United States Patent

[11] 3,612,150

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[54] **METHOD OF CHANGING THE CROSS SECTION OF CONTINUOUS CASTINGS**
3 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **164/82,** 164/274
[51] **Int. Cl.** **B22d 11/08**
[50] **Field of Search** 164/82, 83, 273, 274, 280, 282, 283

[56] **References Cited**

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Attorney—Sandoe, Hopgood & Calimafde

ABSTRACT: The cross section of a cast strand formed in a continuous casting mold, which has at least one shiftable wall, is changed by stopping the pouring of metal into one end of the mold and the withdrawal of a partially solidified strand from the other and allowing the strand and end portion remaining in the mold to cool enough to be self-supporting. An insert having its upper portion corresponding to the new cross-sectional area desired for the strand, and having its bottom portion conforming to the area of the original strand, is placed on the aforesaid strand end portion. If the new cross section is to be larger, the shiftable mold wall, or walls, are moved outward to receive an appropriate insert and to correspond to the new size defined by the upper portion of the insert. If the new cross section is to be smaller, an appropriate insert is placed on the strand end portion in the mold and sufficient metal is poured into the mold to partially fill the interior of the insert; then, when this additional metal has solidified enough to be self-supporting the strand is withdrawn slightly from mold and the shiftable wall, or walls, are moved inward against the upper portion of the insert to define the new strand size.

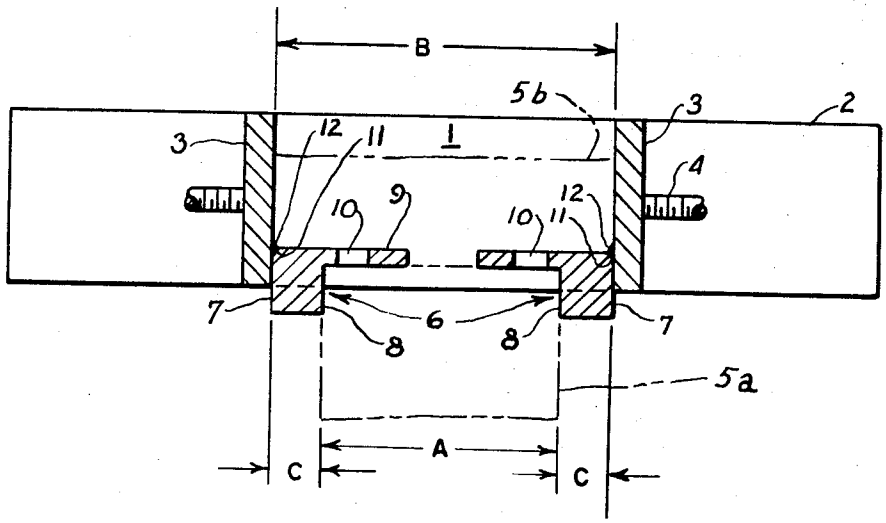


FIG.1

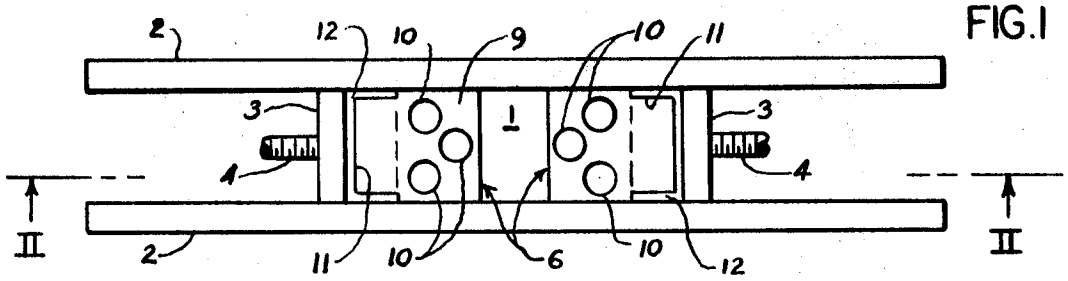


FIG.2

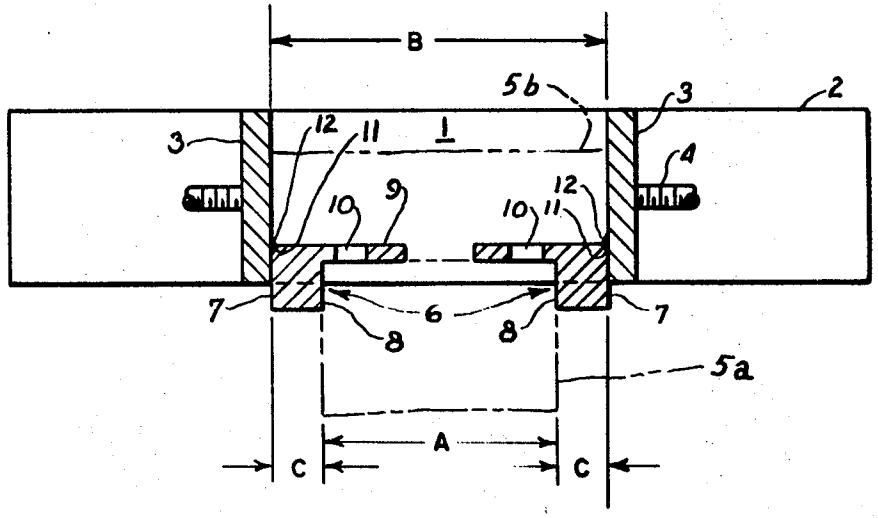


FIG.3

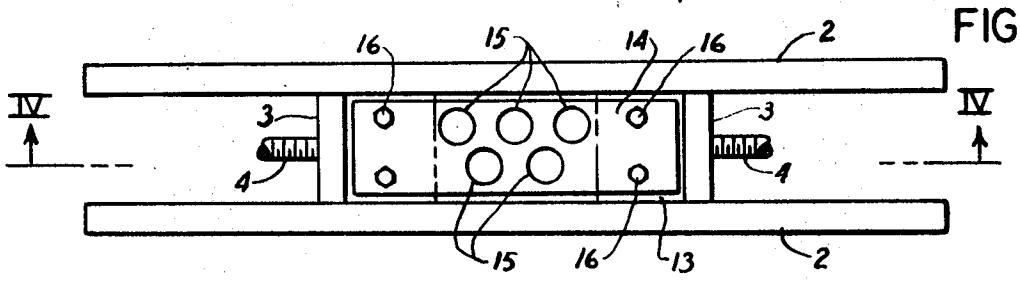
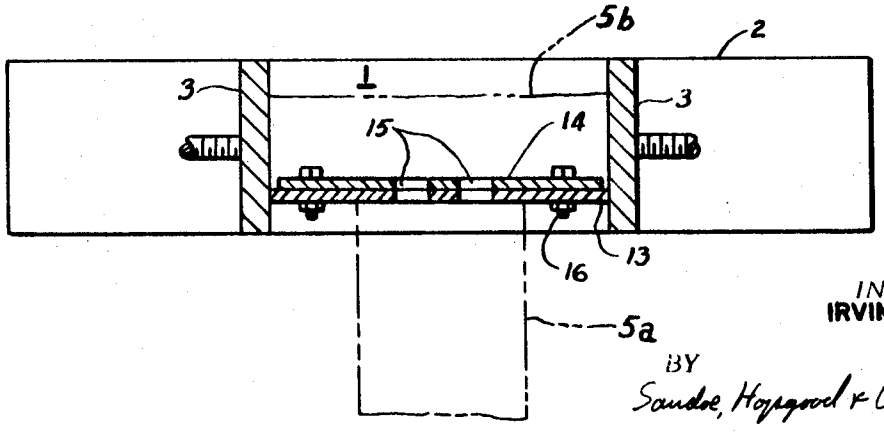


FIG.4



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FIG.5

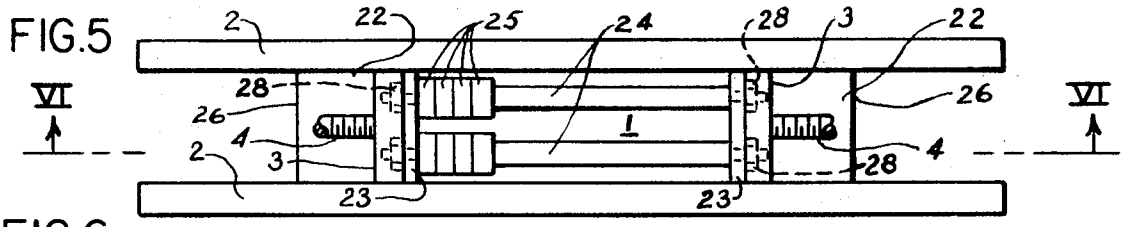


FIG.6

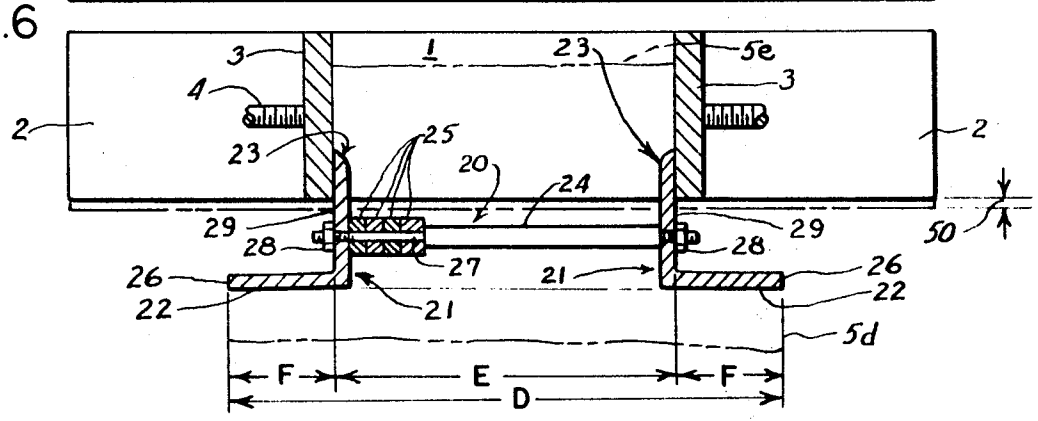


FIG.7

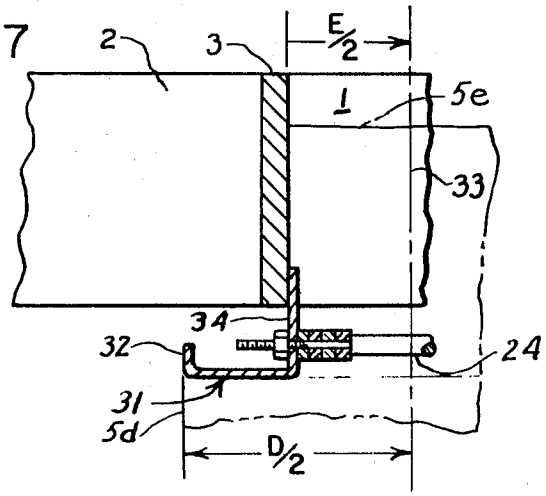


FIG.8

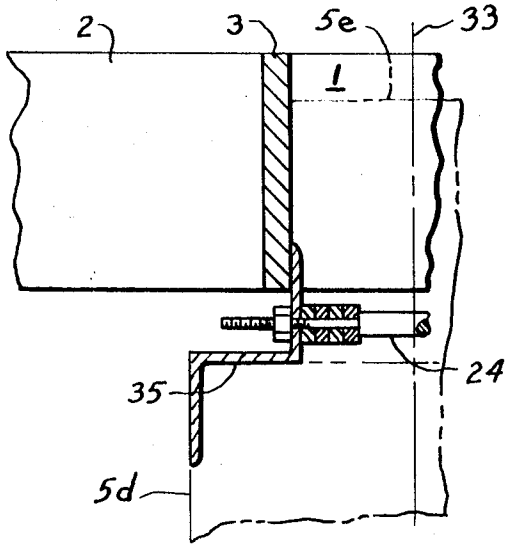
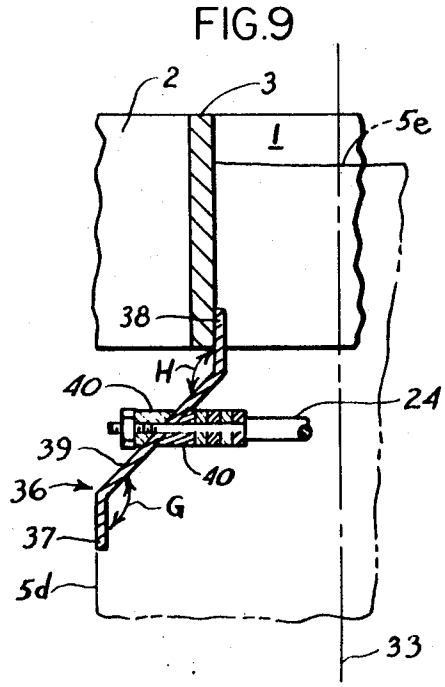


FIG.9



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METHOD OF CHANGING THE CROSS SECTION OF CONTINUOUS CASTINGS

This invention relates to the continuous casting of metal and, more particularly, to a new method and apparatus for changing the cross section of continuous castings.

It is often desired to adapt continuous casting apparatus for the production of castings of different cross sections. One way in which this can be done is to use interchangeable molds, but it has also been proposed to use molds with adjustable walls. However, before the pouring of metal in the adjusted mold can begin, the old casting has to be withdrawn completely from the casting machine, and a dummy bar has to be fitted with a dummy bar head of the new strand size and has to be inserted into the machine and transported up to the mold, so that the dummy bar head plugs the mold. The above described operations are rather time consuming and they take too long when the charges for making the castings of different cross sections follow each other in fairly rapid succession, particularly when the cross section is to be changed during the casting of a single charge.

It is an object of the present invention to provide a method and apparatus which is suitable to increase or decrease the cross section of a casting by the use of inserts, which avoids the above-mentioned drawbacks.

According to the invention, the above object is achieved by stopping the pouring of metal into the mold. The withdrawal of the partly solidified strand is either stopped simultaneously with the stopping of the pouring, or the withdrawal is continued for a relatively short time, but only to such an extent, that the metal level in the mold remains at an elevation above the exit end of the mold. This means a section of strand remains contained in the mold and is supported and cooled by it. After the thickness of the solidified skin of this strand section has increased sufficiently, the mold will be opened when the cross section of the strand has to be increased.

When the mold is opened, at least one of the walls, or two opposite walls, will be shifted. In molds for casting slabs, the shiftable wall or walls are preferably the walls forming the shorter sides of the cross section.

When the cross section of the strand has to be increased, one or both of two opposite mold walls will be shifted until the mold cavity has a cross section which is slightly larger than the required new strand size in order to facilitate the introduction of the inserts into the mold. Inserts, which are slightly smaller than the gap between the strand and the mold wall or walls, are lowered into the mold by conventional machinery or manually and are placed into the gap or gaps in such a way as to plug them. Thereafter, the mold walls are closed again to a position in which the mold cavity has the same cross section as the desired new casting, thereby pressing the inserts against the mold wall and the strand, forming a tight seal.

Each insert has an outside surface which rests against a mold wall, while the inside surface rests against one side of the strand. The gap between the strand and the mold wall or walls is plugged by the wall thickness of the insert. A horizontal, inwardly protruding flange on the inserts rests upon the strand end, thereby anchoring the insert in vertical direction. It is also possible to simply place a plate horizontally upon the strand end, said plate having substantially the same size as the desired new strand cross section, and then to close the mold walls again to a position corresponding to the new strand size, thereby pressing against the plate and forming a tight seal.

After the mold has been closed, the pouring of metal can be resumed and the strand will increase to the desired cross section. The plates and the horizontal flanges of the inserts have perforations of sufficient size and numbers, or one rather large central hole, to insure that the newly poured metal fills said perforations and welds to the old strand to form a strong link for withdrawing the rest of the old strand together with the new, enlarged casting.

The above-described inserts may be either of fireproof or refractory material such as asbestos, graphite or firebrick, or of material which will partly melt during the casting process, such as a steelplate or even a layer of steel wool, or may be a

combination of refractory material and metal, depending on the size and shape of the required insert. The inserts and plates may be sized to leave a small gap between them and the mold walls in closed position, so that asbestos seals can be packed into this gap in a conventional manner.

When the cross section of the strand has to be decreased, the pouring of metal is stopped and the withdrawal mechanism is also stopped before the strand end leaves the mold. The mold remains closed and appropriate inserts are lowered into it as described previously. In this instance the inserts are each two angular pieces each of which has an upwardly projecting vertical flange for defining the position of a side of the new strand and a horizontally, or downwardly projecting flange to rest on or engage the end of the original strand. These angular insert pieces may suitably be L-shaped, Z-shaped or modified Z-shaped in cross section. Both pieces of the insert are adjustably spaced apart by tie rods, plates or spacers attached to their vertical flanges. The distance between the two opposite bottom flange ends facing and abutting the shiftable mold walls is kept slightly smaller than the corresponding strand dimension, to facilitate the placing of the insert into the molds. The distance between the outsides of the two opposite vertical flanges is slightly smaller than the corresponding dimension in the desired smaller cross section of the strand.

After the placing of the inserts, pouring is continued for a short time, the liquid metal filling the cavity created by the opposite vertical angles and the two opposite nonshifting walls. Shortly before the metal level has reached the upper edge of the vertical flanges, pouring is stopped again. After this additional metal has formed a solidified skin of sufficient thickness to keep its shape, the opposite shiftable mold walls will be opened, and the strand with the added metal attached is lowered until the bottom flange of the transition piece has passed out of the exit end of the mold sufficiently to permit closing of the mold around the transition piece. Thereafter, the mold walls are closed to a position corresponding to the desired smaller cross section of the strand and abutting the vertical flanges of the inserted angles, which are parallel to the mold walls, and pouring is resumed.

The above-described inserts for decreasing the strand width result in an abrupt change of the strand size and a gradual decrease in the strand width, by means of a transition piece, may be advantageous under certain conditions, but is generally desirable to keep the transition piece as short as possible.

The invention will be hereinafter described with reference to illustrative embodiments shown in the drawings in which:

FIG. 1 is a plan view of a continuous casting mold with inserts positioned to cause an increase in the strand cross section;

FIG. 2 is a vertical section on lines II—II of FIG. 1;

FIG. 3 is a plan view of a continuous casting mold with a different type of insert positioned to cause an increase in the strand cross section;

FIG. 4 is a vertical section on lines IV—IV of FIG. 3;

FIG. 5 is a plan view of a continuous casting mold with an insert assembly positioned to cause a decrease in the strand cross section;

FIG. 6 is a vertical section on lines VI—VI of FIG. 5;

FIG. 7 is a vertical section through part of a continuous casting mold showing a modified insert component;

FIG. 8 is a vertical section through part of a continuous casting mold showing another modified insert component; and

FIG. 9 is a vertical section through part of a continuous casting mold showing still another modified insert component.

Referring to FIGS. 1 and 2, a mold opening 1 is defined by fixed walls 2 and movable walls 3, which are actuated by screws 4. For increasing the cross section of a strand 5*a* from the width A to a strand 5*b* having the width B, inserts 6 have been placed between the walls 3 and the strand 5*a* to plug the gaps C. The outside surface 7 of each insert rests against the mold wall 3, while an inside surface 8 rests against the strand 5*a*. Each insert 6 has a flange 9 which rests on the strand 5*a*.

Said flanges 9 have perforations 10 to improve the bond between the narrow strand 5a and the wide strand 5b. The edges 11 of the inserts might be bevelled, forming grooves with the mold walls. Asbestos seals 12 might be packed into said grooves.

An alternative form of an insert for increasing the cross section of a strand 5a is shown in FIGS. 3 and 4. A refractory plate 13, which has the same size as the cross section of the wide strand 5b, is placed horizontally upon the upper end of the narrow strand 5a. Depending on the casting conditions, a steelplate 14, or even a layer of steel wool which has a slightly smaller area than said refractory plate, can be connected to the refractory plate by conventional means, such as bolt connections 16. Matching perforations 15 in both plates will be filled by liquid metal, which forms after solidification a strong bond between the narrow strand 5a and the wide strand 5b. It is of course possible to use only a steelplate or only a refractory plate separately, in which case the steelplate would have the same size as the cross section of the wide strand 5b.

FIGS. 5 and 6 show an embodiment of the invention for decreasing the cross section of a strand 5d from the width D to a strand 5e having the width E. For this purpose, an insert assembly 20 is placed into the mold opening 1 on the top of the upper end of the wide strand 5d, while said upper end is still contained between the mold walls 2 and 3. The insert assembly 20 is composed of two angle pieces 21, which have vertical flanges 23 adjustably connected by tie rods 24 and outwardly extending horizontal flanges 22. The angle pieces 21 are spaced apart so that the distance between the outer edges 26 of their horizontal flanges corresponds to the width D of the wide strand 5d and abut the movable mold walls 3, for aligning the insert assembly 20 in the mold opening 1. The distance D between the outer edges 26 of the angles 21 is adjustable by adding spacers 25 on, or removing them from, a reduced end portion 27 of the tie rod 24 and then tightening the nuts 28. As shown the width D of the wide strand 5d is to be reduced on both sides by the width F of the horizontal flanges 22 to the width E of the narrow strand 5e, so that there is a distance between the outsides 29 of the two opposite vertical flanges 23.

After placing the insert assembly 20 in the mold opening 1, metal is poured into the space between the vertical flanges 23 and the opposite nonshifting walls 2 of the mold to fill this space to a point below the level of the upper edges of the flanges 23. The additional metal welds to the top end portion of the original strand 5d which is exposed in the central portion of the insert assembly and secures the insert assembly in place. When the added metal is solidified enough to be self-supporting and to hold the insert assembly in position, the shiftable mold walls 3 are backed off to permit the end of the strand and the insert assembly 20 attached thereto to be withdrawn enough for the bottom flanges 22 to be below the exit end of the mold and for the shiftable walls 3 to be closed against the vertical flanges 23. In the case of molds which, in operation, are oscillated in a vertical direction—for example, by being oscillated over a distance indicated by arrows and lines at 50 in FIG. 5—the strand is withdrawn an amount that the bottom flanges 22 will not interfere with the oscillation, but such that the upward strokes of the oscillations will not carry the exit end of the mold above the top ends of the vertical flanges 23.

When the shiftable mold walls 3 are moved in against the vertical flanges 23, as above, casting is resumed.

FIG. 7 shows an alternative design in which the functions of the two angles 21 as described with reference to FIGS. 5 and 6 are taken care of by two bars 31, which are suitably provided by a commercial C-shaped bar cut into half horizontally along the web. The distance between the outside 32 of the vertical flange and the centerline 33 of the mold opening 1 is D/2, while the distance between the outside 34 of the web and the centerline 33 is E/2.

FIG. 8 shows another alternative, in which a commercial Zee-bar 35 has the same function as the C-bar 31 in FIG. 7.

FIG. 9 shows still another alternative design which results in a gradual transition between the wide strand 5d and the narrow strand 5e. The bars 36 being used for this purpose consist of two vertical flanges 37 respectively 38 which form angles G respectively H with the web 39 which are larger than 90° but smaller than 180°. The two opposite bar sections 36 are connected by at least one tie rod 24. The incline of the web 39 is compensated by bevelled washers 40.

What is claimed is:

1. A method of changing the cross-sectional area of a continuously cast strand being cast in an open-ended, continuous casting mold which has at least one wall movable to a different selected position for defining a different cross-sectional area of the mold, comprising, stopping the pouring of metal into one end of the mold and the withdrawal of a cast strand from the other exit end so as to leave an end of the strand in the mold, letting said end of the strand solidify sufficiently to become self-supporting, moving said movable wall as required for an insert unit to be placed on said end of the strand and placing an insert unit on said end, said insert unit resting on said end of the strand and extending completely across the mold in direction between opposite stationary walls thereof and having at least one part which defines a distance across the mold in the direction between said movable wall and a wall opposite thereto, said distance being the new width of the strand in the latter direction, there being openings through the insert unit opening onto said end of the strand, moving said movable wall for said insert unit to be engaged between the movable wall and the wall opposite thereto, and then resuming the pouring of metal into the mold and the withdrawal of a cast strand from the exit end of the mold.

2. The method of claim 1 applied for increasing the cross-sectional area of said strand and including moving said movable wall outward from the mold for placing the insert unit on said end of the strand.

3. The method of claim 1 applied for decreasing the cross-sectional area of the strand including placing the insert unit on the end of the strand within the mold, pouring sufficient metal into said insert unit to at least partially fill it and letting the latter metal cool until it is self-supporting, withdrawing the strand from the mold far enough for said end of the strand to be out of the mold and for the upper parts of opposite wall portions of the insert unit to remain within the mold to be engaged by the movable wall of the mold and the mold wall opposite thereto by moving the movable wall inward, moving the movable wall inward for the insert to be engaged as aforesaid, and then resuming the pouring of metal into the mold and the withdrawal of a cast strand from the exit end of the mold.