

[54] **APPARATUS FOR REGENERATING
FOUNDRY SAND**

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241/40, 41, 42, 60, 79.1; 51/5, 9

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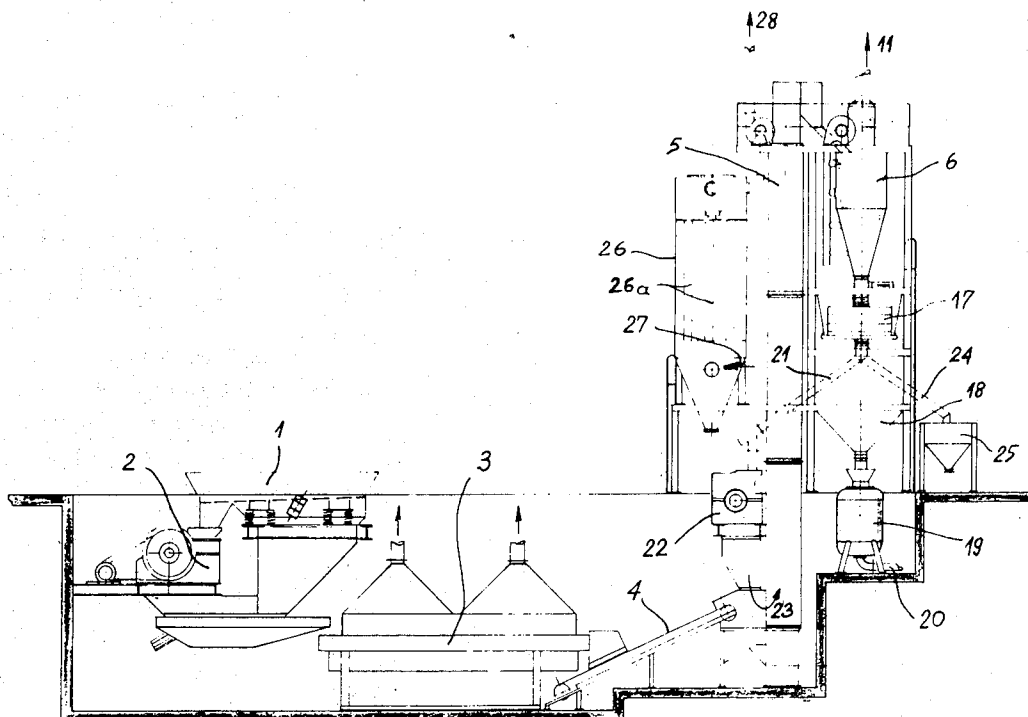
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[57] **ABSTRACT**

Apparatus for the regeneration of foundry sand, particularly sand coated with irreversible inorganic and/or organic binding agents. The sand molds are broken to free the castings and the lumps of hot sand crushed and cooled to ambient temperature. The grains of sand are then separated from the coating of binder and sieved to obtain a selected range of grain sizes equivalent to that of suitable new foundry sand. Grains of sand of excessive size may be pulverised and returned for re-processing. Dust is removed from the sand at one or more of the stages of the process where dust is caused to form. Castings are recovered from the mold fragments by a magnetic or electronic separator.

9 Claims, 4 Drawing Figures



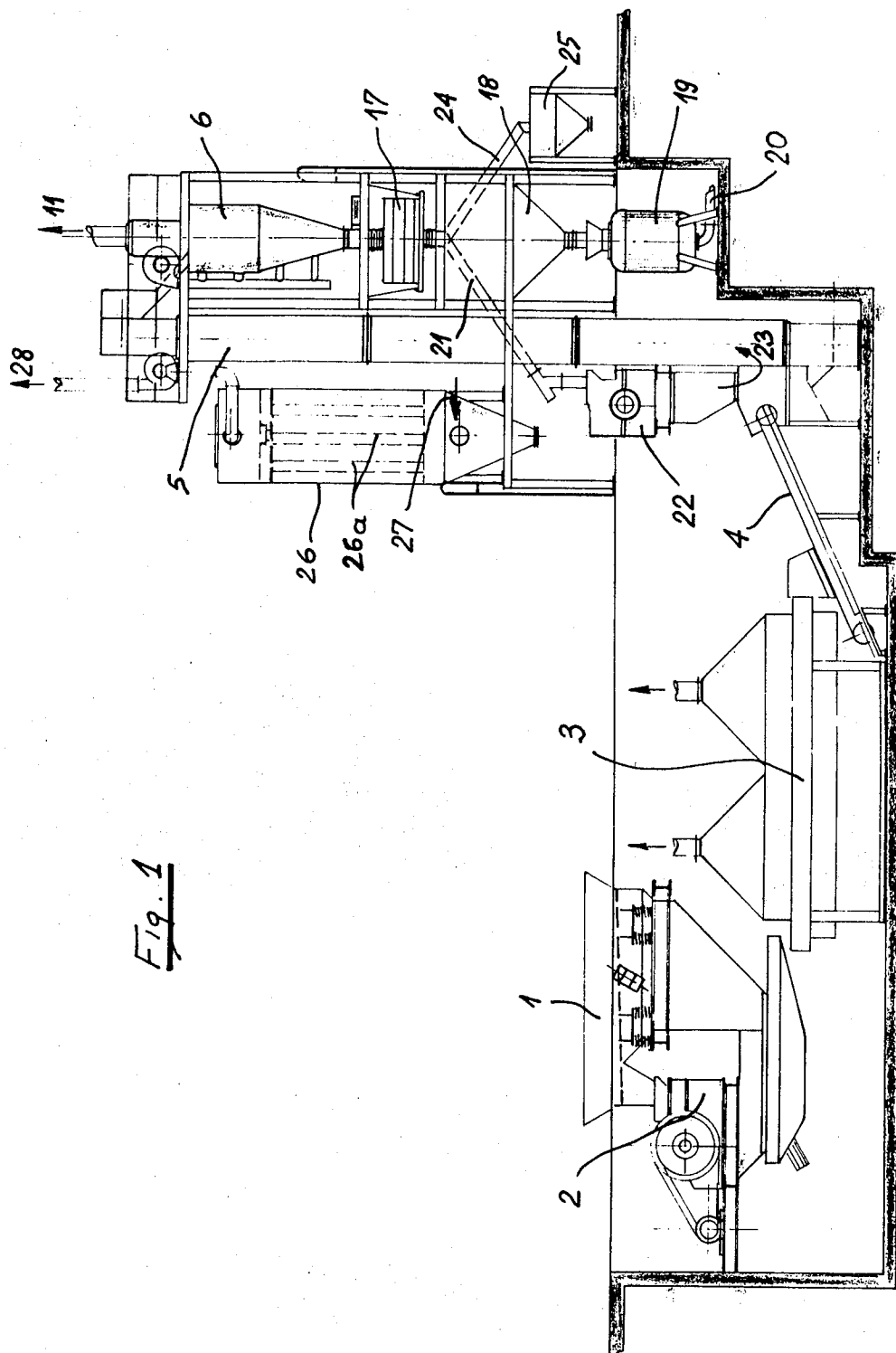
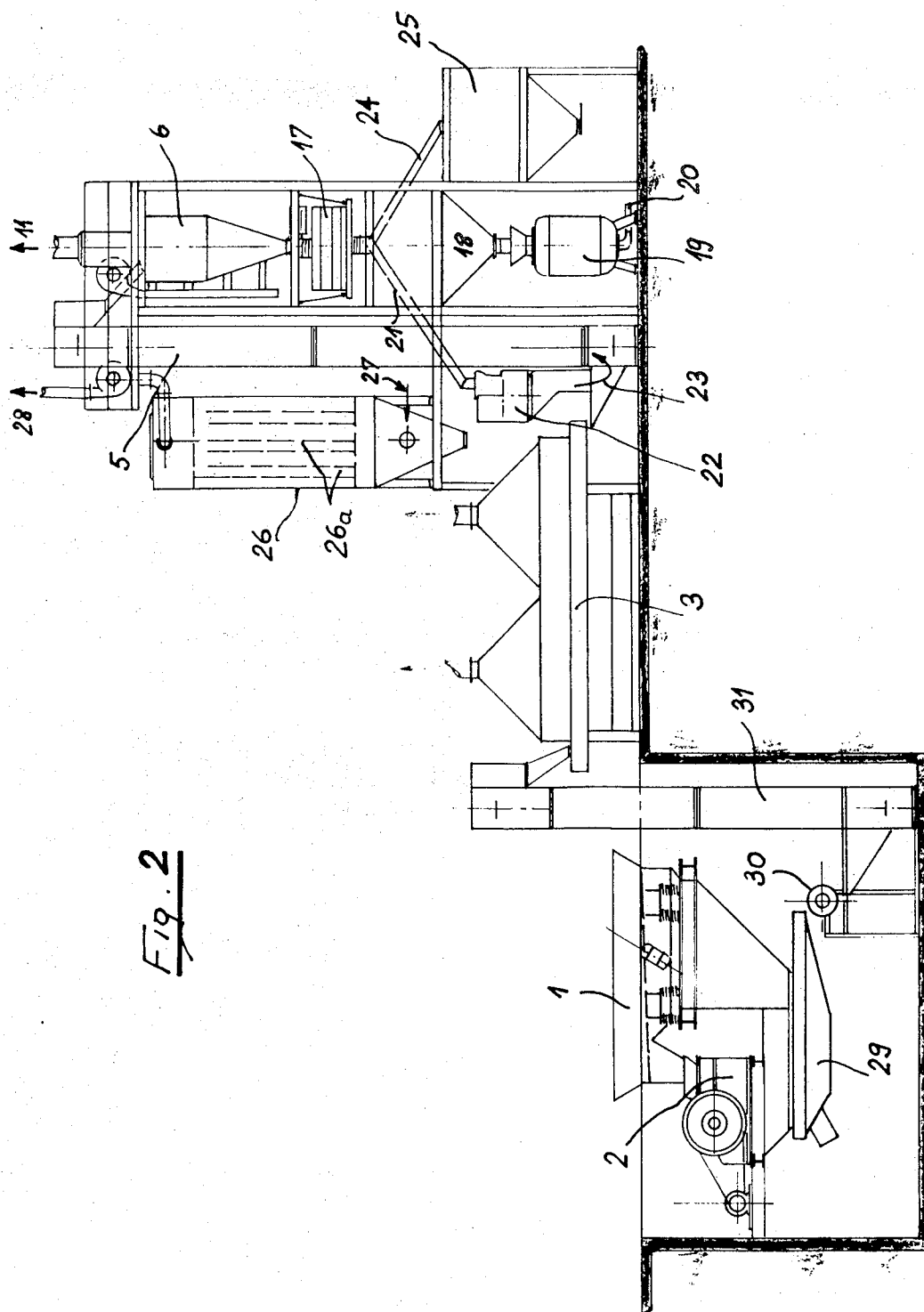
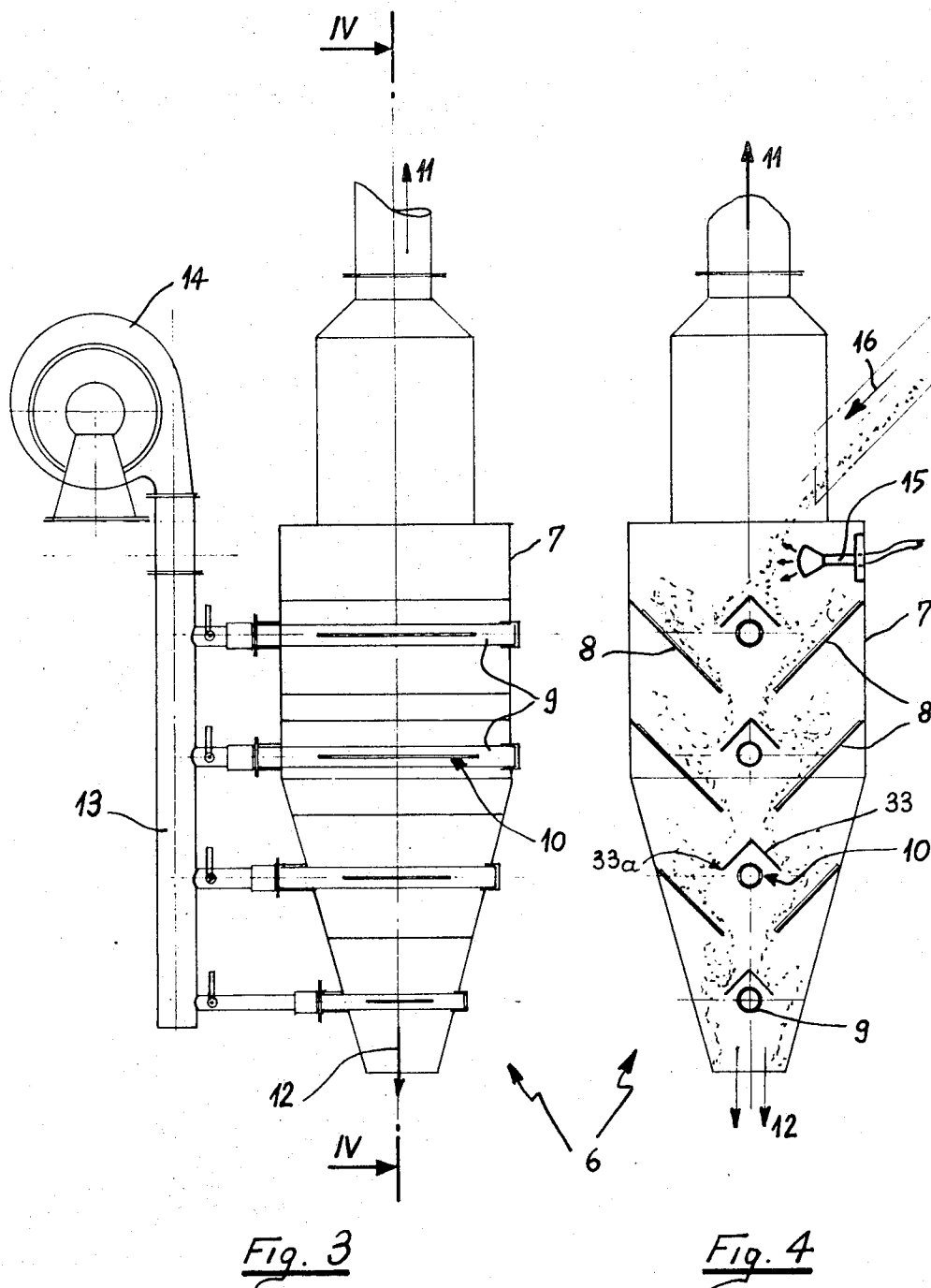


Fig. 1





APPARATUS FOR REGENERATING FOUNDRY SAND

BACKGROUND OF THE INVENTION

This invention relates to a process and apparatus for the regeneration of foundry sand; in particular foundry sand which was prepared with irreversible binders such as silicates and organic resins (furan, furan urea-formaldehyde, furan phenol, etc.).

For quite some time the rising price for foundry sand and the problems arising in foundry sand removal have forced foundrymen to look for ways in which foundry sand could be recovered and re-used in molding operations. In the course of time methods have been devised for the recovery of argillaceous sands, synthetic Bentonite sands, cement sands and finally, with only 50 percent success, sodium silicate processed sands (known as the "CO₂ process" or the "liquid sand" process).

The development of organic binders like phenolic resins for shell molding processes and furan resins for no-bake processes has shown the old types of sand recovery units to be unsuitable and that a new technique was required for the recovery of "burnt" sands in which one not only recovered the sand but in the true sense of the word regenerated it. If the argillaceous sand reclamation process simply requires a breaking of the lumps, a removal of the gates and risers, and a regrinding and missing with water before re-use, this is not so with siliceous sands which contain sodium silicate or organic resins (furan and phenolic) as binders. In these two cases the sand becomes coated with a layer of mineral binding agent (silicate) or organic binding agent (resin) and, contrary to clay, this binding agent, as soon as it has set, becomes inert and thus cannot be re-used. A still more serious drawback is the fact that this film of binding agent becomes a contaminant when the sand is simply recuperated, i.e., re-used after crushing but without the suitable physical treatment. The fact is that the accumulation of carbonates (in the case of the silicate) or of nitrogen and organic substances (as in the case of resins) rapidly results in flaws making it necessary to reject the castings concerned.

In the sphere of regeneration, a first technique has been developed in which, by way of a new feature, the organic substances undergo calcination, the sand thus acquiring properties similar to its original characteristics. The technique unfortunately suffers from the drawback of being extremely expensive, very slow and relatively unproductive. It is now only used for the sands obtained by the "shell molding process", agglomerated with phenolic resins. In the case of the furan resins used in the no-bake process, owing to the fact that the cost of calcination is 2.5 times higher than in the case of the phenolic resins, this process cannot be profitably adopted, and the same applies for sodium silicate.

PURPOSE OF THE INVENTION

The aim of the present invention is to eliminate the foregoing drawbacks, for which purpose it relates to a process and an apparatus for the regeneration of foundry sand, particularly of sand prepared with irreversible organic binding agents (sodium silicates) and/or organic binding agents (e.g., furan resins) of the same type as those used in treatments by the "dry method," i.e., in which the apparatus as in any elemen-

tary reclaiming plant, comprises first devices enabling the casting to be separated from the mould by breaking the latter, and second devices for crushing the fragments of the mould, to which first device are added, in particular, devices enabling mechanical attrition to be carried out, i.e., the separation of the film of binding agent in which the grains of sand are encased, the said additional devices enabling a completely clean and thoroughly screened sand to be obtained, absolutely free of dust.

SUMMARY OF THE INVENTION

According to the invention, a process for the regeneration of foundry sand, particularly of sand prepared with inorganic and/or organic irreversible binding agents, comprising initial stages in which the molds are broken and the burning sand crushed, is characterized by the fact that the said sand is cooled, in order to bring it to a temperature close to ambient, after which the grains of sand are separated mechanically from the film of binding agent in which they are encased, by simply introducing the said grains into a current of air, under a high pressure, in such a way that they are flung out against the metal side wall of a hermetically sealed casing having a vertical axis of symmetry, causing their enclosing matrix to burst, after which a granulometric selection is carried out by means of at least two screens of different mesh size, restoring the range of grain sizes to that which would be required of an appropriate new sand, the grains of sand of dimensions included between those of the mesh sizes of the two screens then being recuperated, after which the grains of sand too large to pass through the screen of greater mesh size and also those too small to pass through the screen of smaller mesh size being rejected, the sand then being freed of dust in at least one of the places, e.g., at the crushing stage, the mechanical separation stage or the screening stage, where it undergoes a mechanical treatment causing such dust to form.

BRIEF DESCRIPTION OF THE DRAWINGS

A description will now be given of various examples of the present invention, without any limitative effect and by reference to the attached drawings, in which:

FIG. 1 is a schematic diagram of a complete sand regeneration plant;

FIG. 2 is an alternative version of the plant shown in FIG. 1;

FIG. 3 is an elevation of apparatus for the separation of the grains of sand from their coating of binding agent, this apparatus being known as the "elutriator"; and

FIG. 4 is a longitudinal section along the line IV—IV of the elutriator shown in FIG. 3.

DESCRIPTION OF SPECIFIC EMBODIMENTS

The apparatus for the regeneration of casting sand, particularly sand prepared with irreversible binding agents of the inorganic type (sodium silicate) and/or organic type (furan), consists of a conventional recuperation apparatus followed by a plurality of additional devices enabling a sand unsuitable for further use after emerging from the conventional installation to be converted into a sand which recovers its original characteristics, i.e., which for this purpose is cleaned mechanically for the removal of its mineral and/or organic gangue, broken up, screened and freed of dust.

The conventional sand recuperating installation comprises the following two units; a stripping grid 1, which is stationary, vibrating or of the impact type, its purpose being to break up the mold, enabling the casting to be recovered at the same time, and a preliminary crusher 2 of the hammer "jaw" or roller type, of which the purpose is to reduce the large lumps of sand to finer particles.

The complete sand regenerating plant to which the present invention relates comprises a series of new devices which follow the said conventional installation. In the order in which the grains of sand are treated the additional installation takes the following form, by reference to FIG. 1:

a. A sand cooling channel 3 cools the burning sand coming from the stripping unit and reduces its temperature to a level close to the ambient temperature, this being the only temperature likely to be suitable for the use of sands bound with sodium silicates or organic resins. Any type of cooling apparatus may be used, but that preferred is a continuous cooler based on the fluid bed principle, since the advantage of a cooler with a metallic fluidization channel resides in the fact that it makes it possible to avoid the rapid deterioration suffered by the conventional rubber conveyor belts as a result of the excessively hot sand.

b. A belt conveyor 4 or alternatively a vibrating chute, equipped with a separator for the metallic particles, either of the magnetic type (with a drum or band) for the ferrous metals or of the electronic type for the non-ferrous metals and the diamagnetic alloys.

c. An elevator 5 conveying the sand to the upper part of a pneumatic apparatus enabling the sand to be cleaned in order to free it of the film of mineral or organic binding agent in which each grain is encased, the apparatus being known as an "elutriator" and usable, according to the particular method selected, as a secondary cooler.

d. An elutriator 6 of which the description will be better understood by reference to FIGS. 3 and 4; this apparatus, with several working stages, consists of a hermetically sealed casing 7 with a vertical axis of symmetry (e.g., a cylindrical cone, prism or truncated pyramid) in which a current of fluid, conveniently air, of medium or high pressure, forces the sand which enters through inlet 16 at an even rate from the centre to the walls of the casing 7. In FIGS. 3 and 4 the air feed conduits 9 (fed with air at medium or high pressure) are horizontal and extend across the casing 7 as far as a general gas supply conduit 13, itself connected to a pressure source 14 in the form of a compressor, blower or ventilator. Each conduit 9 is provided with orifices, e.g., in the form of narrow longitudinal slots 10 extending over almost the entire length of the conduits 9 and enabling a vigorous horizontal current of gas to be projected, according to the "air layer" principle, towards the walls of the casing 7, the said current of gas itself carrying along the grains of sand. Needless to say, the gas could equally be projected by means of other devices, such as a vertical column having lateral projection nozzles at each stage, and these projection devices thus form an integral part of the present invention.

When the grains reach the enclosure 7 they first of all fall by the mere force of gravity and thus in a direction parallel to the vertical axis of symmetry of the casing, after which they are projected from the centre towards the walls, in a direction substantially perpendicular to

the said axis, before being intercepted by a set of internal baffles 8 which are provided on the wall of the casing and over which the grains of sand slide, causing a reverse movement of the grains which are thus returned evenly from the wall to the centre of the casing. Furthermore, a cap 33 is situated above each pressure gas conduit 9 in such a way that its lower edges 33a contact the plane in which the current of gas circulates at considerable pressure, and the grains of sand which fall by force of gravity and slide along the said cap are immediately re-introduced into the current of gas perpendicular to the axis of symmetry.

The repeated projection of the sand towards the walls thus breaks the enclosing matrix of binding agent, which is carried along by the current of air while the sand itself, by the mere force of gravity, drops from one stage to another in order to undergo a further cleaning process. The number of stages depends solely on the output of the apparatus and on the extent to which the sand is to be so cleaned.

The elutriator 6 offers advantages by comparison with apparatus which simply subjects the sand to mechanical friction, firstly because the current of air separates and removes through dust outlet 11 the dust which has been produced, instead of allowing it to flow freely through the sand outlet 12 together with the sand, and secondly because the violent stirring action to which the sand is subjected in the successive currents of air results in a by no means negligible reduction in the temperature of the sand, this temperature being, in practice, reduced from 150° C to 40° C.

The air pressure inside the general supply conduit 13 for the elutriator 6 is only of relative importance, as it is only the impact created by the projection of the sand against the wall of the apparatus that has to be retained. The air pressure at the entry of the elutriator 6 can thus vary according to the cross section of the apparatus (distance to be covered by the sand), the number of stages selected and the hourly delivery of the sand to be treated. By way of an example, these numerical data being in no way limitative, a compromise between the air delivery, air pressure, wear on the walls, sand cleaning quality, dust removal and cooling is obtained with an air speed between 15 and 50 metres per second and an air delivery between 4 and 12 cubic metres per minute, per ton of sand treated per hour. Furthermore, for sands not sensitive to moisture, such as foundry sands and certain mineral products, the cooling qualities of the elutriator can also be improved by the addition of an atomizer system for the application of very fine drops of volatile liquid such as water, this system being shown schematically by an atomiser 15 situated, for example, vertically underneath the sand inlet 16. The atomizer 15 advantageously provided with means for regulating the water delivery, in order to ensure the fully efficient cooling of the sand by enabling the quantity of water introduced to be added to the heat of the sand reaching the elutriator, in such a way as to keep the sand at a constant temperature at its outlet 12. By way of an example, a water delivery regulator inside the elutriator is provided in the form of a thermometer for measuring the temperature of the sand, this thermometer being situated inside or at the outlet 12 of the elutriator 6, or else in the form of a moisture testing device which verifies the degree to which the sand has been dried after it has been cooled.

The elutriator 6 thus supplements the crusher 2, of which the action was limited to that of nullifying the points of connection between the grains of sand. By projecting the sand at a high speed onto the walls of the casing 7 and also by the friction between the grains of sand themselves, the separation of the sand, grain by grain, is completed by splitting its coating of binding agent.

e. A screening apparatus 17 with at least two screens, of different mesh sizes, arranged one above the other. In actual fact the superimposed screens will be between two and eight in number. Their main purpose is to effect a granulometric selection of the sand to obtain a grain size range covering the same sizes as that of an appropriate new sand, the effect being to render possible the further use of the sand screened between a maximum and a minimum value as specified for accurate mold and core manufacture.

Screens are selected according to the use the selected sand is to be put after regeneration, in the same way as grain selection would have been effected in order to obtain the most suitable granulometry for a new sand for mold manufacture. The use of multiple screens, which is an original application according to the invention, also makes the following possible:

In the case of two screens, to eliminate the finest grains, starting from the screen size regarded as unacceptable. In the case of more than two screens, to effect a still finer selection of the sand, by accurately regrouping it on the desired screens and eliminating all those which appear unacceptable.

By way of an example, use can be made of screens arranged in stages, one above the other, with successive rejects at each stage, the sizes of these screens usually ranging from No. 30 to No. 140, according to the AFS standards.

f. A storage hopper 18, preceding a pneumatic transport device 19 for conveying the grains of sand of which the dimensions are intermediate; the maximum and minimum determined by the screening device 17 of at least two stages. The grains are propelled through tubular conduits 20 to an enclosure where the sand is recuperated and reutilized for the manufacture of moulds or cores.

The elimination of the finest grains of sand obtained after the screening is carried out at the same time as that of the dust, by means of a device to be described hereinafter. As regards the grains of which the dimensions are above the acceptable maximum and which cannot be directly re-utilized as such, two solutions are possible, as follows:

1. The coarse rejects can be conveyed through a conduit 21 to a secondary crusher 22 (e.g., a hammer mill or "pulverizer") with a high circumferential speed, preferably operating at a negative pressure (for dust removal). The purpose of the crusher 22 is to supplement, by its action, that of the elutriator 6, thus reducing the size of the grains of sand and causing their coating of binding agent to burst. In the lower part of the crusher 22 the grains of sand are returned to the cycle, in the direction indicated by the arrow 23, starting from the bottom of the elevator 5 in the assembly already described. In the embodiment illustrated the crusher 22 acts solely on the excessively large grains of sand; if desired by the user of the installation, however, it goes without saying that this latter device, installed at the top of the conveyor 4, can also act on all the grains of

sand, even before they are transported by the elevator 5, and simultaneously on the coarse rejects, as described previously, this special arrangement still being within the scope of the principle of the invention on which the present installation is based.

2. The coarse rejects can be conveyed through a conduit 24 into a recuperation hopper 25. The adoption of this alternative path allows a certain number of pieces of agglomerated sand or "calibrated granulates" to be recuperated separately, in order to be reutilized in this state, instead of conveying them to the crusher 22 to be reduced to the suitable grain size; the fact is, particularly for large moulds and cores, that these granulates can be used as very economical fillers, thus economising in the use of silicate or organic binding agents.

g. A dust collection chamber 26, of which the suction intakes are situated in those places where the sand undergoes a mechanical treatment liable to cause dust form, i.e., the preliminary crusher 2, the elevator 5, the elutriator 6, the screening apparatus 17 and the secondary crusher 22. The main purpose of the dust removal chamber 26 is to enable a perfectly clean sand to be obtained; for this purpose it differs from the hitherto customary dust removal processes, of which the sole purpose is the elimination of the dust liable to be spread to the atmosphere and to render the work unpleasant and dangerous (involving the risk of silicosis).

The purpose of the dust removal chamber 26 is the reason why the suction intakes (omitted from FIGS. 1 and 2, in order to render the drawings clearer) are situated in each mechanical treatment device. Consequently, not only the atmosphere will be protected but, above all, the sand will be freed at its actual source of the dust which is usually carried along with it. In the present case the intensity of the dust removal is governed by other rules than those usually adopted, and the dust removal chamber 26 consists of a very large suction device taking the form, for example, of a vertically disposed cylinder in which the air is taken in by suction at the bottom, at the inlet 27, while the air contaminated by the dust, the finest grains of sand and the coatings of binding agent detached from the sand grains is removed at the outlet 28, at the top of the chamber 26, after filtration, for example, in filter sacks 26a or in a wet separation apparatus.

In addition to the aforementioned units (a) to (g) the complete sand regeneration installation comprises an electric control cabinet (not shown in the drawing) combining the controls for the various items of apparatus described and rendering them automatic, together with a set of safety devices to ensure the satisfactory operation of the plant despite the shocks caused to the feed system by the mould stripping operation.

Needless to say, the invention is not confined to the method of application or to the constructional version described in the foregoing. Various alternative constructions of the installation are possible without thereby departing from the scope of the invention defined in the appended claims particularly the modified construction shown in FIG. 2 of the type of installation already described, there being provided, as separate units, in an intermediate position between the preliminary crusher 2 and the cooling channel 3; a vibrating distributor 29 followed by a separator 30 for recovering the metal parts the latter being either magnetic (with a drum or band) for ferrous metals or electronic for non-ferrous metals and non-magnetic alloys, followed

by an elevator 31. In an arrangement of this kind the belt conveyor 4 which followed the cooling channel 3 in FIG. 1 is replaced by the elevator 31 preceding the said cooling channel.

What is claimed is:

1. Apparatus for the regeneration of foundry sand, particularly sand coated with irreversible inorganic and/or organic binding agents, comprising means for breaking sand molds to remove the castings therefrom, means for crushing the hot lumps of sand, cooling apparatus for cooling the crushed sand to ambient temperature, separating means for separating the grains of sand from their coating of binding agent, the said separating means comprising a hermetically sealed casing with a vertical axis of symmetry, and means for directing at least one blast of fluid horizontally within the casing whereby sand falling through the casing is projected against the lateral walls of the said casing until the matrix of the binding agent is caused to burst, screening means for submitting the separated sand to granulometric selection by at least two screens of different mesh sizes to obtain a granulometric range equivalent to that desired of a new foundry sand, and means for removing dust from the sand in at least one of said crushing, separating and screening means where dust is caused to form.

2. Apparatus as claimed in claim 1, further including a secondary crushing apparatus, at least one tubular conduit for conveying grains of sand of excessive size rejected by said screening means into said secondary crushing apparatus wherein the dimensions of the grains of excessive size are reduced and their coating of binding agent caused to burst, and means to enable the grains of sand subjected to the secondary crushing apparatus to be re-cycled together with those emanating from the cooling apparatus whereby grains from both sources are conveyed together towards the separating means.

3. Apparatus as claimed in claim 1, wherein there is provided upstream of the cooling apparatus at least one separator for separating metallic particles from the sand, said separator being either of the magnetic type for the ferrous metals, or of the electronic type for the non-ferrous metals and non-magnetic alloys.

4. Apparatus as claimed in claim 1, wherein at least

one horizontally disposed conduit extends through the hermetically sealed casing, each conduit being connectable to a source of gas under pressure and having an orifice whereby at least one horizontal current of gas can be projected at considerable pressure from each conduit in a direction substantially perpendicular to the axis of symmetry of the casing, said separating means further comprising a set of internal baffles mounted on the wall of the casing and on which grains of sand slide evenly from the wall towards the centre of the casing, and a cap mounted above each pressure gas conduit and of which the lower edge contacts the plane in which the current of gas issues from the orifice, whereby grains of sand which drop by force of gravity and slide along the said cap are immediately re-introduced into the current of gas.

5. Apparatus as claimed in claim 4, wherein the separating means further comprises at least one atomizer for spraying a volatile liquid to cool the grains of sand as they enter the separating means.

6. Apparatus as claimed in claim 5, wherein the atomizer is provided with means for regulating the rate of delivery of the volatile liquid, whereby the quantity thereof can be adjusted according to the temperature of the sand entering the separating means.

7. Apparatus as claimed in claim 1, including a storage hopper for storing the grains of sand of acceptable size, the storage hopper being connected to a pneumatic conveying device for conveying the grains of sand.

8. Apparatus as claimed in claim 1, further comprising a recuperation hopper for the recuperation and storage of the grains of sand of excessive size, the recuperation hopper being connected to the screen of the larger grain size by means of a conduit.

9. Apparatus as claimed in claim 1, wherein the dust removal means consists of a chamber with a vertical axis of symmetry, the chamber being provided with an air intake orifice at the bottom thereof and with an outlet orifice at the top thereof for the evacuation of the air contaminated with dust, the finest grains of sand and the particles of binding agent detached from the grains of sand, means being provided to connect the said chamber to one or more of the units of the apparatus where the sand undergoes mechanical treatment.

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