July 13, 1965 E. A. HANNE-WIAME 3,194,539

MIXING APPARATUS

Filed Feb. 10, 1961 2 Sheets-Sheet 1

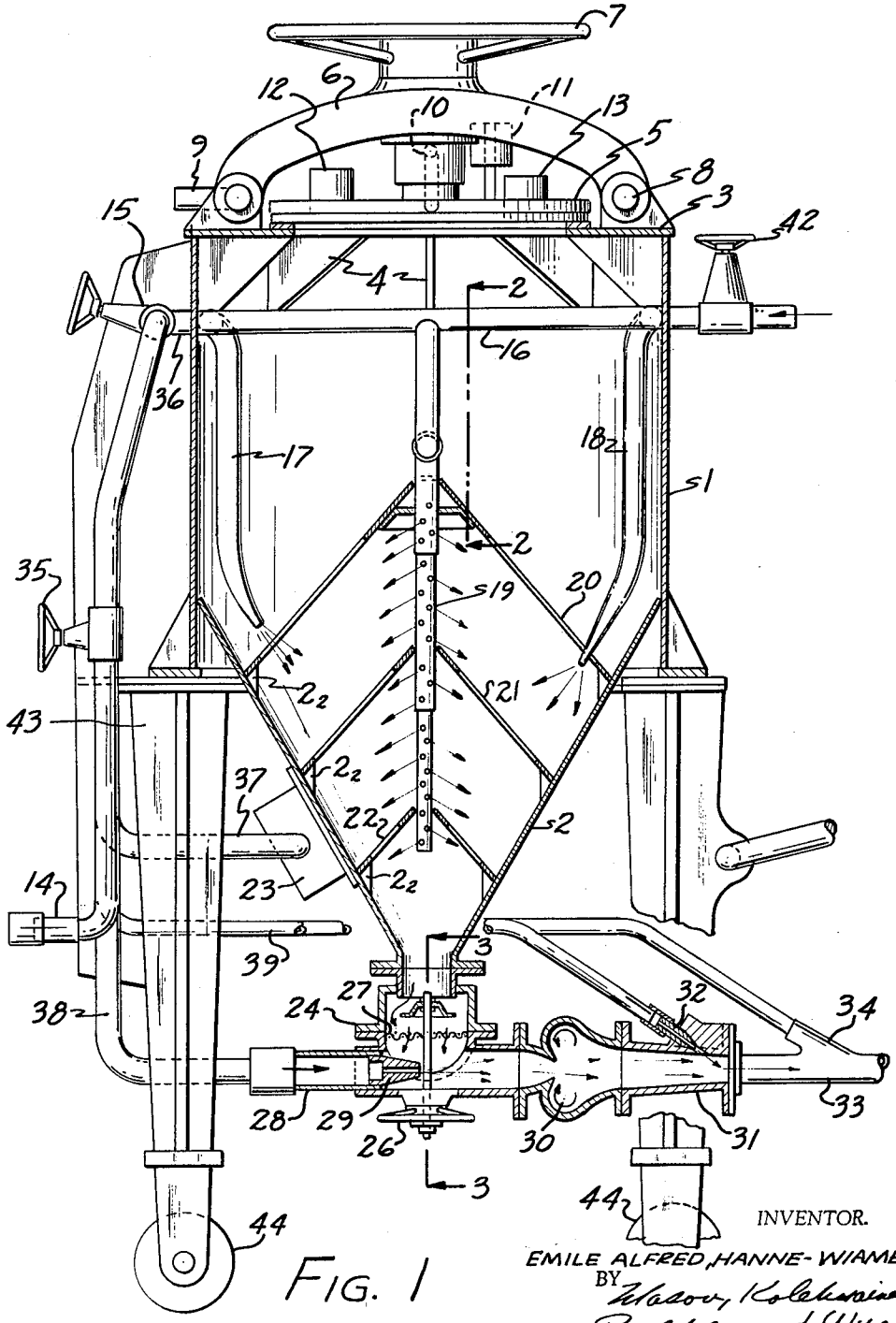


FIG. 1

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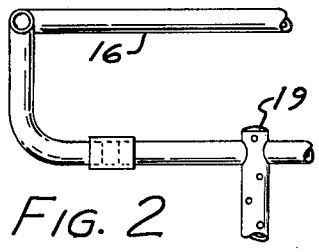


FIG. 2

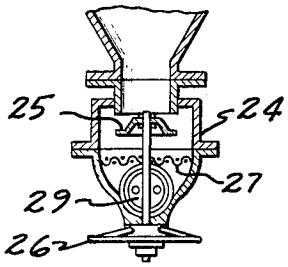


FIG. 3

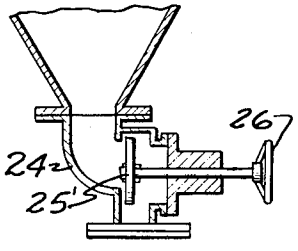


FIG. 4

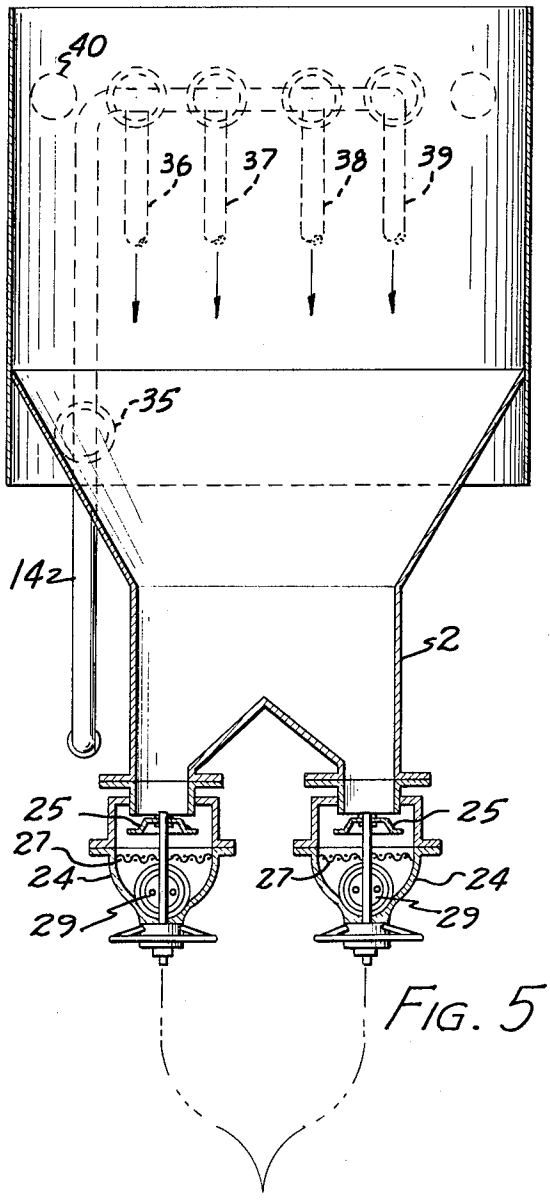


FIG. 5

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3,194,539

MIXING APPARATUS

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Claims priority, application France, Feb. 11, 1960, 818,216, Patent 1,250,107
3 Claims. (Cl. 259—4)

A first purpose of the invention is to provide a process for elaborating steel from cast iron and metal alloys in which the speed of action of finishing or addition products injected into the molten metal mass is increased.

Another purpose of the invention is to facilitate the action of the finishing products which act as reaction or reducing agents, or as composition elements.

Another purpose of the invention is to allow the treatment of liquid baths of ferrous metals, steel, cast iron and alloys by using a gas to blow finishing products or addition materials in powder form beneath the surface of the liquid metals so that at the moment of dispersing the products in the liquid mass there is intimate internal contact, thereby increasing the speed of action on the liquid metal of the products injected.

Another purpose of the invention is to improve the productivity of melting equipment used for producing steel, cast iron and alloys and, as a result, to make the production more economical.

FIGURE 1 shows a sectional view of the apparatus;

FIGURE 2 is a sectional view taken along line 2—2 of FIG. 1 showing the feeder for supplying the central column;

FIGURE 3 is a sectional view along line 3—3 of FIG. 1 showing the discharge chamber;

FIGURE 4 is a fragmentary sectional view of another embodiment of a discharge chamber for use in the apparatus of FIGURE 1;

FIGURE 5 is a partial sectional view of another embodiment of the apparatus as characterized by the features of the invention and having two discharge chambers.

According to the invention, to intensify the contact surface of solid materials for treatment with the molten mass, metallurgical operations are carried out which consist of introducing finishing products under the surface of the liquid bath by means of the apparatus shown in the above-mentioned figures and by means of a gas carrying either all or part of the products suitable for these operations.

This method is based on the most rapid means for economically effecting various metallurgical operations in liquid baths by means of materials which are currently utilized in iron smelting.

In order to have a perfect injection, it is necessary to have an intimate contact of the powdered product which, by stirring with the liquid metal, must, according to the object sought and the chemical composition of the product, act as a reaction or reducing agent or as a composition element.

Various types of apparatuses are provided for carrying out the process of which FIGURE 1 is an example.

The equipment essentially consists of a tank 1 formed of a steel cylinder whose lower part is formed by a conical portion 2 which is funnel-shaped. The cylinder 1 is closed at the top by a steel sheet 3 whose rigidity is strengthened by ribs 4.

This sheet 3 defines aperture which is used for filling the tank. This aperture is closed by a cover 5 held in position by a screw actuated by a hand-wheel which exerts a pressure in order to obtain the seal-tightness inside the tank. The screw exerting a central pressure controlled by the hand-wheel 7 is mounted on a strap 6 articulated around a hinge 8 to enable opening. A locking system 9 enables the strap to be hooked on its opposite side.

Two hoisting rings 10 enable this apparatus to be transported by an overhead or ordinary crane, etc.

The safety of the apparatus is ensured by a safety valve 11 mounted on the sheet 3, while a rapid escape diaphragm 12 and a value regulated with a permanent leak 13 are mounted in the removable cover 5.

Inside the tank and on the conical part, catches 2_2 are provided at various heights for maintaining cones for distributing the material.

The fluidification, injection and atomization of the materials are effected by means of compressed air or an inert gas under pressure. These gases are conveyed to the interior of the apparatus through piping 14 feeding a collector 15. A circular ramp is connected to this collector 15 placed inside the apparatus on which pipes 17 and 18 are mounted branching off at various heights inside the cylinder 1.

On the column 16 (FIGURE 2) a connection is provided for supplying the central column 19. This central column comprises, on its lateral surface, a series of apertures enabling the passage of the gas under pressure, the upper and lower apertures of the piping 19 being closed.

In FIGURE 1, it will be noticed that the column 19 is made up of elements inserted in each other, each of the elements comprising a distributing cone for materials whose free end rests on the catches 2_2 of the conical cylinder 2. These elements 20, 21 and 22 can be easily removed through the top movable part of the apparatus.

A pneumatic vibrator 23 is placed at the base of the apparatus and ensures the regular descent of materials into the mixing chamber. This pneumatic vibrator is fed through piping 36 and 37 coming from the collector 15.

The injecting member itself consists of a chamber 24 made in two parts placed at the base of the conical portion 2. One of the two parts is integral with said conical portion and the other is bolted on to the fixed part. Inside this chamber, the opening enabling the delivery of materials is regulated by a valve plate 25, itself controlled by a hand-wheel 26 acting through a rod.

It will be seen that the rod of the hand-wheel carries a deflecting screen with holes 21 sloping at 45°. On the main body of the chamber 24, a detachable injector 28 is connected and supplied with gas through the compressed air inlet pipe 38 coming from the collector 15. This detachable injector 28 comprises an injection head 29 with double apertures whose diameter varies according to the pressure required for atomizing the products (FIGURE 3). This injector ensures the passage of the product through the deflecting screen 27 and sends it towards the chamber 30 for putting into suspension (FIGURE 1).

The mixture thus pulverized passes into an atomizing chamber 31 where another gas under pressure introduced through the opening 32 speeds up the discharge of the products towards the injecting jet 34. A supplementary atomizer 33 is provided on the sleeve of the injecting jet and enables the mixture to be regulated and prevents any drop in pressure in the pipes connecting the apparatus to the injecting jet.

A gate 35 controls the opening of the inlet of gas under pressure from the main pipe 14 towards the collector 15.

It is quite obvious that gates are placed on each of the pipes supplying the various members, so as to control the independent closing of the latter.

Two manometers 40 and 41 enable the pressure to be known at any moment that exists in the inlet pipe and the inside of the tank.

A supplementary inert gas inlet can be put into operation on all the circuits by means of a gate 42, after the

closing of the compressed air intake in the tank by the gate 35.

The apparatus thus formed is mounted on a frame 43, which latter comprises rolling means such as rollers 44 or similar devices. This arrangement enables the apparatus to be put into operation at any spot in equipments.

According to one alternative embodiment, the mixing chamber (FIGURE 4) may comprise a closing device whose control takes place horizontally, contrary to the preceding system whose control takes place vertically. We see here a rod actuated by a hand-wheel 26 which closes the aperture at the base of the tank by means of a valve plate 25'. This arrangement is often employed when apparatuses are required with several outlets. Various types of apparatuses are made according to the same arrangements, and an apparatus can be equipped with single tank as shown in FIGURE 1, or an apparatus may be provided with two tanks. Apparatuses can also be made with two asymmetrical tanks, of which the second is provided with a large capacity and has one or two outlets for discharging highly concentrated products in the transporting gas.

FIGURE 5 is an example of a two-outlet apparatus, and there are two inlet chambers 24 each comprising a double aperture injection sheet 29 and a regulating system with hand-wheel 26. These hand-wheels actuate the valve plates 25 to enable the eventual closing of the outlet of one or more products.

According to another alternative embodiment, an apparatus may be obtained fitted with two asymmetrical tanks of which the second one has a greater capacity and one of the pipes fitted with different systems for regulating distribution.

This alternative is obtained by varying the section of the mixing chamber and the diameter of the interchangeable injector placed at the inlet of each chamber, so as to convey products of various densities and size distribution with a controlled time and delivery.

According to the same method, apparatuses can be obtained fitted with three tanks that can have a very large capacity, 1000 liters, for instance.

This process enables a maximum efficiency to be obtained by utilizing the maximum of iron ore, low content copper pyrites, mill-scale, etc., which cost less than scrap iron, cast iron or liquid metal for running in duplex.

Iron ore is currently employed for the oxidizing stage during which it is sought to eliminate certain impurities of the initial charge.

This process is thus based on the charging of iron ore necessary for oxidizing carbon, phosphorous, and if required, other impurities for adding oxidizing slags, the removal of these slags, the refining of the liquid metal by means of new slags, neutral or reducing, the eventual carburization, the addition of deoxidizing alloys and composition, and finally, pouring. The process of the invention enables the initial metal charge (cast iron, scrap or liquid metal coming from other molten metal) by a corresponding quantity of iron containing iron ore, pyrite ashes, mill-scale or other ferrous products, this process enabling operations to be conducted in one movement and to inject by blowing under the surface of the bath, a certain quantity of products suitable for the metallurgical necessities sought, at the rate, and with the kind of melting apparatus employed.

By commencing during the elaborating of the carburization operation of the first part of the cast iron charge, scrap or liquid metal, we obtain a ferrous metal containing reducing elements and eventually fixed finish.

After this, the replacement products—iron ore, pyrite ashes, that are introduced into the liquid charge of electric furnaces are subjected to violent whirlwinds which ensure an intimate contact between the elements that must enter into reaction.

An example of application to a 20-ton electric arc furnace is described. Independently of the electric power, the productivity of an electric furnace essentially depends on its melting speed, the duration of the refining period and that of deoxidization.

The electric furnace charged with part of its initial charge rapidly melts the solid charge put in, so that at the end of smelting, the liquid metal treated by injection technique gives a liquid bath of high carbon content and suitable chemical composition for receiving the charge of iron ore or pyrite ashes.

In the case of cold charges of pyrite ashes or iron ore in the shape of powders, the quantity of powdered materials to be injected must not exceed a certain dose, for beyond a reasonable proportion, the duration of injection and refining is prolonged, thus cancelling out the gain in smelting.

By using pyrite ashes containing about 56% of iron, iron ore with a high iron content, mill-scale, etc., the actual quantity of iron introduced may reach 20% of the total metal charge. By means of charges pre-heated in a rotary furnace it clearly seems that it suffices to charge according to the capacity and electric power of the furnace 50 to 60% of scrap or liquid metal for forming a carburized bath.

The refining of the liquid carburized bath is ensured by pouring into the electric furnace the balance of the metal charge formed by pyrite ashes, iron ore, mill-scale, etc. plus carbon, plus CaO and melting, pre-heated and partially pre-reduced in the rotary furnace.

In this manner, we have refined metal in the electric furnace, and the slag oxidizing in the liquid state pours out of the furnace through a spout.

Economical refining is obtained as explained above, by pouring into the electric smelting furnace, in a manner controlled both for quantity and time, a hot and partially pre-reduced charge; if necessary, refining can be terminated by injecting powdered iron ore or mill-scale conveyed by compressed air gas with or without the addition of gaseous oxygen.

When oxidization and the dephosphoration that accompany it are deemed to be sufficient, and according as to whether the operation is effected with a scoria or two slags, which depends on the quality of steel sought, in the latter case, the scoria is extracted from the furnace.

This process by injection also enables, in electric furnaces and even in Martin furnaces, large quantities of treated ferrous products to be utilized.

For example, in Martin furnaces, the limits may be diminished that are allowed by the shade and quality of the steel to be obtained, up to a given extent, of the quantity of cast iron put in, and to replace the tonnage extracted from the cast iron by ferrous moduluses.

Numerous applications of the process have been carried out on various smelting apparatuses employed in siderurgy, such as electric furnaces, acid converter, rotary furnace filled at 100% with cold or liquid metal charges. They have given very good results with regard to the quality of the products elaborated with a saving in refining time of 50% over the duration of the conventional process.

Furthermore, the present invention, which has the purpose of introducing into a molten metal mass, reaction and combination agents, enables the following advantages to be obtained:

(a) The rate of melting a metal charge is speeded up thanks to injecting an exothermic recarburizing mixture, in the form of powder, that is introduced at any moment of elaboration and for any quantity of carbon sought under the surface of the liquid metal by means of an apparatus described above and by means of a conveying gas such as compressed air.

The reducing components of the recarburizing mixture possess an affinity for oxygen that is greater than that of iron; this means a rise in temperature due to the exothermic action caused by the action of the combined products that are particularly absorptive of the oxygen

of the bath and the air. With the rise in temperature of the bath, the rate of carbon yield is very high.

Recarburizing injections improve heat exchanges enabling a distinct reduction to be obtained in the consumption of electric power of electrodes, refractories, etc. of calories (gas fuel oil) in the case of the Martin and rotary furnaces.

The production of high quality cast iron by the injection technique in the electric furnace, for instance, is much easier than by the conventional process which consists of recarburizing the bath from time to time during the operation, either by diffusion or precipitation.

(b) The decarburizing method by using the oxygen jet enables, in numerous cases, very good results to be obtained, as compared with ordinary methods which consist of throwing oxidizing products on to the surface of the bath (scoria-metal).

The process consists of causing to pass into a liquid bath, by means of the above-mentioned apparatus, fine oxidizing elements by means of a gas conveying compressed air with or without the addition of gaseous oxygen.

The oxygen of the air and oxidizing elements and possibly the addition of gaseous oxygen, burn the materials to be eliminated, silicon, carbon, phosphorus, and this combustion is accompanied by a rise in temperature. According to the composition of the metal and the scoria, the speed of decarburization rises in more or less considerable proportions.

Among others, this technique procures the following advantages:

Accelerated decarburization,

Rapid desilication of the liquid bath,

Ease of working the bath.

By the acid process, regularity in its chemical composition in relation to the final shade sought for the steel, etc.

(c) Deoxidization and desulphurization

During this stage, the scoria is formed of lime, then spar and other various materials; thus, under the slag, we have a ferrous metal which it is necessary to deoxidize by means of the reducing alloys used in siderurgy which particularly lend themselves to deoxidization and also as finishing elements, for completing the steel.

Frequently, one and the same reducing element plays the same part; we can distinguish the deoxidizing action and that of finishing.

(I) In the case of deoxidization, its part is:

To deoxidize

To desulphurize

(II) The finishing alloy has the purpose of:

Imparting to the steel the characteristics sought for in relation to the finishing element,

To refine the grain,

To increase the physical properties of the steel, etc.

For the deoxidization, calming and desulphurization of the steel, the process consists of introducing into the liquid bath various deoxidizing alloys together with desulphurizing products in the form of powders, either into the furnace or in the ladle, by means of a fluidifying appliance and by means of a conveying gas.

The disturbance of the bath caused by the injection and rising to the surface of extremely fine particles of the products, while favoring degasifying, ensures a wide dispersion of these particles which intimately react in contact with the metal mass and with the elements to be eliminated from the steel.

The heat-producing power of the reducing elements appears to be very interesting, for at each temperature, there exists a dividing coefficient with the combination element dissolved in the liquid metal.

Light reacting and deoxidizing agents are blown in so as to maintain reducing conditions during treatment, and the very lively reaction of the reducing compounds with the bath is shown by a sound deoxidization accompanied by an increased fluidity of the metal.

What I claim is:

1. Apparatus for mixing and fluidizing a solid powdered material with a gaseous fluid and transporting the fluidized mixture into a liquid bath; comprising hopper means for containing a quantity of said powdered materials, said hopper means including a frusto-conical lower portion having an outlet at the lower end thereof, conduit means in said hopper means extending downwardly into said frusto-conical portion including a central duct in axial alignment therewith having a plurality of openings spaced along a substantial length thereof for directing a flow of said fluid radially outward to fluidize and mix said powdered material, a plurality of spaced apart distributing cone elements formed around said central duct extending upwardly and inwardly from said frusto-conical lower portion, injection chamber means below said hopper means having an inlet in communication with the outlet of said hopper means and an outlet, valve means cooperating with the inlet of said chamber means for controlling the flow of fluidized materials from said hopper means, injector means extending into said injection chamber means in axial alignment with the outlet thereof directing a flow of gaseous fluid into said injection chamber means for carrying a flow of fluidized powdered material through the outlet thereof suspension chamber means in communication with the outlet of said injection chamber means axially aligned with said injector means for entraining and mixing said fluidized materials in said gaseous flow from said injector means, and atomization chamber means in communication with said suspension chamber means including a gas nozzle injector for transporting the fluidized mixture from said suspension chamber means into said liquid bath.

2. Apparatus as defined in claim 1 wherein said conduit means includes a plurality of branch conduits extending downwardly in said hopper means spaced outwardly from said central duct and having outlet ends positioned at different levels in said hopper means and directed inwardly toward said central duct.

3. Apparatus as defined in claim 1 wherein said injection chamber means is provided with a deflecting screen disposed between said valve means and said injector means.

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