

3,088,181

Filed July 30, 1959



INVENTORS

— GEOFFREY LITTLEWOOD
JAMES STORRS MORTON

ATTORNEY

1

3,088,181

CONTINUOUS CASTING OF METALS

Geoffrey Littlewood, Sheffield, and James S. Morton, Ockham, near Ripley, England, assignors to The British Iron and Steel Research Association, London, England
Filed July 30, 1959, Ser. No. 830,557

Claims priority, application Great Britain July 31, 1958
3 Claims. (Cl. 22—57.3)

This invention relates to improvements in the continuous casting of metals and in particular to apparatus for reciprocating continuous casting molds.

In carrying out the process of continuous casting, it has in some instances been found advantageous to move the mold for a short distance at the same speed and in the same direction as the casting is withdrawn, as described in U.S. Patent 2,135,183 or at a slightly higher speed as described in U.S. Patent 2,815,551. In both examples, the mold is returned to its original position at a higher speed than that at which the casting is withdrawn. These oscillating movements of the mold are maintained throughout the casting operation. Hitherto it has been suggested to produce this mold movement by means of a cam driven by the withdrawal rolls or by the motor drive to these rolls, with an arm operated by the cam causing the mold to move in a manner depending on the shape of the cam. There are certain well known difficulties in the operation of the mechanical reciprocating mechanism which also tends to be somewhat cumbersome.

According to the present invention, the continuous casting apparatus comprises an open ended mold which is arranged for movement parallel to the direction of ingot withdrawal and hydraulic means are provided for repeatedly causing reciprocations of the mold at predetermined speed, i.e. at a selected amplitude and frequency.

In a preferred form of the invention, apparatus for the continuous casting of metals comprises a continuous casting mold, a piston slidably located within a cylinder, or vice versa, a connection between the mold and a movable piston or cylinder, and means for supplying liquid to the cylinder on the two sides of the piston alternatively to cause the mold to be reciprocated parallel to the direction of ingot withdrawal.

The invention will be more readily understood by way of example from the following description, reference being made to the accompanying drawings in which:

FIGURE 1 is a diagrammatic side sectional view of one form of apparatus for reciprocating the mold; and

FIGURE 2 is a diagrammatic side sectional view of a part of a second form of apparatus for reciprocating the mold.

With reference to FIGURE 1, a cylinder 12 is rigidly secured to an open ended continuous casting mold 13 by rods 14, 15. The mold 13 is of well known construction having an inner liner 11 surrounded by a water jacket 10 which is provided with water inlet and outlet connections 8 and 9. The mold center line 7 is shown, with only one half of the mold 13 illustrated in FIGURE 1. The cylinder 12 is mounted about a piston 16 and extending from each end of the piston 16 are two members 17, 18 secured to fixed mountings 19, 22 respectively. The members 17, 18 are of width or diameter D and d, respectively, and protrude through apertures in the cylinder 12 suitably sealed to prevent leakage.

Two pipes 23, 24 extend to fluid chambers 25, 26 formed in cylinder 12 above and below piston 16 respectively and to pipe 23 is connected an inlet tube and an outlet tube as is similarly connected to pipe 24. Fluid is pumped via the respective inlet tubes to pipes 23, 24 alternately and an exhaust system is arranged to allow fluid to flow from the chambers 25, 26 alternately. For

2

example, when fluid is pumped into chamber 25 via its inlet tube 23, fluid is discharged from chamber 26 through tube 24. The exhaust system is so arranged (see FIG. 2) that no fluid will be lost from the system through an open outlet tube when pumping into a chamber is in process. The exhaust system might comprise a two way valve which permits discharge of fluid through an outlet connected to a chamber into which fluid is not being pumped. For example, fluid may be discharged through the two way valve 27 in the outlet pipe connected to chamber 26 when fluid is being pumped into chamber 25 through two way valve 28 and vice versa. The inlet tube 29 is connected to both of the valves 27 and 28, as is also the outlet tube 30. The valves may be gang operated, or individually positioned, and may be manipulated by hand or by means of automatic instrumentalities. The fluid may be discharged to a supply tank, from which the fluid is pumped into the chambers 25, 26 alternately.

The cylinder 12 is forced downwards, carrying with it the mold 13, when the fluid is pumped into the chamber 26 from the pipe 24; fluid in chamber 25 from the previous cycle is simultaneously discharged through the pipe 23. Conversely, the cylinder 12 is moved upwards when fluid is pumped into chamber 25 and allowed to discharge from chamber 26.

The dimensions D, X and d shown in FIGURE 1 are selected to conform with the relation

$$\frac{v_1}{v_2} = \frac{X^2 - D^2}{X^2 - d^2}$$

where v_1 is the velocity of movement required on the downward stroke of the cylinder, and v_2 is the desired velocity of the upward stroke of the cylinder as shown in FIGURE 1. By way of example, if it is required that $v_2 = v_1$ then from the above relation, $d = D$. Alternatively, if it is required that $v_2 = 4v_1$ then

$$d^2 = 4D^2 - 3X^2.$$

The speed of the mold on the downward stroke of the cylinder 13 may be preferably equal to or greater than the ingot withdrawal speed. Similarly the speed of the mold on the upward stroke of the cylinder 13 may be preferably greater than the ingot withdrawal speed. In the system disclosed, the amplitude and frequency of the mold reciprocation may be adjusted by regulation of the motion of the valves, and/or by changing the rate of flow of fluid to the cylinder 12.

An alternative method which dispenses with the need for a differential piston is shown in FIG. 2 wherein molten metal is delivered, as indicated at 40, to the upper end of, and an ingot 34 which is formed in and continually withdrawn from, a water cooled mold 33 by withdrawal rolls 31. A platform 32 is attached to the mold 33 and is connected at each end to a hydraulic means for lowering and raising the platform 32 and the mold 33. Only one such means is shown in FIGURE 2 of the drawing and as there illustrated comprises a piston 35 located in a cylinder 36, the piston rod 37 of the piston 35 protruding through an aperture in the cylinder 36 and the piston rod 37 being connected to the platform 32. Spring 38 is located between the piston 35 and the bottom of the cylinder 36 so as to counterbalance the dead weight of the mold 33 and the platform 32.

Fluid is constantly pumped into the fluid chambers 39, 42 of the cylinder 36 from a pump 41 via inlet tubes 43, 44 respectively. In the inlet tubes 43, 44 are two metering valves 45, 46 respectively. Leading from the chambers 39, 42 are two pipes 47, 48 connected to a storage tank 49, tank 49 supplying the pump 41 with fluid. The exhaust pipes 47, 48 contain valves 52, 53 respectively. Valves 52, 53 are alternately closed by any known means.

The metering valves 45, 46 are required to be set in

such manner that the rate of flow into the respective chamber will produce the required movement when a valve 52 or 53 is closed. The rate of flow may be altered during operation of the device either manually or by linking the valve controls to the ingot withdrawal device by well known electrical or mechanical means.

Movement of the piston 35 does not take place until one or other of the valves 52, 53 is closed at appropriate points on the cycle. The bore of the exhaust pipes 47, 48 are sufficiently larger than that of the inlet tubes 43, 44 to accommodate the constantly flowing fluid and the displaced fluid.

The apparatus may also be applied by connecting one end of a lever to the connecting piston rod 37 and attaching the other end of the lever to the mold 33, in which case only one cylinder is necessary.

While in accordance with the provisions of the statutes we have illustrated and described herein the best form and mode of operation of the invention now known to us, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by our claims, and that certain features of our invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. In continuous casting apparatus wherein molten metal is delivered to one end of a continuous casting mold and an embryo ingot is withdrawn from the opposite end of said mold, the combination comprising hydraulic means supporting said mold for positive reciprocation at selected rate in a direction parallel to the longitudinal axis of said mold, said hydraulic means including a cylinder and a piston therein, a reservoir for hydraulic fluid, a pump, tube means connecting said reservoir and pump with opposite end portions of said cylinder including a first tube connected with one end portion of said cylinder and on one side of said piston, a second tube connected with the end portion opposite from said one end portion and on the side of said piston opposite said one side of said piston for flow of fluid to said opposite end portions and connecting the opposite end portions of said cylinder with said reservoir for discharge of fluid from the opposite end portions of said cylinder, and adjustable valve means in said tube means operable independent of said ingot withdrawal for directing flow of fluid at a selected rate to one end portion of said cylinder and the flow of fluid from the opposite end of said cylinder for movement of said hydraulic mold support means in one direction, reversing said valve means being operable to reverse the direction of movement of said hydraulic mold support means.

2. In continuous casting apparatus wherein molten metal is delivered to one end of a continuous casting mold and an embryo ingot is withdrawn from the opposite end of said mold, the combination comprising hydraulic means supporting said mold for positive reciprocation in a direction parallel to the longitudinal axis of said mold, said hydraulic means including a movable cylinder with a piston therein, piston rods extending from opposite faces of said piston and through the ends of said cylinder to fixed external locations, said piston rods being of different diameters, a reservoir for hydraulic fluid, a pump, first tubular means connecting said reservoir and pump with opposite end portions of said cylinder and opposite sides

of said piston for a substantially uniform rate of introduction of fluid to said cylinder, second tubular means connecting the opposite end portions of said cylinder and opposite sides of said piston with said reservoir for discharge of fluid from said cylinder, and valve means in said first and second tubular means for directing flow of fluid to one end portion of said cylinder and one side of said piston and from the opposite end portion of said cylinder and the opposite side of said piston for movement of said cylinder in one direction, and on reversal of said valve means to cause movement of said cylinder in the opposite direction.

3. In continuous casting apparatus wherein molten metal is delivered to one end of a continuous casting mold and an embryo ingot is withdrawn from the opposite end of said mold, the combination comprising hydraulic means supporting said mold for positive reciprocation in a direction parallel to the longitudinal axis of said mold, said hydraulic means including a cylinder and a piston therein, a spring within the lower portion of said cylinder and bearing on said piston forming a counterweight for said mold, a reservoir for hydraulic fluid, a pump, a pipe connecting said reservoir and pump, inlet tubular means connecting said pump with opposite end portions of said cylinder including a first tube connected with one end portion of said cylinder and on one side of said piston, a second tube connected with the end portion opposite from said one end portion and on the side of said piston opposite said one side of said piston for flow of fluid to said opposite end portions, restrictor means in said inlet tubular means for regulating the rate of hydraulic fluid flow through each of said tubular means, outlet tubular means connecting the opposite end portions of said cylinder with said reservoir for discharge of fluid from the opposite end portions of said cylinder including a third tube connected with one end portion of said cylinder and on one side of said piston, a fourth tube connected with the end portion opposite from said one end portion and on the side of said piston opposite said one side of said piston, and adjustable valve means in each of said outlet tubular means for controlling the rate of discharge of fluid from said cylinder, the discharge of fluid from one end portion of said cylinder being determinative of the direction of movement of said hydraulic mold support means, and the rate of flow to the one end of said cylinder as regulated by said restrictor means and in cooperation with the rate of fluid flow from the opposite end of said cylinder being determinative of the rate of movement of said hydraulic means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,743,367	Maybach	Jan. 14, 1930
2,482,342	Hubbert et al.	Sept. 20, 1949
2,556,795	Cannon	June 12, 1951
2,582,029	Halward	Jan. 8, 1952
2,815,551	Hessenberg et al.	Dec. 10, 1957
2,818,616	Rossi	Jan. 7, 1958

FOREIGN PATENTS

776,285	Great Britain	June 5, 1957
567,524	Belgium	May 31, 1958
839,276	Great Britain	June 29, 1960