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**Knell et al.**

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[54] **METHOD OF INTRODUCING THE DUMMY BAR INTO A CONTINUOUS CASTING MOLD AND APPARATUS FOR THE PERFORMANCE OF THE AFORESAID METHOD**


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[51] **Int. Cl.** ..... **B22d 11/08**

[58] **Field of Search** ..... 164/82, 273 R, 274, 282



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[57] **ABSTRACT**

A method of introducing a dummy bar into a continuous casting mold which comprises withdrawing at least one of two mold walls on opposite sides of the continuous casting mold in a direction substantially normal to the longitudinal axis of the continuous casting mold. The dummy bar is introduced into the opened continuous casting mold and is subjected to the action of guide means so that the dummy bar is guided through the continuous casting mold at a given distance from the walls of the mold until the stopping and withdrawing head of the dummy bar assumes a prescribed position within the continuous casting mold. Then the guide means is removed from the continuous casting mold, and the previously displaced mold wall is returned into its casting position.


**14 Claims, 4 Drawing Figures**

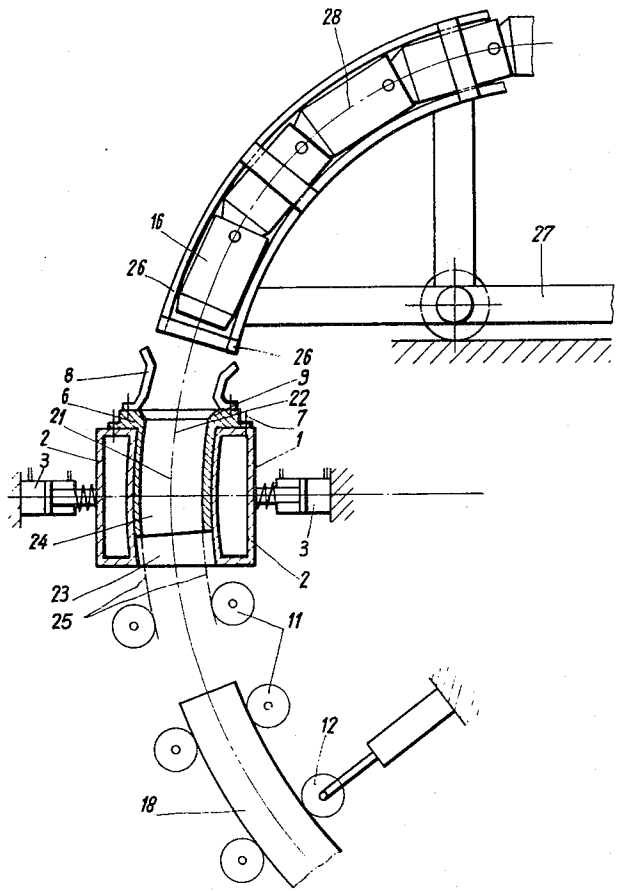
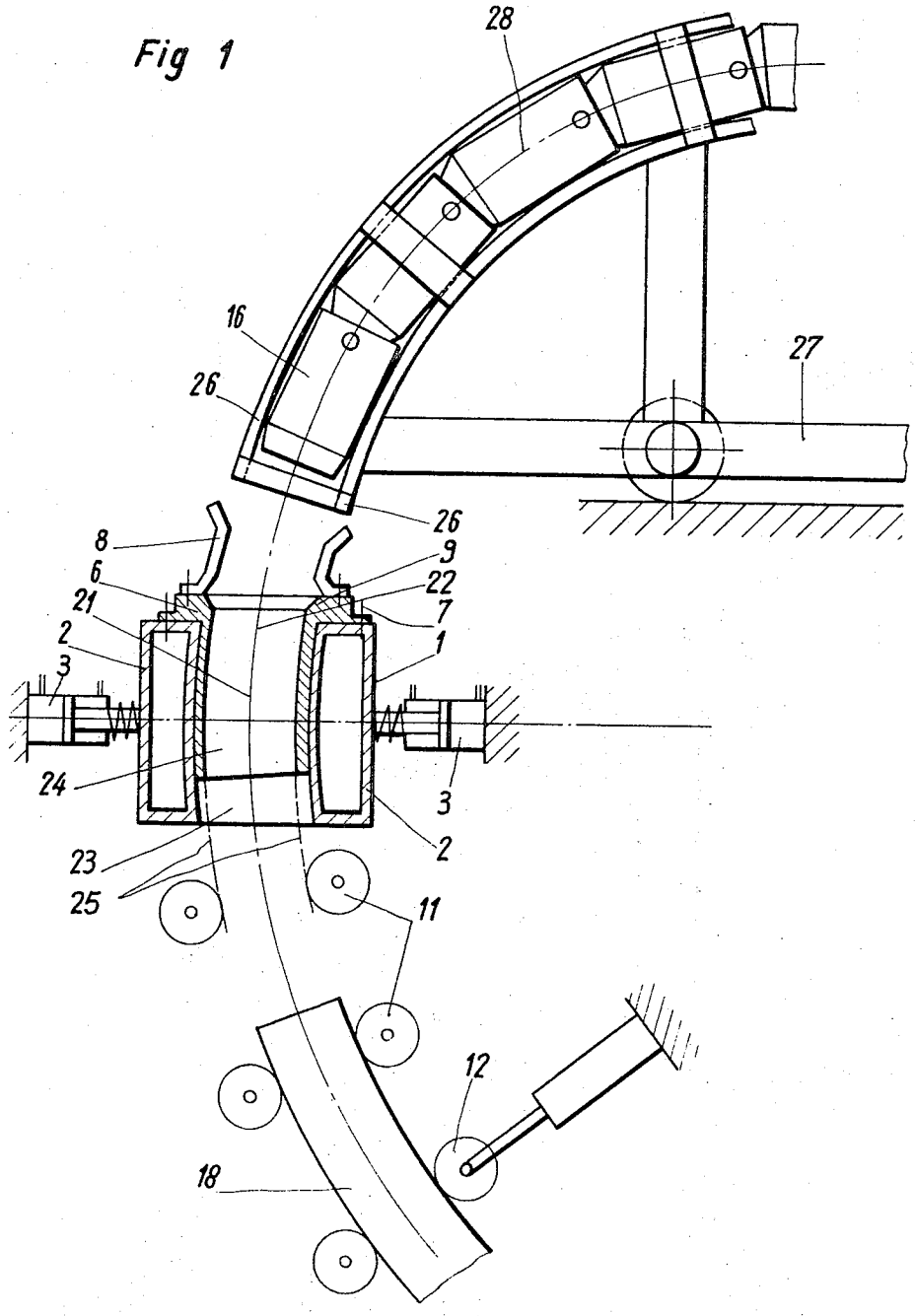


Fig 1



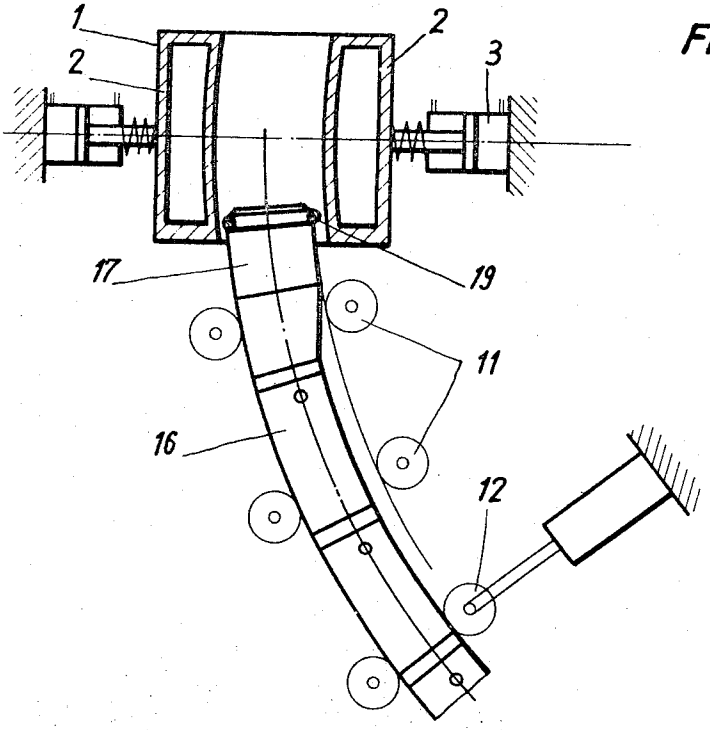



Fig 2

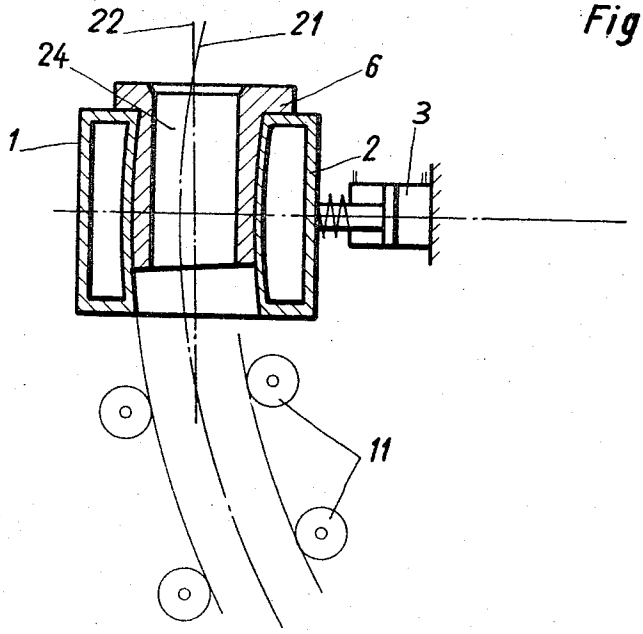
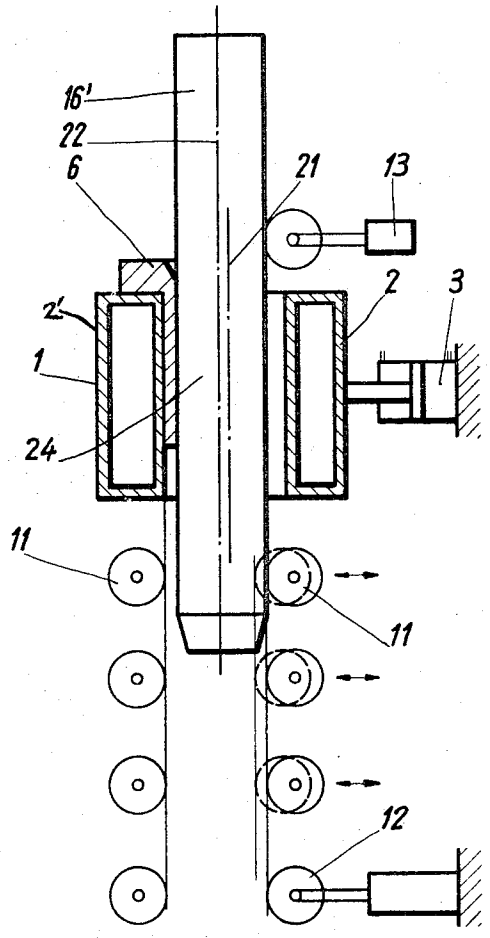



Fig 4

Fig 3



# METHOD OF INTRODUCING THE DUMMY BAR INTO A CONTINUOUS CASTING MOLD AND APPARATUS FOR THE PERFORMANCE OF THE AFORESAID METHOD

The apparatus for introducing a dummy bar into a continuous casting mold comprises a continuous casting mold having at least one of two mold walls on opposite sides of the continuous casting mold movable in a direction away from the longitudinal axis of the continuous casting mold, and guide means for guiding at least one side of the dummy bar.

## BACKGROUND OF THE INVENTION

The present invention relates to a new and improved method of introducing a dummy bar into a mold which resorts to the technique of conveying the end of the dummy bar into a position above the entry opening into the mold, passing the dummy bar through the mold, withdrawing such dummy bar from below the mold until the stopping and withdrawing head is in its prescribed position in which it is sealed, and this invention also pertains to a new and improved apparatus for the performance of the aforesaid method.

During continuous casting through open-ended molds, the outlet end of such mold must be closed before pouring begins. This is so firstly in order to prevent the metal that is poured into the mold from flowing out of the open end of the mold, and secondly to allow the head of the continuous casting to solidify or freeze and to establish a firm connection with a dummy bar. For this purpose, the dummy bar which is conventionally provided with a stopping and withdrawing head, is introduced into the mold via the roller apron adjoining the outlet end of the mold by rotating drive rollers in the apron in a direction contrary to the normal casting withdrawal direction.

Introduction of the dummy bar into the outlet end of the mold is associated with the disadvantage that the dummy bar cannot be fed to the driven rollers until such time as the end of the preceding hot casting has cleared such rollers. As should be readily apparent, this constitutes a considerable loss in time and prevents maximum utilization of the continuous casting plant.

Now it has already been proposed to introduce the dummy bar from the entry or casting end into the mold, and in this regard Japanese Pat. No. 495,358 constitutes relevant prior art. With the help of auxiliary handling means, the dummy bar is conveyed from a position in which it does not interfere with the casting operation into a position above the entry opening into the mold, then this dummy bar is lowered into the mold by auxiliary drive means until it is gripped by further drive means beyond the outlet end of the mold and further conveyed by these last-mentioned drive means until the stopping and withdrawing head has reached its prescribed position within the mold. This procedure enables the dummy bar to be introduced into the mold as soon as the trailing end of the directly preceding metal casting has left the mold. However, a drawback with this technique is that the dummy bar frequently damages the mold walls, resulting in castings of inferior quality, possible metal break-out, and the necessity of premature replacement of the mold.

With either of the above-discussed techniques of introducing the dummy bar into the mold, sealing means must be inserted between the stopping and withdrawing head and the mold walls in order to insure that the outlet end of the mold is properly sealed. The necessity of sealing the clearance gap between the stopping and withdrawing head and the walls of the mold also involves a significant loss in time.



## SUMMARY OF THE INVENTION

Hence, from what has been discussed above, it should be recognized that the continuous casting art is still in need of techniques and equipment for introducing the dummy bar into a continuous casting mold in a manner not associated with the aforementioned drawbacks and limitations of the prior art proposals. Therefore, a primary objective of the present invention is to provide an improved method of, and apparatus for, introducing the dummy bar into a continuous casting mold in a manner which effectively and reliably fulfills the existing need in the art and is not associated with the aforementioned drawbacks and limitations of the prior art proposals.

Another significant object of the present invention relates to a new and improved method of, and apparatus for, introducing the dummy bar into a continuous casting mold from the entry end of such mold without the danger of damaging the mold walls.

Still a further significant object of the present invention relates to a new and improved method of, and apparatus for, introducing the dummy bar into a continuous casting mold in a manner permitting reduction in the idle time between consecutive pours.

Now, in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the proposed method aspects of this development contemplate retracting at least one of two opposite walls of the continuous casting mold in a direction normal or perpendicular to the mold axis, guiding the dummy bar at a distance from the mold wall through the continuous casting mold until the stopping and withdrawing head is in its prescribed position within the continuous casting mold, then removing the guide means and returning the mold wall into casting position. By practicing this procedure there is prevented damage to the walls of the continuous casting mold by the dummy bar, and there is safeguarded against impairment of the quality of the casting, metal break-out from occurring, and there is also rendered possible an improvement in the operating efficiency and economies of the continuous casting plant.

The equipment used for practicing the inventive method employs an open-ended continuous casting mold having at least one of two oppositely situated walls of the mold movable in a direction normal to the mold axis. According to an important manifestation of the inventive equipment, there is provided guide means which is located at least at one side of the dummy bar.

If a universal dummy bar is employed in which only the stopping and withdrawing head need be replaced for a change of cross-section and the dimensions of the head and the dummy bar may be the same or differ, it is advantageous to adjust the guide means during the introduction of the dummy bar to the different cross-sections of the dummy bar. Moreover, an additional reduction in the idle times of the continuous casting plant can be realized if, in those instances when a seal or sealing member is employed, this seal is inserted into the

joint between the mold wall and the stopping and withdrawing head before the mold wall or walls have been returned into casting position, the clearance gap between the mold walls and the stopping and withdrawing head being sealed by the closing of the mold wall or walls shifted back into casting position.

In order to insure that the dummy bar does not damage either the continuous casting mold or the subsequently arranged cooling and guiding devices, the guide means are preferably constructed and arranged such that they define a cavity which in conjunction with the guide elements or guide means following the continuous casting mold form an entry path for the dummy bar.

According to an advantageous constructional manifestation of the guide means for continuous casting molds having at least two movable mold walls on opposite sides, the center axis in the casting direction of the mold cavity defined by the guide means coincides with the corresponding axis of the open mold.

In a continuous casting plant in which one side of the continuous casting mold is fixed and only the other side is movable, it is useful if the subsequently arranged or following guide means on the same side as the retractable side wall of the mold are likewise displaceable. Entry of the dummy bar will then be possible when the center axis in the casting direction of the mold cavity defined by the guide means is parallel to the corresponding axis of the continuous casting mold when open.

An advantageous constructional arrangement in the case of arc-type or curved molds is realized where the center axis in casting direction of the hollow cavity defined by the guide means is inclined in relation to the corresponding axis of the open casting mold. In the case of continuous casting molds equipped with only one retractable side wall or mold wall, this enables the dummy bar to be introduced without necessitating displacement of the following guide means or elements.

The auxiliary device for feeding the dummy bar can be simplified by providing at the end of the guide means in the entry end of the mold a support means which determines the entry path of the dummy bar. This support means guides the dummy bar centrally into the pathway or hollow space defined by the guide means and prevents flexible dummy bars, usually composed of individual members, from deviating from the prescribed path.

In the case of dummy bars consisting of individual members, it is contemplated in accordance with another physical manifestation of this invention, to construct the guide means in such a manner that the distance between the end of the guide means nearest the outlet end of the casting mold and the first guide element following the casting mold, is less than the subdivision or pitch of the individual members forming the dummy bar, particularly attention then being paid to the length of the first member of the dummy bar to enter the continuous casting mold. The outlet end of the continuous casting mold as well as the guide and cooling means following the continuous casting mold, are thus protected against damage.

When employing a universal dummy bar equipped with interchangeable stopping and withdrawing head, or several dummy bars of different cross-sections, as well as appropriate adjustable molds, the guide means may be attached to the side walls of the mold. This enables the adjustable side walls of the mold to be moved to the desired cross-section of the dummy bar together with the associated guide means.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. **1** illustrates the upper part or region of an arc-type continuous casting plant or installation, partly in section, and showing the feed means for the dummy bar, a continuous casting mold with movable side walls, a dummy bar-guide means inserted into the casting mold, and the following portion of an apron or strand guide arrangement;

FIG. **2** illustrates a continuous casting mold with movable side walls and the dummy bar in a position prior to reclosing the mold walls;

FIG. **3** illustrates the disposition of the guide means in a continuous casting mold having a movable mold wall at only one side and a straight hollow mold cavity or compartment; and

FIG. **4** illustrates an embodiment of dummy bar-guide means wherein the bar guide axis does not coincide with the axis of the interior or hollow space of an arc-type or curved continuous casting mold.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, and in particular, referring initially to the embodiment of continuous casting installation as depicted in FIG. **1**, there is depicted therein an open-ended continuous casting mold **1** having an arcuate- or curved-shaped internal mold cavity with the mold walls **2** on two opposite sides of the casting mold **1** being retractable. These movable mold walls **2** may be displaced by any suitable mechanical means or, as illustrated, hydraulically or pneumatically, by actuator cylinder units **3**. Prior to casting or pouring of the metal, the end of a dummy bar **16** is conveyed by appropriate handling means **27**, such as the illustrated carriage unit, into a position above the entry opening into the continuous casting mold **1**. The dummy bar **16** advantageously possesses an articulated construction formed, for instance, from individual hingedly interconnected dummy bar elements or sections. With a suitable construction of the continuous casting plant, it would be also possible to use a rigid, arched or curved dummy bar.

Now, before the dummy bar **16** is introduced into the casting mold **1**, the mold walls **2** are retracted in a direction normal to the longitudinal or lengthwise extending mold axis to provide adequate space for the insertion of a bar guide or guide means **6**. This bar guide means **6** is inserted into the hollow mold cavity or internal compartment **23** as soon as the mold walls **2** have been retracted, the bar guide means being positionally located by suitable means in the form of a flange and adapted to cooperate with opposite sides of the dummy bar **16**. However, the bar guide means **6** may also be mounted upon the casting mold **1** or it may be slidably attached to the end of the dummy bar and enter the mold cavity **23** together with the dummy bar.

In the exemplary illustrated embodiment this bar guide means **6** defines or delimits a hollow compart-

ment 24 which in conjunction with the guide elements 11, shown in the form of rollers, arranged below the casting mold 1, forms a path 25 for the dummy bar 16. The dummy bar 16 which has been moved into preparatory position for introduction into the continuous casting mold 1 by the handling means 27, is maintained in the prescribed arcuate entry path by supporting means 26. The supporting means 26 also functions as a centering means insuring that the dummy bar 16 upon entering the cavity or compartment 24 will follow the axis 22 of the cavity defined by the guide means 6 and which axis coincides with the corresponding axis 21 of the opened mold. When articulated dummy bars 16 are used, another function of the supporting means 26, in cooperation with a further supporting device 8, located on the end of the dummy bar-guide means 6, associated with the entry end of the continuous casting mold 1, is to prevent the dummy bar 16 from being deflected out of the entry axis 28 by forces that may take effect during its introduction. The dummy bar is now guided at a distance from the mold wall or mold wall means determined by the thickness of the dummy bar-guide means 6, this dummy bar moving through the continuous casting mold until the stopping and withdrawing head, indicated by reference character 17 in FIG. 2 and not particularly illustrated in FIG. 1, reaches its prescribed position within the casting mold. Following the continuous casting mold 1, the dummy bar 16 is guided and supported by the subsequently arranged guide elements 11 and it is then ultimately gripped by the driving rollers or rolls 12 which then undertake the work of further conveying such dummy bar 16. The distance between the end of the dummy bar-guide means 6 nearest the outlet end of the continuous casting mold 1 and the first guide element 11 below such casting mold is less than the sub-division or pitch of the individual consecutive elements or members serving to form the dummy bar 16 itself. In this connection the length of the first member of the dummy bar is of particular importance. As soon as the stopping and withdrawing head 17 has reached its prescribed position within the continuous casting mold 1, then, the guide means 6 for the dummy bar and the supporting device 8 are removed and the mold walls are restored into their correct casting position.

When during consecutive pours, the ladle reaches the casting plant too late to permit an unbroken sequence of pours to be maintained, the introduction of the dummy bar can begin as soon as the last hot casting 18 has left the mold, i.e., during the further withdrawal of this hot casting 18 the dummy bar 16 can already enter the continuous casting mold 1 and a fresh pour can already begin shortly after the preceding casting 18 has cleared the driving rollers 12. This procedure permits the interval between pours to be reduced between 40 per cent and 50 per cent in relation to techniques which resort to introduction of the dummy bar from the outlet end of the casting mold through which the casting is withdrawn.

Advantageous solutions can be realized particularly then if the dummy bar-guide means 6 is easily detachable from the movable mold walls, for instance by the schematically represented pins 7, and the retracting means 3 for the displaceable mold walls 2 are also employed for moving the bar guide means 6 which in such case would be divided or formed of sections. The withdrawing means 12 is adjustable in any suitable and conventional manner well known in this art to the dimensions of the dummy bar.

Now in FIG. 2 there is illustrated an embodiment of the invention which enables the intervals between pours to be even further reduced. Here, the work of sealing the clearance gap between the stopping and withdrawing head 17 and the continuous casting mold 1 before beginning the casting or pouring operation can be simplified by placing a seal or seal member 19 into the gap between the mold walls 2 and the stopping and withdrawing head 17 before the mold walls 2 are restored back into desired casting position. This seal 19 may be introduced into the continuous casting mold 1 during such time as the stopping and withdrawing heads 17 is introduced into the casting mold, or it may be placed in position after the stopping and withdrawing head 17 has already attained its prescribed position within the casting mold. By again closing the mold, that is by closing for instance at least two adjoining mold walls 2, the seal 19 is compressed and shaped to fit the clearance gap. In other words, closing of the mold walls simultaneously operates to seal the stopping and withdrawing head 17 inside the continuous casting mold 1. The structure of the seal does not constitute part of the subject matter of this disclosure and same has been described in greater detail in the commonly assigned, copending United States application, Ser. No. 225,148 filed Feb. 10, 1972, and entitled: "Method of and Means for Sealing a Stopping and Withdrawing Head in a Continuous Casting Mold for Steel."

As is also illustrated particularly well in FIG. 2, the dummy bar 16 may possess different cross-sections. Such differing dimensions of the dummy bar are required when castings of different cross-section are to be cast, and exchangeable stopping and withdrawing heads 17 are employed. With such continuous casting plants it is advantageous if the mold walls 2 can be adjusted to the different cross-sections of the castings and the dummy bar. This will allow for appropriate guiding of both a thin dummy bar 16 and, when required, a thicker stopping and withdrawing head 17.

FIG. 3 illustrates a continuous casting mold 1 having a straight mold cavity or internal compartment and one fixed sidewall 2' as well as a rigid dummy bar 16'. Only the mold wall 2 opposite the fixed sidewall or mold wall 2' is movable. The dummy bar-guide means 6 is appropriately attached to the fixed side or stationary mold wall 2' and cooperates with only one side of the dummy bar 16' as illustrated. In this embodiment it is the displaceability of the subsequently arranged guide elements 11 and 12 that enables the dummy bar 16' to be introduced. The length of the zone providing this displaceability depends upon the length and external shape of the dummy bar 16'. The dummy bar 16' can be introduced when the center axis 22 in the casting direction of the hollow space or compartment 24 defined by the dummy bar-guide means 6 is approximately parallel to the corresponding axis 21 of the opened mold 1. On the entry side of the continuous casting mold 1 there may be provided additional means 13 for the purpose of maintaining the dummy bar 16' pressed against the guide means 6 and to prevent this dummy bar 16' from deviating from the axis 22 and damaging the unprotected wall 2 of the continuous casting mold 1. The dummy bar 16' is therefore located and guided at a distance from the mold wall or wall means determined, on the one hand, by the thickness of the dummy bar-guide

means 6, and, on the other hand, by the arrangement and pressure of the press-on means 13 and the guide elements 11 and 12. A limited deviation from the axis 22 in the case of short dummy bar 16' is nevertheless possible in straight molds provided that the dummy bar 16' does not make contact with the unprotected sidewall 2 of the casting mold 1.

Finally, in FIG. 4 there is illustrated an arrangement for introducing a flexible dummy bar through an arc-type or curved continuous casting mold 1, in which only one wall 2 of the casting mold is movable. In such case, the dummy bar-guide means 6 which is formed with a straight internal cavity or compartment 24 is designed such that the center axis 22 in the casting direction of the cavity 24 defined or delimited by the guide means 6 is inclined in relation to the corresponding axis 21 of the open mold 1. Flexible dummy bars adjust themselves below the dummy bar guide means 6 to a curved path which merges into the prescribed guide path 21 through the apron.

The invention is not limited to the exemplary illustrated embodiments. It is entirely possible to use the teachings of this invention in analogous manner for the same solutions in connection with horizontal casting plants.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims. Accordingly,

What is claimed is:

1. A method of introducing a dummy bar into an adjustable continuous casting mold, comprising the steps of withdrawing at least one of two mold walls on opposite sides of the continuous casting mold in a direction substantially normal to the longitudinal axis of the continuous casting mold, inserting a dummy bar guide means in said continuous casting mold, introducing the dummy bar into the continuous casting mold so that the dummy bar moves through the continuous casting mold at a given distance from the walls of the mold to protect such mold walls from damage by the dummy bar, continuing the guided movement of the dummy bar until the stopping and withdrawing head of the dummy bar assumes a prescribed position within the continuous casting mold, removing the guide means from the continuous casting mold, and returning the previously displaced mold wall into its casting position.

2. The method as defined in claim 1, including the step of adjusting the guide means to different dimensions of the dummy bar during such time as the dummy bar is guided through the continuous casting mold.

3. The method as defined in claim 1, including the step of sealing the clearance gap between the stopping and withdrawing head and the mold walls by closing the displaced mold wall after a seal has first been placed in position where the joint to be sealed is located.

4. The method as defined in claim 1, including the step of guiding at least one side of the dummy bar by means of said guiding action.

5. An apparatus for introducing a dummy bar into and adjustable continuous casting mold, comprising a continuous casting mold having at least one of two mold walls on opposite sides of the continuous casting mold movable in a direction away from the lengthwise axis of the continuous casting mold, means for selectively moving said at least one movable mold wall, and guide means between the dummy bar and at least a wall of said continuous casting mold for guiding at least one side of the dummy bar and protecting the mold walls from damage by the dummy bar.

6. The apparatus as defined in claim 5, further including guide elements arranged below the continuous casting mold, said guide means delimiting a hollow cavity which in conjunction with said guiding elements below the continuous casting mold form a pathway for the introduction therealong of the dummy bar.

7. The apparatus as defined in claim 6, wherein the central axis of the hollow cavity delimited by said guide means in the casting direction coincides with the longitudinal axis of the continuous casting mold when in open condition.

8. The apparatus as defined in claim 6, wherein the central axis of the hollow cavity delimited by the guide means in the casting direction is substantially parallel to the lengthwise axis of the open continuous casting mold.

9. The apparatus as defined in claim 6, wherein the central axis of the hollow cavity delimited by the guide means in the casting direction is inclined in relation to the lengthwise axis of the open continuous casting mold.

10. The apparatus as defined in claim 5, wherein said continuous casting mold has an entry end, and supporting means for codetermining the axis of entry of the dummy bar at that end of said guide means which is situated at the entry end of said continuous casting mold.

11. The apparatus as defined in claim 5, especially for use with articulated dummy bars composed of individual hingedly connected dummy bar members, wherein said continuous casting mold includes an outlet end, guide elements situated beneath the outlet end of said continuous casting mold, the distance between the end of the guide means situated nearest the outlet end of the continuous casting mold and the first guide element arranged below the outlet end of said continuous casting mold being shorter than the subdivision of the individual members of the dummy bar.

12. The apparatus as defined in claim 5, wherein said guide means is connected with the continuous casting mold, and wherein at least one side wall of the continuous casting mold is retractable together with the associated guide means.

13. A method of introducing a dummy bar into a continuous casting mold, comprising the steps of withdrawing at least one of two mold walls on opposite sides of the continuous casting mold in a direction substantially normal to the longitudinal axis of the continuous casting mold, introducing the guide means into the opened continuous casting mold either together with or prior to entry of the dummy bar into such opened continuous casting mold, introducing the dummy bar into the opened continuous casting mold, subjecting the dummy bar to the action of said guide means so that the dummy bar is guided through the continuous casting mold at a given distance from the walls of the mold to protect such walls from damage by the dummy bar and until the stopping and withdrawing head of the dummy bar assumes a prescribed position within the continuous casting mold, then removing the guide means from

the continuous casting mold, and returning the previously displaced mold wall into its casting position.

14. A method of introducing a dummy bar into an adjustable continuous casting mold, comprising the steps of inserting a dummy bar guide means in the continuous casting mold, withdrawing at least one of two mold walls on opposite sides of the continuous casting mold in a direction substantially normally to the longitudinal axis of the continuous casting, introducing the dummy bar into the continuous casting mold, so that the dummy bar moves through the continuous casting mold at a given distance from the walls of the mold to protect such mold walls from damage by the dummy bar, continuing the guided movement of the dummy bar until the stopping and withdrawing head of the dummy bar assumes a prescribed position withint the continuous casting mold, removing the guide means from the continuous casting mold, and returning the previously displaced mold wall into its casting position.

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