M. DOUTEUR.

APPARATUS FOR THE CONTINUOUS PRODUCTION OF INGOTS.

APPLICATION FILED SEPT. 9, 1908.

944,668.

Patented Dec. 28, 1909.

2 SHEETS—SHEET 1.

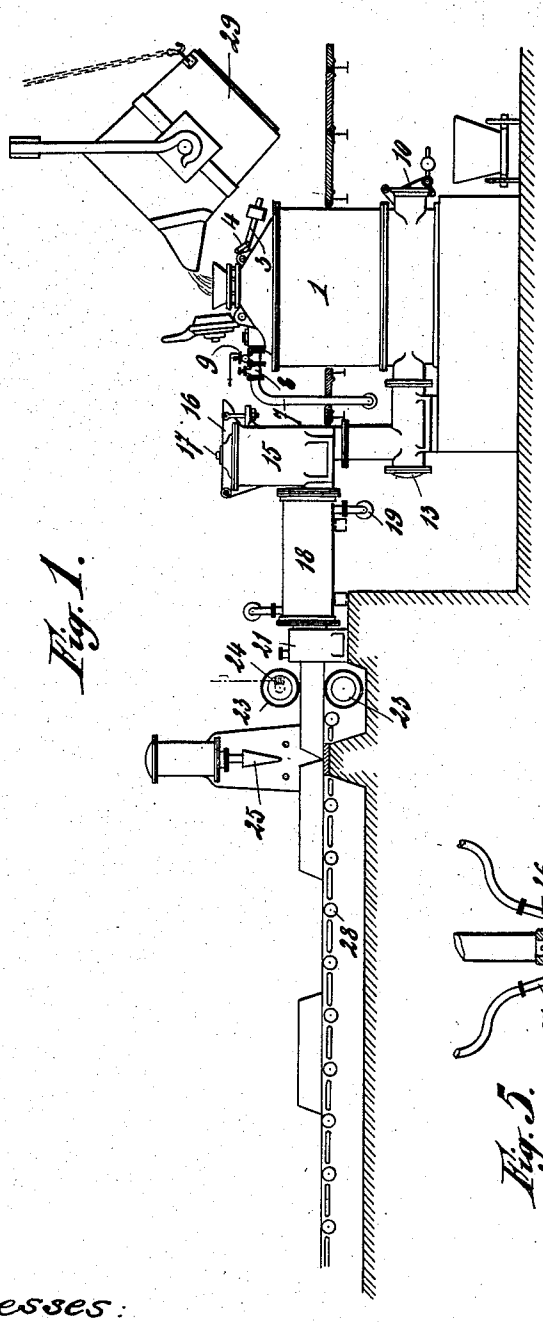

Fig. 1.

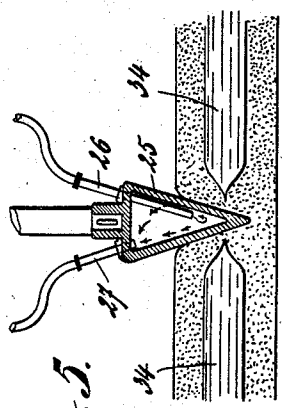

Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 2.

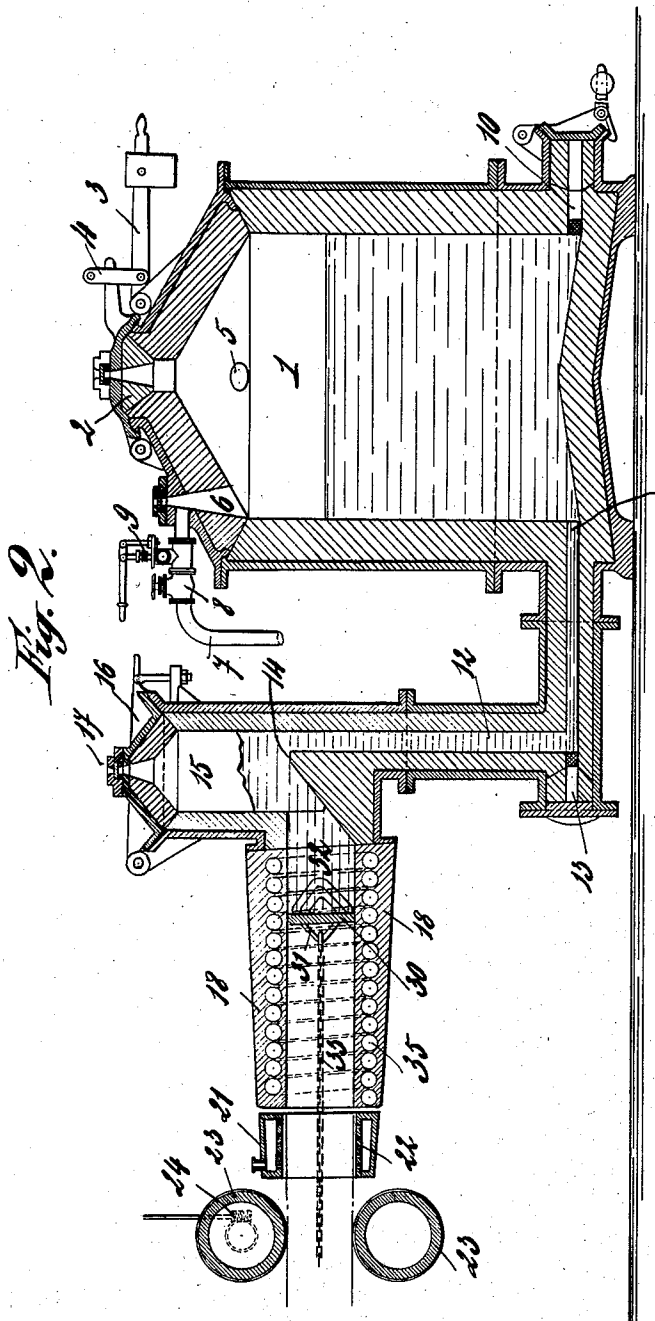


Fig. 4.

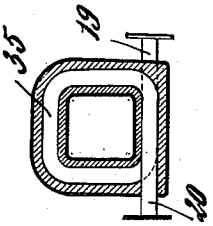
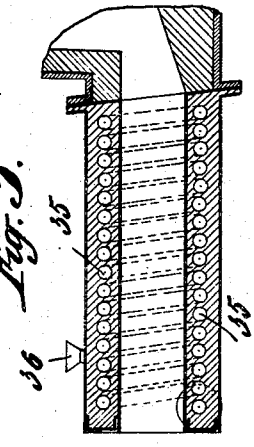


Fig. 3.



Witnesses

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR THE CONTINUOUS PRODUCTION OF INGOTS.

944,668. Specification of Letters Patent. Patented Dec. 28, 1909.

Application filed September 9, 1908. Serial No. 452,325.

To all whom it may concern:

Be it known that I, MATHIEU DOUTEUR, a subject of the King of Belgium, residing at Ekaterinoslaf, Russia, have invented new and useful Improvements in Apparatus for the Continuous Production of Ingots, of which the following is a specification.

Certain processes of manufacturing steel ingots are known, in which a continuous ingot is cast in one piece by causing steel to continuously circulate in an ingot mold cooled to solidify the steel, so that the latter can be cut into ingots of the desired length as it passes out of the mold.

It has not hitherto been possible to adopt these processes in practice, owing to the difficulties attending them more particularly with regard to the considerable danger of the operation. In all these processes, whether the ingot is drawn through the mold in a horizontal or a vertical direction, the mass of steel in the mold supports the entire weight of the melted charge in the casting vessel. If, therefore, the ingot is insufficiently congealed or cooled during its withdrawal, and breaks, the liquid core escapes from the mold and is followed by the whole of the melted steel in the vessel. This gives rise to dangerous dispersals of molten metal, and may cause terrible explosions if the said metal comes into contact with water. Moreover, apart from this important drawback, the said processes are attended with a similar risk at the moment of cutting the continuous ingot into sections. It frequently occurs that at the moment at which the ingot passes under the cutting apparatus the core is not completely solidified, so that when the cut is made a certain quantity of metal runs out, and causes the shape of the ingot to be spoiled, or its quality to be seriously deteriorated. The said processes are also attended with the continuous risk arising from the necessity of cooling the mold with water. The mold used consists generally of a mass of metal inclosing a water-chamber or water-conduit. If for any reason the cooling is insufficient there is the risk that the insufficiently cooled ingot will break at the moment of withdrawal, giving rise to the dispersal of metal or to the disadvantages mentioned with reference to the cutting of the ingot. Moreover, if the mold should crack the flow of water on the ingot or molten steel may give rise to dangerous explosions.

The object of the present invention is to obviate these disadvantages and to enable the continuous production of ingots to be carried out in a practical manner, free from danger.

In order to absolutely dispose of the disadvantages hitherto arising from the action of the molten charge on the mold, the invention substantially consists in placing the ingot mold with its observation chamber at the level, or slightly above the level, of the molten steel mass in the casting vessel, and in placing the latter in communication with the ingot mold by means of an ascending conduit into which molten steel is forced by air or gas pressure acting on the contents of the casting vessel. With this arrangement the mold can be rapidly isolated from the casting vessel in case of danger or other necessity, for example by opening a cock or valve, without operating closing or like devices arranged in the conduit between the mold and casting vessel, such devices being liable to be inoperative when required, owing to their exposure to the action of molten steel.

To obviate the above mentioned disadvantages arising from the cutting of imperfectly solidified ingots, the invention utilizes for the operation in question a hammer having a continuously cooled, hollow, cutting member or part, which effects a supplementary cooling of the steel, when it enters the same, sufficient to produce the solidification of any metal which may have remained liquid at the core. In order to provide a further preventive of inconvenience and risk arising from insufficient cooling of the ingot mold, the latter is constructed in the form of a coiled tube of strong material, for example steel, and is more particularly distinguished from the ingot molds heretofore known, by the fact that it traverses a mass of metal fusible at a comparatively low temperature, so that the melting of this metal affords an indication that the ingot is insufficiently cooled, and accidents or loss are thus avoided.

The annexed drawing illustrates by way of example a construction embodying the invention. Figure 1 is an elevation of plant for the manufacture and automatic manipulation of ingots. Fig. 2 is a vertical section of the casting apparatus on a larger scale. Fig. 3 illustrates another form of construction of the ingot mold. Fig. 4 is a corresponding cross section. Fig. 5 is a separate

sectional view of the cutting member of the hammer used for cutting the ingots.

In the drawings 1 represents a vessel which receives the molten metal and has at the top a hinged cover 2, normally held down by a lever 3, with a safety weight and a link 4. The vessel 1 is provided with a conduit 5 for sucking off the gases, and with a duct 6 having a view hole. To the duct 6 is joined a compressed air pipe 7 provided with a cock 8 and valve 9 for regulating the pressure. The vessel 1 has gates 10 and 11, and the gate 11 leads to an ascending conduit 12 provided at its lower part with an orifice 13 for cleansing purposes. The conduit 12 leads to a kind of dam 14 in a regulating and observation chamber 15 having a cover 16 and view hole 17. To the chamber 15 is connected a water cooled ingot mold 18, into which water is introduced by means of a conduit 19, the said water being discharged through a conduit 20 opposite the conduit 19. The ingot mold 18 preferably has in series with it a hollow cast ingot mold 21 provided with perforations 22. Beyond the ingot mold 21 are placed two cylinders 23 of the type of those used in the manufacture of laminated iron. The axle of one of these cylinders actuates a worm gear 24 connected to an out-put indicator of any suitable type. Beyond the cylinders 23 there is a drop hammer, the hollow cutting member 25 of which is continuously cooled by means of water circulating through pipes 26 and 27. Beyond the hammer there is arranged a conveyer 28.

The action of the apparatus is as follows. The steel is taken from the Martin furnace or converter by means of a ladle 29, provided with an elongated spout to facilitate the pouring of the liquid metal. When the metal in the ladle has been cleansed the ladle is conveyed to the vessel 1 and its contents are poured into the latter, the vessel having been previously heated by means of a wood fire fed with compressed air from the cock 8 and pipe 7. The preliminary heating operation is however only required when starting work; subsequently the successive castings supply the requisite heat. The level of the liquid steel in the vessel 1 must never exceed the level of the top of the dam 14 in the chamber 15, so that metal only flows to the ingot mold when required. Owing to this arrangement of the vessel 1 and chamber 15 the mass of liquid metal in the vessel 1 can at any moment be separated from the metal required to form the ingot, and the metal is cast with an upward flow, so that the purity of the ingot is further increased. When the vessel has been closed the injurious gases contained in the molten steel are sucked off. This operation, which has the advantage that it causes the gas bubbles to burst, is performed by producing a vacuum with the aid of suitable suction apparatus connected to the orifice 5 of the vessel 1.

Prior to casting an ingot a cast iron stopper 30 is inserted into the mold 18, the said stopper having on one side an eye 31, and on the other a plurality of inter-crossing iron bails 32 cast in one with the stopper. The joint made by the stopper is hermetically sealed with clay and a chain 33 is connected to a winch fastened to the eye 31. The cock 8 is then opened to admit a small quantity of compressed air to the vessel 1. This air is caused by the heat to expand, so that its pressure is increased, but the discharge valve 9 does not allow the pressure in the vessel to exceed a certain limit. Under the action of this pressure on the liquid mass, the level of the steel in the chamber 15 is caused to rise above the dam 14, and steel flows into the ingot mold 18. In the latter the steel is immediately solidified by the cooling action due to the water circulating through the pipes 19 and 20. The stopper 30 is thus sealed to the front end of the ingot, and the latter is then drawn through the mold by means of the chain 33. The speed at which the ingot is withdrawn is regulated according to the color and hardness of the steel. After issuing from the mold 18 the ingot enters the supplementary mold 21, in which it is acted on by humid vapor at low pressure which enters through the holes 22 and accelerates the formation. The internal diameter of the mold 21 is slightly larger than that of the ingot, so that the latter does not make contact with the walls, and that the vapor can act freely on the ingot.

On issuing from the mold 21 the front end of the ingot passes between the two cylinders 23. The cable 33 is then disengaged, and movement is imparted to the ingot by means of the cylinders; the latter may be rotated by means of an electro-motor the speed of which can be easily controlled and varied. Beyond the cylinders the ingot is cut by the hammer 25, and during the cutting the section surfaces are cooled by the cold water in order to solidify, at the part cut, the metal still liquid at the core 34 of the ingot (Fig. 5). The ingots cut off are transferred by the conveyer 28 to the rolling mill or suitable furnace. The core of each ingot remains liquid and transmits heat to the external parts, so that there is a recrudescence of heat, as is the case when the metal leaves the furnace.

The purpose of the gate 10 at the rear of the vessel 1 is to allow of slagging the metal in case, after a number of castings, it is judged desirable to do so notwithstanding the cleansing to which the metal has been subjected in the ladle. The orifice 13 is used at the end of the operation, for discharging the residual metal in the vessel 1 and conduit 13, in order that the said metal may be used for a subsequent operation. This conduit is

cleaned with the aid of compressed air, by the same method as adopted in converters.

The ingot mold 18 is continuously cooled, for the purpose of absorbing heat from the molten steel; it may have a single wall, as shown in Fig. 2, or a composite wall as shown in Figs. 3 and 4. Which ever type is adopted the mold is provided with a pipe 35 serving for the circulation of water and forming a coil coaxial with the mold. This coil consists of iron or drawn copper and is so embedded in the mass of which the mold consists that the water does not come into contact with the melted steel if the ingot mold cracks or become worn. The construction shown in Fig. 2 is carried out in cast iron or bronze. The construction shown in Figs. 3 and 4 comprises an envelop of sheet steel or copper inclosing a mass of tin, lead or antimony in which is located the circulation coil. These metals having low melting points melt if the cooling is not sufficiently energetic, and thus give warning so that accidents may be avoided. The melting of the said metals can be seen through the observation aperture 36 (Fig. 3). At the orifice through which the water passes from the mold apparatus such as thermo-meter, water-meter, etc., is preferably arranged to facilitate the control of the operations.

The length of the ingots may be measured or the out-put may be automatically controlled, by means of the apparatus actuated by the worm gear 24.

In carrying the invention into practical effect a second vessel, similar to the vessel, 1, may be used and connected by another conduit 12 to the chamber 15, so that one casting vessel is always available for use.

The cooling water circulating in the wall of the mold 18 is preferably under pressure, so that a maximum of heat may be absorbed by a given quantity of water, the temperature of the water being raised to boiling point.

The mold 18 may be fixed to the chamber 15 by means of bolts, so that it can be exchanged for another of different section by having a flange or the like of the same diameter.

The conveyer rollers 23 may be hollow and cooled by water entering them through their axles.

The vessel 1 may be provided with a naphtha blower which can be fed with air from the compressed air pipe and used if it is judged necessary to reheat the mass of steel in the vessel.

In addition to completely obviating the drawbacks hereinbefore set forth, the invention has the advantage that it can be very easily carried into effect; the working and upkeep are simple and economical as regards manual work, power, and management.

What I claim is:

1. In combination a vessel adapted to contain a charge of molten metal, an ingot mold placed substantially at the normal level of the molten metal in said vessel, means for causing the molten metal to flow into the ingot mold, means for drawing or forcing the metal from the mold as it solidifies and means for solidifying the ingot while cutting the same after issuing from the mold.

2. In combination a vessel adapted to contain a charge of molten metal, an ascending conduit provided at the lower part of said vessel, a water cooled ingot mold connected to said ascending conduit, the said ingot mold being substantially at the normal level of the molten metal in the vessel, means for causing the molten metal to flow into the ingot mold, means for drawing or forcing the metal from the mold as it solidifies and means for solidifying the ingot while cutting the same after issuing from the mold.

3. In combination a vessel adapted to contain a charge of molten metal, a cover adapted to close said vessel, a pipe connected to said vessel for the introduction of compressed air in said vessel, an ascending conduit in communication with the lower part of the vessel, a regulating chamber connected to said ascending conduit, a dam placed in said chamber, a water cooled ingot mold connected to said chamber, said ingot mold being substantially at the normal level of the molten metal in the vessel, means adapted to be inserted into the mold for drawing the ingot through the mold, and means for solidifying the ingot while cutting the same after issuing from the mold.

4. In combination a vessel adapted to contain a charge of molten metal, an ingot mold placed substantially at the normal level of the charge of molten metal in said vessel, a connection between said mold and the lower part of the vessel, whereby the molten metal can only reach the mold when acted upon by a pressure in the vessel, means for drawing the ingot through the mold and a water cooled hammer for cutting the ingot when issuing from the mold.

5. In combination a vessel adapted to contain a charge of molten metal, a water cooled ingot mold comprising a mass of metal having low melting point, said mold being placed substantially at the normal level of the charge of molten metal in the vessel, a connection between said mold and the lower part of the vessel, whereby the molten metal can only reach the mold when acted upon by a pressure in the vessel means for drawing the ingot through the mold and a water cooled hammer for cutting the ingot when issuing from the mold.

6. In combination a vessel adapted to contain a charge of molten metal, a water cooled

ingot mold comprising a mass of metal having a low melting point, means for establishing communication between said mold and the vessel, whereby the molten metal can reach the mold, means for drawing the ingot through the mold, and means for cutting the ingot when issuing from the mold.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

MATH. DOUTEUR.

Witnesses:
J. St. Clairfaralli,
D. Papiachi.