Oct. 15, 1940. S. JUNGHANS 2,218,171

APPARATUS FOR CONTINUOUS CASTING PROCESSES

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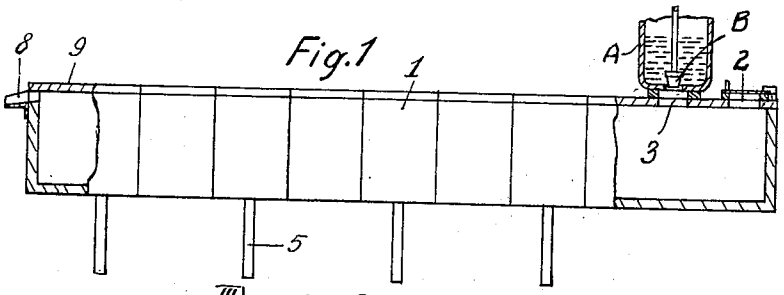


Fig.1

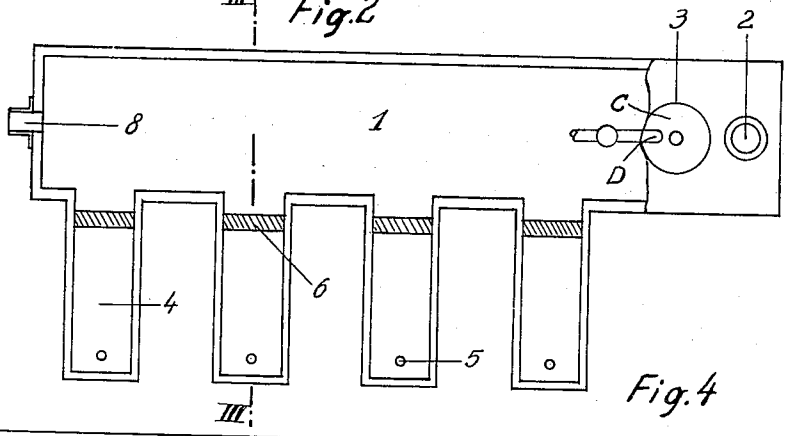
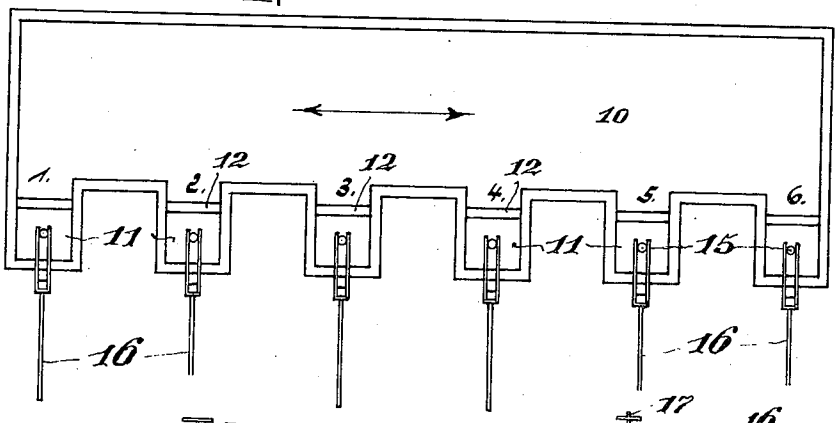


Fig.2

Fig.4



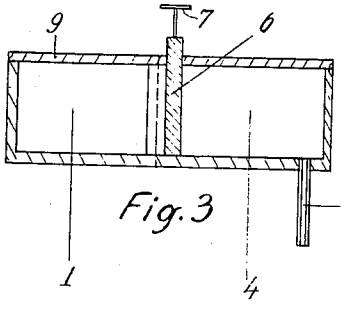


Fig.3

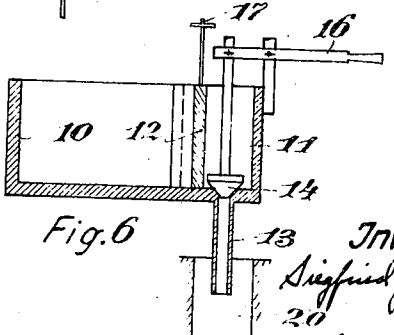


Fig.6

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Fig. 5

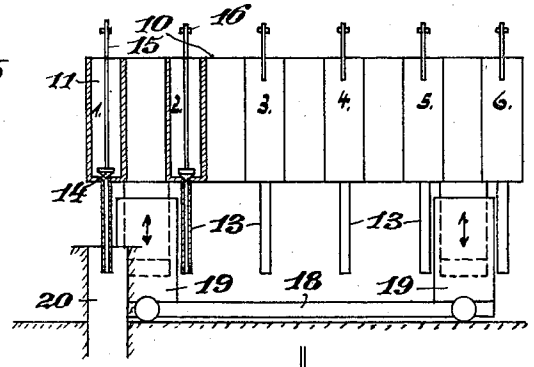


Fig. 7

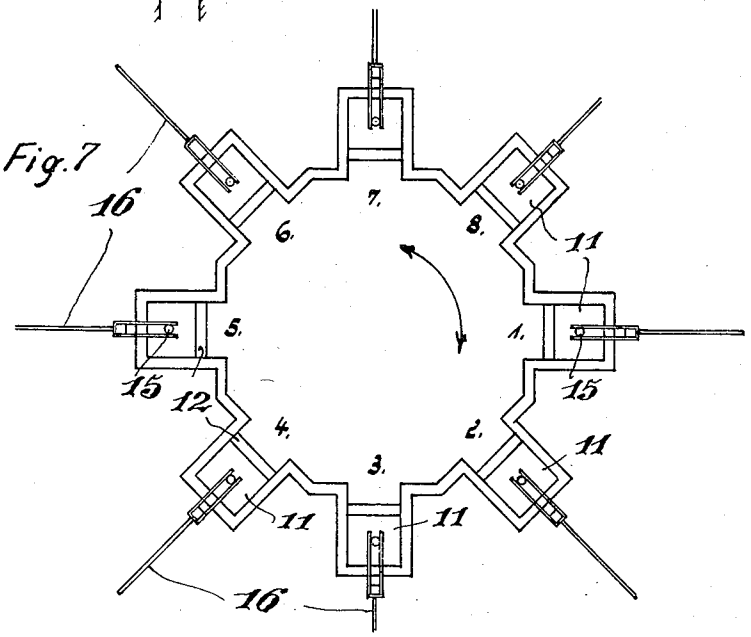
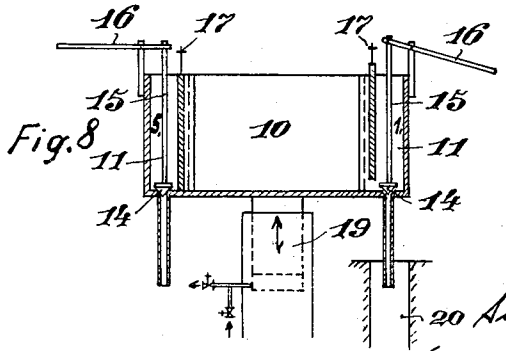


Fig. 8



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Fig. 9

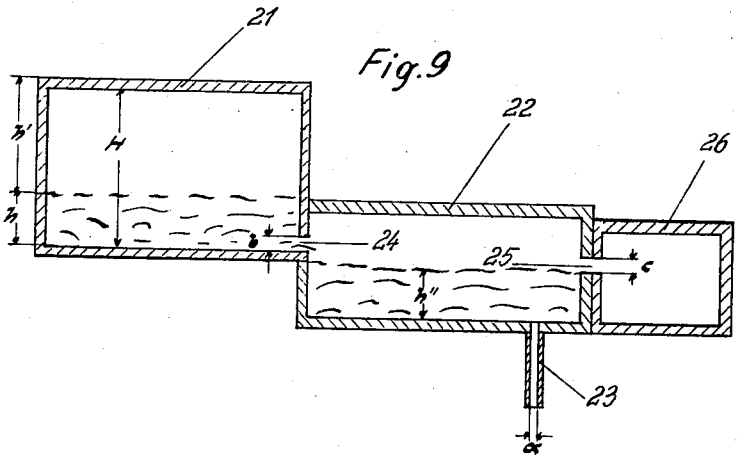
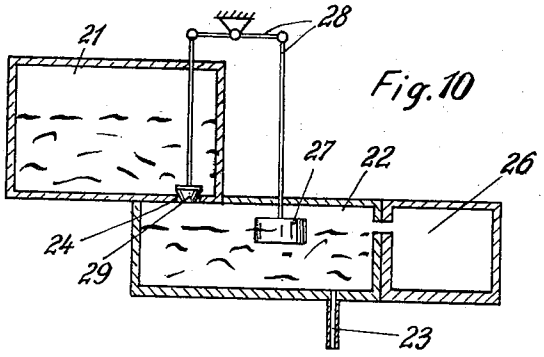


Fig. 10



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UNITED STATES PATENT OFFICE

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APPARATUS FOR CONTINUOUS CASTING PROCESSES

Siegfried Junghans, Stuttgart, Germany

Application January 13, 1938, Serial No. 184,752
In Germany September 15, 1936

1 Claim. (Cl. 22—79)

The invention relates to metal casting, and pertains particularly to devices by means of which the molten metal (high and low melting point metals and metal alloys) is conveyed during the casting (and especially in continuous casting) to the casting moulds as uniformly as possible as regards quantity and speed.

In the various continuous casting processes one of the principal conditions for producing a satisfactory casting is that a constantly uniform rate of discharge must be maintained.

The present invention proposes basically three different fundamental solutions of the problem of the uniform feeding of the metal, as being the most suitable for the various working conditions (casting of large quantities in steel and copper foundries etc. or casting in small or medium foundries etc.).

In all the known continuous casting processes which have hitherto been applied in practice, a uniform rate of discharge of the metal entails certain limitations as regards the casting speed (which is in most cases slower than in the normal processes hitherto applied) and also owing to the necessity of having available the requisite durable materials for the pipe lines, conduits and channels for conveying continuously the liquid metal. Owing to these limitations it has not been possible hitherto to utilise the continuous process for the casting of large quantities, such as occur in steel works, copper and other foundries. One of the plants proposed in the present invention makes use of a distributing container into which the liquid metal is conveyed from one or more melting or holding furnaces by means of one or more ladles. The distributing container consists preferably of a main chamber and several side chambers which branch from the main chamber and can be shut off from the main chamber.. From each of these side chambers a nozzle leads to a corresponding mold. The nozzles are adapted to be replaced by others of the same or of a different cross-sectional area of discharge. The number of molds working can be regulated by shutting off or opening the requisite number of side chambers, the total cross-sectional area of the nozzles working being such as to be able to deal with the maximum discharge from the ladle or from the furnace into the distributing container. Fluctuations in the discharge from the ladle or from the furnace, due to diminution of the amount or the height of the metal, are met with by regulating, i. e. increasing accordingly a pneumatic pressure in the ladle or in the furnace in order to attain a constantly uniform discharge from the ladle into the container. The plant is capable of being adapted in every way to the working conditions and requirements prevailing at any time.

A second plant for maintaining a uniform rate of discharge of the molten metal into the molds is operated according to the following conditions. In certain continuous processes a uniform rate of discharge is obtained, for example, by conveying the metal to the mold through a rising-pipe in which exists a correctly proportioned pressure, or again by conveying the metal via a container from which it is discharged at a uniform rate under pressure due to the height of fall.

In the case of high-melting point metals and metal alloys, such as steel, copper, tungsten, and the like, or in the case of metals affecting the pipe lines, conduits and channels to a high extent, difficulties arise owing to the fact that the refractory substance of which the nozzles are made are unable to withstand the high temperatures without undergoing an alteration of their physical characteristics so that the cross-sectional areas of the nozzles change and thus influence the uniformity of the rate of discharge of the metal. It is true that this drawback can be eliminated both as regards enlargement and narrowing of the nozzles, by altering the pressure during the casting process by means of a pressure line, but as this requires a pressure plant which is per se very complicated and is still further complicated owing to the fact that the pressure must be accurately proportioned to the constantly varying cross-sectional nozzle areas. In casting processes in which the molten metal is conveyed via a container, from which the molten metal is discharged by gravity, there is however no possibility of effecting such regulation.

Now, as no substances are known to date which will withstand these high temperatures or the attacks of certain metals without physical changes, another method must be found for obtaining a uniform rate of discharge of these high melting point metals in continuous casting processes.

According to the invention this new method consists in that, in the case of the above mentioned plant, the metal is conveyed via a container which is provided with several nozzles, which can be connected and disconnected separately and also be replaced. In this case however only one nozzle is worked at a time. After some time, when the sectional area of this nozzle has altered to such an extent as to interfere with the uniformity of the rate of discharge, this nozzle is disconnected and another nozzle put into action.

The worn nozzle can then be renewed so that when the second nozzle in turn is worn out, the first nozzle can be put into action again in place of the second nozzle.

This means of maintaining a uniform rate of discharge is applicable to all cases, irrespective of whether the molten mass is discharged under its own, or under auxiliary pressure, since also in the latter case no special regulating devices need be provided for the auxiliary pressure.

The third solution relating to a plant for maintaining a uniform rate of discharge to the mold is intended for the following conditions. As mentioned above, the molten mass is conveyed to the nozzle from the furnace or from some other container, by means of a path which includes a fall the height of which can be regulated, or by means for producing pressure in some other way for the purpose of maintaining a uniform rate of discharge in continuous casting processes. Now, the aim of the invention is in the first place to eliminate the drawback which arises in such a plant owing to the fact that the molten mass is conveyed under pressure, and in the second place to offer the possibility of constantly maintaining a uniform rate of discharge in such plants where for some reason or other the pressure is not specially regulated.

The main characteristic of the third plant therefore consists in that an intermediate container is provided between the container which holds the molten mass, that is the melting furnace or a separate heating furnace, and the nozzle from which the molten mass is discharged at a uniform rate into the mold, the head of the molten mass being kept at a constant level in this intermediate container. For this purpose the discharge from the main container into the intermediate container is kept somewhat larger than the discharge from the latter through the nozzle and the excess metal thus accruing is removed from the intermediate container via an overflow drain.

The fundamental idea of the invention resides therefore in the recognition of the fact that where the quantity poured in equals the quantity discharged it is impossible to maintain a uniform rate of discharge throughout or a uniform rate of discharge can at least be maintained only with difficulty. Secondly, the invention takes into consideration the fact that so long as the discharge continues the level of the metal in the main container must continue to fall, thereby also decreasing the pressure and thus altering the rate of discharge within certain limits, so that even if the discharge from the main container were equal to the discharge through the nozzles, the changing level of the liquid in the main container would still bring about a changing rate of feed to the nozzles. For this reason provision is made for the feed to the nozzle and to the intermediate container from which the nozzle branches off, to be always greater than the discharge from the nozzle and for the excess metal to be drained away.

In this way it is possible to obtain automatically with simple means a correct regulating of the discharge of metal from the nozzle into the mould.

The excess which is discharged through the overflow drain is preferably collected in a separate accumulator so that it can be used again later.

The accompanying drawings illustrate by way of example three different plants constructed according to the invention.

Figures 1 and 2 illustrate the first plant, which is provided, for example, for casting purposes in a steel foundry, these figures being respectively a side view, partly in section, and a plan view.

Figure 3 shows a section on the line III—III of Figure 2.

Figures 4 to 8 illustrate the second plant, the essential characteristics of which are mentioned above.

Figure 4 is a plan view of a long container.

Figure 5 is a front view, partly in section, of a casting plant having a container according to Figure 4.

Figure 6 is a sectional view of Figure 4.

Figure 7 is a plan view of a circular and radially arranged container, and

Figure 8 is a sectional view of Figure 7.

Figures 9 and 10 illustrate in longitudinal section two embodiments of the third plant.

In the first casting plant shown in Figures 1 to 3, 1 is a rectangular container made of refractory bricks and having two bosses, 2 and 3, upon which the casting ladles containing the liquid metal can be placed.

4 are the narrow side chambers which branch off from the main container 1, and lead to the nozzles 5.

6 are slides made of refractory bricks, by means of which it is possible to admit or shut off the flow of metal from the main container 1 to the side chambers 4, each slide being separately controlled by means of the handles 7.

Each nozzle 5 has an outlet into one of the known devices used in continuous casting processes or into a mold, which are not here shown in detail as they do not form part of the invention. The ladles A which contain from 5 to 20 tons of molten metal according to the size of the melting furnace (one complete charge) have the usual plug stoppers B and can be hermetically sealed by means of a cover C.

The sectional areas of the nozzles 5 depend upon the sectional area of the casting to be cast and it may therefore be advantageous to adapt the nozzles to be detachable or in some other way replaceable. The total sectional area of the nozzles 5 must however always equal the maximum discharge from the ladle, in other words, the total sectional area of the nozzles in use at any time must be so proportioned as to allow them to deal with the maximum discharge from the ladle, that is to say the quantity which discharges when the ladle is quite full. As the rate of discharge from the ladle diminishes as the quantity and thus also the height of the head of metal decreases, the requisite amount of pneumatic pressure is applied through pipe D during the discharge to the contents of the ladle and to the contents of the container 1 which can be covered by means of the lid 9, for maintaining a constant rate of discharge, until the ladle is empty and the ladle 3, being a full ladle, can reestablish the desired rate of discharge.

The regulation of the rate of discharge by means of pressure need not be resorted to, of course, until the usual regulation by means of the ladle plug is no longer sufficient to ensure a uniform flow. This happens mainly when the outlet opening has been much enlarged by the liquid jet, or as often occurs owing to the varying nature of the refractory material the funnel walls have "expanded" that is to say the hole has narrowed. In order to guard against

surprises in this respect and to be sure that by applying pressure a regulation of the rate of discharge will result, endeavours should be made always to use such refractory material for the ladle as tends to expand rather than to wear away. If material is used which wears away the plug opening must be so chosen initially on the basis of practical experience, that the widening of the discharge opening progresses approximately at the same rate as the speed of the discharge tends to decrease owing to the decreasing level of the molten mass, so that also at this point an equilibrium can be established.

As the sectional areas of the castings vary from time to time according to the manufacturing programme the container 1 is provided with the requisite number of side chambers 4 for obtaining a total cross-sectional area of the nozzles, which in the case of minimum cross-sectional area of the castings, will be able to deal with the maximum discharge from the ladle. When later on castings of larger sectional area are to be cast, a corresponding number of side chambers 4 and nozzles 5 are put out of action, by shutting off the respective side chambers by means of the slides 6.

The container 1 and the side chambers 4 are so designed, that before putting the plant into service or, if necessary, also during casting operations, they can be heated, and after starting up they can be covered, so that the molten metal, if necessary can be protected against coming into contact with oxygen. If necessary, for example in the case of copper, the container 1 and the side chambers 4 can also be protected by means of a neutral gas which is admitted therein through suitable devices.

In order to prevent technical errors from causing an overflow in the container 1 or in the side chambers 4, the container 1 is provided at 8 with an overflow drain, which drains off any excess metal into a collecting device.

The plant described above, besides being highly adaptable at all times to the prevailing working conditions, possesses the further advantage that owing to the relatively large surface created by the container 1 and the side chambers 4 in relation to the depth of the melt, small errors in the regulating of the discharge have only a very slight effect upon the individual nozzles, so that also in this respect is meets the reqirements of heavy duty working in large steel works and foundries, while at the same time ensuring a relatively great measure of accuracy.

In the second plant shown in Figures 4 to 5, the rectangular container 10 is provided with six side chambers 11, which can be shut off from the main part 10 of the container by means of the slides 12. In the bottoms of the chambers 11 the nozzles 13 are inserted in such a way that they can be cut off from the chambers 11 by means of the valves 14. The valves 14 can be actuated from the outside by the rods 15 and 16. The slides 12 can be adjusted also from the outside by means of the handles 17.

The container 10 is, as may be clearly seen particularly in Figure 5, arranged upon a trolley 18, having two supports 19, the lower part of which serves as a cylinder into which the upper part fits in the manner of a ram. The container 10 can thus for example be raised or lowered as required by hydraulic means.

The method of working is as follows:

The container 10 is filled with molten metal, care being taken in known manner, for example by covering the container or by admitting thereto a protective gas in the first place that the molten metal does not oxidise, and secondly that the molten metal is kept at the correct temperature by means of heating devices around the container and the nozzles.

The container 10 is then raised until the lower edge of the nozzle is above the upper edge of the mold 20 indicated in Figure 5, and the container 10 is then displaced by means of the trolley 18 until the nozzle No. 1 is above the mold 20. By lowering the container 10 the nozzle No. 1 is lowered into the mold. The slide 12 appertaining to the chamber No. 1 and the corresponding valve 14 can now be opened by means of the rods 17, and 15, 16 so that the molten mass can flow from the container 10 into the mold 20. After some time, when the nozzle No. 1 is no longer working properly, the valve 14 and the slide 12 of chamber No. 1 are closed, the container 10 is raised by means of the extensible support until the lower edge of the nozzle is again above the upper edge of the mold 20, and the trolley is moved along until the nozzle No. 2 arrives at the mold 20. By lowering the container 10 the nozzle No. 2 is then lowered into the mold 20 so that when the slide 12 and valve 14 appertaining thereto are opened the nozzle can be put into service by allowing the molten mass to be discharged at a uniform rate into the mold 20. When this nozzle in turn wears, the same procedure is repeated, nozzles Nos. 3, 4, 5 etc. being successively brought into section. The worn nozzles can now be renewed so that when the last nozzle is worn, nozzle No. 1 can again be put into service.

The same working method applies to the circular or radially disposed embodiments illustrated in Figures 7 and 8.

The container 10 is in this embodiment adapted to be raised and lowered upon a single support 19, and is in addition rotatable and provided along its periphery with the individual chambers 11, which are numbered 1 to 8. Each of these chambers 11 can be disconnected by means of a slide 12 and the nozzle which is adapted to be detachable from the bottom of the chamber can be disconnected by means of a valve 14.

Each of the chambers 11 to turn allows the molten mass to be discharged through the nozzle 13 appertaining thereto into the mold 20, when the corresponding slide 12 and valve 14 are open, and when this nozzle is worn the next chamber 11 and its nozzle are connected in the manner described above, whilst the worn nozzle is renewed.

In the plant illustrated to Figures 9 and 10, the embodiment shown in Figure 9 provides for an intermediate container 22 adjacent to the furnace 21, which is the melting furnace proper or a separate heating furnace, the nozzle 23 conveying the metal from this container to the mold 20. The sectional area b of the outlet 24 in the bottom of the furnace 21 is so dimensioned that the discharge of molten mass from this outlet into the intermediate container is always greater than the discharge from the nozzle 23, the sectional area a of which is correspondingly proportioned. The rate of discharge in addition to being determined by the sectional area a of the nozzle is also determined by the level h'' in the intermediate container 22 and consequently there is arranged in the intermediate container an overflow drain 23 at a level corresponding to the level h'', through which the excess metal can drain off into the collecting container 26. The

result is that quite independently of the level of the liquid in the container 21 the level of the liquid in the container 22 and consequently also the rate of discharge from the nozzle 23 are kept constant.

As however the changing level of the liquid in the container 21 generates a varying pressure, so that the rate of discharge through the opening 24 will vary, the sectional area *b* of the discharge outlet 24 must be so proportioned that when the liquid in the container 21 has reached the level *h*, the discharge into the intermediate container 22 will still remain greater than the discharge from the nozzle 23. This, of course, causes a relatively large overflow at the beginning of casting when the level is higher.

In order to eliminate this excessively large overflow the embodiment shown in Figure 10 is provided with a float 27 in the intermediate container by the aid of which the feed from the furnace 21 to the intermediate container 22 can be regulated.

In the embodiment according to Figure 10 the main container is as in the case of the embodiment in Figure 9 also rigidly disposed, and the float 27 in this instance regulates a plug 29, which is provided in the overflow drain aperture 24 between the main container 21 and the intermediate container 22.

As may be clearly seen in Figures 9 and 10, this arrangement affords the possibility of arranging for the whole plant to work in airtight conditions, so that the molten mass cannot be attacked by the atmospheric oxygen. In the same way it is possible to heat the whole plant, that is to say the main container 21, the intermediate container 22 and the nozzle 23, and, if desired, also the accumulating container 26, so as to maintain the molten mass at the requisite casting temperature at all points.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

Apparatus for continuously feeding molten metal into a plurality of molds for the production of continuous ingots, comprising a wide, open main channel, a plurality of short secondary channels directly connected to the said main channel, a nozzle connected with each of the said secondary channels, a plurality of molds into each of which one of the said nozzles extends, a ladle having an opening in its bottom adapted to discharge molten metal into said main channel, and means to applying pneumatic pressure to the molten metal in said ladle in order to control the rate of discharge therefrom.

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