

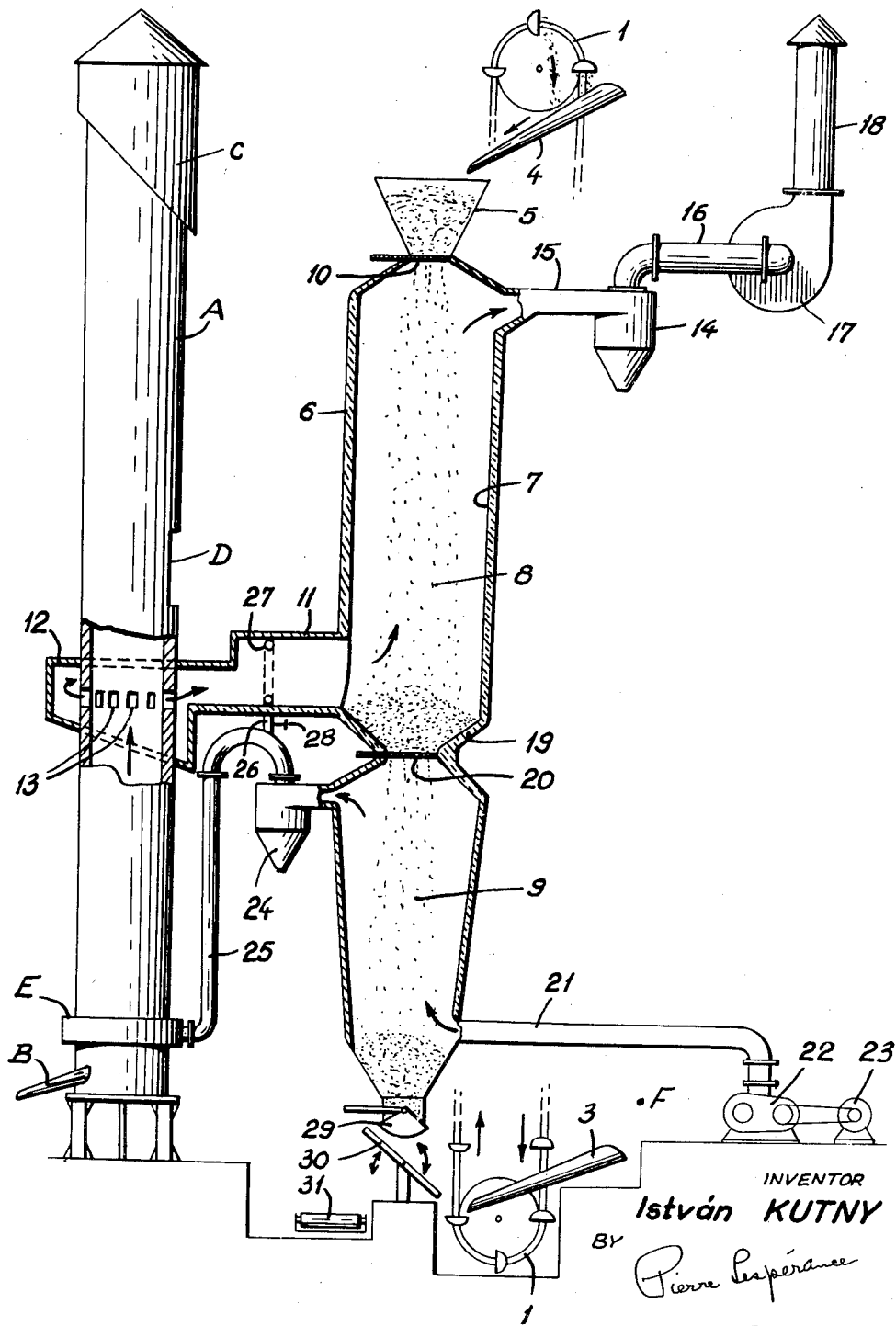
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SAND REGENERATING AND CUPOLA PREHEATING APPARATUS

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The present invention relates to a method and means for regenerating or reclaiming foundry sand, and more particularly foundry sand used in the casting process known as shell molding.

Shell molding is a casting process which was German developed about ten years ago and is characterised by the fact that the sand is mixed with a thermo setting resin, and is then formed into the core or mold and heated to form a biscuit of relatively small thickness and having sufficient strength and dimensional stability whereby the biscuit can be used per se and produces a casting of high dimensional accuracy and very good surface finish whereby subsequent machining operations can be entirely eliminated or at least considerably diminished.

In view of the above noted and other advantages, the shell molding process is being used more and more.

The actual practice in shell molding is to discard the sand or spent biscuits after use due to the high cost of reclaiming the sand in accordance with known methods and means.

It is therefore the main object of the present invention to provide a sand regenerating method and means which are highly efficient and economical which are therefore capable of being used to advantage in foundries employing shell molding.

Still another important object of the present invention is the provision of an apparatus and method for sand regenerating in shell molding, which include preheating the air fed to the cupola used for producing the casting metal.

Yet another important object of the present invention is the provision of a sand regenerating method which produces sand of very high purity.

Still another important object of the present invention is the provision of a method and means of the character described in which the apparatus used is of relatively inexpensive and simple construction and which is very versatile that is which can be made to function in accordance with the varying rate of production of the foundry.

The foregoing and other important objects of the present invention will become more apparent during the following disclosure and by referring to the drawing in which: the single FIGURE is a schematic representation of the apparatus in accordance with the present invention, shown combined with a conventional cupola for preparing the casting metal.

Reference is now made more particularly to the drawing.

Reference character A indicates a conventional cupola such as found in foundries for preparing the melt which is discharged by spout B at the base of the long vertical shaft, the top of which forms a chimney for evacuation of the combustion gases into the atmosphere, the chimney having a protecting cap C in the drawing. The cupola is provided at approximately half its height with an opening D for the constituents necessary to having melted iron. Combustion air is fed under pressure at the base of the cupola through feeding ring E.

The material used for shell molding consists mainly of a resin and sand mixture. The sand is first washed and cleaned and the resin is incorporated therein in the amount of between four to five percent by weight. The resin is a synthetic thermo-setting resin, preferably a

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phenol resin, such as phenol formaldehyde and a catalyst is admixed, for instance hexamethylene tetramine. In addition, a mold release agent may be incorporated to the resin-sand mixture, for instance, a silicone type agent or a lubricant such as calcium stearate.

The mixture is molded into the desired shape and cured by heat whereby the resin or plastic forms a strong bond for the sand particles. After use of the shell molds and cores, the resin has been partially carbonized by the heat of the molten metal and the sand further contains non-combustible impurities produced by contact with the molten metal. The spent biscuit breaks easily into lumps and free flowing sand.

In accordance with this invention, the spent biscuit and sands are passed through a crushing apparatus of any type in order to obtain entirely free flowing material, and this material is brought to the feeding station F of the apparatus where it is fed to an elevator 1 of any suitable type by means of a chute or spout 3; the elevator 1 discharges the sand to be treated into a second chute 4 at the top of the elevator system and the material is directed into a hopper 5 mounted on top of a high vertical column 6.

The column 6 has preferably a circular cross section and is made of metal lined with fire clay 7; it has a height nearly equal to that of the cupola A and is divided into two vertically superposed chambers, namely, an upper combustion chamber 8 and a lower heat exchange chamber 9.

The spent foundry sand flows continuously from hopper 5, which is always kept nearly full into the upper chamber 8 through a sand control device such as a screen 10 extending across the communication between hopper 5 and chamber 8, thus the sand drops freely through upper chamber 8 at a regulated flow rate such that each sand particle is spaced from the others.

The lower end portion of the upper chamber 8 is in communication with a laterally extending duct 11 which serves to supply hot gases to the chamber 8; the duct 11 communicates with a gas collecting ring 12 which surrounds the cupola A preferably at a level just below the opening D and which serves to collect combustion gases produced in the cupola which are drawn into collecting ring 12 through a series of bleeding openings 13 made in the wall of the cupola.

The upper end of chamber 8 is in communication with the inlet of an induction cyclone 14 through duct 15. The outlet of cyclone 14 is connected by duct 16 to the suction inlet of a ventilator 17. The suction head of the latter is variable and controlled by a thermostat such that the gases will be discharged to the atmosphere at a constant temperature, through discharge stack 18.

The lower end portion 19 of the upper chamber 8 has an inverted conical shape, the smaller diameter opening of which forms a communication with the lower chamber 9, said communication being provided with a means for regulating the outflow of sand from the upper to the lower chamber, said means being constituted by a screen or the like 20. A certain amount of sand is always retained on the screen 20 in the conically shaped lower end portion 19 and said sand constitutes a gas trap between the upper and the lower chambers. Sand is discharged in a continuous flow into the lower chamber through screen 20. Lower chamber 9 has slightly tapered side walls such that the diameter of the chamber is less in its lower portion. Fresh air is fed to chamber 9 through duct 21 communicating with the lower end portion of said chamber and with a positive action blower 22 actuated by electric motor 23. The upper end of chamber 9 is in communication with a cyclone 24 which is under pressure, the outlet of which communicates with the air feeding ring E of the cupola A through duct 25. Duct 25 is provided with a

bleeding tube 26 which serves to feed hot air directly into the combustion gas feeding duct 11 through ring tube 27. The bleeding tube 26 is provided with a control valve 28.

The lower end of the heat exchange chamber 9 is normally closed by a valve member 29 which is opened to discharge the sand unto a flip type platform 30 which is adapted selectively to discharge the sand into the elevator 1 or unto a conveyor 31 for bringing the sand to the resin admixing station. When discharged into the elevator 1 the sand is recycled through the apparatus.

The combustion gases collected from cupola A through bleeding openings 13 will have a temperature varying between 1500° F. and 2500° F. and preferably between 1700° F. and 2000° F. and said gases are sucked through the system by ventilator 17. They contain around 10% carbon monoxide with only a slight amount of oxygen, for instance 2%, and therefore the carbon monoxide is burnt by admission of secondary air through bleeding tube 26, thus a secondary combustion takes place within the lateral duct and the upper chamber. The secondary air can be adjusted by control valve 28 and so the temperature of the inlet gases can be partially controlled by the secondary air, so as to obtain about 2000° F. in the upper chamber 8. When said gases come in contact with the spent sand, flowing down the chamber, there is a highly efficient heat exchange contact between the sand particles and the hot combustion gases being remembered that one gram of sand of the size normally used for foundry purposes is equal to about 217 centimeter square of heat exchange surface area. Thus, the sand particles are quickly heated up from room temperature. The sand flows in counter current relation with respect to the upwardly flowing gases. The resin coating the sand particles is therefore brought to combustion temperature and burns inside chamber 8 thereby releasing additional heat such that the combustion process is carried out at about 2000° F.

The speed of flow of the combustion gases varies up to a maximum of about two meters per second and the time of contact between the gases and the sand is selected between fifteen and thirty seconds. The speed of flow of the gases is sufficient to effect mechanical washing of the sand. Thus, undersized non-combustible particles are carried away and separated from the desirable sand particles. These contaminating particles are separated within the cyclone 14 and the spent gases are discharged to the atmosphere through stack 18, at about 500° F.

The sand particles which are now free of all combustible materials collect at the bottom of chamber 8 and they still contain a considerable amount of sensible heat, being at a temperature of about 1300° F. The cleaned sand trickles continuously through the screen 20 into the lower heat exchange chamber 9 where they give up their sensible heat by coming into heat exchange contact with fresh air fed into lower chamber 9 through air supply duct 21. The air entering chamber 9 is at room temperature that is 70° F. and is heated up to about 750° F. by contact with the sand. Any particles contaminating the air is separated therefrom within cyclone 24. Thus clean preheated air is fed to the bottom of the cupola thereby effecting considerable saving in the operation of the cupola itself by requiring a lesser amount of fuel such as coke. In spite of less coke burned, overheated metal can be tapped at the cupola spout.

Fresh air flowing upwardly through lower chamber 9 travels at about one to one and one-half meter per second. A small amount of said fresh air is bled through bleeding tube 26 and fed into the upper chamber as mentioned previously.

The sand to be treated may be fed to the upper chamber 8 from hopper 5 at a continuous rate and the treated sand is therefore discharged from the lower chamber at the same rate. In the case of a 27" I.D. cupola, the rate of feeding will be about four tons per hour; this rate will

vary in proportion with the size of the cupola. The apparatus is designed for a capacity corresponding to the maximum use of sand in the foundry. When the demand is lower, a varying amount of the treated sand is recycled through the apparatus by discharging the sand directly into the elevator 1.

In accordance with the method of the present invention, new sand which has to be added to make up for sand lost during casting operation is also treated in the apparatus of the present invention by being added up to a maximum of twenty percent by weight to the sand fed to the hopper 5. Thus, this sand is also heated to the high temperature of 2000° F. in the apparatus and this dries the sand and breaks up the water of crystallisation contained in the sand.

Sand deprived of its water of crystallisation has been found to be better suited for shell molding process.

From the foregoing, it will be noted that the process of the present invention requires a minimum of external energy, and that the otherwise wasted cupola gases are recuperated and used for initiating the combustion of the resins and other combustible materials admixed with the sand to be reclaimed. The upwardly flowing combustion gases quickly bring the temperature of the sand to the required combustion temperature, said temperature being of the order of 2000° F. The upwardly flowing gases also cause mechanical separation of the undesirable non-combustible impurities which are mostly undersized sand particles by carrying said particles out of the chamber 8. Due to the high combustion temperature used, very clean sand is obtained. Sand which contains sensible heat is brought into heat exchange relationship with the primary air to be used in the cupola and which effects further washing of the sand. The preheated air causes very efficient combustion within the cupola and also results in a considerable fuel saving and in higher cupola temperature.

The bleeding tube 26 enables the regulation of the temperature within the upper chamber 8 and the regulation of the amount of oxygen needed for the combustion of the carbon monoxide, resin and combustible impurities.

The apparatus of the present invention is compact and comprises a single circuit system and the column 6 has a smooth and uniform interior surface which minimizes friction by the sand, the latter having a high abrasive action.

The shape of the column 6 is such that the lower end portion of each chamber 8 and 9 is tapered to form means for containing sand treated in the respective chambers, said sand pockets serving as gas traps between the two chambers and between the lower chamber and the exterior; the sand contained in hopper 5 also serves as a gas trap.

Sand treated by the apparatus of the present invention has a high purity and is suitable for reusing in the shell molding process.

While a preferred embodiment of the present invention has been illustrated and described, it is understood that various modifications may be resorted to without departing from the spirit and scope of the appended claims.

What I claim is:

1. A method for regenerating spent foundry sand used in the shell molding process and containing combustible and non-combustible impurities, comprising trickling the spent sand downwardly in a free fall through a first treatment zone, collecting high temperature cupola produced gases and passing the same through said first zone in counter current heat exchange relation to said sand to thereby elevate the temperature of said sand, to cause combustion of said combustible impurities within said first zone and to carry away the non-combustible impurities, leading the gases and the latter impurities out of said first zone, trickling the hot treated sand downwardly in a free fall through a second zone disposed vertically un-

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derneath said first zone in counter current heat exchange relation with an upwardly flowing stream of fresh air to thereby preheat said fresh air, leading said preheated air to a cupola for use as combustion air and collecting the regenerated sand from said second zone.

2. A method as claimed in claim 1, further including separating the non-combustible impurities contained in the gases discharged from said first zone and discharging the cleaned gases to the atmosphere.

3. A method as claimed in claim 2, further including separating solid particles from the fresh air issuing from said second zone before it enters said cupola.

4. A method as claimed in claim 1, wherein said combustion is carried out at a temperature of about 2000° F.

5. A method as claimed in claim 1, wherein said high temperature gases collected from the cupola are sucked through said first zone.

6. A method as claimed in claim 1, further including by-passing a portion of said preheated fresh air directly into said high temperature cupola produced gases ahead of said first zone to control the temperature and amount of oxygen in the gases entering said first zone.

7. A method as claimed in claim 1, wherein said first and second zones are superposed, the sand collecting at the bottom of said respective zones serving as gas trap between said zones and between the second zone and the atmosphere.

8. A method as claimed in claim 1, wherein at least part of the regenerated sand discharged from said second zone is recycled through said first and second zones.

9. A method for regenerating spent foundry sand used in the shell molding process and containing a thermo setting resin and non-combustible impurities, comprising trickling the spent sand downwardly in a free fall through a first treatment zone, collecting combustion gases produced in a cupola and at a temperature of between 1500° F. and 2500° F., adding fresh air to said gases and passing the air added gases through said first zone in counter-current heat exchange relation to said sand to thereby elevate the temperature of said sand to about 2000° F. and cause combustion of said resin within said first zone, and at such a speed as to carry upwardly the non-combustible impurities, leading the gases and non-combustible impurities out of said first zone, trickling the treated hot sand down through a second zone disposed vertically underneath said first zone in counter-current heat exchange relation with an upwardly flowing stream of fresh air to thereby preheat said air, leading said fresh air to a cupola for use as combustion air and by-passing a part of said preheated fresh air to constitute the fresh air added to

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said gases collected from said cupola, and discharging regenerated sand out of said second zone.

10. An apparatus for regenerating spent foundry sand used in the shell molding process comprising in combination, a column internally lined with fire resistant material, having an intermediate portion of restricted internal cross-section and a transverse perforated partition at said restricted portion thereof to thereby separate said column into two vertically superposed chambers, inlet and outlet conduits communicating with the lower and upper ends of the upper chamber respectively, the lower inlet conduit being in communication with a foundry cupola at a level for collecting combustion gases produced in said cupola, power operated suction means connected to the upper outlet conduit for sucking the cupola produced gases upwardly through said first chamber, hopper means in communication with the top of said column, means for discharging sand from said hopper means downwardly through said first zone, said sand collecting on said partition and flowing down through said second zone, conduit means between the upper end of said second zone and the bottom part of said cupola and air blower means for supplying fresh air to the bottom part of said second zone whereby said air is preheated by coming into heat exchange relationship with the sand flowing through said second zone, means at the lower end of the column for discharging the regenerated sand to the exterior, and by-pass means for bleeding preheated air from the conduit leading to said cupola and admitting said heated air into said inlet conduit for the combustion gases.

11. An apparatus as claimed in claim 10, further including a cyclone separator in the outlet conduit of said first zone and ahead of said sucking means.

12. An apparatus as claimed in claim 11, further including a cyclone separator in the outlet conduit of said second zone and ahead of said by-pass means.

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