Aug. 21, 1928. 1,681,191

J. MAXIMOFF ET AL

APPARATUS FOR REFINING METALS

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Fig.1.

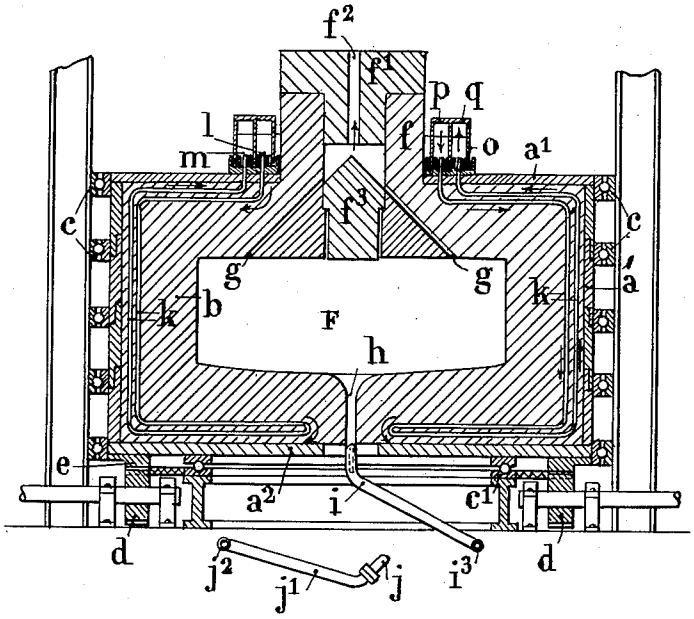
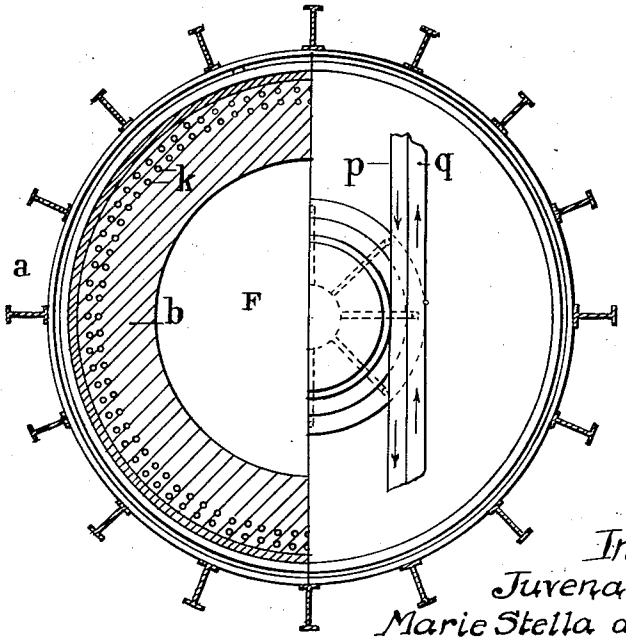


Fig.2.



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Fig.3.

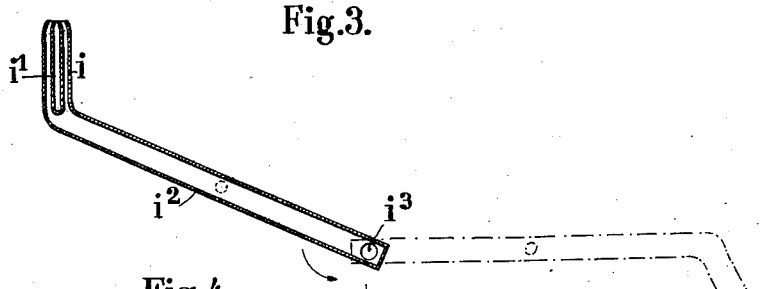


Fig.4.

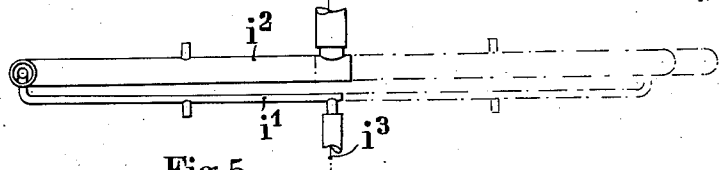


Fig.5.

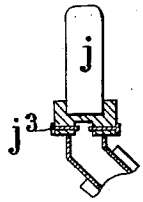


Fig.6.

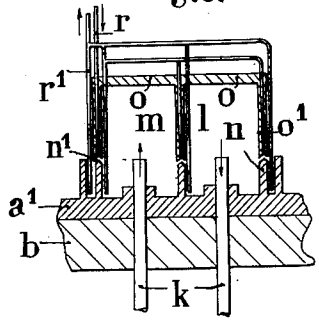


Fig.7.

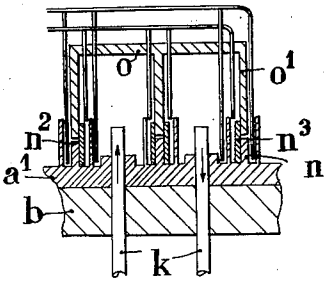


Fig.8.

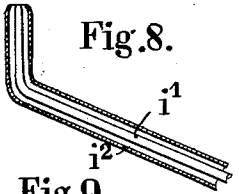
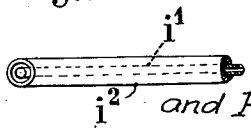


Fig.9.



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Fig.10.

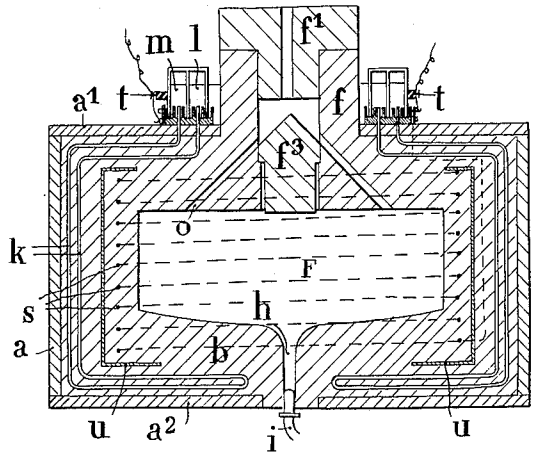
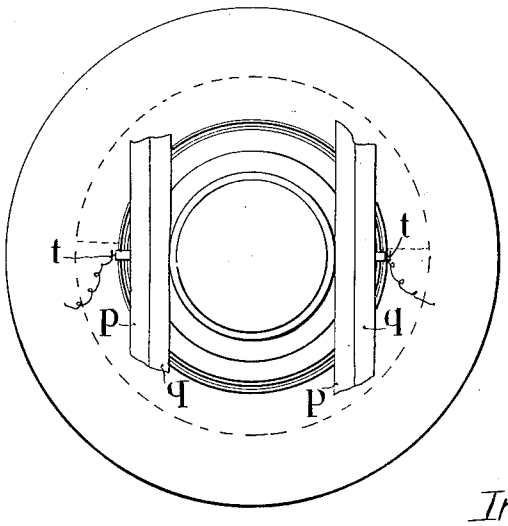


Fig.11.



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Fig.12.

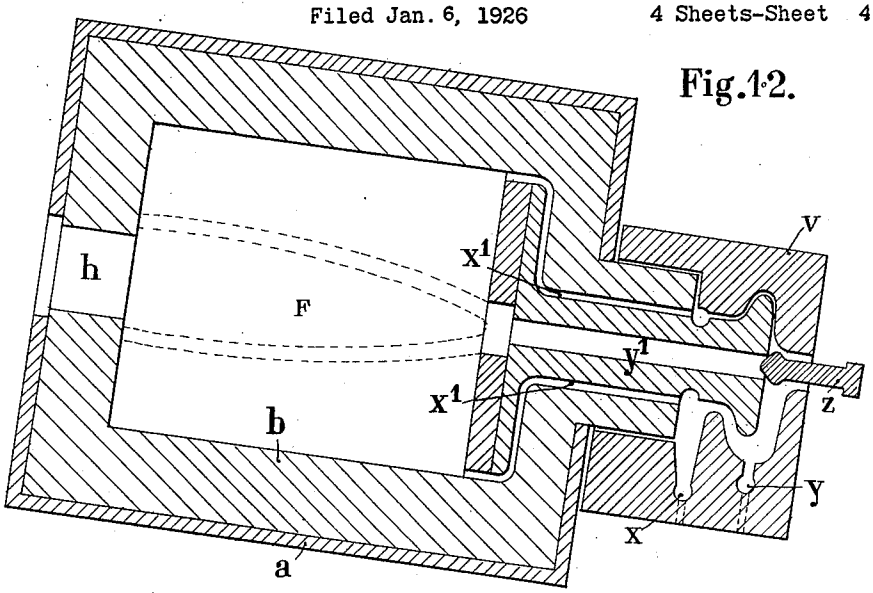
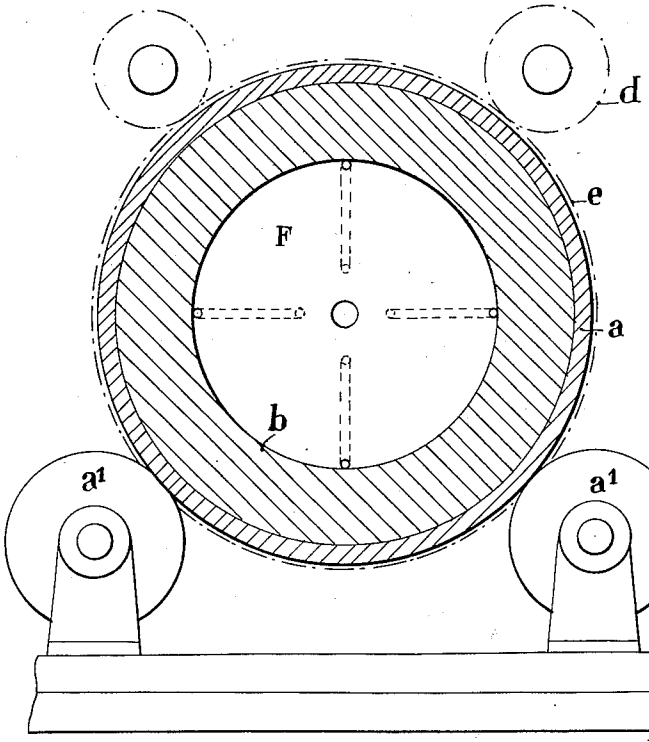


Fig.13.



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Patented Aug. 21, 1928. 1,681,191

UNITED STATES PATENT OFFICE.

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APPARATUS FOR REFINING METALS.

Application filed January 6, 1926, Serial No. 79,584, and in France November 28, 1925.

It is known that steel, whether it comes from the Bessemer converter, the Siemens Martin furnace or from the crucible, always contains impurities, slags, agglomerates of special constituents, dissolved gases, etc. The same is true of pig-iron. The most improved refining processes which have been used cannot free them from these impurities which diminish the physical, chemical and even electrical qualities of the steel and cause considerable waste at the time of moulding and of the other operations to which they are subjected.

The present invention has for object a mechanical process permitting to very rapidly and effectively separate steel and pig-iron from the various impurities and dissolved gases. This process has no action on the compounds chemically combined, or dissolved in the steel, but it allows of removing all the materials which form with steel or pig-iron in a molten condition a very intimate mechanical mixture. It does not do away with the effect due to the liquation of iron carbides, but it sensibly reduces the inconvenience of the same.

The invention essentially consists in subjecting to the action of centrifugal force the metal to be refined, by subjecting it at the same time to a heating which allows of bringing it to a sufficient degree of fluidity.

Moreover, for obtaining the said refining, the new process is characterized by a combined action of centrifugal force and gravity, as will be explained hereinafter.

The process forming the subject matter of this invention is substantially carried out by a combination of means permitting to bring the metal to a temperature sufficiently high for producing a real superheating and of means allowing, by movement of rotation at a speed suitably controlled according to the phases of the operation, to develop at the same time centrifugal force and to thus obtain the desired refining.

The invention also comprises an apparatus for carrying out this process, constituted by a casing of refractory material, so arranged as to be capable of rotating at a high speed, and of a heating system, either by the combustion of a gas, or by means of electric currents, and particularly of Foucault currents, or both combined. Means are provided for continuously bringing the combustible gas, or the electric current, to the rotating system, notwithstanding the rotary movement.

The apparatus is provided with a cooling system by circulation of air adapted to prevent superheating of the peripheral part of the casing; this system is so combined as to establish the necessary communications between fixed air inlet and outlet conduits and the rotary system.

In a form of construction applicable in case of discontinuous operation the apparatus also comprises channels for introducing the molten metal and distributing it to the periphery of the rotating part and an exhaust conduit arranged at the center.

In another form of construction applicable in case of continuous operation, the apparatus is provided with a collecting separating device where are collected on the one hand the pure metal, on the other hand the slag which flows outside either in a continuous manner, or at intervals as short as desired.

The refined steel obtained by means of this process and of this apparatus is absolutely free from gases and impurities and perfectly homogeneous. The qualities of this metal are sensibly improved, particularly the mechanical resistance which is considerably increased.

In order that the invention may be clearly understood, various forms of construction of the apparatus such as it can be realized have been illustrated in the accompanying drawing given by way of example only.

In this drawing:

Fig. 1 is a vertical section of an apparatus for discontinuous operation and heated by means of gas.

Fig. 2 is a corresponding view partly in plan view and partly in horizontal section.

Figs. 3 to 9 illustrate details of construction.

Figs. 10 and 11 are two views similar to Figs. 1 and 2 and relate to a modification, in case of electric heating.

Fig. 12 is a longitudinal section of an apparatus for continuous operation.

Fig. 13 is a cross section corresponding to the preceding figure.

As illustrated in this drawing, the new apparatus comprises a rotating casing adapted to receive the liquid steel and constituted

by a steel armour a formed, for instance, by rings fitted one in the other and bolted together. The cylinder thus obtained is integral with bottoms or heads a^1, a^2. It is internally lined with a coating of refractory material b, made for instance of magnesia, quick lime or any other material which is not attacked by the liquid metal. At the interior is thus formed a chamber F of suitable capacity.

The device thus constituted is mounted on several bearings c, c^1 and it can be actuated by pinions d gearing with a toothed crown e integral with the bottom.

The upper part forms a kind of flue f which can be closed by a movable plug f^1 in which is provided a conduit f^2. The bottom of the flue is closed by a cone f^3 from which start channels g obliquely arranged and leading in the rotating chamber at a sufficient distance from the axis of rotation.

The bottom of the furnace is perforated with an axial conduit h in which can be fitted the end of a burner i receiving a mixture of combustible gas and air, led in by pipes i^1 and i^2, Figs. 3 and 4. This burner can rock on an axis i^3, so that it can be moved away from the conduit h and in its place can be positioned a plug j made of graphite and carried by a support j^1 pivoting on an axis j^2. The plug j is mounted on the said support through the medium of a step bearing j^3 (Fig. 5) which allows this plug to rotate with the furnace.

For preventing the wall of the rotating apparatus to reach an excessive temperature, the lining b is cooled by a circulation of air, which latter can be realized as illustrated by means of pipes k one end of which opens in an air distributing conduit l and the other end in another conduit m. These conduits are formed by crowns n (Fig. 6) integral with the rotating part, and a double inverted channel member o. This double channel member is rigid with inlet and outlet conduits p, q which serve at the same time as supporting beams for the portion of the apparatus which is above the rotating system. The circulation of the air takes place as indicated by the arrows. It is produced by a pump or fan. The hot air can be used for feeding the burner.

The joints between the fixed member and the movable members are situated at n^1 (Fig. 6) or n^2 (Fig. 7). In the case of Fig. 6, these members are engaged together according to a U-shaped profile. In the case of Fig. 7, the edges of the crowns n and o^1 which are in contact are straight and the resilient fluid tight rings n^3 are applied on the joints.

The lubrication of the friction parts is ensured by means of oil fed by pipes r; the excess is removed through other pipes r^1.

The operation of this apparatus is as follows:

The chamber F is heated by means of the burner i introduced in the conduit h. The combustion products escape through the passage f^2. For preventing superheating of the casing, the system of ventilation is put in action. The cold air coming in for instance through the conduit p enters into the annular space l forming a distributing chamber, passes through the pipes k, issues from the latter at m and is evacuated by the conduit q. The rotating device is caused to rotate by means of the pinions d.

For charging the chamber F, the plug f^1 is removed and the molten metal to be refined is poured in the flue f; the metal can thus be directly poured from the converter or it can be brought along in a ladle.

The liquid falling at f, passes in oblique channels g which bring it to the peripheral portion of the chamber. The centrifugal force acts nearly immediately on the metal which moves towards the periphery and has no tendency to issue through the central lower conduit h. For greater security the pressure is increased in the burner i during charging, in order to prevent the metal from entering the conduit h, as long as it does not completely participate to the movement of rotation and that its molecules are not yet subjected to the totality of the centrifugal force which may be developed by this rotation.

The metal is left for a certain time in the apparatus; this time depends on several factors: the speed of rotation of the thickness of the metal layer operated upon, the nature of the metal, etc.

Under the action of the centrifugal force the densest portions move to the periphery, it is the pure metal; the foreign materials, which are the lightest, are at the center. For separating these foreign materials, the gas burner is removed; the speed of rotation is diminished; the impurities flow away through the conduit h and they are received in a slag carriage. After flowing away of the impurities, the speed of rotation is again increased for preventing the steel to flow away in its turn into the slag carriage. This carriage is replaced by a ladle and the speed of rotation is diminished so that the steel flows into this ladle. The heating is then reestablished for a next operation.

It will be seen that at the time the speed of rotation is diminished, gravity is permitted to act for the purpose of effecting the separation of the various elements as just explained. There is therefore in the new process, a characteristic combination of the action of centrifugal force and of that of gravity.

Instead of placing the two tubes i^1 and i^2 of the burner parallel, Fig. 4, they can be placed one inside the other, as illustrated in Figs. 8 and 9, this arrangement rendering the apparatus less cumbersome.

The new apparatus can be heated in any other manner than by combustion of a gas.

In particular, electric heating can be used. In this case, it is convenient to employ heating currents such as Foucault parisitic currents.

Figs. 10 and 11 illustrate a modification of the furnace with electric heating. In the lining is arranged a winding s the ends of which are connected to contacts t each comprising a ring and a wiper. A magnetic screen u is arranged about the winding. The remainder of the apparatus is similar to that of Fig. 1.

Heating by gas and electric heating can also be combined: the latter can serve for terminating the heating and bringing the steel to a temperature at which its fluidity is sufficient.

Instead of a discontinuously operating apparatus a continuously operating apparatus can also be realized, such for instance as that shown in Figs. 12 and 13.

This apparatus comprises a cylinder similar to that already described, in which a combustible gas is injected at h, or provided with an electric heating winding; this apparatus comprises also a circulation of air as previously and the means (not shown) for ensuring the same.

This cylinder rests on rollers a^1 and rotates about an axis forming a certain angle with the horizontal, so that during the rotation the fluid baths of slag and steel are internally limited by surfaces in the shape of a paraboloid of revolution diagrammatically illustrated in the drawing.

Its characteristic portion is a header separating the refined steel and the slag and composed of members rotating with the cylinder and of a fixed block v leaving between it and these members intervals x and y which constitute the pockets wherein accumulate the steel and the slag: the annular pocket x communicates through conduits x^1 with the peripheral portion of the chamber; the annular pocket y communicates through a conduit y^1, controlled by a s crew plug z, with a central portion in which accumulate the impurities. Outlet conduits formed in the fixed block v lead outside in a continuous manner, on the one hand the steel and, on the other hand, the impurities. These conduits can also be plugged up and periodical tappings as frequent as desired can be effected.

The steel to be refined is introduced at h in a continuous manner or at short intervals, but without stopping the apparatus which constantly rotates, through a suitable feeding pipe.

The steel obtained by the process and the apparatus which have just been described is perfectly homogeneous and absolutely free from gases and impurities. Its resistance to stresses of any kind, its resiliency, its hardness, etc. are very superior to those of the best crucible steel.

Owing to the fact that it contains neither gases nor impurities, air holes, settlings and other usual defects are avoided upon moulding and the enormous waste which occurs with the known processes is done away with.

The above arrangements are given by way of example only, the invention can be carried out according to any modification of execution based on the principles which have been set forth. Moreover, the forms, dimensions, details of construction and the material used for the apparatus, can be varied without departing from the principle of the invention.

Claims:—

1. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace about its vertical axis, means for heating the interior of the furnace, and means rotatable with the furnace for cooling the walls of the furnace to prevent excessive heating thereof.

2. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace about its vertical axis, means for heating the interior of the furnace, and means rotatable with the furnace for cooling the walls of the furnace to prevent excessive heating thereof, said cooling means being located in the walls of the rotatable furnace.

3. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace about its vertical axis, means for heating the interior of the furnace, and means rotatable with the furnace for cooling the walls of the furnace to prevent excessive heating thereof, said cooling means comprising means for circulating air through the furnace walls.

4. The apparatus recited in claim 1, together with a crown rigid with the furnace and communicating with said cooling means, and an inverted crown fitted on said first-mentioned crown and leading from a supply of cooling air so as to provide for communication between the supply of cooling air and the cooling means during rotation of the furnace.

5. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace, and a narrow discharge opening in the bottom of the furnace at the axis of rotation hereof.

6. The apparatus recited in claim 5, together with means for temporarily closing said opening.

7. The apparatus recited in claim 5, together with a burner adapted to fit in said opening to close same temporarily while heating the interior of the furnace.

8. The apparatus recited in claim 5, together with a burner adapted to be rocked into engagement with the opening to close same temporarily while heating the interior of the furnace.

9. The apparatus recited in claim 5, together with a burner adapted to be rocked

into engagement with the opening to close same temporarily while heating the interior of the furnace, and a plug adapted to be rocked into engagement with said opening to replace the burner and close the said opening when the furnace has been heated to the required temperature.

10. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace, means for heating the interior of the furnace, means rotatable with the furnace for cooling the furnace walls, a flue in the top of the furnace at the axis of rotation of the furnace, and a plug fitted in said flue.

11. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace, means for heating the interior of the furnace, means rotatable with the furnace for cooling the furnace walls, a flue in the top of the furnace at the axis of rotation of the furnace, and a plug provided with an exhaust conduit fitted in said flue.

12. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace, means for heating the interior of the furnace, means rotatable with the furnace for cooling the furnace walls, and means for introducing a charge into the furnace between the axis of rotation and the periphery.

13. An apparatus for the refining of metals comprising a rotatable furnace, means for rapidly rotating the furnace, means for heating the interior of the furnace, means rotatable with the furnace for cooling the furnace walls, an opening in the top of the furnace, and radial conduits diverging from the said top opening into the interior of the furnace so that the material fed into said opening may be introduced into the furnace between the axis of rotation and the periphery thereof.

The foregoing specification of our "Apparatus for refining metals," signed by us this 14th day of December, 1925.

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MARIA STELLA de COSTA, born VINCENT.
ROBERT PAUL DANIEL KREBS, otherwise known as LUC GALLICANNE.