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281, 82, 66, 259; 222/193

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[54] **CONTINUOUS CASTING APPARATUS WITH
CONTROLLED OVERFLOW CASTING TUBE IN
TUNDISH**
8 Claims, 5 Drawing Figs.

[52] U.S. Cl..... 164/281,
164/337, 222/193
[51] Int. Cl..... B22d 11/10

ABSTRACT: In a method and apparatus for controlling the flow of molten metal from a tundish into a continuous casting mold a casting tube is provided in the tundish opening through the bottom thereof with a rising tube around the casting tube extending above the upper end of the casting tube and above the level of molten metal in the mold. Openings in the walls of the rising tube let metal into it from the tundish. A gas, preferably inert, is fed into the rising tube to mix metal to rise up and overflow into the casting tube and down into the mold.

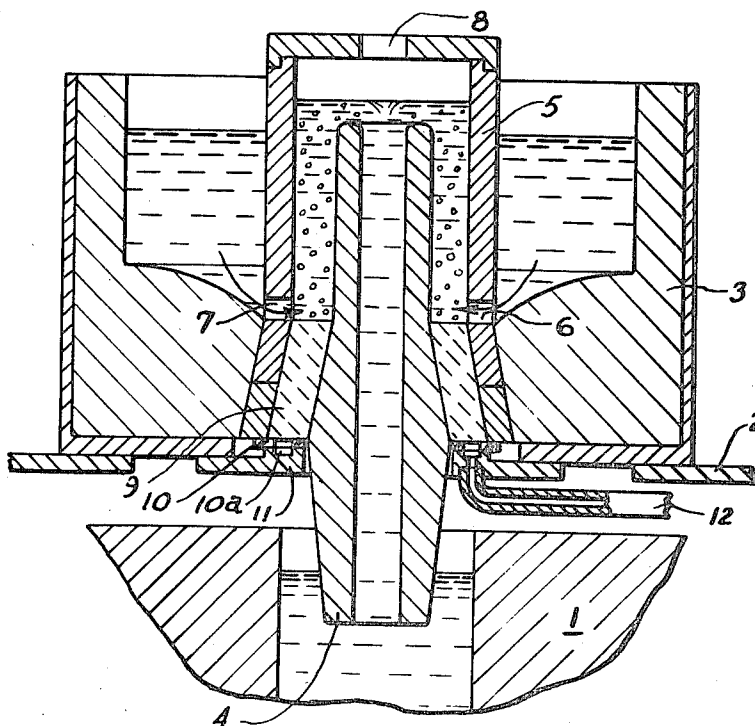


FIG. 1

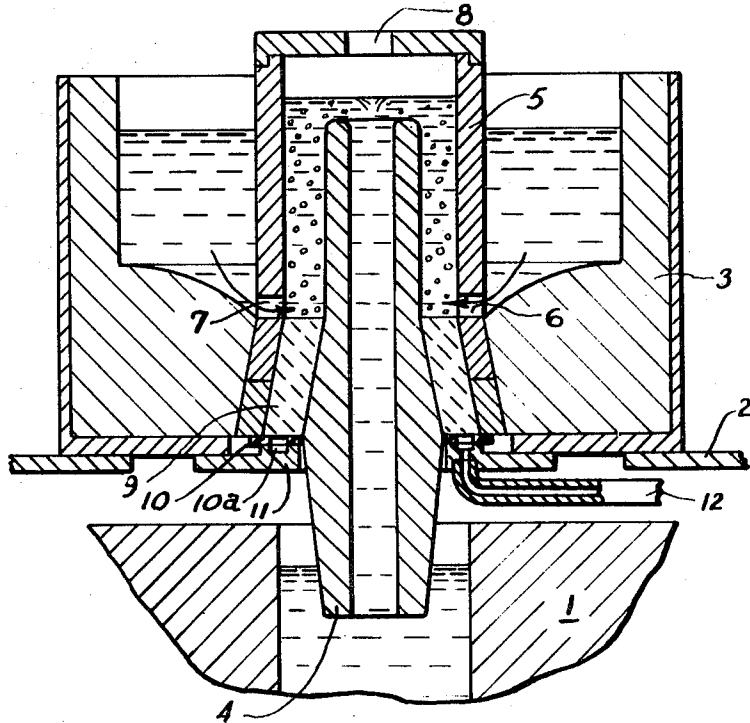
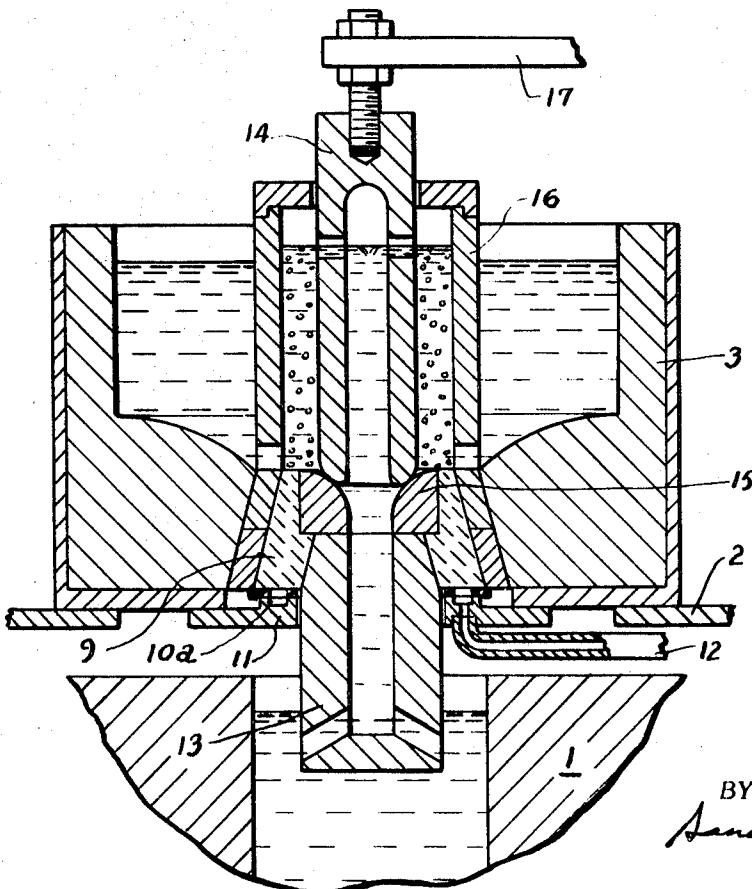


FIG. 2



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FIG. 3

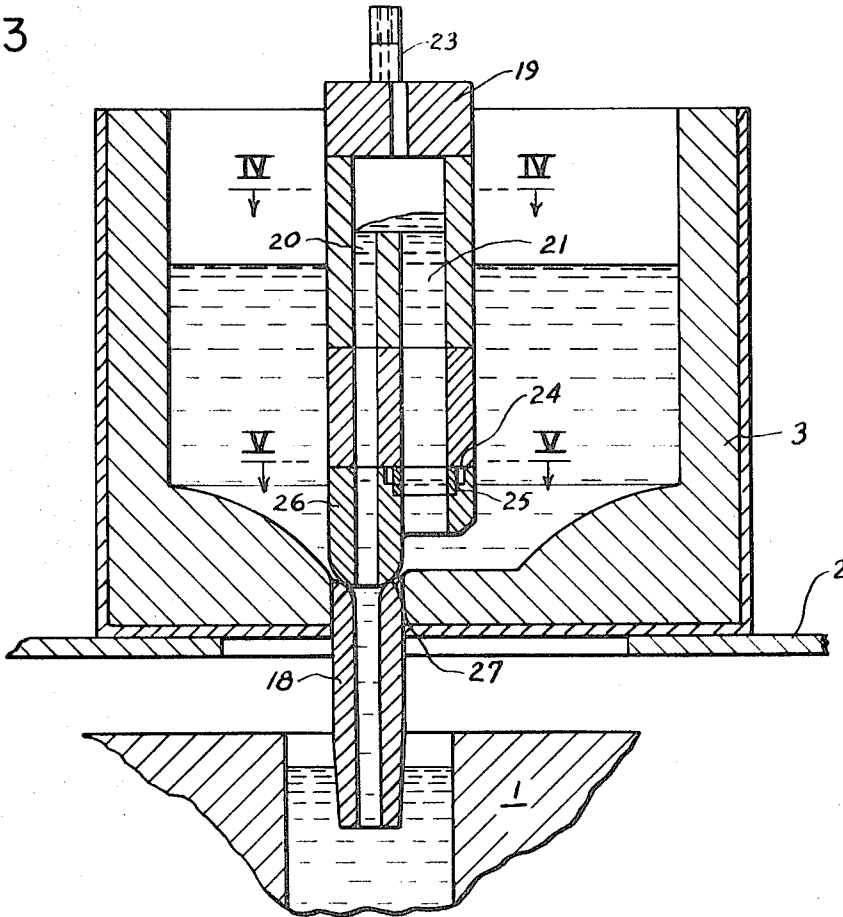


FIG. 4

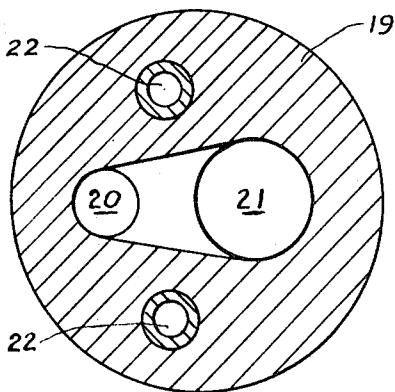
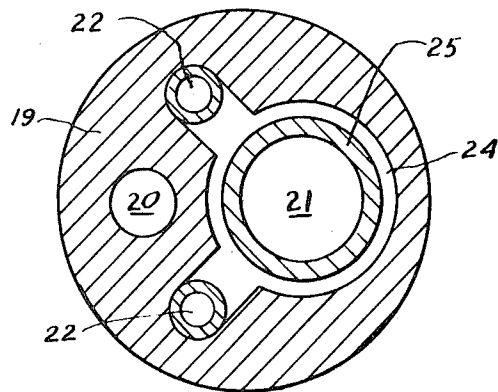


FIG. 5



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CONTINUOUS CASTING APPARATUS WITH CONTROLLED OVERFLOW CASTING TUBE IN TUNDISH

The flow of molten metal poured into a continuous casting mold has to be accurately controlled because it is governed by the intensity of the mold-cooling process and therefore of the permissible withdrawal speed of the cast strand. The stopper rods used in the prior art are subject to heavy wear and freeze frequently, causing interruptions in the casting process.

It is known in the prior art to control the flow of molten metal from a tundish into a mold by using vacuum which lifts the metal in a rising tube to an overflow. This process has the disadvantage that the mold and the rising tube have to be vacuum-tight, so that the mold is only accessible after the shroud has been removed. It requires an expensive vacuum pump, and it is also difficult to obtain a constant vacuum due to the gases escaping from the molten metal.

In still another prior art process the flow velocity of the molten metal in a launder is controlled by an adjustable gas jet which flows in opposite direction to the molten metal. It is claimed that the metal flow can be stopped completely by increasing the gas flow accordingly. The flow of the molten metal, however, cannot be stopped if there is any difficulty in the gas supply, and the described apparatus cannot completely empty the ladle without additional equipment.

The principal object of the present invention is to provide a method and an apparatus for controlling, within a wide range, the flow of metal from a tundish into a continuous casting mold, whereby the above-described difficulties in the prior art designs are avoided.

According to the present invention this is accomplished by mixing the molten metal in the rising tube with gas and thereby raising its metal level as compared to the tundish metal level. It is advantageous to mix the gas and the metal already in the lowest part of the rising tube, and an inert mixing gas should preferably be used.

It is already known to transport molten metal by mixing it with gas through a rising tube into a degassing vessel at a higher elevation and to accumulate this metal in still another vessel after degassing. The present invention, however, shows a novel method for the reliable and controllable conduction of molten metal into a continuous casting mold, which includes the manual or automatic regulation of the gas supply as a function of the mold metal level.

An apparatus for performing the method of the present invention comprises a casting tube which is attached to the bottom of the tundish and extends downward below the mold metal level, and upward within the tundish to a level higher than the highest tundish metal level. Within the tundish the casting tube is surrounded by a rising tube which has a gas supply and holes in its lower part to permit the inflow of molten metal, while its upper end projects above the upper end of the casting tube.

A pipe can conduct gas to the rising tube, or it could conduct gas to a gas-permeable refractory brick which is located in the rising tube or which is a base block of the rising tube.

The casting tube may consist of two sections to insure the complete emptying of the tundish. The upper section may be vertically movable and would have a sealing surface with the lower section, which extends into the mold.

In another design the upper casting tube and the rising tube are combined as a unit which is connected to the lower casting tube and which is mounted in the tundish by the lower end of the upper casting tube resting on a sealing surface of the upper end of the lower casting tube.

The gas can be supplied from above through ducts in the wall of the rising tube which lead either directly into the lower part of the rising bore or to a ring of gas-permeable refractory brick surrounding the rising bore.

Three embodiments of the invention are shown in the drawings in which:

FIG. 1 is a sectional elevation of apparatus attached to a tundish comprising a casting tube and a rising tube with gas supply;

FIG. 2 is a sectional elevation of an apparatus comprising upper and lower casting tube sections;

FIG. 3 is a sectional elevation of an apparatus in which an upper casting tube, a rising tube and gas ducts form one unit;

FIG. 4 is a horizontal cross section along the line IV—IV of FIG. 3; and

FIG. 5 is another horizontal cross section of the unit shown in FIG. 3 taken at the elevation of the gas distributing channel, along line V—V of FIG. 3.

FIGS. 1 to 3 show a tundish 3 resting on a support 2 located above a mold 1. In the embodiment of the invention shown in FIG. 1 a casting tube 4 is attached to the bottom of the tundish and extends downward below the mold metal level and also upward further into the tundish. The casting tube 4 is surrounded concentrically by a rising tube 5 which has molten metal inlet holes 6 and 7 at its lower part and a gas exit opening 8 at its upper end.

At the base of the rising tube, in the annular space between the casting tube 4 and the base of rising tube 5, is a bottom provided by a gas-permeable refractory block 9 which rests on a seal ring 10 on a ring flange 11 and which has a channel 10a for distributing gas supplied to a channel by a pipe 12 from a source (not shown).

Molten metal in the tundish enters the rising tube 5 through the openings 6 and 7 where it mixes with a gas, preferably an inert gas, so that the mixture rises up and flows over the top of the casting tube 4 and down through the casting tube into the mold 1.

In the embodiment of the invention shown in FIG. 2 the casting tube consists of a lower discharge tube 13, which has lateral outlet openings into the mold and which is attached through the bottom of the tundish, and of an upper inlet tube 14 which rests on a sealing surface of an intermediate tube 15. The upper part of the upper inlet tube 14 projects through an opening in a rising tube 16, which is concentric around the tube 14, and can be lifted by a lifting mechanism 17 for draining any molten metal which remains in the rising tube and the tundish at the end of a casting run.

In the embodiment of the invention shown in FIGS. 3, 4 and 5 a downwardly projecting lower discharge tube 18 is attached through the bottom of the tundish 3. Located within the tundish is a cylindrical body 19 which incorporates an upper casting tube 20, a rising tube 21 and the gas ducts 22 (FIGS. 4 and 5). Gas is supplied through an inlet connection 23 and conducted by the gas ducts 22 to a distributing channel 24 (FIG. 5) which surrounds a ring 25 of gas-permeable refractory material which is mounted in the inner wall of the rising tube 21.

A discharge section 26 of the cylindrical body 19 rests on a sealing surface 27 of the lower discharge tube 18, and the cylindrical body 19 can be lifted by a lifting mechanism (not shown) for draining any molten metal which remains in the rising tube and the tundish at the end of casting.

During casting the flow of molten metal is regulated by increasing or decreasing the gas supply as a function of the mold metal level by manual or automatic control.

What is claimed is:

1. Apparatus for controlling the flow of molten metal from a tundish into a continuous casting mold comprising a casting tube mounted in the tundish opening through the bottom thereof with its upper, open end extending upwardly above the bottom of the tundish to a height above the normal level of molten metal in the tundish, a rising tube in the tundish around the casting tube with space therebetween and with its upper end above the upper end spaced of the casting tube, said rising tube having at least one lower opening through it for metal in the tundish to flow into the space between said tubes, and means for controllably supplying gas to the metal in the lower part of said space to mix therewith and cause said metal to rise up said space and overflow into the casting tube.

2. Apparatus according to claim 1 comprising a pipe conducting gas to the lower part of the rising tube.

3. Apparatus according to claim 1 comprising a gas-permeable refractory brick located in the lower part of the rising tube and a pipe conducting gas to said refractory brick.

