer having a temperature gradient thereacross of approximately 200° F. when the hot top contains molten steel.

4. In a high efficiency hot top, a metal casing, a refractory semipermanent lining therefor comprising low heat capacity, low heat conductivity, semipermanent porous insulating blocks carried by and backed by said casing, and a molded refractory veneer about one half inch in thickness of low heat conductivity and limited life covering completely the inner surface of said lining.

5. In a high efficiency hot top, a metal casing, a refractory semipermanent lining therefor comprising low heat capacity, low heat conductivity, semipermanent insulating blocks carried by and backed by said casing, said blocks being covered on their inner surfaces with a protective soft refractory veneer approximately one-half inch in thickness having a temperature gradient thereacross of approximately 200° F., when the hot top contains molten steel.

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6. In a high efficiency hot top, a metal casing, a refractory semipermanent lining therefor comprising blocks having a capacity for withstanding temperatures not in excess of approximately 2600° F. without appreciable deterioration and having low heat capacity and conductivity, said blocks on their inner sides having an adherent refractory veneer about one-half inch in thickness and having a temperature gradient thereacross of approximately 200° F. when the hot top contains molten steel of a temperature of approximately 2800° F.

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