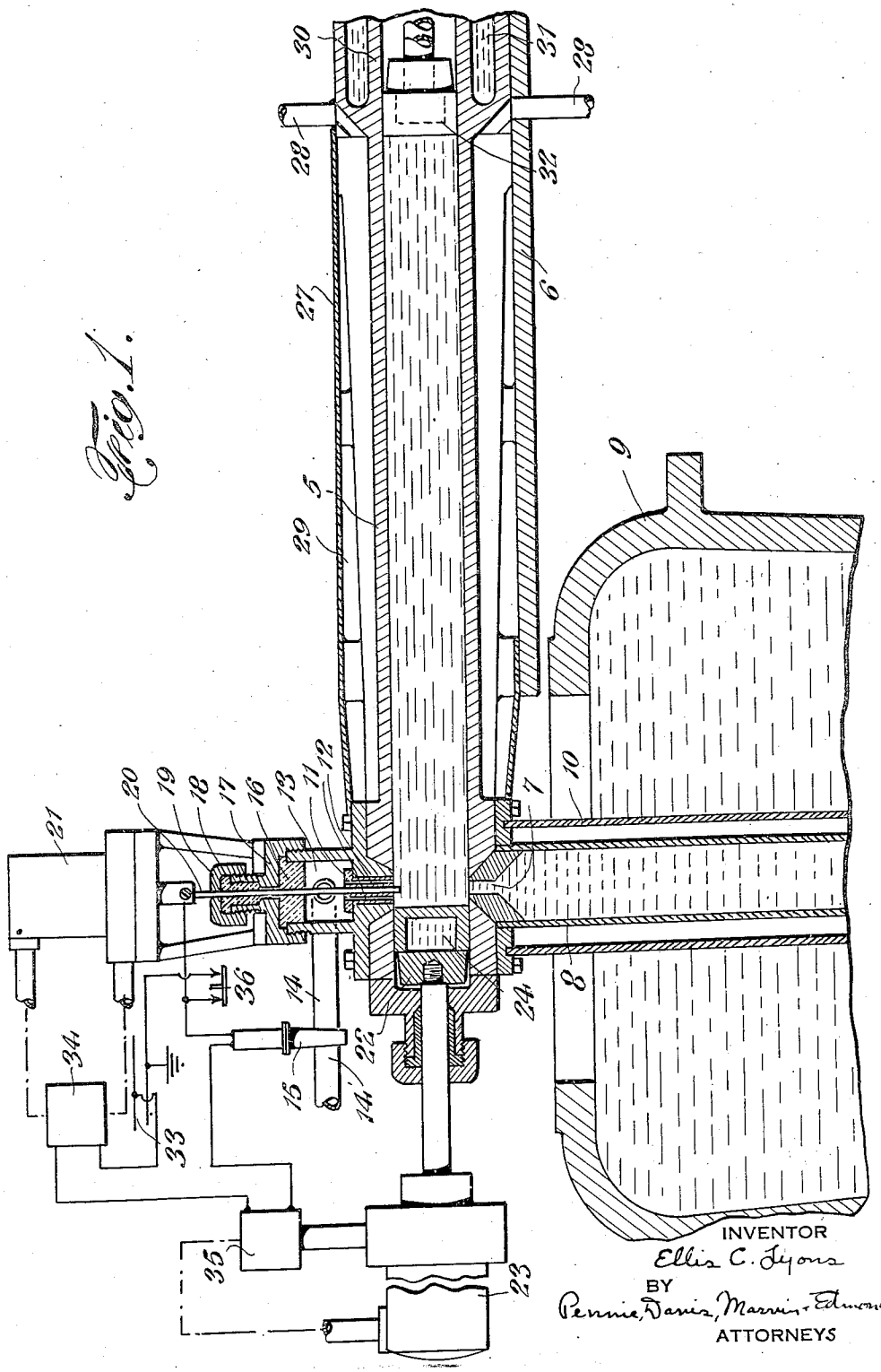
June 4, 1946. E. C. LYONS 2,401,491

CASTING MOLTEN METAL

Filed Jan. 5, 1945 2 Sheets-Sheet 1

Fig. 1.



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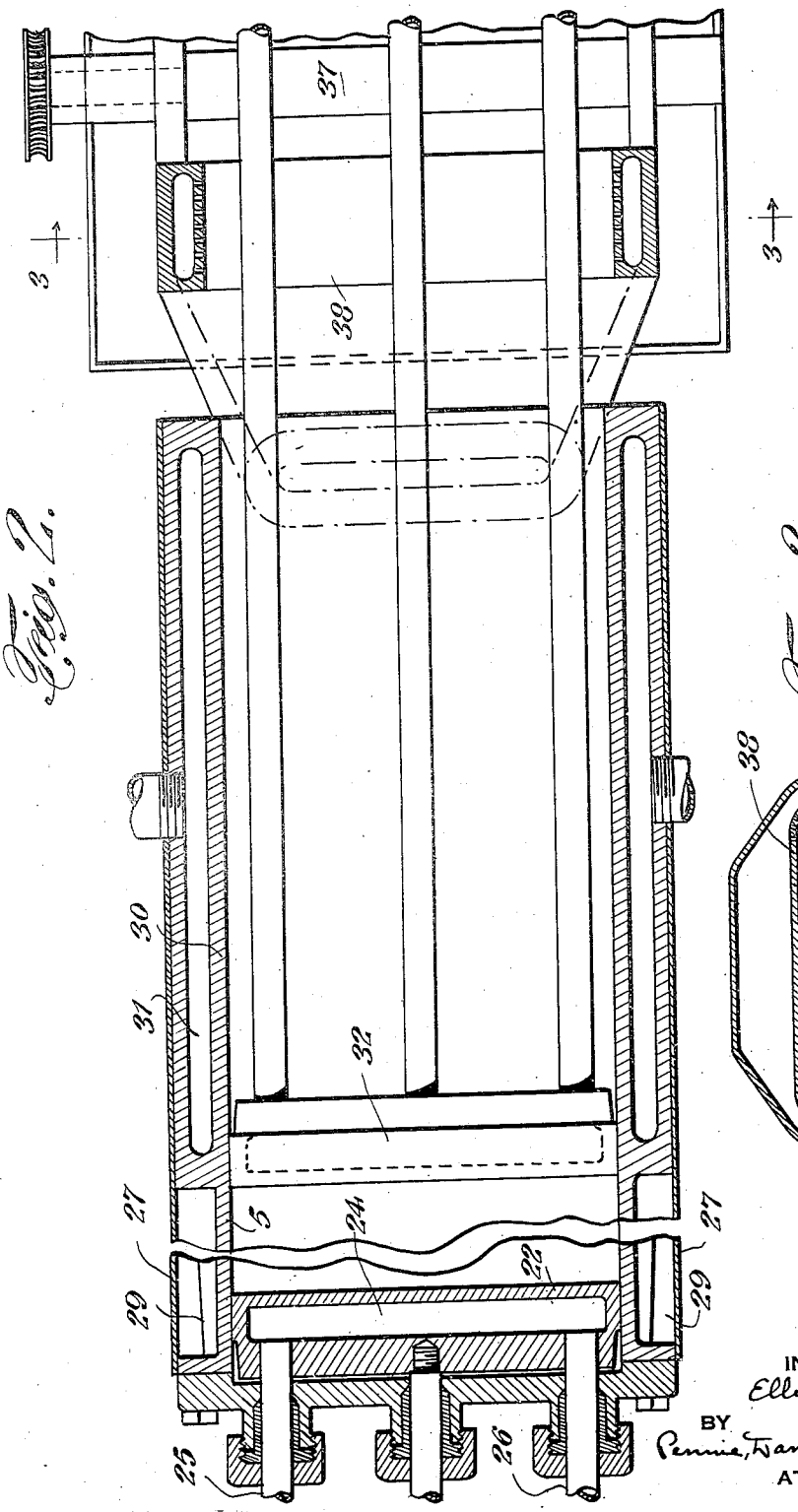


Fig. 2.

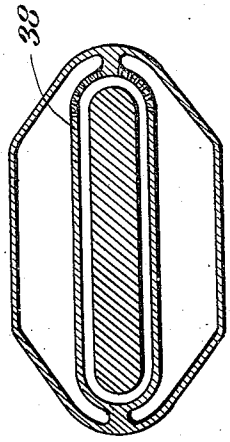


Fig. 3.

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CASTING MOLTEN METAL

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Application January 5, 1945, Serial No. 571,502

7 Claims. (Cl. 22—73)

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This invention relates to the casting of easily oxidizable metals such as magnesium base metals or alloys, and has for its object the provision of an improved apparatus therefor.

Magnesium base metals or alloys, and other easily oxidized metals, are customarily cast under a protective cover, such, for example, as an inert gaseous atmosphere, frequently produced by burning sulfur. Considerable skill and experience is required for the production of satisfactory castings, and even with due regard for the protection of the molten metal from oxidizing influences such as air, the amount of scrap produced is apt to be excessive. The present invention aims to provide an improved apparatus for casting such metals, and particularly for casting slabs and ingots for rolling or equivalent mechanical working, in which cleaned and purified molten metal is cast, with a maximum of oxidizing influence, with the production of castings of highly satisfactory and uniform quality and with a minimum of scrap.

The apparatus of the invention comprises a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber. The casting chamber is adapted to be evacuated, and when evacuated molten metal is drawn into the casting chamber through an intake duct communicating therewith and depending into the body of clean and purified molten metal to be cast. When the casting chamber has been filled to the desired extent with molten metal, means are provided for terminating the evacuation of the chamber and for pushing the suitably solidified casting from the casting chamber into the cooling chamber. In the preferred form of the apparatus, a reciprocable plunger forms one end wall of the casting chamber, and means are provided for reciprocating this plunger throughout the length of the casting chamber. The contemplated synchronous operation of the apparatus is advantageously attained by an electrode adapted to extend into the casting chamber. When the electrode is grounded by molten metal in the casting chamber, suitably provided means operate (1) to retract the electrode from the casting chamber, (2) to terminate the evacuation of the casting chamber, and (3) to actuate the plunger reciprocating means to cause the plunger to push the suitably solidified casting from the casting chamber into the cooling chamber. A second reciprocable plunger forms the other end wall of the casting chamber for the first casting, and is then withdrawn through the cooling chamber,

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and thereafter the end of the casting then in the cooling chamber forms the corresponding end wall of the casting chamber during the next casting operation. In the complete and preferred form of the apparatus, the casting in the cooling chamber is pushed by the immediately succeeding casting in the casting chamber, when the latter is itself pushed into the cooling chamber, on to supporting rollers or the like where the casting is sprayed with water for a complete chill. The walls of the casting chamber and of the cooling chamber, and also the reciprocable plungers, are artificially cooled in any appropriate manner.

The foregoing and other novel features of the invention which I believe to be patentably characteristic thereof are set forth in the appended claims. The principles of the invention will be best understood from the following description taken in conjunction with the accompanying drawings, in which,

Fig. 1 is a side elevation, partly in section and somewhat diagrammatic, of the casting end of an apparatus embodying the invention,

Fig. 2 is a top plan, partly in section, of the apparatus, and

Fig. 3 is an end section taken on the section line 3—3 of Fig. 2.

The apparatus illustrated in the accompanying drawings comprises a slab casting chamber or mold 5 appropriately supported on a circular base 6. Molten metal is delivered to the casting chamber through a nozzle or port 7 secured in the upper end of an intake duct 8. The intake duct is open at its lower end and depends into the molten metal in a pot 9, and is preferably enclosed by a concentrically spaced outer pipe 10.

The port 7 extends through the bottom of the casting chamber approximate one end thereof. Above the port 7 an electric insulator 11 extends through the top of the casting chamber. The insulator 11 has two or more longitudinal openings or ports 12 providing communication between the casting chamber and an air compartment 13 above and surrounding the insulator. The compartment 13 is in communication with a vacuum pipe 14 connected to a suitable source of vacuum or reduced pressure 14' and having a solenoid controlled valve 15. The compartment 13 is hermetically closed at the top by a primary insulator 16 and cooperating gland nut 17 and a secondary insulator 18 and cooperating gland nut 19. An electric conductor or electrode 20 extends through the insulators 11, 16 and 18 and is adapted to be vertically reciprocated by the piston of a hydraulic cylinder 21.

A reciprocable plunger 22 fits snugly in the casting chamber 5 and is adapted to be moved to and fro throughout the length of the chamber by the piston of a hydraulic cylinder 23. The plunger 22 forms one end of the casting chamber, and is provided with an interior compartment 24 for a circulating cooling medium, such as water. Cooling medium is delivered to the compartment by an inlet pipe 25 and withdrawn through an outlet pipe 26.

The exterior of the casting chamber is air-cooled. To this end the casting chamber is surrounded by a metal shield 27, appropriately spaced therefrom, and cooling air is delivered to the space between the casting chamber and the shield by air ducts 28. The space between the casting chamber and the metal shield may advantageously be provided with metal cooling fins 29.

A cooling chamber 30 directly adjoins the casting chamber 5 and is in effect a continuation thereof. The walls of the cooling chamber 30 have compartments 31 for the circulation therethrough of a liquid coolant. A starting plug or plunger 32 is reciprocably mounted in the cooling chamber 30, and is generally similar to the plunger 22, being interiorly water-cooled and operatively connected to a hydraulic cylinder, or the like, positioned beyond the casting discharge end of the apparatus.

When the apparatus is to be operated, the pot 9 is filled with clean and purified molten metal. The surface of the molten metal is preferably protected against oxidation by a suitable cover of flux or inert gas. Additional clean and purified molten metal is siphoned into the pot 9, from time to time, so that casting may be continued indefinitely. The intake duct 8 depends into the body of molten metal to within a short distance from the bottom of the pot. For the first or initial casting, the plunger 32 is moved through the cooling chamber into position to form one end of the casting chamber. The plunger 22 forms the other end of the casting chamber. The electrode 20 extends a short distance into the casting chamber, and the valve 15 is open permitting evacuation of the chamber. Evacuation of the casting chamber draws molten metal through the intake duct 8 until the molten metal contacts the electrode 20. The electrode 20 may be adjusted to vary the length thereof that extends into the casting chamber, so that when the electrode is contacted by the molten metal, the desired and predetermined amount of molten metal fills the casting chamber.

The electrode 20 is grounded by the contacting molten metal and the solenoid of the valve 15 is thereby energized from a source of electric energy 33 and the valve is closed, thus terminating evacuation of the casting chamber. Simultaneously, the electromotive control means 34 for the hydraulic cylinder 21 is energized and the piston thereof elevates the electrode 20 and retracts it from the casting chamber. At the same time, the electromotive control means 35 of the hydraulic cylinder 23 is energized and the plunger 22 is advanced to put sufficient pressure on the still molten or plastic metal in the casting chamber to completely fill the chamber. The artificial cooling of the walls of the casting chamber, including the plungers 22 and 32, promptly solidifies the metal in the chamber to a sufficient extent to permit the plunger 22 to push the casting from the casting chamber into the cooling chamber. As the first casting is pushed into the cooling chamber, the plunger 32 is withdrawn through the cooling chamber to an inoperative and out-of-the-way position, and thereafter the casting then in the cooling chamber forms the other end of the casting chamber.

The electromotive control means 35 may advantageously be designed to effect, upon each energization, one complete cycle of movement (i. e. forward and back) of the plunger 22, whereupon the plunger is returned to its initial position, forming one wall of the casting chamber. The electrical circuits and operating means are simply and diagrammatically illustrated in Fig. 1 for explanatory purposes, and it is to be understood that various agencies and instrumentalities may be provided for effecting the contemplated sequence of operations characteristic of the invention. When the plunger 22 has returned to its initial position, a push button or similar type of electric switch 36, manipulated by the operation, (1) energizes the electromotive means 34 to cause the hydraulic cylinder 21 to lower the electrode 20 to its casting position extending a predetermined distance into the casting chamber, (2) energizes the solenoid of the vacuum valve 15 to initiate evacuation of the casting chamber, and (if necessary) (3) sets the electromotive means 35 to effect (upon the next contact of molten metal with the electrode 20) the next cycle of movement of the plunger 22. Thereupon the cycle of casting operations is repeated.

As the plunger 22 starts its forward movement, it momentarily closes the port 7 of the intake duct 8 and the vacuum ports 12. The vacuum valve 15 may advantageously be designed to permit the establishment of atmospheric pressure in the casting chamber behind the plunger 22, so that molten metal is not drawn into the chamber during the cycle of movement of the plunger. The return movement of the plunger expels the air thus admitted to the casting chamber and at the same time establishes a reduced pressure in the chamber on the other side of the plunger. To maintain the advantage of the reduced pressure thus established in the casting chamber, during the return movement of the plunger 22, the switch 36 should be manipulated as the plunger moves past the ports 7 and 12, whereupon as the plunger clears and opens these ports the casting chamber is in communication with the source of vacuum 14' and molten metal is drawn through the port 7 into the casting chamber.

When the second casting has suitably set or solidified in the casting chamber, the plunger 22 pushes this casting into the cooling chamber and the casting then in the cooling chamber is pushed out of the cooling chamber onto rollers 37 or other suitable supports, where it is completely chilled by a water spray from the perforated water pipe system 38.

The operation of the apparatus is automatic and is entirely controlled by the grounding of the electrode 20 first by the molten metal in the casting chamber and then by the manually operated switch 36. Various control agencies, other than those more or less diagrammatically indicated in Fig. 1, may be used for effecting the contemplated synchronous and automatic operation of the various parts of the apparatus as hereinbefore described. The single electrode 20 may of course be replaced by a pair of electrodes adapted to be bridged by the molten metal in the casting chamber, as described in my copending application Ser. No. 571,501, filed January 5, 1945, thus avoiding the necessity of a grounded source of

electric energy. Multiple inlet ducts may be used in place of the single inlet duct 8 shown. The purified and clean molten metal is withdrawn from the pot 9 with a minimum contact with any oxidizing influence, and little or no oxidation takes place in casting. The apparatus is particularly adapted for casting ingots, billets, slabs and the like, but may be constructed for the casting of any desired forms or shapes. While particularly adopted for the casting of magnesium base alloys, the invention may be applied with advantage to the casting of any easily oxidized metal.

I claim:

1. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, means for evacuating the casting chamber, means operative when a predetermined amount of molten metal has been drawn into the casting chamber for terminating the evacuation thereof, and means operative when said predetermined amount of molten metal has been drawn into the casting chamber for pushing the suitably solidified casting from the casting chamber into the cooling chamber.

2. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, an electrode adapted to extend into the casting chamber, means for retracting said electrode from the casting chamber when the electrode is contacted by molten metal in the casting chamber, means for terminating the evacuation of the casting chamber when the electrode is contacted as aforesaid, and means operative when said electrode is contacted for pushing the suitably solidified casting from the casting chamber into the cooling chamber.

3. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, means for evacuating the casting chamber, an electrode adapted to extend into the casting chamber, and means operative when the electrode is contacted by molten metal in the casting chamber for (1) retracting the electrode from the casting chamber, (2) terminating the evacuation of the casting chamber and (3) pushing the suitably solidified casting from the casting chamber into the cooling chamber.

4. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, a reciprocable plunger forming one end wall of the casting chamber, a second reciprocable plunger adapted to form the other end wall of the casting chamber, means for evacuating the casting chamber, means operative when a predetermined amount of molten metal has been drawn into the casting chamber for terminating the evacuation thereof, means operative when said

predetermined amount of molten metal has been drawn into the casting chamber for actuating said first-mentioned reciprocable plunger to push the suitably solidified casting from the casting chamber into the cooling chamber, and means for withdrawing said second reciprocable plunger through the cooling chamber whereby the end of the solidified casting in the cooling chamber forms one end wall of the casting chamber during the next casting operation.

5. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, means for evacuating the casting chamber, a reciprocable plunger forming one end wall of the casting chamber, and means operative when a predetermined amount of molten metal has been drawn into the casting chamber for (1) terminating the evacuation of the casting chamber and (2) actuating said reciprocable plunger to push the suitably solidified casting from the casting chamber into the cooling chamber.

6. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, means for evacuating the casting chamber, a reciprocable plunger forming one end wall of the casting chamber, means for reciprocating said plunger throughout the length of the casting chamber, an electrode adapted to extend into the casting chamber, and means operative when the electrode is contacted by molten metal in the casting chamber for (1) retracting the electrode from the casting chamber, (2) terminating the evacuation of the casting chamber and (3) actuating said plunger reciprocating means to cause the plunger to push the suitably solidified casting from the casting chamber into the cooling chamber.

7. In an apparatus for casting molten metal, a casting machine having a casting chamber and a juxtaposed cooling chamber directly communicating with the casting chamber, an intake duct communicating with the casting chamber and adapted to depend into a body of molten metal, a reciprocable plunger forming one end wall of the casting chamber, a second reciprocable plunger adapted to form the other end wall of the casting chamber, means for evacuating the casting chamber, an electrode adapted to extend into the casting chamber, means operative when the electrode is contacted by molten metal in the casting chamber for (1) terminating the evacuation of the casting chamber and (2) actuating said first-mentioned reciprocable plunger to push the suitably solidified casting from the casting chamber into the cooling chamber, means for withdrawing said second reciprocable plunger through the cooling chamber whereby the end of the solidified casting in the cooling chamber forms one end wall of the casting chamber during the next casting operation, and means for spraying a cooled casting with water when it is pushed from the cooling chamber by said first-mentioned reciprocable plunger and the two immediately succeeding solidified castings.

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