Nov. 1, 1938. S. JUNGHANS 2,135,184

APPARATUS FOR CONTINUOUS CASTING OF METAL RODS

Filed June 30, 1936 3 Sheets-Sheet 1

Fig. 1.

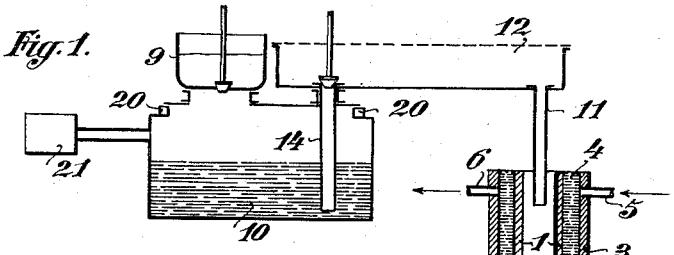


Fig. 2.

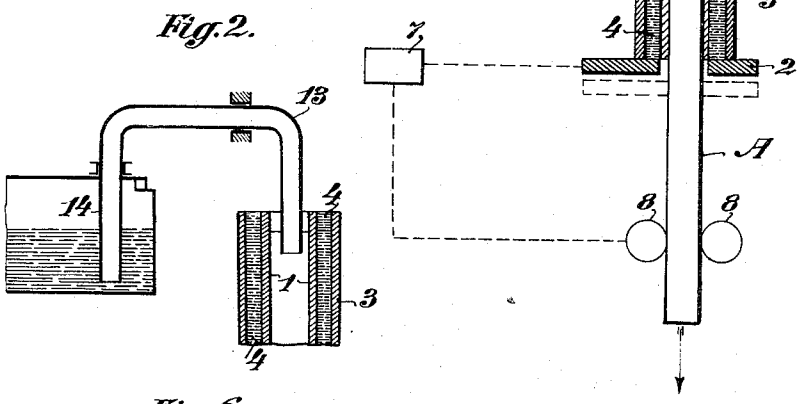


Fig. 6.

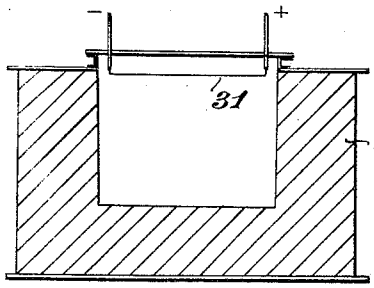


Fig. 8.

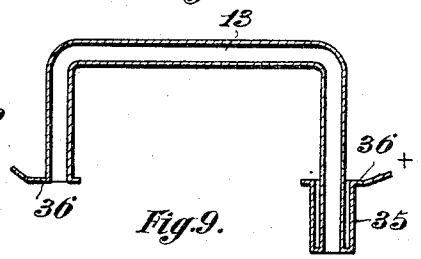
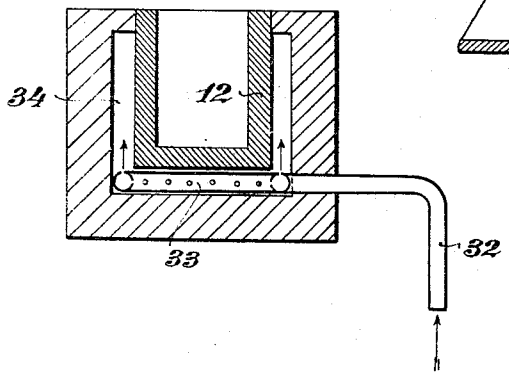
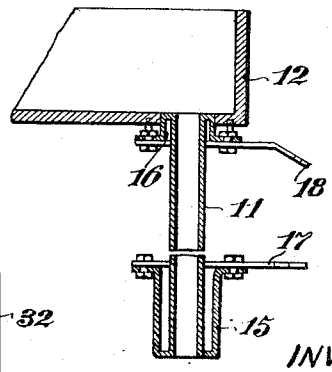


Fig. 9.

Fig. 7





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Nov. 1, 1938. S. JUNGHANS 2,135,184

APPARATUS FOR CONTINUOUS CASTING OF METAL RODS

Filed June 30, 1936 3 Sheets-Sheet 2

Fig. 3.

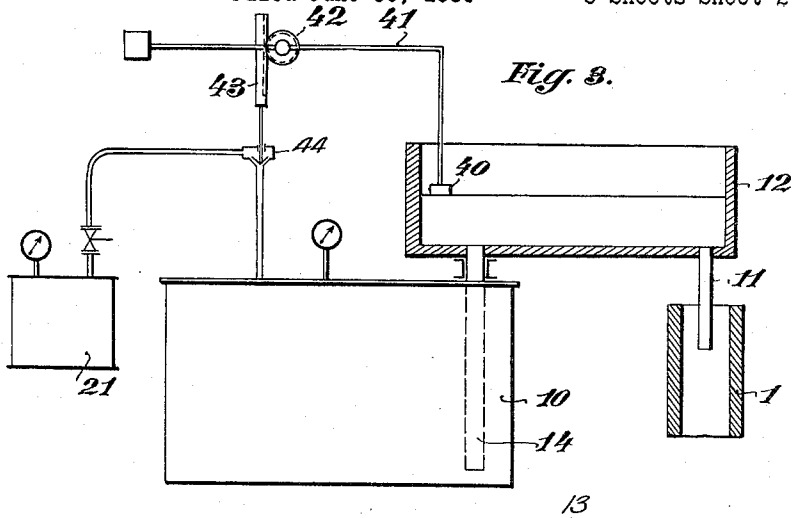


Fig. 4.

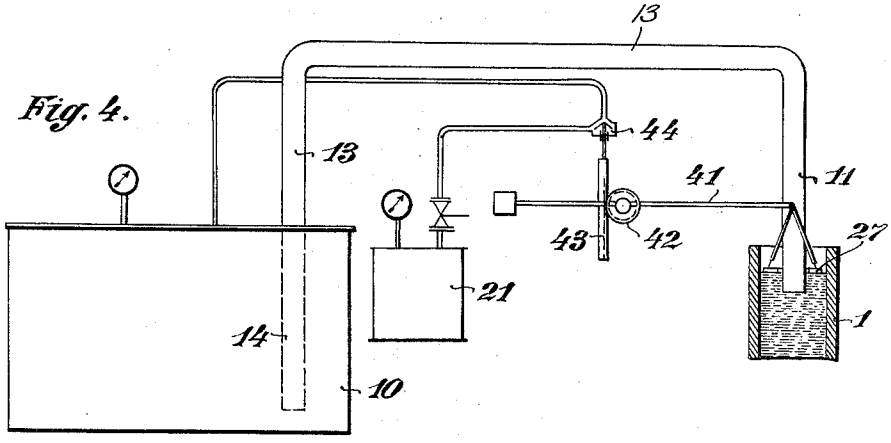
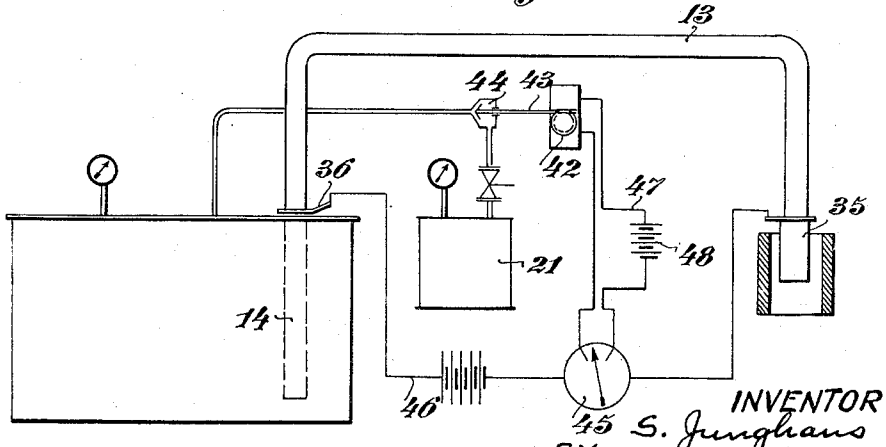


Fig. 5.



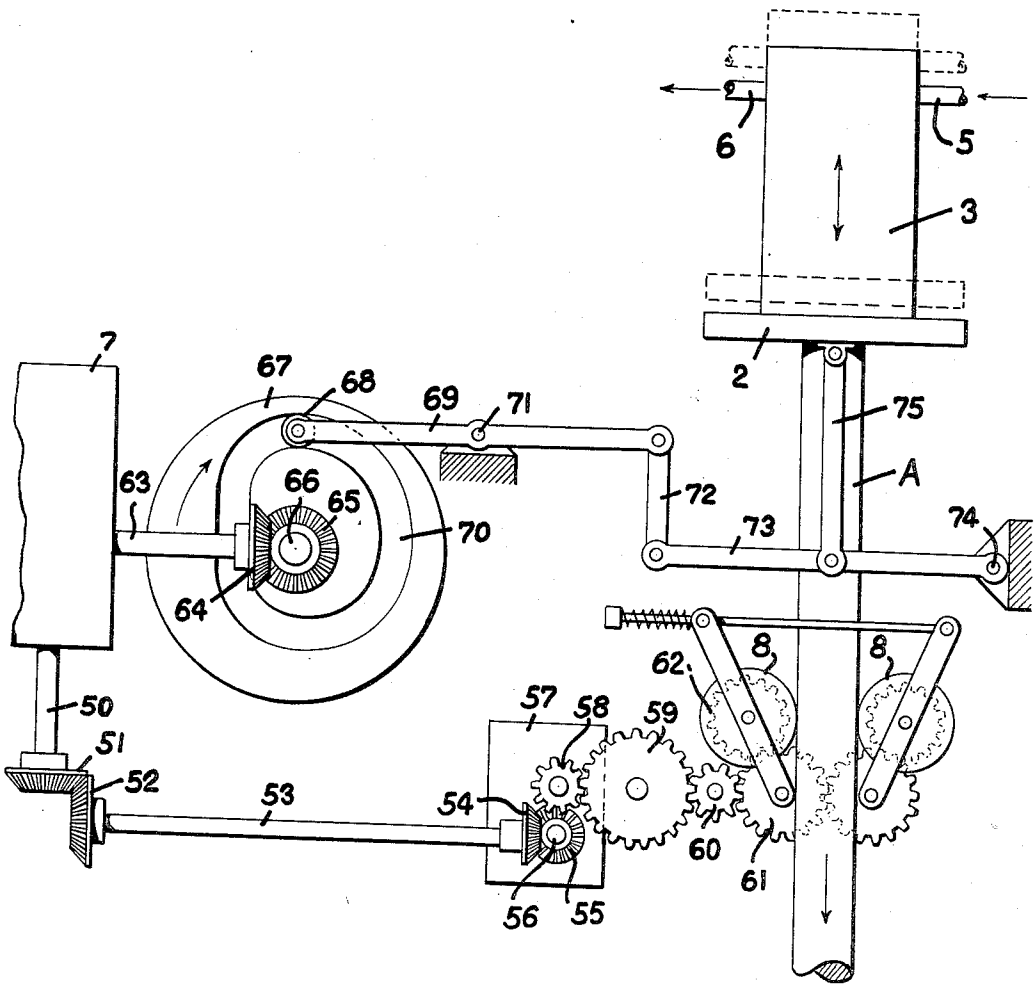
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APPARATUS FOR CONTINUOUS CASTING OF METAL RODS

Filed June 30, 1936 3 Sheets-Sheet 3

Fig. 10.



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2,135,184

UNITED STATES PATENT OFFICE

2,135,184

APPARATUS FOR CONTINUOUS CASTING OF METAL RODS

Siegfried Junghans, Stuttgart, Germany

Application June 30, 1936, Serial No. 88,215
In Germany October 19, 1933

8 Claims. (Cl. 22—57.3)

My invention relates to an apparatus for the continuous casting of dense metal rods with the use of cooled casting moulds in which the solidified rod is pulled away from the gate or pouring-in point.

With these objects in view, according to my invention the effective delivery area of the nozzle and the linear speed and temperature at which liquid metal is passed therethrough, are all maintained constant, the liquid being delivered at a rate such that the metal at any time in the mould is solidified up to a point close under the liquid surface thereof.

To this end the liquid metal is discharged by regulatable pneumatic pressure from a holding or re-heating furnace into a container situated at a higher level, and travels thence under gravity to the constant area casting nozzle, the level of liquid in the container being maintained substantially constant by altering the pneumatic pressure.

Another object of my invention is to provide mechanism by which the regulation of the pneumatic pressure in the furnace can be effected by or in accordance with fluctuations in the level of the metal either in the casting mould or the container.

A further object of the invention is to provide means for heating the metal at a constant temperature along its path from the furnace to the charging nozzle in a very economical way.

This application is a continuation in part of my copending application Serial No. 748,046, filed October 12, 1934.

The accompanying drawings diagrammatically illustrate examples of specific devices for carrying out the present invention.

Figure 1 shows diagrammatically the whole installation, Figure 2 a modified part of the installation according to Figure 1. Figs. 3 to 5 illustrate different regulatory means to maintain constant the speed of discharge of the molten material. Figs. 6 to 9 show heating means, Figs. 6 and 7 for the containers, and Figs. 8 and 9 for the conduits. Figure 10 shows the means for driving the feed rolls and for reciprocating the mold.

The installation comprises substantially the following parts:—

The casting mould 1 in the form of an open ended chill mould has a cooling jacket 3, between which and the casting mould circulates the cooling medium 4 admitted for instance at 5 and discharged at 6. The properties and the dimensions of the casting mould are calculated so that it supplies the proper thermal conditions for a continuous process of working. More particularly the wall of the mould may be made as thin as possible, considering the physical properties of the material of which the mould is made.

Preferably, the casting mould is vertically reciprocated in the direction of the casting being produced, by means of a drive which is connected to the table 2, and comes from a central point. Due to the constant shifting of the metal surface relatively to the casting mould wall, constant alteration of the heat stresses of the casting mould wall is provided for, so that the discharge of heat at the point of the metal level or the chilled mould wall constantly changes, and in that way, the greatest possible discharge of heat is produced.

The casting A itself is seized directly under the table below its lowest position of reciprocation by a pair of rolls 8 which are intended for the advance of the casting A, or for rolling or treating the same. The rolls 8 are also driven from the central point 7 with the interposition of suitable counter-shafting in such manner that the casting is advanced or fed at the same speed as that at which the casting mould is advanced. The control of the casting mould is by suitable driving members, and the control can take place also in such a manner that the return movement of the casting mould 1 to the initial position takes place at an increased speed. The movement is, therefore, such that in the direction of advance of the casting, no movement of the casting mould relatively to the casting takes place, and in the opposite direction, the mould is stripped off from the casting until it returns again to the initial position. The casting mould travels, therefore, in one direction with the casting, and is moved back whilst the casting is still continuously moved forward.

A mechanism for producing the movement previously described is illustrated in Figure 10 in which the driving connection between the central point 7 and the rolls 8 comprises shaft 50 carrying a bevel gear 51 which meshes with bevel gear 52 on shaft 53. The other end of this shaft carries bevel gear 54 which meshes with bevel gear 55 on shaft 56 entering a speed changer 57 of any conventional construction. From this speed changer a set of intermeshing gears 58, 59, 60, 61 and 62 drives the rolls 8.

The previously described movement of the mold is accomplished through shaft 63 carrying bevel gear 64 which meshes with bevel gear 65 on shaft 66 which carries a cam 67. Roller 68 on lever 69 rides in the cam track 70. The lever 69

is mounted on a fixed pivot 71, and the other end of said lever is connected to link 72. Said link is also connected to lever 73 mounted on a fixed pivot 74. A link 75 connects lever 73 to the mold table 2.

The cam 67 rotates in clockwise direction and the cam track 70 is so shaped as to cause downward movement of the mold at a constant speed during approximately three quarters of a complete revolution of the cam, and to cause return or upward movement of the mold at an increased speed during the remaining quarter revolution of the cam. The previously described gear train for driving the rolls 8 is such as to cause said rolls to rotate at a constant peripheral speed equal to the speed of downward movement of the mold produced by the cam 67. The exact speed, of course, may be set at the beginning of the casting operation by suitable adjustment of the speed changer 56.

For the regulation or the speed of discharge of the molten material from the casting or pouring-in opening is provided the following apparatus:

The molten material brought from the smelting holding furnace in a ladle 9 passes first into a furnace 10 which is intended to keep the molten material hot in the manner hereinafter described. From the holding or reheating furnace the molten material passes to the casting nozzle proper 11 which projects into the open end of the casting mould. The molten material is supplied from the reheating furnace 10 to the nozzle or to the casting mould preferably not directly, but indirectly, namely, through a supply channel or a container 12 (Figure 1) or 13 (Figure 2). The supply channel is arranged above the reheating furnace and the nozzle, the molten material being transferred by pressure applied to the reheating furnace.

The container interposed between the reheating furnace and the nozzle comprises according to one construction a trough 12 into which the molten material is forced upwardly from the reheating furnace. The level of the molten material in the trough determines the rate of escape of the molten material from the nozzle.

Fig. 3 shows the regulatory means when using a container 12 situated at a higher level than the reheating furnace which is under regulatable pneumatic pressure. It must be pointed out that the effective delivery area of the nozzle will not be regulated in order to maintain a uniform rate of flow, but only the pneumatic-pressure is adjusted, according to the invention. In Fig. 3 the float 40 is connected with a counterbalanced lever 41, the pivot of which may consist of a pinion 42. This pinion engages with a rack 43, which operates a valve 44 to control the pneumatic pressure produced in the pressure apparatus 21 and applied to the reheating furnace 10. Thus, when the level of the molten metal in the container 12 rises, the valve 44 would tend to close in such a manner that the pressure applied to the reheating furnace is reduced. Thereupon the rate of feeding of the molten material in the upward direction to the container 12 would be reduced, so that the level of the molten material in this container 12 reaches the previous level which is to be held constant. Of course, the device can be made very sensitive. The regulation of the pneumatic pressure in the furnace 10 to prevent oscillations of the level of the molten metal, and to maintain a uniform speed of discharge into the mould has many practical operating advantages over regulation direct by a valve provided in the area of the nozzle.

In place of the trough 12, may also be used a closed pipe 13. In this case the rising pipe 14 carried upwards out of the reheating furnace 10, the pipe section 13 and the nozzle 11 leading into the mould, consist of a single U-shaped piece of pipe. The speed of discharge of the molten material from the nozzle cannot be controlled in this case from this supply track. On the contrary, for this purpose is used a float 27 placed according to Fig. 4 round the nozzle 11 on the metal surface in the mould and indicating the changes of level of the metal surface. When using a closed pipe 13 in place of the trough 12, a device for regulation is preferably provided as shown in Fig. 4. A float 27 is placed around the nozzle 11 on the surface of the metal in the mould and transmits its movements in the vertical direction to a rack gear 42, 43 which controls the valve 44. Thus, the pressure applied to the reheating furnace is regulated in accordance with the variations in the level of the molten metal in the mould in such a manner as to keep the rate of discharge always the same.

Fig. 5 illustrates an automatic regulating device which regulates the pressure in the reheating furnace in accordance with variations in the ohmic resistance which are produced by the variation in the filling or charge of the supply channel. Into the electric heating circuit 46 for the closed pipe 13 an ammeter 45 is inserted, the variations of which are transmitted to another circuit 47 fed by a battery 48 and having a relay which controls the valve 44 for the pneumatic pressure of the furnace 10 by means of the rack gear 42, 43 corresponding to the variations of the ammeter 45. By regulating the pressure the speed of discharge of the molten material can be easily and precisely maintained constant.

In addition to the reheating furnace, the rest of the supply channel is also kept at a constant temperature. This can be done by means of any desired heating. When a trough 12 is used, the trough 12 and the rising pipe 14 are preferably heated together, whilst the heating of the nozzle is preferably effected separately, and if at all possible, electrically. When using a U-shaped pipe 13 according to Fig. 2, the whole pipe is preferably heated electrically.

Fig. 6 represents the reheating furnace 10, wherein the heating element, precisely adjustable, is diagrammatically illustrated as comprising an electric-resistance 31, the holder of which is preferably mounted in the cover of the furnace. Thus, the reheating furnace can be kept at a constant temperature.

Another manner of heating is illustrated in Fig. 7, showing the trough 12, which is heated by a stream of hot gases fed through the pipe 32 having the perforated outlet 33 in order to fill up the chamber 34 between the container 12 and the revetment wall.

It is preferable to heat the whole supply channel from the furnace to the end of the nozzle. For this purpose are used the connections built for instance as indicated in Figs. 8 and 9. Fig. 9 shows the construction of the nozzle when it is heated independently. Over the two ends of the nozzle or tube 11 are placed sleeves 15, 16, which are connected to the ends of the nozzle 11. Secured to the said sleeves are brackets 17, 18, which receive the connection terminals for the heating cables.

The closed pipe 13 can also be heated by supplying electric current to the ends of the pipe (Fig. 8). Over the ends of this pipe may be placed either a sleeve 35 or a flange 36 and these flanges or sleeves receive the connection terminals for the heating cables.

When using a syphon pipe according to Fig. 2, the heating of the supply channel can be effected by supplying electric current to the reheating furnace through the metal bath itself, whilst at the nozzle end the connection is arranged in the manner shown in Fig. 9.

The pipes coming in contact with the molten material, and more particularly the mould, are made of a non-corroding material containing, in addition to iron, a high proportion of chromium. By high proportion of chromium, I mean at least twenty per cent chromium, and preferably between twenty per cent and thirty per cent. In the case of electrical heating, the pipes should be formed of a material which, moreover, has a greater co-efficient of resistance than the molten material. Moreover, the material of which the supply channel is made, whether electrical or other heating be used, must be made of a material which does not form an alloy with the molten material. For maintaining constant the heating temperature, as well as for ensuring a perfect process of casting, it is advisable to line the pipe conveying the molten material with a ceramic composition inside and/or outside. This composition could be preferably made up of well known materials such as steatite, silomanite, or the like.

The working of the installation is as follows:

Let it be assumed that the reheating furnace is filled with molten material and that the whole supply channel from the reheating furnace to the discharge end of the nozzle is heated and maintained at the necessary constant temperature. The reheating furnace is tightly closed. Pressure is then admitted by means of the pressure generator 21 into the reheating furnace. The said pressure acts on the metal surface in the furnace and forces the molten material through the rising pipe 14 upwards into the container 12. The pressure is controlled in such a manner that the desired speed of discharge through the nozzle into the casting mould is obtained. The casting mould is now filled in stationary state until the metal surface reaches the desired level, that is to say, the desired position relatively to the nozzle orifice. At this moment the drive 7 of the mould is thrown in, and the rolls 8 also begin their advance. It goes without saying that before starting a plug is introduced into the mould. This plug, which is guided by the rolls, becomes connected to the incoming metal. When the feed roll is thereupon started, the plug will pull with it the solidified end of the cast rod, and the process is thus started.

The speed of discharge of the molten material from the nozzles is controlled in the construction shown in Fig. 1 by the head of the molten material in the trough 12. The float which is provided there may be connected either to an optical or to an acoustic indicator device, the regulation taking place in accordance with its indications. The float in the trough 12 can be connected to an automatic regulating device (Fig. 3) which regulates the pressure in the reheating furnace in accordance with the level variations in such a manner as to keep the speed of discharge always the same.

When a syphon pipe is used according to Fig. 2, the element responding to the pressure fluctuations is a float (Fig. 4) on the metal surface in the casting mould. The regulation of the speed of discharge is effected then by varying the pressure in the manner previously indicated for the trough 12.

In the case of electrical heating of the supply channel, the variation of pressure can be effected, instead of by a float, in accordance with variations in the ohmic resistance (Fig. 5) which are produced by the variation in the filling or charge of the supply channel. In practice, as the element responding to the change of resistance, an ammeter switched into the heating circuit is used, and the regulation of the pressure apparatus 21 is effected in accordance with the indications of the said ammeter.

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

1. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, means for pouring molten metal continuously into one end of said mold, means for withdrawing solidified rod continuously from the other end of said mold, and means for reciprocating said mold longitudinally of said rod in timed relation therewith such that said mold moves with the rod in one direction at the same speed as the rod.

2. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, means for pouring molten metal continuously into one end of said mold, means for withdrawing solidified rod continuously from the other end of said mold, means for reciprocating said mold longitudinally of said rod in timed relation therewith such that said mold moves with the rod in one direction at the same speed as the rod, and such that said mold moves in the opposite direction at an increased speed.

3. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold having a vertical passage therethrough open at both ends, a furnace, an intermediate container between said furnace and said mold, said container being located at a level above the upper end of said mold, means to feed molten metal continuously at a constant rate from said furnace to said container, and a tube of fixed diameter connected to said container and arranged to discharge molten metal by gravity continuously at a constant rate into the open upper end of said mold.

4. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold having a vertical passage therethrough open at both ends, a furnace, an intermediate container between said furnace and said mold, said container being located at a level above the upper end of said mold, means to feed molten metal continuously at a constant rate from said furnace to said container, a tube of fixed diameter connected to said container and arranged to discharge molten metal by gravity continuously at a constant rate into the open upper end of said mold, a float in said container, and means operated by said float to control said feeding means to maintain a substantially constant level of molten metal in said container.

5. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, a furnace, an intermediate container between said furnace and said mold, said container

being located at a level above both said furnace and said mold, means to feed molten metal continuously at a constant rate from said furnace to said container, a tube of fixed diameter connected to said container and arranged to discharge molten metal by gravity from said container into said mold, and means for maintaining the molten metal in said container at a substantially constant level, whereby the rate of discharge of molten metal to said mold through said tube of fixed diameter is maintained substantially constant.

6. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, a furnace, means providing a passage for molten metal from said furnace to said mold, means to feed molten metal through said passage continuously from said furnace to said mold, automatically operated means for controlling the flow of molten metal through said passage to cause said molten metal to be discharged at a constant rate into said mold, and means to maintain said entire passage from the furnace to the mold at a constant and uniform temperature.

7. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, a furnace, means providing a passage for molten metal from said furnace to said mold, means to apply pneumatic pressure to the molten metal in said furnace to cause the same to flow through said passage, and means controlled by the molten metal flowing through said passage to control the pneumatic pressure applied to the molten metal in said furnace to cause molten metal to be discharged at a constant rate into said mold.

8. Apparatus for the continuous casting of metal rods, comprising, in combination, a chilled mold, a furnace, means providing a passage for molten metal from said furnace to said mold, means to apply pneumatic pressure to the molten metal in said furnace to cause the same to flow through said passage, and automatically operated means to control the pneumatic pressure applied to the molten metal in said furnace to cause molten metal to be discharged at a constant rate into said mold.

SIEGFRIED JUNGHANS.