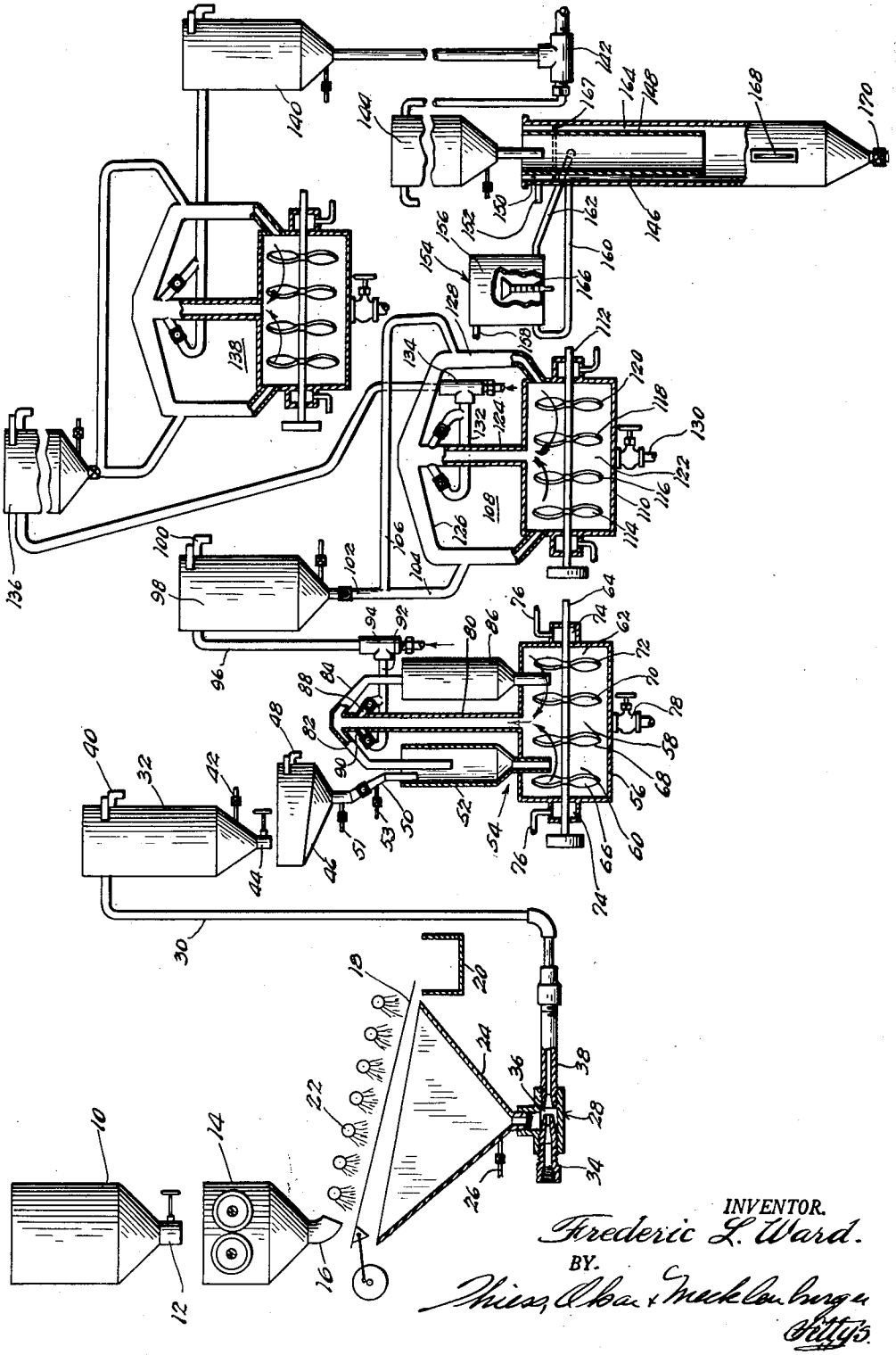
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METHOD AND APPARATUS FOR CLEANING FOUNDRY SAND

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METHOD AND APPARATUS FOR CLEANING FOUNDRY SAND

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This invention relates to a process and apparatus for cleaning sand and more particularly to a process and apparatus which is particularly effective for removing carbon adhered to particles of used foundry sand whereby the sand is conditioned for reuse as a foundry or core sand.

In the usual practice for preparing foundry molds sand is mixed with an organic binder and the resulting mass is formed to produce a mold having the desired shape. When the mold is contacted with molten metal the organic binder tends to carbonize leaving a considerable amount of carbon or carbonaceous material deposited on the sand. This carbon prevents the sand from being used again for preparing a mold, particularly in those instances where precision casting is required. Many thousands of tons of foundry sand are discarded each year because the presence of carbonaceous material and other materials renders the sand unsuitable for reuse.

Many methods have been proposed in the past for separating carbonaceous material from foundry sand so that the sand may be reutilized, however, none of them have been economically practical. A particular object of this invention is the provision of a method and apparatus for cleaning a used foundry sand in such a manner that it may be readily reused.

A further object of this invention is the provision of a method and apparatus for efficiently cleaning foundry sand at a very low cost and with a minimum of equipment.

A still further object of this invention is the provision of a method and apparatus for cleaning used foundry sand whereby substantially all of the carbon and fines are removed so that the clean product may be utilized as a core sand if desired.

A still further object of this invention is the provision of an apparatus for cleaning foundry sand which may be constructed from readily available equipment.

A still further object of this invention is the provision of a process for cleaning foundry sand which is more suitable for use in many instances than fresh sand for similar purposes.

Further and additional objects will appear from the following description, the accompanying drawings and the appended claims.

In accordance with one embodiment of this invention, a process and apparatus have been provided which dislodges carbon from sand particles by hurling two streams of sand in liquid suspension against each other at high velocity. The process contemplates moving two streams of sand in liquid suspension at high velocity in opposite directions and impinging these streams one against the other whereby the carbon and other foreign material adhering to the sand particles are dislodged. In accordance with a preferred embodiment of this invention, the process is one which is cyclic in nature wherein the liquid suspension of impinged sand particles is divided

into two streams and recycled to the two high velocity streams for reimpingement. The process of this invention may be conducted as a batch operation or it may be made continuous if desired.

Preferably the apparatus in which the process of this invention is carried out comprises a cylindrical scrubber having a horizontally disposed axis. The scrubber comprises a central abrasion or impingement zone and two oppositely disposed end zones. Means including a conduit are provided for circulating the impinged streams from the impingement or abrasion zone back to the two end zones exteriorly of the scrubber. The sand suspension that has been cycled through the scrubber may then be passed to one or more flotation zones in order to seperate the dislodged carbon and fines from the scrubbed sand particles. Preferably hydraulic jets having relatively long venturi throats are employed for transporting the sand-water suspension from the scrubbing zone to the flotation zones. The jets are particularly useful since they provide additional means for scrubbing the sand particles as they pass through the equipment.

In accordance with one embodiment of this invention, a battery of scrubbing zones may be employed with flotation means interposed between successive scrubbing zones whereby carbon and fines are removed from the scrubbed suspension prior to the introduction of the suspension of sand into the next succeeding scrubbing zone. After the scrubbed sand has passed through the final scrubber and flotation zone, it may then be passed through a hydraulic separator or classifier in order to remove last traces of soluble matter, fines, carbon or other oversize or lightweight particles.

For a more complete understanding of this invention, reference will now be made to the accompanying drawing which is a more or less diagrammatic showing of one form of apparatus in which the process of this invention may be carried out.

The apparatus shown in the drawing comprises a hopper or bin **10** which serves as temporary storage means for used foundry sand. In operation the dry sand is discharged through valve **12** into a grinder or pulverizer **14** wherein the lumps of foundry sand are comminuted to reduce them to individual sand particle size. The dry material is then discharged through spout **16** onto a 30 mesh vibrating screen **18**. Oversize particles are collected in a receptacle **20** for discard. Water is sprayed onto the upper surface of the vibrating screen **18** through a plurality of spray nozzles **22** and the water and sand including the fines pass through the screen **18** into a hopper **24**. The sand is maintained in a fluidized aqueous suspension by continuously introducing a small amount of water into the bottom of the hopper **24** through a valved conduit **26**.

A fluid suspension of sand and water is withdrawn from the bottom of the hopper **24** through a hydraulic jet **28** and forced through a conduit **30** into the top of a flotation chamber **32**. The jet **28** is a high pressure pump operated by a stream of water discharged at about 800 p. s. i. through the nozzle **34** into the jet chamber **36** as will be readily understood. Preferably the venturi throat **38** of the jet is long and narrow in construction in order that a large amount of turbulence will be imparted to the jetted sand suspension. This turbulence results in the abrasion of the sand particles which serves in some degree to scrub off some of the carbon that may be adhering thereto.

The jetted mixture is discharged into the flotation chamber **32** and lightweight carbon particles or fines contained in the suspension may be floated off of the top by excess water supplied by the jet through an overflow means **40**. A small amount of water is continuously

introduced into the bottom of the flotation chamber 32 by means of a valved conduit 42 in order to prevent sand from packing in the bottom of the chamber 32 and to provide in part excess water for flotation out of the overflow 40 as above described. A suspension of sand and water is continuously or intermittently withdrawn from the chamber 32 through a valved fitting 44 and introduced into a chamber 46 from which additional lightweight carbon particles and fines may be separated from the sand by a flotation method, the latter being withdrawn through the overflow spout 48. The fluid suspension including sand particles having carbon adhered thereto is then continuously or intermittently withdrawn from the flotation chamber 46 through the valved conduit 50 for discharge into a first scrubbing zone. Water may be continuously introduced into the conduit 50 through valved lines 51 and 53 in order to prevent packing of sand within the conduit 50 and adjacent the valve.

The sand suspension is discharged from the conduit 50 into a funnel 52 which forms a part of a first scrubbing zone 54. This zone comprises a horizontally disposed cylindrical chamber or scrubber 56 defining a centrally located impingement or abrasion zone 58 and oppositely disposed end zones 60 and 62. Extending through the chamber 56 is an axial shaft 64 having a plurality of propellers or impellers 66, 68, 70 and 72 rigidly affixed thereto. The propellers may be provided with an abrasion-resistant coating of rubber or other material if desired. Propellers 66 and 68 are pitched in one direction and propellers 70 and 72 are pitched in the opposite direction so that when the shaft 64 is rotated at a high rate of speed by any convenient means (not shown) the propellers will hurl a fluid sand suspension from the ends 60 and 62 of the chamber toward the central impingement zone 58 at a high velocity. The shaft 64 is bearinged in the opposing end walls of the chamber 58 by suitable water bearings 74 into which water under pressure is applied through conduits 76 thereby providing a continuous flow of water into the scrubber 56 and preventing sand from finding its way into these bearings 74. These bearings of course are shown only diagrammatically in the drawing.

The scrubbing chamber 56 is provided with a bottom discharge valve 78 which may be utilized for cleaning operations or for discharging the scrubbed suspension from the scrubbing zone when it is desired to operate the scrubber batchwise. Extending upwardly from the impingement zone 58 of the scrubber 56 is a standpipe 80 communicating at its upper end with a pair of stream dividing conduits 82 and 84. Conduit 82 discharges into the funnel 52 and conduit 84 similarly discharges into a similar funnel 86. The funnels 52 and 86 discharge into opposite ends of the scrubbing chamber 56, it being noted that the discharge end of each of these funnels terminates at a point closely adjacent the shaft 64 and between a pair of impellers 66 and 68 and 70 and 72 which serve to hurl the sand-water suspension from the end zones 60 and 62 toward each other to the zone of impingement 58. It has been found preferable in this modification to have the discharge ends of the funnels 52 and 86 terminate closely adjacent the shaft 64 since by this construction it has been found possible fully to fill the scrubber 56 with a suspension of sand in water during operation. Also the provision of the standpipe extending vertically above the impingement zone for a substantial distance permits the maintenance of a pressure in the impingement zone which in combination with the discharge ends of the funnels 52 and 86 prevents the formation of undesired air pockets within the scrubbing chamber during operation.

Thus when a suspension of sand in water is passed into the funnel 52 and the scrubbing chamber 56 and after the scrubber has become substantially full of the

fluid suspension then the rapid rotation of the shaft 64 by any suitable means causes the formation of two streams of sand and water suspension moving in opposite directions to the impingement zone 58. At this point the sand particles are rapidly hurled against each other whereby the sand particles strike against each other and the carbon is dislodged. The impinged stream is withdrawn from the scrubber through the standpipe 80 and is divided by the conduits 82 and 84 and falls back into the funnels 52 and 86 whereafter it is recycled to the scrubber 56 in a manner that will be understood. Thus means are provided exteriorly of the chamber 56 for recirculating the suspension from the impingement zone to the respective end zones.

It is important to note that the shaft 64 is rotated at a high rate in order to permit the oppositely moving streams of suspension to be hurled against each other at high velocity. Thus it is preferred that the peripheral speed of outer ends of the impellers 66, 68, 70 and 72 be between 3,000 and 5,000 feet per minute in order to impart the desired velocity to the impinging streams. The velocity is such that the heat generated on account of the impingement and abrasion is sufficient to raise the temperature of the sand and water suspension to a value above about 120° F. after about ten minutes of operation. This temperature increase further functions to dislodge carbon by reason of thermal expansion effects.

After the sand is subjected to a desired degree of abrasion or scrubbing in the scrubbing zone 54, then it may be withdrawn through the valve 78 for further treatment. However, it is preferred that the scrubbed sand be continuously or intermittently withdrawn from the apparatus through valved conduits 88 and 90 extending from an upper end of the standpipe 80. It will be noted that withdrawal conduits 88 and 90 are located upstream of the discharge end of conduit 50 so that in a continuous operation all sand will pass at least once through the scrubber chamber and impingement zone. The conduits 88 and 90 merge into a conduit 92 which supplies the influent for a jet pump 94 which serves to elevate the scrubbed sand-water mixture through conduit 96 to a flotation zone 98. The jet pump 94 has substantially the same structure as jet pump 28 previously described and is operated with a stream of water at about 800 p. s. i. Scrubbed-off particles of carbon, as well as fines, are floated off through the overflow spout 100 and the sand suspension is passed through a valved conduit 102 and branch conduits 104 and 106 to a second scrubbing zone 108.

Scrubbing zone 108 is similar to scrubbing zone 54 in that it comprises a cylindrical scrubbing chamber 110 having a rotatable shaft 112 extending therethrough. The shaft has fixedly mounted thereon propellers 114, 116, 118 and 120 which are pitched in such a manner as to force a suspension of sand and water toward the central area 122 of the scrubbing chamber. In operation the shaft 112 also rotates at a sufficient speed to move streams of sand and water suspension at high velocities in opposite direction to the zone of impingement 122 wherein the carbon is dislodged from the particles of sand. The mixture is then forced by the pressures obtaining in the impingement zone 122 through an upwardly extending standpipe 124 from which it is passed to a pair of legs 126 and 128 for reintroduction into the end zones of the scrubbing chamber 110. Thus the sand particles in the scrubbing zone 108 are subjected to a plurality of impingements and the travel of material through this zone (as well as through the zone 54) is in the shape of a pair of rings which rings are concentric throughout a portion of their length, the concentric portion being in this instance the standpipe 124. If desired, the scrubbed sand may be withdrawn from the chamber 110 through a valved conduit 130. Preferably, however, it is withdrawn from the standpipe 124 through a pair of valved conduits 132 and pumped by another jet pump 134 to an-

other flotation chamber **136** from which additional carbon and fines are floated from the suspension. Thereafter the sand suspension is passed through another scrubbing zone **138** which may be substantially the same as the scrubbing zone **108** and the sand is scrubbed in the same manner.

In scrubbing zones **108** and **138** sand and water are circulated as above described in two closed rings. The entire system at this point is closed so that no air is introduced into the scrubbing chambers. In scrubbing zone **54**, air is prevented from entering the scrubbing chamber by always maintaining a substantial level of suspension in each of the open funnels **52** and **86**.

The sand scrubbed in zone **138** is eventually passed to a flotation chamber **140**, then through a jet pump **142**, another flotation chamber **144** and introduced into a hydraulic classifier. This classifier comprises a main chamber **146** having a tube **148** extending downwardly therein and through which the sand suspension descends after being discharged from the flotation chamber **144**. The chamber **146** is filled with water and means are provided for flowing water in a stream upwardly through the tube **148** at a constant rate. The sand particles settle in the water in the tube but the upward movement of the water carries off the more buoyant particles for overflow into an upper annular chamber **150** and ultimate discharge through a conduit **152**. The supply of water to the classifier **146** is maintained constant by means of a flow regulator **154**. This regulator includes a chamber **156** into which water is continuously introduced through conduit **158**. Water is withdrawn from the chamber **156** through a plurality of conduits **160** and **162** for introduction at spaced points into the annular chamber **164** between the tube **148** and the inside walls of the chamber **146**. Only two conduits **160** and **162** are shown in the drawing, but it is preferred that there be four of them having four discharge ends spaced equally around the chamber **164**. The rate of flow of water into the chamber **156** through the tube **158** is somewhat greater than that which can be accommodated by the conduits **160** and **162** discharging into the classifier chamber **146**. Thus a portion of the water introduced into the chamber **156** is withdrawn by a vertically adjustable overflow conduit **166**. It will be apparent that the vertical adjustment of the conduit **166** determines the pressure head on the water passed to the hydraulic classifier through the conduits **160** and **162**. Obviously this pressure head determines the rate of flow of the water downwardly through the annular passageway **164** and upwardly through the tube **148**. Therefore the height of the overflow tube **166** is important in determining the particle size of sand that will settle into the bottom of the classifier **146**. It will be apparent from the drawing that annular ring **167** separates the inflow chamber **164** from the overflow chamber **150**.

The cleaned sand having a uniform particle size collects in the bottom of the classifier and the level therein may be observed by a sight glass **168**. The sand may be withdrawn therefrom as required through a valve conduit **170** whereafter it is dried in the usual fashion and may be reused as a foundry or core sand.

It will be apparent from the foregoing description that an efficient process and apparatus has been developed for cleaning used foundry sand very efficiently and at a relatively high rate. The apparatus may be used intermittently or continuously as desired. For small operations only one scrubber is necessary, care being taken to circulate the sand through the scrubbing system for a sufficient time to dislodge substantially all of the carbon from the sand particles. However, in large operations it is preferred to employ a battery of two, three or more scrubbers as indicated in the drawing.

In the operation of the apparatus it has been found that sand may be satisfactorily cleaned where the average total residence time of the sand particles in the several scrubbing zones is from ten minutes to one hour. The sand-water suspension in each scrubbing chamber has a high percentage of sand, suitable ratios being between about 20 and 100 gallons of water for each ton of dry sand, an important consideration being to provide a fluid stream having a high concentration of particles to ensure their mutual bombardment when the two streams are impinged against each other. If desired, suitable detergents or acid or alkaline washing agents, such as sodium acid fluoride or sodium hydroxide may be added to the suspension being scrubbed in order to assist in the removal of carbon from the particles. These agents are removed from the final sand particles in the flotation and hydraulic classification operations. In a system in which the individual scrubbing chambers have a diameter of 20 inches and are about 46 inches in length, in which the center standpipe is about 7 feet high and 6 inches in diameter, and in which the propellers are about 17 inches in diameter and rotate at a rate of about 850 revolutions per minute, the sand will be adequately cleaned when the total average residence time of the particles in the several scrubbing zones is between about 10 minutes and about one hour.

While particular embodiments of this invention are suggested above, it will be understood, of course, that the invention is not to be limited thereto, since many modifications may be made, and it is contemplated, therefore, by the appended claims, to cover any such modifications as fall within the true spirit and scope of this invention.

I claim:

1. Process of cleaning used foundry sand which comprises the steps of screening the sand in presence of water to remove oversized adventitious material, fluidizing the sand with a jet of water and passing it to relatively quiescent settling zones wherein loose carbonaceous impurities will be floated off, transferring the residual sand to a first attrition chamber in which said sand while fluidized with water is subjected to attrition by impelling means hurling the sand particles against each other, transferring the thus treated sand to a further settling zone wherein carbonaceous particles which have been loosened from the sand are floated off; again submitting the sand in fluidized condition to attrition in the manner hereinabove recited, and again passing the treated sand through a settling zone.

2. The process as recited in claim 1, in which the sand is treated a third time in an attrition chamber.

3. The process as recited in claim 2 in which a final elutriation step follows the operations to remove clay-like impurities smaller than the grains of the sand.

4. Apparatus for cleaning used foundry sand which comprises means for screening the sand in the presence of water to remove over-sized adventitious material therefrom, jet means for fluidizing the residual sand, and means for passing it to a quiescent settling zone, a settling zone provided with means for floating off loose carbonaceous impurities, an attrition chamber comprising a housing having an elongated horizontal axis, a shaft passing therethrough, means for transferring the residual sand to said attrition chamber, propellers on said shaft arranged so as to throw liquid in opposed directions toward the center of said chamber, exit means on said chamber for discharging the material therefrom, and means for introducing portions of the material thus discharged to said chamber, means connected with said discharge means for transferring treated sand and water in fluidized condition to a second quiescent settling zone, and means for passing sand settled in said second zone to a second attrition chamber, which mechanically is substantially identical to the first mentioned attrition chamber, a further quiescent settling zone, and means for passing settled-out sand therein to an elutriation zone, means for passing water into the bottom of said zone to wash from the sand therein particles lighter than the sand particles, and means for finally discharging sand from said elutriation zone.

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