

- [54] **FOUNDRY SAND REDUCER AND RECLAIMER**
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- [22] Filed: **July 26, 1973**
- [21] Appl. No.: **382,789**
- [52] U.S. Cl. **241/14, 241/24, 241/26, 241/29, 241/69, 241/79, 241/263, 241/273.1, 241/DIG. 10**
- [51] Int. Cl. **B02c 19/20**
- [58] Field of Search **241/1, 14, 24, 26, 29, 241/30, 69, 79, 79.2, 94, 175, 262, 263, 273.1, 283, 284, DIG. 10; 209/234**

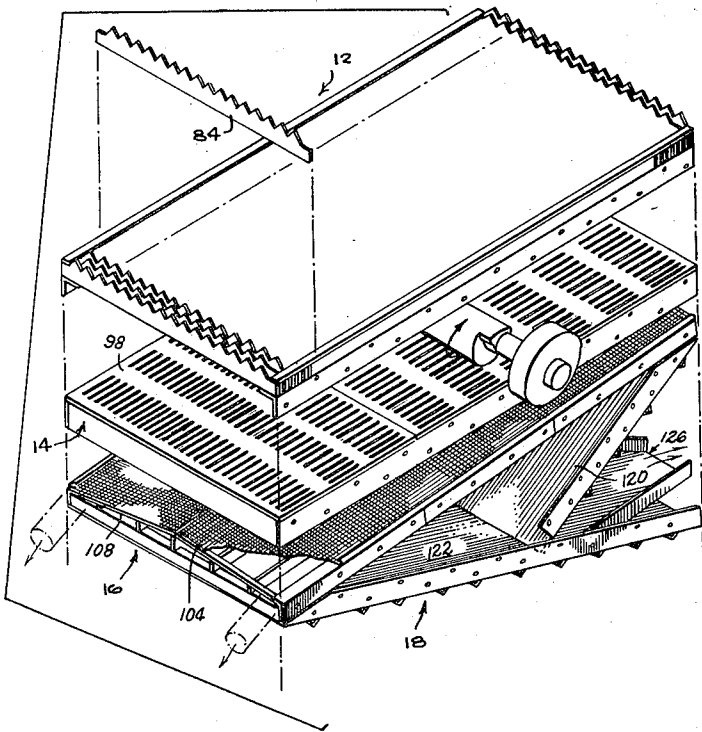
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Attorney, Agent, or Firm—Mason, Fenwick & Lawrence

[57] **ABSTRACT**

A foundry sand reducer and reclaimer using solely vibration to effect formation of individual grains and removal of substantially all organic matter coated on the grains.

29 Claims, 8 Drawing Figures



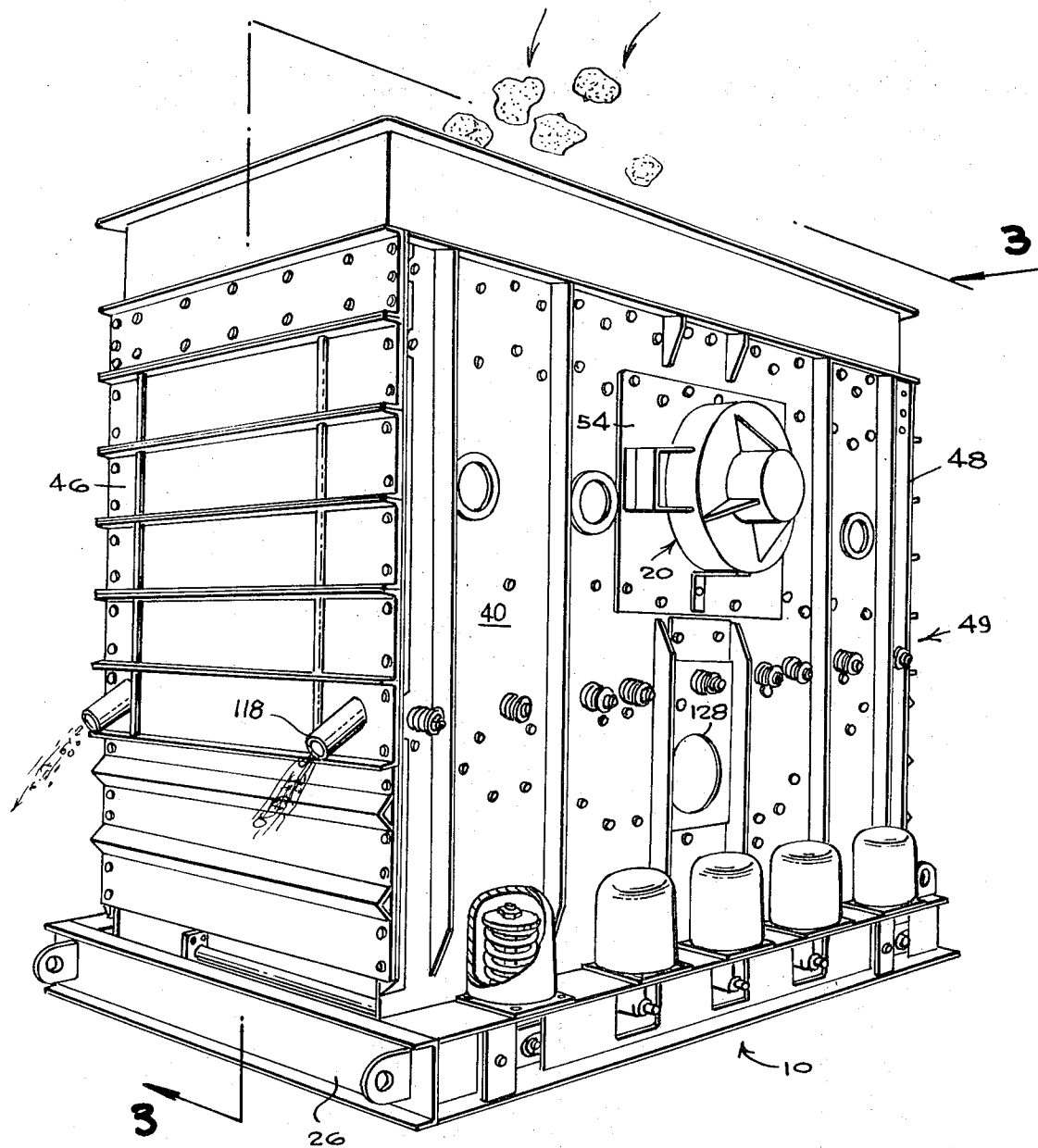


Fig-1

Fig-2

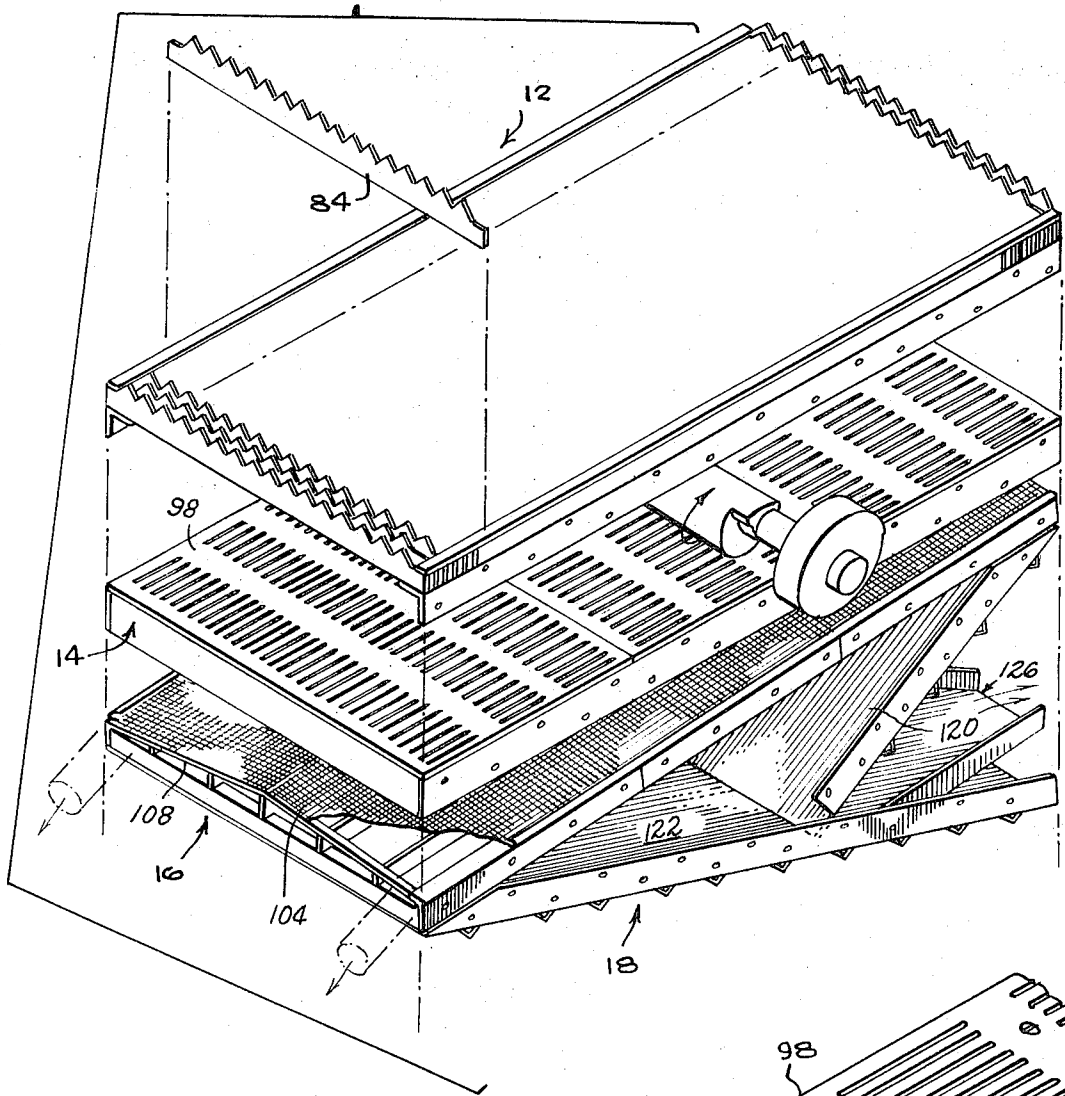
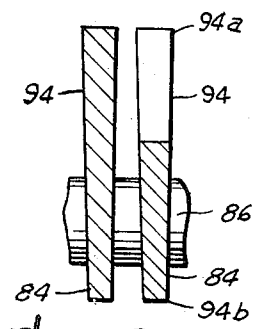


Fig-8

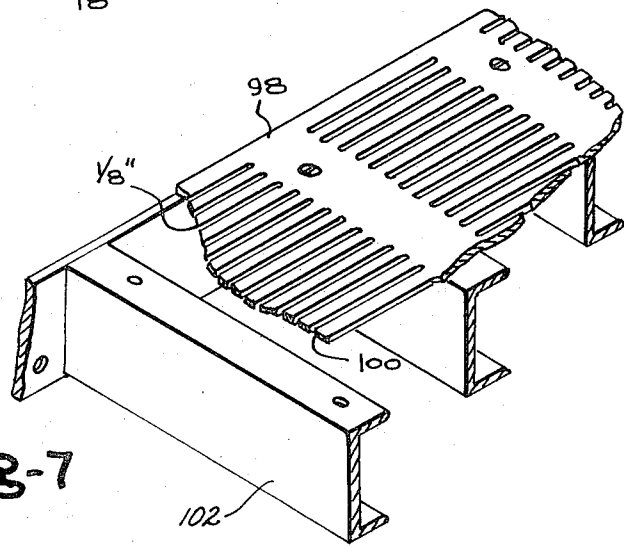


Fig-7

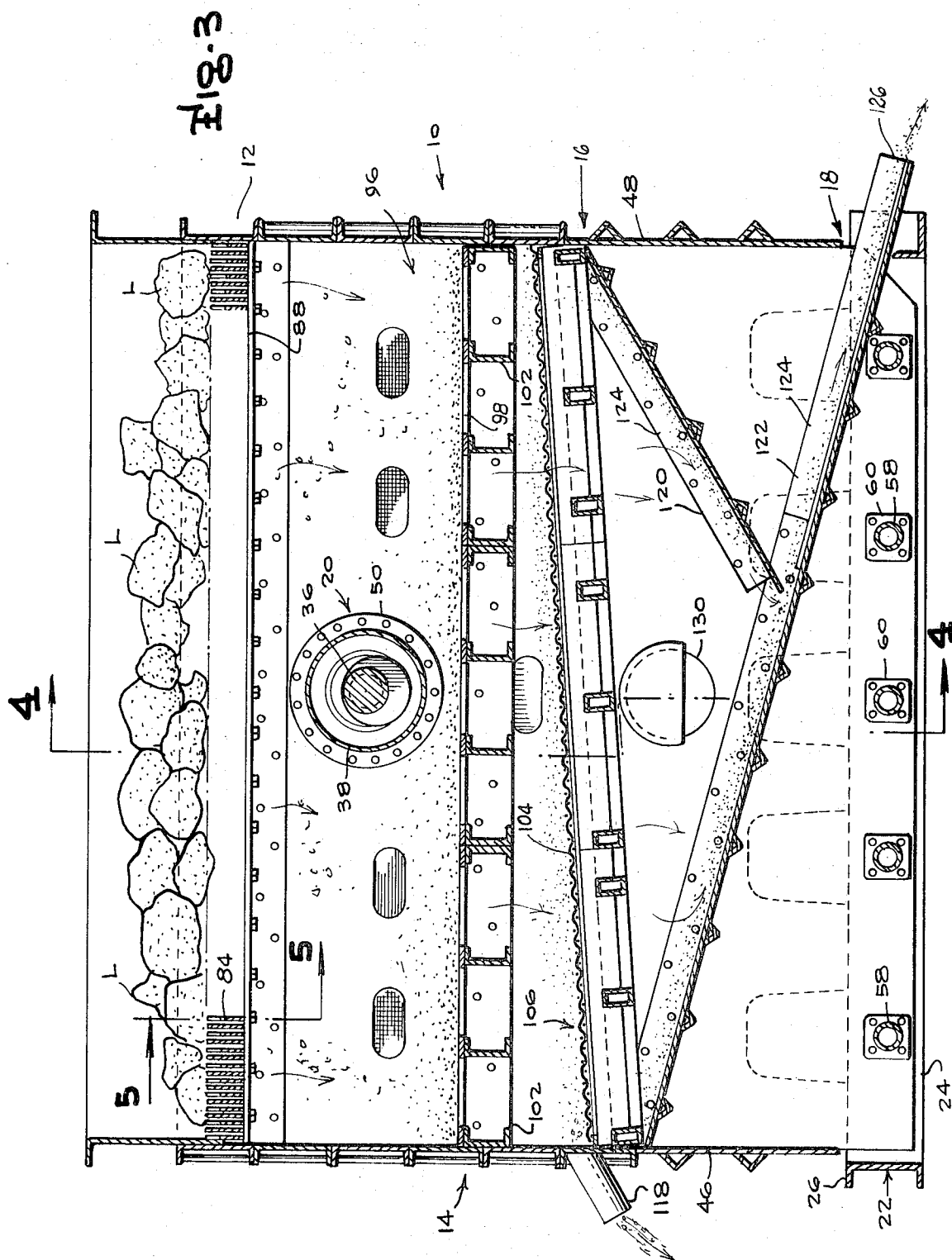
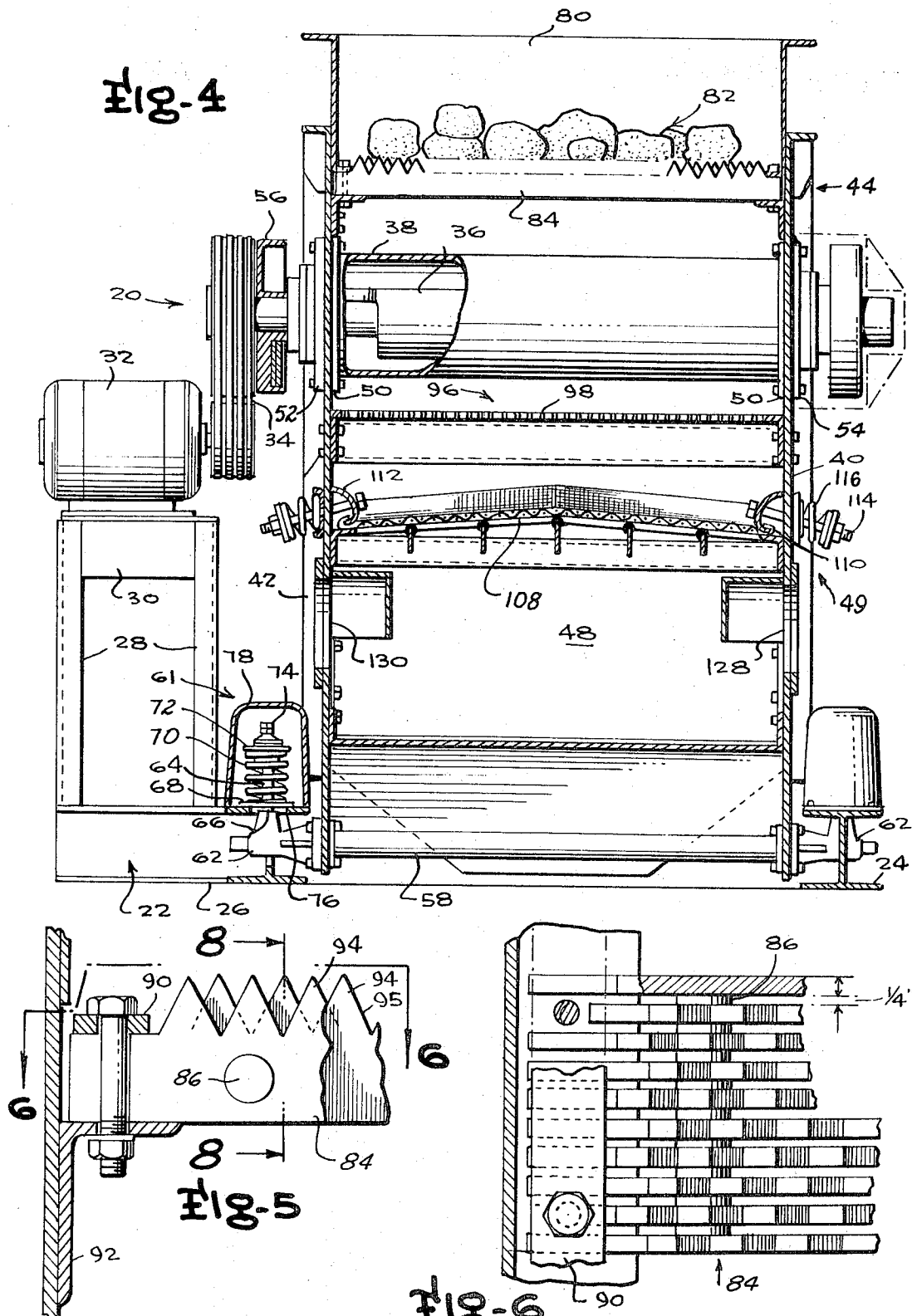


Fig-4



FOUNDRY SAND REDUCER AND RECLAIMER

The present invention relates generally to an apparatus and method for treating foundry sand. More particularly, the present invention is concerned with method and apparatus for the treating of large lumps or chunks of foundry sand that previously formed a mold or core for the casting of metal parts including reducing the size of the sand lumps to an individual grain size without significantly fracturing the sand grains while removing substantially all binder matter coating the grains.

BACKGROUND OF THE INVENTION

In conventional foundry practice, the basic operations for making sand molds or cores for metal castings include the packing of the molding sand around the pattern and in the core box that is used to shape the mold and core. In the molding operation, it is necessary to force the sand around the pattern in order to achieve accurate castings without surface blemishes or defects. Thereafter, the metal is poured and followed by proper cooling, the casting may be removed.

An important requirement in the sand casting operation is the mold and core sand. This sand may be of various types dependent on the size and type of the casting material. One type of sand in common use in foundry practice is silica sand grains mixed with additives or other binder materials.

The binders, usually mixed with the sand, aid in holding the shape of the mold and core after the pattern or core box has been removed and add various other characteristics to the molds and cores.

The binders have historically included cereals; ground pitch; seal coal; gilsonite; fuel oil; wood flour, molasses; dextrin; core oil, which is a mixture of linseed oil, resin, and thinner such as kerosene; corn flour; various protein binders, such as gelatin; casein; glue; coal tar; pitch; petroleum pitch; wood and gum rosin. In the past decade, foundry technology has introduced new binders replacing those mentioned above. These new binders form a chemical reaction in the mold. Among such binders are resins classified as furans, alkyls, urethanes, urea-, and phenol-formaldehydes. Also included are silicates such as sodium silicates and cement.

While the advantages of utilizing binders generally outweigh the disadvantages, it is nevertheless important for the foundrymen to take care in the use of the binders since they vaporize during the casting operation and give rise to the possibility of gas bubbles causing pin holes and other inaccuracies in the casting.

The problem of vaporization is particularly acute upon attempted re-use of the sand after an initial mixture of the silica sand with the binder. Upon examination for reuse, some of the sand grains will be bare due to the burning off of the organic material during the previous pour and therefore, additional organic materials must be added for the re-use of the sand in the next molding cycle, while other grains will be completely coated. When additional organic material is added to what previously remained there is oftentimes produced a vaporization of the organic material that is too great to be controlled and results in a reject casting. When casting large pieces requiring days and weeks of cooling, the economic loss is readily apparent.

The foundry practice is replete with methods and apparatus for attempting to reclaim the sand particles both as to coated matter on the grains and the final size distribution of the sand particles. Previous techniques attempted to remove as much of the organic matter coated on the grains as is possible, but they failed in achieving a substantially organic-free sand grain having not more than about 5 percent organic material by weight remaining without destroying the desirable particle size distribution which typically would allow about 80 percent of the sand grains to be retained upon 30 - 100 mesh screens.

The reclamation of the sand as to size originally did not pose a severe problem since the sand bound with the historically used binders generally involved a shakeout operation which would produce loose sand with perhaps only 5 percent lumps by weight. These lumps were found to require little energy to degrade to individual grains due to the low yield of the binding forces holding the binder coated sand grains together. Typical of this simplified sand reclaiming operations is Davies' U.S. Pat. No. 2,488,381 in which superposed shakeout members were used.

This low energy requirement for such old binder coated sands is in striking contrast to the high energy input the art found to be required to break up to tightly bound lumps and clumps of much larger size obtained from the use of the chemical reaction type binders. These extremely large chunks must be reduced to individual grain size to be useful to the foundryman and to permit the removal of this current type of binder from the sand.

The previously known methods of reclaiming the chemical reaction type binder coated foundry sand utilize some form of impact grinding, crushing or blasting or other rigorous action which may ultimately remove much of the organic material coating from the grain of sand but cause more serious problems by reason of the fracture of the sand granules due to the impact forces imposed upon the sand granule. The fracture of the sand grain is a serious defect in foundry sand since size distribution uniformity of the molding sand is important in obtaining the permeability necessary for good casting operation. The fracture of the sand grains forecloses the desirable gaseous permeability of the mold by filling these interstices. The result is usually a rejected casting.

While it is recognized that sand grain size distribution must be retained, the use of impact or crushing forces heretofore had been a part of every reclaiming operation known in the art for reclaiming chemical reaction type binder coated sand. Vibration techniques and the use of vibratory screens on the other hand are known and practiced but always in combination with the use of sufficient impact or pressure force that fractures the sand granule, rendering it substantially less useful than the desired uniform size sand grain.

OBJECTS OF THE INVENTION

It is accordingly an object of the present invention to provide a method and apparatus for reclaiming sand and removing substantially all of the binder matter previously mixed with the sand grains.

Another important object of the present invention is to reclaim the foundry sand and remove substantially all of the binder matter without fracturing the sand grain.

A further object of the present invention is the provision of method and apparatus for utilizing wholly vibration forces to reduce the large lumps of foundry sand into clean individual grains.

Another object of the present invention is the provision of a method and apparatus wherein vibration forces alone reduce the lump of foundry sand to individual grain size and also effect the abrading of one grain upon another to remove the binder material from the grain.

This invention also has as an important object in the provision of an apparatus and method for maintaining a mass of sand grains in a substantially unsupported state as in a fluidized bed wherein agglomerates of the sand grains are reduced in size and simultaneously individual grains are abraded against each other to remove the binder matter.

A further object of the present invention is the provision of apparatus and method for reducing and classifying the sand grains while removing organic matter therefrom without fracturing the sand grains.

These and other objects of the present invention become readily apparent upon a careful perusal of the specification including the drawings.

THE DRAWINGS

FIG. 1 is a perspective overall view of the apparatus and including an illustration of a cutaway of the spring supporting mechanism.

FIG. 2 is a perspective view partly exploded illustrating the top disintegration zone, the scrubbing zone where the sand grains are in substantially unsupported, fluidized state, the screening zone and the lowest or discharge zone. Included in this illustration also is a perspective view partly in section of an enlarged view of the slotted plate forming the scrubbing zone.

FIG. 3 is a cross-sectional view taken along the lines 3—3 of FIG. 1 and illustrating the entire operation for reducing and reclaiming foundry sand.

FIG. 4 is a cross-sectional view taken along lines 4—4 of FIG. 3 illustrating the vibration mechanism and mounting.

FIG. 5 is an enlarged view taken along lines 5—5 of FIG. 3 illustrating the sawtooth arrangement in the disintegrating zone.

FIG. 6 is a fragmentary view partly broken away of the top zone illustrating the spacers and sawtooth arrangement.

FIG. 7 is a fragmentary view partly broken away of the scrubbing zone.

FIG. 8 is an enlarged cross-sectional view taken along lines 8—8 of FIG. 5, and partly broken away, illustrating the thickness of the teeth forming the gripping means.

DESCRIPTION OF THE APPARATUS

Referring to the drawing, FIGS. 1 through 4 generally illustrate the reducer and reclaimer apparatus of the present invention.

In its broadest aspects the reducer-reclaimer may be composed of several stages, or zones, as may be best seen in FIGS. 2 and 3. The first zone 12 is designed to disintegrate the large lumps L of foundry sand in which the individual grains are bound together by a binder coating, such as the usual resin binder that forms a chemical reaction in the mold.

The stage below the disintegrating stage is the scrubbing zone 14 wherein the grains are vibrated into a fluidized or unsupported state. Below the scrubbing deck is a screening zone 16 through which the individual grains pass and the large agglomerates or pieces of trapped metal are retained. At 18 is shown the discharge zone wherein the individual grains have been essentially cleaned and classified and are then discharged.

The reducer-reclaimer 10 is vibrated with a conventional motorized vibrator 20 as shown in FIG. 4.

The reducer-reclaimer of the present invention in more specific detail is composed of a platform or base 22 composed essentially of channel members 24 which are interconnected by cross channel members 26 to form the more or less rectangularly shaped platform or base 22. In FIG. 4, the centrally disposed cross channel member, 26, is extended beyond the longitudinal channel iron 24 and supports vertical upright members 28 suitably supporting a motor mount 30 which receives a conventional motor, 32. Conventional belts 34, drive an eccentrically weighted shaft 36 which is positioned within housing 38 that is secured to front 40 and rear 42 walls forming a frame 44 of the reducer-reclaimer. The front and rear walls 40 and 42 are joined at their extremities by side walls 46 and 48 to form in effect a box 49. The housing 38 is provided with a radial flange 50 on either end which is bolted to the respective front and rear walls 40 and 42 and to apertured plates 52 and 54 on the outside of the side walls. Suitable bearing mechanism not forming a part of the present invention may be retained between the flange 50 and the aperture plates 52 and 54 to permit the rotation of the eccentric shaft 36. Eccentrically weighted flywheel 56 is provided at the motor end of the shaft 36 to vibrate the box 49.

The frame 44 is supported directly by tubular cross members 58 spaced along the channel members 24 as may be seen from FIG. 3 and secured to the frame by a plurality of flanges 60 positioned on each side of the front and rear walls, 40 and 42. At the location of the position of each of the tubular cross members 58 on the exterior of the frame is positioned a spring assembly including a support arm 62 having an upstanding rod 64. At the base of the rod 64 and resting upon the channel member 24 is a spring seat 68 supporting a vertically disposed spring 70. At the upper end of the rod 64 is a collar 72 bearing against the spring and held in place with nut 74. The rod 64 as shown protrudes upwardly through an opening provided in channel number 24 as shown at 76 and permits the spring seat 68 to be supported by the channel member 24 around the opening 76. Housing 78 covers the spring assembly member formed by the spring 70 and its associated elements.

The disintegration zone, as may be best seen from FIGS. 2 through 6, includes a frame extension member 80 surrounding the upper portion of the reducer-reclaimer to form a hopper. The extension is secured to the frame 44 in any suitable manner below the upper edge of the extension 80 to house the disintegrating section or zone, 82. This disintegrating zone is composed of sawtooth blades 84 spaced as best shown in FIG. 6 by spacers 86 to maintain the blades 84 in position. The sawtooth blades are welded and held in place by retaining plate 90 and clamped to angle irons 92 secured to the front and rear walls 40 and 42. As may be

best seen in FIG. 5, the teeth 94 are in alternate or staggered position relative to each other. The spacing between the teeth is approximately one-fourth inch, and the teeth are of a width at the apex 94a of about one-half inch and at the base of the blade 94b, the blade narrows to approximately three-eighths of an inch. The purpose for the tooth being wider at the apex than the blade is at the bottom is to prevent any of the tramp metal or other large pieces from becoming lodged at a point below the apex of the teeth.

The saw teeth are of a height preferably not less than 2 inches and form angles by their sides 95 of about 30° to 45° from the vertical to provide sufficient area to contact and grip the lump L and cause its disintegration. A lower height of the teeth than 2 inches even flat could be used but tends to reduce the efficiency in terms of tons of sand per hour produced. The tooth height could be raised beyond 2 inches, perhaps to 3 inches or more but after the tooth height has been raised beyond the preferable range of 2 to 4 inches, the tramp metal that is usually present in the foundry sand removed from the mold would tend to bend the tips of the teeth. Most preferably, the tooth height has been found to be 2 ½ inches.

The large lumps 82 that are thrown into the hopper formed by the guard 80 and on top of the sawtooth blades are disintegrated during the vibratory motion of the frame to grains or agglomerates of sand grains coated with organic material of a size approximately no larger than one-fourth inch, which is the maximum spacing preferred between the teeth to obtain maximum efficiency but the precise spacing is not a critical feature.

The scrubbing zone 96 is one of the most important aspects of the invention in that here the scrubbing of the particles takes place. As shown, the scrubbing deck or decks 96 is composed of a plate or plates 98 having a plurality of slots 100. The slots 100 of the scrubbing deck may vary from one-thirtysecond to about three-sixteenths and may be spaced from ½ to 2 inches apart.

Material passing through the scrubbing zone would generally be less than one-eighth inch size and usually will be individual grains with substantially all of the binder matter removed due the fluidizing effect produced by the scrubbing deck when in its vibratory motion.

The plate 98 is secured to the frame by being supported upon channel members 102 spaced across the apparatus as may be best seen in FIG. 3.

As the sand grains fall through the slots 100 they are impeded in their travel by the screen 104 forming the third or screening zone 106. The screen is supported on an incline as shown in FIG. 3 and is in a convex position supported by screen support 108. The longitudinal edges of the screen 104 are turned back as shown at 110 forming a hook which is engaged by a C-shaped retainer 112 that stretches the screen over the screen support 108. Spring-biased rod 114 with the assistance of spring 116 maintain the spring in tension along its longitudinal length. The screen 104 is preferably a twelve mesh screen which provides essentially the final classification that may be a screen size between 10 mesh and 20 mesh.

Due to the inclination of the screen 104 large agglomerates and tramp metal not passing through the screen 104 are discharged through chute 118 in the sidewall 46.

After the sand grains fall through the screen 104 they are received upon auxiliary discharge pan 120 and discharge pan 122 that are inclined as best shown on FIG. 3. The discharge pan may be a solid plate or may be a screen between about 150 and 250 mesh. The discharge chutes 120 and 122 are provided with upstanding flanges 124 that are bolted to the front and rear walls. The sand is then discharged at 126 with substantially all of the binder removed.

THE METHOD

In accordance with the method of this invention, the sand grains are cleaned such that only 5 percent or less of binder matter by weight remains coated onto the sand grains but it is possible to remove even greater amounts of the binder matter from the grains. It is critical that in the present invention no impact or crushing force is applied to the grains of sand and thus the uniformity of the original size distribution is maintained. In addition, the attrition of the coating resulting from the vibratory motion creates round grains which is desired in the foundry rather than the subangular particles produced by crushing.

The practice of the method is simply to place the large lumps L in the hopper and onto the sawtooth disintegration zone. At this time the entire frame is vibrating by reason of the rotation of the eccentric shaft 36. The vibration is preferably created by the shaft rotating at approximately 1,000 RPM although speeds of from several hundred to 5,000 or more rpm may be utilized. The vibration is preferably one producing a vertical displacement of about one-fourth inch and a horizontal component of about three-eighths of an inch. The range may be from one-eighth to one-half inch vertical displacement and one-eighth to five-eighths horizontal displacement. Such vibration is sufficient to be effective for the purposes of the present invention.

The dump of large lumps of foundry sand including tramp metal and other impurities is placed on top of the sawtooth blades 84. The saw teeth 94 grip the large lumps and adjacent lumps not held by the teeth are free to move against the large lumps so gripped. The result of the vibration and the physical contact between the lumps is a disintegration of the lumps into agglomerates of grains of sand. Each agglomerate may be a few to hundreds or more individual grains being bound by the binder which must be removed. Unlike prior art crushing or impact means for reducing the size of the lumps, the vibration in the disintegration zone fractures the lumps along the binder interface and not through the grain.

As the individual grains are removed from the large lumps they pass through the spacing between the blades 84 and fall to the scrubbing zone 96 and onto the vibrating plate 98. Here the great mass of the agglomerates of the grains as well as individual grains are massed into a bed that may be 1 inch to a foot in depth. Preferably the bed depth is about 2 inches. By reason of the vibration, the grains are in an essentially continuously unsupported condition which may be more descriptively stated to be a fluidized state. This fluidized state is an important aspect of the present invention because due to the unsupported position of a majority of the grains, the grains will hit each other in their random motion and gently but effectively, after countless numbers of such mutual contacts among the irregular grains of sand with its binder coating, the grains will begin to

be cleansed of this coating. By maintaining the fluidizing state for from about 10 seconds to 15 minutes before passing through the scrubbing zone, the grains will be not only further reduced from the agglomerates that may have existed but also will be scrubbed quite clean. 5

Through the use of the scrubbing deck alone, if there is sufficient time, the grains will be cleansed to not more than 5 percent by weight of the binder coating. It is important therefore that to achieve the benefits of the present invention, the vibrating be sufficiently vigorous to maintain a fluidized or unsupported bed of the grains and that the time in the scrubbing zone be sufficient to remove all the binder matter desired. Preferably 20 to 40 seconds is usually adequate. No maximum time except that which is dictated by commercial efficiency need be placed upon the time the sand grains are in the scrubbing zone. 15

Gradually the sand grains will fall through the slots 100 and pass to the screening zone. It should be understood, however, that the slots are only provided to effect a simple means of passing the grains through to the following zone. It is possible for the scrubbing plate or plates to be continuous and without slots and inclined so that the grains will pass from an end of each plate to the succeeding plate or zone. 20

After the sand grains are passed through the scrubbing zone, they enter into the screening zone 106 with screen 104 vibrating in the same manner. The screen 104 again vibrates to maintain the particles in a fluidized state to enable the individual grains to further remove additional binder matter. The final screening or classifying is employed in order to produce usable foundry sand. 25

If in fact the scrubbing zone above removes all the required binder, then the screening zone would act principally as a sorting zone to trap and remove any of the tramp metal or other impurities that have passed through the other two zones and discharge those impurities and tramp metals out through the chutes 118. 30

The final discharge pan adds further vibration which may be adequate to fluidize the particles above and may aid in classifying the sand grains falling into this zone. The discharge pans may be screens of 100 to 300 mesh or preferably 200 mesh, which meets the terms of the present invention. An air source, not shown, also preferably draws air through openings 128 and 130 over the discharge pans and out through the apparatus to remove any of the very light binder particles that have been abraded from the sand grains. 35

Another facet of this invention is the incorporation of all the required apparatus in a single unit that is simple and economical to operate. 40

We claim:

1. The method of reducing into individual grains, large lumps of foundry sand formed from sand grains coated with organic material and foundry binders formed by chemical reaction in the mold and reclaiming the grains into reusable foundry sand without impact forces sufficiently severe to fracture the sand grains comprising: 45

vibrating said large lumps of foundry sand to produce agglomerates of sand grains and individual grains in a first zone, passing said sand grains to a second zone, 50

vibrating said grains in said second zone to maintain said grains substantially continually in an unsupported state, contacting substantially each of said 55

grains with adjacent grains while in said unsupported state for at least 10 seconds to reduce the agglomerates to individual grains by cleaving said agglomerates along the interface of the binder, and simultaneously abrading said grains with adjacent grains to remove a sufficient amount of binder coated on said grains to permit commercial foundry reuse, and thereafter collecting said individual sand grains. 60

2. The method of claim 1 wherein:

said vibrating in said first zone includes the step of holding some of said large lumps for vibrations with teeth in said first zone while other large lumps are in rubbing contact with said first large lumps in order to reduce the size of said lumps. 65

3. The method of claim 2 including:

said teeth being in a saw tooth arrangement.

4. The method of claim 1 including:

separating tramp metal from said large lumps during said vibration.

5. The method of claim 1 including:

providing openings in said first zone through which said grains pass to said second zone, said openings being of greater size adjacent said second zone compared to the size in said first zone. 70

6. The method of claim 5 including:

providing a plurality of teeth in said first zone to hold said large lumps.

7. The method of claim 6 including:

vibrating said grains in said second zone from 10 seconds to 15 minutes before passing through said zone, screening said grains received from said second zone to classify said grains. 75

8. The method of claim 1 including:

providing a plurality of teeth in said first zone to hold said large lumps.

9. The method of claim 1 wherein said vibrating in said first zone includes the step of holding some of said large lumps for vibration with teeth in said first zone while other large lumps are in rubbing contact with said first large lumps in order to reduce the size of said lumps and including separating tramp metal from said large lumps during said vibration and providing openings in said first zone through which said grains pass to said second zone, said openings being of greater size adjacent said second zone compared to the size in said first zone. 80

10. The method of claim 1 including:

vibrating said grains in said second zone from 10 seconds to 15 minutes before passing through said second zone.

11. The method of claim 1 including:

maintaining said unsupported bed of said grains in said second zone for between 20 to 40 seconds.

12. The method of claim 1 including:

providing a plurality of openings in said second zone below said grains permitting said grains to pass through said second zone.

13. The method of claim 1 including:

vibrating said grains in said second zone for at least 10 seconds to substantially remove all coated organic materials from said grains.

14. The method of claim 1 including:

screening said grains received from said second zone to classify said grains.

15. The method of claim 14 including:

screening said grains for at least 10 seconds. 85

16. The method of claim 15 wherein: the time is about 2 - 5 minutes.

17. An apparatus for reducing the size of large lumps of foundry sand formed from sand grains coated with conventional foundry organic materials and reclaiming said grains by removing a substantial portion of said organic material from said grains without impact forces upon said lumps and grains, said apparatus comprising:

a base, a frame mounted on said base for vibratory movement relative to said base,

vibratory means mounted on said base and connected to said frame for vibrating said frame,

means connected to said frame and forming a first zone to reduce said large lumps to smaller size by vibration,

means connected to said vibrating frame forming a second zone having a bed for receiving the discharge from said first zone, said bed being vibrated sufficiently by said vibratory means to produce a substantially unsupported mass of said grains in a fluidized state, whereby said grains are simultaneously abraded by adjacent grains to remove said organic material.

18. The apparatus of claim 17 including:

power means operable upon said vibratory means to vibrate said frame,

said power means being positioned upon said base to form a unitary apparatus.

19. The apparatus of claim 17 including:

spaced gripping means in said first zone to hold a first portion of said large lumps whereby other large lumps are free to contact said first portion of said large lumps.

20. The apparatus of claim 19 including: said gripping means having greater thickness in the direction of the first zone and less thickness in the direction of the second zone.

21. The apparatus of claim 20 including: said gripping means being a plurality of upwardly extending teeth, said teeth being spaced a greater distance toward the discharge end of said first zone than at the top of said teeth.

22. The apparatus of claim 19 including: said gripping means being a plurality of upwardly extending teeth.

23. The apparatus of claim 22 including: said teeth being spaced a greater distance toward the discharge end of said first zone than at the top of said teeth.

24. The apparatus of claim 23 including:

said spacing being about one-fourth inch.

25. The apparatus of claim 17 including:

a discharge chute being a continuous solid plate with discharge at one end.

26. The apparatus of claim 17 including:

said bed having a plurality of spaced slots through which said grains pass

27. The apparatus of claim 26 including:

said slots being about one-eighth inch in width.

28. The apparatus of claim 17 including:

a third zone having a screen connected to said vibrating frame for selectively separating said grains from tramp metals.

29. The apparatus of claim 28 including:

said screen having about a 12 mesh size.

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