

July 29, 1947.

H. W. SPOONER

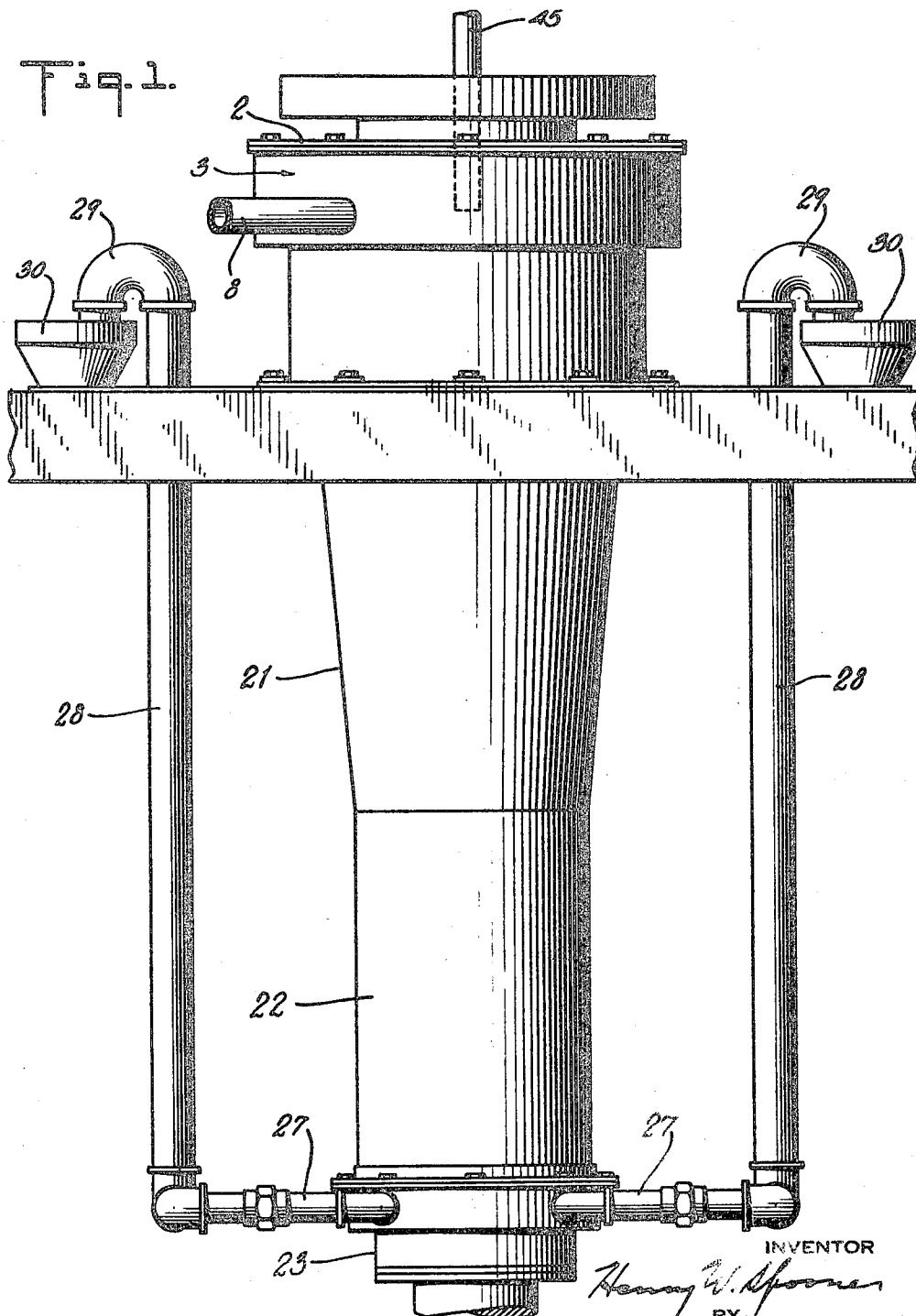
2,424,640

APPARATUS FOR CASTING METALS CONTINUOUSLY

Filed Oct. 21, 1942

3 Sheets-Sheet 1

Fig. 1.



INVENTOR

Henry W. Spooner

BY

Emory Vanney, Whittmore & Doty

ATTORNEYS

July 29, 1947.

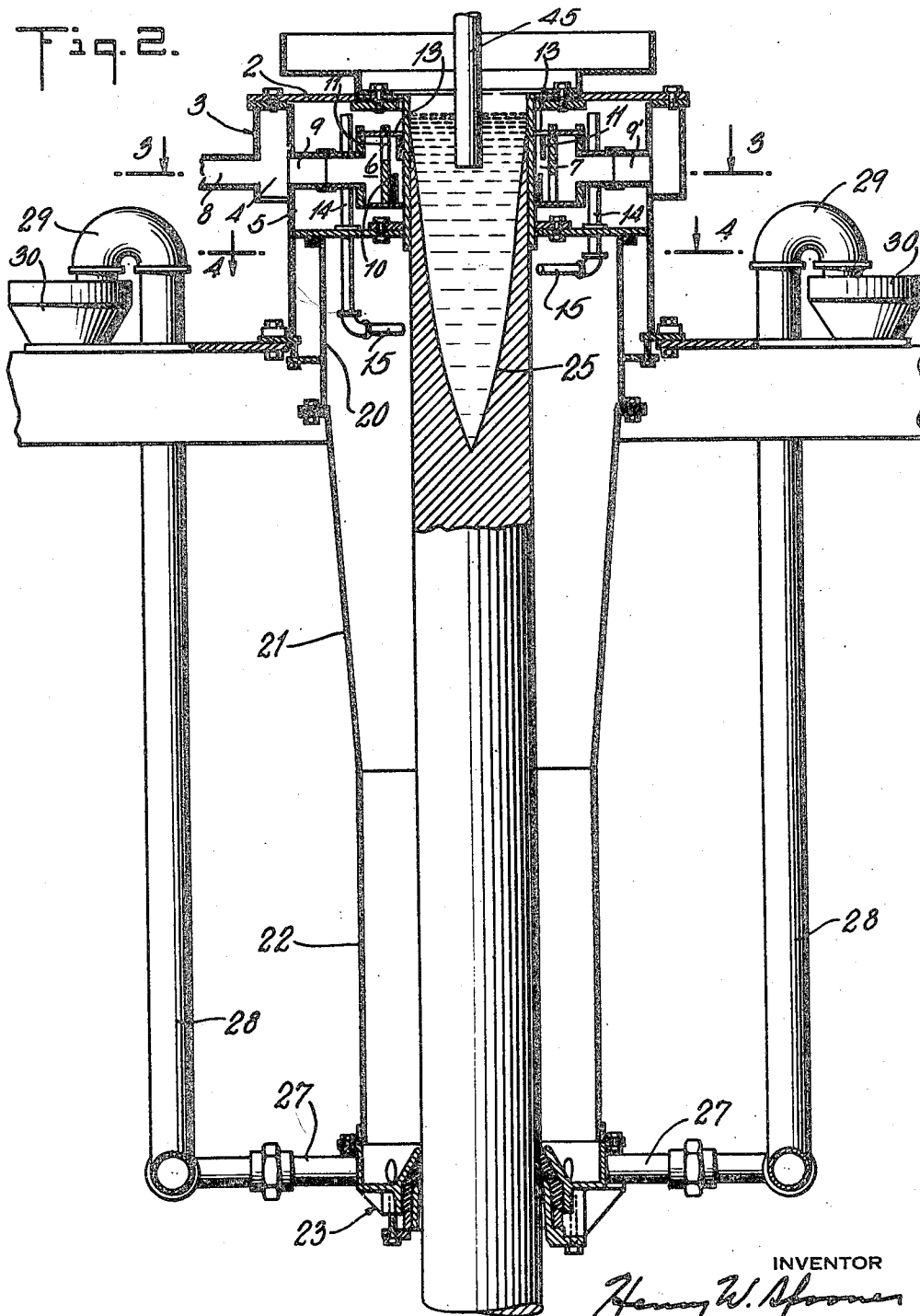
H. W. SPOONER

2,424,640

APPARATUS FOR CASTING METALS CONTINUOUSLY

Filed Oct. 21, 1942

3 Sheets-Sheet 2



INVENTOR

Henry W. Spooner

By Emory Varnay, Whittamore & Dix
ATTORNEYS

July 29, 1947.

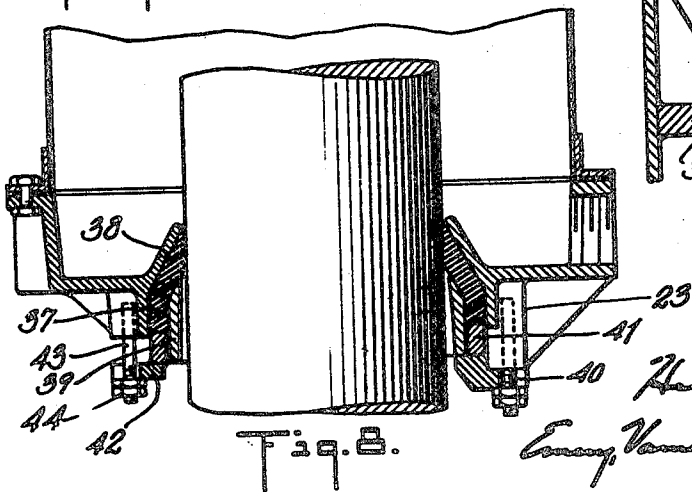
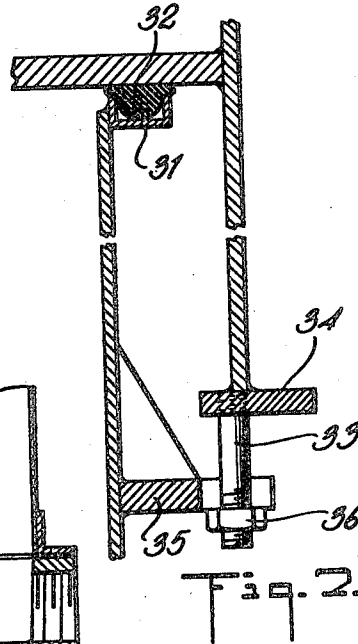
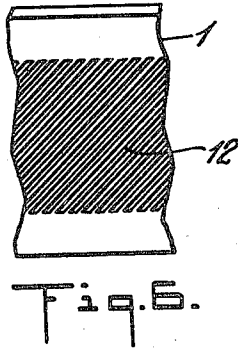
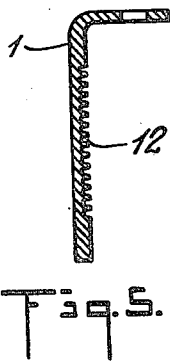
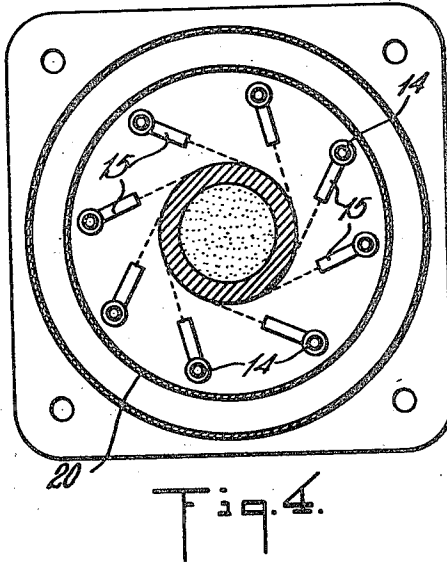
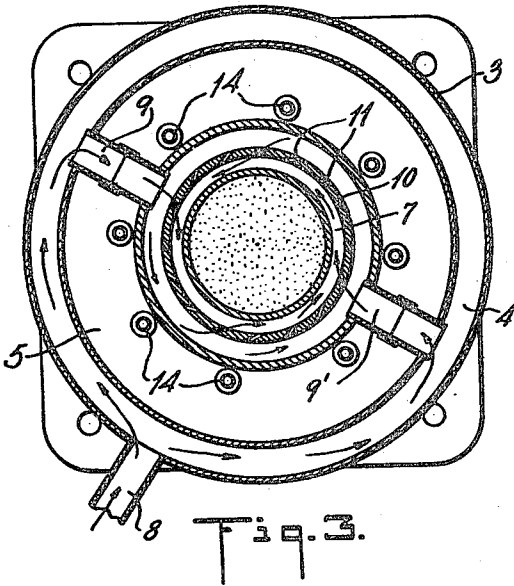
H. W. SPOONER

2,424,640

APPARATUS FOR CASTING METALS CONTINUOUSLY

Filed Oct. 21, 1942

3 Sheets-Sheet 3



INVENTOR
H. W. Spooner
BY
Emory Vance Whittemore, Jr.
ATTORNEYS

UNITED STATES PATENT OFFICE

2,424,640

APPARATUS FOR CASTING METALS
CONTINUOUSLYHenry W. Spooner, Short Hills, N. J., assignor to
Irving Rossi, West Orange, N. J.

Application October 21, 1942, Serial No. 462,791

5 Claims. (Cl. 22—57.2)

1

This invention relates to apparatus for casting metals continuously, that is, apparatus in which molten metal is poured continuously into one end of a mold and solidified ingot is removed continuously from the other end.

It is an object of the invention to provide apparatus having a mold in which improved cooling conditions may be maintained during the casting operation, in order to improve operating conditions and to improve the quality of the solidified ingot.

Other objects and advantages of the invention will appear hereinafter.

A preferred embodiment of the invention selected for purposes of illustration is shown in the accompanying drawings, in which,

Figure 1 is a front elevation of the casting mold.

Figure 2 is a vertical section therethrough.

Figure 3 is a transverse section on the line 3—3 of Figure 2.

Figure 4 is a transverse section on the line 4—4 of Figure 2.

Figure 5 is a vertical section through the mold liner.

Figure 6 is a fragmentary side elevation of the mold liner.

Figure 7 is an enlarged fragmentary section showing the means for securing the lower water jacket.

Figure 8 is an enlarged vertical section showing the lower packing ring.

Referring to the drawings, the apparatus illustrated is particularly designed for use in connection with the practice of the continuous casting process disclosed in Junghans Patents Nos. 2,135,183 and 2,135,184, in which the casting mold is reciprocated longitudinally of the solidified ingot in timed relation therewith in the manner described in said patents, but since the reciprocation of the mold forms no part of the present invention, the means for effecting such reciprocating movement are not shown herein. Furthermore, while the present apparatus is particularly designed for use in connection with the Junghans process, it will be understood that it may also be employed to advantage in other continuous casting processes.

In the commercial operation of the Junghans process, both in Germany and the United States, it has been the practice to use a water cooled mold and to spray additional cooling water directly against the ingot immediately below the bottom of the mold as the ingot emerges therefrom in order to remove heat from the ingot in

2

addition to that removed through the water jacket of the mold itself. This idea was not original with Junghans, for even in the early development of the art it had been proposed to apply cooling fluid directly to the ingot (see Trotz 894,410, Douteur 944,668 and Coats 1,503,479), and this practice has also been adopted by more recent inventors (see Williams 2,079,644).

The practice of spraying the emerging ingot as employed in the commercial operation of the Junghans process has been useful, but I have observed two difficulties, (1) that the quantity of heat which can be removed by spraying is limited and (2) that heat removal by spraying is uneven, frequently resulting in greater cooling on one side of the ingot than on the other, with consequent curvature of the ingot. In cases where it has been attempted to apply water directly to the ingot in a manner similar to that proposed by Coats, 1,503,479, curvature and even cracking of the ingot frequently resulted because of uneven cooling.

I have discovered that the constant maintenance of even cooling conditions is an important prerequisite of successful continuous casting, and that such conditions should be maintained throughout the cooling zone. An object of the present invention is to provide for the maintenance of such conditions.

As shown, the mold liner 1 has a flanged upper end which is bolted to a plate 2 forming a cover for the water jacket 3. The water jacket is divided into several compartments, an outer chamber 4, herein designated as the inlet chamber, a chamber 5, herein designated as the outlet chamber, a chamber 6, herein designated as the distributing chamber, and a chamber 7, herein designated as the cooling chamber. Cooling water enters the inlet chamber 4 through pipe 8 and passes from this chamber to distributing chamber 6 through two oppositely disposed pipes 9, 9'.

A partition wall 10 separates the distributing chamber from the cooling chamber, and this wall is provided with a plurality of vertical slots 11, preferably staggered and alternating from the top and bottom and distributed at intervals around said wall. The slots are preferably narrow so that water flowing through them is discharged in the form of flat jets, and for best results the slots are cut at an angle to radii passing through them such that the jets are discharged more or less tangentially to the wall of the mold liner.

One of the causes of uneven cooling is the presence of steam bubbles on the outside surface of the mold liner. Furthermore, such steam bubbles

3

tend to insulate the mold liner and reduce the rate of heat transfer therethrough. By directing the jets as above described, and by thus creating a rapid circulation of the cooling water around the mold liner, the formation of such steam bubbles is substantially reduced, and such bubbles as tend to form are quickly swept off and condensed.

The mold liner is preferably made of metal of good thermal conductivity, such as copper, and the outside surface of the mold liner is preferably grooved as indicated at 12, to increase the surface for heat transfer. Such grooves are inclined upwardly at an angle of 45°, which, in cooperation with the rotary circulation of the surrounding water tends to throw the hottest water upwardly, thus moving it out of the cooling chamber 6 through the space 13 provided for this purpose.

The water leaving the cooling chamber flows into the outlet chamber 5, and overflows through a plurality of pipes 14 which extend through the bottom of the outlet chamber. The lower ends of the pipes 14 are provided with nozzles 15 for a purpose hereinafter described.

Immediately below the water jacket 3 is a second water jacket in which cooling water is applied directly to the ingot. The said jacket comprises a cylindrical upper section 20, a tapered mid section 21 and a cylindrical lower section 22. Secured to the lower end of the section 22 is a packing ring 23 described in detail hereinafter.

The length of the mold liner and its surrounding water jacket relative to the length of the lower water jacket is subject to adjustment depending on the type of metal being cast and on operating conditions such as the desired rate of withdrawal of the ingot. In the embodiment shown, the mold liner is relatively short, for experience has shown that it is only necessary to extend the liner downwardly a distance sufficient to permit a relatively thin shell of metal to solidify on the outside of the ingot while contained therein. Therefore, since the direct application of cooling water to the ingot results in more efficient heat removal than is possible through the mold liner, it is advisable to make the mold liner as short as possible consistent with the formation of an outer shell of a thickness sufficient to sustain the molten metal in the interior. The interior of the ingot may remain in molten condition for a considerable distance below the mold liner of course, as indicated by the dotted line 25, Figure 2, representing a typical condition in actual operation. In general, it may be observed that the more rapid the rate of withdrawal of the ingot, the deeper the molten metal will extend, it being necessary merely to insure that the ingot is completely solidified on emerging from the lower water jacket.

Cooling water is supplied to the lower water jacket through the pipes 14 and nozzles 15 previously referred to, the nozzles being arranged to direct jets of water substantially tangentially to the ingot as shown in Figure 4. It is also advisable to stagger the nozzles on two or more levels as shown in Figure 2. In this manner a rotary circulatory motion of the cooling water is set up in the lower water jacket which again, as in the upper water jacket, reduces the formation of steam bubbles and sweeps off those which tend to form, thus promoting even and rapid cooling. The rotary circulation induced by the nozzles extends downwardly substantially to the bottom of the water jacket and the tapered form of the mid section 21 increases the velocity of the downwardly flowing water. The heated water is re-

4

moved at the bottom of the jacket through nipples 27 in the packing ring, said nipples being connected to risers 28 terminating in return bends 29 which discharge into funnels 30.

By adjusting the length of the risers 28 the level of the water in the lower water jacket may be adjusted as desired. As shown, the length of the risers is such as to just maintain the jacket full of water, but by increasing the length of the risers somewhat, the cooling water may be forced up into the space between the wall of the ingot and the wall of the mold. By still further increasing the length of the risers, the apparatus may be used for practicing the process described in Junghans application Serial No. 211,651, filed June 3, 1938, in which cooling water is forced upwardly to a point above the surface of the molten metal.

The lower water jacket may be secured to the upper water jacket in any suitable manner, but for convenience in operation and maintenance it is preferably removable. For this purpose a channel 31 is secured to the upper edge of the section 20, and a packing ring 32 is mounted in the channel. Studs 33 are threaded into the supporting flange 34 of the upper jacket and extend through slots in the lugs 35 mounted on the side wall of the section 20. By setting up on the nuts 36 the packing ring is pressed against the bottom plate of the upper jacket to provide a water tight seal.

It is important also to provide a satisfactory packing at the bottom of the lower water jacket to prevent leakage of water around the surface of the ingot. For this purpose I provide a cylindrical rubber packing or gasket 37 which is located between the flange 38 of the ring 23 and an inner ring 39 in such manner that the upper edge of the packing is bent inwardly and held against the surface of the ingot. The ring 39 is held in fixed position by a plurality of bolts 40 threaded into the ring 23 and extending through lugs formed in ring 39. The packing may be adjusted against the ingot by gland ring 41 having lugs 42 at intervals engaged by studs 43. By setting up on nuts 44, the packing may be forced upwardly and inwardly, so that it may be adjusted for wear, and to apply the necessary pressure to prevent leakage.

The apparatus is operated in a manner generally similar to that described in the Junghans patents previously referred to, molten metal preferably being continuously supplied to the open upper end of the mold through a tube 45, the orifice of which is below the surface of the molten metal. At the same time the solidified ingot is withdrawn continuously from the lower end of the mold, the rate of withdrawal being controlled by power driven rollers (not shown) which engage the ingot.

It will be understood that the invention may be variously modified and embodied within the scope of the subjoined claims.

I claim as my invention:

1. A mold for continuous casting machines, comprising, a mold liner and a water jacket surrounding said mold liner, the outside wall of said mold liner having inclined grooves formed therein, said water jacket having a cooling chamber immediately surrounding said mold liner, and a distributing chamber surrounding said cooling chamber, said distributing chamber being separated from said cooling chamber by a partition having slots therein providing communication between said chambers, said slots being formed

5

at an angle such as to discharge jets of cooling water substantially tangentially to said mold liner and in the direction of the upward inclination of said grooves.

2. A mold for continuous casting machines, comprising, a mold liner and a water jacket surrounding said mold liner, a second water jacket below said mold liner, the water in said second water jacket being applied directly to the ingot, and a plurality of pipes through which water may flow from the first water jacket to the second water jacket, said pipes terminating in nozzles directed so as to discharge jets of water substantially tangentially to the wall of said ingot.

3. A mold for continuous casting machines, comprising, a mold liner and a water jacket surrounding said mold liner, a second water jacket below said mold liner, the water in said second water jacket being applied directly to the ingot, a plurality of pipes through which water may flow from the first water jacket to the second water jacket, said pipes terminating in nozzles directed so as to discharge jets of water substantially tangentially to the wall of said ingot, and a riser connected to the bottom of said second water jacket and extending upwardly a distance at least sufficient to maintain a full head of water in said second water jacket, the water in said second water jacket being maintained in rotary circulation by the jets discharged from said nozzles.

4. A mold for continuous casting machines, comprising, a mold liner and a water jacket surrounding said mold liner, a second water jacket below said mold liner, the water in said second water jacket being applied directly to the ingot, and means for inducing a rotary circulating mo-

6

tion of the cooling water in said second water jacket around the ingot, and simultaneously inducing motion of such water lengthwise of the ingot, said second water jacket having a portion thereof tapered downwardly and inwardly and serving to progressively increase the velocity of the cooling water moving therethrough.

5. A mold for continuous casting machines, comprising, a mold liner and a water jacket surrounding said mold liner, a second water jacket below said mold liner, the water in said second water jacket being applied directly to the ingot, a plurality of nozzles in said second water jacket directed to discharge jets of water substantially tangentially to the wall of said ingot at a point near the upper end of said jacket, and an outlet opening near the bottom of said jacket, said second water jacket having a portion thereof tapered downwardly and inwardly and serving to progressively increase the velocity of the cooling water moving therethrough.

HENRY W. SPOONER.

REFERENCES CITED

25 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
30 1,503,479	Coats	Aug. 5, 1924
2,304,258	Junghans	Dec. 8, 1942
1,573,089	Rice	Feb. 16, 1926
643,278	Sponsel	Feb. 13, 1900

FOREIGN PATENTS

Number	Country	Date
35 504,521	Great Britain	Apr. 26, 1939