

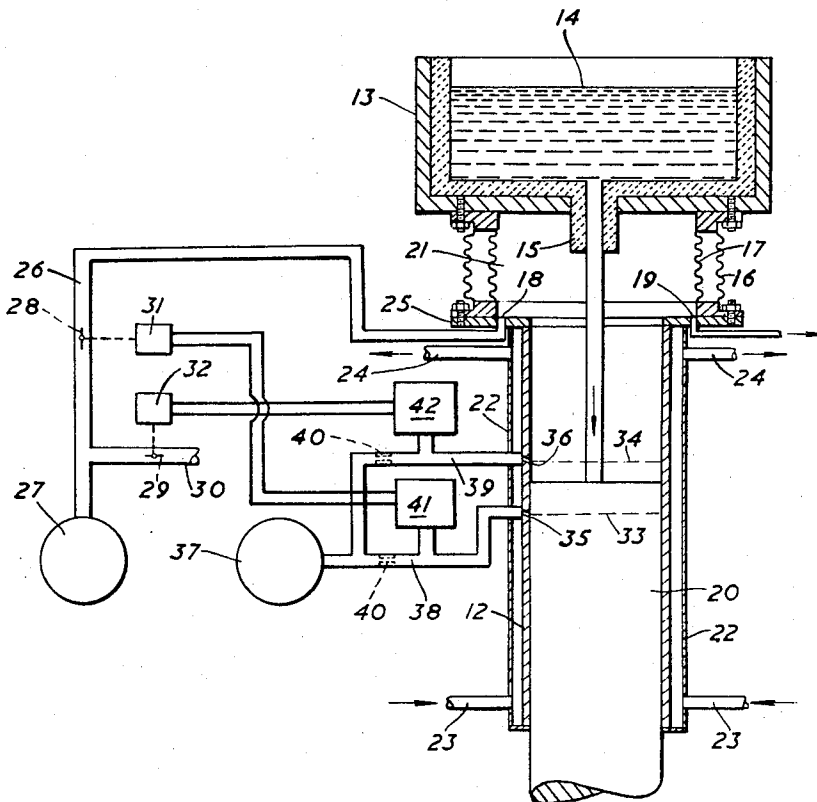
June 9, 1959

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2,889,596

CASTING OF METALS

Filed Feb. 26, 1957



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2,889,596

CASTING OF METALS

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Application February 26, 1957, Serial No. 642,539

3 Claims. (Cl. 22—57.2)

This invention relates to the casting of metals and is particularly concerned with the continuous casting of metals using a mould into one end of which molten metal is introduced and from the other end of which the solidified ingot is continuously withdrawn.

In most continuous casting methods for metals, and particularly ferrous metals, the liquid metal has been poured into the mould in controlled quantities by means of a refractory nozzle selected so that the liquid level in the mould is maintained substantially at a constant level for a given casting rate. This however entails careful control and it is far preferable to supply the mould by gravity feed from a tundish into which the whole or a proportion of the charge from a steel-making furnace, for example, is deposited, the casting mould being attached to the tundish. So far the continuous supply of metal from a tundish in this way has not been practical because in operation the flow from the tundish causes the level of liquid metal in the mould to rise up the mould to the tundish and, when ferrous metals are being cast, the metal erodes or sticks to the refractory material of which the tundish nozzle is made.

For practical reasons, it is not possible to seal completely the top of the mould to the bottom of the tundish when ferrous metals are being cast and other expedients must be used to maintain the level of the metal in the mould within desired limits.

An object of this invention is to control the level of metal in a mould when supplied from a tundish.

In accordance with the present invention, continuous casting apparatus comprises an open-ended mould, a duct for supplying casting material to one end of the mould, which end is connected to the duct to form a substantially closed space above the casting material in the mould and means for adjusting the pressure within the space so as to control the rate of supply of casting material from the duct to the mould.

Preferably the apparatus comprises an open-ended mould, a duct for supplying metal by gravity feed to one end of the mould, which end is connected to the duct to form a substantially closed space above the metal in the mould, and means for automatically controlling the pressure within the space, and hence the rate of supply of metal from the duct, by the level of the metal in the mould. Thus, when the metal rises in the mould, the gas supply is controlled to increase the pressure of the gas in the mould and thereby to reduce the rate of feeding from the reservoir. The system operates to maintain the level of the metal within limits and thereby ensures the existence of a space of substantially constant volume between the metal in the mould and the reservoir.

The reservoir may have a number of outlets each supplying a different continuous casting mould. In this case, there may be a common source of gas under pressure, the supply of gas to each mould being individually controlled by the level in that mould.

The pressure above the metal level in the mould may

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be controlled by a number of control elements located at different levels in the mould such that the covering of any one element by the metal causes an increase in the supply of gas and hence a decrease in rate of flow from the reservoir. By these means, the metal level is maintained within prescribed limits, and compensates automatically for changes in the level of the metal in the reservoir, due for example to recharging of the reservoir, and for changes in the rate of withdrawal of the solidified ingot from the mould.

While the invention has greatest utility in connection with the casting of ferrous metals owing to the destructive action of the ferrous metals on the refractory nozzle material, it is also applicable to the casting of non-ferrous metals.

It is of course preferred to employ a reducing gas or an inert gas, such as nitrogen or argon, for supply to the mould.

The invention will be more readily understood by way of example from the following description of continuous casting apparatus in accordance therewith, reference being made to the accompanying drawing which is a sectional view of a continuous casting mould and tundish with control elements shown schematically.

Referring to the drawing, the open-ended continuous casting mould 12 is mounted on springs as described in British specification Nos. 715,282 and 15382/54 so that to be capable of small vertical movements. The mould 12 is located below a nozzle 15 of a tundish 13 which forms a reservoir for liquid steel 14. The liquid steel flows out of the tundish 13 as a stream and solidifies within the mould 12 to form an ingot 20 which is continuously withdrawn from the mould in known manner.

The mould 12 has a usual water cooling jacket 22, water being supplied to the jacket through pipes 23 and withdrawn therefrom through the pipes 24. The upper lip of the mould 12 has secured to it an annular platform 25 to which are bolted two concentric stainless steel bellows 16, 17, which are also bolted at their upper end to the bottom of the tundish 13. There is, therefore, formed, above the ingot 20 a substantially sealed space 21 enclosed by the bottom of the tundish 13, the mould wall and the bellows 16, 17.

The platform 25 is provided with two passages 18, 19. The passage 19 is connected to atmosphere and provides an artificial leak from the space 21 so as to render negligible any accidental leaks from the space and the effect of gassing of the steel. The other passage 18 is connected by the pipe 26 to a pump 27 which pumps an inert gas, such as nitrogen, at a constant rate. The supply of the gas to the space 21 through the pipe 26 is controlled by a first valve 28 located in the pipe 26 and a second valve 29 located in a relatively low capacity bleed pipe 30, venting to atmosphere. The valves 28, 29 are operated by relays 31, 32 respectively and these relays are operated when the steel in the mould 12 is above the levels indicated at 33, 34 respectively.

At the levels 33, 34 there are small apertures 35, 36 in the wall of the mould and these apertures are supplied with an inert gas by a constant displacement pump 37 through the pipes 38, 39, each of which contains a restriction 40. Each of the pipes 38, 39 between the restrictions 40 and the apertures is in communication with a pressure operated switch 41, 42 of the diaphragm type. Switches 41, 42 control the supply of electric currents to the relays 31, 32 respectively. Considering the level 33, when the metal in the mould is below this level, the gas applied through pipe 38 can freely escape into the mould and the pressure in that pipe is relatively small; when, on the other hand, aperture 35 is covered by the steel in the mould, escape of gas is substantially cut off and the

pressure in pipe 38 increases and operates the pressure switch 41.

The pressure of gas in the space 21 controls the rate at which molten steel flows by gravity from the tundish 13 into the mould 12 and this pressure, in turn, is controlled by the positions of the valves 28, 29. When the relays 31, 32 are de-energised, valve 28 is closed and valve 29 is open. Accordingly, when casting commences and the steel in the mould is below the level 33, the pressure within the space 21 is substantially atmospheric pressure and steel passes into the mould at a high rate. As soon as the steel covers aperture 35, switch 41 is operated and the relay 31 is energised, causing valve 28 to be opened. The pressure in space 21 rises and the rate of flow of steel decreases. If the steel should rise above level 34, switch 42 is operated to cause the valve 29 to close and to increase further the pressure within space 21 and to cut off the flow of steel to the mould.

Accordingly, during casting, the level of steel in the mould 12 will oscillate about either level 33 or level 34, depending on whether the flow permitted when the steel is below levels 33 and 34 is less than or greater than that required for precisely matching the supply rate with the withdrawal rate. In either case, however, the mean rate of supply of steel to the mould 12 is maintained substantially equal to the mean withdrawal rate from the mould, irrespective of the actual rate of withdrawal and irrespective of the ferro-static pressure of the steel in the tundish 13.

It will be appreciated that the rate at which the gas is supplied by the pump 27 exceeds the leakage through passage 19 so that pressure can be built up in space 21 when the valve 28 is open.

The provision of the bellows 16, 17 permit the mould 12 to move slightly both longitudinally and laterally as required by virtue of its spring mounting.

While it has been stated that the gas supplied by the pumps 27, 37 is an inert gas, that gas may equally well be a reducing gas if so desired. The mould is lubricated in known manner, for example, as described in British specification No. 8087/54.

We claim:

1. Continuous casting apparatus for metals, comprising an open-ended mold, a reservoir for a metal to be cast, a duct for continuously supplying metal from the reservoir to the mold, wall means joining said mold at its metal receiving end to the reservoir, said wall means defining a substantially closed gas space between said end of the mold and the reservoir, supply means for supplying pressure gas to said space, said supply means comprising a gas pump, a first normally closed and second normally open valve means, first conduit means connect-

ing the pump to said space through the first valve means, and second conduit means connecting the pump to the atmosphere through the second valve means, the pressure within the space controlling the rate of flow from the reservoir to the mold, and automatic control means controlled by the level of metal in the mold for controlling the flow of gas from the supply means to the space to maintain a gas pressure in said space holding the metal level within a predetermined range during operation, said control means including a first and a second control device responsive to a predetermined minimum level and a predetermined level respectively of the metal in the mold, said first control device opening the first valve means in response to a metal level above said minimum level to increase the gas pressure in said space and said second control device closing the second valve means in response to a metal level above said maximum level to increase further the gas pressure in said space.

2. Continuous casting apparatus according to claim 1 in which each of the control devices comprises means for supplying gas to an aperture in the mould wall at one of the levels, a device responsive to the pressure of the gas supplied to the aperture which device is operated to opposite conditions when the aperture is respectively above and below the level of the metal in the mould and actuating means for operating the valve means controlled by the respective pressure responsive device.

3. An apparatus according to claim 1 wherein each of said control devices comprise a pressure responsive device controlling the respective valve means and a conduit connecting the pressure device to an aperture in the mold wall and to a supply of pressure gas, one of said apertures being located at the minimum metal level in the mold and the other at the maximum metal level, the gas pressure acting upon each of said pressure responsive devices being controlled by the metal level covering and uncovering respectively the respective aperture, covering of the apertures causing the pressure device to open and close respectively the associated valve means.

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