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 [73] Assignee **United States Steel Corporation**

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[54] **FLEXIBLE STARTER BAR FOR CONTINUOUS CASTINGS**
3 Claims, 7 Drawing Figs.

[52] U.S. Cl. 164/274
 [51] Int. Cl. B22d 11/08
 [50] Field of Search 164/274, 282

References Cited

UNITED STATES PATENTS

3,274,653 9/1966 Foldessey et al. 164/274
 3,239,894 3/1966 Masters et al. 164/274
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ABSTRACT: The flexible starter bar of the invention comprises a rigid head portion hingedly connected with an elongated flexible body portion. The body portion is comprised of continuous top and bottom flat thin steel plates connected together by transversely extending spaced tie rods which pass through spaced lugs welded to the inner faces of the flat steel plates. The flat steel plates are spaced apart by pairs of superposed narrow bars longitudinally aligned between pairs of the lugs. Adjoining faces of the spacer bars have mating machined slots aligned with slotted holes in the lugs to accommodate the tie rods.

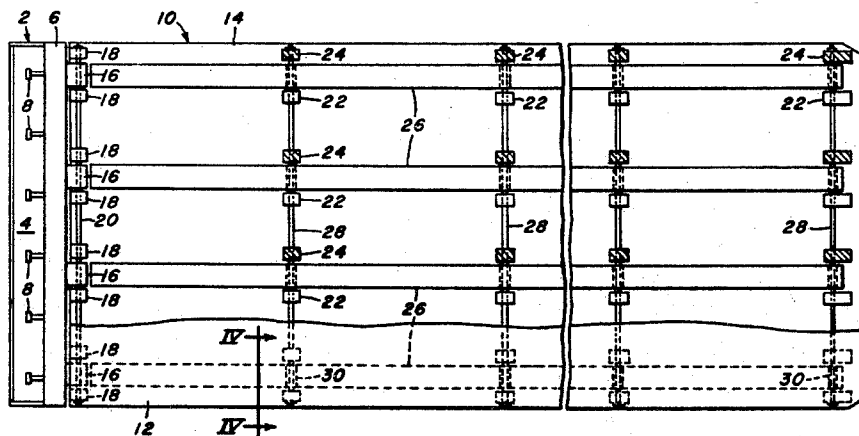


FIG. 1.



FIG. 2.

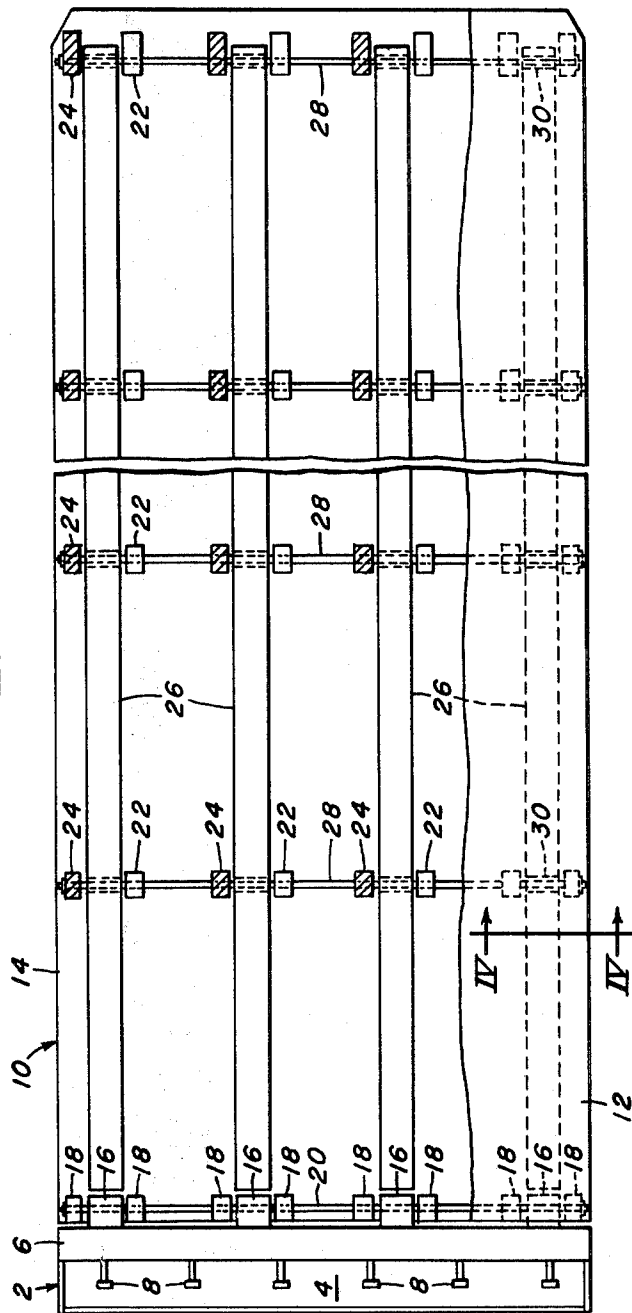


FIG. 3.

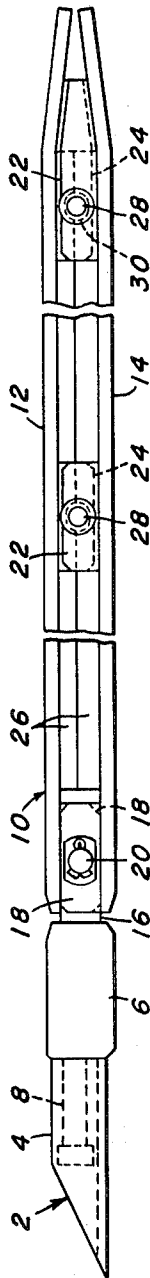
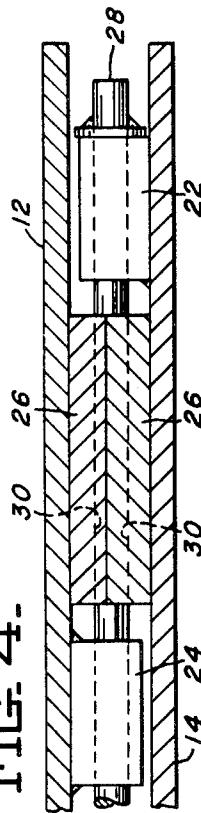


FIG. 4.



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FIG. 5.

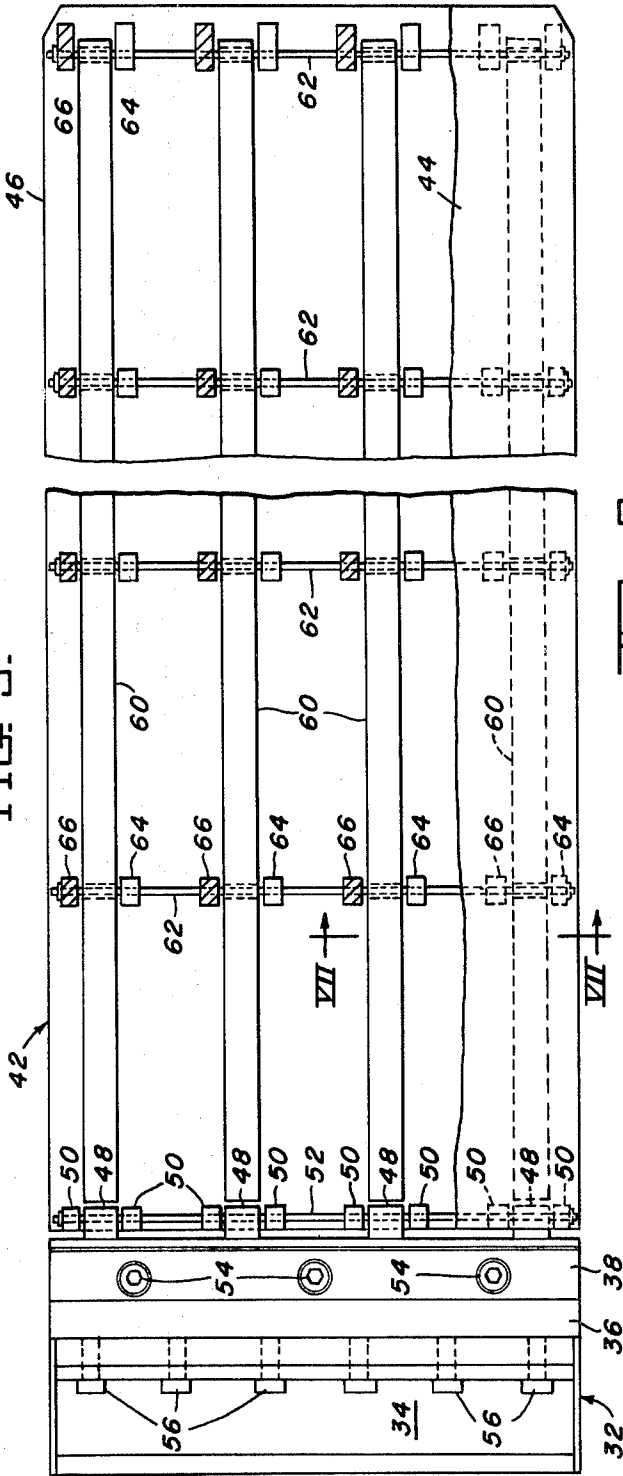


FIG. 6.

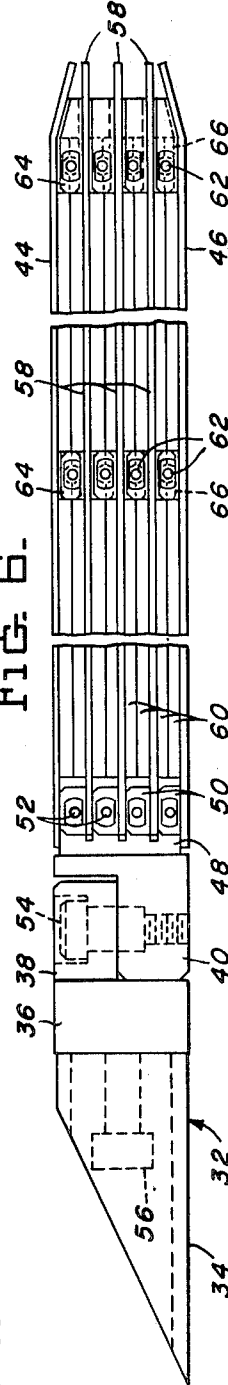
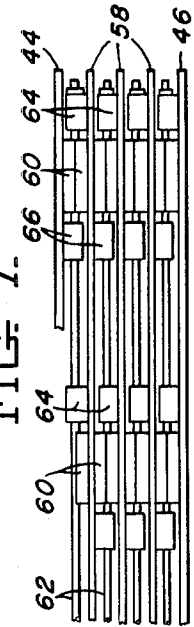


FIG. 7.



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FLEXIBLE STARTER BAR FOR CONTINUOUS CASTINGS

The present invention relates generally to continuous casting equipment and, more particularly, to an improved flexible starter bar for use with a continuous slab-casting mold.

BACKGROUND OF THE INVENTION

Typical casting machines used for the continuous casting of slabs conventionally include a gravity flow, open end mold, which may be disposed vertically or inclined from the vertical, and pinch rolls, bender rolls and straightener rolls. The rolls are angularly displaced relative to the plane of the mold so as to effect bending of the columnar casting descending from the mold into a curved path so it may eventually be delivered horizontally for cutting into required lengths. Examples of casting machines are disclosed by U.S. Pat. Nos. 2,920,359 and 2,904,860.

In continuous casting of slabs, a starter bar is utilized for conducting the casting from the mold and starting it through the pinch rolls, bender rolls and straightener rolls to a horizontal position. Where a rigid steel starter bar is used, it must be disconnected from the casting before the bar reaches the bending and straightening rolls. Such separation of starter bar and casting is necessary because the elements used for bending and straightening the hot casting are not strong enough to bend and straighten a solid, cold steel starter bar. If the solid steel starter bar was not removed at this point, the bending and straightening elements of the continuous casting apparatus would either be damaged themselves or they would deform the bar permanently to such an extent as to render it useless for future operations. This necessary removal of the rigid starter bar presents a number of difficult problems since the bar is heavy and bulky and requires additional manpower and space for manipulation to effect its removal from the casting.

In efforts to avoid the problems inherent in the use of solid steel starter bars, attempts were made to use solid starter bars made of relatively soft metals such as aluminum, brass of the like. However, such attempts were unsuccessful since it was found that after each use of such a bar in a continuous casting operation, including complete passage of the bar through the bending and straightening elements, the diameter of the bar was reduced and it became harder due to the compression and bending action of the pinch rolls, bender rolls and straightening rolls on the starter bar. This, of course, made the use of solid starter bars of relatively soft metal impractical.

Prior to my invention, starter bars made up of flexibly interlocking segments were also used in an attempt to avoid the problems presented by the use of solid starter bars. Examples of certain types of flexible starter bars are disclosed in U.S. Pat. Nos. 2,920,359, 3,220,068, and 3,239,894. Such starter bars were found not to be entirely satisfactory. They were difficult to handle and guide since they did not have the ability to withstand compression or side thrust. Such flexible starter bars had to be supported at close intervals to prevent them folding upon themselves as, for example, on a long runout table where the conveyor rollers are spaced relatively long distances apart.

It is, accordingly, the primary object of my invention to provide an improved flexible starter bar for continuous casting which is capable of use through the rolls used to conduct a casting from a substantially vertical path to a horizontal path to travel after leaving the mold of a continuous casting machine.

It is another object of my invention to provide a flexible starter bar for continuous casting which will remain straight and rigid enough to perform its required function of supporting its head portion in position as a temporary bottom of the mold of the continuous caster while molten metal is initially poured into the mold and thereafter remain rigid in the vertical plane during withdrawal of the starter bar from the bottom of the mold as casting proceeds; and yet be capable of being bent and straightened through the same bending and

straightening rolls through which the casting is drawn by the starter bar without damage to either the rolls of the starter bar itself.

SUMMARY OF THE INVENTION

The improved starter bar of my invention comprises a relatively short head portion and an elongated body portion hingedly joined together. The head portion is adapted to function as a temporary bottom of the mold of a continuous caster and also to attach to the metal in the mold. The body portion supports the head portion and draws it together with the casting through the pinch rolls, bending rolls, and straightening rolls of the continuous caster. The body portion is composed of continuous top and bottom plates held together mechanically in spaced-apart parallel relationship by means of a plurality of spaced, transversely extending tie rods or hinge pins disposed between the top and bottom plates. The tie rods extend through lines of pairs of spaced lugs which are welded alternately to the inner surfaces of the top and bottom plates. A plurality of superposed slotted spacer plates extend longitudinally of the body portion between each pair of lugs. The tie rods pass through the slots in the spacer plates. This arrangement provides freedom of sliding movement between the contiguous surfaces of the top and bottom plates and the spacer plates and thus renders the starter bar flexible as it moves through the various elements of the continuous casting machine.

BRIEF DESCRIPTION OF THE DRAWINGS

A complete description of the invention may be obtained from the following detailed description and explanation which refer to the accompanying drawings illustrating the present preferred embodiment. In the drawings:

FIG. 1 is a diagrammatic elevational view, partly in section, showing the starter bar of the invention in a continuous casting machine;

FIG. 2 is a top plan view with parts removed for clarity of a preferred embodiment of the flexible starter bar of the invention;

FIG. 3 is an enlarged side elevational view of FIG. 2;

FIG. 4 is a cross-sectional view taken substantially along the line IV—IV of FIG. 2;

FIG. 5 is a top plan view similar to FIG. 2 of a modified embodiment of the invention;

FIG. 6 is an enlarged side elevational view of FIG. 5; and

FIG. 7 is a cross-sectional view taken substantially along the line VII—VII of FIG. 5.

Referring more particularly to the drawings, reference numeral 2 designates generally the head portion of the starter bar of the invention which head portion includes a scoop-shaped element 4 at its forward end adapted to function as a temporary bottom of the mold 5 of a continuous casting machine and to receive and retain molten metal from the mold. The inner end of the head portion 2 constitutes a solid metal chill plug or bar 6 having spaced anchor bolts 8 projecting therefrom into the scoop 4. The anchor bolts facilitate connection of the molten metal from the mold with the head portion of the starter bar as the molten metal chills on contact with the chill plug 6.

Reference numeral 10 designates generally the body portion of the starter bar of the invention which includes elongated continuous top and bottom plates 12 and 14, respectively, arranged in spaced, parallel relation.

The head portion 2 is hingedly connected with the body portion 10 by means of spaced lugs 16 which project from the end of the head portion 2 adjacent the body portion 10, pairs of lugs 18 welded or otherwise securely attached to the inner surfaces of the top and bottom plates 12 and 14, one on either side of one of the lugs 16, and a tie rod or hinge pin 20 which extends through oversized aligned openings in the lugs 16 and 18, as best shown in FIG. 2.

Bottom plate 14 has a plurality of spaced transverse rows of spaced lugs 22 welded thereto and extending upwardly therefrom toward, but terminating short of, the top plate 12. Top plate 12 has a plurality of spaced transverse rows of spaced lugs 24. The lugs on the top plate extend downwardly from its inner surface toward, but terminate short of, the bottom plate 14. The lugs in each of the rows are provided with aligned slotted openings for a purpose which will become apparent.

A plurality of spaced pairs of superposed spacer plates 26 extend longitudinally of the body portion 10 with each pair being confined between a pair of lugs 22 and 24 in each of the rows of lugs attached to the inner surfaces of the top and bottom plates. A tie rod or hinge pin 28 extends through the slotted openings in the lugs 22 and 24 of each of the rows of lugs and through slotted mating recesses 30 in the adjacent surfaces of each pair of spacer plates 26 between the respective lugs 22 and 24.

For optimum results, a lubricating compound may be applied to all the sliding surfaces of the body portion 10 so as to insure greater flexibility of the starter bar as it passes through the bending and straightening elements of a continuous casting machine.

As best seen in FIG. 3, at the end of the body portion 10 remote from the head portion, the top and bottom plates 12 and 14 are bent toward each other so as to form a generally tapered structure to facilitate introduction of the end of the starter bar into the pinch rolls, bending rolls, and straightening rolls, of a continuous casting machine.

In operation, the starter bar is positioned initially with the head portion 2 forming the bottom of the mold 5 of a continuous casting machine, as best shown in FIG. 1. Molten metal M is then poured into the mold 5. When the bottom of the column of molten metal in the mold 5 contacts the chill plug 6, it chills and adheres to the head portion 4 of the starter bar. Then the starter bar is withdrawn to conduct the cast metal from the mold and is made to pass through the pinch rolls 25, bending rolls 27, and straightening rolls 29 of the continuous casting machine to conduct the casting to a horizontal cutting table (not shown) where the hot metal can be cut into slabs of desired size.

After each continuous casting operation, when the starter bar has served its purpose to conduct the casting to the cutting table, the head portion of the starter bar is removed from the body portion thereof by removing the tie rod or hinge pin 20. The head portion is permitted to remain connected with the end of the casting which is subsequently cropped. After a new head portion is connected with the body portion, the starter bar is ready to be used again.

In the modified embodiment of the starter bar of the invention shown in FIGS. 5, 6 and 7, reference numeral 32 designates generally the head portion of the starter bar which consists of a scoop-shaped element 34 having a chill plug base 36 of solid metal formed with an overhanging projection 38. Projection 38 is normally disposed above a chill plug connection 40, which, in turn, is connected with the adjacent end of the body portion, designated generally by reference numeral 42, of the starter bar.

The body portion 42 of the modified embodiment of the starter bar of the invention includes continuous elongated top and bottom plates 44 and 46, respectively, which are arranged in spaced parallel relation. Lugs 48 project from the chill plug connection 40 and are interfitted between pairs of lugs 50 which are welded to the inner surfaces of top and bottom plates 44 and 46. The head portion 32 and the body portion 42 are hingedly connected together by means of a tie rod or hinge pin 52 which passes through aligned oversized openings in the lugs 48 and 50.

The head portion 32 is connected to the chill plug connection 40 by means of shoulder bolts 54, as best shown in FIGS. 5 and 6.

A plurality of spaced anchor bolts 56 project from the chill plug base 36 of the head portion 32 into the scoop 34 to facilitate connection of the starter bar to the cast metal.

A plurality of intermediate plates 58, which are arranged in parallel spaced-apart disposition by means of slidable pairs of spacer plates 60, are sandwiched between top and bottom plates 44 and 46 with the entire assembly being held together by means of tie rods or hinge pins 62 which extend transversely across the body portion 42 spaced longitudinally thereof. The tie rods 62 each extend through one of a plurality of rows of aligned pairs of lugs 64 and 66. The lugs 64 are welded to and project upwardly from the bottom intermediate plate adjacent thereto while the lugs 66 are welded to and project downwardly from the upper intermediate plate 58 adjacent thereto. Each of the lugs terminates short of the intermediate plate toward which it extends. The topmost lugs 66 are welded to the inner surface of the top plate 44 while the lowermost lugs 64 are welded to the inner surface of the bottom plate 46.

The mode of operation of the above-described modified embodiment of the starter bar of the invention is essentially the same as that of the mode of operation described relating to the preferred embodiment of the starter bar of the invention.

After the modified starter bar of the invention is used to conduct a casting to the cutting table, the head portion is permitted to remain connected with the end of the casting which is subsequently cropped. The body portion 42 is removed from the head portion 32 by removing the shoulder bolts 54 to disengage the overhanging projection 38 of the chill plug 36 from the chill plug connection 40. A new head portion is then attached to the body portion by means of shoulder bolts and the starter bar is ready for use again.

It will now be apparent that the starter bar of the invention constitutes a flexible element, with a head portion at one end adapted to function as a temporary mold bottom, which is sufficiently rigid to be pushed upwardly, as shown in FIG. 1, between pinch rolls 25, which control the descent of the casting from the mold 5; and sufficiently flexible to travel between and conform to the path defined by the bending rolls 27, which define the desired curved path for the casting, and through the straightening rolls 29.

While I have shown but one embodiment of my invention, other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A flexible starter bar for continuous casting comprising a head portion and an elongated body portion pivotally connected end-to-end, said body portion comprising elongated spaced top and bottom plates disposed in parallel relation, a plurality of spaced transversely extending series of aligned pairs of spaced lugs between said top and bottom plates, one lug of each said pairs of lugs being attached to and depending from said top plate and the other being attached to and projecting upwardly from said bottom plate, at least two superposed continuous spacer plates extending longitudinally of said body portion between each pair of lugs of each of said series, the lugs of each of said series having aligned openings therethrough and said spacer plates having transverse slots therethrough aligned with the openings in each pair of lugs adjacent thereto, and a tie rod extending through each of said series of lugs and the spacer plates extending between the pairs of lugs of each of said series, each of said tie rods being slidably disposed in the openings of the lugs of its respective series and the slots in the spacer plates disposed between the pairs of lugs of its respective series.

2. A flexible starter bar as defined by claim 1 in which the pivotal connection between said head portion and said body portion includes a plurality of aligned spaced lugs projecting from the end of said head portion adjacent said body portion, a plurality of aligned pairs of spaced lugs projecting from the end of said body portion adjacent said head portion, each of said lugs on said head portion being disposed between the lugs of one of said pairs of lugs on the end of said body portion, and a tie rod extending slidably through the aligned lugs on said head portion and the adjacent end of said body portion.

3. A flexible starter bar as defined by claim 1 including a plurality of spaced anchor bolts projecting from the end of said head portion remote from said body portion.