July 23, 1968 F. W. RYS 3,393,727

CONTINUOUS CASTING MACHINE HAVING BILLET SHAPE MAINTAINING ROLLERS

Filed Oct. 22, 1965

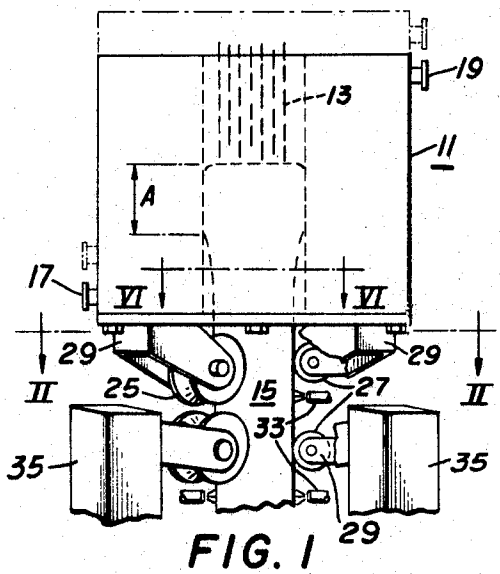


FIG. 1

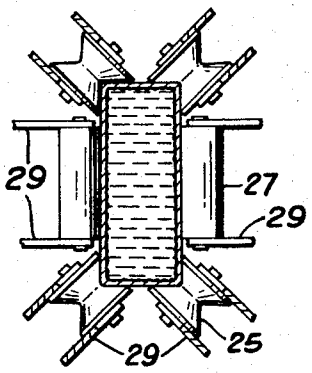


FIG. 2

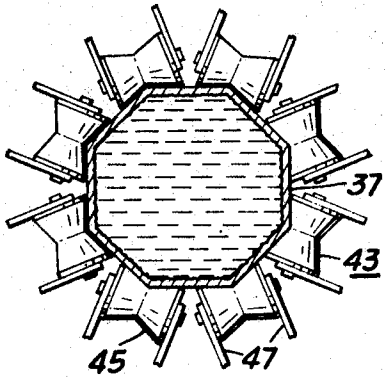


FIG. 3

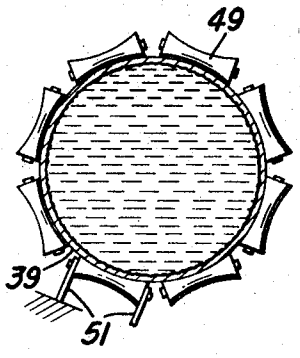


FIG. 4

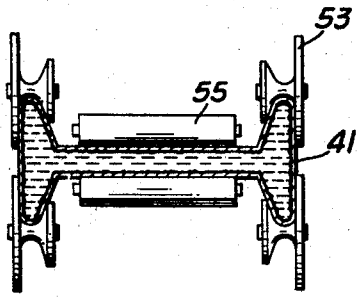


FIG. 5

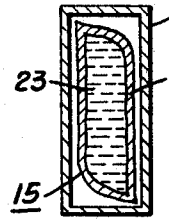


FIG. 6

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CONTINUOUS CASTING MACHINE HAVING BILLET SHAPE MAINTAINING ROLLERS

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1 Claim. (Cl. 164—282)

ABSTRACT OF THE DISCLOSURE

Continuous cast strands emerging from a casting mold are supported at their corners and along their flat surfaces, or, in the case of cylindrical or ovalar shaped strands, along arcs of the periphery of the strand in order to maintain the desired cross sectional shape of the strand until its skin develops sufficient thickness and the strand is stabilized.

Continuous cast strands having the preformed shape of a structural member are formed in the mold and supported in the same manner.

This invention relates generally to metal casting and more particularly to apparatus for use in the continuous casting of strands of metal, especially steel.

The conventional apparatus for casting a continuous strand of steel includes a casting mold which is vertically reciprocable, and into which molten metal is poured from a ladle and tundish arrangement; a cooling chamber directly below the mold, through which a continuous casting passes and wherein the casting is sprayed with cooling water; an apron structure within the cooling chamber on which the casting is supported; and a withdrawal mechanism such as a set of powered pinch rolls which engage and withdraw the casting in a continuous manner from the cooling chamber and mold.

Heretofore, the continuously cast billet was cooled immediately as it emerged from the mold, but it was not shaped, and in many instances the billet froze, having a rhombic cross section shape instead of the desired rectangular shape.

The present invention provides a novel support for the continuously cast billet which supports both the corners and the flat sides of the billet, and maintains the billet in the desired form until it freezes and becomes sufficiently solid throughout its cross section to stabilize its shape adequately.

For a further understanding of the present invention and for advantages and features thereof, reference may be made to the following description taken in conjunction with the accompanying drawing forming a part of the application which shows for the purpose of exemplification several embodiments of the invention.

In the drawing:

FIG. 1 is a schematic elevational view of a vertical casting mold incorporating one embodiment of the invention;

FIG. 2 is a view along line II—II of FIG. 1;

FIG. 3 is a schematic plan view, similar to the view of FIG. 2, of an embodiment of the invention adapted to guide and support an octagonal shaped billet;

FIG. 4 is a schematic plan view, similar to the view of FIG. 2, of an embodiment of the invention adapted to guide and support a cylindrical shaped billet;

FIG. 5 is a schematic plan view, similar to the view of FIG. 2, of an embodiment of the invention adapted to guide and support a billet in the shape of a preformed structural beam blank; and

FIG. 6 is a sectional view along line VI—VI of FIG. 1.

FIG. 1 illustrates a conventional vertically reciprocable continuous casting mold **11** into which a stream of molten

metal **13** may be poured from a conventional ladle-tundish arrangement (not shown), and from which a strand **15** of cast metal is being continuously withdrawn. The casting mold **11** is provided with the usual inlet **17** and outlet **19** conduits by means of which cooling fluid is introduced into the mold to cool the walls thereof.

In the continuous metal casting process, it is recognized that there is a first zone, designated as A in FIG. 1, of close intimate contact of the molten metal **13** with the walls of the mold. In this first zone, heat is rapidly transferred from the molten metal **13** to the cooling fluid within the mold wall cavity, and below the initial zone of contact A, the molten metal **13** solidifies and forms a thin skin **21** (FIG. 6). Below the region A, the outer surface of the casting cools and contracts and shrinks away from the intimate contact with the cooler mold walls that it had initially. And so, since the casting **15** is no longer in intimate contact with the mold walls below the zone A, the rate of heat transfer from the molten metal is accordingly reduced. The casting **15** radiates heat to the walls of the mold and the skin **21** continues to thicken progressively as the casting moves downward.

FIG. 6 is a cross section through a typical casting, taken at the level VI—VI within the casting mold **11**, and illustrates the typical shape of a continuous cast strand **15** which is commencing to solidify into a rhombic shape but which was intended to be rectangular. The central portion **23** of the rhombic shaped steel strand is molten, and remains molten throughout a considerable length of the casting below the mold **11**; the skin **21** being relatively thin in the region of the level VI—VI.

It is understood of course that the skin **21** increases progressively in thickness inwardly as the casting descends, due to the forced cooling of the outer surface of the casting by means of water sprays which will be mentioned hereinafter.

A vertical cast steel strand has a relatively long molten core extending below the bottom of the mold. This is in great contrast to the condition present within a vertical continuously cast strand of other metals such as copper, aluminum, magnesium, and the like. Metals such as copper, aluminum and magnesium have a very shallow molten crater that is entirely resident within the boundaries of the mold. Actually, a continuously cast strand of metal such as copper, aluminum and magnesium, is entirely solid when it leaves the mold and such strands generally conform closely to the shape of the mold walls; whereas, a continuously cast strand of steel tends to assume the rhombic shape shown in FIG. 6, and mentioned previously.

However, continuous castings which are produced in accordance with the present invention are supported by the novel apparatus shown in the several embodiments of the drawings, and do not deviate appreciably from their initial shape as formed in the mold.

The embodiments of FIGS. 1 and 2 comprise a group of horizontally coplanar corner rollers **25** and a plurality of side rollers **27** which are journalled in suitable supporting brackets **29** that are secured to the bottom of the mold **11** in a conventional manner. Each corner roller **25** has a V-groove **31** in its peripheral surface and the included angle between the sides of the V-groove **31**, in the embodiments of FIGS. 1 and 2, is 90°. Thus, these corner rollers **25**, in association with the slab side rollers **27**, tend to conform a strand which tend to have a rhombic shape **15**, to a desired rectangular shape shown in FIG. 2. In the embodiments illustrated elsewhere in the drawings, the included angle of the groove in the rollers may be 45° as in FIG. 3, or the groove may be a circular arc as in FIGS. 4 and 5.

In a particular installation, there may be a plurality of groups of corner **25** and side **27** rollers as suggested in

FIG. 1, arranged in vertical spaced apart relation. Preferably, the groups are spaced together as closely as is practicable, leaving just enough vertical space for the usual arrangement of cooling water spray nozzles **33**. It is preferable to attach the first or uppermost set of corner and side rollers **25**, **27** to the bottom of the mold **11**, because they are thus able to reform the strand, which tends to have the rhombic cross sectional configuration as illustrated in FIG. 6, as a rectangle as soon as it emerges from the mold and while the skin **21** is not too thick to resist reforming. The lower sets of corner and side rollers **25**, **27** are preferably fixed to any suitable frame structure **35**, shown schematically in FIG. 1. In some applications it may be desirable and preferable to so position the corner and side rollers **25**, **27** that they engage the strand at an upper level within the mold walls, such as within the region below zone A and the bottom of the mold.

While the embodiment of FIG. 1 suggests that the cast strand descends substantially vertically, it is to be understood that, in accordance with the teachings in a copending application Ser. No. 381,620, filed July 10, 1964, the path of the continuous cast strand **15** may be expected to change from the vertical attitude to the horizontal attitude without using the conventional bending roller mechanism (not shown), and that the corner and side rollers **25**, **27** merely reform the cast strand to a desired shape, usually rectangular, and do not exert a bending force on the casting as might be expected.

It will be recognized then, that the corner **25** and side **27** rollers accomplish several purposes such as: reforming the newly formed pliable cast strand to a desired cross sectional shape; maintaining the cast strand within a prescribed path of travel while the skin **21** continues to thicken as a result of the spray-nozzle cooling arrangement **33**; and supporting the cast strand when the skin is thinnest and weakest.

FIGS. 3, 4 and 5 illustrate different embodiments of the invention as adapted to: a continuous casting **37** having an octagonal cross section (FIG. 3); a continuous casting **39** having a circular cross section (FIG. 4); and a continuous casting **41** having the preformed cross sectional shape of a structural H-beam (FIG. 5).

The continuous octagonal strand **37** is reformed by a plurality of vertical arranged groups of coplanar corner rollers **43** in each of which there is a groove **45** having an included angle of 45° between the sides of the groove. Each corner roller **43** is journally mounted in suitable support brackets **47**, which may be similar to the brackets **29** indicated in FIG. 1. While there are no side rollers in the embodiment shown in FIG. 3, it may be desirable to provide such side rollers in some instances, particularly whenever the lateral unsupported side surface of the strand, between adjacent corner rollers, is excessive. Such side rollers would in accordance with the invention be coplanar with a group of corner rollers **43** at a respective level.

Likewise, the strand **39**, having a circular cross section, utilizes a plurality of rollers **49** each of which is journally mounted in support brackets **51** and has a biconcaval cross sectional outline, about as shown in FIG. 4.

The preformed structural member **41** of FIG. 5 is illustrated, for the purposes of this application, as an H-beam blank and utilizes a plurality of corner rollers **53** that are adapted to the rounded end forms of the flanges of the preform H-beam, and a pair of opposed side rollers **53** that engage the web portion of the preformed H-beam blank.

It will be recognized by those skilled in the art that other preformed continuous cast strands may have the shape of I-beams, channels, Z-bars, angles, and the like; each of which utilizes a plurality of groups of appropriately shaped corner rollers and side rollers, about as shown in FIG. 5.

That continuous castings having the shape of partially formed structural beams can be made and supported in accordance with the present invention is of great significance in the art of steel casting. For example, a casting formed and supported in accordance with the invention could eliminate several of the rolling steps now required to form the structural beam. Such a saving can be of great economic significance in the steelmaking art.

The type of roller supporting apron used heretofore is recognized as not being readily adaptable to support a preformed structural beam blank, but, however, the present invention overcomes this inadequacy. The usual rhombic shaped billets, as well as such preformed beam blanks, can be readily reformed as rectangular billets and these can be supported in an effective and satisfactory manner.

While the foregoing has described the invention in relation to a vertical casting mold **11**, having an internal casting cavtiy that has substantially vertical planar walls, the invention is not so limited. Actually, the casting mold **11** may have an internal cavity formed by substantially parrallel arcuate walls, or walls which taper slightly. Associated with such arcuate mold there may be both corner-supporting and lateral-surface supporting rollers which may be similar to the types of rollers described hereinbefore.

Likewise, a horizontal casting mold may be used with which both corner and lateral supporting rollers or the type described previously may be affixed to the mold in the manner indicated hereinbefore.

While in the embodiment shown in FIGS. 1 and 2, only two pairs of opposed side rollers at different levels engage the lateral surfaces of the rectangular shaped casting, it should be understood that additional pairs of lateral surface engaging rollers may be utilized whenever the width of the casting is considerably greater than its thickness.

The present invention may also be utilized to guide continuous castings in the form of hollow tubes, as well as solid castings having other geometrical cross-sectional shapes, such as ovals and squares.

From the foregoing it should be apparent that the apparatus of the invention provides a simple and effective solution to the problem of casting a continuous strand that will have a rectangular or other preferred shape. The usual continuous casting apparatus heretofore available is not entirely effective and is inadequate to reform a continuously cast steel strand that has deviated from a preferred shape, since there is no support at the corners of the strand, and the corners are the region wherein most of the shape deformity occurs. The present invention is adaptable also to support continuous cast strands having many various cross sectional shapes. One set of corner rollers can be readily replaced by another set of corner rollers when the mold shape is changed and the shape of the cast strand is changed.

Although the invention has been described herein with a certain degree of particularity, it is understood that the present disclosure has been made only as an example and that various modifications and changes may be made within the scope of the invention as defined by the appended claim.

What is claimed is:

1. In continuous metal casting apparatus, the improvement comprising:

(a) a vertically reciprocable casting mold wherein molten metal partially solidifies and forms a continuous cast strand having a cross section that simulates a structural shape having a web portion and flange portion;

(b) a pair of spaced apart coplanar first rollers having parallel first axes engaging opposite sides of said web portion; and

(c) second rollers engaging the extremities of the flange portion and having second axes parallel to the first axes;

(i) both said first and second rollers maintaining the original shape of said cast strand as it emerges from said mold.

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