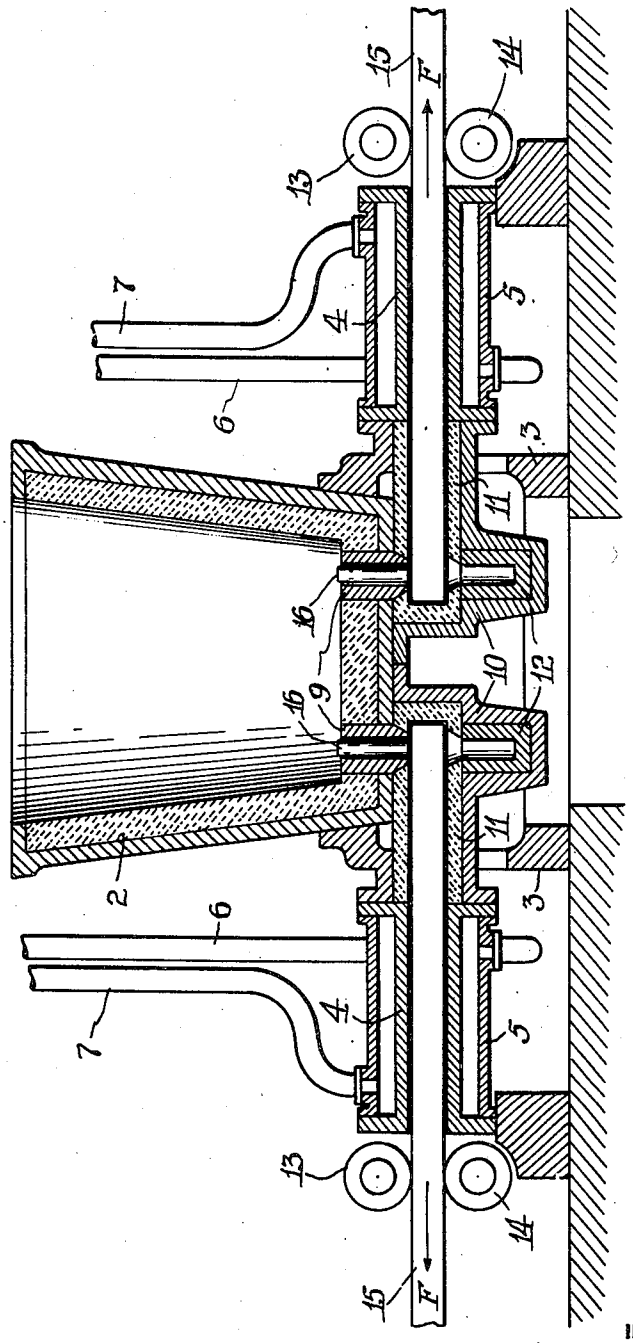
Jan. 17, 1950 J. F. A. JACQUET 2,494,619

INSTALLATION FOR THE CONTINUOUS CASTING OF INGOTS

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FIG. 1.



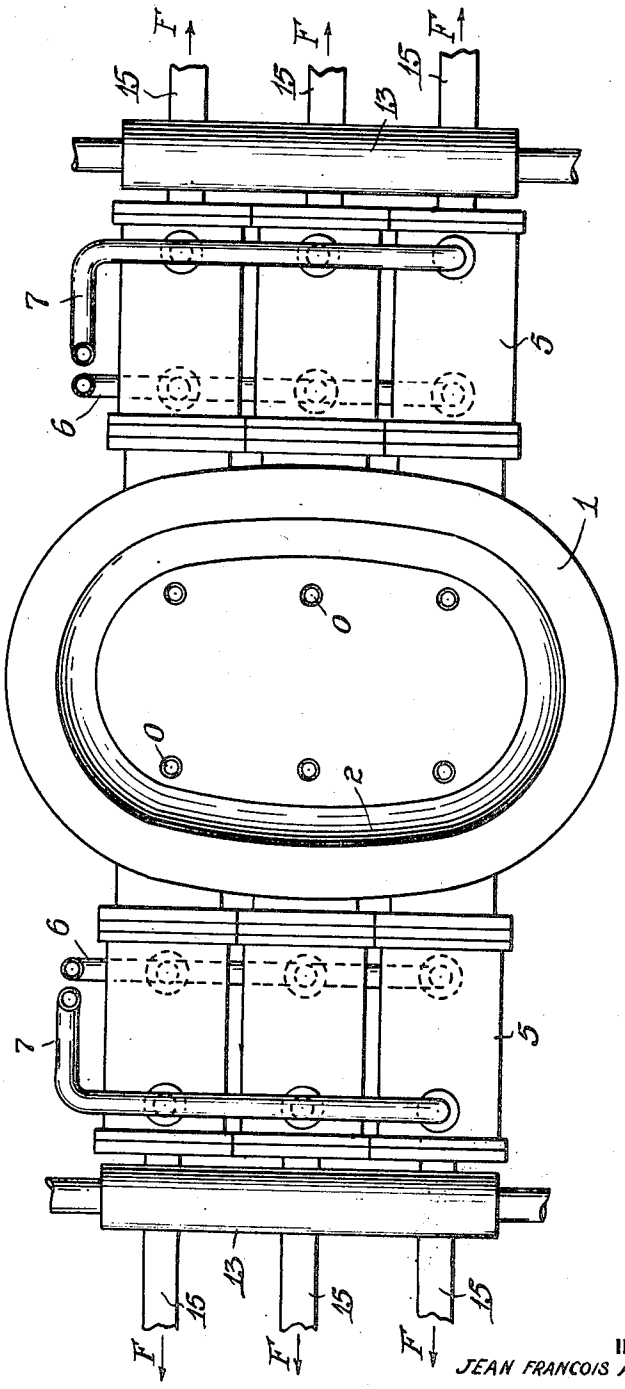
INVENTOR:
JEAN FRANCOIS AUGUSTE JACQUET
BY
Richardson and David
ATTORNEYS

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INSTALLATION FOR THE CONTINUOUS CASTING OF INGOTS

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FIG. 2.



INVENTOR:
JEAN FRANCOIS AUGUSTE JACQUET

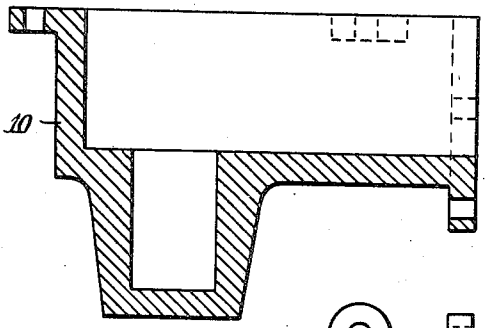
BY
Richardson and David
ATTORNEYS

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INSTALLATION FOR THE CONTINUOUS CASTING OF INGOTS

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FIG. 3.



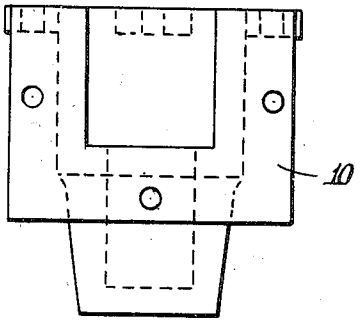


FIG. 4.

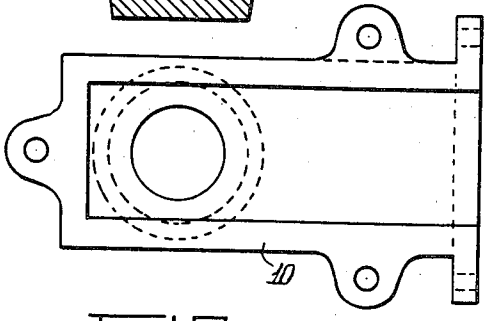


FIG. 5.

INVENTOR:
JEAN FRANCOIS AUGUSTE JACQUET

BY
Richardson and David
ATTORNEYS

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UNITED STATES PATENT OFFICE

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INSTALLATION FOR THE CONTINUOUS CASTING OF INGOTS

Jean François Auguste Jacquet, Brussels, Belgium

Application January 26, 1946, Serial No. 643,630
In Belgium February 11, 1943

Section 1, Public Law 690, August 8, 1946
Patent expires February 11, 1963

1 Claim. (Cl. 22—57.2)

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My present invention relates to an installation for the continuous casting of ingots comprising a stationary casting pocket and one or several horizontal ingot casting moulds, each containing an ingot core and each provided with a cooling arrangement.

Various methods and arrangements have already been proposed for realising this operation but none has been capable of industrial application with a view to effecting ingot manufacture from all metals, including steel.

The present invention may be conveniently adapted for the manufacture of ingots from all ferrous or non ferrous metals although a particular application of the casting of ingots from steel is hereinafter described.

It was found that difficulties encountered up to the present are attributable to a large extent to the fact that it is indispensable for a given casting that the vessel destined to receive the metal in molten state must be carefully freed from the congealed metal which results from the preceding casting and which adheres to the lateral walls and base of the vessel, as well as to the refractory conduit for the outflow of the metal, and that this removal of the congealed metal should take place without the necessity of dismantling the refractory lining of the vessel as this should serve for a maximum number of operations.

One of the objects of the present invention is to suppress this defect of known apparatus and at the same time, to enable ingot castings to be effected in an entirely automatic manner.

A further object of the present invention is to ensure that the molten metal is not subjected to air exposure during the process and to make possible the simultaneous casting of several ingots from a single casting pot and so reduce the casting speed. The increased efficiency of the cooling fluid thus obtained will enable the metal to solidify to a sufficient degree to avoid ruptures and wrinkles occurring in the skin of the ingot during the course of discharge from the casting machine.

Among the advantages thus obtained by such an installation should be noted the material improvement in the quality of the metal at the same time as a considerable lowering in the price of the manufactured products, this improvement of the quality being notably concerned with the homogeneous condition of the metal, the fineness, regularity, and purity of the grain, the absence of cavities, wrinkles and other defects present in ingots cast by the known methods.

According to the invention, this installation is characterised principally in that each horizontal

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ingot mould is caused to communicate with an opening in the bottom of the pocket through a refractory horizontal conduit, which has the same section as the ingot mould, is housed in a box open towards the top and secured in an easily detachable manner to the bottom of the pocket, in such a way that this housing can be readily separated from the bottom referred to, even in the case in which after the casting operation, the refractory conduit and the brick lining the casting opening in the bottom of the pocket, should be filled with metal which may have become solidified and might be connected to that which may eventually be found congealed in the pocket.

In the practical application of the invention, the removable box referred to contains a brick which is arranged co-axially with a brick lining the opening in the bottom of the box and which is provided with a bore terminating in the horizontal refractory conduit and destined to receive upon the displacement towards the exterior of the ingot mould core, a refractory pin fitted in the cavity of the brick in the opening of the base of the pocket.

Moreover, the liquid metal contained in the casting pocket may, with advantage, be subjected to the action of pressure exercised conveniently with the aid of a piston or like organ. The interior of the pocket containing the metal is lined with refractory material and the piston at the same time as it exerts a pressure upon the liquid metal, is caused to compress a plastic material of a refractory kind disposed in a space comprised between a prolongation of the piston and the internal surface of the portion not lined of the pocket in such a way that this plastic material forms a joint between the piston and the internal refractory lining in the lower portion of the pocket containing the metal.

On the annexed drawings:

Fig. 1 is a vertical cross section and Figure 2 is a plan view showing a plant, according to the invention, in which a pressure is not exerted on the metal contained in the pocket.

Figs. 3, 4 and 5 represent respectively a vertical section, a profile view and a plan view of the removable box-like runner. They illustrate by way of example, how it may be constructed in order to enable its rapid detachment from the base of the pocket.

The installation illustrated in Figure 1 comprises fundamentally a metallic casting pot 1 which has the shape of the frustum of a cone, which is provided with a refractory lining 2 and which is held in a support 3.

The bottom of the pocket 1 in the example shown is provided with six openings O, (Fig. 2) permitting the flow of metal towards six ingot moulds 4 arranged horizontally. Those ingot moulds are, with advantage, made of a metal of high thermic conductivity, for example, of an alloy of Al—Si or Al—Cu of the Elpax or Duralumin class. In order to increase the resistance to bursting, they could, with advantage, be strengthened or bound, for example; by means of steel wire (not shown) wound round them under convenient tension. Each ingot mould 4 is surrounded by a sleeve 5 with which are connected two pipes 6 and 7, one of which supplies to the sleeve 5 a cooling fluid which is evacuated by the other after heating.

Each opening O in the bottom of the pocket 1 is provided with a refractory brick 9 pierced longitudinally with a cylindrical bore, through which the steel can flow out.

Moreover, secured to the bottom of the pocket 1 for example, by bolts or clamps, are removable box-like runners 10 the number of which corresponds to that of the openings O and in each of which is fitted at a right angle to the direction of the brick 9 a hollow cylindrical brick 11 the bore in which has the same section as that of the ingot to be cast. The runner 10 contains a further hollow brick 12 having the same bore as that in the brick 9 and terminating at its upper extremity in the cavity of the horizontal brick 11. The axes of the bricks 9 and 12 coincide as shown in the drawing.

Directly connected to the metal runner 10 is the ingot mould 4 having the same internal cavity as the hollow brick 11.

Means are provided, moreover, as shown in Figs. 3, 4 and 5 enabling the runner 10 to be separated from the pocket 1 even in the case in which the bricks 9 and 11 should be filled with solidified steel which may be integral with residue in the casting pot, that is to say, metal which may have become solidified in contact with the refractory lining of the pocket forming a crust thereon.

Thanks to this removability, the runner 10 may be readily separated from the base of the pocket 1 even in the case in which after the operation, the brick 11 and the brick 9 should be filled with steel that may have solidified and have become bound at the base of the pocket but eventually formed in the pocket 1.

In the event of a solidification of steel in the interior of the bricks 9 and 11 the runner 10 would be removed, the brick 11 broken in order to reach the steel and thereupon the vertical body of this solidified steel cut away by a blow-pipe or any other means. The metal solidified in the bottom of the pocket 1 can then be removed from the pocket together with the steel which has solidified in the brick 9 and bound to the said metal solidified in the bottom of the pocket; this removal can take place easily in view of the decreasing section from bottom to top of the casting pot.

At the exit of the ingot mould are disposed two cylinders 13 and 14, the distance between which can be varied by any appropriate means and which may rotate in opposite directions.

Use is made in a known manner of an ingot mould core 15 which before the introduction of the steel into the pocket 1 will be fitted in position to occupy entirely the interior cavity of the ingot mould 4 and that of the brick 11. The free extremity of this core 15 is engaged between the two cylinders 13 and 14.

At that end of the ingot core which extends into the cavity of the brick 11 provision may be made of one or several organs such as hooks, destined to remain plunged in the metal, whereby after solidification the ingot can be carried along by the ingot core 15, with which it has become bound by the means referred to.

Before filling the pocket 1, the bore in the brick 9 is fitted with a cylindrical pin 16 of the same composition as the brick and resting by its base on the ingot core 15. This pin 16 is intended to form a plug and to prevent the metal contained in the pocket 1 from passing into the casting conduit before it is necessary. Otherwise, the metal which would fill this conduit and remain there during the filling of the pocket, would become solidified.

After the pocket 1 has been charged, the ingot core 15 is displaced in the direction of the arrow F lengthwise to enable the pin 16 to drop into the cavity in the brick 12 filling it completely.

In this way, the casting opening in the pocket is automatically freed from its plug and the casting of the ingot proper may then commence, the steel arriving at this moment in the cavity of the brick 11.

The gate of the entry for the cooling fluid into the sleeve 5 is then opened and the cylinders 13 and 14 put into operative use.

Obviously, according to the progress of the casting, cutting of the continuous ingot and provision for auxiliary cooling may be made by any desired means after the exit of the ingot from the mould.

In the eventuality of a solidification of steel in the bore of bricks 9 and 11, the runner 10 can also be removed easily, the brick 11 is broken and the steel having eventually been solidified cut away as hereinabove explained. A difference consists however in that the casting pot 1 and its refractory lining 2 can then be separated from the base 3^1 and lining 2^1. This enables the removal from the base of the steel solidified therein as well as that contained in the brick 9.

As will be readily conceived, the flow of the steel outside the pocket 1 right up to the ingot mould is effected under the protection from air and the generation of gas produced during the casting in the usual processes of ingot manufacture will be rendered impossible.

The gases developed during the flow of the metal in the ingot moulds are extremely noxious and in this respect, the installation, the object of the invention, offers, therefore, a great advantage compared with others hitherto used.

Moreover, the whole installation is completely above ground which again constitutes an important advantage and thanks to the possibility of realising without inconvenience or difficulty the run of the metal into several horizontally disposed ingot moulds it is possible to cause several ingots to be cast concurrently from the same casting pocket. The speed of the flow may, due to this fact, be reduced to useful proportions and the action of the cooling medium be thus made more efficient.

There is no reason why the pocket should not be provided with the largest number possible of outflow openings. To each pair of cylinders could be subordinated two ingot moulds in parallelism. But one could also provide as many ingot moulds as would be compatible with the interior diameter of the pocket so that two pairs of cylinders might serve for the casting of the largest possible number of ingots and that one couple of cylinders disposed at one side of the pocket could

take off a series of parallel ingots in one direction and another pair of rollers disposed laterally to the casting pot and diametrically opposed to the first pair would take off another series of ingots as for example in Figure 2.

During the execution of the ingoting operations, it may be of advantage to provide for a pressure action to be exerted on the molten metal contained in the pocket 1.

In accordance with the exchange of temperature between the steel arriving in the ingot mould 4 and the cooling fluid in the housing 5, a crust of steel is formed, so to say, instantly by the contact with the cooled walls of the ingot mould.

The nature, the temperature, the pressure of this fluid will all be judiciously determined as also the thickness and the length of the ingot mould, as well as the section of its housing.

The described installation will be found to satisfy all the conditions indispensable to casting on an industrial scale.

According to the study made by the applicant, these essential conditions are the following:

1. The ingot mould should be horizontal (in order to avoid casting pits of prohibitive depths).

2. The horizontal ingot mould should be connected to the pocket itself without disruption of continuity (in order that the weight of metal of the pocket may co-operate with the run and compensate for the tractional effort exercised by the delivery cylinders).

3. After each casting operation, the crust of the metal solidified by contact with the lining of the pocket, should be capable of being removed.

The above explanations show that this condition is more particularly envisaged in the actual invention and that the means which are fundamental thereto enable the result depending on this condition, to be attained.

4. The outflow conduit should be provided in the base of the pocket, and not in its lateral wall.

As a matter of fact, an opening in the lateral wall would prevent extraction of metal congealed upon contact with the refractory lining of the pocket and of the outflow conduit.

Moreover, an opening provided in the lateral wall would not enable the pocket to be completely emptied, which however, is indispensable.

Even in the case in which the opening were as near as possible to the base of the pocket, it would happen that at the end of the flow, the metal could not run out under pressure and the reduced speed of its outflow would provoke its solidification to a much greater thickness, not only in the base of the pocket but also in the conduit connecting it to the ingot mould, and this metal could not be extracted from the pocket.

It should be added that should the metal attain a level below the level of the ingot mould, the ingot could not be formed in a normal manner.

5. The pocket should contain the total of metal for the ingot to be cast before the outflow of the metal may commence.

This necessity results from the fact that quite frequently (and one may say always in the case of steel), final additions are made not in the furnace but in the pocket. The outflow of the metal from the pocket into the mould cannot, therefore, commence until these final additions to the totality of the cast have been made.

Moreover, it is indispensable to wait a few moments before casting when the pocket is full in order to enable impurities contained in the metal to rise to the surface of the bath.

6. The metal should not penetrate into the outflow conduit during the filling of the pocket.

If this should happen, this metal in the outflow conduit would become solidified therein. The opening should, therefore, be obstructed from the inside of the pocket during the time necessary for filling it with the metal.

7. The speed of the casting should likewise be reduced if possible, in order to permit the cooling fluid to exercise its cooling action with the maximum efficiency.

8. The pocket must be emptied of its contents while the condition of the metal remains amenable to its running.

This condition is one which appears to be obvious without explaining its necessity.

It is easy to appreciate that this installation, the object of this invention, will permit of the fulfillment of the whole of the above conditions. With the conditions referred to above under (8) in mind, the applicant has provided for the multiplication of the ingot moulds with the object of enabling the whole of the contents of the pocket to be emptied during the time desirable for this operation while making it possible:

(a) to slow down the linear speed of the flow in a manner to obtain a sufficient drop of the temperature of the metal during its passage into the ingot mould;

(b) to avoid the employment of ingot moulds of abnormal lengths which would render the arrangement incapable of industrial application.

The invention is of considerable interest both from the point of view of the material improvement of the quality of the metal and that of the lowering of the cost of the products thus produced.

Tests have proved the perfect homogeneity of the ingot metal, of its fineness, its regularity and purity of grain, the rational absence of cavities, wrinkles and other flaws traceable in ingots cast by the habitual methods.

This notable improvement of the quality of the metal is attained on the one hand due to the rapidity with which its solidification takes place which results in the avoidance of segregations provoking a heterogeneous character of the metal, and on the other hand, thanks to the fact that cavities or other flaws caused by contraction of metal in the course of its solidification, are non-existent due to the uninterrupted run of the molten metal through the zone of its solidification.

The absence of such flaws which occur in ingots cast by known methods and result in losses of up to or even exceeding 25% represents an economic advantage of considerable importance. Moreover, the invention results in an important simplification of the manufacture which enables ingot production to be effected practically in an automatic manner.

What I claim is:

A casting apparatus comprising a refractory vessel having a base, said base being provided with an outlet bore therethrough having a vertical axis, a removable plug in said outlet bore, a horizontally disposed runner communicating with said outlet bore, said runner having a chamber protruding downwardly therebelow in alignment with said outlet bore, said chamber being of a size to accommodate said plug at the initiation of flow of molten metal from the vessel to the runner, including an ingot core in said runner disposed for horizontal withdrawal therefrom and

supporting said plug in said outlet bore prior to initiation of flow.

JEAN FRANÇOIS AUGUSTE JACQUET.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
560,661	Trotz	May 26, 1896
770,130	Trotz	Sept. 13, 1904
944,370	Monnot	Dec. 28, 1909
944,668	Douteur	Dec. 28, 1909
1,018,217	Szathmary	Feb. 20, 1912
1,209,039	Rowley	Dec. 19, 1916
1,313,593	Griffith	Aug. 19, 1919
1,681,943	Marshall	Aug. 28, 1928
1,873,549	Coffey	Aug. 23, 1932
2,121,280	Bell	June 21, 1938
2,126,808	Phillips	Aug. 16, 1938
2,135,465	Eldred	Nov. 1, 1938
2,187,720	Williams	Jan. 23, 1940
2,257,713	DeBats	Sept. 30, 1941
2,371,604	Brennan	Mar. 20, 1945

FOREIGN PATENTS

Number	Country	Date
447,272	Belgium	Oct. 31, 1942
449,161	Belgium	Mar. 31, 1943
138,769	France	Sept. 10, 1880
905,295	France	Apr. 9, 1945
27,644	Luxemburg	June 1, 1945