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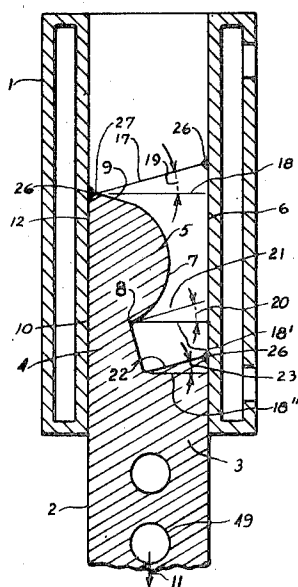
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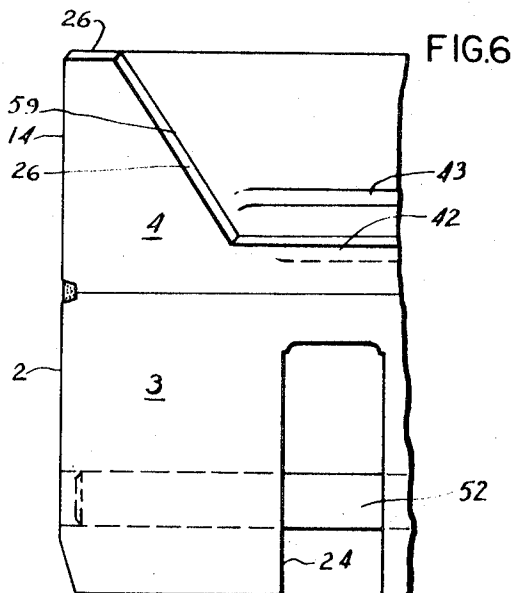
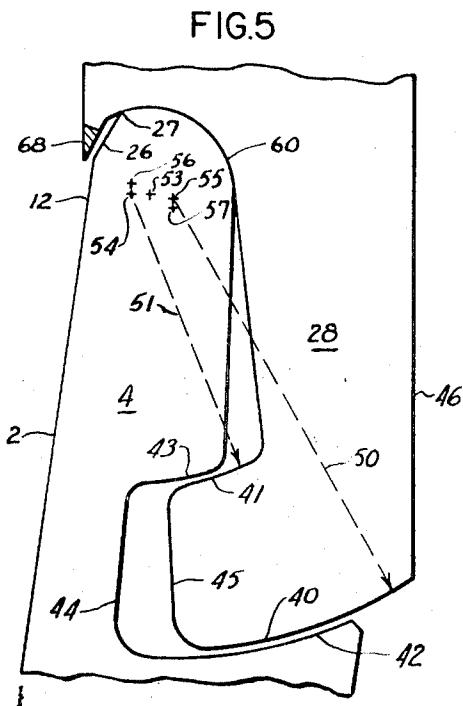
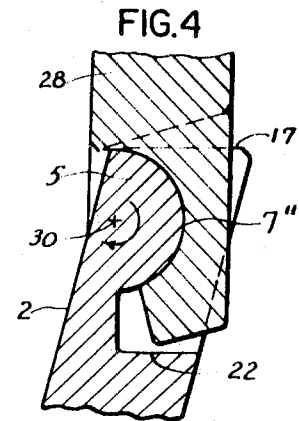
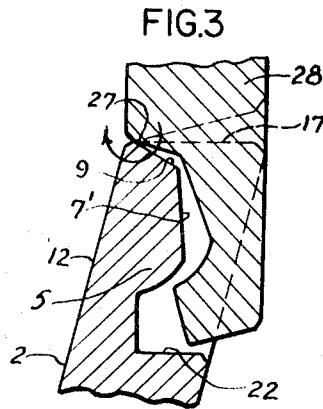
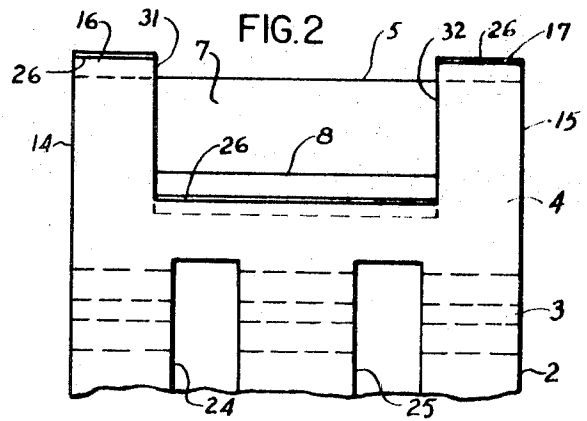
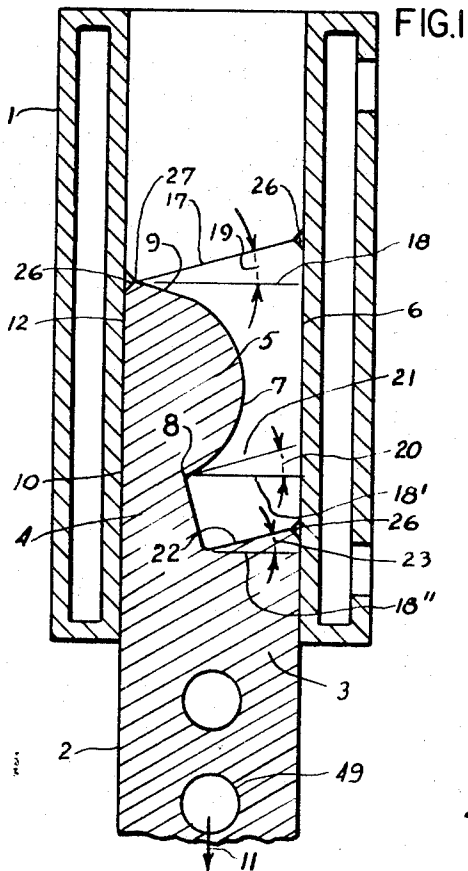
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[54] **DUMMY BAR HEAD FOR CONTINUOUS CASTING**
AND METHOD OF USING SAME
 15 Claims, 6 Drawing Figs.

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 [51] Int. Cl. **B22d 11/08**
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274, 282, 283

ABSTRACT: In continuously casting steel wherein the bottom end of an open-ended chill mold is closed for the start of casting by the head of a dummy bar, the upper end of the dummy bar head which is received within the mold is undercut on one side to form with an adjacent wall of the mold a cavity into which molten steel poured into the mold is received and solidifies. The undercut side of the head has a projection to extend into the cavity and toward said first wall of the mold. The face of the upper end of the head in back of the projection has at least a part of its surface bearing against the mold wall which is opposite said first mold wall, when the head is in the mold. The projection and the cavity are shaped to enable the upper end of the head to be separated from the steel that has solidified in contact therewith in the mold, after the head and said solidified steel are withdrawn from the mold, by transverse circular movement of the lower end of the head away from the portion of the steel that solidified in the cavity.





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DUMMY BAR HEAD FOR CONTINUOUS CASTING AND METHOD OF USING SAME

The present invention relates to a method and apparatus for continuously casting steel, wherein the bottom end of an open-ended chill mold is closed by a dummy bar head before pouring begins, the dummy bar head having a configuration so that molten steel poured into the mold by solidifying in the mold forms a strand and creates a connection between the strand and the dummy bar head, which connection permits the strand to be withdrawn, and, after withdrawal and further cooling of the strand, is quickly and easily broken for detaching the dummy bar head from the strand.

For starting a continuous casting a dummy bar connected to a dummy bar head is required. When pouring begins the dummy bar head closes the open bottom end of the mold and must later be detached from the strand.

PRIOR ART

A known method of connecting the head to the dummy bar is by means of a hook-shaped coupling and to uncouple the head from the dummy bar by relative displacement laterally with respect to the longitudinal casting axis. One drawback of this method is the rigid connection of part of the dummy bar head to the strand by coupling elements which remain embedded in the strand after separation. For the purpose of separation the dummy bar head must first be cut off from the end of the strand and after cooling the coupling elements must be removed from the dummy bar head. Consequently, these operations cannot be carried out during casting. This involves loss of time because the dummy bar head cannot be immediately reintroduced into the end of the mold to permit pouring of the next casting to commence. If no time is to be lost, several heads for castings of different cross sections must be kept available.

It has already been proposed to insert coupling elements such as rails into the head, said rails forming the coupling of the dummy bar head to the steel in the mold for withdrawal of the cast strand. These coupling elements which remain embedded in the end of the strand are separated from the dummy bar head by application of lateral thrust. In this procedure time and material are wasted because new coupling elements must be inserted into the head for each new casting and the elements that have been embedded in the casting are lost.

Recurrent difficulties are experienced, principally because the cast steel welds not only to the coupling elements but also to the head and therefore complicates and delays the separation. Additional difficulties arise because forces due to shrinkage stress act on the rails and cause them to warp in their sockets, so that special devices are needed for effecting separation. Furthermore, these rails interfere with the natural shrinkage and cause extended cracks to appear at the leading end of the casting, which cause considerable waste.

OBJECT OF THE INVENTION

It is the object of the present invention to provide a method, and apparatus for performing the method, of satisfactorily withdrawing the cast strand, and of detaching the end of the strand from the head at the end of the dummy bar while casting continues, in a relatively simple way and in a manner that requires no additional coupling elements.

BRIEF DESCRIPTION OF THE INVENTION

According to the invention this is achieved by partly embedding the head in the steel in a configuration permitting the head to perform a rotary and/or tilting motion, though creating an interfitting coupling connection for withdrawing the casting. The head is subsequently detached by rotating and/or tilting it in a manner deflecting its longitudinal axis out of alignment with the longitudinal axis of the casting and then, after complete separation, removing the head from the path of the casting.

In order to prevent unwanted transverse displacement of the head relative to the casting due to components of thrust generated between coating geometries during withdrawal, another feature of the proposed method consists in providing a component of force which counteracts any such transverse displacement.

The proposed apparatus for performing the method is characterized in that the upper part of the head is formed at least in its central region with a portion projecting towards the opposite wall of the mold, said projection having surfaces geometrically designed to be separable from the solidified casting by a rotary and/or tilting motion of the head whereas at least the face of said upper part of the head on the back of said projection at least partly bears against the cooperating mold wall and the upper face of the bottom part of the head closes the remainder of the open end of the mold.

In order to facilitate the separation of the head from the casting the projection according to the invention may be of semicylindrical shape; as a variation the cylindrical projection may have a flat face on the side facing the opposite mold wall. The projection provides an edge or fulcrum about which the head can tilt and thereby effect a rapid and clean separation.

As is well known, the weight of the casting may apply a downward thrust to the head. Owing to the particular configuration of the projection, this thrust could displace the head transversely with respect to the casting and cause premature separation. However, this is prevented with a dummy bar head of this invention by having the upper face of the bottom part of the head inclined at a positive angle to a plane normal to the casting axis.

To provide a satisfactory seal at the lateral walls of the mold, the lateral walls of the upper part of the head are flush against the mold walls. Preferably the lateral parts of the head may be trapezium shaped.

The force required for the withdrawal of the casting could likewise cause transverse displacement and premature disengagement. In order to prevent this from occurring it is further proposed that the faces of the upper part of the dummy bar head facing the open end of the mold could also be inclined at a positive angle to a plane normal to the casting axis. Moreover, it is proposed that the angle formed by a plane tangent to the surface of the projection at its bottom edge with a plane normal to the casting axis could be less than the positive angle of the aforementioned faces. Alternatively, the angle of the upper face of the bottom part of the head could be equal to or smaller than the angle at the bottom edge of the projecting surface.

Furthermore, in order to ensure that the initiation of a tilting motion will cause a rapid separation of the head from the casting, it is preferred to place the edge about which the head will tilt in the region where the surface on the back of the projection intersects a flat surface of the top of the projection.

THE DRAWINGS

These and other features of the invention will now be more particularly described with reference to embodiments shown in the drawings in which:

FIG. 1 is a cross-sectional view of a dummy bar head in accordance with this invention inserted into the open end of a mold,

FIG. 2 is an elevation of the dummy bar head of FIG. 1,

FIG. 3 is a cross section of one form of dummy bar head embodying the invention and of the solidified steel in which it has been embedded, showing the head in the process of being detached by tilting,

FIG. 4 is a cross section of another form of dummy bar head and of the steel in which it has been embedded, showing the head in the course of being detached by a rotary motion,

FIG. 5 is another embodiment of a dummy bar head which in configuration resembles a catch, and

FIG. 6 is a partial elevation of the embodiment shown in FIG. 5.

DETAILED DESCRIPTION

With reference to FIG. 1, a cooled open-ended mold 1 is shown with a dummy bar head 2 inserted therein, the lower part 3 of the head plugging the open bottom end of the mold 1. This lower part 3 of the head 2 is attached by hinge means indicated at 49 to a dummy bar (not shown).

The upper part 4 of the head 2, which in this embodiment is integrally formed with the bottom part 3, is provided in its center region with a cavity including a substantially semicylindrical projection 5 which extends towards the opposite wall 6 of the mold. As an alternative, the upper part 4 of the head might be detachably connected to the lower part 3 to facilitate a replacement of the upper part which is exposed to greater wear. The bottom part 3 is formed with recesses 24 and 25 which interfit with the end of the dummy bar (not shown).

The semicylindrical projection 5 which faces the opposite wall 6 of the mold has a smooth curved surface 7 terminating along a line 8 at the bottom. However, this projecting portion 5 might also be bounded by differently shaped arched and/or flat faces. At the upper portion of projection 5 the surface 7 merges into a flat face 9 which forms a fulcrum at 27. The described form of construction therefore provides a fulcrum 27 about which the dummy bar head can tilt at the line of intersection between the face 9 and the side 12 of the head at the back of the projection 5. A separation of the head from the steel in which it is embedded is thereby substantially facilitated.

In the embodiment shown in FIG. 2 the projection 5 is in the central portion of the head and ends at the side faces 31 and 32. The projection 5 could, however, be made to extend all the way across the head to the adjacent walls of the mold.

Molten steel is poured into the mold 1 from a pouring vessel (not shown) and the dummy bar head 2 is embedded therein in a manner permitting the head to be disconnected subsequently from the solidified strand by being rotated or tilted relative to the strand. Since the back 12 of the projection, and preferably also the side faces 14, 15 (FIG. 2) of the upper part 3 of the head 2 bear against the mold walls, it is difficult for the steel to enter the interfaces. Such entry of steel may be even more effectively prevented by the interposition of sealing means, such as asbestos cords, and to facilitate placement of asbestos cords between the mold walls and the adjacent faces of the head the corresponding edges of the head are bevelled as indicated at 26.

By suitably designing the dimensions of the head, sufficient heat is immediately abstracted from the steel poured into the cavity between the mold wall 6 and the projection 5 to cause the steel to solidify without welding to the head. At the same time a geometrically interfitting coupling connection is formed between the head and the casting formed in the mold so that the casting can be withdrawn with the aid of the head. As soon as this coupling has been established, the withdrawal of the casting from the mold is initiated by a withdrawing unit (not shown). After leaving the mold the casting is further cooled in a secondary cooling zone and eventually discharged completely from the casting apparatus.

For detaching the head from the casting the head is first slightly turned and then tilted about the fulcrum edge 27 so that its axis is deflected out of alignment with the longitudinal axis 11 of the casting and then completely removed from the path of the casting.

When castings are produced in a continuous casting plant equipped with an arcuate guideway for the withdrawal of the casting therethrough, the dummy bar (not shown) - which may consist of an articulated chain, for example - passes through a withdrawing unit and is pulled onto a tiltable table which is located above the exit for the casting. The head can then be detached from the casting by the tilting of the table. This arrangement permits the head to be detached in an extremely simple way. However, other methods of detaching the head can be devised.

One major advantage afforded by the proposed method is that the head can remain on the dummy bar and is thus im-

mediately ready for reuse for starting a successive casting run. The resultant saving in time is particularly significant when new charges are to be poured in continuous succession.

As already described, the face 12 of the head on the back of the projection 5 is adapted to be in flush contact with the wall 10 of the mold. The two side faces 14, 15 of the head, as shown in FIG. 2, may likewise bear flush against the adjacent walls of the mold. Alternatively, these faces 12, 14 and 15 could be arranged to make contact with the mold wall only along a short part of their length or even only along one edge, the remainder being at a certain possibly varying distance from the adjacent mold wall.

The upper part 4 of the head may have top end faces 16 and 17 which, as shown, may be inclined at a positive angle 19 to a plane 18 normal to the longitudinal casting axis 11. This positive angle 19 should be greater than an angle 20 between a plane 21 tangent to the surface of the projection 5 at its bottom edge 8 and the associated normal plane 18'. As subsequently described, the lower part of the face of the projection 5 may also be flat, in which case the angle 20 is the angle between this latter flat face and the plane 18'. This arrangement of angles counteracts the component of force which is generated by the curved geometry of the projection 5 in the adjacent metal of the casting and which tends undesirably to displace the head transversely with respect to the casting.

The upper face 22 of the bottom part 3 of the head - a face which may be referred to as the undercut face is likewise set at a positive angle 23 to a plane 18'' normal to the casting axis 11. This angle 23, which may be smaller than or equal to the angle 20, likewise prevents the head from being undesirably thrust out of coupling engagement with the casting and of being prematurely detached therefrom.

Thus, as just described, and as shown in the drawings, each of the angles 23 and 19 operate to prevent premature transverse displacement of the head. Experience has shown, however, that the positive angle 23 of the undercutting face 22 is usually enough to prevent any unwanted displacement of the head relative to the casting so that the degree and direction of the angle 19 is not critical in most cases, and may be a negative angle. To facilitate sealing at the bevelled edges 26 the projection 5 may be shortened, the positive angle 23, and also the positive angle 20, may be enlarged, and the angle 19 may be a negative angle, even to the extent that the positive angle 23 and the negative angle 19 are inclined so that the bevelled edges 26 of the end faces 16, 17 meet the bevelled edge 26 of the undercut face 22. Thus the sealing edge of the head inclines little, and it is easier to place scrap on the head for accelerating the cooling of the molten steel in the mold.

Unwanted displacement of the head relative to the casting may also be resisted by the provision of appropriate guide means, such as rollers, until such time as the head and the leading end of the casting reach the point where they are intended to be uncoupled.

FIG. 3 shows another embodiment of the invention in which the projection 5 has an additional flat contact face 7' merging into a curved face in casting direction. This remaining curved face could likewise be replaced by a flat face. FIG. 3 also shows this head 2 in the position it occupies when it is being tilted or tipped out of engagement, the tipping motion being about a fulcrum edge 27 which is in the region where the face 12 at the back of the projection 5 intersects the upper flat face 9. The position of the fulcrum edge 27 is substantially determined by the position and shape of the contact face 7' which must be so disposed in relation to the fulcrum edge 27 that a tilting motion about this edge will disengage the head without jamming the head by contact between the tilted head and the surrounding solidified steel of the casting.

FIG. 4 is yet another embodiment of the head in which the projection 5 has a semicylindrical contact face 7'' which thus has the general configuration of one-half of a roller having its axis at 30. However, curved faces of other configurations would also form suitable contact faces. A semicylindrical face as shown at 7'' permits the head to be detached by first rotat-

ing it in the enveloping steel about the axis 30 and then pulling it off the end of the casting.

FIG. 5 shows another embodiment wherein the upper part 4 of a head 2 which, in shape, resembles a catch so that the casting 28 solidifies to form a nose in the undercut recessed portion of the upper part 4 of the head. As shown, the undercut faces 42 and 43 of the recess and the surface 44 at the bottom of the recess have molded the faces 40, 41 and 45 of the nose of the casting. The face 46 of the casting has been molded by the wall of the cooled mold.

In the drawing the head 2 is shown in a position in which it is in the process of being detached. The upward extension of the head contains a system axis 53 about which the rotary or tipping motion of the head takes place. The upper end face 60 of part 4 of the head is curved relative to this system axis 53 and causes a recessed complementary mating face to be molded into the adjacent end portion of the casting 28. During the tilting motion of part 4 these two complementary faces do not at first separate, but slide relatively across each other.

On the left of the system axis 53 is a center 54 about which the face 41 of the nose curves at a radial distance 51, and on the right of the system axis 53 is a second center 55 about which the other face 40 of the casting nose curves at a radial distance 50. A tilting motion of the head about the system axis 53 causes the center 55 to move to the point marked 57, whereas the center 54 moves to 56, so that the undercut faces 42 and 43 are situated on circles, having radii 50 and 51, about the points 57 and 56. It will be seen that a small angle of tilt opens up a relatively wide clearance gap between the faces 41 and 43 as well as between 40 and 42, and that an increase in the angle of tilt leads rapidly to the creation of a wide gap between the head and the corresponding faces of the casting. At the same time the surfaces 44 and 45 will of course move away from each other. The tilting motion for disconnecting the head does not proceed to completion about the system axis 53, but in its final stages is about the fulcrum edge 27.

The edge between the curved face 60 of the head and its back face 12, which bears against the sidewall of the mold, is preferably chamfered to form a bevel 26. A sealing material is rammed into the angle between the bevel face 26 and the sidewall of the mold, and this sealing material will usually remain adhering to the casting 28 in the form of a narrow fillet 68.

FIG. 6 is a partial elevation of a dummy bar head having a shape resembling a catch for use in a casting plant for continuously casting slabs. Adjacent its end faces 14 (and 15, not shown) the head has a trapezium-shaped configuration 59 which facilitates sealing. Transversely of the longitudinal axis of the casting, the recess, which is to be filled with steel, tapers, so that the side face 46, (FIG. 5) of the casting is widest and the casting narrows towards the projection and thus facilitates the separation of the head from the casting. The lower part 3 of the head 2 is provided with the coupling pin 52 which connects the head to the rest of the dummy bar (not shown) and which permits the head to be pulled out of alignment with the casting by the dummy bar so as to perform the desired tilting motion of the head.

What is claimed is:

1. A method of continuously casting steel comprising closing the bottom end of an open end chill mold by a dummy bar head before pouring begins, then pouring molten steel into the mold, cooling the molten steel in the mold, which by solidifying in the mold adjacent the dummy bar head and the mold walls causes a direct interfitting coupling connection to be formed between the casting and the dummy bar head, thereby permitting the casting to be withdrawn, withdrawing the dummy bar head and casting from the mold, and, after withdrawal and further cooling of the casting, detaching the dummy bar head therefrom, said method being characterized in that the dummy bar head which comprises a hook-shaped projection at its upper end which is partly embedded in the solidified steel of the casting in a configuration permitting the head to perform a tilting motion with respect to the casting is

tilted with respect to the casting in a manner deflecting its longitudinal axis out of alignment with the longitudinal axis of the casting to separate said dummy bar head from the casting, and, after complete separation, removing the dummy bar head from the path of the casting.

2. The method of claim 1, characterized in that the steel which solidifies above the dummy bar head and between the dummy bar head and the mold wall counteracts any unwanted transverse displacement of the dummy bar head in relation to the casting caused by components of thrust generated between coacting geometries during withdrawal.

3. A dummy bar head for use in apparatus for the continuous casting of steel wherein the bottom end of an open-ended chill mold is closed for the start of casting by a dummy bar head placed therein before steel is poured into the mold, said head having its upper end undercut at one side to form with a first adjacent wall (6) of the mold a cavity into which molten steel poured into the mold is received and solidifies, said undercut side of the head having a projection (5) extending into said cavity and toward said first wall of the mold when the head is in the mold, the face (12) of the upper end of the head in back of the projection having at least a part of its surface bearing against the mold wall (10) which is opposite said first wall when the head is in the mold, the surfaces of said projection being arched and terminating in a transverse fulcrum edge to enable the upper end of the head to be separated from steel that has solidified in contact therewith in the mold, after the head and said solidified steel are withdrawn from the mold, by tilting movement of the lower end of the head away from the portion of the steel that has solidified in the cavity.

4. The dummy bar head of claim 3, characterized in that the projection (5) is semicylindrical.

5. The dummy bar head of claim 3, characterized in that the projection (5) has at least one flat face (9,7') facing the opposite mold wall (6).

6. The dummy bar head of claim 3, characterized in that the lateral faces (14, 15) of the upper part (4) of the dummy bar head bear against the walls of the mold.

7. The dummy bar head of claim 6, characterized in that the inside faces (59) of the lateral parts of the dummy bar head are inclined toward the longitudinal casting axis (11) to form a cavity which tapers in the casting withdrawal direction.

8. The dummy bar head of claim 3, characterized in that a fulcrum edge (27) is provided in the region where the said face (12) in the back of the projection (5) intersects the upper edge of the projection.

9. The dummy bar head of claim 3, characterized in that the upper face (22) of the bottom of the cavity in the dummy bar head is inclined upwardly toward said adjacent first wall (6) at an acute positive angle (23) to a plane (18'') normal to the longitudinal casting axis (11).

10. The dummy bar head of claim 9, characterized in that said acute positive angle (23) is equal to or smaller than the positive angle (20) between a plane (21) tangent to the surface of the projection (5) at its bottom edge (8) and a plane (18') normal to the longitudinal casting axis (11) and intersecting said bottom edge (8).

11. The dummy bar head of claim 3, characterized in that the top faces (16, 17) of the dummy bar head are inclined upwardly toward said adjacent first wall (6) at an acute positive angle (19) to a plane (18) normal to the longitudinal casting axis (11).

12. The dummy bar head of claim 11, characterized in that said acute positive angle (19) is greater than said acute positive angle (20) between a plane (21) tangent to the surface of the projection (5) at its bottom edge (8) and a plane (18') normal to the longitudinal casting axis (11) and intersecting said bottom edge (8).

13. The dummy bar head of claim 3, characterized in that the surface (60) of the upper portion of the projection (5) facing said first wall (6) of the mold is curved on a first radius about a first center (53) located in the upper end portion of the head, that the surface (43) of the lower portion of the pro-

7

jection facing said first wall (6) is curved on a second radius, longer than the first, about a second center (54) which is spaced from the first center at the side thereof away from the surface of the projection and close to a line transversely through the first center from the surface of the projection to said face of the head in back of the projection, and in that the surface (42) of the upper face (22) of the bottom of said cavity is curved on a third radius, longer than the second, about a third center (55) which is spaced from the first center at the side thereof toward the surface of the projection and close to

8

said transverse line through the first center.

14. The dummy bar head of claim 13, characterized in that the second and third centers (54, 55) are approximately equidistant from the first center (53).

15. The dummy bar head of claim 13, characterized in that the second center (54) of the surface (43) of the lower portion of the projection facing said first wall (6) of the mold is above said transverse line.

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