United States Patent [19]
Huber

[11] 3,765,470
[45] Oct. 16, 1973

[54] CONTINUOUS CASTING MACHINE

[75] Inventor: **Horst Huber**, Roselle Park, N.J.

[73] Assignee: **Sergio J. Castagnoli, c/o Robert E. Moss**, New York, N.Y.

[22] Filed: **July 14, 1971**

[21] Appl. No.: **162,383**

[52] **U.S. Cl.** **164/274**
[51] **Int. Cl.** **B22d 11/08**
[58] **Field of Search** 164/82, 87, 274, 164/282, 283

[56] **References Cited**

UNITED STATES PATENTS

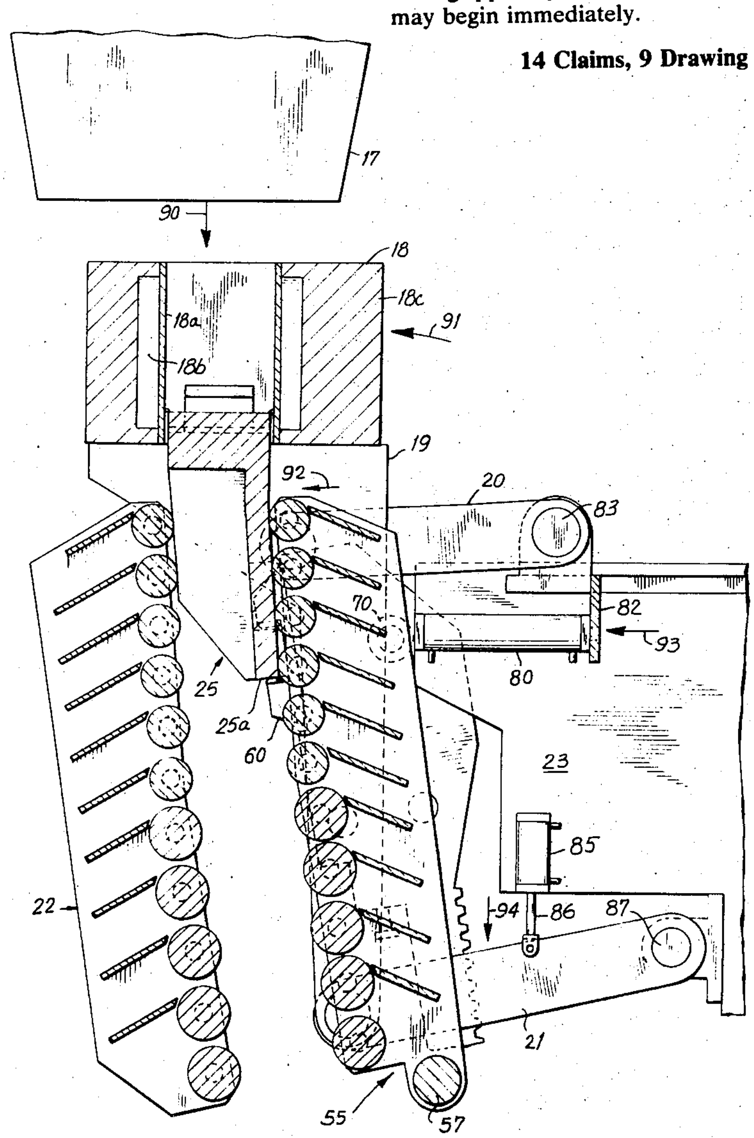
3,433,287	3/1969	Greenberger	164/274
3,167,829	2/1965	Hess	164/282
3,344,844	10/1967	Reinfeld	164/274
3,409,071	11/1968	Ciochetto	164/274
3,426,835	2/1969	Michelson	164/274
3,495,651	2/1970	Rokop	164/274

Primary Examiner—J. Spencer Overholser
Assistant Examiner—John S. Brown
Attorney—George Gottlieb et al.

[57] **ABSTRACT**

A continuous casting machine having an arcuate channel into which molten metal is poured. The metal is guided through the channel and then straightened as it exits from the bottom of the channel and onto a horizontal conveyor. Two pinion-driven racks are provided at the sides of the arcuate channel, each rack having a head for gripping one of two arms of a starting plug which is inserted at the top of the channel while the flow-through mold at the top of the channel is moved out of the way. The racks are then driven so that the starting plug leads the casting down the channel, the rack heads being separated from the starting plug automatically at the bottom of the channel so that the racks can be returned immediately to the top of the channel while the casting continues. In this manner, as soon as the tail end of a casting exits the mold, the mold may be moved out of the way, a new plug may be inserted at the top of the channel with its arms gripped by the two rack heads, and a new casting may begin immediately.

14 Claims, 9 Drawing Figures



PATENTED OCT 16 1973 3,765,470

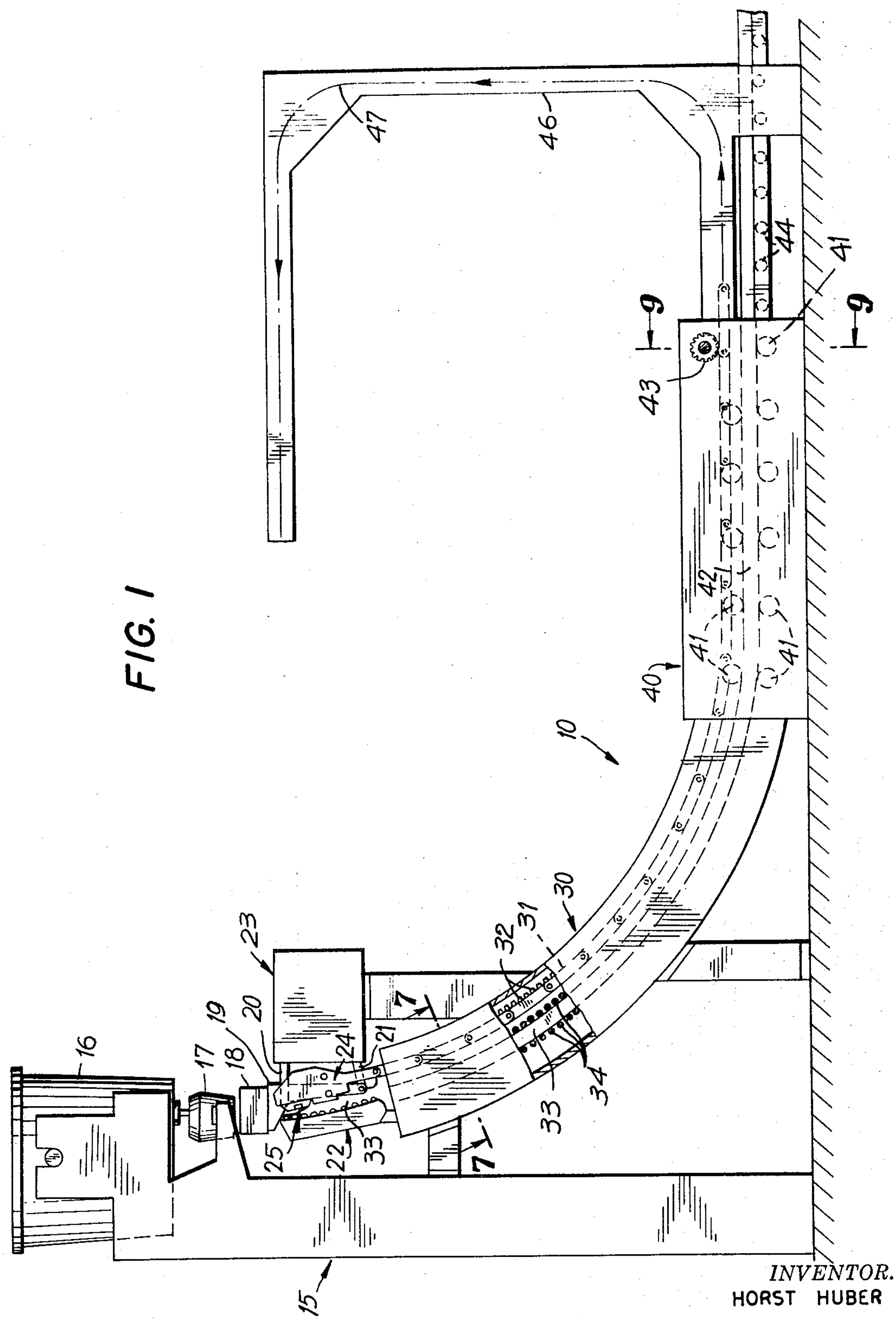


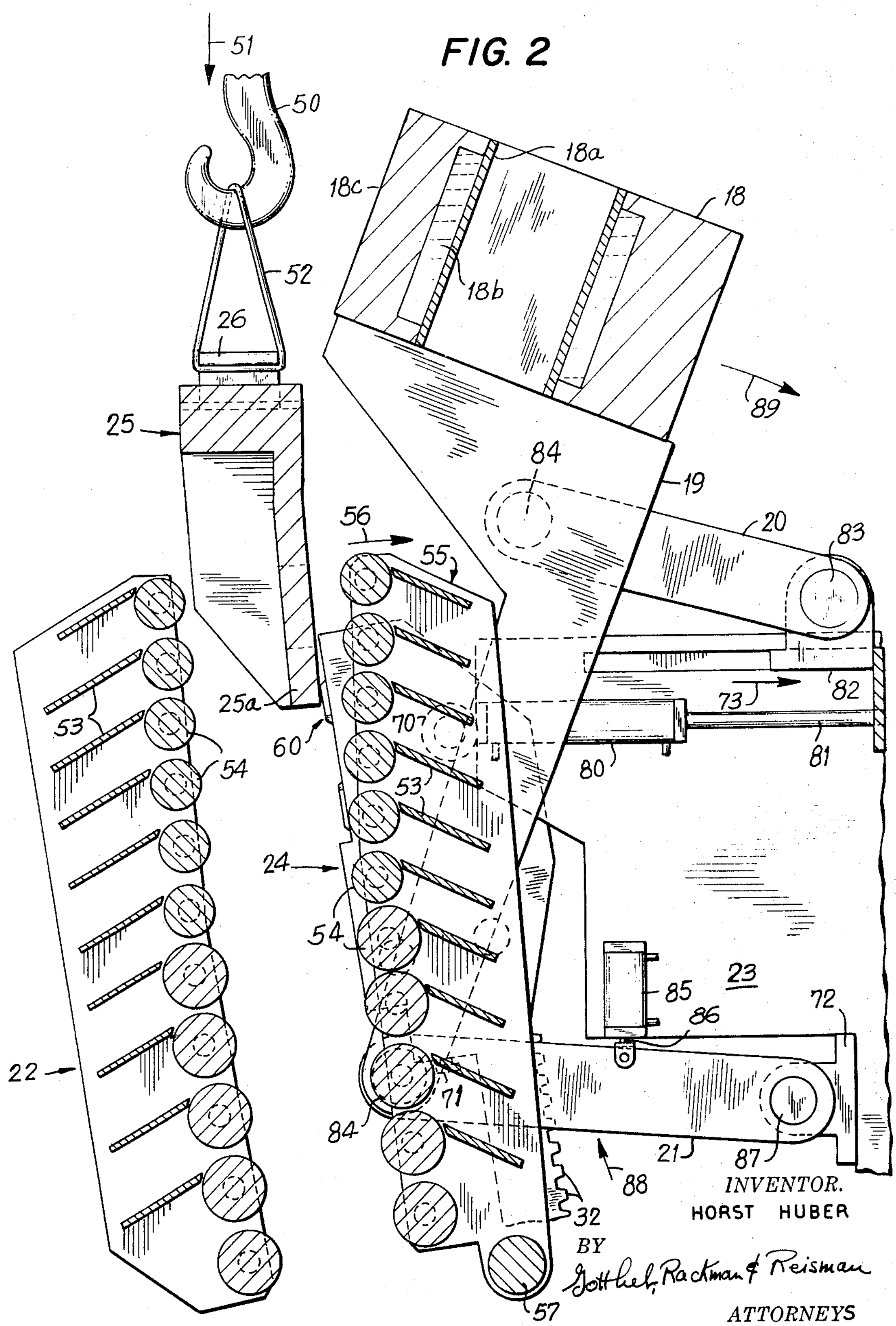
FIG. 1

INVENTOR.
HORST HUBER

BY Gottlieb, Rackman & Reisman
ATTORNEYS

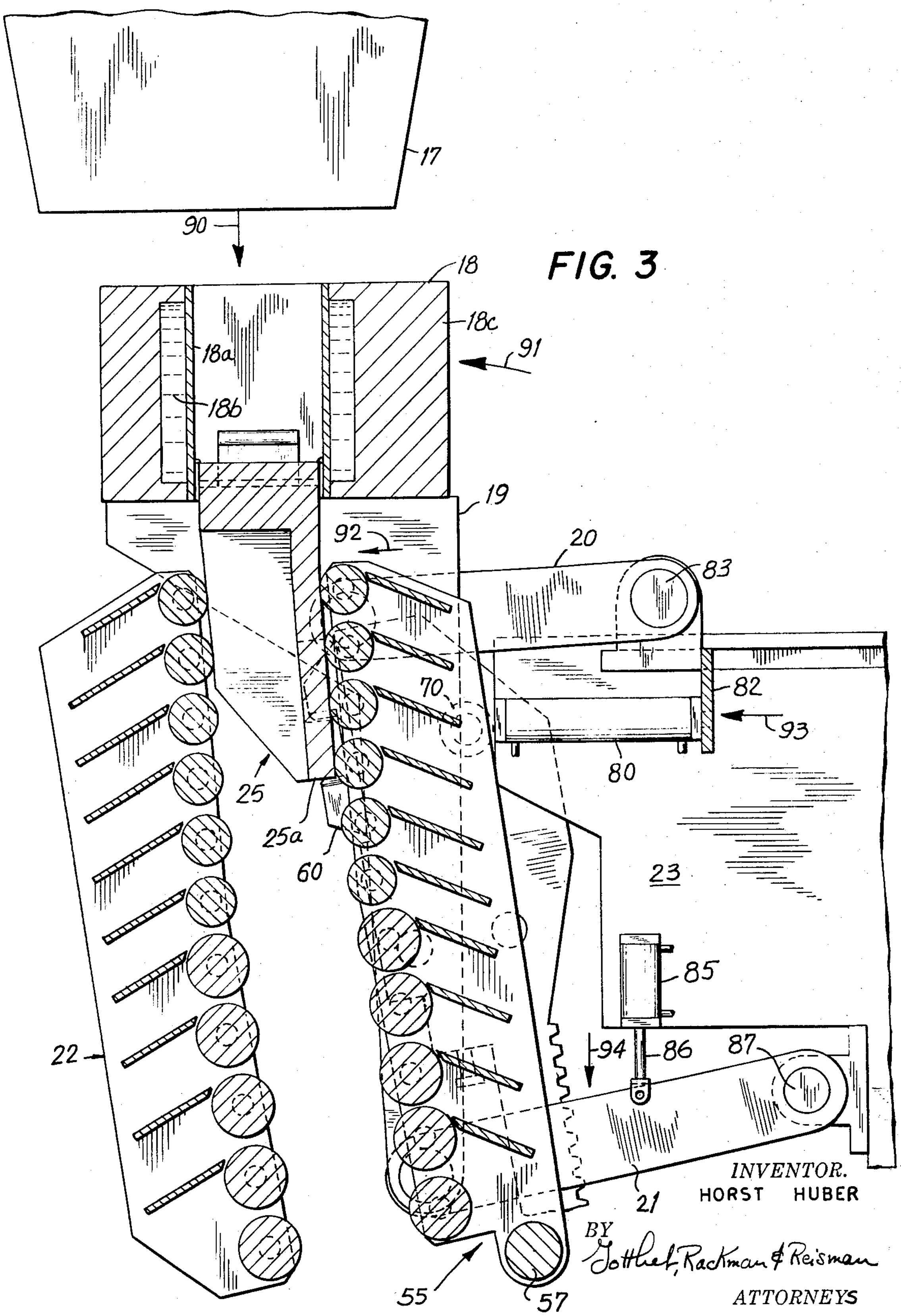
3,765,470

FIG. 2



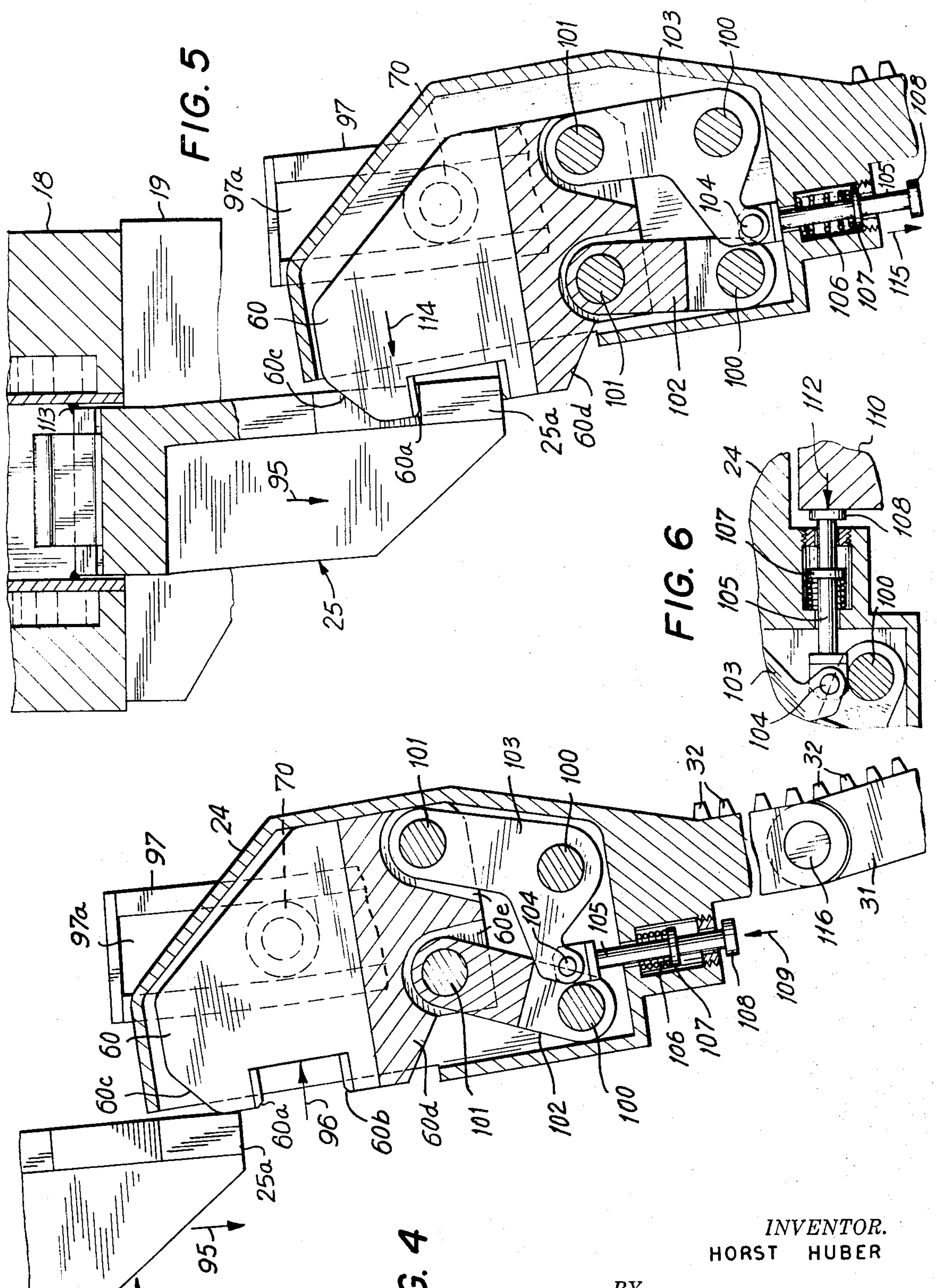
INVENTOR.
HORST HUBER
BY
Gottlieb, Rackman & Reisman
ATTORNEYS

FIG. 3



INVENTOR.
HORST HUBER

BY
Gottlieb, Rackman & Reisman
ATTORNEYS



INVENTOR.
HORST HUBER

BY
Gottlieb, Rackman & Reisman
ATTORNEYS

PATENTED OCT 16 1973

3,765,470

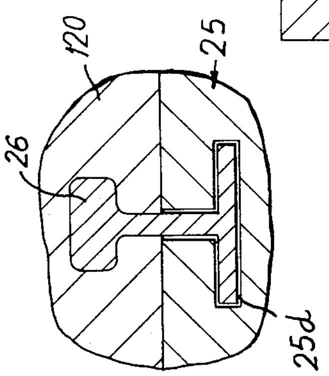


FIG. 8

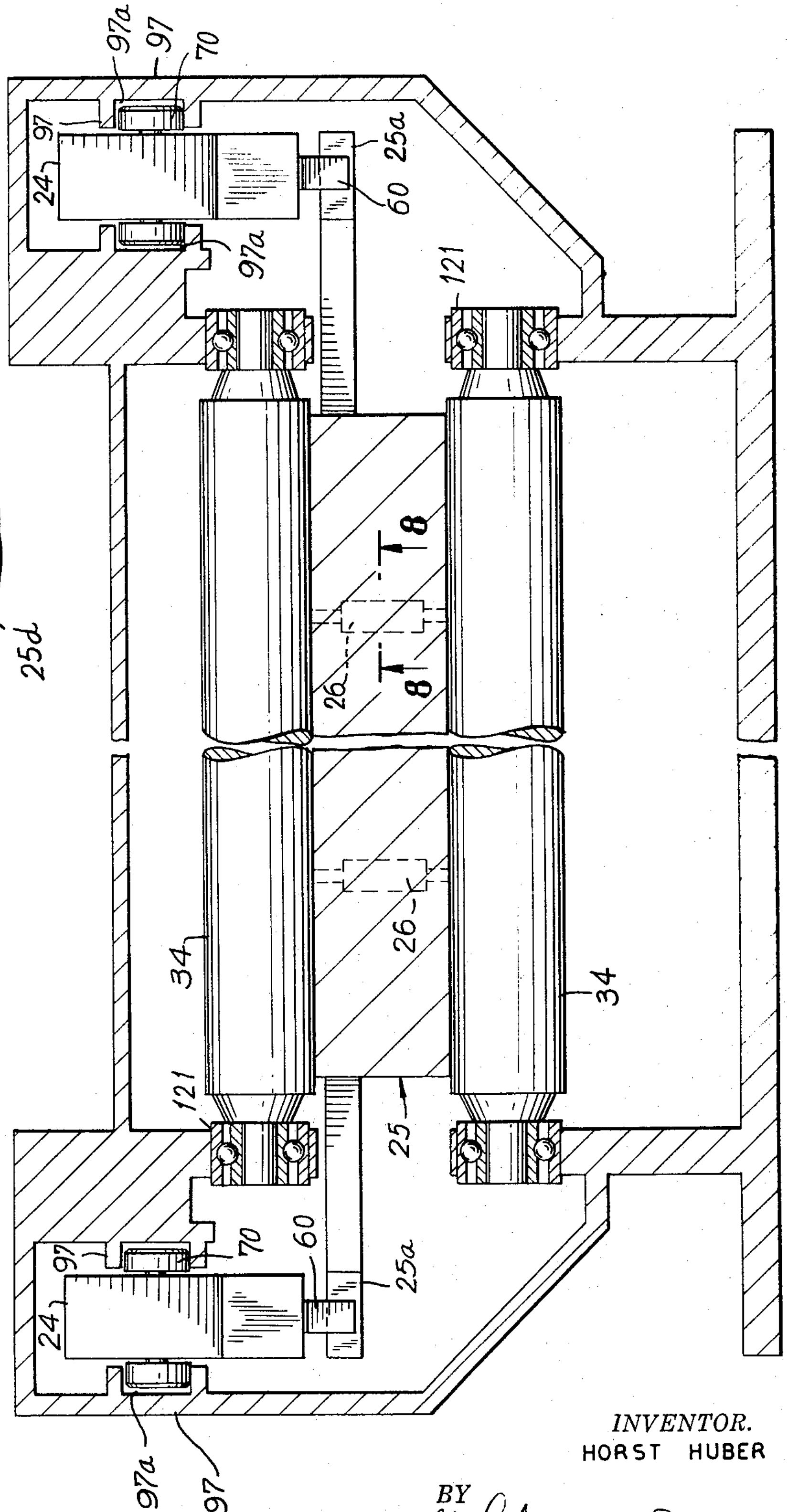


FIG. 7

INVENTOR.
HORST HUBER

BY
Gottlieb, Rackman & Reisman
ATTORNEYS

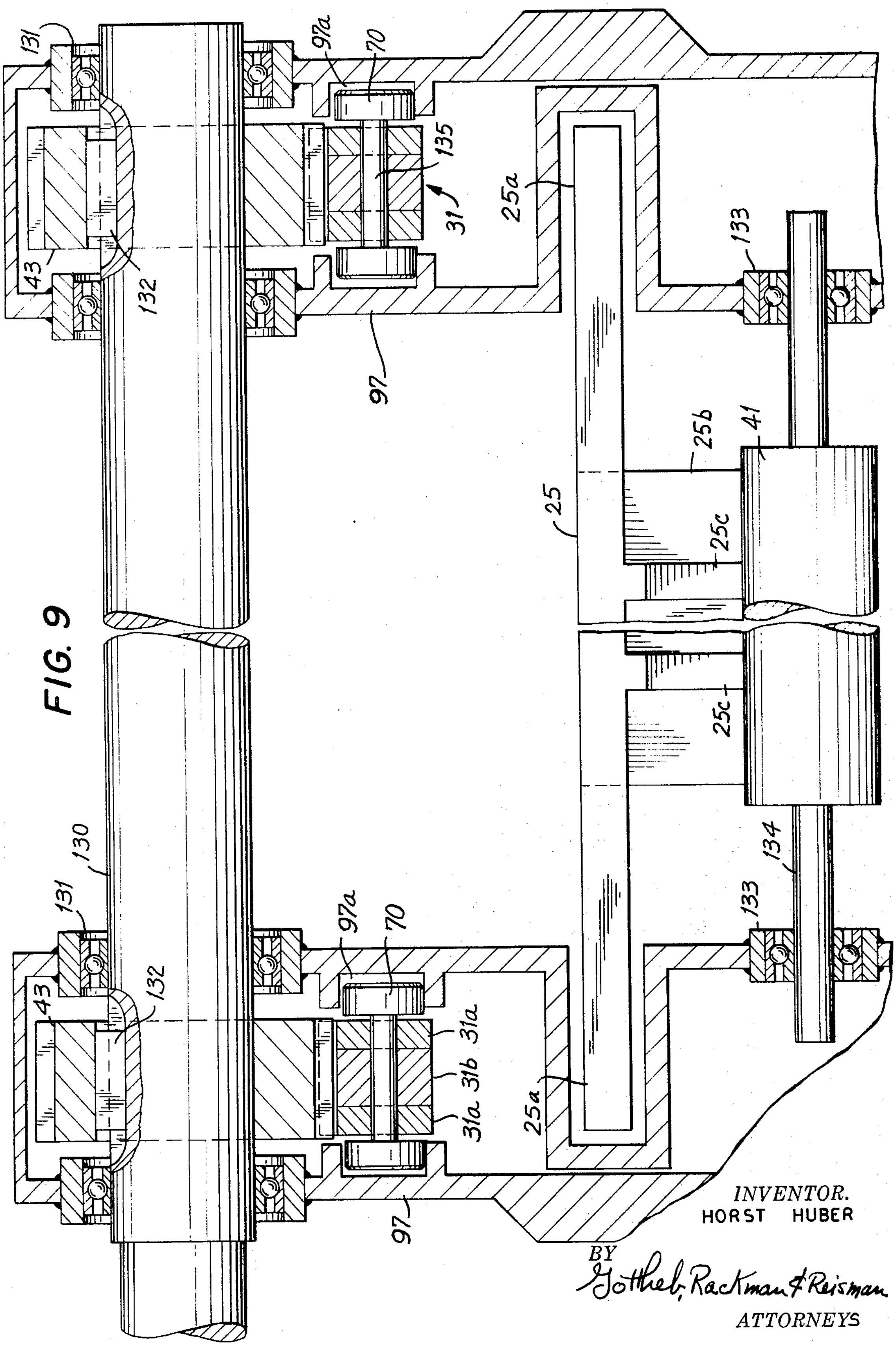


FIG. 9

INVENTOR.
HORST HUBER
BY
Gottlieb, Rackman & Reisman
ATTORNEYS

CONTINUOUS CASTING MACHINE

This invention relates to continuous casting machines, and more particularly to improved starting mechanisms for such machines.

In a conventional continuous casting machine, molten metal (e.g., steel) is poured through a flow-through mold into an arcuate channel and is then guided through the channel with its direction changing from the vertical to the horizontal. The ingot or slab after emerging from the channel is straightened and subsequently cut into desired lengths. An arcuate channel is generally used in continuous casting machines in order to reduce the overall height of the machine. The flow-through mold is usually water-cooled and is often reciprocated to ensure a smooth flow. When the metal exits the mold and enters the channel, it is only partly solidified and has a liquid center of substantial depth contained within a solid outer skin. As the slab moves within the arcuate channel, it is sprayed with water in order to advance the solidification process.

Before the casting begins, a steel plug is placed somewhere in the vicinity of the top of the arcuate channel. The plug serves as a temporary bottom for the slab. As the molten metal is poured through the mold, the plug is driven downward along the channel, thus leading the forward edge of the slab which is formed. At some point near the end of the arcuate channel, the drive of the plug is terminated. In some machines, the drive mechanism is simply disconnected from the plug and the plug remains attached to the forward end of the slab and continues to move with it along the horizontal conveyor. The plug is subsequently separated from the forward end of the slab so that it can be re-used. In other machines, the plug is physically separated from the forward end of the slab near the end of the arcuate channel rather than simply ceasing to drive it and then letting it continue to move with the slab. In either case, pinch rollers at the leading end of the horizontal conveyor straighten the slab and continue to pull it forward so that a slab of any desired length can be formed. One of the major problems with prior art machines is that it usually requires many minutes to position a new plug prior to the start of a new casting. This necessarily results in a considerable waste of machine time.

It is a general object of my invention to provide a continuous casting machine in which a starting plug may be positioned rapidly so that the machine can be set up quickly between castings.

A common prior art technique for positioning the plug is to utilize a heavy chain attached to the plug which can be moved through the arcuate channel. For example, in U.S. Pat. No. 3,426,835, issued to A. Michelson on Feb. 11, 1969 and entitled "Starting Mechanism For Continuous Casting Machine", there is disclosed a carrier chain which is contained within the channel prior to the start of a casting. One end of the chain is attached to the starting plug at the top of the channel. As molten metal is poured from a tundish through the mold cavity, the chain is pulled so that the plug descends the arcuate channel. The chain, as it is being pulled down the channel, is directed out of the casting path,at the front end of the horizontal conveyor. As the end of the chain attached to the plug enters the horizontal conveyor, the end of the chain is automatically disconnected from the plug; the plug continues to move with the slab while the carrier chain is held out of the way.

To set up the machine for another casting, a new plug is attached to that end of the carrier chain which was last to leave the arcuate channel, and the chain, with the attached plug leading it, is then moved up the arcuate channel (in the reverse direction) until the plug is within the mold. The problem with this technique is that it wastes time for two reasons. First, the plug and chain cannot be driven up the arcuate channel until the tail end of the cast slab clears the arcuate channel. If the channel length is sixty feet and the casting speed is forty inches per minute, for example, it is apparent that even after pouring of the molten metal ceases, several minutes must elapse until the channel is clear for reverse travel of the chain. Second, after the channel is clear, it requires several minutes to move the heavy plug and chain all the way up to the mold. Thus, considerable time is wasted between casting cycles. Another problem with machines of the type shown in the Michelson patent is that the height of the chain must be the same as the height of the slab. During casting, the same rollers first pull the chain and then pull the slab. In many machines, the height of the channel can be adjusted to control the height of the cast slabs. A machine of the Michelson type therefore requires the substitution of a new chain each time the channel height is adjusted.

Several techniques have been developed for reducing the set-up time. For example, in Michelson U.S. Pat. No. 3,446,270, issued on May 27, 1969 and entitled "Apparatus For Continuous Casting", there is disclosed a technique for allowing the chain to exit the arcuate channel at a point considerably in advance of the end of the channel (the front end of the horizontal conveyor); the chain, with a new plug, is returned to its starting position by causing it to enter the arcuate channel at the same point where the chain previously exited. But in this case also it is still necessary to wait for the tail end of the slab to clear that part of the arcuate channel which is traveled by the chain before the return of the chain can begin, and it is still necessary to wait for the chain, with a new plug, to reach the top of the arcuate channel before a new casting may begin.

Still other techniques have been devised for reducing the time which is wasted between castings. In Foldessy U. S. Pat. No. 3,318,366, issued on May 4, 1967 and entitled "Continuous Casting Apparatus Having Mold Plug", for example, there is disclosed a mechanism for moving the mold away from the top of the arcuate channel, placing a plug underneath it, and then replacing the mold with the underlying plug at the top of the channel. In this way, it is not necessary to move a new plug all the way up through the channel prior to a new casting. At the start of a casting, two internal endless chains pull the plug downward at a controlled speed. At a predetermined point in its downward travel, a piston rod is operated to force the plug out of the channel. The closed loop chains, since they need not be returned to initial positions, together with the mechanism for inserting a plug at the top of the channel, reduce the set-up time of the Foldessy machine. However, the machine suffers from several disadvantages. One of these is the fact that the internal closed-loop chain arrangement makes it difficult to utilize an arcuate channel, and consequently the Foldessy technique appears attractive only for purely vertical machines which thus must be quite high. In fact, the Foldessy patent discloses only a purely vertical machine. Furthermore, the Foldessy machine requires a different mold for each plug size, each plug requires an internal lug-engaging mechanism, and the mold must be moved away (thereby requiring the breaking of the water-hose connections) each time a new plug is put in place. Also, because the chains are intermeshed with the rollers under the mold, it takes considerable time to repair the machine following an accidental metal breakout.

In accordance with the principles of my invention, a starting plug is inserted on top of an arcuate channel while the mold is pivoted slightly out of the way (not enough to require the breaking of water-hose connections). Two open-ended racks are positioned along the sides of the channel each having a head which can grip an outrigger, or arm, which extends from a respective side of the plug. The two racks are initially in the up position with their respective heads being at the level of the mold. When the mold is moved out of place and a new plug is lowered on top of the channel, the two rack heads grip the outriggers on the plug. The mold is then returned to its normal position and a new casting is begun by driving the racks, each of which is provided with a series of teeth on its upper surface, by respective pinions while molten metal is poured through the mold. When the ends of the racks attached to the plug reach the bottom of the arcuate channel, the heads are released from the plug outriggers. The plug then continues to move with the slab as the slab is pulled forward by the pinch rollers which also straighten it. At the same time that the casting continues, the two racks, which are outside the channel, are returned to their starting positions so that the heads are in place to receive a new plug as soon as pouring of the molten metal through the mold ceases so that the mold can be moved out of the way.

It is a feature of my invention to provide in a continuous casting machine having a vertical arcuate channel a mechanism for temporarily pivoting the flow-through mold slightly away from the top of the channel for allowing a starting plug to be placed at the top of the channel.

It is a further feature of my invention to utilize a starting plug which has two arms extending outwardly from the sides of the channel.

It is a further feature of my invention to provide two linked racks outside the channel and positioned along the channel sides, each rack having a head for gripping one of the starting plug arms when the head is at the top of the machine and a new plug is lowered and placed at the top of the channel.

It is a further feature of my invention to pull the two racks at the start of the casting so that they move along the sides of the arcuate channel but external to it with their heads following the curve of the channel as they are moved downward.

It is a still further feature of my invention to automatically control the release of the plug by the heads when the heads have reached the bottom of the arcuate channel, whereby the plug continues to move along a horizontal conveyor at the front of the slab and the two racks may at the same time be returned up along the sides of the channel so that their heads can be placed in the starting positions for immediate insertion of a new plug at the end of the metal pouring in progress.

Further objects, features and advantages of the invention will become apparent upon consideration of the following detailed description in conjunction with the drawings, in which:

FIG. 1 depicts a continuous casting machine constructed in accordance with the principles of the invention;

FIG. 2 depicts in greater detail the mechanisms at the top of the arcuate channel and the manner in which a starting plug is placed at the top of the arcuate channel;

FIG. 3 is similar to FIG. 2 and shows the starting plug in place at the top of the channel;

FIG. 4 depicts in detail the head at the end of each side rack for gripping one arm of the starting plug and further shows the manner in which the gripping element within the head is moved as a starting plug is lowered into the arcuate channel;

FIG. 5 depicts the head of FIG. 4 after the plug has been lowered and gripped by the head;

FIG. 6 depicts the manner in which each of the two heads is automatically released from the plug after having moved through the arcuate channel;

FIG. 7 is a sectional view taken through the line 7—7 of FIG. 1;

FIG. 8 is a sectional view taken through the line 8—8 of FIG. 7; and

FIG. 9 is a sectional view taken through the line 9—9 of FIG. 1.

FIG. 1 depicts in side elevation the major components of a continuous casting machine **10**, of the type shown in the above-identified patents, but constructed in accordance with the principles of my invention. The machine includes a frame **15** which supports both a ladle **16** containing molten metal and a conventional tundish **17**. The molten metal is transferred from the ladle to the tundish in a manner known in the art so as to control the pouring of molten metal from the tundish into flow-through mold **18** at a constant pressure. The mold is held on top of platform **19** which is pivotally connected to two arms **20** and **21** on each side of the platform. These two arms, on each side, are in turn coupled to control mechanism **23**. As will be described in detail below, the control mechanism moves the four arms so that platform **19** and mold **18** move in two distinct ways. During the set-up procedure, the platform and the mold are pivoted slightly, out of the way of the channel, so that a plug can be lowered into the channel. (While the plug is being lowered, the ladle and tundish can also be held out of the way in a conventional manner.) The second way in which the platform and mold move is a short reciprocating up-and-down motion during the actual casting process to ensure a smooth flow of metal through the mold as is known in the art.

The arcuate channel is designated by the numeral **33**, there being a plurality of rollers such as rollers **34** which define the channel height. Although not shown in the drawing, it is known in the art that the two opposing lines of rollers can be moved relative to each other to vary the channel height, and thus the height (or thickness) of the cast slabs. Parallel to the channel are two side racks **31**, each of which includes a series of links having teeth **32** on one side thereof. The rollers **34** and the racks are contained within arcuate-shaped frame member **30**. At the top of frame member **30** there is mounted a channel entrance frame **22**, shown most clearly in FIG. **2**, which includes a plurality of entrance rollers **54** and water spray jets **53**. A similar entrance frame 55 is disposed on the other side of the channel as shown in FIG. 2. Although not shown in the drawing, water spray jets are also provided between rollers 34 within frame member 30 in a conventional manner to further cool the cast metal as it moves down the arcuate channel.

FIG. 1 also depicts one of the rack heads 24 in its starting position near the top of the channel with a starting plug 25 also shown as having one of its outwardly extending arms gripped by the rack head. The details of the rack head will be described below with reference to the other drawings.

At the exit end of the arcuate channel there is a frame section 40 which contains a plurality of rollers 41 which define a horizontal channel 42. These rollers not only straighten the metal slab as it exits the arcuate channel but also continue to transport it in the horizontal direction. The slab, after exiting frame section 40 of the machine, continues to be transported by rollers 44 to a cutting station (not shown).

The two racks 31 also pass through frame section 40. Each of the racks is driven by a respective pinion 43. When each pinion moves in the counter-clockwise direction, as viewed in FIG. 1, the respective rack is moved to the right in FIG. 1 and follows the path shown by arrows 47 within storage frame 46. The storage frame serves to provide an area for containing the racks as they are withdrawn from frame section 30. When each of the pinions moves in the clockwise direction, the respective rack is forced to the left in FIG. 1. The maximum upper position of a rack head 24 is that shown in FIG. 1, each pinion moving in the clockwise direction until the respective head is near the top of the arcuate channel as shown. When the racks move in the downward direction, they move until the heads are at a position within frame section 40 at which they release the starting plug, as will be described below. (As will be apparent to those skilled in the art, the storage frame can be located at a lower level if desired.)

FIG. 2 depicts the manner in which a starting plug 25, having two outwardly extending arms 25*a*, a slab-supporting section 25*b* and reinforcing ribs 24*c*, as seen most clearly in FIG. 9, is lowered into the arcuate channel, the entrance to which is defined by rollers 54 contained within frame elements 22 and 55. Platform 19 contains a central section which supports mold 18 and two downwardly extending arms on either side of frame section 55. Each of the downwardly extending arms is pivoted to two respective links 20 and 21, as shown by pivot elements 84. Each of arms 20 is pivoted to a movable bracket 82 as shown by the numeral 83, and each of the arms 21 is pivoted to a stationary bracket 72 attached to control mechanism 23. Within the control mechanism are two piston actuators 80 and 85, having respective piston rods 81 and 86. In order to move mold 18 away from the top of the channel so that a starting plug 25 can be lowered into it, actuator 85 is controlled to pull in rod 86 and actuator 80 is controlled to push out rod 81. The pulling in of rod 86 causes link 21 to rotate upward in the direction of arrow 88. The pushing out of rod 81 causes bracket 82 to move to the right as shown by arrow 73. These two movements cause platform 19 and mold 18 to pivot in the direction of arrow 89 so that a clear path is provided for lowering starting plug 25 into the channel entrance.

At the top of the plug there are several rails 26 (see FIG. 8), as is known in the art, and in order to lower the plug into the channel a crane 50 may be utilized, one of several cables 52 being shown as supporting one of rails 26 from the crane. As the crane is lowered in the direction of arrow 51, it is apparent that the plug, after the platform 19 and mold 18 are pivoted out of the way, can be inserted into the channel.

Frame member 55, which carries rollers 54 and water spray jets 53, is pivoted at 57 and is caused to move slightly clockwise in the direction of arrow 56 (by a mechanism not shown) prior to the lowering of the plug into the channel. This facilitates insertion of the plug. Thereafter, frame member 55 is returned in the direction of arrow 92 shown in FIG. 3 to its normal position. FIG. 3 shows the manner in which mold 18 is returned to its normal position after plug 25 is lowered and cables 52 are removed. (The mannner in which the plug is held in place and not allowed to fall through the channel will be described below.) Actuator 80 first causes inward movement of piston rod 81 so that bracket 82 moves in the direction of arrow 93. This causes platform 19 and mold 18 to move in the direction of arrow 91 to a position directly above the upper end of plug 25. Thereafter, actuator 85 causes rod 86 to move downward in the direction of arrow 94 so that platform 19 and mold 18 are lowered. The mold is conventional and includes an inner lining 18 *a*, a water jacket 18*b* (with means, not shown, for moving water within the jacket to cool the metal poured through the mold) and an outer supporting structure 18*c*. As is known in the art, it is desirable to reciprocate the mold up and down slightly (e.g., by one-half inch) in order to facilitate a smooth flow of molten metal through the mold. This is accomplished during the casting by causing actuator 85 to move piston rod 86 up and down. The clockwise and counter-clockwise motion of link 21 around pivot 87 causes platform 19 and mold 18 to alternately move up and down as molten metal is poured from tundish 17 through the mold as shown by arrow 90.

On each side of the channel there is a rack 31 at the upper end of which there is provided a head housing 24. The housing is a continuation of the rack and includes teeth 32 which are of the same shape as the teeth on the links comprising each rack. A pair of rollers 70 are provided on the two sides of each of the head housings. These rollers, as well as comparable rollers which interconnect the different links of each rack, move through channels, to be described below, to guide each rack and its housing so that they are moved along a path parallel with that of the arcuate channel.

Within each head housing there is a gripping element 60 seen most clearly in FIGS. 4 and 5. The gripping element has a forward slot defined by edges 60*a* and 60*b*, the dimension of the slot conforming to one of the arms 25*a* of the starting plug. The gripping element also includes a central section 60d and a lower section 60e which contains two pivots 101. Each of these pivots serves to connect the gripping element to a respective one of internal links 102 and 103. The two links are in turn connected to pivot elements 100 to the head housing 24. Link element 103 is also pivoted, as shown by numeral 104, to a rod 105 which extends through the head housing. The rod is provided with two stops 107 and 108, and a spring 106. The spring tends to force the rod downward (out of the housing). This, in turn, causes link 103 to rotate in the counter-clockwise direction around pivot 100 and thus results in gripping element 60 being forced to the left out of housing 24.

When each rack is moved upward along the arcuate channel, the respective head housing is held in position by the pair of rollers 70 contained within channels 97*a* of guide element 97. The housing is thus held in a stationary position as the plug is lowered into the channel. Initially, the gripping element 60 is in its maximum forward position as shown in FIG. 5, with spring 106 being in its maximum extended position. As the bottom of one of arms 25*a* bears against edge 60*c* of the gripping element, the gripping element is forced back into the housing as shown by arrow 96 in FIG. 4. This, in turn, causes link 103 to rotate around pivot 100 in the clockwise direction and rod 105 to be drawn into the housing and the compression of spring 106. As the plug continues to be lowered in the direction of arrow 95, eventually arm 25*a* clears the gripping element, at which time spring 106 expands once again and the gripping element moves outward as shown by arrow 114 in FIG. 5. At this time, arm 25a is held within the slot defined by edges 60a and 60b of the gripping element. The starting plug is thus locked in place and cannot fall through the channel even after cables 52 are removed. Subsequent movement of the starting plug is controlled by the two racks on either side of the channel which pull the heads now fixed to the two arms of the plug. FIG. 5 shows the plug in the starting position, after platform 19 and mold 18 have been returned to their normal positions. The drawing also shows a conventional rope 113 which is often wrapped around the border of the upper end of the starting plug to prevent the flow of molten metal down the sides of the plug. FIG. 4 further shows the teeth 32 contained on each head housing and each rack link, as well as a pin 116 for connecting the uppermost link in each rack to the respective head housing.

As pinions 43 (FIG. 1) move in the counter-clockwise direction to withdraw the racks from arcuate frame 30, plug 25 is drawn through the arcuate channel and the casting is formed. The pinions bear against the teeth on the racks and toward the end of the rack movement they bear against the teeth on the head housing. At this time, it is necessary to control the release of the plug by the heads. This is accomplished by the provision of a stop 110 (FIG. 6) on each side of frame section 40 (FIG. 1) in the vicinity of each of the pinions. As each head housing is moved to the right in FIGS. 1 and 6, the housing being guided by rollers 70 contained within channels 97*a*, stop 108 on pin 105 bears against a respective one of stops 110. At this time, the pin is moved into the housing as shown by arrow 112 in FIG. 6 and link 103 is caused to rotate in the clockwise direction around pivot 100. This, in turn, draws the gripping element 60 into the housing and releases the respective arm of the starting plug. The plug continues to be transported to the right in FIG. 1 at the leading end of the slab. As for the racks, they stop moving as soon as the heads release the starting plug. This can be accomplished under manual control simply by stopping the motor which drives pinions 43, or automatically by providing a switch in the motor circuit which is opened as soon as the gripping elements are withdrawn into the head housings.

With the heads released from the starting plug arms and because the two racks are external to the arcuate channel, it is apparent that the pinions can immediately be turned in the clockwise direction of FIG. 1 so that the heads and racks move upward to the starting position even as the casting is continued. In this manner, when the last of the molten metal has been poured through the flow-through mold 18, even though many minutes may elapse before the tail end of the casting exits the arcuate channel, the heads are in a position to receive a new plug. The mold is simply moved out of the way and a new plug inserted. In fact, a second casting may be begun even before the tail end of a previous casting has left the arcuate channel.

FIG. 7 is a view taken along line 7—7 of FIG. 1 after the starting plug has started to move down the channel. In this view, channels 97*a* within guides 97 are seen carrying rollers 70. A roller 70 is provided on each side of each of head housings 24. Also shown are the two elements 60 gripping the two arms 25*a* of the starting plug. Rollers 34 are carried by bearings 121 as is known in the art, starting plug 25 moving through the arcuate channel defined by the rollers and the plug being followed by the casting. FIG. 7 also shows conventional rails 26 at the top of the starting plug. These rails are shown in further detail in FIG. 8. The rails are contained within T-slots 25*d* of the starting plug and serve two functions. First, they are used for lowering the starting plug into position as shown in FIG. 2. Second, as is conventioanl practice, they serve to secure the starting plug to the leading edge of the cast metal. As is known in the art, the starting plug can be removed from the cast slab simply by forcing it to slide in the direction of the rails out of the plane of the slab.

FIG. 9 is a view taken through the line 9—9 of FIG. 1 and shows the manner in which the two racks are driven. The two pinions 43 are secured to a common shaft 130 by keys 132 in a conventional manner. The shaft is contained within bearings 131 and is driven in either direction by a motor (not shown). Underneath the two pinions are the guide channels 97*a* in which the rollers 70 are contained. Successive links of each rack are pinned together as shown by pin 135 in FIG. 9, at the two ends of which are rollers 70. A first end of each link contains two outer lugs 31*a* and the second end contains an inner lug 31*b*. As is known in the art, this permits the second end of one link to be inserted into the first end of an adjacent link, with the two ends being held together by a pin 132. By providing rollers 70 at the two ends of each pin, the racks are controlled to move along channels 97*a*. FIG. 9 also shows the starting plug 25 being carried by one of bottom rollers 41 (FIG. 1). Each of the rollers is mounted on a shaft 134 contained in respective bearings 133.

Although the invention has been described with reference to a particular embodiment, it is to be understood that this embodiment is merely illustrative of the application of the principles of the invention. Numerous modifications may be made therein and other arrangements may be devised without departing from the spirit and scope of the invention.

What I claim is:

1. A continuous casting machine comprising an arcuate channel having an entrance facing upward and an exit facing in the horizontal direction, means for straightening and transporting in the horizontal direction cast metal which exits from said arcuate channel, a pair of racks each for moving external to and adjacent a respective side of said channel along the path of said channel, each of said racks having an arm-gripping

head at the end closest to the entrance of said channel, means for enabling the placement of a starting plug at the top of said channel, said starting plug having two outwardly extending arms which can be gripped by said rack heads when said rack heads are in position near the entrance of said channel, means for pouring molten metal into the entrance of said channel, means for moving said racks for controlling the descent of a starting plug in said channel as molten metal is poured therein, and means for controlling the release of said starting plug arms by said rack heads when said rack heads are near the exit of said channel, said rack moving means being further operative to return said racks in the opposite direction subsequent to the release of said starting plug arms by said heads to reposition said heads near the entrance of said channel.

2. A continuous casting machine in accordance with claim 1 wherein said means for pouring molten metal into said channel entrance includes a flow-through mold normally positioned on top of said channel, and said starting plug placement enabling means include means for pivoting said flow-through mold away from the top of said channel so that said starting plug can be placed at the top of said channel prior to return of said mold to its normal position.

3. A continuous casting machine in accordance with claim 2 wherein each of said racks includes a plurality of links having a series of teeth thereon, and said rack moving means includes pinion means for engaging the teeth on said rack links for moving said racks in either direction along the sides of said channel.

4. A continuous casting machine in accordance with claim 3 wherein each of said rack heads includes a housing and a movable gripping element therein, each of said heads further including means for allowing a starting plug arm to force the gripping element to move within said housing away from its normal position when said starting plug is first placed at the top of said channel while said head is positioned near the entrance thereof, said gripping element thereafter moving back to its normal position to grip said starting plug arm, and means for automatically moving said gripping elements relative to said housings to release said starting plug arms when the starting plug is near the exit of said channel.

5. A continuous casting machine in accordance with claim 4 further including a pair of guide means disposed along respective sides of said channel and means attached to each of said racks along the length thereof for insertion into a respective one of said guide means to control the travel of said rack in either direction along the line of curvature of said arcuate channel.

6. A continuous casting machine in accordance with claim 4 wherein said moving means controls each of said racks to alternately move in opposite directions along a path which is parallel to that of said channel.

7. A continuous casting machine in accordance with claim 2 wherein each of said rack heads includes a housing and a movable gripping element therein, each of said heads further including means for allowing a starting plug arm to force the gripping element to move within said housing away from its normal position when said starting plug is first placed at the top of said channel while said head is positioned near the entrance thereof, said gripping element thereafter moving back to its normal position to grip said starting plug arm, and means for automatically moving said gripping elements relative to said housings to release said starting plug arms when the starting plug is near the exit of said channel.

8. A continuous casting machine in accordance with claim 2 further including a pair of guide means disposed along respective sides of said channel and means attached to each of said racks along the length thereof for insertion into a respective one of said guide means to control the travel of said rack in either direction along the line of curvature of said arcuate channel.

9. A continuous casting machine in accordance with claim 2 wherein said moving means controls each of said racks to alternately move in opposite directions along a path which is parallel to that of said channel.

10. A continuous casting machine in accordance with claim 1 wherein each of said rack heads includes a housing and a movable gripping element therein, each of said heads further including means for allowing a starting plug arm to force the gripping element to move within said housing away from its normal position when said starting plug is first placed at the top of said channel while said head is positioned near the entrance thereof, said gripping element thereafter moving back to its normal position to grip said starting plug arm, and means for automatically moving said gripping elements relative to said housings to release said starting plug arms when the starting plug is near the exit of said channel.

11. A continuous casting machine in accordance with claim 1 further including a pair of guide means disposed along respective sides of said channel and means attached to each of said racks along the length thereof for insertion into a respective one of said guide means to control the travel of said rack in either direction along the line of curvature of said arcuate channel.

12. A continuous casting machine in accordance with claim 1 wherein said moving means controls each of said racks to alternately move in opposite directions along a path which is parallel to that of said channel.

13. A continuous casting machine comprising an arcuate channel having entrance and exit ends, the channel being adapted to receive a starting plug, means for transporting cast metal which exits from said arcuate channel, elongated gripping means, means for moving said gripping means back and forth in descending and ascending directions along paths which are external to and parallel with the path of said channel, said gripping means being operative to grip a starting plug at the entrance end of said channel, means for releasing said gripping means from said starting plug when said starting plug is near the exit end of said channel, means for pouring molten metal into said channel entrance end, a flow-through mold normally positioned on top of said channel, and means for moving said flow-through mold away from the entrance end of said channel so that a starting plug can be placed at the entrance end of said channel prior to return of said mold to its normal position.

14. A continuous casting machine comprising an arcuate channel having entrance and exit ends, the channel being adapted to receive a starting plug, means for transporting cast metal which exits from said arcuate channel, elongated gripping means means for moving said gripping means back and forth in descending and ascending directions along paths which are external to and parallel with the path of said channel, said gripping means being operative to grip a starting plug at the en-

trance end of said channel, means for releasing said gripping means from said starting plug when said starting plug is near the exit end of said channel, guide means disposed along said channel and means attached to said gripping means along the length thereof for insertion into said guide means to control the travel of said gripping means in either direction along a path parallel with the path of said arcuate channel.

* * * * *