Nov. 1, 1938. S. JUNGHANS 2,135,183

PROCESS FOR CONTINUOUS CASTING OF METAL RODS

Filed Oct. 12, 1934 2 Sheets-Sheet 1

Fig. 1.

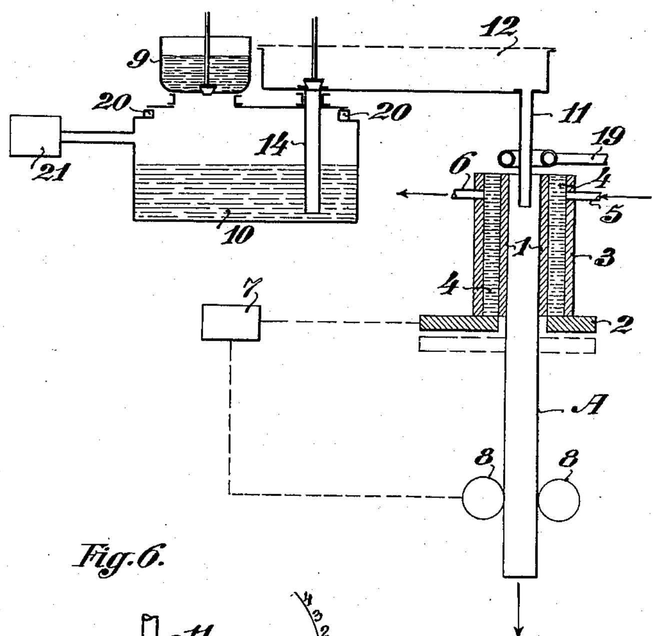


Fig. 6.

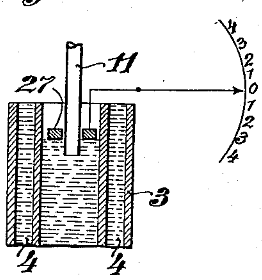
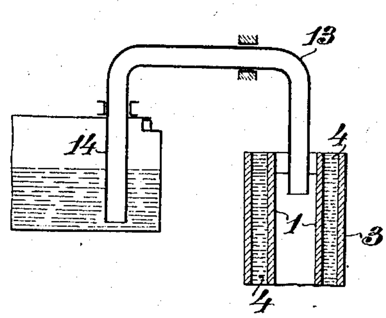


Fig. 2.



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Filed Oct. 12, 1934 2 Sheets-Sheet 2

Fig. 3.

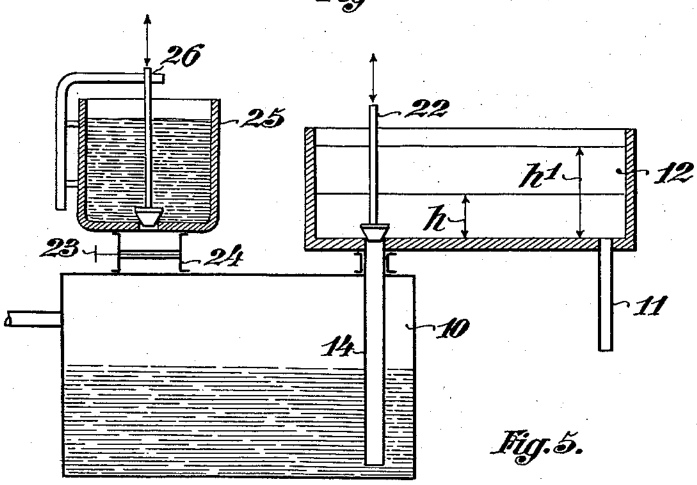


Fig. 5.

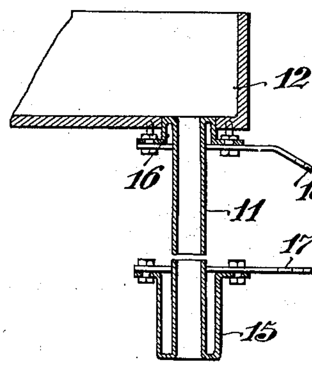
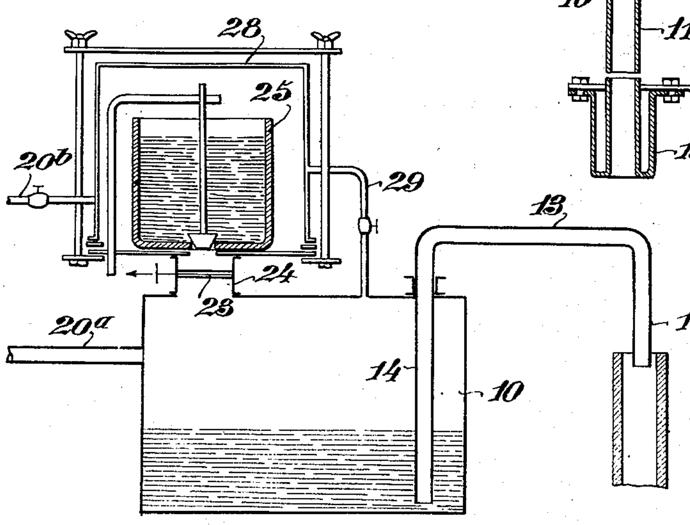


Fig. 4.



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2,135,183

PROCESS FOR CONTINUOUS CASTING OF METAL RODS

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In Germany October 19, 1933

10 Claims. (Cl. 22—57.2)

My invention relates to a process 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.

According to my invention the molten material is flowed into the mould at constant speed, and constant temperature and with the exclusion of any injurious vapours and gases, and the rod produced is simultaneously cooled in such a manner as to ensure as perfect solidification as possible of the portion of the rod contained in the mould.

This rule is based on the discovery from long practical experiments that a dense product, and a really continuous casting in the form of rods can be obtained only when the supply of the metal to the casting mould is maintained throughout the process of casting thoroughly uniform as regards the temperature, and the speed of discharge, protected from injurious gases and vapours, and at the same time the discharge of heat is regulated in such a manner as to ensure as perfect solidification as possible of the rod portion or section contained in the casting mould. For the purpose of obtaining immediate solidification to a point close under the metal surface, it will frequently be advisable to use the smallest possible practicable speed of supply or to adapt this speed to the requirements at the time.

As regards the casting apparatus, according to the invention use is made of a rule well known in itself, of constantly altering the position of the metal surface or level relatively to the wall of the casting mould by reciprocating the casting mould during the casting in the longitudinal direction of the cast rod which is being produced, this reciprocating being done in a special manner namely so that the mould is moved to a given distance with the same speed as the rod, and thereupon—preferably at an increased speed—returned to the initial position. The use of this means is more particularly indicated when using standard casting moulds with the thickness of wall now generally used. For moulds of high grade special materials which allow of a very thin wall being used, the reciprocation may be omitted, and the mould left stationary. These means for constant variation of the position of the surface relatively to the wall, greatly assist continuous casting in such moulds.

Further features of the invention which contribute to the production, in practical continuous operation, of an endless casting of dense and uniform texture, will be described hereinafter.

The accompanying drawings diagrammatically illustrate with reference to examples the process as well as the individual devices for carrying it into practical effect.

Figure 1 shows diagrammatically the whole installation, Figure 2 a modified part of the installation according to Figure 1. Figure 3 shows the apparatus for filling up when using a given discharge apparatus. Figure 4 shows the apparatus for filling up when using a different discharge apparatus. Figures 5 and 6 are detail views.

The installation comprises substantially the following parts:—

The casting mould 1 in the form of an open ended chilled mould has a cooling jacket 3, between which and the casting mould circulates the cooling medium 4 admitted for instance at 5 and discharge 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 relative 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 of the chill 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.

The cast rod produced by this movement of the casting on the one hand and of the casting mould on the other hand, travels continuously and uniformly for the purpose of further treatment to suitable treating machines.

For the regulation of 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 furnace in a ladle 9 passes first into a holding 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 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 and the setting of the trough above the mould determines the speed of escape of the molten material from 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 Figure 6 round the nozzle 11 on the metal surface in the mould and indicating the changes of level of the metal surface, which changes are then utilized in a manner well known in itself for the automatic or hand regulation.

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 Figure 2, the whole pipe is preferably heated electrically.

It is preferable to heat the whole supply channel from the beginning to the end of the nozzle. For this purpose are used the connections built for instance as indicated in Figure 5. Figure 5 shows the construction of the nozzle when it is heated alone independently. Over the two ends of the nozzle pipe 11 are placed further pipes 15, 16 and connected to the ends of the nozzle pipe 11. At the free ends of these pipe branches placed over the nozzle, are provided flanges 17, 18 which receive the connection terminals for the heating cables.

When using a syphon pipe according to Figure 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 Figure 5.

In the case of electric heating of the supply channel of the molten material, the regulation of the speed of discharge and if desired the regulation of the heating temperature can be derived from the changes of the ohmic resistance which take place in accordance with the degree of filling of the supply channel with the molten material.

The pipes coming in contact with the molten material more particularly also the mould, are made of a non-corroding material containing in addition to iron a high proportion of chromium. In the case of electrical heating, for the pipes is also used such a material which however 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 material such as steatite, silomanite or the like.

A further important feature of the invention is that the space between the metal surface and the corresponding front end of the casting mould, is permanently closed against any injurious vapours and gases. This is achieved by arranging in, and closing, the space in question by means of a gas or liquid layer which prevents in a reliable manner, oxidation of, or other action on the metal surface and therefore a formation of scale between it and the wall of the mould and at the same time may be used as a lubricant between the casting and the wall of the mould.

Another factor ensuring perfect casting and preventing formation of blow-holes and pipes, consists in the nozzle reaching close to, or under the metal surface, in order to avoid a free jet which produces an unsteady casting and behaviour of the metal surface, as well as carrying away of gases. The position of the nozzle orifice relatively to the metal surface must also always remain the same for ensuring a perfect carrying out of the casting process.

The supply of the covering medium and lubricant to the space in the casting mould above the metal surface is effected by means of a device 19 adapted to the shape of the casting mould orifice, which distributes in a uniform manner through several orifices the covering material which is constituted by gas, oil, molten salt and the like, that is to say shuts off the casting chamber or space from the outside.

The working of the installation and the method of carrying out the process are 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 set in such a manner that the desired speed of disharge 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, the rolls 8 also beginning 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.

Owing to the vertical reciprocation of the casting mould, the metal surface which always occupies the same level in space and therefore the same level relatively to the nozzle, will constantly vary its position relatively to the wall of the casting mould.

Before starting, or at a suitable subsequent moment, the protecting device 19 is put into operation and as a further contribution to the perfect casting of a continuous casting and for the purpose of avoiding oxidation and scale formation phenomena, produces a space free from injurious gases.

The speed of discharge of the molten material from the nozzles is controlled in the construction shown in Figure 1 by the head of the molten material in the trough 12. The float (not shown in the drawing) which is provided there, may be connected either to an optical or to an accoustic indicator device, the regulation taking place in accordance with its indications. When an acoustic indicator device is used, the regulation of the level in the trough 12, or of the speed of discharge, is effected by hand. The float in the trough 12 can be connected to an automatic regulating device 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 Figure 2, the element responding to the pressure fluctuations is a float 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 bath 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 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 is used an ammeter switched into the heating circuit, and the regulation is effected at the pressure apparatus 21 in accordance with the indications of the said ammeter.

The charging of the reheating furnace takes place according to the invention during the uninterrupted process of casting and is carried out in various ways, depending on whether the container through which molten metal flows to the nozzle comprises a trough 12 or a syphon 13 closed in itself.

When the trough is used, the process of filling takes place in the following manner (Figure 3): The bath is completely filled by raising the pressure, for instance to the "level" h' (h indicating the normal level) and thereupon the pipe 14 is closed by a plug 22. The pressure is then taken away from the reheating furnace, the closing cover 23 of the filling tower 24 is opened and the filling ladle 25 put on. The plug 26 closing the filling hole is then withdrawn and the molten material flows into the furnace. After removing the emptied filling ladle, the filling tower is closed again and pressure readmitted. At the same time the plug 22 in the bath is removed and the process of flow from the reheating furnace to the nozzle will take place continuously. The charging of the molten material into the furnace could be of course effected also with other filling and closing members of any desired kind.

When a syphon is used according to Figure 2, the filling must be done under the casting pressure as in the syphon there is not, as in the bath, a reservoir behind the reheating furnace, which makes possible continuous casting during the filling process. When syphon is used, the filling is done by means of the following apparatus and in the following manner:

The filling ladle is placed on the filling tower of the reheating furnace and over it is put a bell 28 closing the ladle in an air-tight manner from the outside. The pressure in the bell is thereupon raised through a separate pipe 28b to the same value as the pressure in the reheating furnace, and for the purpose of equalizing any slight pressure differences a connection pipe 29 arranged between the bell and the reheating furnace is opened. The valve 23 provided in the filling tower, is thereupon opened, and the plug holding the molten material in the filling ladle is opened. The metal will flow then into the reheating furnace. The latter is then shut off again by the valve 23 in the filling tower. In the same way the connection pipe 29 between the bell and the furnace is also closed again, and the pressure discharged from the bell through the pipe 28b. The bell is then removed for the purpose of removing the filling ladle.

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:—

1. A process for the continuous casting of metal rods which comprises pouring molten metal continuously at a constant rate into one end of a chilled mould, and withdrawing solidified rod continuously at a constant rate from the other end, while causing intermittent relative motion between the solidified rod and the mould, such that there is no relative motion between the solidified rod and mould during a substantial portion of the casting time, but there is relative motion therebetween during another substantial portion of the casting time.

2. A process for the continuous casting of metal rods which comprises pouring molten metal into one end of a chilled mold and withdrawing solidified rod continuously from the other end, and causing continuous relative motion between the surface of the molten metal and the wall of the mold, while causing intermittent relative motion between the solidified rod and the wall of the mould, such that there is no relative motion between the solidified rod and mould during a substantial portion of the casting time, but there is relative motion therebetween during another substantial portion of the casting time.

3. A process for the continuous casting of metal rods which comprises pouring molten metal into one end of a chilled mold and withdrawing solidified rod from the other end, and causing continuous relative motion between the surface of the molten metal and the wall of the mould, while causing the solidified rod to remain stationary with respect to the mould wall during the major portion of the casting time, and to move with re-

spect to the mould wall during a lesser portion of the casting time.

4. A process for the continuous casting of metal rods which comprises pouring molten metal continuously at a constant rate into one end of a chilled mould, withdrawing solidified rod continuously at a constant rate from the other end, and reciprocating the mould longitudinally of the solidified rod in such manner that during the entire time that the mould moves in the same direction as the rod, it moves with the solidified rod at the same speed as the rod.

5. A process for the continuous casting of metal rods which comprises pouring molten metal continuously into one end of a chilled mould, withdrawing solidified rod continuously from the other end, and reciprocating the mould longitudinally of the solidified rod in such manner that the mould moves in one direction with the solidified rod at the same speed as the rod, and moves in the opposite direction at an increased speed.

6. A process for the continuous casting of metal rods which comprises pouring molten metal continuously at a constant rate to the open upper end of a chilled mould through a pipe of less cross sectional area than the cross sectional area of the mould, reciprocating said mould, protecting the molten metal surface at the open upper end of the mould from oxidation, and maintaining the level of the molten metal in the mould always at the same level above the discharge end of the pipe.

7. A process for the continuous casting of metal rods which comprises pouring molten metal continuously at a constant rate into the open upper end of a chilled mould through a pipe projecting into said mould and having less cross sectional area than the cross sectional area of said mould, and withdrawing solidified rod continuously at a rate which maintains the surface of the molten metal constantly at the same level above the discharge end of said pipe.

8. The method of feeding molten metal for the continuous casting of metal rods which comprises feeding molten metal continuously from a furnace to a container, and from said container to a mould at a constant temperature, said molten metal flowing from said container to said mould by gravity through a pipe of fixed diameter, and maintaining a substantially constant head of molten metal in said container in order to obtain a substantially constant rate of flow to said mould.

9. The method of feeding molten metal for the continuous casting of metal rods which comprises feeding molten metal continuously from a furnace to a container and from said container to a mould at a constant temperature by applying pneumatic pressure to said furnace, said molten metal flowing from said container to said mould through a pipe of fixed diameter, and maintaining a substantially constant pressure on the molten metal in said container in order to obtain a substantially constant rate of flow to said mould.

10. A process for the continuous casting of metal rods which comprises pouring molten metal continuously at a constant rate into the open upper end of a chilled mould, withdrawing solidified rod continuously at a constant rate from the other end of said mould, maintaining the temperature of the inflowing molten metal always constant throughout, and maintaining cooling conditions such that the metal freezes at a point close to the upper surface of the molten metal in the mould.

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