Feb. 19, 1963 BO MAGNUS TIGERSCHIOLD 3,077,646

PROCESS FOR PRODUCING HOT TOPS

Filed Sept. 9, 1958 3 Sheets-Sheet 1

Fig. 1.

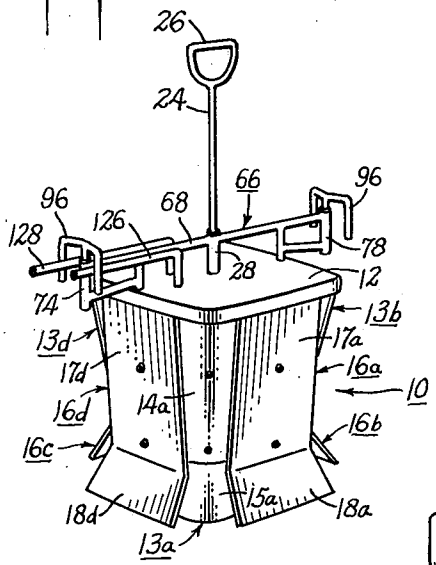


Fig. 2.

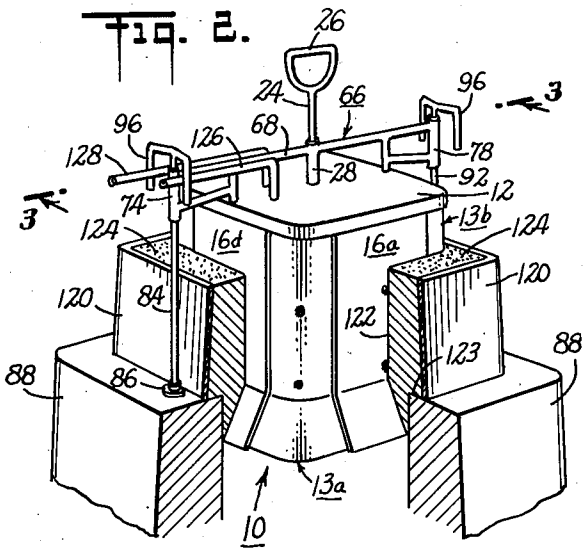
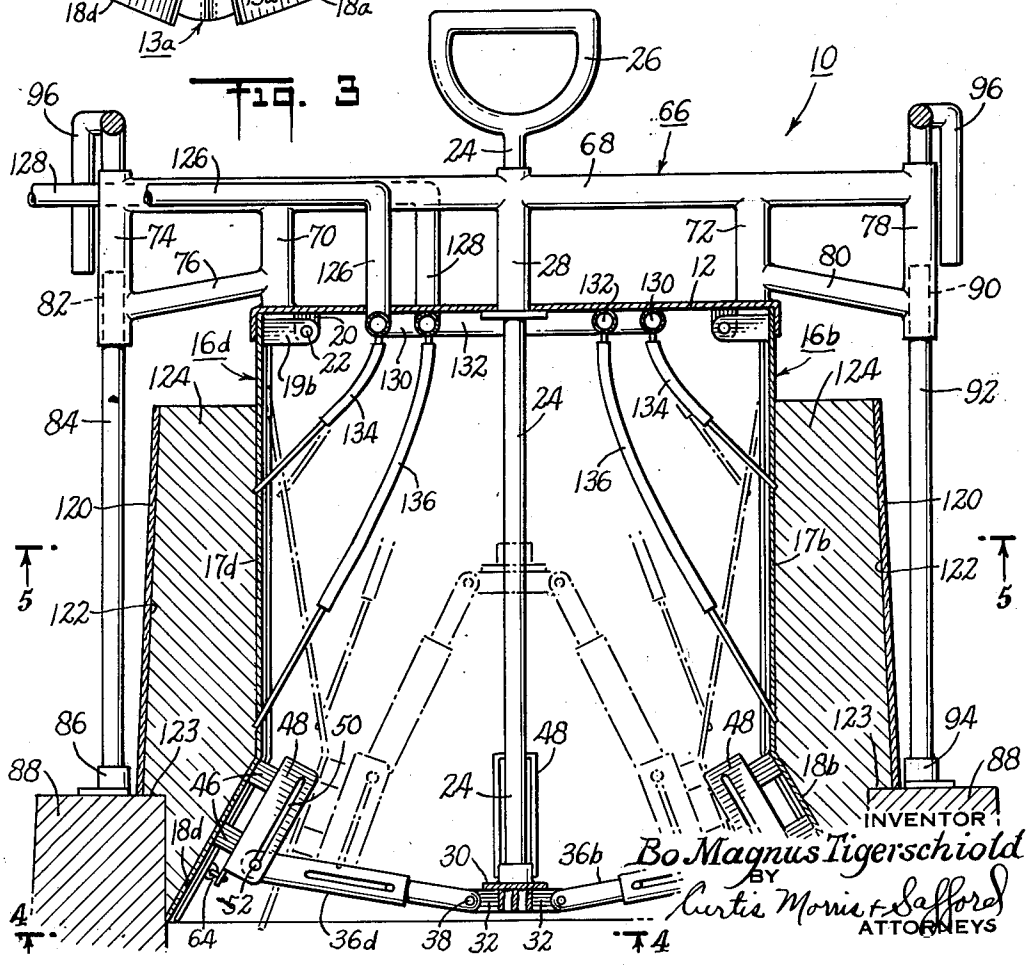


Fig. 3



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Fig. 4

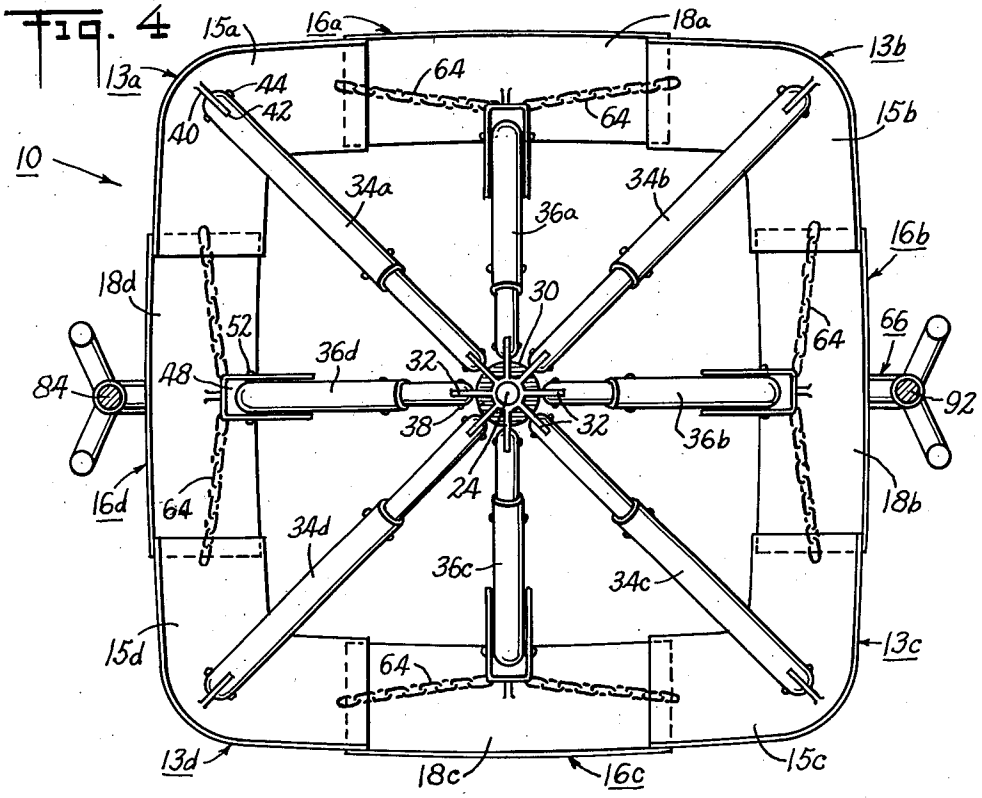
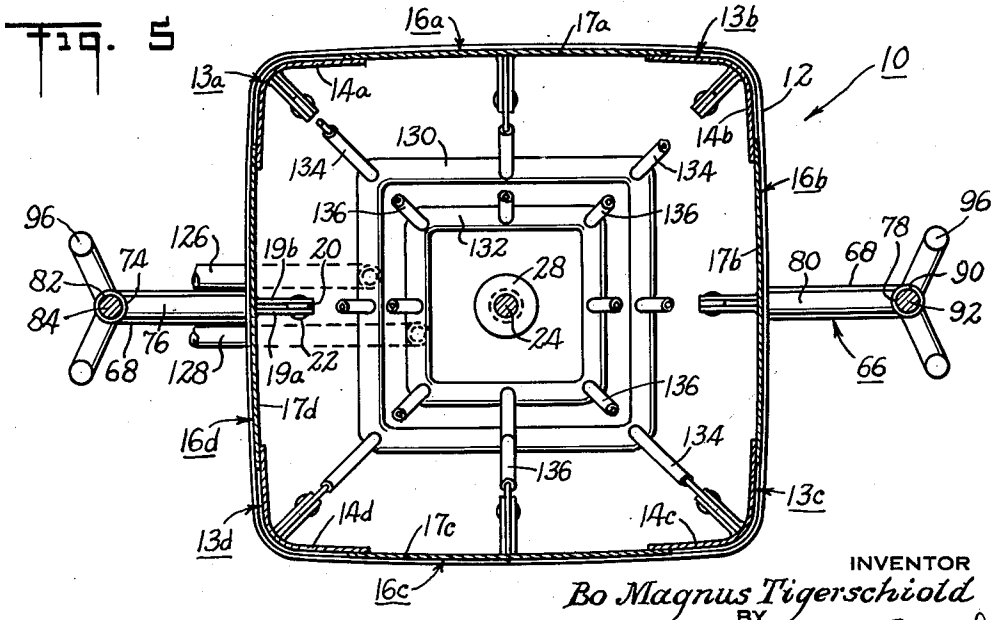


Fig. 5



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Fig. 6

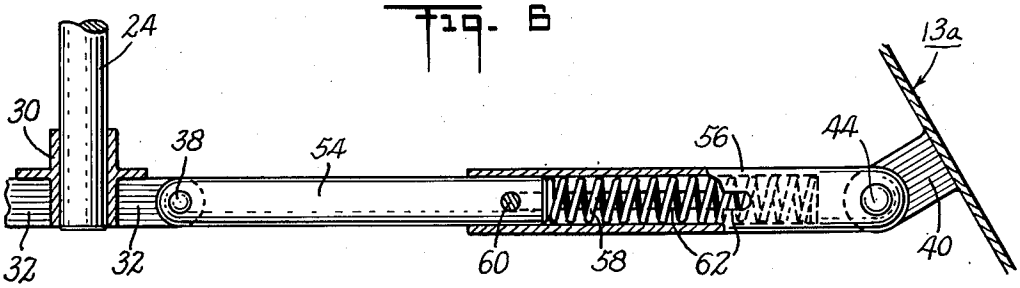


Fig. 7

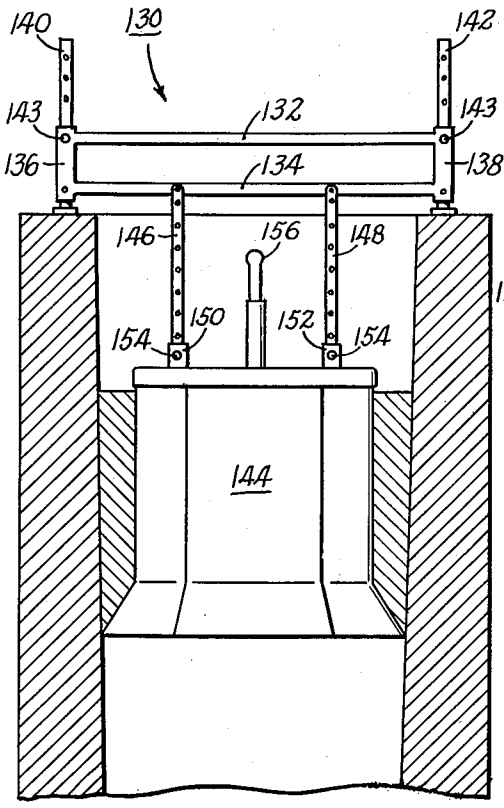
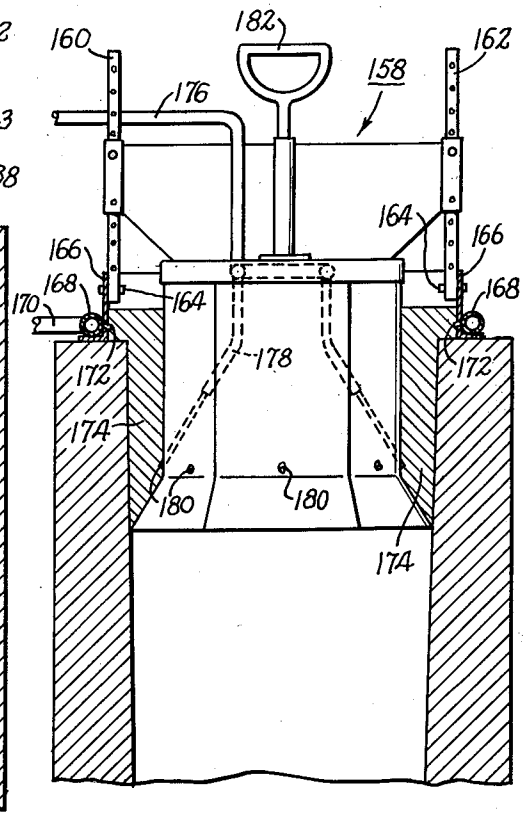


Fig. 8



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PROCESS FOR PRODUCING HOT TOPS

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Filed Sept. 9, 1958, Ser. No. 759,885
Claims priority, application Sweden Dec. 20, 1954
6 Claims. (Cl. 22—192)

In the casting of steel ingots the soundness of the ingots and their freedom from shrinkage cavities are insured by the use of a so-called "hot top" which generally consists of a refractory form placed on top of the mold in which the ingot is to be cast or inserted partially or entirely into the mold prior to pouring of the metal into the mold. The hot top operates to decrease heat losses from the upper portion of the body of metal that is poured into the mold and thereby maintains a reservoir of molten metal near the top of the mold. As the main body of metal in the mold shrinks upon cooling, molten metal from this reservoir flows into the main portion of the mold and thus prevents formation of shrinkage cavities therein.

The metal within the hot top may be kept molten by any of several methods, i.e. by adding additional quantities of molten metal from time to time after the first pouring or by the use of "pipe eliminators" which are placed on top of the molten metal within the hot top and either burn to generate heat or enter into exothermic chemical reactions to keep the metal liquid. Refractory heat insulators, e.g. "fuller's earth," are also sometimes used as "pipe eliminators."

In the casting of small ingots, these hot tops may take the form of fire clay shells which may be preheated before being placed on the mold. In the casting of large ingots hot tops may be in sections formed of fire clay bricks. In some countries a rammed-in type of hot top is commonly used, especially in the casting of small "big end up" ingots. In this case a refractory material such as silica sand is mixed with a binder and rammed between a template and a recess of the upper part of the mold. The template used is so shaped that it diverges upwardly and hence can be removed after formation of the hot top without damaging the molded refractory lining. Thus, this type of hot-top has its widest cross-section at the top end which is disadvantageous in respect to yield when rolling the ingot into smaller sections or billets. These difficulties increase with the size of the ingot.

When compared with other types of hot tops the rammed-in type has the advantage that it is essentially integral with the mold, and there are no spaces between the hot top and the mold into which the liquid metal can enter. When the nature of the hot top is such that there are spaces between the hot top and the mold, the liquid metal may enter these spaces and unite with the top of the mold, thereby preventing free shrinkage from taking place. If such union occurs ruptured ingots may result.

A special type of rammed-in hot top is known in connection with "big end down" molds. In this case there is inserted into the mold an adjustable stand which rests on the floor or other support upon which the ingot mold rests. On this stand at a desired height within the mold a template is placed which converges toward the top end of the mold and fits against the walls of the mold to form a trough within which a hot top mass may be inserted. A refractory lining is then rammed between the template and the mold wall. Thereafter the mold is lifted from its support thereby disengaging the template from the hot top so that the template and its associated stand in effect are removed from the open bottom end

of the mold. This method of making hot tops is rather complicated and expensive as it takes a comparatively long time to erect and fit such a stand and template in the mold and to remove them after the ramming of the hot top is completed. Another drawback of this type of hot top is that it can be used only for "big end down" molds.

In accordance with the present invention the difficulties outlined above are avoided by using a novel type of expansible and collapsible template to produce rammed in hot tops that converge upward. In a preferred embodiment of the present method a hot top is produced in a mold adapted to be used for the casting of steel or other metals by introducing at least partially into the mold an expansible and collapsible template that is in its collapsed condition and then expanding the template to bring the lower portions thereof to bear against the inside walls of the mold to form a trough therebetween. A refractory mass is introduced into the trough between the template and the mold and caused to harden therein, after which the template is collapsed or taken apart and lifted out of the mold. By making the template collapsible or demountable it is easy to remove it from the mold after the refractory mass has been formed, whether the mold has its greater cross-section at the top or the bottom and whether the mold is closed or open at the bottom end.

The present method of manufacturing hot tops for casting molds provides a number of advantages over methods that have been previously used, among which the following advantages may be mentioned:

(1) The hot top is very cheap to manufacture due partly to the fact that the collapsible (or otherwise demountable) template employed may be used over and over again and partly to the fact that the hot top material may consist of inexpensive substances such as silica sand, granulated slag or the like combined with a suitable adhesive or mixed with suitable chemical agents for hardening. For example, the hot top material may be mixed with a water glass solution and after it is introduced into the trough between the template and mold, a hardening fluid such as carbon dioxide gas may be passed through the mixture to convert the mass into a self-sustaining body adhering to the inner wall of the mold. The making of hot tops according to this procedure has been found to require only a short time and to involve relatively little labor.

(2) When using the present method, no recess around the upper end of the molding surface of the mold is required, and hence the height of the hot top within the mold may be readily varied so that a particular mold may be used to produce ingots of different weights. It is also easy to vary the size of the hot top proper by ramming it to different heights and thus to make it of a suitable size for the particular type of steel being produced.

(3) When separate hot tops are used which are placed on top of the mold, it is sometimes necessary to plane or otherwise machine the top of the mold so that the hot top will fit properly thereon. When hot tops are made according to the present method the need for such careful surfacing of the top of the mold is eliminated.

(4) The present method shares with other methods of producing rammed-in hot tops the advantage that no spaces can be formed between the hot top and the mold where the liquid metal can enter, thereby uniting the hot top metal with the metal of the mold and thus preventing free shrinkage from taking place. If such union occurs ruptured ingots may result.

(5) The template used in the present method may be generally bell-shaped or hood-shaped with a closed upper end that prevents any hot top material from falling into the mold during the ramming process.

(6) A hot top formed according to the present method need not be located completely within the mold. The template may if desired be placed so that only the lower portion thereof is introduced into the mold. A hot top mass is then placed around the relatively small part of the template which is inserted into the mold, as well as around that portion of the template which projects above the mold. By forming only a small part of the hot top within the mold a relatively high yield of useful metal can be obtained from a given size of mold and the mold weight per ton of ingot, is reduced. Also it is easier to strip the ingot from the mold when the sink head extends above the upper end of the mold. Moreover the heat-insulating properties of the hot top may also be improved, since it is possible to make the upper portion of the hot top thicker than would be possible where the hot top is entirely inserted into the mold.

(7) Since the hot top converges toward the top of the mold, the ingot cast in the mold has a relatively small uninsulated upper surface and there is less consumption of "pipe eliminator" in cases where a pipe eliminator is used.

(8) A further and important advantage of the method of the present invention is that it makes readily possible the casting of an ingot having an upper portion with a pre-determined frusto-pyramidal configuration. It has been found that the amount of useful metal recovered from an ingot during the rolling operation can be substantially enhanced by forming the upper end of the ingot with a frusto-pyramidal configuration such that the angle of the pyramid and the percentage reduction in the cross-dimension of the pyramidal portion of the ingot are maintained within certain specified ranges. More particularly it has been found that if the ingot is cast with an upper end having a converging taper between 25° and 40° with respect to the vertical and having a total reduction in its cross-dimension of about 40% to 60%, excessive over-rolling of the outer portion of the ingot during the subsequent rolling operation can be avoided and the portion of the ingot which must be cropped and rejected can be reduced to a minimum. As pointed out in more detail hereafter, by using the method and template of the present invention, casting of ingots having pyramidal upper ends which meet these requirements can be readily achieved.

In cases where a hot top is to be formed that extends above the top of the mold, it may be desirable to arrange a collar formed of a suitable material, e.g. steel plate, on top of the mold. This collar preferably converges upwards for easy removal. The collar serves to support the upper portion of the hot top mass during its formation. If the hot top mass has sufficient strength or can be treated to give it sufficient strength, the collar may be removed before casting the ingot. If the hot top mass does not have sufficient strength, the collar is left in position during the casting operation. In those cases where only a small portion of the template extends above the mold, it has been found unnecessary to use a collar on the top of the mold.

In the previous description reference has been made only to casting of steel or other metal ingots in molds. The method of the invention can also be used to form a refractory insert in a riser in the manufacture of castings of steel or any other metal. The present method and template can be used to form an upwardly converging refractory insert in the riser of a casting mold in essentially the same manner in which they are used to form a hot top in the casting of ingots as described in detail herein.

It is accordingly an object of the present invention to provide an improved method of forming hot tops for casting molds to be used in casting steel or other metals. It is another object of the invention to provide a novel collapsible template for use in making such hot tops. It is still another object of the invention to provide a casting mold having a hot top at the upper end thereof, which hot top has a predetermined angle of convergence and a predetermined reduction in its cross dimensions to provide an ingot having improved rolling characteristics. Other objects of the invention will be in part obvious and in part pointed out hereafter.

The many objects and advantages of the present invention can be best understood and appreciated by reference to the accompanying drawings which illustrate templates incorporating a preferred embodiment and two modifications of the present invention.

In the drawings:

FIGURE 1 is a perspective view of a template incorporating the invention and showing the general relationship between the parts thereof;

FIGURE 2 is a perspective view of the template supported on the top of a mold and in its expanded position, with a hot top formed in the trough defined by the template and the mold;

FIGURE 3 is a vertical section taken on the line 3—3 of FIGURE 2 and particularly showing the linkage mechanism for expanding the sides of the template and the flexible tubes for conducting a hardening fluid to the hot top mass;

FIGURE 4 is a bottom view of the template further showing the linkage mechanism for expanding and collapsing the template;

FIGURE 5 is a section taken on the line 5—5 of FIGURE 3 looking up toward the top of the template and particularly showing the manifolds for the hardening fluid and portions of the branch conduits that lead therefrom;

FIGURE 6 is a detailed view of one of the side plate actuating links showing the arrangement of the spring therein;

FIGURE 7 is a side view of a modified form of template which includes adjustable supporting members whereby the bell portion of the template can be located completely within the mold and its height within the mold can be varied; and

FIGURE 8 is still another modified form of template that includes a peripheral supply conduit for the hardening fluid.

Referring to the drawings and more particularly to FIGURES 1 and 4, the template there shown which is designated as a whole by the numeral **10** is of a generally bell-shaped or hood-shaped configuration and comprises a top **12** and a series of relatively slideable overlapping plates that form the expansible and collapsible side walls of the template. More particularly the side portions of the template comprise four corner plates **13***a*, **13***b*, **13**c and **13***d* and four side plates **16***a*, **16***b*, **16***c* and **16***d* that overlap the corner plates. As shown in FIGURE 1, the template **10** flares outwardly near its lower end. More particularly each of the corner plates **13***a* to **13***d* comprises an upper section **14***a* to **14***d* respectively which is substantially vertical when the template is in its expanded position and a lower section **15***a* to **15***d* respectively which extends obliquely downward and outward from the bottom of the upper section **14***a* to **14***d*. In like manner each of the side plates **16***a* to **16***d* comprises an upper section **17***a* to **17***d* respectively and outwardly flaring lower section **18***a* to **18***d* respectively. As will be more fully pointed out hereafter, the purpose of the outward flare at the bottom of the template is to provide the hot top with a converging section that will properly shape the upper portion of the ingot.

As best shown in FIGURES 3 and 5 the side plates and corner plates are pivotally suspended from the top **12**. More particularly the side plate **16***d* has secured to its upper edge a pair of ears **19***a* and **19***b* that embrace a tab **20** secured to the top **12**. A pivot pin **22** extends through the ears **19***a* and **19***b* and the tab **20** to provide a pivot connection so that the side plate **16***d* can swing inwardly and outwardly as the template is collapsed or expanded. The other side plates **16***a* to **16***c* and the corner plates **14***a* to **14***d* are similarly suspended from the top **12**.

Still referring to FIGURE 3, collapsing and expanding

movement of the template is effected by means of a vertically reciprocable, axially located actuating rod **24** having a handle **26** at its upper end. The actuating rod **24** is slidable in a hollow post **28** that is secured to the top **12**. The actuating rod **24** is connected to the side plates **16***a* to **16***d* and corner plates **13***a* to **13***d* through a series of resilient links. As shown in FIGURES 3 and 4, the bottom of actuating arm **24** is provided with a fitting **30** having a series of radial tabs **32** to which the resilient links are pivotably connected.

Referring particularly to FIGURE 4, the fitting **30** is connected to the corner plates **14***a* to **14***d* by the resilient links **34***a* to **34***b* respectively. Similarly fitting **30** is connected to the side plates **16***a* to **16***d* by the somewhat shorter resilient links **36***a* to **36***d* respectively.

The mode of connection of the links **34***a* to **34***d* and **36***a* to **36***d* to the fitting **30** and the side plates and corner plates is illustrated in FIGURES 3 and 4. The end of link **34***a* nearest the actuating rod **24** is bifurcated and receives one of the tabs **32**. A pivot pin **38** extends through the inner end of the link and the associated tab **32** to provide a pivot connection between the link and actuating arm. The inner ends of the other resilient links are similarly connected to the actuating arm.

The connections of the resilient links to the corner plates are somewhat different from the connections of the links to the side plates. Still referring to FIGURE 4, the lower sections **15***a* to **15***d* of the corner plates **13***a* to **13***d* are each provided with an upstanding tab **40** that fits into a slot **42** formed in the outer end of one of the resilient links **34***a* to **34***d*. Tab **40** held in place in slot **42** by a pivot pin **44** to provide a pivot connection between the resilient link and corner plate.

The connections of the outer ends of links **36***a* to **36***d* to the side plates **16***a* to **16***d* respectively can be most conveniently described in relation to link **36***d* as shown in FIGURES 3 and 4. Mounted on the section **18***d* of plate **16***d* by means of a pair of tabs **46** there is a U-shaped yoke **48** having a slot **50** formed in the sides thereof. The outer end of link **36***d* is positioned in the yoke **48** and secured for sliding movement in slot **50** by a pin **52**. The slotted connection between links **36***a* to **36***d* and side plates **16***a* to **16***d* respectively is provided because of the fact that these links are shorter than the links **34***a* to **34***d* which are connected to the corner plates. If links **36***a* to **36***d* were rigidly connected to their respective side plates they would tend, as the actuating rod **24** is moved upwardly, to draw the side plates in more rapidly than the corner plates are drawn in by links **34***a* to **34***d* and thus prevent proper collapsing of the template.

As has been previously indicated, the links **34***a* to **34***d* and **36***a* to **36***d* are resiliently compressible. As best shown in FIGURE 6 of the drawing, each of the links comprises a pair of telescoping sections **54** and **56**. The telescoping section **56** is tubular and has positioned therein a spiral spring **58** which bears against one end of the telescoping section **54**. A pin **60** is provided which extends through the end of telescoping section **54** and through a pair of slots **62** formed in the tubular telescoping section **56**. The construction is such that the links are axially compressible against the resilient resistance of spring **58**, and relative movement of the telescoping sections **54** and **56** is limited by motion of pin **60** in slot **62**. As will be more fully pointed out hereafter the links are made compressible to cause the lower edges of template **10** to bear resiliently against the inner walls of an ingot mold when the template is expanded therein.

The operation of the apparatus so far described should be largely apparent from the foregoing description. Referring particularly to FIGURE 3, as the actuating rod **24** is drawn upwardly by means of handle **26**, the inner ends of links **34***a* to **34***d* and **36***a* to **36***d* are drawn upwardly thus pulling the side plates and corner plates of the template inwardly to collapse the template. Similarly when the handle **26** is pressed downwardly the links force the side plates and corner plates outwardly around their pivoted upper ends. As best shown in FIGURE 4, the lower end of each of the corner plates **13***a* to **13***d* is connected to each of the two adjacent side plates by the chains **64** which insure that the desired overlapping relationship between the side plates and corner plates will be maintained, particularly when the template is in its expanded position.

Referring again to FIGURE 3 of the drawings, it will be noted that when the template is in its expanded position the horizontal plane containing the pivots **38** is below the plane of pivots **52**. This over-centering of the linkage mechanism serves to latch the template in its expanded position when the lower rim of the template has pressed against the mold wall as more fully described hereafter.

The manner in which the template may be mounted on a mold is illustrated in FIGURES 2 and 3 of the drawings. Secured to the top **12** of the template there is a mounting frame, generally designated by the numeral **66**, and comprising a cross-bar **68** which is secured to top **12** through the post **28** previously referred to as well as through the posts **70** and **72**. At its left end cross-bar **68** is secured to a vertical support member **74** which is also secured through a brace **76** to post **70**. Similarly at its right-hand end, cross bar **68** is provided with a support member **78** secured through brace **80** to post **72**. Support member **74** has recess **82** formed in its lower end into which fits the upper end of a supporting leg **84** having a foot **86** that rests upon the top of an ingot mold **88**. In like manner, support member **78** has a recess **90** into which fits the upper end of a leg **92** having a foot **94** that rests on the top of mold **88**. Thus the template is supported through the frame **66** on top of the mold in such manner that a portion of the template extends into the mold.

The template is normally introduced into the mold, in a collapsed state indicated by the dotted lines in FIGURE 3 and then actuating handle **26** is pressed downwardly to force the side and corner plates of the template outwardly as previously described and cause the lower edges of these plates to be pressed against the inner walls of the mold **88**. Since the links **34***a* to **34***d* and **36***a* to **36***d* are axially compressible against spring action, the plates are resiliently urged against the mold walls. The template is latched into position by over-centering of the linkage mechanism as previously described.

As previously indicated, it is desirable that the template be so constructed, that it may be introduced different distances into mold. Variation of the vertical position of the template in relation to the mold can be achieved in various ways. For example, supporting legs **84** and **92** of different lengths may be used. In the construction shown in FIGURES 1 to 5 of the drawings, the outer ends of the cross-bar **68** are provided with the relatively short legs **96** by means of which the template can be supported when it is desired to position the collapsible portions of the template entirely within the mold.

The manner in which the template is used is particularly illustrated in FIGURE 2 of the drawings. In cases where the template is to be introduced only a small distance into the mold, there is placed on top of the mold **88** a thin-walled metal ring or collar **120** that has a slight upward convergence. The template **10** in its collapsed position is introduced into the mold to the extent permitted by legs **84** and **92**, and handle **26** is then pressed downwardly to cause the lower ends of the pivoted plates of the template to be urged resiliently against the inner walls of the mold. The ring **120** and the interior walls of mold **88** define with the pivoted plates of the template **10** an annular trough **122** into which a suitable hot top mass **124** is introduced. It will be noted that the bottom of ring **120** is spaced outwardly from the interior of mold **88** to form a shoulder **123** that causes a portion of the hot top

mass to overlap the top of the mold, thereby providing additional support for the hot top.

The material of which the hot top is formed may be any of those materials that have conveniently been used for forming the rammed-in type of hot top, such as silica sand crushed slag and the like. The hot top mass desirably includes a hardening agent such as a sodium silicate solution, e.g. water glass, which causes hardening of the mass and strong adhesion to the mold walls.

In order to promote rapid hardening of the hot top mass after it has been introduced into trough **122**, it is desirable that a hardening fluid such as carbon dioxide be supplied thereto, and means for supplying such a hardening fluid to the hot top mass are illustrated in the drawings. Referring to FIGURES 1 and 2, the hardening fluid is supplied to the interior of the template through a pair of conduits **126** and **128**. As best shown in FIGURE 5 of the drawings, conduits **126** and **128** pass through the top **12** of the template and are connected to a pair of manifolds **130** and **132**, secured to the underside of the top of the template. The manifold **130** (see also FIGURE 3) is connected by a series of flexible branch conduits **134** to each of the side plates and corner plates of the template at points located somewhat above the middle of the template. Similarly the manifold **132** is connected by flexible tubes **136** to each of the side plates and corner plates at points somewhat below the middle of the template. The discharge ends of the flexible tubes **134** and **136** open into the hot top mass in such manner as to cause the hardening fluid to flow therethrough and permeate the hot top mass. By using two separate manifolds the hardening fluid can be introduced into the hot top mass at different points under different pressures. Thus uniform distribution of the hardening fluid throughout the hot top mass can be more rapidly achieved.

It has been found that by feeding the hardening fluid to the hot top mass at a plurality of points that are both vertically and circumferentially spaced with respect to one another, hardening of the mass can be effected in no more than a few minutes' time. Thereafter the handle **26** is pulled upward to collapse the template and the template is lifted from the mold, leaving the hardened hot top adhering to the upper part of the mold.

In the introductory portion of the present specification it was pointed out that the yield of useful metal from an ingot can be enhanced by forming the ingot with a frusto-pyramidal upper portion having an angle of 25° to 40° and a reduction in cross-dimensions of 40% to 60%. The present template provides a means of shaping the hot top mass to achieve this objective. Thus the lower sections **15***a* to **15***d* of corner plates **13***a* to **13***d* and the lower sections **18***a* to **18***d* of side plates **16***a* to **16***d* may be formed with a slant height such as to cause the converging portion of the hot top to have a reduction in internal cross-dimensions of 40% to 60%. Also the lower section of each plate may form with the upper section an obtuse angle of 140° to 155°, thus providing a hot top having the desired angle of convergence, i.e. 25° to 40°. Hot tops having other specialized configurations can be formed by suitable modification of the side plates and corner plates of the template.

Turning now to FIGURE 7 of the drawings, the template there shown is particularly adapted to be used in cases where the bell portion of the template is positioned well within the mold. The template of FIGURE 7 has a supporting frame **130** comprising the cross-bars **132** and **134** and the hollow uprights **136** and **138**. Slideable within the uprights **136** and **138** are the perforated supporting legs **140** and **142** respectively that rest on the top of the mold. Removable pins **143** are provided that extend through uprights **136** and **138** and the holes of legs **140** and **142**. The construction is such that the uprights may be adjusted upwardly or downwardly on legs **140** and **142** to adjust the height of frame **130** with respect to the mold.

The bell portion of the template, identified by numeral **144**, is mounted on frame **130** by means of the perforated supporting members **146** and **148** that are slideable through collars **150** and **152** respectively secured to the top of the bell portion **144**. Pins **154** are provided to secure the bell **144** to supporting members **146** and **148**. The construction is such that the bell **144** can be adjusted vertically along the supporting members **146** and **148** to adjust the depth of the template within the mold.

The template includes a handle **156** that can be manually actuated to expand or collapse the template as previously described. The specific structure of bell **144** may be similar to that of FIGURE 1.

Another modified form of template is disclosed in FIGURE 8 of the drawings. The template of FIGURE 8 comprises a frame **158** and legs **160** and **162** generally similar to the corresponding portions of the templates of FIGURES 1 and 6. Pivotally connected to the lower ends of legs **160** and **162** by means of pins **164** there is a collar **166** shaped to conform with the top of the mold and adapted to rest thereon. Extending around the collar **166** and supported thereon is a distributing tube **168** to which a hardening fluid such as carbon dioxide can be supplied from a supply pipe **170**. The tube **168** is provided with inwardly directed discharge nozzles **172** through which carbon dioxide can be supplied to the hot top mass **174**. The flow of carbon dioxide through nozzles **172** supplements the flow of hardening gas through supply pipe **176**, distributing tubes **178** and openings **180** into the lower part of the hot top mass **174**.

In operation the template of FIGURE 8 is lowered into the mold until the collar **166** rests upon the top surface of the mold. Then, successively, the template is expanded by pushing down handle **182** until the slideable plates engage the inner walls of the mold, the hot top mass **174** containing water-glass is introduced into the space between the template and mold up to the level of collar **166** above tube **168**, and carbon dioxide is blown in through the lower openings **180** as well as through the nozzles **172** of collar **168** to promote hardening of the hot top mass.

After collapsing and removal of the template, the hot top will "hang" on the upper edge of the mold. Consequently this type of hot top may be used with advantage in molds having their big end down. It is evident that by positioning the template as indicated in FIGURE 2, a larger ingot can be made in a given size mold than when the template is positioned within the mold as in FIGURE 7.

From the foregoing description it should be apparent that the present invention provides a template and method of forming hot tops capable of achieving the objectives set forth at the beginning of the present specifications. It has been found that by using the present method and apparatus hot tops can be formed in a few minutes having good strength and adherence to the interior wall of the mold. The relative vertical positions of the template and mold can be readily varied so that hot tops can be formed which extend only slightly into the mold or which are entirely formed within the mold. In the latter case the use of a collar **120** as illustrated in FIGURE 2 is, of course, unnecessary.

It will of course be understood that numerous changes can be made in the structure disclosed without departing from the spirit of the invention as defined in the appended claims. Thus although the template illustratively described is substantially square in cross-section, it is evident that the template can be readily modified to have a circular, oval or rectangular cross-section if the mold with which the template is to be employed has such a configuration. Also the number of side plates can be varied as desired. Other modifications within the scope of the invention will be apparent to those skilled in the art.

This application is a continuation-in-part of my pend-

ing application Serial No. 552,609, filed December 12, 1955, now abandoned.

I claim:

1. In a method for forming a hot top selectively at any of a plurality of different levels within an ingot casting mold having substantially continuous side walls, the steps which comprise lowering an outwardly expansible template in the collapsed state thereof at least partially within the upper portion of said ingot mold to the selected level therein substantially below the top thereof, expanding the lower portion of said template outwardly and adjustably varying the cross-section of said template for bringing the lower edges thereof into engagement with said side walls of said mold substantially entirely therearound forming upwardly converging template surfaces defining with said mold walls a trough around the inside thereof with the configuration and at the level desired for said hot top, depositing in said trough a hardenable hot top mass including refractory material and a binder therefor, supplying a hardening fluid into said deposited mass effecting hardening of said binder to form said hot top affixed to and around the inner surface of said mold walls at said selected level therein, collapsing said expansible template inwardly to a cross-sectional dimension less than the smallest cross-sectional dimensions within said hardened hot top, and lifting said collapsed template from said mold and through said hot top to leave said hot top completed and finished in said mold and ready to receive molten metal cast thereinto.

2. The method as recited in claim 1 in which said binder for said refractory material in said hardenable hot top mass is a silicate binder, and in which said hardening fluid for said mass is carbon dioxide.

3. The method as recited in claim 1 in which said hardening fluid for said mass is supplied thereinto simultaneously at a plurality of spaced openings through said template.

4. The method as recited in claim 1 in which said upwardly converging template surfaces form correspondingly converging surfaces around the lower end of said hot top mass as formed in said casting mold.

5. The method as recited in claim 1 in which said expansible template is adjustably supported vertically within said mold at said selected level therein.

6. The method as recited in claim 4 in which said upwardly converging template surfaces form an angle of between 140° and 155° with the vertical axis of said mold and said template therein, and in which said upwardly converging template surfaces have slant heights such that the cross-sectional dimension defined by the upper edge of said converging template surfaces in said expanded position thereof in said mold is 40% to 60% less than the cross-sectional dimension defined by the lower and outer edges of said converging template surfaces.

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