Aug. 11, 1931. A. MUSSO 1,818,812

ELECTRIC FURNACE

Filed March 14, 1928

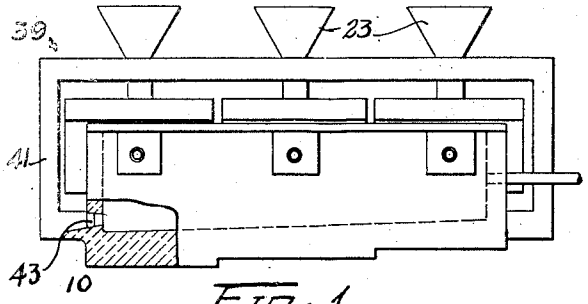


Fig.-1

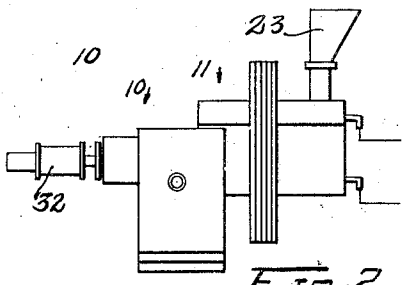


Fig.-2

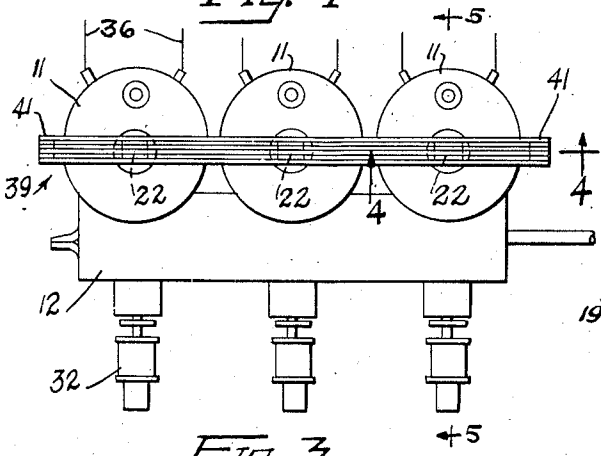


Fig.-3

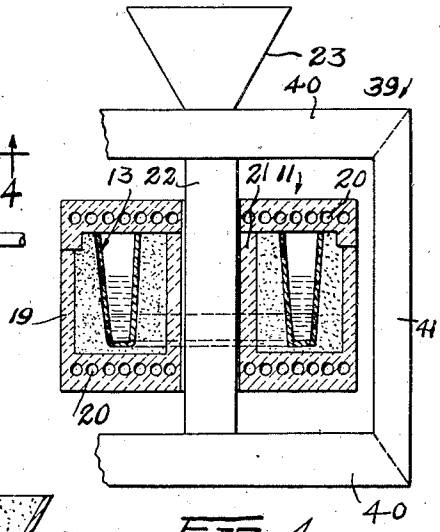


Fig.-4

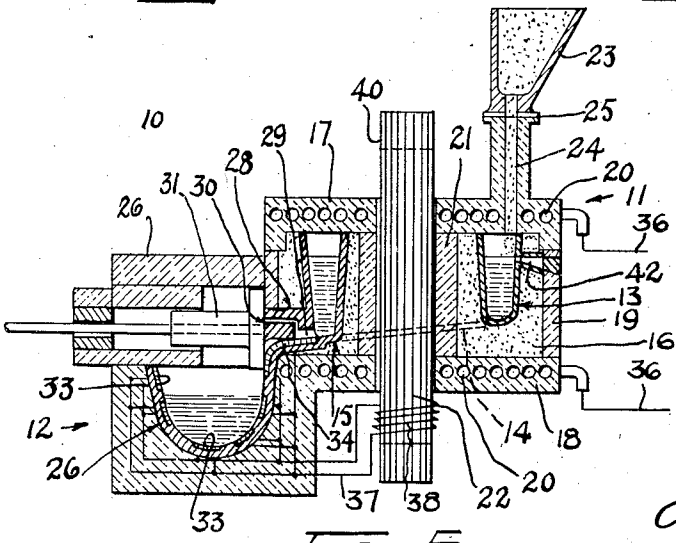


Fig.-5

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UNITED STATES PATENT OFFICE

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ELECTRIC FURNACE

Application filed March 14, 1928. Serial No. 261,486.

The invention relates to induction electric furnaces and heat treating processes for the manufacture of iron and steel.

One object of the invention is to provide an improved continuously operating electric furnace.

Another object of the invention is the provision of an improved device of the character described, in which the melting and soaking of the metal occurs continuously in separate stages.

A further object of the invention is to furnish a device of the nature set forth, wherein the metal may be melted and directly changed into a desired iron or steel in separate portions of the device.

Further objects of the invention are to provide an improved device of the type specified in which a plurality of melting hearths are heated by as many phases of the electric current; in which the said hearths discharge into a single soaking trough; in which means is provided to control the input of metal into a hearth, and the output thereof into the said trough; in which automatic valve means prevents the level of the metal in a hearth from becoming too low; in which each hearth is in proximity to the trough, so that the travel of the molten metal from one to the other is a minimum, there being means furnishing heat to the metal in course of its travel.

Still further objects of the invention reside in the provision of an improved two stage process in which metal is continuously melted, and from the melt, a quantity is constantly drawn off for soaking and manufacture into any desired quality of iron or steel; in which the melting and soaking occurs under the influence of electric currents; and in which there is no intermediate solidification of the metal.

Other objects will in part be evident and in part pointed out hereinafter.

Generally described, the invention provides an electric furnace acting in two stages, first to melt the iron and then to soak the same, this operation being continuously practiced in separate communicating portions of the furnace. The iron obtained in the first stage contains various impurities, which accumulate at the top of the melt and may be periodically removed. From the bottom of the said melt, there is a slow, regulated flow of iron into a soaking trough, in which gases occluded in the iron are gradually driven off, to form a refined iron, of the desired crystalline structure, or an alloy steel. The "pinch" effect obtained in the molten metal due to the action of electric current thereon, with the consequent mixing action, produces a uniform structure of the metal in the trough.

In the drawings,

Figure 1 is a front elevation of an embodiment of the invention with parts in section.

Fig. 2 is a side elevation of the same.

Fig. 3 is a top plan view of the same.

Figs. 4 and 5 are enlarged vertical sections taken on the lines 4—4 and 5—5 respectively of Fig. 3.

Referring in details to the drawings, 10 denotes an electric furnace embodying the invention. The same includes a plurality of metal melting units 11 discharging into a common soaking pit or trough 12. The units 11 are in close side by side relation, while the trough 12 extends therealong and beneath the same. Within the scope of the invention, the units 11 and the trough 12 can be of various well known constructions, and in the arrangement shown are merely illustrative. If desired, they may be of unitary or integral construction, as by the provision of common interconnecting walls, or a single setting.

Each melting unit includes an annular hearth 13 which is provided with an inclined bottom 14 that is lowest at the discharge end 15 of the hearth. This hearth is surrounded by a refractory insulating material 16, of a granulated or broken character, as, for example, carborundum. Upper and lower slabs or walls of refractory material 17 and 18, and side and end slabs or walls 19 wholly enclose the hearth and its surrounding material 16. The walls 17 and 18 are provided with openings 20 through

which a spiral tubular electrical conductor passes through which water flows to cool it. The primary coil in the grooves 20 is of flat spiral form, so that a plurality of these coils are employed, one at the top of the melting hearth and the other at the bottom thereof. These coils can therefore be readily replaced, on becoming damaged or burning out, since it is merely necessary to remove the wall or slab containing the particular coil. Between the said walls, and centrally of said hearth is a refractory block 21, through which and the upper and lower walls extends a magnetic core 22. Supported on the upper wall 17 is a hopper 23 that discharges metal into the hearth through a passageway 24. The latter is remote from the discharge end 15 of the hearth. The quantity of material passing therethrough can be adjusted and set by any suitable valve 25.

The soaking unit 12 includes a trough 26 set into a refractory wall 27 which wholly encloses the same. The said trough is in proximity to the hearth 13 and communicates therewith at 28. This communication is restricted to produce an orifice at 29 that controls the outflow of metal from the hearth into the soaking unit. The said communication may be enclosed by the trough and the hearths, or the setting thereof as shown. Should the level of metal in the hearth become too low, a valve or plug 30 actuated in any suitable manner may temporarily cut off the said communication. The said plug may be mounted on a guide 31 above or in an upper part of the trough, and is preferably automatically operated by a solenoid 32. The valve may be retained at a required temperature by the heat of the resistance 34 and the heat of the trough, singly or together. The means for timing the energizing of the solenoid for the purpose specified may be of any type well known in the art.

The trough 26 is internally heated by resistances 33 in the wall thereof. A resistance 34 is also provided in the communicating portion 28, at the lower wall thereof, to prevent solidification of any metal passing from the hearth into the trough, so that this passage is always retained clear. Communicating with the trough is a pipe 26*a* that permits occluded gases that are driven off from the metal to be removed by any suitable means connected to the pipe, as, for example, a pump, which, being conventional, has not been shown.

The number of the melting units 11 corresponds to the number of the phases of the electric current used, so that by the employment in each unit of a current of a different phase, economy of operation is obtained. Thus there are three units for a three phase current. The current enters the unit 11 at its terminals 36 and induces a secondary current in the circuit 37 which is connected to the resistances 28 and 34 and is wound around the core 22 at 38. The latter may form a unitary structure 39 for the several heating units passing completely around the said units. The said structure includes upper and lower bars 40 from which extend the cores 22 and the vertical end bars 41.

In operation, metal is fed continuously into the hearth from the hopper 23. The pinch effect of the current causes an agitation of the metal, and the slag rapidly rises to the top and is removed through an opening 42. From the bottom of the hearth, the metal is drained slowly and continuously into the trough 26. The metal in the trough is consequently of a high degree of purity, and on soaking the same, occluded gases are driven off. The pinch effect of the current aids in the mixing of the metal for obtaining a uniform structure. The temperature in the trough can be regulated to obtain a desired crystalline formation, and alloy steel can be produced directly in the trough. On leaving the trough, as for example, at the tap hole 43, the metal is ready for rolling or other steel mill operations.

I claim:

1. A device of the character described, including a melting hearth, a soaking trough, electrical heating means therefor, and other means communicating with the trough and the bottom of the hearth to permit metal to flow by gravity from the hearth to the trough, said other means being wholly encased by the hearth and the trough.

2. A device of the character described, including a melting hearth, a soaking trough therebeneath, means affording restricted communication between the trough and the hearth, and means to directly heat the first mentioned means substantially uniformly therealong.

3. An electric furnace including a melting hearth, a soaking trough, communicating means therebetween, and a valve for said means above the trough, and heated by the heat of the trough.

4. A device of the character described, including a melting hearth, a soaking trough therebeneath, a substantially horizontal passage communicating with the hearth and trough to permit metal to flow from the former to the latter, a valve in said passage to control the said flow, and means to directly heat the said passage to prevent solidification of metal therein.

5. A device of the character described, including a melting hearth, a soaking trough, a passage for the flow of metal from the hearth to the trough, and coacting means to render the flow of the metal intermittent.

6. A device of the character described, including a furnace having a chamber for a

molten metal, said chamber being closed against the access of air thereinto, means to heat the same, means to permit withdrawal from the chamber of occluded gases released from the metal, without admitting any other gas into the chamber, inlet and outlet means to control the movement of metal through the chamber, and separate means at the free surface of the melt for the removal of impurities that collect on said surface.

7. A device of the character described, including a melting hearth and a soaking trough, both the hearth and the trough having a non-uniform vertical cross section, means to afford communication between the same for a flow of metal from the former to the latter, electrical means to induce a secondary current in the melting hearth, and to heat the soaking trough, and means adjacent to the free surface of the melt in the hearth for the withdrawal of impurities collected on the surface of the metal.

8. An electrically heated furnace including metal melting and heat soaking chambers in proximity to each other, the heat soaking chamber being relatively lower than the melting chamber, means of communication between a lower portion of the melting chamber and an upper portion of the soaking chamber, said means of communication permitting a flow of molten metal from below the free surface of the liquid metal in the melting chamber into the heat soaking chamber, means to provide a substantially uniform flow of the metal through said means of communication, closure means for an upper portion of the melting chamber whereby flux for the metal may be admitted into the said melting chamber adjacent to the free surface of the liquid metal therein, and means for the removal of the slag formed on the free surface of the metal and independently of the pure liquid metal below the layer of fluxing material.

9. An electrically heated furnace including metal melting and heat soaking chambers in proximity to each other, the heat soaking chamber being relatively lower than the melting chamber, means of communication between a lower portion of the melting chamber and an upper portion of the soaking chamber, said means of communication permitting a flow of molten metal from below the free surface of the liquid metal in the melting chamber into the heat soaking chamber, means to provide a substantially uniform flow of the metal through said means of communication, closure means for an upper portion of the melting chamber whereby flux for the metal may be admitted into the said melting chamber adjacent to the free surface of the liquid metal therein, and means for the removal of the slag formed on the free surface of the metal and independently of the pure liquid metal below the layer of fluxing material, and means to heat the means of communication by heat applied in close proximity thereto.

10. An electrically heated furnace, including melting hearths, a soaking trough, means of communication between the melting hearths and the soaking trough, allowing a liquid metal to flow by gravity from the former to the latter, means permitting the withdrawal of fluxing materials and materials attracted thereby independently of the flow of substantially pure metals from hearths to the soaking trough, an electric circuit for multiple phase current for heating the hearths, the circuit having means providing a single phase current for each hearth, the circuit having other means coacting with the first named means, to induce a secondary current for heating the soaking trough, and means for heating the communicating means for liquid metals from the melting hearths to the soaking trough to temperatures above the melting points of the metals being treated, means for feeding metals to the melting hearths with controlled flow of the metals, circuit means at the means of communication for heating the same, and means to exclude air from the hearths and trough.

11. An electrically heated furnace, including a melting hearth, means of communication between the melting hearth and a soaking trough, the soaking trough being enclosed against the access of air thereto, said trough having a refractory wall, and electrical heating means including resistances embedded in the wall of the trough, means withdrawing the fluxing materials and materials attracted thereby in the melting hearth, independent of the means of communication for the substantially pure metal passing from the melting hearth to the soaking trough, means for heating the melting hearth and the means of communication between the melting hearth and the soaking trough, above the temperatures of melting of metals being treated.

12. An electrically heated furnace, comprising a melting hearth, a soaking trough, a means of communication from the melting hearth to the soaking trough, means for withdrawing fluxing materials from the surface of the liquid metals being treated in the melting hearth independent of the means of communication for the liquid metals passing from the hearth to the trough, means for excluding air from the hearth, the means of communication to the soaking trough, and the soaking trough, a removable slab forming part of the enclosing walls of the furnace and permitting access thereinto, said slab including a tubular, water cooled pri-

mary coil therein, and coacting electrical heating means to separately heat the trough, the hearth and the means of communication therebetween, to temperatures above the melting points of the metals being treated.

In testimony whereof I affix my signature.

ALFRED MUSSO.