CONTINUOUS CASTING MACHINE

Inventors: Richard D. Follrath; Charles W. Martin, both of Greenville; Russell L. Race, Ada; Gerald McPherson, Greenville, all of Mich.


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ABSTRACT

A horizontal continuous metal casting system adapted to efficiently and safely cast a metal ingot and cut the ingot into predetermined lengths. The machine includes a graphite mold which is supported within an adjustably positionable water jacket and is uniformly cooled by tangentially directed streams of water about its outer periphery. The drive means for moving the emerging cast ingot in a downstream direction away from the mold includes a plurality of drive rollers that are axially movable by air cylinder actuating means to vary the roller driving pressures and to compensate for variations in the diameter of the cast ingot. The machine has various safety features including a protective enclosure for shielding the operator from the heat and splattering of molten metal flowing into the mold and rotatable gates mounted at the mouth of the mold for sensing unintended bleed-out of molten metal.

18 Claims, 14 Drawing Figures
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CONTINUOUS CASTING MACHINE
DESCRIPTION OF THE INVENTION

The present invention relates in general to continuous casting of metal, and more particularly, to an integrated system for horizontally casting aluminum and its alloys and for cutting the emerging cast ingot into predetermined lengths.

Since horizontal continuous casting systems have considerably lower equipment and installation costs than do vertical casting systems, horizontal casting machines recently have been employed for use by even the small volume aluminum extruder so as to permit him to reclaim his scrap directly and recast it into reusable billets. However, a number of problems have been encountered in the use of present horizontal aluminum casting machines, particularly when used by the small extruder who may not be highly experienced in metal casting.

Such present horizontal casting systems have had both performance and safety inadequacies. For example, due to the horizontal position of the mold, difficulties have been encountered in evenly cooling the casting mold and the emerging ingot, resulting in metallurgical imperfections in the ingot. Moreover, when water-cooled graphite molds have been employed in such machines, the mold frequently must be replaced. Due to the build-up of foreign material about the mold during its use, in present machines mold removal and replacement generally is not readily accomplished. Further difficulties have been experienced in accurately positioning the replacement mold in the machine.

In addition, since the starting tube employed to commence the casting process generally is about 1 1/8th inch greater in diameter than the cast ingot, and inherent variations unavoidably occur in the diameter of the ingot as it is cast, the downstream drive rollers of current machines frequently will not maintain firm driving engagement with the starting tube and cast ingot so that the rate of movement of the emerging ingot may be affected. In the past, it has been necessary to make manual adjustments to the drive rolls in close contact with the hot moving ingot to reinstate the necessary driving pressures. The intense heat near the furnace and the emerging ingot, the chance of unexpected bleed-out of molten metal from the mold, and even possible eruptions of molten metal from the holding box have further presented dangers to the operator in the immediate vicinity of the machine.

Accordingly, it is an object of the present invention to provide an improved horizontal aluminum continuous casting system that is safer and more efficient in operation than such prior casting machines.

Another object is to provide a continuous metal casting system as characterized above which has a water-cooled graphite mold that is readily removable and replaceable, and is adapted for precise selective positioning. A related object is to provide such a continuous casting system which includes means for quickly and accurately positioning the starting tube in the mold during the commencement of the casting process.

A further object is to provide a horizontal continuous casting system of the above kind which has means for more uniformly cooling the graphite mold and the emerging cast ingot.

Another object is to provide a continuous casting system as set forth above with downstream ingot driving means which are easily adjustable to compensate for differences between the diameter of the starting tube and the ingot and for variations in the diameter of the cast ingot.

Still another object is to provide a continuous casting machine of the above type which includes means for shielding the machine operator from intensive heat of the molten metal or eruptions of the metal at the holding box and for automatically shutting off the machine in the event of a bleed-out of molten metal at the mouth of the mold.

Yet another object is to provide an integrated continuous metal casting system of the above kind which has means for cutting the cast ingot into predetermined lengths as it is being cast and for automatically placing such ingots on a stacking table.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. 1 is a partially diagrammatic side elevation view of a continuous casting machine embodying the present invention;

FIG. 2 is a partially diagrammatic top view of the machine shown in FIG. 1;

FIG. 3 is an enlarged side view of the molten metal holding box, the casting mold, and ingot drive assembly for the machine illustrated in FIG. 1;

FIG. 4 is a top view of the holding box, casting mold, and drive assembly shown in FIG. 3;

FIG. 5 is an end elevational view of the ingot drive assembly, taken in the plane of line 5—5 in FIG. 4;

FIG. 6 is an enlarged fragmentary section of the molten metal holding box and casting mold, taken in the plane of line 6—6 in FIG. 4 and showing in phantom for illustrative purposes the end of a starting tube within the mold;

FIG. 6a is an enlarged fragmentary section showing the manner in which the casting mold is secured in position adjacent the molten metal holding box;

FIG. 7 is an enlarged fragmentary section taken in the plane of line 7—7 in FIG. 4 showing the mold support;

FIG. 8 is an enlarged fragmentary section taken in the plane of line 8—8 in FIG. 4 showing the safety gates located at the mouth of the casting mold;

FIG. 9 is an enlarged vertical view of a starting tube support cradle utilized in the run-out table of the illustrated machine;

FIG. 10 is an enlarged fragmentary section of two of the adjustable drive rolls included in ingot drive assembly;

FIG. 11 is an enlarged side elevational view of the saw assembly included in the illustrated machine;

FIG. 12 is a top view of the saw assembly shown in FIG. 11; and

FIG. 13 is an end elevational view of the saw assembly shown in FIG. 11.

While the invention is susceptible of various modifications and alternative forms, a specific embodiment thereof has been shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that it is not intended to limit the invention to the particular form disclosed, but, on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.
Referring more particularly to FIGS. 1 and 2 of the drawings, the invention is there embodied in an illustrative horizontal aluminum continuous casting machine. The machine comprises basically a reverberatory melting furnace 10, a casting unit 11, and a saw assembly 12. The casting unit 11 in this case includes a molten metal holding box 14, a casting mold 15, and a drive assembly 16 all supported as a single unit by a frame 18 in a recessed pit 19 immediately downstream from the furnace 10. The frame 18 has a plurality of legs 20 supporting a pair of longitudinally extending side panels 21 that are interconnected by cross panels 22. Molten metal flows from the furnace 10 into the boxing box 14 which, in turn, is channeled into the mold 15. A cast ingot 24 emerging from the mold 15, as shown in phantom in FIGS. 1 and 2, is continuously propelled by the drive assembly 16 and is guided into the saw assembly 12 which cuts the ingot into predetermined lengths and deposits them onto a storage table 25.

The furnace 10 is supported above a concrete base 26 by an I-beam frame 28 and includes a conventional refractory lining 29 and a refractory base 30 for the containment of molten metal, as shown in FIG. 6. Suitable heating means is provided for melting scrap aluminum and like metal alloys introduced into the furnace. The furnace has a tap-out block 31 formed with a tapered aperture 32 to permit the flow of molten metal from the furnace 10 to the holding box 14 which is supported by the casting unit frame 18 at an elevation slightly below that of the furnace bed 30 and is connected to the furnace by a transfer trough 34. The holding box 14 similarly has a refractory lining 35 for containing molten metal 37. To permit emptying of the holding box 14 after each usage of the machine, the holding box has a drain hole 36 in its lower side and a removable plug 38 (FIGS. 4 and 6).

In carrying out one aspect of the invention, means are provided for permitting an operator to accurately and safely control the flow of metal from the furnace 10 in the holding box 14. To this end, a selectively adjustable metering rod 39 formed with a cone-shaped head 40 is supported above the holding box 14 for cooperation with the tap-out block aperture 32. The metering rod head 40 preferably has an outer liner of a known type that is replaceable after each casting operation. To facilitate longitudinal movement of the metering rod 39, a forward end of the rod threadably engages a support 41 mounted at the top front side of the holding box 14. By turning a round handle 42 secured at the forwardmost end of the metering rod 39, the head may be selectively and precisely moved relative to the tap-out block 31 to accurately govern the flow of molten metal.

To protect the operator of the machine from the intense heat and possible eruption or other splattering of molten metal that might occur during its flow from the furnace into the holding block box 14, a protective housing 44 is supported above the holding block box 14. The illustrated housing 44 has a metal panel construction formed in a general rectangular shape enclosing the top of the holding box 14. To permit access to the interior of said housing 44, a door 45 having a viewing window 46 is hinged mounted to one of the side panels of the housing. A latch 48 releasably secures the door in a closed position. Since the metering rod handle 42 is on the outside of the housing 44, an operator may easily control the flow of metal from the furnace and is effectively protected from the molten metal.

For the purpose of forming the cast ingot, the casting mold 15 is of a sleeve-shaped graphite construction and is adapted to be continuously cooled by water about its outer periphery during the casting operation. The mold is connected at its upstream end to a header 49 which is supported within the lower front wall of the holding box 14 and serves to direct the flow of molten metal 37 from the holding box 14 to the mold 15. The header 49 extends a distance from the wall of the holding box and is formed with a central nozzle opening 50 that becomes gradually larger as it progresses from the interior of the holding box to the mold. The graphite mold 15 is formed with a lip portion 51 that overlaps the protruding end of the header 49.

In carrying out another feature of the invention, the graphite mold is supported for ready removal and replacement and may be adjustably positioned relative to the holding box. As best shown in FIGS. 6 and 7, the mold 15 is carried in an adjustable support 52 comprising a cylindrical water jacket 54 with a pair of vertical plates 55 extending upwardly from the water jacket. The upper ends of the vertical plates 54 are connected by cross members 56 that extend laterally outward from the plates 54 for positioning on the top of the two frame side panels 21. The water jacket 54 surrounds the mold 15 and supports it coaxially therein by means of inwardly extending radial plates 58, 59 to form a cooling chamber 60 about the outer periphery of the mold 15. A forwardmost radial plate 61 has a central opening slightly larger than that of the outer periphery of the mold so as to define an angular exit port 62 for cooling water. Lines 64 connected to the water jacket on opposite sides thereof supply water from a suitable source to the cooling chamber 60 (FIG. 7). For the purpose of illustrating the manner in which the lines 64 are connected to the water jacket 54, in FIG. 6 the lines 64 have been revolved 90° to a vertical plane.

To vertically adjust the position of the mold 15 relative to the holding box 14 and the header 49, adjusting bolts 65 are provided in threaded apertures in each of the cross members 56 for engagement with the upper edges of the frame side panels 21. By threadably advancing or retracting the bolts 65 in their respective aperture, the height of the support 52 and the mold 15 is supported therein may be selectively varied. To adjustably position the mold 15 in a lateral direction, depending flanges 66 extend downwardly from the horizontal cross members 56 in close relation to the side frame panels 21. Each flange 66 is formed with an inwardly directed U-shaped opening 68, and adjusting bolts 69 passing through each opening 68 couple the flange 66 to the side frame panel 21 with the desired spaced relationship.

When the mold 15 is in position about the protruding cylindrical portion of the header 49, an external shoulder 69 formed near the end of the mold is interposed between the rearward radial flange 58 of the water jacket 54 and a cylindrical flange 70 extending from a vertical panel 18a of the support frame 18 so that the mold is held in firm engagement with the header 49. To remove the mold 15 from the header 49 for replacement by a new mold, as is periodically necessary with such graphite molds, the water lines 64 may be discon- nected and, after removing the lateral adjusting screws 69, the support 52 containing the mold 15 may be slid
a downstream direction off the end of the header 49. The mold 15 may then be removed from the water jacket 54 for replacement.

Since deposits of foreign material from the cooling water generally accumulate on the outer surface of the mold within the cooling chamber 60, in prior horizontal casting machines, it often has been difficult to slide the tight fitting water jacket 54 off of the mold. To alleviate this problem, the rearward radial plate 58 of the water jacket is made of a two-part disengageable construction. As best shown in FIG. 6a, the radial plate 58 includes a first flange 71 which is welded to the outer cylindrical wall of the water jacket 54 and formed with openings of significantly greater diameter than the outer dimensions of the mold. A removable plate 72 formed with an opening that fits in close water-tight relation with the mold 15 is secured to the first flange 71 by screws 74. A suitable gasket may be interposed between the flange 71 and the removable plate 74 to provide a watertight seal. By removing the screws 74 so that the plate 72 is disengaged from the water jacket 54, the larger opening of the flange 71 permits quick removal of the water jacket from the mold leaving the plate 72 in position on the mold for removal later.

The operation of the horizontal casting process relies on the necessity of keeping the molten metal above the solidification temperature until it contacts the smooth, continuously cool, casting surface of the graphite mold. The molten metal must then be rapidly transformed into a solid skin defining the outer surface of the cast ingot. This allows the ingot to be slowly withdrawn from the mold while solidification of the ingot is being completed. By virtue of the horizontal orientation of the mold, heretofore it has been difficult to evenly cool the mold so that the ingot can be cast with the optimum metallurgical qualities.

In keeping with the invention, cooling water is directed into the water chamber 60 in a tangential direction about the outer surface of the mold 15 from the lines 64 at the opposite sides of the mold. In the illustrated embodiment, water is directed from each of the lines 64 in a counterclockwise direction, as viewed in FIG. 7. The support flange 59 has a plurality of circumferentially spaced apertures 76 which permit the water to flow to the entire length of the mold and then onto the emerging ingot through the exit port 62. It has been found that by directing the cooling water in such a tangential manner, the water tends to continue to circulate about the horizontal mold as it flows to the exit port 62, thereby achieving more uniform cooling of the mold and the ingot being formed therein. After the water has run onto the emerging ingot, it eventually drops into a tank 78 located below the mold and drive assembly. The water may be pumped from the tank 78 to a suitable cooling tower and then recirculated through the mold in a conventional manner.

At the start of the casting operation, a starter tube 79, shown in phantom in FIG. 6, is inserted a short distance into the open end of the mold 15 to block the initially entering molten metal. The starting tube 79 preferably is of such length that it extends out of the mold to at least the end of the drive assembly 16 so that it can be positively driven by the drive assembly to start the downstream movement of the cast ingot. The end of the tube 79 inserted in the mold is formed with a dovetail extension 80 which becomes embedded in the molten metal and serves to assist in pulling the ingot away from the mold after the mold is completely filled and solidification of the ingot has commenced.

To accurately support the starting tube in the mold, a removable and adjustable cradle template 81 (FIGS. 4 and 9) is secured to the first cross panel 22 downstream from the mold 15. Each of the cross panels 22 is formed with a generally U-shaped top opening 82 (FIG. 5) which permits the passage of the moving ingot 24 with ample clearance. The cradle template 81 is formed with circumferentially spaced pads 85 for supporting the starting tube 79 and relieved areas 86 between the pads 85 permit cooling water emerging from the end of the water jacket 54 to flow down the ingot past the cradle template 81 to further the cooling of the ingot. The cradle template 81 is secured to the first cross panel by fastening means, such as screws, passing through slightly oversized apertures 84 which permit sufficient adjustable positioning of the template on the cross panel 22 so that the starting tube may be precisely aligned with each new replacement mold that is installed. A similar cradle template 88 preferably is secured to the cross panel 22 at the end of the drive assembly 16, but this template need not be formed with water passage relieved areas (FIG. 4). After a casting operation has commenced, the cradles 81 preferably may be removed from their respective cross panels 22 leaving the emerging log to be supported by the drive assembly 16 as will be described below. If the cradles are not so removed, it is possible that slight blisters or warpage of the emerging log might engage the cradles, causing movement of the log to be hindered and the machines to be unnecessary shut down.

To move the starting tube and the emerging cast ingot away from the mold, the drive assembly 16 includes a plurality of power driven rollers 89 located above and below the starting tube 79 and the intended line of travel of the emerging ingot 24. In the illustrated embodiment, the drive assembly includes two identical sets of drive rollers 89. Each set includes two rollers 89a, 89b mounted on a shaft 90a above the level of the ingot, and two rollers 89c, 89d mounted on a shaft 91 below the ingot level. The rollers 89 each have inwardly tapered cone-shaped surfaces adapted to engage the sides of the starting tube and the cast ingot. The shafts 90, 91 are rotatably mounted between the side frame panels 21 by suitable flange bearings 92 (FIGS. 5 and 10), and the rollers 89 each are secured to their supporting shafts by a key 94 for rotation with the shaft and axial movement relative to the shaft. Each pair of rollers 89a, 89b and 89c, 89d are separated by a collar 95 coaxially mounted at the center of the respective shaft and secured thereto by a pin 96.

For rotatably driving the shafts 90, 91 and the drive rolls 89, a protruding end of each shaft carries a drive sprocket 98. A suitable electric motor 99 is mounted below on a frame 100 adjacent the water tank 78 and is adapted to drive an output shaft 101 of a reducer 102 through a chain and sprocket connection 104. The reducer output shaft 101 carries two driven sprockets 105, 106 (FIGS. 3 and 5). One endless chain 108 is trained about the reducer sprocket 105, idler sprockets 109, 110 and the two drive sprockets 98 carried by the shafts 90, 91 for one set of the drive rollers 89. Another chain 111 is trained about the other reducer sprocket 106, an idler sprocket 112, and the two drive sprockets 84 for the shafts 90, 91 of the other set of drive rollers. Operation of the motor 99 thereby drives all of the rol-
In carrying out another aspect of the invention, means are provided for readily adjusting the axial position of the drive rollers 89 in unison and by appropriate control means, the speed of the motor, and thus the drive rollers, may be varied for the particular casting operation.

In the illustrated embodiment, each set of drive rollers has an air cylinder 114 mounted on opposite side panels 21 intermediate the shafts 90, 91 for simultaneously actuating both the upper and lower drive rollers located on the respective side of the shafts. Thus, an air cylinder 114 is mounted on one side of the frame for actuating the drive rollers 89a, 89c and another air cylinder 114 is mounted on the opposite frame side panel 21 for actuating the rollers 89b, 89d. Since each of the air cylinders 114 is identical in construction and operation, only one need be described in detail.

The air cylinder 114 shown in FIG. 10 includes a piston rod 115 that is connected to the center of an axially adjustable hub 116 which is supported at opposite ends by the upper and lower shafts 90, 91 through cylindrical openings 118 in the hub 116. Interposed between each cylindrical hub opening 118 and the respective shaft 90, 91 is a bearing sleeve 119 to permit free rotation of the shafts relative to the hub. A grease fitting 120 extending radially through operable ends of the hub 116 permits lubricant to be applied to the bearings 119. The hub 116 in this case has a pair of flanges 121 which are welded to the body of the hub adjacent the rollers 89a, 89c. The rollers 89a, 89c each are secured to one of the hub flanges 121 by a retaining ring 122 for axial movement with the hub 116 and for relative rotational movement. Each retaining ring 122 is secured to one of a hub flange 121 by a plurality of screws 124 and is formed with an inwardly directed radial flange 125 that engages a groove 126 formed in the respective roller 89a, 89c. To facilitate the rotational movement of each roller 89c, 89e relative to the retaining ring 122 and hub flange 121, a radial bearing plate 128 is interposed between the hub flange 121 and the roller and a grease fitting 129 is provided in the retaining ring 122 to lubricate the surfaces between the retaining ring and the roller. Since the key connection between the rollers 89a, 89c and their respective shafts 90, 91 permits relative axial movement of the rollers, actuation of the air cylinder 114 will exert an axial force on the hub 116 that is transmitted to both rollers to simultaneously move them. The central collar 95 in this case serves to limit axial roller movement in the inward direction and similar stop means may be provided for limiting roller movement in the opposite direction.

It will be appreciated that by appropriate monitoring means an operator located at a safe and comfortable distance from the hot emerging ingot may selectively regulate the pressure to the cylinders 114 and thus the position and driving pressures of the drive rollers 89.

As a further safety feature of the machine, means are provided for automatically stopping the drive rollers in the event of a bleed-out of molten metal from the mouth of the mold 15 or the formation of a blister or other protruding deformity in the emerging cast ingot. As best shown in FIGS. 6 and 8, a pair of rotatable gates 130 are mounted at opposite sides of the downstream end of the mold 15. The gates 130 each are mounted on a shaft 131 that is pivotably secured at opposite ends by brackets 132 extending outwardly from the forwardmost plate 61 of the water jacket 54. The gates 130 each are formed with a semicircular opening 134 the diameter of which is greater than the intended diameter of the cast ingot 24 by a predetermined amount, preferably about 5/8th of an inch. To keep the gates in a normally closed position, as shown in the drawings, magnetic flanges 135 are provided at the top of each gate.

In the event of an unintended bleed-out of molten metal from the mouth of the mold or the formation of a blister or the like on the emerging ingot, the metal will contact the safety gates 130, overcome the magnetic closure force of the flanges 135, and push the gates to an open position. To sense such opening of the gates, each shaft 131 has an eccentrically mounted cam 136 at the upper end thereof which is engageable with a limit switch 138. Appropriate circuitry may be employed to automatically turn off the power to the drive motor 99 upon actuation of the limit switch 138. As a further safety precaution in the event of bleed-out of molten metal, a predetermined water depth may be maintained in the tank 78 below the mold and drive rollers so that the run-out molten metal will be contained within the tank and quickly cooled.

As the ingot 24 leaves the casting unit drive assembly 16, it is guided onto the saw assembly 12. The saw assembly 12 is mounted on a frame 139 which has a pair of guide rollers 140 at its forwardmost end. The saw assembly includes a carriage 141 slidably mounted upon ways 142 for longitudinal movement on the frame 139 parallel to the ingot 24. To move the carriage 141 in such a longitudinal direction, an appropriate hydraulic cylinder 144 is located intermediate the ways 142. A saw 145 with a conventional rotary cutting blade 146 is mounted upon the carriage 141 on ways 148 for lateral movement relative to the ingot through actuation of a hydraulic cylinder 149. A protective guard 147 may be provided about the saw blade 146. Secured forwardly of the carriage 141 for movement with the carriage is a clamping mechanism 150 having a pair of clamping arms 151 immediately downstream of the saw assembly guide rollers 140. The clamping arms 151 are movable by means of a hydraulic cylinder 152 between an open position which permits passage of an ingot 24 relative into the saw assembly and a closed position engaging the ingot.

The ingot is moved into the saw assembly under power of the drive rollers 89 until a predetermined length is sensed by a limit switch 154 located at the downstream end of the saw assembly 12 which activates the hydraulic cylinder 152 for the clamp 150 causing the clamping arms 151 to engage the ingot 24. The engagement of the clamp about the ingot, the saw carriage 141 will be moved along its ways 142 with the moving ingot. At the same time, the saw 145 is energized and the hydraulic cylinder 149 actuated to move the saw in a lateral cutting direction to cut through the ingot as the saw and log progress in a downstream direction.

At the end of the sawing cycle, the saw 145 has moved to the position shown in phantom in FIG. 13 and has progressed a longitudinal distance along the carriage ways 142 so that the cut-off ingot length is centered over and rests upon a saw table 155. The saw table 155 has an upwardly inclined flange 156 on one
side thereof that is positioned in close relation to the moving ingot when the table is in a horizontally disposed position to prevent the cut ingot length from rolling off that side of the table.

In order to automatically transfer the cut-off length of ingot 24 from the table 155 to the adjacent storage pallet 25, the table 155 is pivotally mounted on a transverse rod 158 supported by a vertical extension 159 of the furnace 139. To tilt the table 155, a hydraulic cylinder 160 located below the outer end of the table has a piston rod 161 which is rotatably secured to the table for movement between an extended horizontal table position and a retracted tilted table position, shown in phantom in FIG. 13. To facilitate such movement of the table, the lower end of the hydraulic cylinder 160 is pivotally mounted to a horizontal extension 162 of the support frame 139. Thus, by actuation of the hydraulic cylinder 160, the table 155 may be tilted downwardly causing the ingot length supported thereon to roll or be dumped onto the storage pallet 25 (FIG. 2).

Upon completion of the sawing and dumping operations, the saw 145 is returned to its laterally retracted position by actuation of the hydraulic cylinder 149, the hydraulic clamp 150 releases the ingot and the carriage 141 is then returned to its upstream position by actuation of the hydraulic cylinder 144. It will be understood that the sequencing of the operation of the ingot clamps 151, the outward movement of the cutting saw 145, the saw return movement, and the carriage return movement may all be controlled through a suitable hydraulic power unit.

As can be seen from the foregoing, the continuous horizontal casting system of the present invention is both safe and highly efficient in operation. Such a system makes it possible for even the small aluminum extruder to now readily and efficiently reclaim its own scrap directly and recast it into the reusable ingots. In fact, one operator can generally control the operation of the machine, except for perhaps changing of the furnace. It will be understood that while the illustrated machine is intended for casting one continuous ingot, multiple ingots could be cast by placing two more units side by side and feeding them from a common furnace.

We claim:

1. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a graphitic casting mold having cylindrical outer periphery and an internal horizontally directed casting surface extending through said mold and communicating with said holding box, a water jacket surrounding and supporting said graphitic mold and defining a cooling chamber about the outer periphery thereof, means for supplying water to said chamber and into direct contact with the outer periphery of said graphitic mold for uniformly cooling said mold and molten metal therein to continuously form and cast a metal ingot, said water supply means including at least two water supply lines connected to said water jacket on opposite sides of said mold for directing water in a tangential direction about said mold so as to impart a circumferential flow of water about the mold as it is in contact with the outer periphery thereof, and drive means for moving said continuously cast ingot in a downstream direction away from said mold.

2. The continuous metal casting machine of claim 1 including means for selectively adjusting vertically and laterally the position of said water jacket and the mold supported therein relative to said holding box without disassembly of said water jacket.

3. The continuous casting machine of claim 1 in which said drive means includes a plurality of pairs of cone shaped rollers for engaging opposite sides of a cast ingot as said ingot emerges from said mold, said rollers of each pair being mounted in axial spaced relation for rotational movement and relative axial movement, power means for rotatably driving said rollers, and means including selectively operable air cylinders for axially moving said rollers of each pair relative to each other and to the emerging cast ingot to compensate for variations in the diameter of said ingot and to adjust the driving pressures of said rollers.

4. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a casting mold having an internal horizontally directed casting surface extending through said mold and communicating with said holding box, a selectively removable water jacket surrounding and supporting said mold and defining a cooling chamber about the outer periphery thereof, a frame having a pair of spaced apart longitudinally extending side panels at opposite ends of said mold and water jacket, said water jacket having upper horizontal cross members removably supporting said water jacket on said frame side panels with said mold adjacent said holding box, a plurality of screws supported within said cross members for engagement with said frame side panels whereby rotational adjustment of said screws alters the position of said cross member and water jacket relative to said frame side panels, means for supplying water to said water jacket chamber for cooling said mold and the molten metal therein to continuously form and cast a metal ingot, and drive means for moving said continuously cast ingot away from said mold in a downstream direction.

5. The continuous metal casting machine of claim 4 in which said water jacket includes at least two radial flanges for supporting said mold, one of said radial flanges including a first flange part rigidly secured to said water jacket and formed with a central opening substantially larger than the outer dimensions of said mold periphery, a second removable flange part releasably secured to said first flange part and being formed with a central opening for receiving in close relation the outer periphery of said mold, said second flange part being disengageable from said first flange part to permit quick removal of said water jacket from said mold.

6. The continuous metal casting machine of claim 5 in which said two part disengageable radial flange is located at an upstream end of said water jacket, said second radial flange being located downstream from said two-part radial flange and being formed with a plurality of openings to permit the passage of cooling water along the length of said mold periphery, and said water jacket defining an exit port about the outer periphery of said mold at the downstream end thereof to permit the passage of cooling water from said chamber onto an emerging cast ingot.

7. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a casting mold having cylindrical outer periphery and an internal horizontally directed casting surface extending
through said mold and communicating with said holding box, means for directing water uniformly about the outer periphery of said mold for cooling said mold and molten metal therein to continuously form and cast a metal ingot, drive means for moving said continuously cast ingot in a downstream direction away from said mold as it emerges from said mold, means for sensing an accidental bleed-out of metal from the downstream end of said mold, said sensing means including a rotatable gate mounted in a normally close relation to the downstream end of said mold and having an opening therein that is greater than outer dimensions of the merging cast ingot by a predetermined amount, and said gate being rotatable in an outward direction in the event that metal emerging from said mold engages said gate, and limit switch means being actuated in response to said outward rotary movement of said gate to automatically shut off the operation of said drive means.

8. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a casting mold having an internal horizontally directed casting surface extending through said mold and communicating with said holding box for continuously forming a cast ingot, means for directing cooling water about the outer periphery of said mold and the emerging cast ingot, drive means for moving said continuously cast ingot away from said mold in a downstream direction, a frame for supporting said mold and drive means, said frame having a pair of side panels extending longitudinally a distance beyond the end of said mold with a plurality of cross panels secured therebetween, said cross panels each being formed with a generally U-shaped top opening to permit the passage of a moving ingot with substantial clearance, at least one of said cross panels having a removable and adjustable crucible template, and said crucible template being formed with circumferentially spaced support pads arranged to closely coincide with the outer periphery of a moving ingot.

9. The continuous casting machine of claim 8 in which said crucible template has relieved areas between said pads to permit cooling water to flow along the moving ingot passed said template.

10. The continuous metal casting machine of claim 8 including a metal panel enclosure mounted over the top of said holding box for substantially shielding the immediately surrounding area about said holding box from the heat and erosion of molten metal contained therein.

11. The continuous metal casting machine of claim 10 in which said furnace has a tap-out aperture for permitting the flow of metal from said furnace to said holding box, a metering rod extending through said enclosure and having a head at one end for cooperation with said tap-out aperture and a handle at the other end thereof on the outside of said enclosure, support means holding said metering rod in predetermined relation to said tap-out aperture, said metering rod being in threaded engagement with said support means so that upon rotation of said metering rod said head is selectively positionable relative to said tap-out aperture to govern the flow of molten metal from said furnace.

12. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a casting mold having an internal horizontally directed casting surface extending through said mold and communicating with said holding box, means for directing water onto the outer periphery of said mold for cooling said mold and the molten metal contained therein to continuously form and cast a metal ingot, a plurality of pairs of spaced apart, inwardly tapered rollers for engaging said cast ingot as it emerges from said mold to move said ingot in a downstream direction, said rollers of each pair being mounted on opposite sides of the ingot path for rotational movement and relative axial movement, power means for rotatably driving said rollers, and means for adjusting the axial spacing of the rollers of each pair to compensate for variations in the diameter of said ingot and to regulate the driving pressures of said rollers against said ingot.

13. The continuous metal casting machine of claim 12 in which said roller axial spacing adjusting means includes at least one fluid actuated cylinder having a piston rod, means connecting said piston rod one of the rollers of at least one pair, and control means for selectively actuating said fluid cylinder to axially move said connected roller.

14. The continuous metal casting machine of claim 12 in which one pair of said rollers is carried on a rotatable shaft mounted above the line of travel of said ingot and one pair of said rollers is carried on a rotatable shaft mounted below the line of travel of said ingot, said rollers on said lower shaft being vertically aligned with corresponding rollers on said upper shaft, and means for simultaneously moving one of the rollers on said lower shaft and the vertically aligned corresponding roller on said upper shaft axially relative to the respective other roller of each pair.

15. The continuous casting machine of claim 14 including means for simultaneously moving the other roller carried by said lower shaft and the vertically aligned corresponding roller on said upper shaft axially relative to the respective opposite roller of each pair.

16. The continuous casting machine of claim 14 in which said roller moving means includes a hub supported at opposite ends by said upper and lower shafts for relative axial movement, means connecting said one roller on said lower shaft and said aligned roller on said upper shaft to said hub for axial movement with said hub and relative rotational movement, a fluid actuated cylinder having a reciprocal piston rod connected to said hub, and means for selectively actuating said cylinder to move said hub and the upper and lower rollers connected thereto relative to the respective shafts on which said rollers are mounted.

17. A continuous metal casting machine comprising a furnace for melting metal to a molten state, a holding box for receiving molten metal from said furnace, a casting mold having an internal horizontally directed casting surface extending through said mold and communicating with said holding box, means for directing water onto the outer periphery of said mold for cooling said mold and the molten metal contained therein to continuously form and cast a metal ingot, a plurality of rotatable and axially movable rollers for engaging opposite sides of a cast ingot as it emerges from said mold to move said ingot in a downstream direction, power means for rotatably driving said rollers, means for automatically adjusting the axial position of said rollers to compensate for variations in the diameter of said ingot and to adjust the driving pressures of said rollers against said ingot, a saw positioned downstream of said
rollers, means for sensing when a predetermined length of said ingot has moved past said saw, clamping means for engaging said ingot to move said saw in a downstream direction with said ingot upon triggering of said sensing means, means for laterally advancing said saw to cut said ingot to a predetermined length as said saw is moving in a downstream direction with said ingot, a table for receiving and supporting the cut-off length of said ingot upon completion of cutting by said saw, means for automatically tilting said table after an ingot length has been cut by said saw to remove said ingot length from said table, means for returning said saw to its original upstream and laterally retracted position upon completion of cutting of said ingot length, and means for returning said table to its original position for receiving another ingot length.

18. The continuous metal casting machine of claim 17 in which said table is pivotably mounted, and said tilting means is a hydraulic cylinder having a reciprocal piston rod connected to one side of said table.