July 10, 1962 H. J. GISH 3,043,430

SAND SKIMMER

Filed Nov. 18, 1959 2 Sheets-Sheet 1

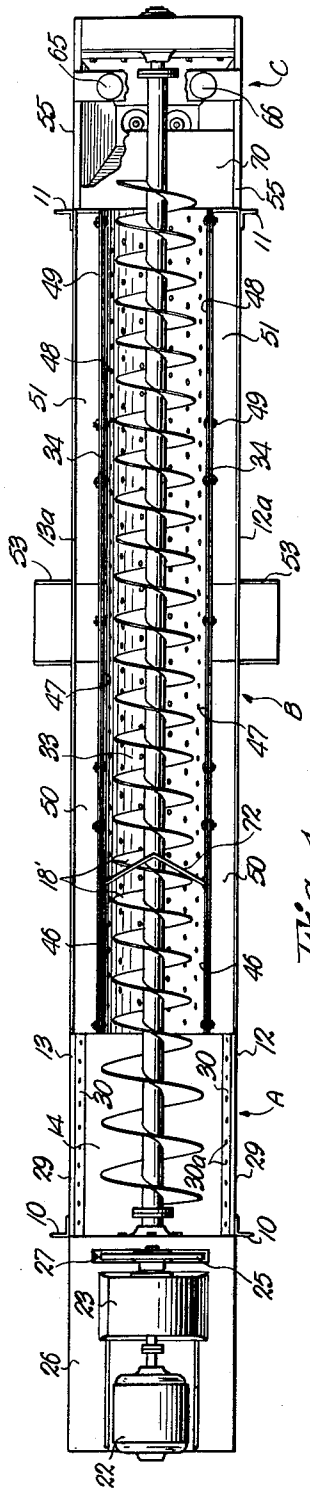


Fig. 1.

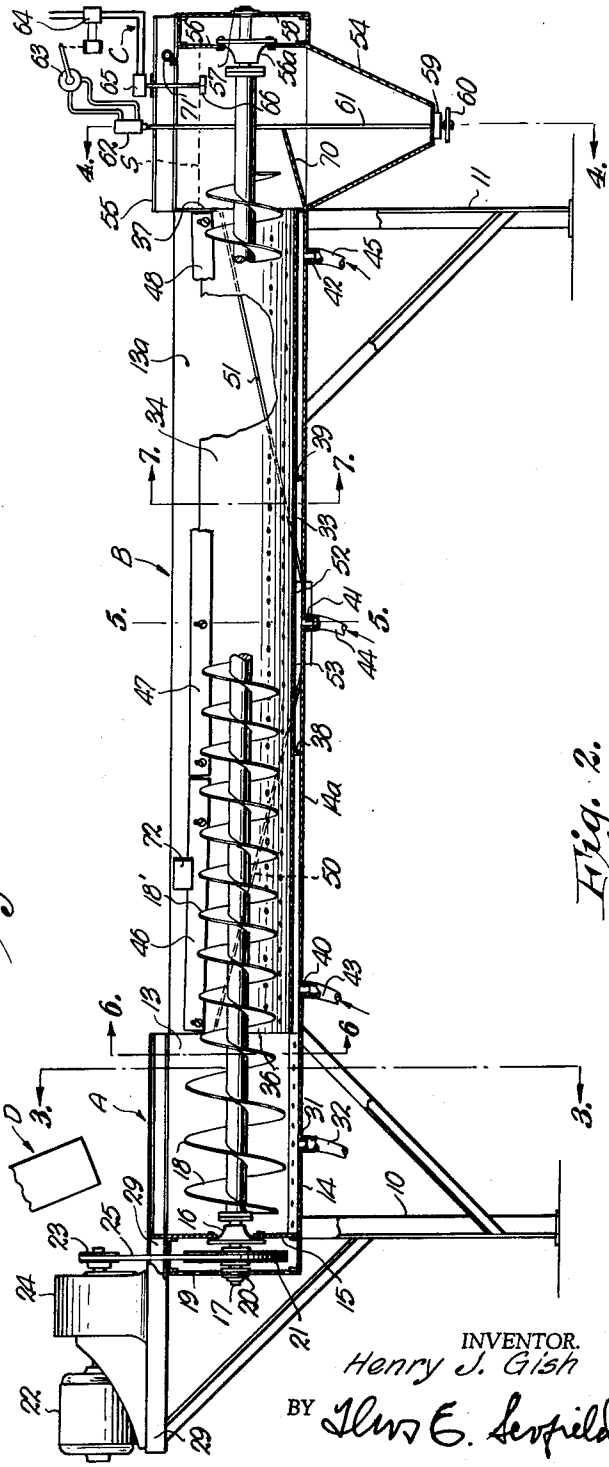


Fig. 2.

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SAND SKIMMER

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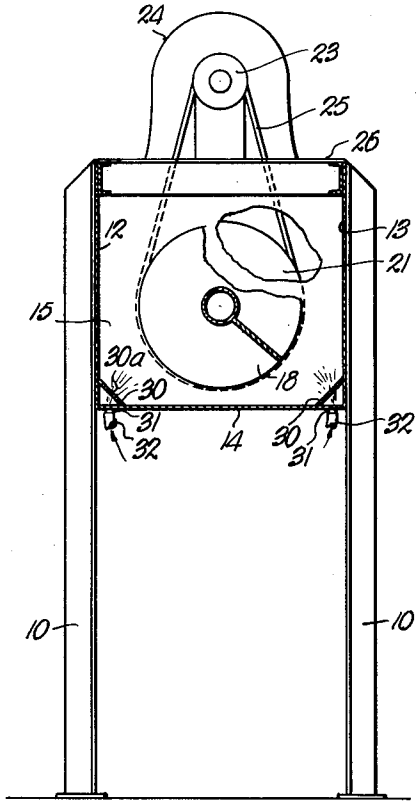


Fig. 3.

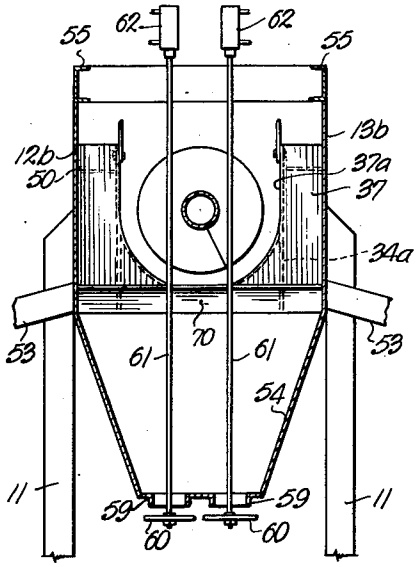


Fig. 4.

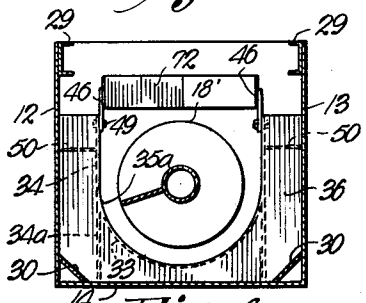


Fig. 6.

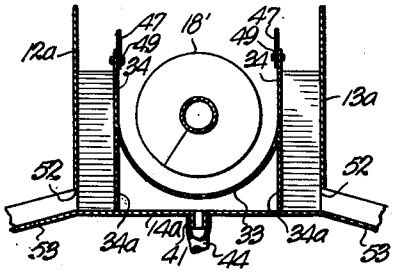


Fig. 5.

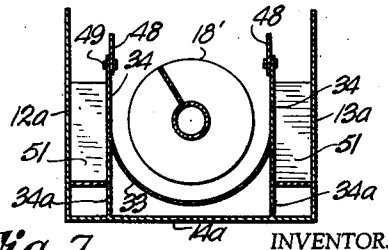


Fig. 7.

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SAND SKIMMER

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8 Claims. (Cl. 209—464)

This invention relates to the washing and cleaning of granular material such as sand by flotation and skimming of foreign matter from the material, and refers more particularly to equipment for accomplishing the separation of lignite, cinders, and organic matter of low specific gravity from the sand more rapidly and efficiently than is possible with apparatus of which I am presently aware.

One of the objects of the invention is to provide a flotation type unit in which, through a unique arrangement of structure, the sand is intermixed with water to form a sand-water pulp which serves as a heavy media, having a specific gravity substantially greater than that of the foreign matter to be removed, and is subjected to continuous cleansing over a relatively long time interval, thus insuring of effective removal of the foreign matter. It is a feature of my invention that cleansing action is accompanied, over the same time interval, by a continuous agitation of the water-sand pulp, thus to continuously loosen and float the foreign matter from the sand.

Another object of the invention is to provide a flotation type unit in which the pulp is moved in one direction in a continuous feed while water is introduced beneath the pulp over substantially the full length of travel of the sand, and is impelled transversely to the direction of the movement of the sand and escapes from the sand close to or at the locus of its introduction. A consequence of the invention in this respect is that a given increment of sand is, in effect, subjected to repeated cleansing during its travel through the unit, as distinguished from the single cleansing occurring in units for like purposes of which I am presently aware.

Another object of the invention is to provide a unit of the character described in which cleaning of the sand can be efficiently carried out on a continuous basis as distinguished from batch cleaning. It is a particular feature of the invention that means are provided for mechanically assisting the de-watering of the water-sand pulp as it approaches and reaches the discharge end of the unit.

Still another object of the invention is to provide a unit of the character described having highly effective waste removal and collection means.

Other and further objects of the invention, together with the features of novelty appurtenant thereto will appear in the course of the following description.

In the accompanying drawings, which form a part of the specification and are to be read in conjunction therewith, and in which like reference numerals indicate like parts in the various views:

FIG. 1 is a top plan view of a preferred sand cleaning unit embodying my invention, parts being broken away for purposes of illustration;

FIG. 2 is a side elevational view of the unit, the skimming trough and casing being shown in longitudinal section, with parts broken away for purposes of illustration;

FIG. 3 is a sectional view, on an enlarged scale, taken generally along the line 3—3 of FIG. 2 in the direction of the arrows;

FIG. 4 is a sectional view on an enlarged scale taken generally along the line 4—4 of FIG. 2 in the direction of the arrows;

FIG. 5 is a sectional view again on an enlarged scale taken along the line 5—5 of FIGURE 2;

FIG. 6 is a sectional view taken generally along the line 6—6 of FIG. 2 in the direction of the arrows; and

FIG. 7 is a sectional view taken generally along the line 7—7 of FIG. 2 in the direction of the arrows.

Referring to the drawings, the general arrangement of the preferred unit embodies an elongate horizontal structure made up of a charging and mixing section A, a central flotation skimming and waste removal section B and a collecting and discharge hopper section C. The sections A, B and C form a continuous structure, which is supported in a horizontal position above the ground by standards 10 and 11, which are connected therewith in a manner later to be described. In the operation of the unit, raw sand is introduced to the charging and mixing section A, as by spout D disposed thereabove (see FIG. 2), is moved through the skimming and waste removal section B, and is discharged therefrom into the hopper section C. As will later be explained in more detail, during its progress through the flotation skimming section B as it enters hopper section C, the sand is subjected to a washing and cleaning action which results in removal from the sand of various foreign matter, particularly lignite or other organic matter of relatively low specific gravity, and it collects in the lower portion of the hopper as clean sand. The clean sand is discharged from the bottom of hopper section C and can be collected in a pile from which it can be withdrawn as required for use as concrete aggregate or for other desirable purposes.

The charging and mixing section A comprises a generally box-like arrangement, open at one end and on top, and having the vertical side walls 12 and 13 and the closed horizontal bottom 14. An end plate 15 closes the left-hand end of the mixing chamber as viewed in FIGS. 1 and 2. A sealed bearing 16 is mounted through an aperture in plate 15, and through the sealed bearing rotatably passes the drive shaft 17 of an elongate screw conveyor or auger having flights 18 in the mixing section and smaller flights 18′ extending on through the flotation skimming section B.

It will be observed that bottom wall 14 of the mixing section extends past the end plate 15 to connect with a vertical plate 19 rising upwardly to connect with structure later to be described. A bearing 20 is supported in a suitable aperture in the plate 19 and journals the shaft 17 of the screw conveyor or auger. A sprocket 21 is keyed to shaft 17 between the upright plates 15 and 19.

The power source for driving the screw conveyor preferably comprises a variable speed heavy duty electric motor 22, which is coupled with a drive sprocket 23 through a speed reducer 24. Drive sprocket 23 is drivingly connected with the auger sprocket 21 by means of a flexible chain 25. The motor and speed reducer are supported on a platform 26 provided with an aperture 27 to receive therethrough the chain 25 (FIG. 1). The platform includes a pair of channel members 29, which lie on opposite sides thereof and extend along and adjacent the upper edges of the side walls 12 and 13 of the mixing section (FIG. 3) and are secured thereto.

Positioned on the lower inside corners of the mixing chamber formed by the junctions of walls 12 and 13 with bottom 14 are inclined plates 30, which form with the corners water conduits or passageways running lengthwise the full length of the mixing chamber. Each of plates 30 is sealed, as by welding, to the wall and bottom, and is provided along its length with spaced perforations 30*a*. Water is supplied to each passageway by means of a nipple 31 communicating with the interior of the passageway through bottom wall 14 and to which is connected a water supply line 32 leading from any suitable pressurized source (not shown). It will be understood that suitable valves (also not shown) will be provided in lines 32 for controlling the flow rate therethrough.

The central flotation skimming or waste removal sec-

tion B of the unit has for its principal element an elongate, open top horizontal trough having a curved or arcuate bottom 33 and the upward extending side walls 34. The trough runs the full length of the flotation skimming section, that is, between the mixing and charging section A and the hopper section C, and is open at both ends. The trough is enclosed on the sides and bottoms by an outer casing made up of extensions 12*a*, 13*a* and 14*a* of the side walls and bottom 12, 13 and 14 of the mixing section A. The walls 34 of the trough are spaced inwardly of the extensions 12*a* and 13*a*, thus leaving a space therebetween. Likewise, the bottom 33 of the trough is spaced above extension 14*a* to leave a space therebetween. It will also be noted that the upper edges of the trough sides 34 are at a lower level than the upper edges of the sides 12*a* and 13*a*.

Referring particularly to FIGS. 5, 6, and 7, each side 34 of the trough is provided with a downward extension 34*a*, which connects with and is secured, as by welding, to the bottom extension 14*a*. The trough bottom 33, members 34*a* and bottom wall 14*a* form together the top sides and bottoms of a compartment which runs the full length of the trough. The ends of this compartment are closed by means of end plates 36 and 37, the former being located at the outlet end of the mixing chamber A (see FIG. 6) and the latter at the inlet end of the hopper (see FIG. 4). Each of the end plates 36 and 37 is provided with a cutout portion forming an arcuate surface 36*a* or 37*a* conforming in contour to the outline of the trough and joined therein. The auger extends through the cutout portions.

The aforementioned compartment is preferably divided into three serially separated sections by spaced partitions 38 and 39, which are curved on their upper edges to conform to and fit closely against the bottom of the trough and join with side sections 34*a* and bottom 14*a*. Each section of the compartment is provided with an inlet nipple 40, 41 or 42. Water supply lines 43, 44 and 45 are connected with the respective nipples, these lines leading from a suitable source of pressurized water (not shown). Again it will be understood that suitable control valves (not shown) will be interposed in lines 43, 44 and 45 in order to control the flow rates therethrough.

Returning again to the trough section, it will be observed that the bottom 33 thereof is provided with spaced perforations all along its length. These perforations are preferably uniformly arranged the length and width of the trough bottom 33. I have found that in a trough 20 feet in length and approximately 2½ feet in width, with a 1 foot 3 inch radius for the trough bottom, the number of perforations should be approximately 200, the perforations being of a diameter of between ⅛ and ¼ inch.

The upper edge of each of the sides 34 of the trough is provided with adjustable weir plates 46, 47 and 48. The weir plates 46 and 48 extend inwardly from the ends of the trough toward the center while weir plate 47 is interposed therebetween. Each plate is provided at intervals with vertically elongated slots through which extend bolts 49 which also connect with the side walls of the trough. The weir plates can thus be adjusted vertically to change the effective height of the trough sides by simply loosening bolts 49 and shifting the plates either upwardly or downwardly as desired, then tightening the bolts again. The end weir plates 46 and 48 on each side preferably have slightly inclined upper edges, the level dropping from the end toward the midsection of the trough.

Interposed between each side wall 34 of the flotation skimming trough and its adjacent side 12*a* or 13*a* of the outside casing and extending therebetween are inclined plate members 50 and 51. The plate members 50 and 51 on each side are oppositely inclined with their lower ends joining bottom wall 14*a* of the casing near the center of the skimming section. They thus form the bottom surfaces of overflow troughs which run along the outside of the central skimming trough. At the center of the flotation skimming section, each casing wall 12*a* or 13*a* is provided adjacent the bottom 14*a* with an elongate horizontal aperture 52 (see FIG. 5) which communicates with a laterally projecting inclined channel-like spout 53 through which any overflow collected in the associated overflow trough will discharge.

The operation of the unit as thus far described is as follows. As earlier noted, raw sand is fed into the mixing section A by means of the supply spout D. This raw sand is preliminarily wetted to form a sand-water pulp by means of introducing water through lines 32 to the perforated conduits formed by corner plates 30. The water is jetted into the raw sand through perforations 30*a* and is thoroughly mixed therewith by the screw flights 18. At the same time, the screw flights serve to impel the pulp into the adjacent end of the flotation skimming trough where it continues to be moved along by the flights 18' of the conveyor.

The principal cleaning of the sand takes place as it moves through the flotation skimming section. Water is introduced into the water compartments below the trough bottom 33 by means of the lines 43, 44 and 45, and is jetted into and upwardly through the pulp through the perforations 33*a*. The upward movement of the water, and the relatively high specific gravity of the sand-water pulp (1.6 to 1.8), combined with the agitation afforded by the conveyor, causes the impurities of lower specific gravity than the pulp to rise to the surface and to float laterally over the weir plates 46, 47 and 48 into the collection troughs formed on the outside of the central skimming trough. The overflow, containing the impurities and undesirable matter, is directed to the lateral discharge spout 53 by the inclined surfaces 50 and 51, from whence it falls to the ground. The skimming action takes place along the full length of the flotation skimming section. I have found, however, that effectiveness of the cleaning is improved by introducing somewhat less water into the pulp as it approaches the discharge end of the skimming section, which accounts for the sub-division of the water compartment by the partitions 38 and 39 and the provision of separate supply lines 43, 44 and 45. By adding less water toward the end of travel through the skimming section, the tendency of the sand to dehydrate by sedimentation can be taken advantage of, the squeezing action resulting therefrom assisting in expelling the impurities.

It will be evident that by adjusting the height of the weir plates and controlling the amount of water added, the classifying action of the unit can be carefully controlled. The long weir surface running the length of the skimming trough on both sides permits a high overflow rate with a low head, and thus low velocity. This, in turn, reduces the likelihood of loss of desirable sand particles while still achieving effective separation of the lighter foreign matter therefrom.

The discharge hopper C includes a conventional tapered hopper bottom 54, which is connected with the vertical side walls formed by the extensions 12*b* and 13*b* of the casing side walls 12*a* and 13*a*. As in the case of the mixing section A, the upper edges of sidewalls 12*b* and 13*b* may be reinforced by channel shaped structurals 55 (see FIG. 4). A vertical end plate 56 extends between walls 12*b* and 13*b* and a watertight seal 56*a* is mounted in an aperture therein. The shaft 17 of the screw conveyor is journaled in bearing 57, supported by a second end plate 58.

The hopper bottom is provided with a pair of spaced discharge outlets 59, each under the control of a reciprocable valve 60 having a valve rod 61 which extends upwardly through the hopper section. There are many ways in which the valve 60 can be controlled to achieve the purposes of the invention, and the details of the operating mechanism, whether manual or automatic, play no part in my invention. However, it is preferable that control

be provided so as to maintain the sand in the hopper section at a level slightly above the level that it assumes in moving through the skimming trough. The desired hopper level is generally represented by the broken line S in FIG. 2.

Level controls are well known, one preferable system being shown schematically in FIG. 2. This system includes a hydraulic or pneumatic cylinder **62** for each valve, the cylinder being operatively connected with the valve rod **61** and capable of reciprocating same whereby to seat and again unseat the valve. The direction of reciprocation is controlled by a valve **63** which may be solenoid operated under the influence of a controller **64**. Controller **64** in turn is actuated in response to the stopping and starting of an electric motor **65** which drives a paddle wheel **66**. The paddle wheel is so located as to be just below the desired level S for the sand. So long as the sand remains at level S or above, the paddle wheel will remain stationary and its valve **63** will remain open. However, if the sand level drops below the paddle blades, the freeing of the motor for rotation results in a change of condition in the controller **64**, which shifts valve **63** and causes cylinder **62** to raise the valve rod **61**. Sand will thus cease to discharge from the hopper until the level rises again to engage the paddle blades, at which time the valve will again close under the influence of the controller.

The size of the discharge openings is determined by the rate of movment of the sand by the screw conveyor. Preferably the discharge openings are given a size which will result in gravity discharge of the sand at substantially the same rate as it is moved through the skimming section, thus to maintain a relatively constant level S in the hopper section.

There is one further feature of the hopper section C which should be noted. It will be observed that at the entrance to the hopper section from the skimming section, there is an upwardly inclined baffle plate **70**, which extends between walls **12***b* and **13***b*, and which, in effect, forms an inclined continuation of the bottom wall **14***a* of the casing. Baffle **70** terminates at approximately the mid-point of the hopper section. Thus, the pulp delivered from the flotation skimming section is forced to ride up the baffle **70** before it can drop into the hopper bottom. The baffle produces a compacting and squeezing action on the pulp, tending to drive the water therein to the surface and float therewith any remaining impurities. To assist in driving these final impurities back toward the skimming section, where they can be floated over the weirs, a bank of water spray nozzles **71** is disposed above the level S at the right hand end of the hopper section, the nozzles being inclined toward the skimming section.

To take care of the back flow of surface water toward the input end, which takes place due to the sand piling up to a high level as it approaches the hopper, a division baffle **72** may be employed. This baffle is generally V-shaped in appearance and extends between and is secured to the weir plates **46**. (See FIGS. 1, 2 and 6.) It will be evident that any surface water attempting to travel back toward the mixing chamber will be caught by baffle **72** and directed laterally to flow on the weirs.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matters herein set forth or shown in the accompanying drawings are to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. Apparatus for removing foreign matter from sand and the like, comprising an elongate horizontal trough having opposed parallel upper side edges and provided with a horizontal bottom having longitudinally spaced perforations, said trough further having a charging end for receiving raw sand and a discharge end, means for mixing water with the raw sand at the charging end of the trough to form a pulp, a rotating screw conveyor disposed in the trough and extending the length thereof, said screw conveyor operating to convey the pulp longitudinally through the trough and to maintain it in an agitated state, means for introducing additional water to said trough through said perforations as the pulp is impelled along the trough, and in an amount to cause overflow along said upper side edges of the trough over substantially the full length thereof whereby materials lighter in specific gravity than the pulp will be floated from the pulp and laterally over said side edges, and waste collectors on the outside of the said trough and arranged to capture said overflow and channel it to a central location.

2. Apparatus as in claim 1, including vertically adjustable weir sections on the trough adjustable to vary the depth of the trough.

3. Apparatus as in claim 1, including a discharge hopper at the discharge end of said trough and having a pulp outlet, and sensing means for determining the level of material in said hopper and operable to control the rate of discharge from said outlet whereby to maintain a preselected level of pulp in said hopper and said trough.

4. Apparatus for removing foreign matter from sand and the like on a continuous basis comprising a mixing chamber having an inlet for raw sand and a side outlet and including means for introducing water into said sand in the chamber, mixing mechanism in said chamber operable to agitate said sand and intermix it with the water to form a pulp and to impel said pulp through said side outlet from the chamber, an elongate horizontal trough having opposed upper side edges and having one end in communication with said outlet whereby to receive the pulp from said mixing chamber, the bottom of said trough being horizontal and provided along its length with a plurality of spaced perforations, a rotating screw conveyor disposed in said trough and extending the length thereof, said screw conveyor operating to convey the pulp longitudinally through the trough to and out the other end thereof, and means for introducing additional water to said trough through said perforations as the pulp is impelled along the trough in an amount to cause overflow along the trough side edges over substantially the full length thereof whereby matter of lighter specific gravity than the pulp will be floated laterally from the pulp and over said edges simultaneously with the movement of the pulp lengthwise of the trough.

5. Apparatus as in claim 4 including overflow collectors on the outside of the trough, said collectors positioned in the path of the overflow and having bottom surfaces inclined with the horizontal whereby to direct said overflow to a central location.

6. Apparatus for removing foreign matter from sand and the like on a continuous basis comprising a mixing chamber having an inlet for raw sand and a side outlet and including means for introducing water into said sand in said chamber, mixing mechanism in said chamber operable to agitate said stand and intermix it with said water to form a pulp and to impel said pulp through said side outlet from the chamber, an elongate trough having opposed parallel upper side edges and having one end in communication with said outlet whereby to receive the pulp from said mixing chamber, the bottom of said trough being horizontal and provided along its length with a plurality of spaced perforations, a rotating screw conveyor disposed in said trough and extending the length thereof, said screw conveyor operating to convey the pulp lon-

gitudinally through the trough to and out the other end thereof, means for introducing additional water to said trough through said perforations as the pulp is impelled along the trough in an amount to cause overflow along said upper side edges whereby matter of lighter specific gravity than the pulp will be floated from the pulp and laterally over said edges simultaneously with movement of the pulp lengthwise of the trough, a discharge hopper in communication with the other end of said trough and having a discharge outlet, and means controlling said outlet and operable to maintain the pulp at a preselected level therein.

7. Apparatus as in claim 6 including a baffle plate extending from said other end of said trough partially into said hopper, said baffle plate being inclined upwardly whereby to increase the resistance to entry of the pulp into said hopper.

8. Apparatus for removing foreign matter from sand and the like comprising an elongate horizontal outer casing having spaced sides and a bottom, an elongate trough coterminous with said casing and disposed between the sides of said casing and having a horizontal bottom spaced above the bottom of the casing and the sides of the trough spaced inwardly from the sides of the casing, extensions on the sides of the trough depending therebelow and joining the casing bottom whereby to form a closed compartment beneath the trough, a water supply line communicating with said compartment, said trough bottom having a plurality of perforations along its length establishing communication between said compartment and said trough, a rotating screw conveyor aligned with and disposed in said trough whereby to impel the sand lengthwise of the trough, and inclined surfaces disposed between the sides of the trough and sides of the casing and operable to channel overflow from over the edges of said trough to a central location lengthwise of the casing.

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