Nov. 9, 1965 J. C. CARPENTER 3,216,689

HOT TOP REFRACTORY AND/OR EXOTHERMIC UNIT

Filed Sept. 17, 1962

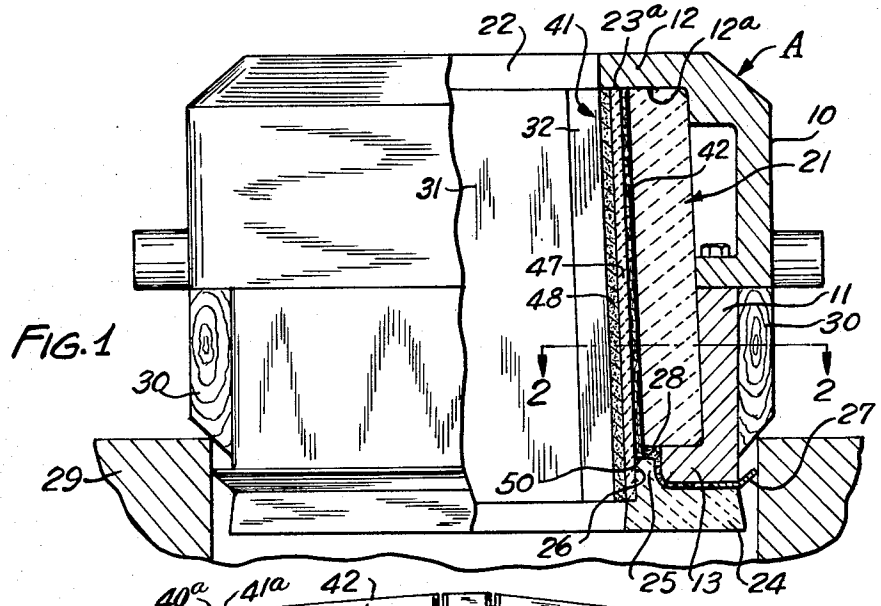


FIG. 1

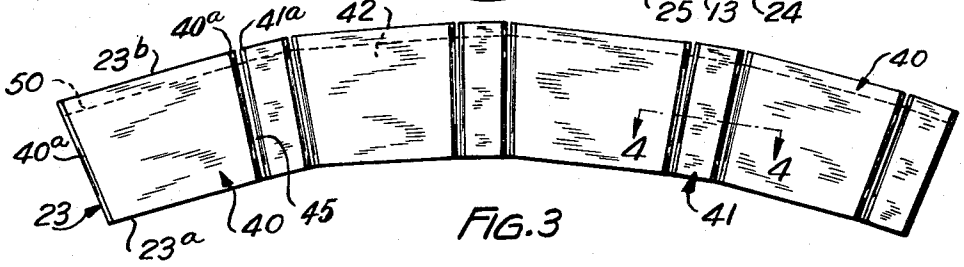


FIG. 3

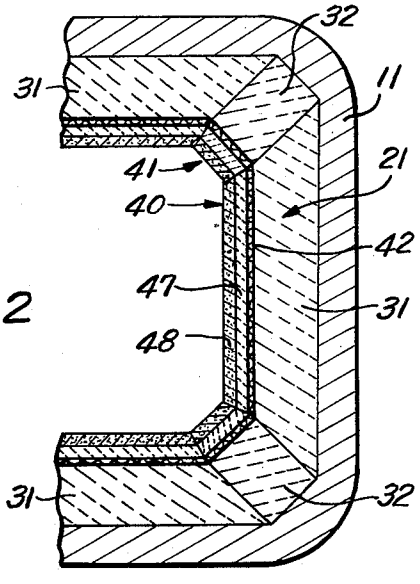


FIG. 2

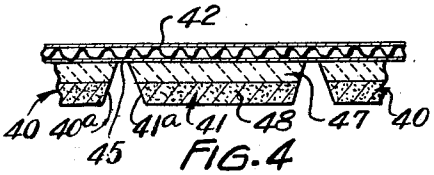


FIG. 4

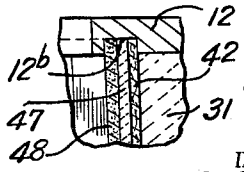


FIG. 5

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United States Patent Office 3,216,689 Patented Nov. 9, 1965

3,216,689

HOT TOP REFRACTORY AND/OR EXOTHERMIC UNIT

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Filed Sept. 17, 1962, Ser. No. 223,949
6 Claims. (Cl. 249—201)

The present invention relates to hot tops and more particularly to hot tops having an annular refractory layer formed by a plurality of preformed refractory panels.

An important object of the present invention is the provision of a new and improved device providing for quick and easy emplacement of preformed panels for forming a hot top lining into proper position for use with ingot molds in the pouring of metal ingots.

Another important object of the present invention is the provision of a novel and improved device which facilitates packing and shipping of preformed panels for use as hot top structures so that loss due to breakage is minimized.

Another important object of the present invention is to provide a new and improved hot top in which preformed panels are assembled to form an annular lining of a hot top with the panels being interconnected by a flexible material which maintains the panels in a predetermined relationship and which allows the panels and the flexible material to be collapsed to form a relatively flat unit for shipment and which maintains the panels in their proper relationship during assembly to form the hot top lining.

Another object of the present invention is to provide a new and improved veneer facing for an insulating lining of a hot top, which facing is comprised of a plurality of preformed refractory panels to be disposed in angular edge abutting relationship with respect to each other to form the veneer facing with the panels being preassembled with a flexible material so that the panels and flexible material may form a relatively flat unit for shipping and so that the panels are held in such relationship that they may be readily assembled into proper hot top forming position by folding the flexible material.

A further object of the present invention is the provision of a new and improved veneer facing, as noted in the next preceding paragraph wherein the flexible material is corrugated cardboard providing a cushion during shipping, easy folding, venting of gases generated during pouring of the mold, and resiliency to permit a proper fit in a reusable hot top even when the tolerances of the other parts of the hot top may vary.

A still further object of the present invention is to provide a facing panel for the insulating lining of a hot top, which panel is constructed of material which weakens when subjected to the temperatures which occur during the forming of an ingot and collapses to facilitate a parting of the hot top from the ingot.

It is also an object of the present invention to provide a new and improved panel insert unit for a hot top which has sufficient strength to be handled and shipped but yet which will present no problem when stripping the hot top.

The present invention provides a preformed panel unit for use in maintaining a molten mass of metal to be fed to an ingot to compensate for shrinkage of the metal during the solidification thereof including a plurality of preformed panels adapted to form a hollow geometric

figure above an ingot mold, and flexible means mounting a plurality of said panels with the adjacent edges of the panels extending generally parallel and being spaced on said flexible means and foldable along a line in each space to position adjacent edges in abutting relationship. When the panels are used as a facing for an insulating lining of a hot top the panels are constructed of a material which weakens when subjected to temperatures during the pouring of the ingot so that they will collapse on the stripping of the hot top from the ingot mold.

Further objects and advantages of the present invention will be apparent from the following detailed description of the present invention made with reference to the accompanying drawings, wherein:

FIG. 1 is a view partly in elevation and partly in section of a hot top of the composite floating type constructed in accordance with the present invention and shown mounted in the open upper end of an ingot mold;

FIG. 2 is a sectional view of a portion of the hot top shown in FIG. 1 taken approximately along line 2—2 of FIG. 1;

FIG. 3 is an elevational view of the preformed panel insert unit used to protect the insulating fire brick lining of the hot top shown in FIG. 1;

FIG. 4 is a sectional view of a portion of the preformed panel insert unit shown in FIG. 3 taken approximately along the section line 4—4 of FIG. 3; and

FIG. 5 is a fragmentary sectional view of a portion of a modified construction of the hot top of FIG. 1.

While the present invention is shown as embodied in a particular type of hot top which has an insulating lining of the insulating fire brick it is to be understood that the invention will find usefulness in various types of hot tops when preformed panels with or without an exothermic facing are to be assembled to form an annular hot top structure.

The present invention is shown in the drawings as embodied in a hot top A. The hot top A insofar as its metal casing and its manner of use are concerned is conventional. The metal casing of the hot top A is formed of an upper section **10** and a lower section **11** suitably secured together. The hot top is shown as being of generally rectangular configuration, but it will be understood that it might be of round, oval or other configuration.

The upper section **10** of the metal casing is shown as provided at its upper end with an integral inwardly extending canopy or flange **12**. The lower section or part **11** of the metal casing has at its lower end an integral inwardly extending lip or flange **13**, which is of less width than the flange **12**.

In the illustrated hot top the metal casing is lined with a light weight insulating material, preferably a porous, fragile, insulating fire brick of poor mechanical strength but good heat insulating properties and low heat capacity and thermal conductivity or castable insulating refractory of equivalent heat duty and permanence. The bricks of the lining **21** are distinguished in this way from high grade, hard, dense brick which, because of their density and mass, have relatively poor heat insulating characteristics and high heat capacity, although they do have good mechanical strength. The insulating lining **21** of the illustrated hot top is mounted between and is supported by the flanges **12** and **13** of the casing, and this insulating lining **21** of the hot top casing is semipermanent in that it is used for a number of pouring operations.

The insulating fire brick used to form the lining **21** of the illustrated hot top have a maximum rated use tem-

perature such that the lining would be destroyed or so severely damaged by the thermal shock of direct contact with the molten metal that it would have to be replaced for each pouring operation. This destruction or damaging of the lining also would be increased because of the mechanical abuses to which it would be subjected during the stripping of the hot top from the sinkhead after the ingot had attained the desired degree of solidification.

Heretofore it has been proposed to protect the insulating fire brick lining of the type of hot top illustrated from thermal shock and mechanical abuses by covering said lining with a protective veneer of preformed protective panel inserts. The purpose of using the protective veneer or panel inserts is to provide a sufficient temperature drop or gradient between the temperature of the molten metal and the temperature to which the insulating lining is subjected so that the latter temperature is one within the rated temperature use of the lining. The insulating lining **21** of the hot top A is protected by such panels and as a result the lining **21** is a semi-permanent lining capable of being reused for a number of pouring operations.

As illustrated, hot top A has a downwardly divergent or tapered central opening **22** or interior, although the opening may also be made with no taper, and in preparing the hot top for a pouring operation the hot top is placed in a suitable stand in inverted position as is well understood in the art. A preformed panel insert unit **23** is then inserted into the interior of the hot top and placed in position in contact with the insulating lining **21**. The insert unit **23** forms an annular veneer layer around the interior of the hot top and, in the illustrated hot top, protects the lining **21** from thermal shock. The insert unit **23** may be positioned inside of flange **12** or have one edge **23***a* under the flange **12** in engagement with surface **12***a* thereof. Preferably the insert unit **23** fits under the flange **12**, as shown in the drawings, for better support in the hot top. Moreover, the surface **12***a* may have a groove **12***b* as shown in FIG. 5 to receive the top of the insert unit. Such a structure makes it more difficult for molten metal to find its way behind the insert unit.

After the insert unit **23** is positioned in the hot top, the refractory bottom ring **24** is placed on the lower end on the hot top as is well understood. The bottom ring **24** is provided with a raised rib portion **25** extending upwardly adjacent the inner end of flange **13** and underlying the insulating lining **21**. The refractory bottom ring **24** is shown as provided on its inner periphery with a recessed portion **26** furnishing a shoulder that engages edge **23***b* of the insert unit **23**, and supports the preformed panel insert unit. It will be understood that the rib **25** might be wider and the recessed portion **26** omitted and the edge **23***b* of the panel insert then would engage the upper surface of the wider rib **25** of the bottom ring **24**. A wiper strip **27** is shown positioned between the lower end of the metal casing and the upper side of the bottom ring **24**, as is well understood in the art. Also any space or clearance between the bottom ring, the metal casing and the lower end of the insulating lining **21** can be sealed with a suitable sealing compound as indicated at **28**. The refractory bottom ring **24** and the wiper strip **27** are secured to the casing in the usual way by suitable attaching clips (not shown) as is well understood in the art.

When the hot top thus equipped is used for a pouring operation, it is positioned a predetermined distance in the upper open end of an ingot mold **29** and initially held in such position by suitable blocks such as the wooden blocks **30**. After the pouring of the molten metal into the mold and the hot top, the blocks **30** are knocked out or destroyed and thereafter the hot top rides on the partially solidified ingot. The preparation, use and advantages of the hot top as broadly described above are well known in the art, and the hot top functions to provide a molten mass of metal to be fed to the ingot to compensate for shrinkage of the metal during the solidification thereof in the ingot mold.

The insulting fire brick lining **21** is shown in FIG. 2 as formed of side portions **31** and corner portions **32**. The portions **31** and **32** have their contacting edge surfaces shaped to closely interfit one another and to closely interlock in position in the hot top between the flanges **12** and **13** of the casing. The insulating lining extends inwardly beyond the inner end of the lower lip or flange **13** and overlies the raised rib **25** of the bottom ring **24**, as clearly shown in FIG. 1.

The illustrated preformed insert unit **23** for the lining **21** of the hot top comprises individual insert panels **40**, **41** suitably secured to a flexible means or material. The panels **40**, **41** form side and corner panels, respectively, and may be formed of a layer of refractory material or other suitable protective material and/or a layer of exothermic material. The panels **40**, **41** are illustrated as made of an essentially self-sustaining refractory supporting layer **47** having integrated therewith on one side an exothermic facing layer **48**. The refractory layer **47** preferably engages and is secured to the flexible material, which in the preferred embodiment is corrugated cardboard **42** forming a backing sheet for the panels. The cardboard backing sheet **42** as clearly shown in FIG. 4 includes a pair of cardboard panels separated by a corrugated sheet.

The layer **47** of the preformed protective panel inserts **40**, **41** may be formed of any high temperature resistance material which preferably does not fuse or slag at the operating temperatures. The composition may vary considerably in its constituent makeup and will not be specifically defined. It should be understood that the layer **47** may be formed of various suitable materials capable of protecting the insulating lining **21**. The exothermic facing layer **48** of the panels may also vary in composition, and as these compositions are known in the art no specific composition will be referred to, it being understood that any suitable exothermic facing layer may be used.

Preferably, after the panels **40**, **41** are formed and dried they are secured to the flexible cardboard **42**. The panels may be secured to the flexible cardboard in any suitable manner as by adhesives or mechanical means such as rivets, pins, or clips. Alternatively, the panels may be molded and formed right on the flexible material, during the manufacture of the units.

The flexible means, as stated above, preferably is corrugated cardboard. However, it is to be understood that any flexible material which has sufficient strength to support the insert units **40**, **41** in assembled relationship could be used. For example, cloth, metallic strip, strong paper, fibrous material, or pressure sensitive tape may also be used. Moreover, a reinforcing wire screen may be used as the flexible means and be imbedded in the panels **40**, **41**. Also flexible tape, metallic or otherwise could be imbedded in the panels and function as the flexible means. Moreover, the material may be cut away when it is not needed for reinforcing or to maintain the panels in their proper relationship.

The panels **40**, **41** are supported by the flexible material, and in the preferred embodiment on the cardboard sheet **42** in such a way that the annular edges **40***a*, **41***a*, respectively, of the panels are parellel and a small spacing **45** is provided between each of the panels. This spacing is such that the insert unit **23** may be easily folded by grasping the opposite ends of the insert unit **23** and folding the flexible material along a line in the space between the panels through an angle necessary to bring the adjacent edges of the panels into engagement. The positioning of the panels **40**, **41** is such that when the flexible material is folded the edges of the panels properly mate forming a hollow geometric figure. During the preparation of the hot top for a pouring operation the insert unit **23** is placed in the hot top as noted above. Specifically,

the hollow geometric figure formed by the insert unit is positioned over the inverted hot top and pushed into position with the edge **23***a* engaging flange **12**. As above described, the grouting, the refractory ring **24**, wiper strips and clips are applied and the hot top is then ready for use.

In the embodiment illustrated the corrugated cardboard backing sheet **42** does not completely overlie the panel units **40, 41**. The one edge **50** of the backing sheet **42** stops short of the adjacent edge of panels **40, 41**. This is to provide for proper support of the panels in the recessed portion **26** of the ring **24** and also provides for refractory to refractory contact at the joint between the panel and the ring. This latter aids the chilling of the metal at the joint. However, the backing sheet **42** may completely overlie the panel members **40, 41**. Moreover, the exothermic layer **48**, when used, may extend completely over the inside face of the ring **24**. In such a structure the refractory layer may be coextensive with the exothermic layer or the refractory layer **47** may terminate short of the lower end of the layer **48** and rest on the top of the ring **24** in the step therein.

It should be noted that since the central opening **22** of the hot top is tapered, the insert unit **23** when collapsed or in its flat condition, as illustrated in FIG. 3 is segmented and somewhat curved, and when folded forms a trapezoidal shape. Moreover, the panels **40, 41** are tapered and the narrow end of the panels engage flange **12**. The tapered panels are necessary because the periphery of the central opening **22** through the hot top varies, with the periphery thereof adjacent flange **12** being smaller than the periphery adjacent ring **24**. If the central opening of the hot top is not tapered, but is formed by parallel sides, then the insert unit **23** in its flat condition would be in the form of a rectangle and when folded forms a rectangular polyhedron.

In this connection it should be noted that while eight panels are mounted on the flexible material in the preferred embodiment and form a completed hot top lining, any number of panels may be supported by the flexible material as dictated by the shape of the hot top opening and the size thereof. It is contemplated that less than the number of panels to form a completed hot top lining may be mounted on the flexible backing and part of the lining may be held in position in the hot top by clips while the other portion of the lining is being positioned in the hot top. This would find particular utility when large hot tops are being prepared. Furthermore, the insert units described above may be used in several courses to provide a complete lining. In such a case, only the innermost unit would be faced with exothermic material.

The use of corrugated cardboard as the flexible material provides particular advantages. With the corrugations running parallel to the edge of the inserts **40, 41** the folding of the cardboard is facilitated. Moreover, the corrugated cardboard provides a venting space between the panels and the lining, and the vertical corrugations provide for quick venting of gases through the space when the ingot is poured. In this connection, the hot top might otherwise be provided with venting means through the top flange for venting the gases to the atmosphere.

The corrugated cardboard also gives the insert unit a degree of resiliency to permit a proper fit in the hot top even when the tolerances of the casing of the hot top and brick lining are close. Moreover, since the insert units are handled and shipped stacked in the flat, the cardboard backing provides a cushion between the panels and minimizes breaking. Also, the cardboard forms a reinforcement for the panels, eliminating the necessity for other reinforcement. To a greater or lesser degree all of the flexible materials mentioned above provide certain of these advantages.

In the preferred embodiment the flexible material forms a backing sheet which contacts the lining **21**. The flexible material could form a front sheet, that is, the flexible material could be positioned as the exposed face of the insert unit. In such a case provision should be made for proper folding so that when folded there is no spacing between the adjacent edge surfaces of the panels. This can be provided for by permitting the folds to fold into the interior of the hot top.

In use, the refractory layers of the protective panels provide the required temperature drop or gradient between the temperature of the molten metal and the temperature to which the insulating lining is subjected, that is, the insulating fire brick lining will not be subjected to a temperature higher than its rated use temperature. While the refractory layers of the panels in the illustrated embodiment are relatively hard, and self-sustaining, they do not because of their relative thinness provide sufficient mass to absorb large quantities of heat from the molten metal such as would be enough to appreciably chill the molten metal and significantly lessen the efficiency of the hot top. Also the refractory supporting layers of the preformed panels, in the illustrated embodiment, keep the exothermic facing layers **48** thereof out of direct contact with the insulating lining and hence the latter is protected from and is not directly subjected to temperatures generated by the exothermic layers when such layers are ignited by the molten metal during the use of the hot top and thereby increase the thermal efficiency of the hot top.

Heretofore refractory panels for protecting the insulating lining of a hot top have been made of material similar to the high strength material of the refractory ring **24**, which material is a sodium silicate bonded sand, so that the panels will have a strength sufficient to minimize breaking during handling. Such panels have at times presented a problem insofar as the stripping of the hot top from the formed ingot and the cleaning of the lining **21** is concerned. The panel would sometimes stick within the insulating lining or to the ingot sinkhead or to both and would not part to allow stripping without damage.

Preferably the refractory layers **47** of the insert unit are made of a material which materially weakens when subjected to the temperatures which occur during the pouring of the molten metal to form the ingot thus allowing layer **47** to readily part so that the hot top can be stripped easily from the ingot without damaging the insulating lining **21** and also permitting the lining **21** to be readily cleaned prior to its next use. Various refractory materials which lose their strength when subject to the temperatures which occur during pouring may be utilized to form the layer **47**. For example, the layer **47** may be made of raw dolomite fines with a sodium silicate binder. Such a material will chemically decompose during the pouring operation to weaken the layer **47** sufficiently to accommodate the stripping of the hot top and the cleaning of the lining **21**. A silica sand bonded by a binder in accordance with the following formula may also be used:

Ingredients:	Approximate percentage by weight
Petroleum coke (about 16 mesh or finer)	2–8
Zinc oxide	about 1
Cane sugar	1–6
Sodium silicate solution	8–17
Silica sand	68–88

The sodium silicate is the binder and the solution preferably has a specific gravity of about 1.39 and 40.6° Baumé specific gravity with the ratio of SiO_2 to Na_2O being preferably approximately 3.25 to 1. When the preferred binder is used the sodium silicate weight in the above recipe is about 30% of the weight of the solution. While various binder solutions may be used the weight of the petroleum coke and sugar should be at least approximately equal to the combined weight of the Na_2O and SiO_2 of the binder with the ratio of sugar and coke corresponding to the above recipe. The sugar and coke is distributed in the binder between the sand particles and will burn out to weaken the structure of the panel and allow the particles of sand bonded by the binder to readily

part. Other burn out materials, such as sawdust or other carbonaceous materials may be substituted for coke.

Refractory materials which weaken on heating tend to be relatively fragile and present handling problems when formed into panels for use in hot tops. The flexible means for interconnecting the panels may also serve the function of a reinforcing for the panels to provide the latter with sufficient strength for shipping and handling.

When a high strength refractory which tends to stick to the lining **21** is used, with a flexible backing such as the cardboard backing sheet **42**, the backing may be impregnated or lined with a material which forms a barrier to prevent the sticking of the layer **47** to the lining **21** or the backing itself may be such a barrier. For example, the cardboard backing may be impregnated with a carbonaceous material which will provide a barrier between the layer **47** and the lining **21**.

The refractory supporting layers **47** of the protective panels **40, 41** not only act as a supporting means for the facing exothermic layers **48** thereof, but provide an effective heat buffer between the molten metal and the insulating lining and between the exothermic facing layers and the insulating fire brick lining. The refractory supporting layers of the panels also protect the insulating lining from the fluxing action produced by the reaction of the exothermic layers, and thus prolong the life of the insulating lining. The use of the refractory supporting layers in combination with the exothermic facing layers of the protective panels and with said panels covering the insulating lining make it possible to produce an extremely low volume hot top while utilizing a minimum amount of exothermic material, thus providing such a low volume hot top at a minimum cost.

The protective panel inserts being preformed can be produced accurately and uniformly as to size and composition in a plant properly equipped for such production. Also the protective panel inserts being self-sustaining and secured to a flexible material can be handled, shipped, stored and used with a minimum of breakage. In addition, the preformed protective panel insert unit greatly facilitates the preparation of the hot tops for a pouring operation, as compared to known methods of applying protective linings as should be apparent from the above description. Specifically, the panel insert unit provides for assembly of a plurality of panels in a hot top at one time and eliminates positioning of one panel at a time in a hot top and the problem of holding the panels in position while the remaining panels are being positioned in the hot top.

Although a specific structural embodiment of the invention has been illustrated and described in considerable detail, it will be understood that the invention is not to be limited thereto but is to be construed as including such variations as come within the scope of the appended claims.

Having described my invention, I claim:

1. A hot top structure comprising a hot top casing having a central opening therethrough, a refractory lining in said casing, a panel insert unit for providing a protective heat and mechanical damage barrier between a mass of metal in the hot top and the refractory lining in the hot top casing, said panel insert unit including a plurality of heat-collapsible refractory insert panels having front sides defining adjacent wall portions of the opening through said casing and back sides disposed so as to face said refractory lining, said insert panels being of a refractory material bonded by a heat-destructible binder and retarding heat transmission to the insulating refractory lining of the casing, flexible material hingedly interconnecting said insert panels for relative movement from relative positions wherein the panels are disposed in side-by-side relationship with adjacent edge surfaces of the panels facing each other to angularly related positions wherein the panels are disposed with the adjacent edge surfaces thereof in area contact and forming the insert unit.

2. A hot top structure including a panel insert unit for forming a facing layer for the refractory lining of a hot top casing having a vertically tapered central opening therethrough to provide a protective heat and mechanical damage barrier between a mass of metal in the hot top and the interior lining of the hot top casing, said panel insert unit comprising a plurality of heat-collapsible refractory tapered insert panels having front sides for defining adjacent wall portions of the opening through said casing and back sides to be disposed so as to face said refractory lining, said insert panels being of a refractory material bonded by a heat-destructible binder and retarding heat transmission to the insulating refractory lining of the casing, flexible material hingedly interconnecting said tapered insert panels for relative movement from relative positions wherein the tapered panels are disposed in side-by-side relationship with adjacent edge surfaces of the tapered panels facing each other to angularly related positions wherein the panels are disposed with the adjacent edge surfaces thereof in area contact and forming a tapered insert unit.

3. A hot top structure as defined in claim **2** further including means for supporting said tapered panel insert unit in the hot top casing including a bottom refractory ring having a portion engageable with a portion of the underside of said insert unit.

4. A panel insert unit for emplacement in a hollow hot top structure to be supported at the upper end of an ingot mold and for location in a tapered hot top structure so as to define a tapered opening through the hot top structure and provide a protective heat barrier therefor, said panel insert unit comprising a plurality of insert panels having front sides for defining portions of the tapered opening through the hot top structure and back sides, a flexible corrugated cardboard connected to the back sides of said insert panels so as to be disposed between the panels and said hot top structure when said unit is emplaced therein, said insert panels having converging sides with the adjacent sides of adjacent insert panels being positioned in a parallel relation to each other when connected, said cardboard interconnecting said insert panels for relative angular movement from relative positions wherein the panels are disposed in a side-by-side relationship to edge abutting positions with adjacent edge surfaces of the panels in engagement over a substantial area substantially throughout the length of the edges, said insert panels being comprised of a refractory insulating material and a heat-destructible binder and said cardboard being adapted to provide a venting space between said insert panels defining said tapered opening and said hot top structure.

5. In a hot top including a hollow hot top structure to be supported at the upper end of an ingot mold, the improvement comprising a multiple panel insert unit providing a protective heat barrier for the hot top structure and comprising a plurality of insert panels having front sides defining portions of a central opening through the hot top structure and back sides facing the hot structure, a flexible corrugated cardboard connected to the back sides of the insert panels and disposed between the insert panels and the hot top structure and interconnecting said insert panels for relative angular movement from relative positions wherein said panels are disposed in a side-by-side relationship with adjacent edge surfaces of the panels facing each other to edge abutting positions with adjacent edge surfaces of the panels in engagement over a substantial area substantially throughout the length of the edges, said panels being comprised of a refractory insulating material and a heat-destructible binder and said cardboard functioning to provide a venting space between said insert panels and the hot top structure.

6. In a hot top as defined in claim **5**, a bottom refractory ring having a portion engageable with a portion

of the underside of the insert unit for supporting the insert unit in the hot top structure.

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