

[54] CONTINUOUS CASTING APPARATUS WITH STRAND SUPPORT MEANS

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[51] Int. Cl. **B22d 11/12**

[58] Field of Search..... **164/82, 89, 282,
164/283**

[56] References Cited

UNITED STATES PATENTS

2,895,190	7/1959	Bungeroth et al.	164/282
3,416,222	12/1968	Pearson	164/82 X
3,515,202	6/1970	Bick et al.....	164/89
3,580,325	5/1971	Schrewe.....	164/82
2,698,467	1/1955	Tarquihee et al.....	164/89
3,608,619	9/1971	Bollig et al.....	164/82 X

FOREIGN PATENTS OR APPLICATIONS

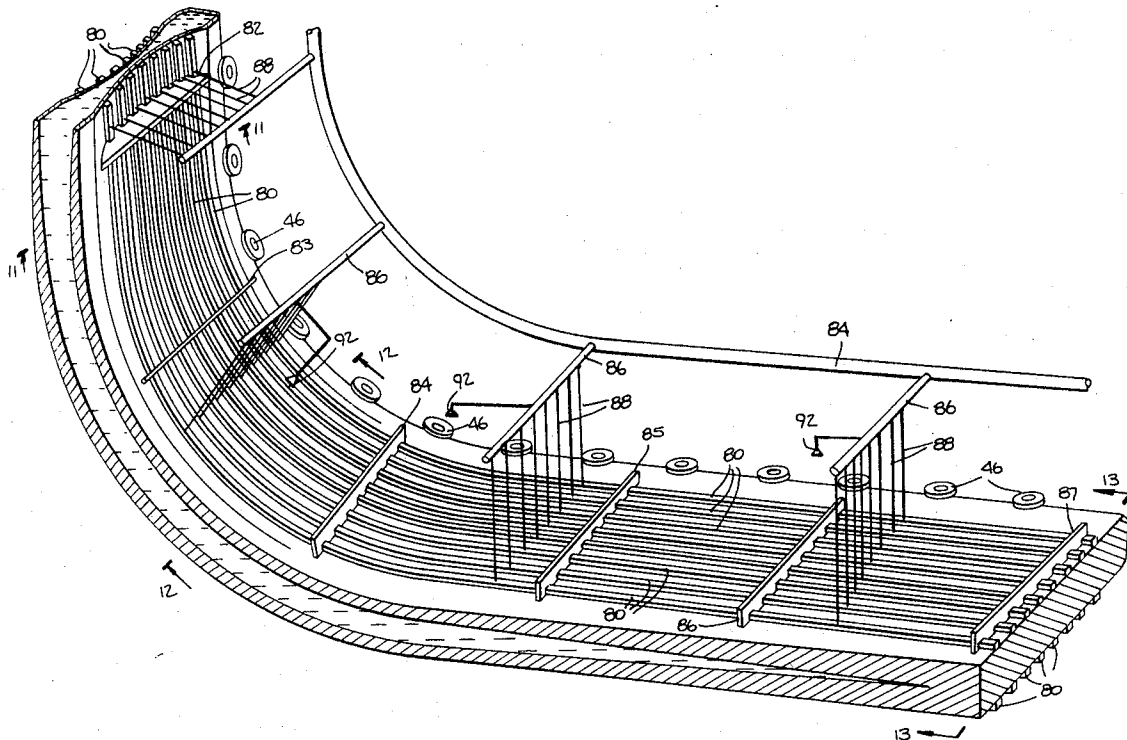
4,532,347	10/1970	Japan.....	164/89
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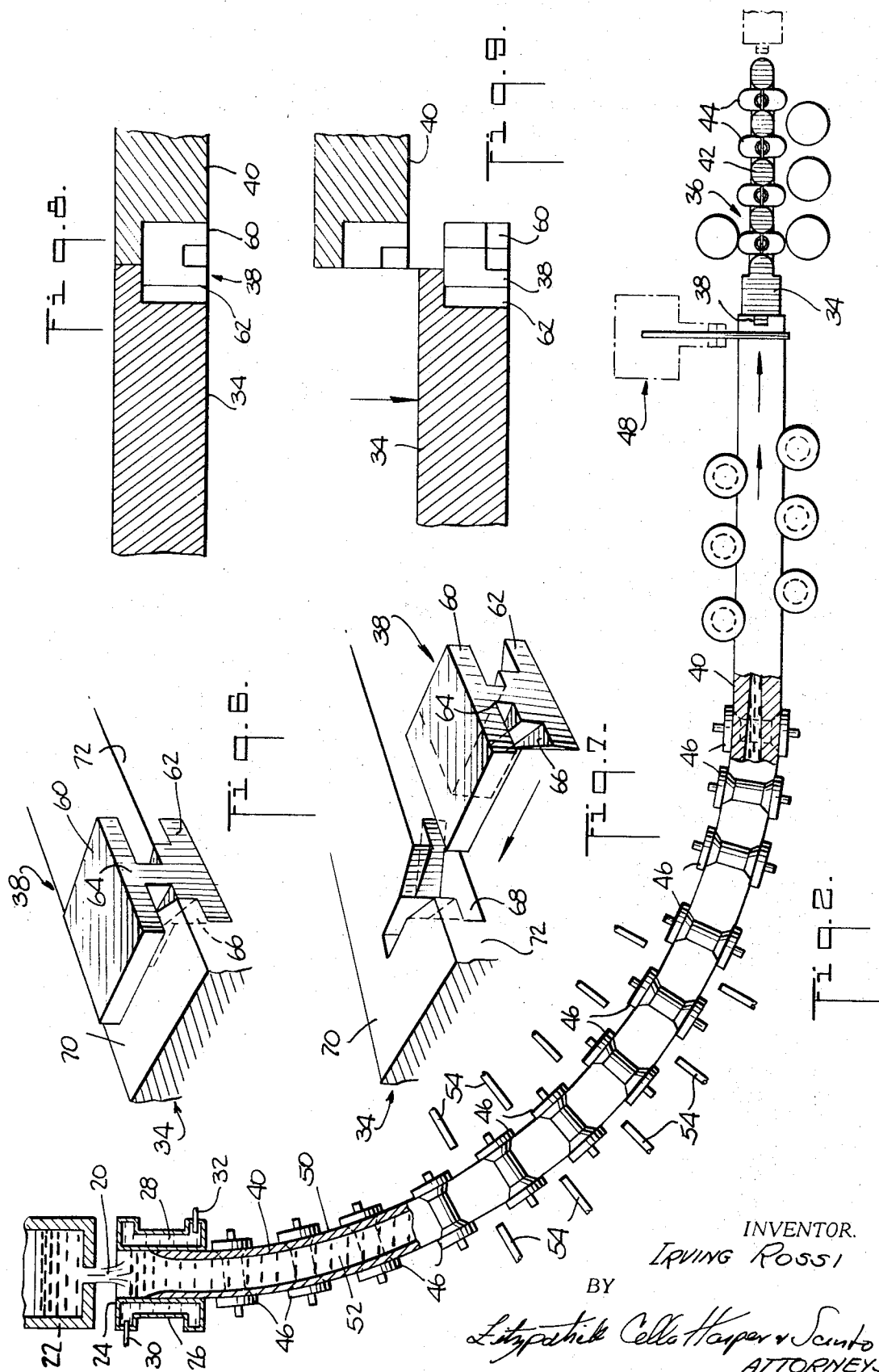
Primary Examiner—R. Spencer Annear
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[57] ABSTRACT

Metal in partially solidified form is pulled continuously from a hollow mold by means of a dummy slab which is thin in one dimension to bend about a curved path and which has aligner elements at its narrower edges to engage edge rolls for positioning the dummy slab. The dummy slab is also provided with removable knockout keys for disconnecting it from the cast metal. Special grid strips maintain the cast metal in an arched or concave configuration along its wide faces for rigidity and allow the wide faces to flatten out during solidification in a controlled manner so that the internal pressure of the metal will force it to a desired ultimate configuration.

26 Claims, 14 Drawing Figures



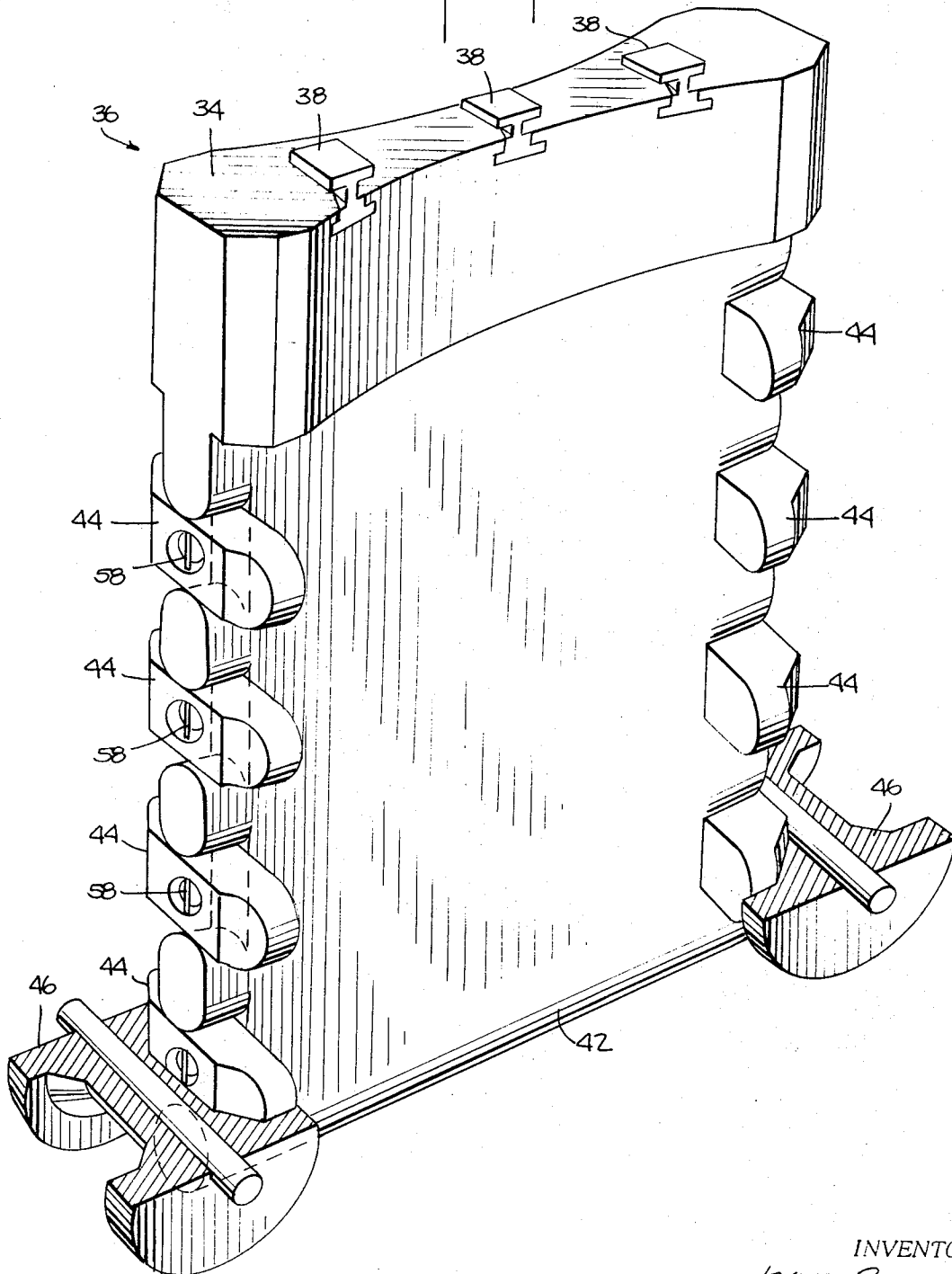


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Fig 4.

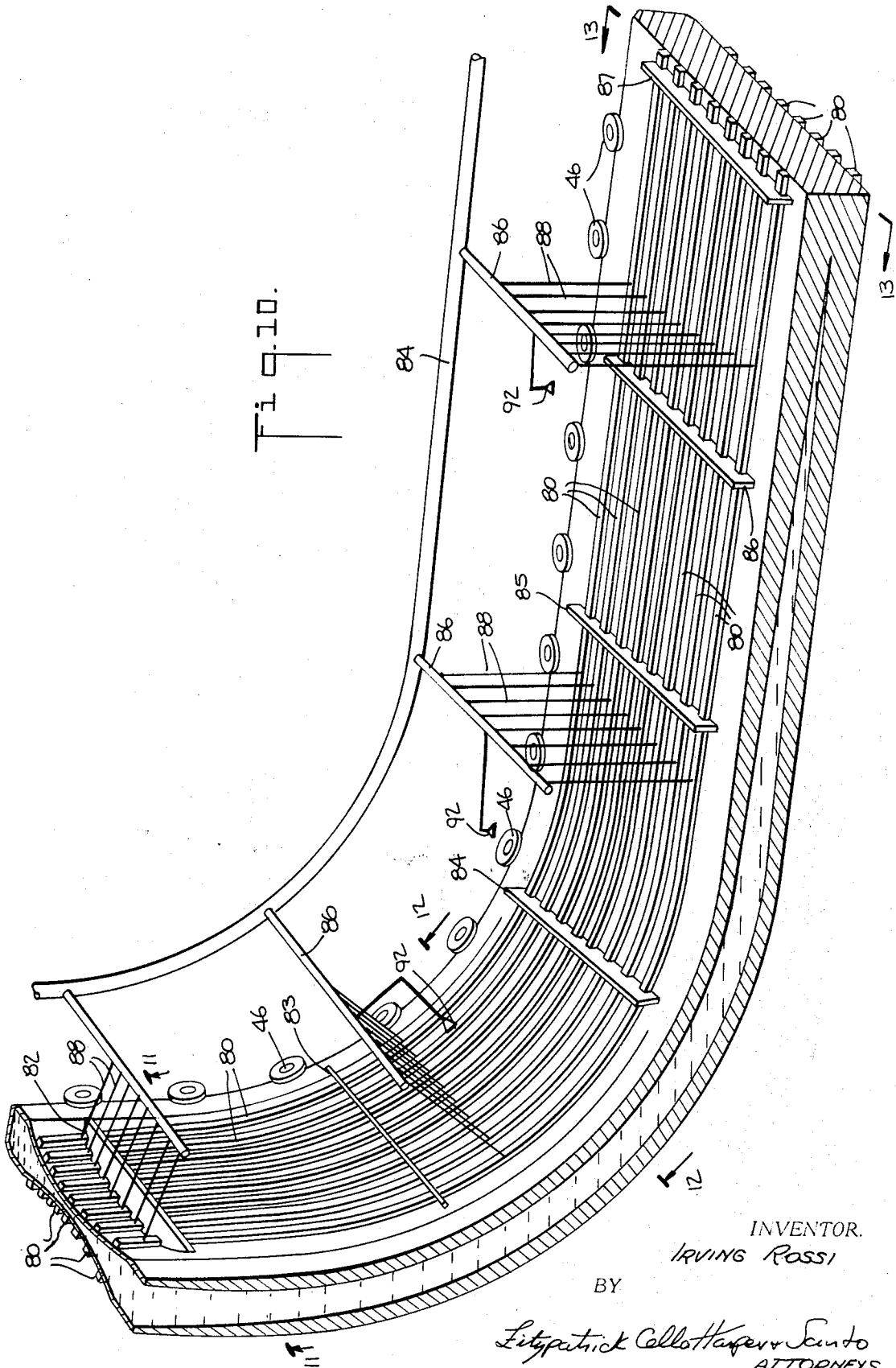


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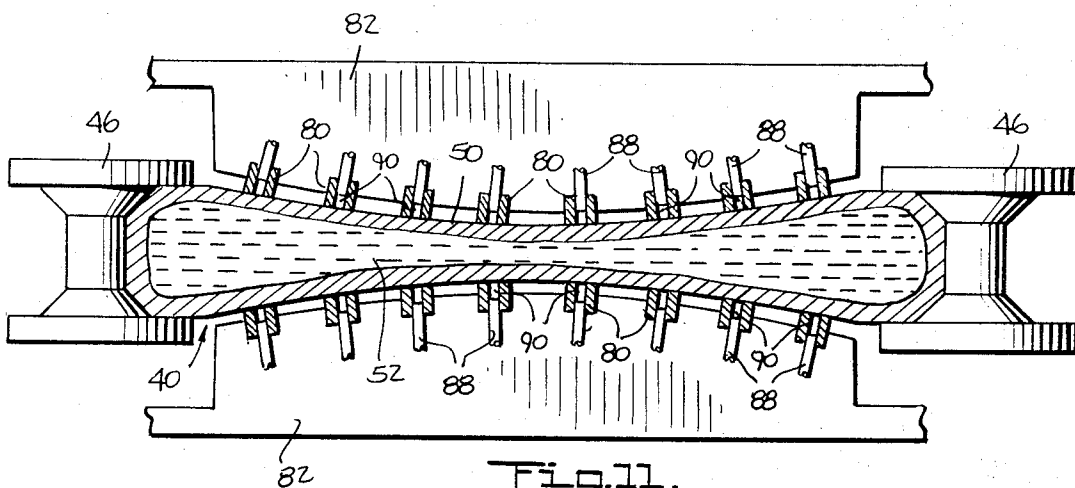


Fig. 11.

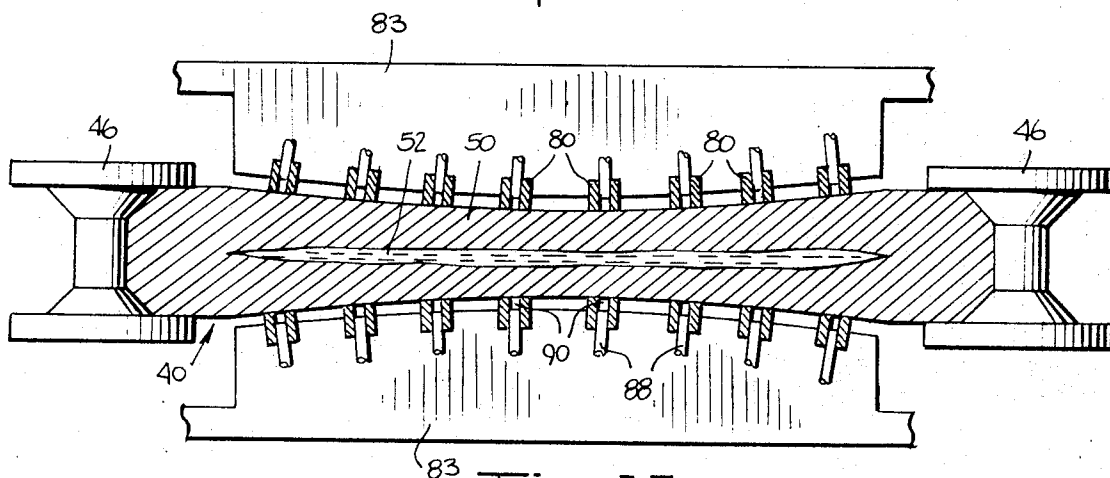


Fig. 12.

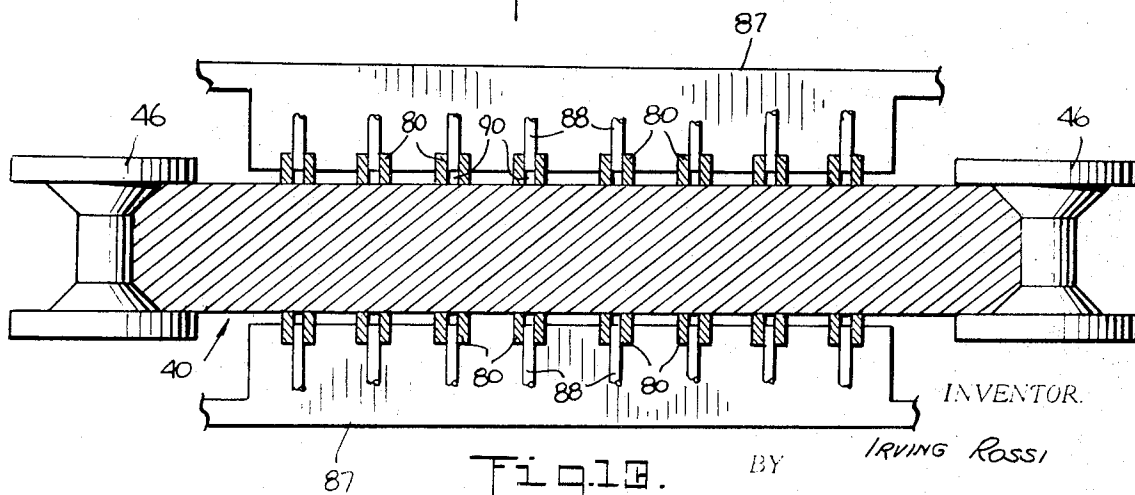
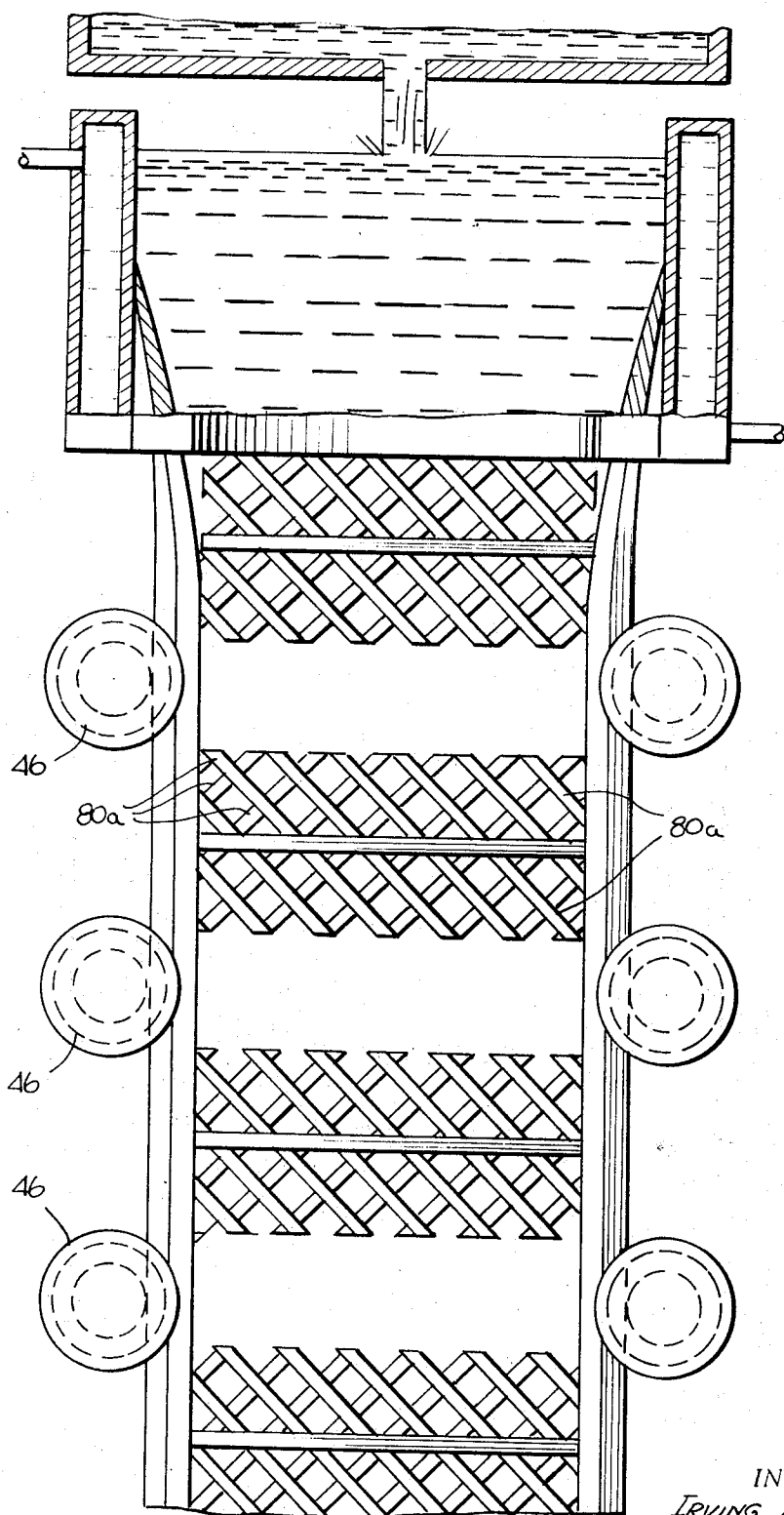


Fig. 13.

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Fig. 14.

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CONTINUOUS CASTING APPARATUS WITH STRAND SUPPORT MEANS

This invention relates to the continuous casting of a strand of metal and more particularly, it concerns novel methods and apparatus for handling the casting as it exits from the mold.

In my earlier filed copending applications Ser. No. 111,488, filed Feb. 1, 1971, Ser. No. 114,592, filed Feb. 11, 1971, there are described techniques for producing a slab of metal by the continuous casting of same from a mold. The mold has an open bottom which is initially sealed by a dummy slab. Molten metal is poured continuously into the mold at the top; and as a shell begins to solidify the dummy slab is withdrawn and draws the solidified shell with it.

As is pointed out in these prior applications, the casting exiting from the mold has an outer solidified shell and a liquid inner core. The core generates outward bulging forces due to ferrostatic pressure; and unless proper support is provided, the outer skin could rupture. This support is obtained, according to the prior applications, by means of special mold configurations and edge rolls which produce and maintain a cast slab cross-section which is curved concavely along its two longer sides. The support of the edge rolls, which operate against the shorter sides, maintain this concavity and the concavity, in turn, effectively buttresses the longer sides against the ferrostatic pressure of the molten inner core. Special grid strips are also provided, as described in the prior copending applications, to assist in maintaining the concave configuration of the slab after it exits from the mold.

The present invention provides various improvements to the above-described continuous casting arrangements. According to one feature of this invention, there is provided a novel dummy slab which enables the cast slab to be pulled downwardly from the mold and around to a horizontal position while maintaining the slab properly positioned between pressure applying edge rolls. This novel dummy slab includes a stopper portion and an integrally formed lead portion. The stopper portion has a cross-section which conforms to the interior of the mold and it serves to receive the initially cast metal. The novel dummy slab has a plurality of alignment elements along its edges. These alignment elements are shaped to engage the edge rolls and thereby keep the lead portion of the dummy slab centered between the rolls during drawing.

Special connecting keys for temporarily coupling the casting to the dummy slab are also provided. These keys each comprise a pair of wing portions extending generally parallel to each other and interconnected by a separating member which extends in a substantially perpendicular direction between them. The wing portions and separating member are coplanar along one edge which is flush with one edge of the stopper portion and the casting. This allows the keys to be knocked out after casting for subsequent reuse.

According to a further feature of the present invention, there are provided novel support grid arrangements which cooperate with the action of the ferrostatic pressure exerted by the molten metal within the cast slab to bring the slab from an initial concave contour to a final rectangular contour. These novel support grid arrangements comprise grid strips which extend along the concave surfaces of the cast slab and follow

it from the mold exit around to its final horizontal position. The grid strips, themselves, are supported to maintain initially the concave contour of the cast slab and to gradually allow the concavity to diminish as the casting advances. It is possible, by controlling the supporting configuration, and causing it to change during solidification, to make use of the ferrostatic pressure within the slab to obtain a casting of predetermined size and contour as it exits from the machine.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for carrying out the several purposes of the invention in different ways. It is important, therefore, that the claims be regarded as including such equivalent constructions and methods as do not depart from the spirit and scope of the invention.

Specific embodiments of the invention have been chosen for purposes of illustration and description, and are shown in the accompanying drawings, forming a part of the specification wherein:

FIG. 1 is an elevational view, partially in section, of a strand casting arrangement in which the present invention is embodied and wherein a dummy slab is positioned in a mold for initiation of a casting operation.

FIG. 2 is a view similar to FIG. 1 and showing the dummy slab after it has pulled a length of casting from the mold;

FIG. 3 is an enlarged cross-sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is an enlarged perspective view of the dummy slab in the arrangement of FIG. 1;

FIG. 5 is an enlarged cross-sectional view taken along line 5—5 of FIG. 1;

FIG. 6 is a fragmentary perspective view showing a strand-to-dummy slab locking key as fitted to the dummy slab;

FIG. 7 is a view similar to FIG. 6 showing the locking key removed from the dummy slab;

FIG. 8 is a view taken in the direction indicated by the arrows 8—8 of FIG. 6, but showing the interlocked arrangement of the dummy slab, the locking key and the end of a cast strand;

FIG. 9 is a view similar to FIG. 8, but showing the cast strand as separated from the locking key and the dummy slab;

FIG. 10 is a fragmentary perspective view illustrating a grid strip arrangement for controlling the cross-sectional configuration of a cast strand along a curved path from an initial vertical direction to a final horizontal direction;

FIG. 11 is an enlarged cross-sectional view taken along line 11—11 of FIG. 10;

FIG. 12 is an enlarged cross-sectional view taken along line 12—12 of FIG. 10;

FIG. 13 is an enlarged cross-sectional view taken along line 13—13 of FIG. 10; and

FIG. 14 is an enlarged elevational view, partially in section, showing an alternate grid strip arrangement.

In the casting arrangement of FIG. 1, molten metal 20, such as molten steel, is poured continuously from a pouring vessel 22 into a hollow tubular mold 24 which is open at both ends. The mold 24, which is preferably of copper, is formed with a surrounding jacket 26; and a coolant liquid 28, such as water, is circulated within the jacket. The coolant liquid is admitted to the interior of the jacket via a coolant inlet conduit 30 and is exhausted via an outlet conduit 32.

The molten metal 20 initially strikes the top of a massive stopper portion 34 of a dummy slab 36. This stopper portion fits closely into the open bottom end of the mold. The metal begins to solidify in the mold 24, and because of the cooling effect of the coolant liquid 28, this solidification begins on the internal mold surfaces. Further, the dummy slab 36 is made of a high thermal conductivity metal such as copper so that the molten metal in the mold 24 begins also to solidify at upper surface of the stopper portion 34 of the dummy slab. The stopper portion 34 is fitted with removable coupling keys 38 around which the molten metal solidifies; and this provides a secure interconnection between the solidifying metal and the dummy slab, enabling the dummy slab to pull the partially solidified metal out from the bottom of the mold 24 in the form of a strand 40, as shown in FIG. 2.

The dummy slab 36 is formed with a lead portion 42 which extends down from the stopper portion 34. A plurality of aligners 44 are secured along the narrow edges of the lead portion in closely spaced relationship. The detailed construction of the draw head 36 will be described hereinafter.

The dummy slab 36 passes down between sets of edge rolls 46 which engage the aligners 44. The edge rolls 46 are arranged to define a path which first extends downwardly from the mold 24 and then curves to a horizontal direction. As can be seen in FIG. 2, the strand 40 of cast metal follows the dummy slab 36 down between the edge rolls 46 and along a horizontal path indicated by an arrow A. A severing device 48 is provided to cut the cast strand 40 into discrete slabs of predetermined length. Drive means 49 are provided to drive rolls 51 which pull the strand 40 along from the mold 24 through the severing device 20. Also, as shown in FIG. 1 the drive means 49 are connected to turn some of the edge rolls 46 to assist in moving the strand 40 along. Since the strand 40 in this region is not fully solidified and has not yet achieved maximum tensile strength the application of driving power to the upper edge rolls serves to reduce pulling stresses on the strand.

As can be seen in FIG. 2, the cooling effect of the inner surfaces of the mold 24 causes initial solidification about the periphery of the strand 40 so that there is initially formed an outer skin 50 which provides a casing for a still molten inner core 52. As the strand 40 progresses away from the mold 24 and continues to cool, the thickness of the outer skin 50 increases while the molten core 52 correspondingly diminishes. The rate of movement of the strand 40 and the rate of cooling thereof (which may be controlled by application of watersprays from nozzles 54), determines the location at which complete solidification takes place.

The presence of the molten core 52 contained within the newly solidified outer skin 50 of the strand 40 provides a considerable degree of flexibility and allows the strand to follow a curved path between edge rolls 46 to

a horizontal path for severing and further handling. Where large slabs are to be formed, however, the outer skin often has not achieved sufficient thickness and strength to contain the still molten core 52. Accordingly, as described in prior applications, the strand 40, which is ultimately to have a rectangular cross-sectional configuration, is initially cast with its longer sides arched inwardly, as can be seen in the cross-sectional mold configuration shown in FIG. 3. The edge rolls 46 press inwardly against the shorter sides of the freshly cast strand 40 to support the arched configuration of the longer sides; and this enables the longer sides to contain the molten core 50 which exerts a continuous ferrostatic pressure in an outward direction.

Although the strand 40 is quite flexible in its partially molten condition and can pass along the curved path defined by the edge rolls 46, the stopper portion 34 of the dummy slab 36, which has the same cross-sectional configuration as the cast strand 40, is rigid and cannot bend. Accordingly, the stopper portion 36 is made quite short; and, as can be seen in FIG. 4, it can pass along the curved path defined by the edge rolls 46. The lead portion 42 of the dummy slab 36, which is integral with the stopper portion 34, is of considerably less thickness than the stopper portion. This provides the draw head with flexibility in the direction of path curvature defined by the edge rolls 46 while maintaining a width dimension extending over the full width of the cast strand so that the lead portion 42 may engage the edge rolls 46 to be guided by them.

As can be seen in FIGS. 4 and 5, the aligners 44, which are secured to the narrow edges of the lead portion along its length, are configured to engage the edge rolls 46 to be held securely and guided by them. The aligners 44 are fitted into slots 56 cut into the edges of the lead portion 42; and each is secured to the lead portion by means of a single screw or bolt 58. This permits a slight degree of pivoting movement of the aligners which allows a smooth movement of the dummy slab down through the edge rolls 46. It will be noted that the slots 56 are rounded where they face the aligners. This rounding facilitates the pivoting action of the aligners.

FIGS. 6-9 show the construction of the coupling keys 38 and the manner in which they temporarily connect the end of the cast strand 40 to the draw head 36. As shown in FIGS. 6 and 7, the coupling keys 38 each comprise upper and lower winged or flanged members 60 and 62, interconnected by a narrow central separating member 64. The lower winged member 62 is stepped, as at 66, and is tapered inwardly from its front edge. As can be seen in FIG. 7, the stopper portion 34 is cut out to form an undercut recess 68 which opens onto an upper surface 70 of the stopper portion. The recess 68 opens out onto a side surface 72 of the stopper portion without any undercut. The recess 68 is shaped to accommodate the lower portion of the coupling key in a manner such that its lower winged member 62 may freely enter into and exit from the recess 68 in a direction parallel to the upper surface 70. The undercut recess 68, however, prevents the coupling key from being pulled out from the recess in a direction perpendicular from the upper surface.

When the coupling key 38 is inserted into the stopper portion 34, as shown in FIG. 7, its upper winged member 60 extends out above and parallel to the upper surface 70 of the stopper portion 34. Thus, when the molten metal 20 is poured down onto the stopper portion,

as shown in FIG. 1, it flows under the upper winged member 60, and upon solidification, becomes mechanically interlocked via the coupling key to the stopper portion so that the dummy slab can pull the strand 40 down through the edge rolls 46.

The interlocked relationship of the end of the strand 40, the coupling key 38 and the stopper portion 34 of the dummy slab 36, is shown in FIG. 8. It will be noted that the coupling key 38 is flush with the side surface 72 of the stopper portion 34 and a corresponding side surface 74 of the strand 40. This permits the coupling key 38 to slip out laterally from both the strand 40 and the dummy slab 36, as shown in FIG. 9, after the dummy slab has finished pulling the strand 40 to its horizontal position. This arrangement enables both the dummy slab and the coupling keys to be reused at the start of subsequent casting operations.

FIGS. 10-13 illustrate arrangements which permit configuration control of the strand 40 as it moves from its vertical to horizontal condition and as it cools and completes its solidification. With these arrangements, it becomes possible to form a rectangular or any other desired cross-section while utilizing the previously-described supporting arch configurations at the mold exit.

As can be seen in FIG. 10, the upper end of the cast metal strand 40 has its longer cross-sectional sides arched inwardly to provide a degree of self-support for the strand as it exits from the casting mold. The solid outer shell 50 is thinnest at this region. Accordingly, unless an excessively arched configuration is maintained, the strand sides will not be self-supporting.

As shown in FIG. 10, external supporting arrangements are provided which permit reduction of the severity of arch configuration. These external supporting arrangements include a plurality of supporting grid strips 80 which extend down along both arched sides of the strand 40. These strips are maintained in spaced apart relation and in relative positions corresponding to the arched configuration of the strand. As can be seen in FIG. 10, there are provided, at various intervals, grid strip support members 82, 83, 84, 85, 86 and 87, which extend transversely to and engage the various grid strips 80 on both sides of the strand 40 and hold them in spaced apart relationship in an arch defining arrangement. The grid strips 80 and the support members 82-87 extend from the mold 24 down along the curved path defined by the edge rolls 46 and along a horizontal extension to a location where the strand 40 is fully formed and is self-supporting in its formed configuration.

The grid strips 80 and their support members 82-87 are, of course, stationary and, during a continuous casting operation, the hot newly cast strand 40 passes down and slides between the strips 80, which press inwardly on the arched sides of the strand.

As can be seen in FIGS. 10-13, the various grid strip support members 82-87 are configured to define a gradually diminishing arch along the path of strand movement. Thus, in the region immediately adjacent the casting mold 24, the arched configuration defined by the first support member 82 (FIG. 11) is most severe. Further down along the path, the arched configuration defined by the subsequent support members, e.g., 83 (FIG. 12), is less severe; until finally, when the strand 40 has reached a fully formed state, the arch configuration disappears and, as can be seen in FIG.

13, the last of the support members 87, defines a flat configuration on each side of the strand 40.

The above-described grid strip and grid strip support arrangements cooperate with the internal pressures produced by the molten core 52 of the strand 40 to allow the strand effectively to shape itself to an ultimate desired finished size and contour (e.g., rectangular) in a single continuous operation while it undergoes a steady cooling and solidification. This arrangement thus avoids the intermittent cooling, reheating and roll pressure which was previously required in continuous casting operations.

The rate of arch flattening along the strand path depends upon several factors including strand size, rate of cooling and radius of path curvature from vertical to horizontal. As the strand 40 moves downwardly from the mold 24, a relatively severe arch configuration is needed to maintain support for the relatively thin outer shell 50 of the strand 40. As the strand moves downwardly and cools, the shell 50 thickens and becomes more self-supporting. However, the internal (ferrostatic) pressure of the molten core 52 also increases downwardly from the mold 24 so that the arched configuration is maintained in the strand 40 until it has completed its downward movement and begins to follow a horizontal path. During this movement, the ferrostatic pressure within the strand continues to exert a bulging effect which is resisted more and more by the thickening outer skin 50. As this occurs, the supporting arch configuration becomes flattened so that eventually the outer shape of the strand 40 is rectangular at the time that the inner core 52 has solidified, and all bulging action from ferrostatic pressure has ceased.

The grid strips 80 must be capable of supporting not only the weight of the strand 40, but in addition, they must be capable of resisting the bulging action produced by the molten core 52.

In order to assist the passage of the strand 40 on the grid strips 80, a lubrication arrangement is provided. As seen in FIG. 10, there is provided a common water supply main 84 extending along the path length; and several manifolds 86 extend from the main in directions transversely across the arched sides of the strand 40. Individual water lines 88 extend from the manifolds 86 to each of the grid strips 80. These water lines, as shown in FIGS. 11, 12 and 13, open into passageways 90 in the grid strips; and these passageways, in turn, open out on the surface of the strip against which the strand 40 presses.

Water is supplied from an external source (not shown) to the main 84 and from there it is distributed via the manifolds 86 and lines 88 to the grid strips 80. The water is forced out under pressure between the grid strips and the strand. The water coming in contact with the hot steel strand is instantaneously converted to steam and the escaping steam facilitates movement between the grid and the strand. This flow of water also cools the grid. In this manner lubrication is obtained. The water pressure must be sufficient to overcome the force of the strand 40 against the strips 80.

The water which is used to lubricate the strand 40 also serves as a coolant since it vaporizes on contact with the strand and absorbs a considerable amount of heat from it. The primary cooling however, is provided by means of further spray nozzles 92, which are directed at the strand 40 in the regions between the grid strips 80 and their supports 82.

It will be understood that the particular arrangement of the grid strips 80 may be modified from the parallel arrangement shown in FIGS. 1-13. Thus, as can be seen in FIG. 14, strips 80a may be arranged to form a criss-cross pattern. In either case, the strips are arranged to maintain an arch forming support on the sides of the strand extending between the edge rolls and to flatten this arch gradually as the strand solidifies and cools. It will be understood that rollers may be employed in the place of the stationary strips.

As indicated in FIG. 14 spaces S may be left unsupported by the grid strips to reduce friction in those regions where the outer shell of the strand is capable of resisting the internal ferrostatic pressure. Having thus described the invention with particular reference to the preferred form thereof, it will be obvious to those skilled in the art to which the invention pertains, after understanding the invention, that various changes and modifications may be made therein without departing from the spirit and scope of the invention, as defined by the claims appended hereto.

What is claimed is:

1. Apparatus for use in the continuous casting of a strand of metal having a substantially rectangular cross-sectional configuration, said apparatus comprising spaced apart support elements defining a path along which the strand passes as it cools, said support elements being arranged at the upstream end of said path to define a first cross-sectional configuration having longer sides inwardly arched toward each other and said support elements being arranged along said path to gradually diminish the severity of the arch of said longer sides, thereby allowing a gradual flattening of said strand toward a full rectangular configuration in the direction of the downstream end of said path.

2. Apparatus according to claim 1, wherein said support elements comprise a plurality of spaced apart elongated strips.

3. Apparatus according to claim 2, wherein said elongated strips are supported by support elements extending transversely thereto at spaced apart locations along said path.

4. Apparatus according to claim 2, wherein said strips are hollow and wherein means are provided to supply a coolant liquid to the interior of said strips.

5. Apparatus according to claim 4, wherein said strips are provided with openings from their hollow interior to said cross-sectional configuration to direct coolant liquid against an element being supported by said strips.

6. Apparatus according to claim 2, wherein said strips are parallel to each other and to said path.

7. Apparatus according to claim 2, wherein said strips are arranged in criss-cross fashion to define a grid.

8. Apparatus for use in the casting of materials, said apparatus comprising a mold into which a molten material may be poured, said mold having a predetermined internal configuration, a support arrangement extending from said mold, said support arrangement comprising a plurality of spaced apart support elements arranged to brace a partially solidified casting from said mold and to hold said element in said predetermined configuration, said support elements including a plurality of spaced apart elongated grid strips extending from the mold and defining a path through which the casting passes, said support elements further including a series

of edge rolls which engage and press inwardly along opposite edges of said strand as it passes along said path means for transferring said partially solidified casting from said mold to said support arrangement and means for causing gradual withdrawal of said support elements from said casting so that the internal pressure of the still molten portion of the material within the partially solidified casting will bulge it to a final predetermined configuration.

9. Apparatus according to claim 8, wherein said mold has an open top into which molten material may be poured and an open bottom from which the material in partially solidified form may be withdrawn and wherein said support elements extend from said open bottom.

10. Apparatus according to claim 9, wherein said support elements follow a path which extends downwardly from said mold and curves to the horizontal.

11. Apparatus according to claim 9, wherein the support elements define, in the vicinity of the bottom of said mold, a cross-sectional configuration which is coincident with that of the bottom of said mold.

12. Apparatus according to claim 11, wherein the cross-sectional configuration of the bottom of said mold is generally rectangular with the longer sides thereof being arched inwardly toward each other.

13. Apparatus according to claim 11, wherein the cross-sectional configuration of the bottom of said mold is in the form of a polygon with various sides interconnected by corners, at least some of said sides being arched inwardly to provide a degree of self-support.

14. Apparatus according to claim 13, wherein said support elements are arranged to push inwardly on the arched sides of said cross-sectional configuration in the vicinity of said mold and wherein said support elements thereafter pull back from the arched sides to allow bulging toward a flattening thereof.

15. Apparatus according to claim 8, wherein said support elements further include a series of edge rolls which engage and press inwardly along opposite edges of a strand of cast material as it passes along a path extending from said mold.

16. Apparatus according to claim 15, wherein said edge rolls on opposite sides of said path gradually spread apart along said path away from said mold.

17. Apparatus for forming an elongated slab of metal, said apparatus having a mold with an open top into which molten metal may be poured, means for cooling said mold so that the metal therein will partially solidify and form an outer shell surrounding a molten inner core, means for withdrawing the partially solidified metal continuously as an elongated strand from the bottom of the mold and for supporting said strand and maintaining same with a cross section having opposite sides which are arched inwardly, said last mentioned means comprising supporting elements which press inwardly on the arched sides at spaced apart locations, said support elements being configured to recede gradually away from the arched sides of the strand in the region where the shell thickens and the ferrostatic pressure of the molten inner core increases to cause bulging of the arched sides of the strand whereby the strand cross section is changed upon solidification to one suitable for further processing.

18. Apparatus according to claim 17 wherein said support elements are arranged in the form of a grid.

19. Apparatus according to claim 18 wherein said grid extends continuously along the path of strand movement.

20. Apparatus according to claim 17 wherein said support elements are positioned at different spaced apart regions along the path of strand movement.

21. Apparatus according to claim 20 wherein said spaced apart regions are regions wherein the ferrostatic pressure within the strand exceeds the arch strength of the outer shell.

22. Apparatus according to claim 17 wherein said support elements are in the form of roll elements.

23. Apparatus according to claim 17 further including means for withdrawing heat continuously from said strand so that the arched sides thereof will be self-supporting against internal ferrostatic pressure in the regions between the support elements.

24. Apparatus for use in the casting of materials, said apparatus comprising a mold having an open top into which a molten material may be poured and an open bottom from which the material in partially solidified form may be withdrawn, said mold having a predetermined internal configuration, a support arrangement extending from said mold, said support arrangement comprising a plurality of spaced apart support elements arranged to brace a partially solidified casting from said mold and to hold said element in said predetermined

configuration, said support elements extending from said open bottom and defining in the vicinity of the bottom of the mold, a cross sectional configuration which is coincident with the bottom of the mold, said cross sectional configuration of the bottom of said mold being in the form of a polygon with various sides interconnected by corners, at least some of said sides being arched inwardly to provide a degree of self support, said support elements being arranged to push inwardly on the arched sides of said casting in the vicinity of said mold and to pull back from the sides to allow bulging toward a flattening thereof, means for transferring said partially solidified casting from said mold to said support arrangement and means for causing gradual withdrawal of said support elements from said casting so that the internal pressure of the still molten portion of the material within the partially solidified casting will bulge it to a final predetermined configuration.

25. Apparatus according to claim 24, wherein said support elements follow a path which extends downwardly from said mold and curves to the horizontal.

26. Apparatus according to claim 24, wherein the cross-sectional configuration of the bottom of said mold is generally rectangular with the longer sides thereof being arched inwardly toward each other.

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