United States Patent

[11] 3,595,303

[72] Inventor **Eric J. Ponting**
167 Tamworth Road, Sutton Coldfield, England

[21] Appl. No. **775,755**
[22] Filed **Nov. 14, 1968**
[45] Patented **July 27, 1971**
[32] Priority **Nov. 16, 1967**
[33] **Great Britain**
[31] **52,209/67**

[54] **APPARATUS FOR CASTING MOLTEN SUBSTANCES**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **164/326,** 164/348, 164/324, 164/283, 18/4 C
[51] **Int. Cl.** **B22d 5/02**
[50] **Field of Search** ..... 18/4 C; 164/348, 324, 325, 326

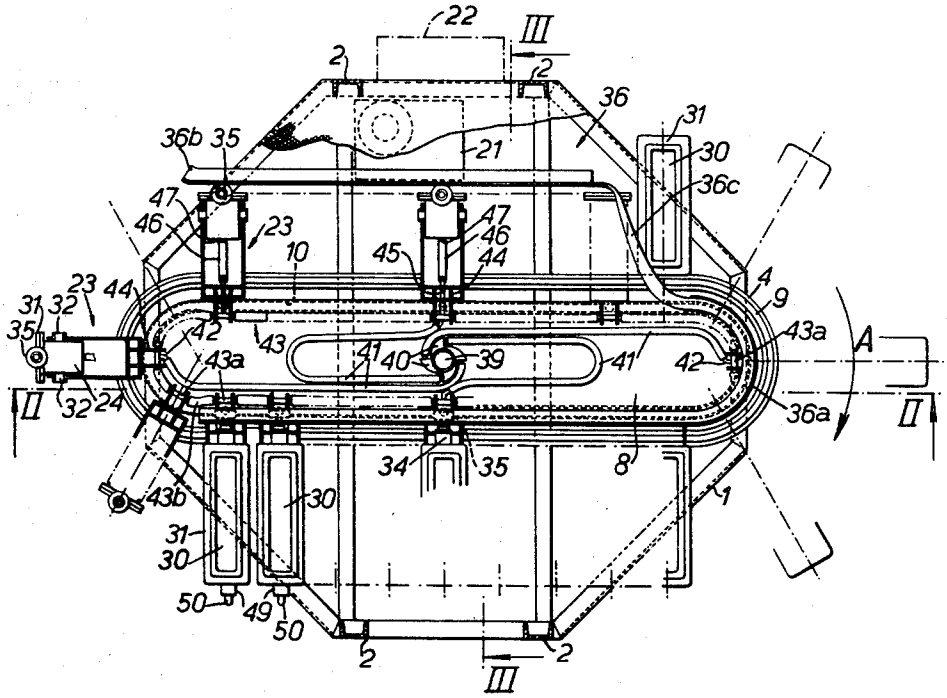
[56] **References Cited**

UNITED STATES PATENTS

2,412,040	12/1946	Gall et al.	164/326
2,672,661	3/1954	Lutz	164/326
669,696	3/1901	Herreshoff	164/326
1,219,289	3/1917	Gounley	164/326
1,779,253	10/1930	Temmen	164/326 X
2,322,795	7/1943	Enderich et al.	164/348 X
3,200,451	8/1965	Worswick	164/DIG. 14
3,099,867	8/1963	Ponting	164/348 X

Primary Examiner—J. Spencer Overholser
Assistant Examiner—V. K. Rising
Attorney—Imirie & Smiley

ABSTRACT: In apparatus for casting molten substances, a battery of molds is carried upon and around the exterior of a horizontal endless conveyor, each mold is so pivoted within a carriage connected to at least one endless chain incorporated in the conveyor, that it tends to tilt from the horizontal to the vertical, and means are provided whereby, when the apparatus is being operated, coolant liquid is sprayed continuously on to the external surface of the molds and, as each carriage is conveyed from a pouring station where a quantity of molten substance is charged into the mold pivoted therein, the mold is held in the horizontal until the substance is at least partially solidified, whereupon the mold is permitted to turn to the vertical to strip the cooled substance therefrom, and is returned to the horizontal before the carriage is returned to the pouring station.



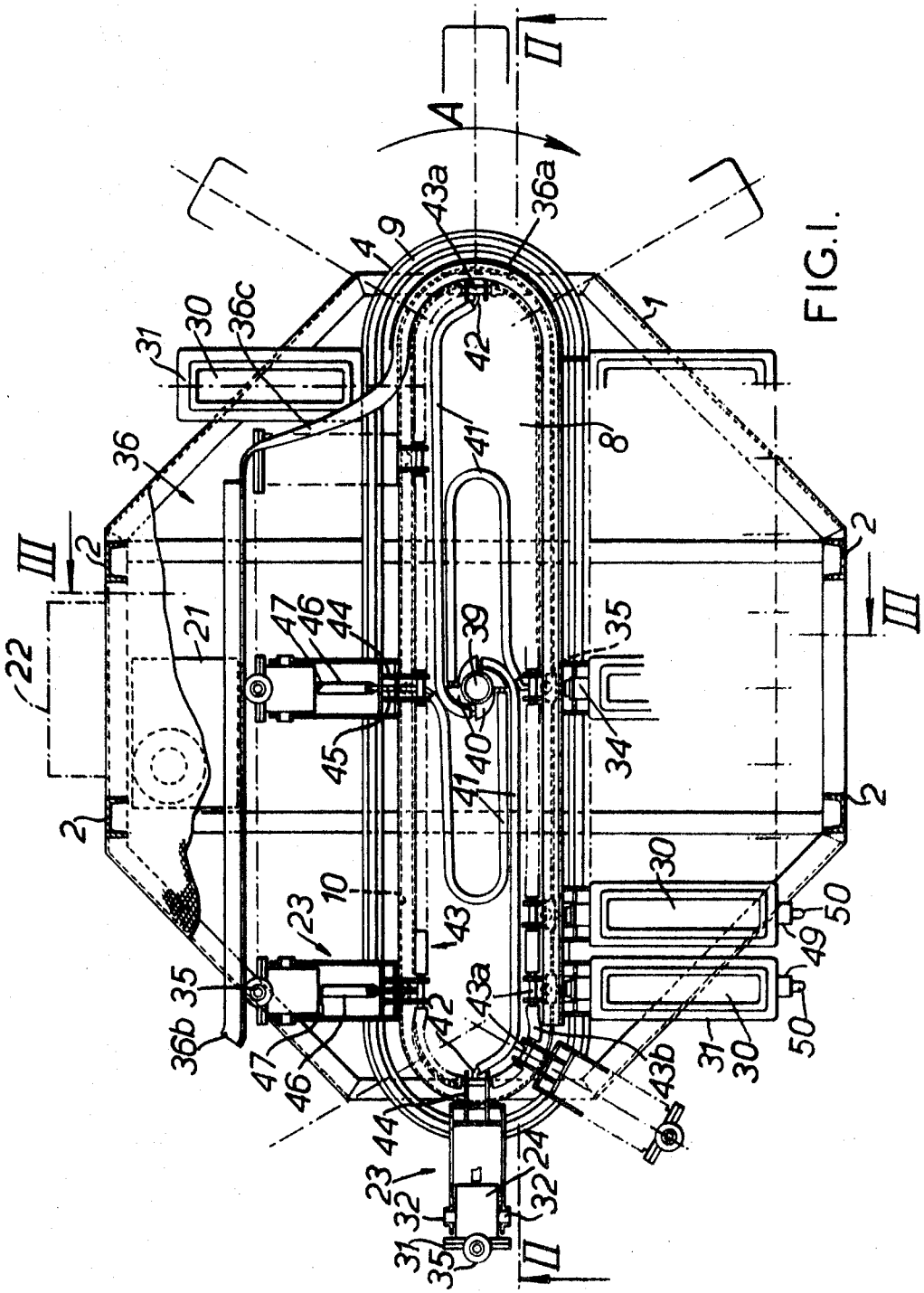


FIG. 1.

INVENTOR
ERIC PONTING
BY Marie & Smiley

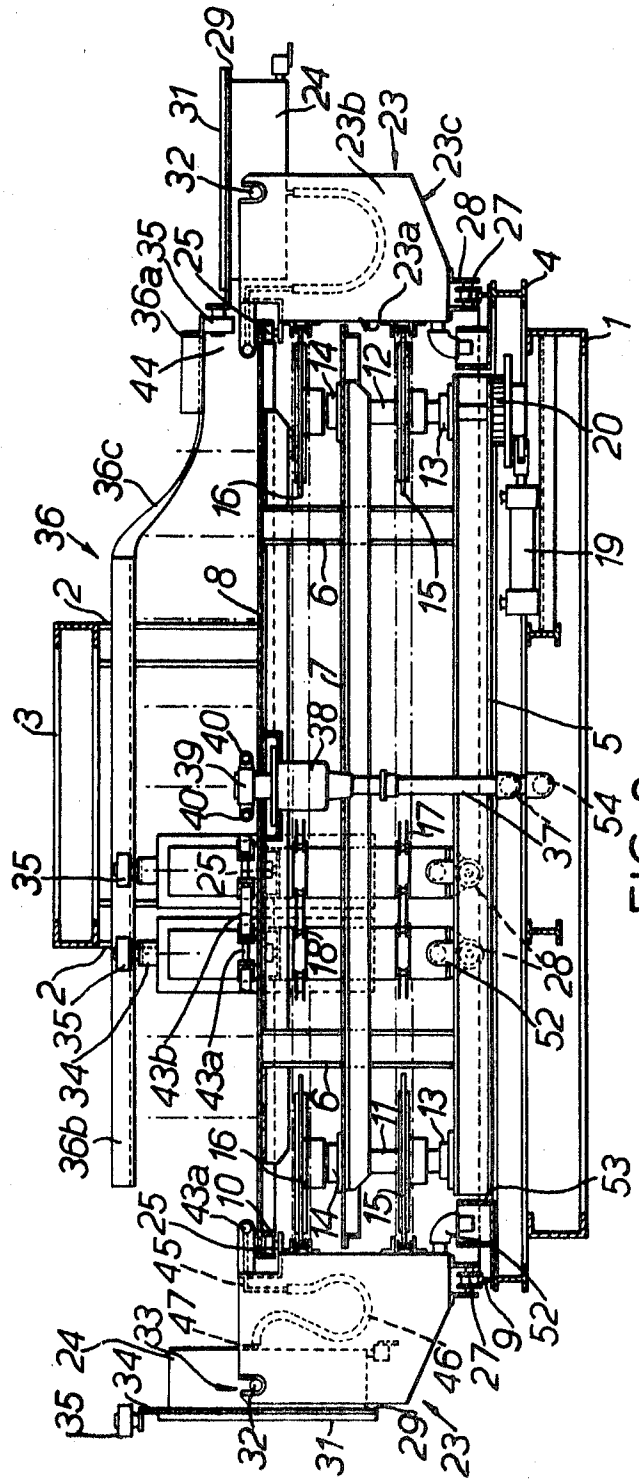


FIG. 2.

INVENTOR
ERIC J. PONTING
BY Mario and Smiley

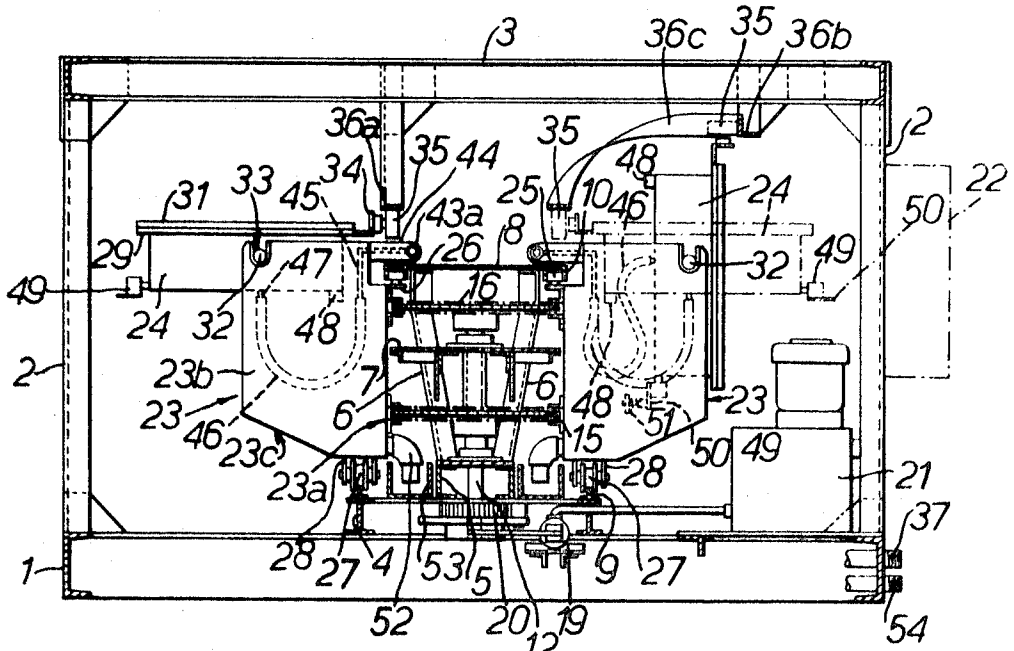


FIG. 3.

INVENTOR
ERIC J. PONTING
BY Morris & Stanley

APPARATUS FOR CASTING MOLTEN SUBSTANCES

FIELD OF THE INVENTION

The invention relates to apparatus for casting molten substances, particularly for casting molten metals in the form of ingots.

SUMMARY

The present invention provides a casting apparatus comprising a battery of molds which is carried upon and around the exterior of an endless horizontal conveyor, and means adapted to charge a quantity of the molten substance into each of the molds in succession, to spray the exteriors of the molds with a liquid coolant so as to cool the substance contained therein, and to strip the cooled substance from each of the molds also in succession.

Preferably, each mold is supported by a corresponding one of a battery of carriages each provided with rollers which engage and are adapted to travel around fixed horizontal and superimposed tracks, and the several carriages are coupled to at least one endless chain incorporated in the conveyor and meshing with sprocket wheels fast upon two vertical shafts of which one is adapted to be rotated by a motor mounted in the apparatus.

Desirably, each mold is fixed within an open top and depends into the interior of a boxlike holder which is pivoted in the corresponding carriage, of which the internal surfaces of the walls and floor are spaced respectively from the external surfaces of the walls and floor of the mold, and which is provided with an internal system of nozzles connected to a supply of water or other liquid coolant, and adapted to spray the liquid continuously over the whole of the said external mold surfaces.

Further, each holder may be so pivoted in the corresponding carriage that it tends to turn from the horizontal to the vertical, means being provided whereby, as the carriage is conveyed from a pouring station where a quantity of the molten substance is charged into the mold fixed in the holder, the latter is retained in the horizontal during a predetermined fraction of the carriage travel, is then allowed to turn to the vertical to strip the cooled substance from the mold and to remain in the vertical during a further predetermined fraction of the carriage travel, and is returned to the horizontal before the carriage returns to the pouring station.

BRIEF DESCRIPTION OF THE DRAWINGS.

The accompanying drawings show, by way of example, apparatus for casting molten substances constructed in accordance with a preferred embodiment of the invention. In the drawings:

FIG. **1** is a part sectional plan of the apparatus, and

FIGS. **2** and **3** are, respectively, sections along the lines II–II and III–III, FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT.

The apparatus comprises a main frame which includes a base **1**, four vertical stanchions **2**, and (see FIGS. **2** and **3**) a gantry **3** secured to the upper ends of and supported by the stanchions.

As shown in FIGS. **2** and **3**, the base **1** supports a superstructure which includes a base frame **4**, an elongated box structure **5** supported upon the frame **4** and extending lengthwise of the apparatus, and stanchions **6** extending upwardly from the structure **5** and carrying a horizontal intermediate decking **7** between their upper and lower ends, and a horizontal top decking **8** at their upper ends.

The superstructure is provided with two horizontal, superimposed endless tracks **9**, **10** having semicircular ends; the lower track **9** is fixed upon the top of base frame **4** whereas the upper track **10**, which is of inverted channel section, is fixed upon the underside and extends around but inwardly of the periphery of the top decking **8**, and each of the semicircular ends of the lower track is concentric to, but of a larger radius than, the corresponding end of the upper track.

Two vertical shafts, **11** **12** are located respectively in the vicinity of the opposite ends of the apparatus below the top decking; each of the said shafts is concentric to the adjacent ends of the superimposed tracks and is journaled in a corresponding one of two bearings **13** provided on the box structure **5** and a corresponding one of two bearings **14** provided on the intermediate decking **7**. An identical pair of sprocket wheels **15**, **16** is fast upon each of the shafts; the two wheels **15** are located at the same distance below the intermediate decking and engage an endless chain **17**, whereas the two wheels **16** are located at the same distance above the said decking and engage a second endless chain **18** so that the chains are also horizontal. In addition, the shaft **12** extends through and beyond the underside of the box structure and is adapted to be rotated intermittently in a sequence of equiangular steps by a double-acting hydraulic cylinder **19** which is carried by the base of the main frame and is adapted to rotate the shaft through a free wheel ratchet device comprising a ratchet wheel **20** fast upon the shaft portion projecting below the said box structure. The hydraulic cylinder is adapted to be operated by fluid delivered from a motor-driven pump **21**, which is also mounted upon the base of the main frame, under the control of a timer (not shown) mounted on a control panel **22** carried by and between two of the stanchions **2**.

The chains **17**, **18** are component parts of an endless conveyor which also comprises a battery of identical carriages **23** and a battery of identical, boxlike mold holders **24**, the carriages being pitched equidistantly apart lengthwise of the conveyor and being located externally of the chains, and each of the mold holders being carried in a corresponding one of the carriages.

Each of the carriages **23** is of U-shape in cross section, the external surface of its flat rear wall **23***a* is anchored to both of the chains by swivel links or equivalent expedients, its sidewalls **23***b* are flat and parallel to one another, project away from the chains at right angles to the rear wall, and their lower edges and the lower portions of their front edges are spanned by a bottom wall **23***c* so as to form a well in the bottom of the carriage. The upper end of rear wall **23***a* is stepped inwardly of the carriage and a roller **25** journaled about a vertical axis upon a horizontal bracket **26** projecting from and located midway between the ends of the tread of the step, is located within, makes peripheral contact with the walls of, and is adapted to travel along the inverted, channel section track **10**. A second roller **27** journaled about a horizontal axis between a pair of brackets **28** fixed to the underside of the bottom wall **23***c*, makes peripheral contact with and is adapted to travel along, the lower track **9**.

Each of the mold holders **24** has an open top which is surrounded by an external flange **29** and is closed by an open-topped mold **30** accommodated within the holder and having an external flange **31** which overhangs, coincides with, and is secured, by bolts or other means (not shown), to the flange **29**; the mold dimensions are such that the whole of the external surfaces of its walls and floor are spaced, respectively, from the internal surfaces of the walls and floor of the holder. The holder is provided with a pair of coaxial fulcrum pins **32** which, respectively, project from and at right angles to the sidewalls of the holder and are received and are rotatable in slots **33** formed in and opening to the upper edges of the carriage sidewalls, the said pins being located nearer to the holder end which is adjacent to the carriage wall **23***a* when the holder is horizontal, than to the opposite holder end so that the holder tends to turn from the horizontal to the vertical, about the common axis of the fulcrum pins, in the direction which causes the open top of the mold to face outwardly of the apparatus as shown, for example, at the left of FIG. **2**. A bracket **34** is secured upon the end of the flange **29** which is adjacent to the carriage wall **23***a* when the holder is horizontal, and a roller **35** is journaled upon the bracket about an axis parallel to the longitudinal centerline of the holder.

A fixed holder-controlling rail **36** suspended from the gantry **3**, comprises a lower, angle section, partially semicircular, partially straight portion **36***a* which extends around one end and along one side of the apparatus inwardly of the battery of carriages **23** and substantially vertically above the track **10**, an upper, angle section straight portion **36** *b* which extends along the opposite side of the apparatus outwardly of the said carriage battery, and an inclined portion **36***c* which extends between and is secured to the adjacent ends of the horizontal portions; the inclined rail portion consists of a strip which, initially, is flat but, before being installed in the rail, is twisted through 90° about its longitudinal centerline, one end thereof being fixed to a horizontal flange of the horizontal portion **36***a*, and the opposite end being fixed to a vertical flange of the horizontal portion **36***b* so that each of the strip ends is coplanar with the flange to which it is fixed.

A pipe **37** fixed within the base of the main frame, is connected to a mains or other supply of water, extends vertically upwards through the center of the intermediate decking **7**, and is connected into a gland **38** having a tubular rotatable head **39** which extends through the top decking **8**; above the latter decking the head is provided with four outlet branch pipes **40** which are pitched at 90° apart around the periphery of the head and each of which is connected into one end of a corresponding one of four flexible pipes **41** (see FIG. **1**). The opposite end of each of the said flexible pipes is connected to a corresponding one of four tubular spigots **42** projecting from, and spaced at equidistant intervals apart along the length of, an endless ring main **43** which is located above and inwardly of the perimeter of the top decking. The ring main comprises a number of rigid tubes **43***a* which are located in a common horizontal plane and each of which is fixed within and projects beyond the opposite sides of a bracket **44** projecting rearwardly from the stepped, upper end of the rear wall **23***a* of a corresponding one of the carriages **23**, and an equal number of flexible tubes **43***b* each of which is connected to the adjacent ends of a corresponding two of the rigid, bracket-supported tubes **43***a*. While the spigots **42** are provided respectively on a selected four of the rigid, bracket-supported tubes, each of every one of the said tubes is provided, as shown in FIGS. **1** and **2**, with a rigid outlet tube **45** which is connected, by a flexible pipe **46**, to a tubular union **47** secured in the underside of the mold holder pivoted upon the same carriage as that on which the bracket-supported tube is carried, and communicating with a duct housed within the holder and provided with the nozzles referred to above. Hence, when water is fed to the supply pipe **37**, it flows through the branch pipes on the rotatable gland head, the flexible pipes **41**, and the spigots **42** into the ring main, and from the said main through the rigid outlet tubes **45** and flexible pipes **46** to the interiors of all of the several holders **24** where it is sprayed continuously on to the external surfaces of the molds by the nozzles.

Each of the mold holders is provided with two water discharge outlets, namely (see FIG. **3**) an uncontrolled outlet **48** and a valve-controlled outlet **49**, each having a flow capacity sufficient to prevent the water which is sprayed on to the mold by the nozzles, from accumulating within the holder to a depth sufficient to submerge any of the nozzles. The uncontrolled outlet is provided in the underside of the holder end which is adjacent to the carriage wall **23***a* when the holder is horizontal and is uppermost when the holder is vertical, so that the said outlet is adapted to discharge water into the well formed by the bottom wall **23***c*, only when the holder is horizontal. The valve-controlled outlet is provided in the opposite end wall and close to the floor of the holder and has a valve-actuating lever **50** which, as the holder turns to the vertical, abuts and is displaced by a stop **51** mounted on the carriage so as to open the valve in the outlet against spring action and enable water to be discharged through the outlet into the said well only when the holder is vertical.

A discharge duct **52** provided at the lower end of the rear wall of each of the carriages, is adapted to deliver the water received in the well into a common endless trough **53** mounted on the frame **4** and provided with a discharge pipe **54** fixed within the base of the main frame.

When the apparatus is in operation, the shaft **12** is rotated by the hydraulic cylinder **19** intermittently and at the termination of each of a sequence of timed intervals of equal duration, in the direction and through an angular distance which drives the conveyor in the direction of the arrow A, FIG. **1**, through a step equal to the pitch by which the carriages **23** are spaced apart.

The rollers **35** of the mold holders pivoted in the carriages ranged along the outside of the lower horizontal rail portion **36***a*, contact and roll along the underside of the horizontal flange of the said portion, thereby retaining the said holders horizontal. A pouring station (not shown) is situated outside and midway between the ends of the semicircular part of the said lower rail portion and the arrangement is such that, as each of the carriages arrives in succession at the station, the conveyor terminates one of its driven steps and remains stationary while a predetermined volume of molten substance is poured into the mold **30** carried in the carriage located at the station, the substance contained in the mold being cooled and at least partially solidified as the carriage is conveyed, step by step, from the said semicircular part and along the straight part of the lower rail portion.

Subsequently, and as each carriage is conveyed in succession beyond the straight part of the rail portion **36***a*, the roller **35** on the mold holder pivoted in the carriage, travels clear of the rail whereupon the holder turns automatically to the vertical, the cooled substance is stripped from the mold within the holder, and the valve-controlled outlet of the holder is opened.

After being conveyed around the end of the apparatus remote from the pouring station, each of the carriages moves, one after the other, to a position wherein the roller **35** on the mold holder pivoted therein, contacts and travels along the vertical flange of the upper horizontal rail portion **36***b*, and then contacts and travels downwardly of the inclined, twisted rail portion **36***c*. As the roller travels down the said inclined portion, the mold holder is turned in the reverse direction until, when the roller reaches the lower end of the inclined rail portion, the holder is returned to the horizontal.

Since water is fed continuously from the ring main to all of the mold holders, the cooling of the molds after the cooled substance has been stripped therefrom, is continued as the rollers **35** travel from the lower rail portion to and along the upper and inclined rail portions, and the water is discharged from the holders into the carriage wells through the valve-controlled outlets. However, as the rollers commence to travel down the inclined rail portion and the mold holders commence their reverse turning movement, the levers **50** move out of abutment with their respective stops **51**, whereupon the valve-controlled outlets are closed and, thereafter, the water is discharged into the carriage wells through the uncontrolled outlets **41**. The water received within the wells is discharged through the respective ducts **52** into the trough **53** and from the trough through the discharge pipe **54** to a drain. If desired, instead of connecting the pipe **37** to a mains supply, the water from the discharge pipe may be delivered to a sump or tank from where it may be pumped back into the pipe **37** for recirculation. Alternatively, the rotary-headed gland **38** may be replaced by any alternative arrangement for delivering a continuous supply of water to the ring main **43**; for example, means may be provided for maintaining the water in the trough **53** at a constant predetermined level, a pump may be mounted on each of the brackets **44** supporting one of the four spigotted, rigid pipes **43***a*, and the intake of each pump may depend into the water in the trough, whereas the output of the pump may be connected to the spigot **42** of the pipe **43***a*.

I claim:

1. Apparatus for casting a molten substance comprising an endless horizontal conveyor, a battery of carriages assembled to, externally of and around the conveyor; a boxlike holder mounted in each carriage and having an open top, a mold fixed within and closing the open top and depending into the interior of each holder, means adapted to charge a quantity of the molten substance into each of the molds in succession,

means contained in each of the holders for spraying a liquid coolant on to the external surfaces of the charged mold depending into and closing the open top of the holder so as to cool the molten substance charged into this mold, at least one outlet in each of the holders for discharging the sprayed liquid from the latter, and means for stripping the cooled substance from each of the molds in succession.

2. Apparatus as claimed in claim 1, wherein each of the carriages has a vertical wall which is provided with a plurality of rollers each engaging and adapted to travel around a corresponding one of an equal number of fixed horizontal and superimposed endless tracks, and the several carriages are coupled to at least one endless chain incorporated in the conveyor and meshing with sprocket wheels fast upon two vertical rotatable shafts of which one is adapted to be rotated intermittently by a motor mounted in the apparatus.

3. Apparatus as claimed in claim 1 wherein each of the boxlike holders is pivoted in the corresponding carriage about a horizontal axis, the internal surfaces of the walls and floor of each holder being spaced respectively from the external surfaces of the walls and floor of the mold depending into and closing the open top or the respective holder, and an internal system of nozzles provided in the holder is connected to a supply of liquid coolant and is adapted to spray the liquid continuously over the whole of the said external mold surfaces.

4. Apparatus as claimed in claim 3 wherein each mold holder is so pivoted in the corresponding carriage that it tends to turn from the horizontal to the vertical, and means are provided whereby, as the carriage is conveyed from a pouring station where a quantity of the molten substance is charged into the mold in the holder, the latter is retained in the horizontal during a first predetermined fraction of the carriage travel, is then allowed to turn to the vertical to strip the cooled substance from the mold and to remain in the vertical during a second predetermined fraction of the carriage travel, and is returned to the horizontal before the carriage returns to the pouring station.

5. Apparatus as claimed in claim 3 wherein an endless ring main supported and surrounded by the carriages, is connected to the supply of liquid coolant at each of a plurality of spaced positions along its length, and to the nozzles within each of the mold holders at a corresponding one of a further plurality of spaced positions along its length.

6. Apparatus as claimed in claim 5 wherein each of the mold holders is provided with two liquid outlets of which one is uncontrolled and is adapted to discharge liquid from the holder into a well in the carriage in which the holder is pivoted only when the holder is horizontal, and of which the other is valve-controlled and closed when the holder is horizontal, the carriage being provided with means adapted to open the valve-controlled outlet when the holder turns to the vertical to enable liquid to be discharged from the holder through the valve-controlled outlet into the well.

7. Apparatus as claimed in claim 6 wherein the flow capacity of each of the liquid outlets is sufficient to prevent liquid from accumulating within the mold holder and submerging any of the nozzles.

8. Apparatus as claimed in claim 6 wherein an endless trough is provided below the carriages and the well of each carriage is provided with an outlet through which liquid received in the well from the outlets of the mold holder pivoted in the carriage, is adapted to flow into the trough.

9. Apparatus as claimed in claim 4 wherein an overhead rail is provided, the said rail comprising a lower horizontal portion which extends from the pouring station along one side of the conveyor and retains the mold holders horizontal during the first predetermined fraction of carriage travel, an upper horizontal portion which extends along the opposite side of the conveyor and is contacted by the mold holders during the initial part of the second predetermined fraction of carriage travel, and an inclined portion which is located adjacent to the pouring station, extends between the upper and lower portions and is contacted by the mold holders during the final part of the said second predetermined fraction of carriage travel to return the mold holders in succession from the vertical to the horizontal.

10. Apparatus as claimed in claim 2 wherein the carriages are pitched at equal distances apart lengthwise of the conveyor and the motor is so controlled that, at the termination of each of a succession of timed intervals of equal duration, it rotates the vertical shaft through an angular distance which drives the conveyor through a distance equal to the pitch at which the carriages are spaced apart.