

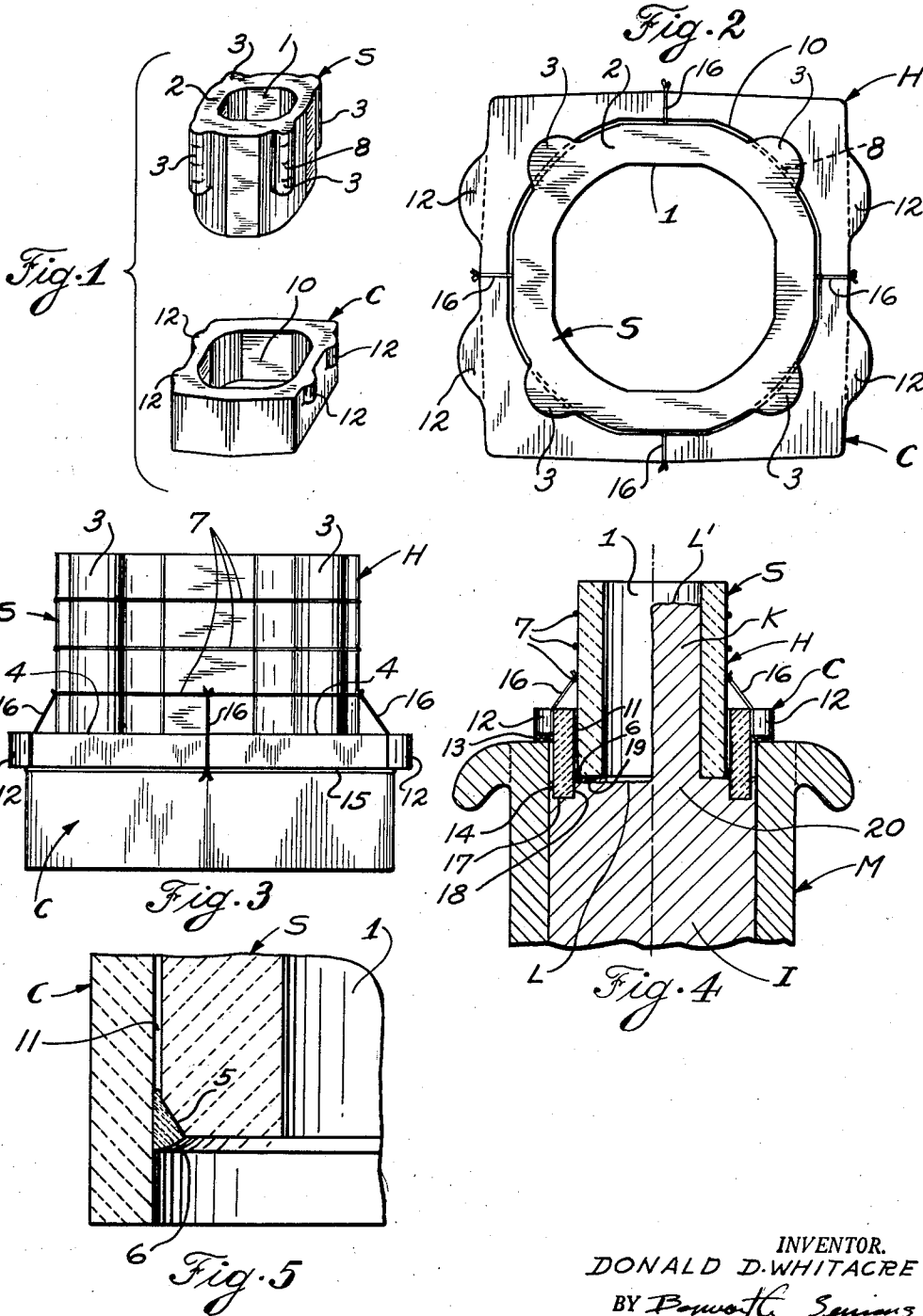
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HOT TOP

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1

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HOT TOP

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This invention relates to hot tops for ingot molds and more particularly to improvements in ceramic or refractory hot tops through which the yield and quality of ingots cast therewith may be increased and enhanced.

An object of my invention is to provide a hot top by the use of which segregation-free alloy steel ingots may be cast with a crop of no more than 10%; an objective long sought but not achieved prior to my invention. A general object of my invention is to improve upon the art and the hot top described and disclosed in the Estep Patent No. 2,159,374 and to solve the problems recognized in and remaining unsolved by the teaching thereof. Another object of my invention is to provide a ceramic hot top of separable parts of different functional characteristics wherewith each part can be made to play its role to greatest advantage in the whole unitary structure, function, operation and result of complete product. Other objects include the provision of a hot top that may be economically manufactured, transported and used; and that has such mechanical strength and thermal properties as to insure the successful and enhanced casting of segregation-free ingots without piping and with the savings and advantages of the novel small crop mentioned above.

A specific object is to provide a hot top and practice of casting ingots so improved over and upon the teaching of the George A. Bole et al. application Serial No. 240,676, filed August 7, 1951, now abandoned, that the desirable and avowed objects and intentions of that application may in fact be achieved.

Other objects and advantages of my invention will appear from the following description of a preferred form and practice thereof; reference being had to the accompanying drawings in which:

Figure 1 is an "exploded" perspective view of the sleeve and collar parts of my hot top axially aligned and spaced prior to assembly;

Figure 2 is a top plan view of my assembled hot top;

Fig. 3 is a side elevation of my assembled hot top;

Figure 4 is a composite longitudinal section showing my hot top in operative relation to the upper end of an ingot mold with a first stage of pouring the ingot suggested in the left half of the figure and the final stage of pouring the ingot and filling the hot top suggested in the right half of the figure;

Figure 5 is a fragmentary enlarged longitudinal section of a bottom portion of my assembled hot top showing a seal between the lower parts thereof.

In the preferred form of my invention herein particularly illustrated and described, the assembled hot top H, Figures 2 and 3, comprises the sleeve or sleeve part S and the collar or collar part C, see Figure 1, the former having its lower end telescopically nested within the latter, see Figure 4, resting thereon and attached and secured thereto, whereby to be employed as a unit and disposed on and within the brim of a big-end-up mold M

2

to perform its intended service in aid of casting the ingot I.

In this preferred form of my invention, the sleeve S takes substantially right, not necessarily circular, hollow cylindrical form and has a thick annular wall characterized by its high uniformly fine porosity, low density, low heat capacity, low thermal transmittance, low specific heat, necessary mechanical strength and resistance to spalling, whereby to embrace the "crop" K (first in the liquid state as suggested in the right half of Figure 4) and keep it, or the last increment thereof to solidify, hot and fluid for such a long period of time in relation to the solidification of the body of the ingot I that the ingot shall be free of piping and segregation, and the final solidified crop with its voids and impurities shall comprise less than $\frac{1}{10}$ the mass of the whole ingot and crop.

The collar C serves to support the sleeve S, fit the interior of the brim of mold externally, fit the exterior of the lower part of the sleeve S internally, anchor and locate the hot top as a whole in its proper relation to the mold and ingot, afford a major element of structural strength for the whole hot top, and is characterized by its strength and higher density and higher heat capacity than the sleeve S. Inter alia, the collar C functions to seal the molten steel from egress between its exterior and the brim of the mold; first making the seal whilst the level L of molten steel is approximately as shown at the left in Fig. 4, and by virtue of its higher heat capacity functions to "freeze" the molten steel around or adjacent its lowermost end and/or between its lowermost end and the adjacent surface of the mold and become substantially bonded or anchored to the upper and outer first frozen crust of the ingot whereby to resist the tendency of the hot top as a whole, and particularly with the low density sleeve S, to float or rise upwardly when the hot top is first filled with molten steel to the level L' as suggested in the right half of Fig. 4.

I prefer to make the sleeve S by longitudinal extrusion, familiar in the manufacture of clay products, of a mixture (wetted for extrusion) of about equal parts by volume of clay, preferably good fire clay, and anthracite silt to which is added up to about 20% sawdust or pulverized bituminous coke of about the mesh of sawdust. Alternatively, the sawdust and/or coke may be omitted entirely. Alternatively, I have also found it practicable to use a mixture of about 40% to 50% clay and about 60% to 50% anthracite silt. Within these ranges of mixtures, after the sleeve has been formed and dried, it is burned until all or substantially all the carbonaceous material has been consumed and burned out leaving a strong, highly porous, minutely voided (perhaps it could be called minutely honeycombed) wall structure of accurately predictable, controllable and uniform density, insulating value and heat capacity and with a smooth non-spalling skin or surface and with predictable and controllable form and dimension. I have found advantage in reducing the clay content of the mixture below $\frac{1}{2}$ and in employing a "slow" burning of the ware at between about 1400° F.—1600° F. That is to say, while I have made many successful hot top sleeves within the present invention with a mixture of equal parts of clay and anthracite silt, the burning time, with wall thicknesses of between $2\frac{3}{4}$ "—3", may be as much as three weeks to effect the whole combustion of all the carbonaceous material and the development of the uniformly and minutely voided structure that I desire. When the proportion of anthracite silt alone to clay is increased, as to 60–40, the burning time is desirably reduced without deleterious impairment of desirable qualities, such as structural strength, resistance to thermal shock and spalling, while the desir-

able density, insulating value and heat capacity is preserved and/or improved. When, as I presently prefer, a mix of 40% clay, 40% anthracite silt and 20% sawdust or granulated coke is employed, the desirable qualities are preserved and enhanced and the burning time for complete combustion of all the carbonaceous content at about the burning temperatures mentioned above is reduced to about $\frac{1}{2}$ that required for the 50-50 mixture of anthracite silt and clay. These examples are stated for illustration of principles upon which other variants may be enjoyed. Within these principles my present observation and understanding suggests: The proportion of clay to combustibles measures the ultimate essential working structural content of the burned ware through which the mechanical and thermal virtues and value are obtained, regard being had for the strength and thermal values arising from the porous or minute honeycomb structure and the firing of the vast surfaces thereof by the correct burning of the ware, including the burning of the ware by the combustible content. The proportion of anthracite silt functions to give the fine porosity with low ash content and advantageous "burning" of the walls and wall surfaces of the pores. The proportion of sawdust or granular bituminous coke tends to burn out ahead of and/or in encouragement of the burning of the anthracite silt and probably intersperses larger small voids or pores throughout the primary minute porous structure, and reduces burning time, probably by making it easier for oxygen to get to the silt or otherwise promote combustion of the silt in the smaller voids or pores in the middle of the wall structure. The net ash residuum of sawdust or coke is small in relation to the initial volume; wet sawdust for example having a high volume in the wet extruded ware relative to the ash thereof in the finished ware. For general guidance, at the expense of oversimplification, I aim to provide and retain in the sleeve S the beneficent qualities and characteristics obtained with the fully burned out 50-50 mixture of good fire clay and anthracite silt and I seek to illustrate by principle and example wherein and how the substance or substantial equivalents of those beneficent qualities and characteristics can be preserved or not deleteriously impaired while gaining other desirable advantages.

I prefer anthracite silt for the major combustible constituent of the pre-extruded and pre-burned mixture because it works easily in extrusion, has a low ash content when burned in, i. e. out of the ware, is relatively inexpensive, does not "shorten" the ware adversely and is readily and naturally obtainable in finely divided form, having preferably the fineness of flour or talcum powder. By shortening, I mean that combustibles with high ash content tend to make the ware more friable. Wheat flour and substantially equally finely divided petroleum coke have properties substantially similar to anthracite silt for the purposes of my invention, regard being had for cost as the same may be affected by price at or near the place of manufacture of the hot tops. The restrained use of sawdust and "granular" bituminous coke within the limits presently suggested has not been found to shorten the ware adversely, but if adverse shortening appears from particular sawdusts or bituminous cokes or from testing or exceeding the upper limits of the proportions thereof that I prefer, then the substitution of coarsely divided (as of about the fineness of sawdust or common granulated table salt or sugar) petroleum coke for all or part of the sawdust or bituminous coke will, pro tanto, relieve or eliminate the adverse shortening of the ware. These particular combustibles and their properties and functions in the practice of my invention are cited for examples and illustration rather than limitation.

The sleeve S produced with the 50-50 clay and anthracite silt mix and the long even burning mentioned above has a uniform density of about 0.65 to 0.68 ounce per

cubic inch, compared with a density of about 1.2 to 1.25 ounces per cubic inch or more for a product of the same clay produced without any initial carbonaceous content. The wall of the sleeve S made of the 50-50 mix, if about $2\frac{1}{2}$ " thick, has an insulating value such that under steady heat conditions with the "hot" side maintained at about 1000° F., the "cold" side will not substantially exceed about 200° F., i. e. at a gradient of about 320° F. per inch. Heat capacity approximately follows density. When the clay content of the mix is reduced as described above, the density is correspondingly, but not necessarily proportionately, reduced, regard being had for shrinkage in burning, and the insulating value correspondingly and similarly enhanced. While I have given below a specific example of the dimensions and proportions of a hot top embodying my invention for use with a particular ingot mold, my understanding and teaching about arriving at the best wall thickness for the sleeve S is presently this: Primarily the office of the sleeve is to delay solidification of the fluid metal "crop" in the feed opening until after the ingot has solidified, the latter being a determinable, substantially direct function of the "diameter" of the ingot adjacent the hot top. As is understood in the art the "diameter" of a square mold is taken approximately equal the side of the square. The sleeve S therefore works against different times for larger and smaller ingots and the efficiency of the sleeve may be measured in terms of how little heat it takes from and allows to flow from the crop before the ingot solidifies. The advantage of low heat capacity in the sleeve is that little heat is taken from the crop to heat the sleeve, so that this consideration alone speaks for a thinner and less dense wall for the sleeve. On the other hand, total insulating value considered alone speaks for a thicker walled sleeve of any given density. My sleeve by virtue of its minute porosity and low density throughout its wall thickness admits a reduction of the thickness of the wall of the sleeve without impairment of the ultimate result as the whole density is and has been reduced because any relative loss of total insulating value is offset by the relative reduction in total heat capacity of the sleeve. Similarly, when my hot top is employed with smaller molds, thinner sleeves S, not necessarily directly proportionately thinner, may be employed in view of the more rapid solidification of the ingot. The contrary tends to follow for larger molds. In sum, the uniform porosity and low density throughout the wall of my sleeve permits, and in part directs, me to choose the optimum wall thickness of the sleeve at approximately the point of balance between the best advantage flowing from reducing total heat capacity and preserving total insulation. This is illustrated in the example of size and proportions given below and contributes, as I believe, materially to the desirable results obtained. I am not unaware of other factors contributing to the preservation of heat in the crop by the wall of the sleeve, such as the color of the ware, the resistance of the skin of the feed opening to surface transfer of heat and the reflective quality of the exterior surface of the sleeve in reducing radiation; factors preserved in my hot top with light color and smooth skin incident to my preferred method of making and burning the ware. Consideration of these thermal factors as such is not intended to obscure the beneficence of the preferred proportion of height to diameter of the feed opening within the sleeve wherein a desirably high static head of molten crop is obtainable and preservable through the ultimate thermal efficiency of the sleeve which defines the shape of the feed opening.

My preference is that the collar C be made by extrusion of wet clay alone, dried and burned in orthodox fashion wherewith to have the expected density of about 1.25 ounces per cubic inch and the usual thermal and physical properties of well-made, dense, burned fire-clay products. For rule of thumb, the collar may have about

5

twice the density and twice the heat capacity per unit of volume of the sleeve (not necessarily twice the unit strength since the minute cellular structure of the sleeve has strength disproportionate to its lightness) and a relatively low insulating value compared with the sleeve.

As suggested in the drawings, the sleeve S has a central right cylindrical opening, or so-called feed opening 1, which may be circular or polyangular or a mixture thereof, preferably tending generally toward circular to preserve strength and minimize surface area in respect to volume; the feed opening preferably being about 120%–140% as long as its mean internal diameter, whereby to afford a substantially great static head of molten steel above the ingot when freshly filled as suggested in the right half of Figure 4. The opening 1 extends from end to end of the sleeve S, and the inner surface of the sleeve, defining the opening, is, as I prefer, smooth, continuous, hard and noticeably resistant to fluid steel absorption or adhesion and tending to be self-preserving and heat reflecting when the opening is filled with molten steel. The wall 2 of the sleeve is thick, $2\frac{3}{4}$ " to 3", for a mold with an upper opening about two feet square, and of uniform thickness throughout, except for the extra thickness incident to external longitudinally extending ribs 3 which, however, are terminated equally spaced distances from the bottom of the sleeve whereby to rest on the upper surface of the collar C, as at 4, and limit the telescopic entrance of the sleeve into the collar, Figures 3 and 4. The lower external surface of the sleeve S is smooth, continuous and cylindrical and of circular or quasi-circular form approximately corresponding to the shape of the feed opening. Preferably the lower outer corner of the sleeve S is chamfered as at 5, Figure 5, to facilitate the application of a ceramic seal 6 between the sleeve and collar as will be more fully described below.

In this preferred form of my invention the volume of the feed opening 1 in the sleeve S is for rule of thumb about, and need not substantially exceed, 10% of the volume of the mold. Other factors bearing on the measurement of the actual volume and mass of the final crop and the accomplishment of the novel smallness thereof will more fully appear below, from which the preferred volume of the feed opening of the sleeve in relation to the mold and ingot can be more particularly stated. As a practical matter a sleeve for a successful hot top embodying my invention used with the above mentioned 2' "square" mold had wall thickness of about $2\frac{3}{4}$ ", a mean internal diameter of about $15\frac{5}{8}$ " and length of $21\frac{1}{2}$ ".

The collar C has a right cylindrical central opening, the circularity or quasi circularity of which corresponds to the lower exterior of the sleeve S and is telescopically receptive of the same, with as close a fit as is practicable with refractory products: I allow a nominal clearance 11, Figures 4 and 5, of about $\frac{3}{8}$ " between the inner surface of the collar and the outer surface of the sleeve in hot tops of about the size mentioned above. Externally the collar C has its side surfaces formed and dimensioned to enter the brim of the mold, Figure 4, with appropriately small clearance therefrom and has short external supporting lugs overlying the top surface of the mold and supporting the collar in the mold as shown in Figure 4. In practice removable wedges 13 may be interposed between the lugs and the top face of the mold in the first instance in the known and usual way. The end surfaces of the collar as well as the end surfaces of the sleeve are cut normal to their axes and the ribs and lugs of the sleeve and collar are formed to locate the sleeve and collar coaxially of each other and coaxially of the mold when the assembled hot top, Figures 2 and 3, is placed in operative relation to the mold as shown in Figure 4. The wall of the collar C is of uniform thickness longitudinally and of variable thickness circumferentially, Figure 2, to accommodate the difference, whatever it may be, in shape between the

6

brim of the mold and the sleeve. The minimum wall thickness of the collar is sufficient to afford necessary structural strength for manufacture and use, but the greatest minimum thickness may respond to the preferred size and proportion of the sleeve and/or hot top as a whole consistent with the entire teachings of the practice of my invention.

To form my whole hot top the lower end of the sleeve S is inserted in the collar C, Figures 2–4; the ribs 3 of the sleeve preferably preventing complete entrance of the sleeve to the full depth of the collar, Figure 4, and, pursuing the dimensional example mentioned above, the collar may have overall length, i. e. height as viewed in Figure 4, of about 9" and the sleeve may enter but about 7" wherewith the lower end of the sleeve stands about 2" higher in the mold than does the collar; thus exposing the lowermost end of the collar to contact with the molten steel when the ingot is first poured to the level L, Figure 4: a thing which I have found to be preferable in the practice of my invention and of apparent advantage toward obtaining the desirable results thereof. For example, the exposed lower end of the collar appears to tend to freeze and bond to the adjacent liquid steel more quickly and tends to anchor the whole hot top in the mold and aid in effecting the seal with the mold as at 14, Figure 4.

Before or after inserting the sleeve in the collar there are tied around the exterior of the sleeve a plurality of wire bands or hoops 7, Figures 3 and 4, and a band or hoop 15 is snugly secured around the collar under the lower ends of the lugs 12. The ribs 3 of the sleeve may be notched as at 8 to receive and locate the bands 7. After the parts are assembled they are firmly tied and secured together by "up and down" ties or tie wires 16 tautly drawn between one or more of the bands 7 and the band or hoop 15. The bands serve the additional function of preserving the hot top against deleterious fracture, or opening if fractured, pending the pouring, casting and/or cooling of the ingot and crop. The ties 16 may be attached to the lugs 12 of the collar as well as or instead of to the band 15. In lieu of the "up and down" ties 16 the sleeve and collar may be bonded together with bonding material placed in the space 11 as described below.

With the sleeve and collar assembled and tied together, the hot top is preferably placed upside-down and the seal 6 putted, poured or troweled in at the chamfer 5 and more or less into the space 11 to seal the space 11 between the sleeve and the collar and prevent molten steel from entering that space or finding egress therethrough. The seal 6 may comprise a wet mixture of an aqueous solution of sodium silicate and "brick dust" or other finely divided and fired refractory, which while wet is readily poured and/or troweled into the annular sealing place and space as shown in Figure 5, and after drying and setting, is resistant to spalling or other harmful deterioration upon contact with molten steel. Alternatively, the space 11, or much of it, above the seal 6 may first be filled with Portland cement to bond or integrate the sleeve and collar together, and the need for the ties 16 thus eliminated; the silicate mixture seal 6 preferably being applied after the cement "thereabove" has been poured or injected into the space 11 to prevent contact between the cement with molten steel and possible deleterious "gasification" from the cement to the ingot. For a second alternative, the sleeve and collar may be bonded together with high alumina cement poured or injected into the space 11, and I may use the same high alumina cement to substitute for the seal 6 because of the resistance of this cement to gasification. Should any bonding material, employed in the space 11 for its bonding virtue as such, tend to have any incompatibility with the ingot or the casting thereof, my preferred silicate seal may always be interposed between the bond and the ingot as shown in Figure 5.

In the practice and operation of my invention the whole hot top H is placed on and in the brim of the mold M as shown in Figure 4 and the initial pour of molten steel made up to about the level L. The pouring is then interrupted for a minute or so (while an initial pour may be made in a different mold), wedges 12 removed, and the first chilling or freezing of the steel adjacent the mold surface and near the lower end of the collar C allowed to take place. I have observed that this initial chilling includes the formation at 14 of a frozen or sufficiently partially frozen annular fin of steel between the lower part of the collar and the mold to seal the space between the collar and the mold against egress of molten steel when the hot top is "filled" with molten "crop." Additionally, my observations lead me to believe that a freezing or quasi freezing of molten steel and/or a bond takes place between the lowermost end of the collar and the ingot at or with the lower end surface 17 of the collar and probably to a lesser degree at and with part of the inside lower exposed surface 18 of the collar by virtue of the small surface areas exposed and small mass involved and the high heat capacity of the bottom of the collar and the proximity of the lower end of the collar to the cold wall of the mold. Contemporaneously, the level L of molten steel may contact the lower end of the sleeve S, but the lower heat capacity of the latter and its high insulating value tends to resist and delay freezing of the steel adjacent thereto. In all events, I have found that after the short conventional pause in the pouring of ingot at the level L my hot top acquires a satisfactory anchorage to the ingot, sufficient to resist harmful floating of the hot top when pouring is resumed, and at the same time begins to preserve and maintain liquidity of the steel and delay freezing thereof at and below the sleeve S, i. e., in or near the lowermost part of the "crop" in or about the part 20 of the casting which lies below the sleeve and above the level of the bottom of the collar.

After the first pour and pause, a second pouring of steel "fills" the sleeve about to the level L' near the top of the sleeve wherewith to provide a high head and reservoir of molten steel to augment the prevention of piping and segregation in the ingot. With my hot top, even though the sleeve is of low density, the tying or bonding of sleeve to the collar and the anchorage of the collar in the mold holds the hot top against harmful floating and leakage of molten crop therefrom or from the brim of the mold. Thus the molten crop K is preserved in place, and the high insulating value and low heat capacity and other beneficent features and/or proportions of the sleeve and hot top keep the small steel content of the hot top molten or fluid long enough so that no more than $\frac{1}{10}$ of the entire casting, comprising ingot and crop needs to be cropped to yield a pipe-free and segregation-free, useful ingot. To put it conservatively, I have reckoned the 10% crop as comprising substantially all the good metal, "sponge" and dross lying above the bottom level 17 of the collar including the stepped part 20 of the casting. In the practice of my invention, however, tests have shown that the stepped bottom of the hot top which includes the part 20 of the casting appears to have "lifted" all the sponge of the crop well up into the feed opening of the sleeve S and that much if not all the part 20 is also substantially segregation-free. Thus some or all of the part 20 need not necessarily be cropped off, and, correspondingly, my invention may be credited with requiring less than a 10% crop or, where 10% is cropped, affording a substantial buffer or safety factor of useful metal in so much of the part 20 as is cropped off.

With the above considerations in mind, the internal volume of the whole hot top in relation to the volume of the ingot and mold may be predicated thus: Since the ultimate solidified crop has all the "piping," porosity and dross from which the ingot has been preserved the volume of the frozen crop as it stands in the hot top in relation to the volume of the ingot will exceed 10% while its

weight and mass is less than 10%. Since the level L' of the crop in its molten state is prudently a few inches lower than the top of the sleeve to prevent inadvertent overflow and spilling, another increment of volume is conveniently added. Since part of the final crop lies within the mold, the whole mold volume is greater than the volume of useful ingot cast therein. A rough balance of these considerations suggests that in this preferred form of my invention the internal volume of the sleeve S may be approximately $\frac{1}{10}$ the volume of the mold, whence the whole internal volume of the hot top, including the diametrically enlarged space 20 will materially exceed $\frac{1}{10}$ the volume of the mold. When, however as the operator judiciously refrains from filling the hot top to the extreme upper level thereof, the final resulting weight of solid metal required to be cropped may be, and characteristically is, no more than $\frac{1}{10}$ the weight of the whole casting; a result long sought and now first obtained by my invention.

While I have illustrated and described preferred forms and practices of my invention, improvements, modifications and changes therein will occur to those skilled in the art without departing from the principles and substance thereof, and I do not intend to be limited in the scope of my patent to the specific forms and examples herein specifically described for the sake of illustration and exposition, nor in any way or manner inconsistent with the promotion of progress in the art accomplished by my invention.

I claim:

1. A ceramic hot top for use with ingot molds for casting ingots comprising an inner substantially cylindrical burned clay sleeve portion open at both ends with a central feed opening and adapted to be disposed above and coaxially of the mold, the wall of said sleeve portion being characterized by its substantially uniform porosity, density and thickness, low density, low heat capacity and high insulating value, having a density of about $\frac{3}{4}$ ounce per cubic inch and insulating value, which under steady heat conditions can maintain about 1000° F. at its inner surface with about 200° F. at its outer surface, the said opening of said sleeve portion having from about 10% to 50% greater height than mean transverse dimension, said hot top also comprising a collar portion formed of dense, strong burned clay with density approximately twice the density of said sleeve portion and with a central opening formed complementarily to the exterior of the lower part of said sleeve portion and closely and freely receiving and encompassing the lower part of said sleeve portion and having a height of between about $\frac{1}{3}$ to $\frac{1}{2}$ the height of said sleeve portion, and having an exterior form complementary to the interior of the upper end of the ingot mold and adapted to be closely and freely disposed therein, means for supporting said collar portion adjacent the brim of said mold with its lower part disposed below the brim, means for holding said sleeve portion against substantial upward or downward motion relative to said collar portion, and means for sealing the lower end of said sleeve portion in relation to said collar portion against flash or flow of fluid metal upwardly therebetween when the ingot is poured and said sleeve portion is substantially filled with fluid metal, said hot top having an internal volume of not more than about 10% of the volume of the ingot and crop and said collar portion having strength in shear and resistance to spalling where it is externally engaged by and bonded to metal of the ingot.

2. A ceramic hot top for use with ingot molds for casting ingots comprising an inner substantially cylindrical burned clay sleeve portion open at both ends with a central feed opening and adapted to be disposed above and coaxially of the mold, the wall of said sleeve portion being characterized by its substantially uniform porosity, density and thickness, low density, low heat capacity and high insulating value, having a density of about $\frac{3}{4}$ ounce

per cubic inch and insulating value which under steady heat conditions can maintain about 1000° F. at its inner surface with about 200° F. at its outer surface, approximately half the volume of said wall comprising voided pores at least the greater part of which are not substantially larger than particles of talcum powder and all said pores having been fired internally by substantially complete combustion of carbonaceous material therein and at least the smaller of said voided pores being substantially free of ash, the said opening of said sleeve portion having from about 10% to 50% greater height than mean transverse dimension, said hot top also comprising a collar portion formed of dense, strong burned clay with density approximately twice the density of said sleeve portion and with a central opening formed complementarily to the exterior of the lower part of said sleeve portion and closely and freely receiving and encompassing the lower part of said sleeve portion and having a height of between about $\frac{1}{3}$ to $\frac{1}{2}$ the height of said sleeve portion and having an exterior form complementary to the interior of the upper end of the ingot mold and adapted to be closely and freely disposed therein, means for supporting said collar portion adjacent the brim of said mold with its lower part disposed below the brim, means for holding said sleeve portion against substantial upward or downward motion relative to said collar portion, and means for sealing the lower end of said sleeve portion in relation to said collar portion against flash or flow of fluid metal upwardly therebetween when the ingot is poured and said sleeve portion is substantially filled with fluid metal.

3. A ceramic hot top for an ingot mold comprising a hollow cylindrical portion having an internal feed opening of volume of about $\frac{1}{10}$ the volume of the mold and of length about 120% to 140% the mean diameter of the opening and having a wall surrounding said opening of thickness from about $\frac{1}{8}$ to $\frac{1}{4}$ the mean diameter of said opening; the wall being characterized by its uniformly

minutely porous structure and low density throughout its thickness and having between about 50% and 60% uniformly distributed voided pores, at least 60% of such pores being not substantially larger than a particle of talcum powder and from none to 40% of such pores being not substantially larger than a grain of granulated table sugar, all said pores having been fired internally by combustion of carbonaceous material therein, substantially all said pores being free of unburned carbonaceous material and at least the smaller of said pores being substantially free of ash, the density of said wall not substantially exceeding 0.7 ounce per cubic inch and said wall having insulating value sufficient to maintain but about 200° F. to 300° F. on its outside against about 900° F. to 1000° F. on its inside under steady heat conditions.

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