APPARATUS FOR HANDLING CONTINUOUS CASTINGS

Fig. 3

Fig. 4

Fig. 5

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The present invention relates in general to apparatus for handling vertically delivered elongated metal products, and more particularly to the handling of an elongated continuous casting as it is produced by a commercial continuous casting apparatus.

In the continuous casting of metals an open ended mold is usually arranged in an upright position to receive molten metal at its upper end, to solidify the metal therein by heat exchange with a cooling fluid and for the removal of the casting from its lower end. For the production of a commercially satisfactory casting the rate of molten metal delivery to the mold and the cooling rate therein are coordinated and maintained substantially uniform for the continuous withdrawal of the casting from the mold at a substantially uniform rate. Under these conditions the longitudinal axis of the casting withdrawn from the mold is essentially vertical and its length is limited only by the amount of molten metal delivered to the upper end of the mold. As a considerable amount of heavy equipment is positioned above the delivery level of the continuous casting, it is necessary to limit the height of such equipment to minimize the cost of the supporting structure. Such a height limitation requires the use of apparatus for cutting the elongated casting in suitable lengths and their prompt removal from the delivery zone to provide space for the continuous downward movement of the succeeding casting.

The delivered metal product might in some instances be deflected or bent from its upright delivery position through an angle of 90° or less to a discharge position. However, such a procedure is dependent upon the character of the material and its cross-sectional dimensions, and the apparatus would be unduly heavy for use with the continuous casting of steel with which the present invention is particularly concerned.

The principal object of the present invention is to provide apparatus for the removal of a vertically delivered elongated metallic product so that as the product is delivered it is removed in a relatively short section to make way for the subsequently delivered length of product. A further and more specific object is to provide apparatus of the character described which is capable of severing a vertically delivered continuous casting into convenient lengths and delivering the lengths of casting to a point of use or storage without interrupting or interfering with the continuity of the casting process. An additional specific object is to provide apparatus capable of severing a continuous casting while it is moving in a substantially vertical direction from the casting mold and to transfer the severed casting to a position out of alignment with the casting mold. A further object is to provide apparatus for sequentially cutting a vertically delivered continuous casting to predetermined lengths and removing each length of casting from the casting apparatus independently of the formation of the continuous casting.

The various features of novelty which characterize our invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which we have illustrated and described a preferred embodiment of our invention.

Of the drawings:

Fig. 1 is an elevation view of the handling apparatus constructed in accordance with the present invention as associated with a continuous casting machine;

Fig. 2 is an elevation of the dummy rod used in the continuous casting operation;

Fig. 3 is an enlarged plan view, partly in section, of the casting cutting apparatus;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 3;

Fig. 4a is a vertical section taken on the line 4a—4a of Fig. 4;

Fig. 5 is a horizontal section taken on the line 5—5 of Fig. 4;

Fig. 6 is an enlarged elevation of the handling apparatus shown in Fig. 1;

Figs. 7, 8 and 9 are horizontal sections taken on the lines 7—7, 8—8 and 9—9, respectively, of Fig. 6;

Fig. 10 is an enlarged elevation view of another portion of the casting handling apparatus shown in Figs. 1 and 6;

Fig. 11 is a vertical section taken on the line 11—11 of Fig. 10; and

Fig. 12 is an elevation of the casting cutting apparatus.

While our improved handling apparatus is adapted for use in the continuous casting of substantially all metals and alloys, our apparatus described herein is particularly designed and especially useful for the handling of continuously cast carbon and alloy steels of the larger cross-sectional dimensions.

In the continuous casting of metals, the molten
metal, such as steel or other metal or alloy is introduced into one end of an upright mold, solidified therein and a semi-finished product ready for final shaping and finishing is delivered from the opposite end of the mold. A continuous casting system of this type is disclosed and claimed in a pending application of I. Harter, Jr., and O. R. Carpenter, Serial No. 10,956, filed February 26, 1948, and is shown generally in Fig. 1. As shown, molten steel is transported to the apparatus by a transfer ladle 10 from the melting furnaces (not shown) and bottom poured to a holding and pouring ladle 11. The ladle 11 is arranged for lip pouring with a regulating mechanism designed to effect a continuous selected pour rate into an adjustably positioned turn dish which discharges the molten metal into the upper end of and along the axial center of an associated casting mold assembly 12.

The metal pouring rate from the ladle 11 is regulated by tilting the ladle about an axis, where the angle of tilt is determined by a motor driven drum hoist 35 connected to one end of the ladle frame by a cable 33 which is passed through a pair of pulleys 35. The molten metal is solidified in the mold assembly 12 by heat exchange with a cooling fluid and continuously withdrawn therefrom as a continuous casting 13 at a controlled rate by a set of power-driven pinch rolls 14. The continuous casting thereafter passes to the handling portion 15 of the apparatus where the casting 13 is sequentially cut to predetermined lengths and delivered to a horiztonal conveyor for transportation to a point of use or storage (not shown).

In initiating the formation of a continuous casting in a dummy casting or starting bar 164, such as illustrated in Fig. 2, is inserted in the mold with its upper end positioned intermediate the length of the mold assembly 12 and with its lower end engaged by the rodents 14. The bar 164 is constructed in a series of short sections 165 for convenience in handling, with the sections held together by means of a pin 166 so that the bar may be assembled and disassembled quickly and easily.

After molten metal has been delivered to the pouring ladle 11 and the casting water is circulating through the mold assembly 12, the molten metal is delivered to the mold cavity defined at its lower end by the top of the starting bar 164. When the molten metal in the mold has reached a predetermined point adjacent its upper end, the pinch rolls 14 are started to withdraw the bar 164 at a uniform selected rate coordinated with the molten metal delivery and the water cooling rate to form an elongated continuous casting. Due to the length of the starting bar, which extends from the rolls to an intermediate position within the mold assembly 12, each successive section 165 of the starting bar projecting below the rolls 14 is disconnected, withdrawn and conveniently stored for future use. Alternately, the starting bar 164 may be lowered as a unit to the ground level by the handling apparatus 15 and stored for future use. Under such circumstances the bar may be reclaimed from ground level storage and reinstalled in the mold to repeat a continuous casting run by a reversal of the handling apparatus, as will be hereinafter apparent.

It will be noted in Fig. 2 that a head 167 on the upper end of the starting bar 164 is provided with a cap screw 168 threaded into the upper end thereof. The lower end of the continuous casting 13 solidifies around and grips the upwardly extending shank and head of the cap screw 168, substantially as shown in Fig. 2 whereby the initially formed casting 13 is withdrawn from the mold by the pinch rolls 14 acting on the bar 164. When the last detachable section 165 of the bar is removed below the rolls 14, the head 167 may be removed by unscrewing from the cap screw 168.

The continuous casting 13 formed in the mold assembly 12 moves downwardly below the pinch rolls 14 into a trough or cradle 91 and when the lower end of the casting approaches a shelf 99 at the bottom of the cradle, a cutting torch 92 is arranged to transversely cut the casting to a predetermined length for each subsequent piece of handling and delivery to point of use. The position of the shelf is adjustable longitudinally of the casting to correspond with the length of the severed casting delivered by the apparatus.

When the lower end of the continuous casting approaches the shelf 99 the torch is used to sever the casting. The casting drops onto the shelf, with the cradle and the severed casting 93 thereafter tilted out of alignment with the following portion of the continuously discharging casting. The cradle lowers to a horizontal position where it is removed from the cradle by a roller conveyor 94. As soon as the severed casting section is removed, the cradle is returned to an upright position to receive the succeeding section of the continuous casting wherein the handling process is repeated, periodically delivering casting lengths to the conveyor 94.

The cutting torch 92 is of the oxy-acetylene type and is mounted on a carriage 95 which is arranged for vertical movement within predetermined limits between the rolls 14 and the cradle 91. This apparatus is shown particularly in Figs. 3, 4, 4a, 5 and 12 wherein the carriage 95 is provided with two pairs of wheels 96 arranged in pairs to bear upon opposite flanges of two horizontally spaced vertical extending channels 97. A counterweight 99 counterbalances the weight of the carriage 95 and when the cutting torch carriage is free of the casting 13 the weight 99 helps in manually raising the carriage to an upper position. The upper position of the carriage 95 is maintained by a stop 99 limiting the downward movement of the counterweight. The upper portion of the carriage is provided with a pair of jaws 100 pivoted about a pin 101 and connected by a linkage 102 and a cross head to the piston rod 99 of a double-acting power cylinder 103. Compressed air is selectively delivered to one or the other sides of the piston of the cylinder 103 to advance or retract the piston rod 99. As shown in Figs. 3 and 12 the rod 99 is in an advanced position so that the jaws 100 grip the casting 13. Thus the casting moves vertically downwardly with the casting and the torch carried on the carriage may be used to sever the casting with a transverse cut. When the cutting has been severed by the torch the jaws 100 gripping the casting are released by a reverse action of the power cylinder and the carriage is returned to its upper position for the next cutting operation as may be required by the continuous discharge of the casting 13.

With the carriage 95 clamped to the casting 13 and moving in a vertical direction therewith, the tip of the cutting torch may be moved in a curved path in a horizontal plane normal to the axis of the casting 12.

The torch 92 is removably mounted in a pair of
brackets 105 depending from a carrier plate 104, which is movably supported from a horizontal plane spaced from the bottom plate of the carriage 96 by a pair of spaced cranks. Each crank includes a pin 107 rotatably supported in a pivot bearing 106 secured to the plate 104 and having a clevis 110 at its upper end which is clamped in a fixed position by a transverse bolt 111 extending through a slot 108 in the crank arm 112. Each crank arm is further provided with an upwardly projecting pin 113 at its opposite end which is rotatably mounted in the carriage 95. A variation in the effective crank throw is obtained by changing the clamped position of the bolt 111 in the slot 108, thereby altering the horizontal spacing between the pins 107 and 113. With this construction the curvilinear path of the tip of the torch 92 may be varied in radius to conform to the outside diameter of the continuous casting 13.

The transverse movement of the torch 92 is accomplished by a transverse screw 114 engaging an internally threaded sleeve 116. The screw 114 is supported by bearings 115 mounted in the frame of the carriage 95 while the sleeve 116 carries a block 118 slidably engaging a guide 119 which is bolted to the plate 104. The screw 114 is rotatable by means of a handwheel 117 through a pair of bevel gears. With the construction described the sleeve 116 moves in a linear direction as fixed by the carriage 95 while the plate 104 and its supported torch moves in an arc by reason of its crank support. The guide movement of the block 118 and the guide 119 also permit movement of the torch in a linear direction at right angles to the direction of sleeve movement so that all progressive positions of the torch are in parallelism.

The cradle 91 of the handling portion 15 of the continuous casting apparatus is shown in Figs. 1 and 6, wherein the cradle with a severed casting 93 supported therein is shown in Fig. 6 in an upright position (shown in solid lines) immediately after the casting is severed by the torch 92, the cradle in an intermediate position (shown in dot-dash lines), and the cradle in a horizontal position (shown in dotted lines) immediately prior to the removal therefrom of the severed casting by the conveyor 94. As shown in Figs. 6, 7, 8 and 9, the cradle 91 is formed by a pair of side channel members 120 and 121 arranged back to back and spaced apart by a set of bottom channel members 122 transversely extending across the bottom 123 of the cradle. The channel members 122 are spaced longitudinally of the cradle 91 to provide openings therebetween matching the rolls of the conveyor 94 when the cradle is in its horizontal position. The top 124 of the cradle, to the left in Fig. 5, is open so that the cradle may be returned to its upright position after delivery of the severed casting, without interfering with the withdrawal of the succeeding section of the continuous casting 13. Depending upon the rate of withdrawal of the continuous casting through the rolls 14, the projecting length of unsevered casting may extend directly forwardly a major portion of the height of the handling portion 15 of the apparatus before the cradle 91 can not be returned to its upright position after the discharge of the preceding section of casting. Any interruption in the continuous casting process must be avoided to maintain a desirable uniformity of product, thus the cradle must be always at the top to accommodate succeeding sections of the casting 13.

The cradle 91 is guided in its movement between a vertical and horizontal position by a pair of flanged wheels 125 on an axle 126 attached to the bottom 123 of the cradle at a location spaced from its upper end, and by a pair of flanged wheels 127 of a narrower gauge on an axle 128 attached to the top 124 of the cradle at its lower end. The wheels 125 are guided by a pair of rails 131 vertically extending from the foundation to a level above the uppermost location of the wheels when the cradle is in an upright position and pair of rails 131' extend vertically upward from the foundation to an intermediate height and are in spaced parallel relationship to the rails 131 a distance corresponding generally to the diameter of the wheels 125. A separate pair of rails 132 extend vertically from the foundation level a short distance to guide the wheels 127 in their vertical movement. The rails 132 extend horizontally from the lower ends of the rails 132 and are joined therewith by curved members 132', providing continuous tracks to guide the movement of the wheels 127. The gauge of the wheels 125 is greater than the width of the cradle, so that the cradle is free to pivot about the axle 126 in its downward movement.

The severed casting 93 and its supporting cradle 91 are lowered from the upright position to the horizontal by an electrically-driven drum hoist 133 equipped with a magnetic brake and connected to the axle 126 by a pair of cables 134. The cables pass over a pair of sheaves 135 which are rotatable about a fixed axis on the structural framework supporting the continuous casting apparatus. Advantageously, a counterweight 128 is provided for the cradle 91. The axis of the sheaves 135 is horizontally offset from the vertical plane of the axle 126 to insure the seating of the wheels 125 upon the rails 131, while the weight of the cradle pivoting about the axle 126 insures the bearing of the wheels 127 against the rails 132.

After the continuous casting has been severed by the torch 92 as previously described, the upper end of the severed casting 93 is forced toward the bottom 123 of the cradle 91 and held in that position until the outward swing of the upper end of the cradle, as determined by the downward movement of the guide wheels 125 and 127, has progressed to a point whereby the weight of the casting will hold it in position against the bottom of the cradle. The movement of the upper end of the severed casting 93 in the cradle is accomplished by a manually controlled power piston 136 which is supported on the framework of the continuous casting apparatus, as shown in Figs. 6 and 7, and arranged with its piston rod 137 bearing on one end of a channel member 146. The channel is pivoted at its upper end about a shaft 141 mounted on the supporting framework of the apparatus. Thus, when a pressure fluid is applied to the power piston 136 the piston rod 137 pushes the lower end of the channel 146 into the open top 124 of the cradle and against the severed casting, pushing the casting laterally toward the bottom 123 to rest against the members 122. The action of the piston is controlled by limit switches (not shown) allowing it to push only when the cradle is near its upright position.

With the lower end of the severed casting 93 supported on the shelf 98 and its upper end resting against the bottom 123 of the cradle, the hoist 133 is operated to feed out the cables 134 to lower the cradle to its casting discharge position. The casting is removed from the cradle by the con-
veyor 94. The conveyor 94 includes a series of circumferentially grooved rollers 142, some of which are motor-driven as shown in Fig. 9, with the spacing between individual rollers such as to match corresponding openings in the bottom 123 of the cradle 91. Due to the necessity for speed in completing the handling cycle for each severed casting, the cradle is lowered to its horizontal casting discharge position with considerable speed.

A shock absorber device 143 is arranged to retard the final angular movement of the cradle in bringing the casting into contact with the grooved rollers. The shock absorber is shown in detail in Figs. 10 and 11 and includes a piston 144 pivotally attached at its lower end to a frame 145 which is rigidly secured to the framework 146 supporting the rollers 142 of the conveyor. The upper end of the piston rod 147 of the piston 144 is arranged for a pivotal connection with a spaced pair of L-shaped arms 150 which are also pivotally attached to a shaft 151 mounted in the framework 146 of the conveyor. The pivotal connection between the piston rod 147 and the arms 150 is shown in section in Fig. 11 and includes a transversely bored cross head 152 attached to the end of the rod 147 and arranged to receive a cross shaft 153 which is bolted at each end to the upper end of both arms 150. A pair of rollers 154 are rotatably mounted on the shaft 153 between the cross head 152 and each arm 150. A pair of contact shoes 155 are rigidly attached in alignment with the cradle side members 120 and 121 and with a channel member 122 of the bottom 123 as a means for transferring the downward thrust of the cradle 91 to the rollers 142.

Thus, when the cradle is lowered from a position of initial contact between the shoes 155 and the rollers 154 such as indicated in Fig. 10, to a final casting discharge position as indicated by the dot-dash lines, the shock absorber device 143 and the shock absorber located in the housing 147 of the conveyor 94 are retained in contact with the rollers 142 of the conveyor 94. During the downward movement of the cradle in contact with the shock absorber device there will be a slight movement of the cradle to the left which will be taken on the cross head 152 and the fixed shaft 153, thus avoiding transmitting the side thrust to the piston rod 147.

The cylinder 144 is supplied with compressed air, at a predetermined pressure sufficient to raise the empty cradle from its lowest position, through a supply line 157 and a conventional one-way valve 158. When the loaded cradle forces the piston downward to compress the air in the cylinder, the speed of lowering to the final cradle position is governed by adjustment of the bleeder valve 156. With the cradle 91 in its discharge position the casting is in contact with the rollers 142 which remove the casting from the cradle. Immediately after the casting is removed, the cradle is returned to its upright position to receive the succeeding length of continuous casting 13, and the handling process repeated.

The safety device 161 is installed between rollers of the conveyor at a position adjacent the discharge end of the cradle when that cradle is in its horizontal position. An arm 162 on the safety device is arranged to project above the conveyor 94 and to be in contact with the severed casting 93 during the period of time the casting is in the cradle and being removed therefrom by the conveyor. The arm is connected with a conventional make and break contact 163 in the power circuit of the motor-driven drum hoist 133 so that it is impossible to raise the cradle 91 while the severed casting 93 is being removed therefrom by the conveyor.

While in accordance with the provisions of the statutes we have illustrated and described herein the best form and mode of operation of the invention now known to us, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by our claims, and that certain features of our invention may sometimes be used to advantage without a corresponding use of other features.

We claim:

1. Apparatus for transferring several lengths of continuous casting from an upright receiving position to a generally horizontal discharge position including an open-ended elongated cradle open on its top side and having a series of spaced openings in its bottom side, a stop plate extending transversely across said cradle adjacent one end thereof to support the severed casting 93 in a hoist arranged to raise and lower said cradle, guide means including a cradle tilting support attached to said cradle on a horizontally pivoted axis positioned intermediate the length of said cradle and movable in a substantially vertical plane to direct the movement of said cradle from its upright position to a generally horizontal casting discharge position, and a plurality of conveyor rolls positioned to project through the spaced openings in the side of said cradle when in its casting discharge position and to remove the severed casting therefrom.

2. Apparatus for transporting severed lengths of continuous casting from a vertical casting receiving position to a casting discharge position including an elongated cradle open at one end and on one side and provided with a series of spaced openings in its opposite side, a longitudinally adjustable stop plate extending transversely across said cradle to support said severed casting therein, a hoist arranged to raise and lower said cradle, guide means positioned to direct the movement of said cradle from an upright position to a horizontal position, a plurality of positively driven conveyor rolls positioned to project through the spaced openings in the side of said cradle when in its horizontal position and to remove the severed casting therefrom, and a safety device actuated by the presence of said casting within said cradle to prevent lifting said cradle from its discharge position until said severed casting has been removed therefrom by said conveyor.

3. Apparatus for handling severed lengths of continuous casting comprising an elongated cradle open at one end and on one side and provided with a series of spaced openings in its opposite side, a stop plate extending transversely across said cradle adjacent one end thereof to support a severed casting therein, a hoist positioned to raise and lower said cradle, guide means arranged to direct the movement of said cradle from an upright casting receiving position to a casting discharge position, a plurality of positively driven conveyor rolls positioned to project through the spaced openings in the side of
said cradle when in its casting discharge position and to remove the severed casting therefrom, and a shock absorbing device positioned to engage the cradle in proximity to said conveyor and to cushion the movement of said cradle into its casting discharge position.

4. Apparatus for handling severed lengths of continuous casting comprising an elongated cradle open at one end and on one side and provided with a series of spaced openings in its opposite side, a plate extending transversely across said cradle to support a severed casting therein, means for maintaining a severed casting within said cradle until in its discharge position including a power piston positioned adjacent the upper end of said cradle operative to direct the movement of said cradle from an upright casting receiving position to a generally horizontal casting discharge position, means for retarding the final movement of said cradle into its delivery position, and a plurality of positively driven conveyor rolls positioned to project through the spaced openings in the side of said cradle when in its casting discharge position and to remove the severed casting therefrom.

5. Apparatus for handling severed lengths of continuous casting comprising an elongated cradle open at one end and on one side and provided with a series of spaced openings in its opposite side, a stop plate extending transversely across said cradle to support a severed casting therein, a hoist positioned to raise and lower said cradle, guide means arranged to direct the movement of said cradle from an upright position to a casting discharge position, a pneumatic shock absorbing device for retarding the final movement of said cradle into said casting discharge position, a plurality of positively driven conveyor rolls positioned to project through the spaced openings in the side of said cradle when in its casting discharge position and to remove the severed casting therefrom, and electric interlocking means actuated by the presence of the severed casting within said cradle to maintain said hoist inoperative when said conveyor is discharging said casting from the cradle.

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