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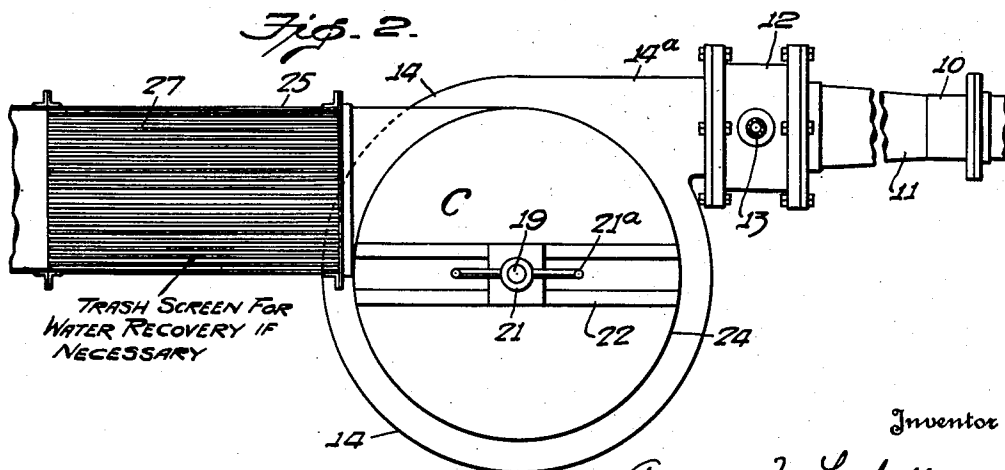
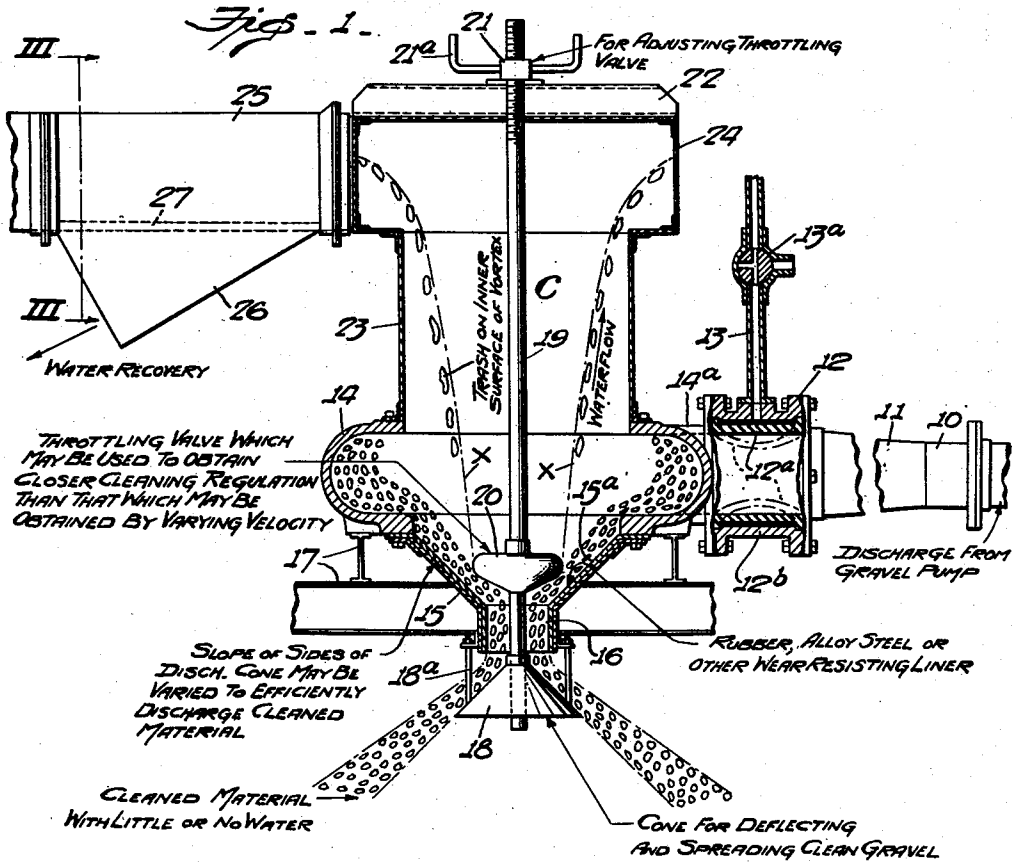
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2,106,532

METHOD AND APPARATUS FOR SEPARATING GRAVEL, AND THE LIKE

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2 Sheets-Sheet 1



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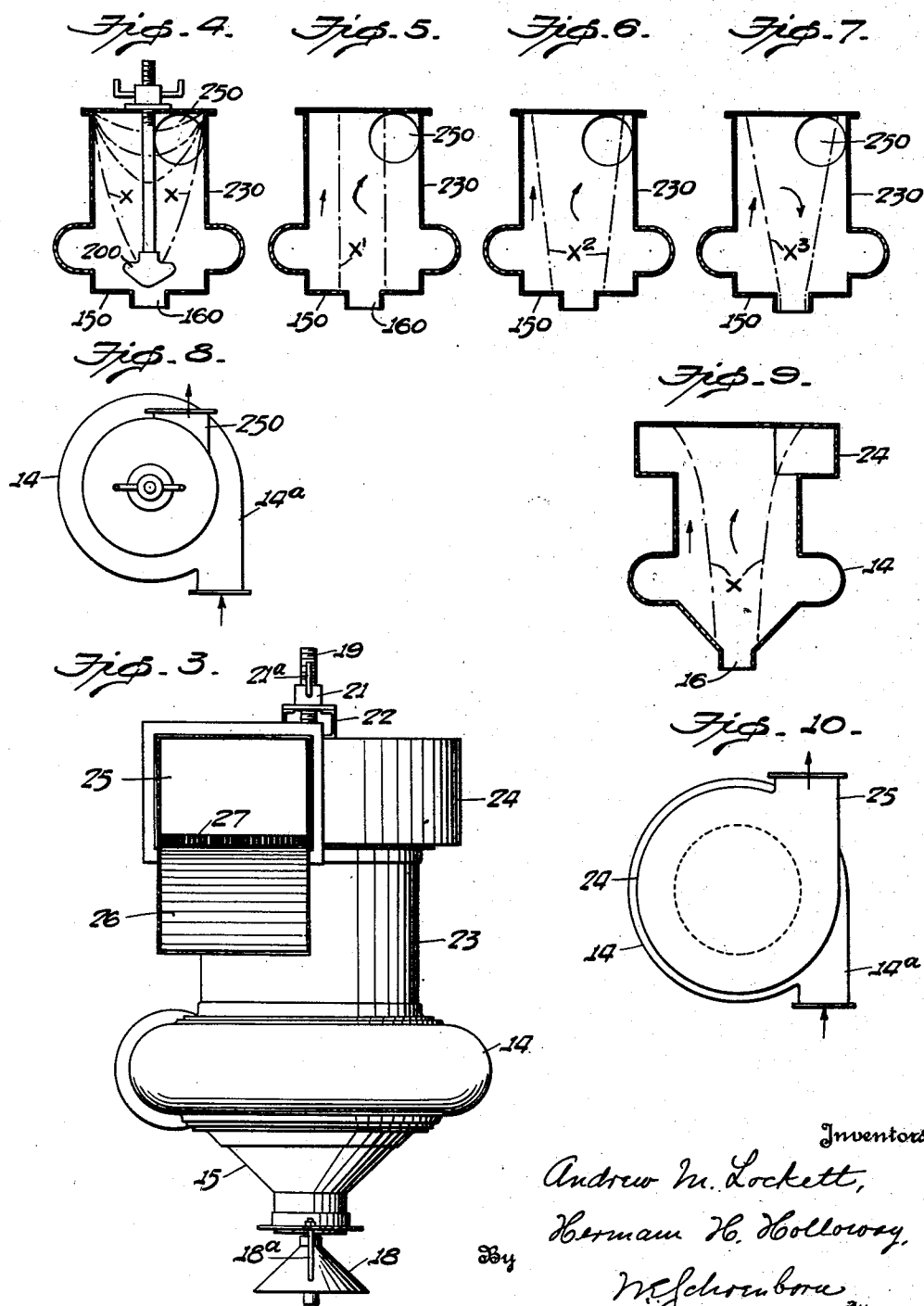
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UNITED STATES PATENT OFFICE

2,106,532

METHOD AND APPARATUS FOR SEPARATING GRAVEL, AND THE LIKE

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6 Claims. (Cl. 209—211)

This invention relates to an improved method of and apparatus for operating on a moving liquid mass laden with materials of different specific gravities to separate the heavier materials in such liquid mass from the lighter materials therein.

The invention embraces a novel method and mechanism for carrying out the same, adapted to receive the output from a pump discharge pipe or other suitable pressure source, and without other operating means than the velocity of the fluid mass delivered from such pipe to effectively segregate the heavier from the lighter materials.

More specifically, the invention embodies a method and apparatus adapted to carry out such segregation under varying conditions as to the character of the liquid mass operated on and as to its velocity of delivery.

In its aspect as a method, the invention consists, primarily, in impressing a rotary movement in a horizontal plane upon a moving mass of material-laden liquid, such as to create a whirling vortex thereof, this results in forcing all of the materials suspended in the water or dragged along the bottom of the entering pipe to be disposed radially inward toward the surface of the vortex, whence the heavier materials not actually suspended will be directed downward by gravity, and pass out of the relatively restricted central discharge openings.

The lighter components of the mass, e. g., the trash, debris, and also the mud laden water, are located at the radially inward portion by the action of the whirling vortex, and the velocity of the incoming liquid which creates such whirling vortex is so adjusted that the radially inward limits of such whirling vortex are radially outward from register with the lower central discharge for the gravel. Hence, such debris and water are forced to follow another outlet, which is upward and out from the top of the working chamber.

Since the whirling vortex is caused by the velocity of the fluid mass entering tangentially an annular casing of semi-circular and uniform cross-section and projecting from the working chamber, it is of prime importance, in the described method, that such entering velocity of the fluid mass be regulated so that, on the one hand, the whirling vortex created is not strong enough to prevent gravity outlet of the gravel, or heavier component, and, on the other hand, not weak enough so that the radially inner limits of the vortex would extend inward into regis-

ter with the central bottom discharge, which would permit the debris and water to be discharged downward with the gravel.

While having other and more general fields of usefulness, the invention is well adapted and designed for separating gravel from the liquid discharge of a gravel pump, or the like, and cleaning the same of foreign substances and trash, such as leaves, twigs, bark, sand, silt, and the like.

While the invention will be herein described more particularly with reference to such use, such reference is intended to illustrate and typify numerous uses in which the invention is of value and importance, involving selective separation of materials of different specific gravities, such as the separation of clay and sand from phosphate and in ore and coal washing.

The foregoing and other objects and advantages of the invention will be better understood from the following detailed description, taken in connection with the accompanying drawings, and the distinctive features of novelty will be thereafter pointed out in the appended claims.

Referring to the drawings, in which similar reference characters indicate the same parts in the several figures,

Figure 1 is an elevation of an apparatus illustrating the invention, the working chamber and control valve being broken away in section;

Figure 2 is a plan view thereof;

Figure 3 is a vertical section on line III—III of Figure 1, with the working chamber shown in elevation;

Figure 4 is a sectional view on a smaller scale showing the working chamber of a modified form of the invention;

Figures 5, 6 and 7 are sectional views of a working chamber similar to that of Figure 4 and illustrating different aspects of the method involved in our invention;

Figure 8 is a plan view of the working chamber of Figure 4;

Figure 9 is a small scale sectional view of a form of working chamber similar to that of Figure 1, and further illustrating the novel method; and,

Figure 10 is a plan view of the working chamber of Figure 9.

10 indicates the discharge pipe from a gravel pipe, this typifying any suitable source of supply under pressure of the liquid mass to be treated. Since it is of importance that the material be introduced into the working chamber at the correct velocity, a nozzle of Venturi formation

is incorporated in the supply pipe to reduce the velocity of flow to approximately the correct rate, and adjacent the connection to the working chamber C a throttle valve 12 is provided, which may be adjusted to vary the entering velocity as required for best results under different conditions.

As shown, the valve comprises a rubber sleeve 12^a having a passage normally coinciding with the pipe bore but capable of being pressed inward, as shown by dotted lines, to reduce the passage by fluid pressure admitted through a pipe 13 to the annular space between the sleeve 12^a and the housing 12^b, in which it is mounted. Fluid pressure to the valve 12 is controlled by a three-way valve 13^a.

The supply pipe and its valve 12 are connected to a tangential extension 14^a of a casing 14, which is located at the base of the working chamber C and constitutes a part thereof. The casing 14 may be approximately semi-circular in cross section, with a flange 14^b at its inner lower portion, to which may be secured a conical bottom 15 leading to a central discharge opening 16 for the gravel.

This bottom and discharge passage may be provided with renewable liner plates 15^a, made of rubber, alloy, steel, or other wear resisting material, and adapted to be replaced when worn out in use.

The casing 14 bearing the working chamber C may be mounted upon a suitable framework support 17.

18 indicates a conical spreader for spreading and deflecting the separated and cleaned gravel delivered from the opening 16, being, for this purpose, secured in spaced relation below said opening by rods 18^a. The spreader 18 also provides a bearing for the lower end of a pipe or rod 19, which extends centrally through the working chamber C. This rod has fixed thereto a plug 20 constituting a throttling valve for the discharge opening 16 and adjustable with reference thereto. For this purpose, the upper end portion of the rod 19 is threaded, as indicated at 19^a, and has fitted thereon an adjusting nut 21 with projecting arms 21^a to facilitate turning thereof. The nut 21 has bearing on bars 22 resting on the top of the working chamber C. This valve 20 is of value and importance in that it makes it unnecessary to keep the whirling vortex of material under as close control as would otherwise be the case, since it aids in preventing the downward escape of the trash and debris, even if the inner limit of the vortex should to some degree recede inward into register with the discharge passage 16.

The casing 14 has fixed to the top thereof a cylindrical housing 23, which constitutes therewith the working chamber C of the apparatus, and has at its top an enlarged portion 24 from which leads a relatively large peripheral discharge pipe 25.

A baffle box 26 may be provided in the bottom of this discharge pipe 25 with a flat screen 27 fitted therein, this construction serving to reduce the velocity of the water and also to separate the trash and debris from the water and fine gravel which may thus be returned to the sump over which the apparatus is erected.

In a broader aspect of the invention, however, as will appear, neither the enlarged top 24 nor the baffle box 26 are essentials, and any desired disposition may be made of the debris and mud laden water after leaving the upper portion 23 of the working chamber C.

In use, the gravel and debris laden water entering the casing 14 tangentially and under considerable pressure from the gravel pump is impressed by the casing 14 with a rotary motion constituting a whirling vortex in which the heavier component, i. e., the gravel is dragged along on the annular and semi-circular in cross-section surface of the casing 14 and the debris and water occupy the radially inner portion, as indicated in Figure 1.

The gravel thence descends by gravity and passes out of the bottom discharge orifice 16, while the debris and water, being spread upward as well as outwardly by the whirling movement, finds egress through the top of the housing and the peripheral discharge pipe 25. The water and fine gravel being dropped through the baffle box 26 and screen 27, the debris is discharged through an extension of the pipe 25.

For the described and proper operation, it is essential that the whirling movement of the vortex be not violent enough to prevent the gravel to settle and discharge by gravity, and, at the same time, such movement must be strong enough to keep the inner limit of the vortex, indicated at x, outside of a line of register with the bottom discharge 16. The necessary and correct regulation of the velocity of the discharge from the venturi 11 is obtained by adjustment of the valve 12, which permits the force of the vortex movement to be controlled with sufficient exactitude to conform to the dotted lines, indicated in Figure 1, for the desired end.

By adjustment of the plug 20, the discharge 16 may be opened to an extent so that, while permitting the gravel to discharge, very little water is allowed to escape with it. Also, as stated, the use of this plug 20 makes it unnecessary to regulate the vortex so closely, since it is located as a bar to the downward movement of debris at the locality of the inner limit of the vortex.

As illustrative of the broader aspects of the invention, as shown in Figures 4 to 8, forms wherein the bottom 15 of the working chamber is flat instead of conical with a central discharge opening 16 in these forms also there is no enlarged top of the working chamber, but the cylindrical body 23 extends upward a suitable distance with a discharge passage 25 at its top for discharging the debris and water. In Figure 4 is shown the plug 20 similar to and similarly mounted as the plug 20. The dot and dash lines in this figure indicate the action of the plug preventing downward discharge of the debris. In Figure 5, the dot and dash line x', and, in Figure 6, the similar line x² indicate the inner limit of the whirl under different conditions.

Figure 7 the similar line x³ indicates a condition where the velocity through the venturi 11 has not been properly regulated and the whirling vortex is not maintained with sufficient force to prevent downward discharge of the debris along with the gravel.

Figures 9 and 10 show a form similar to that of Figure 1, but in these and other respects the invention may be embodied in forms varied from the preferred form, which has been described in detail and as applied to gravel separation.

The present showing and embodiment of the invention is, therefore, to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

What we claim is:

1. The method of separating gravel from trash of lesser density than said gravel, consisting in delivering a mixture of water, gravel and trash tangentially into the lower outer portion of a substantially cylindrical body of confined water under an impetus sufficient to engender in the combined mass of said mixture and body of confined water centrifugal action to develop a vortex having an unobstructed cavity of inverted frusto-conical shape within said vortex and having upper and lower circular passages in direct communication with the exterior of said vortex, and continuously elevating and withdrawing by said centrifugal action the annular rotating mixture of water and separated trash collected adjacent to and surrounding said upper circular passage, and simultaneously washing the gravel by agitating and frictionally engaging the gravel and water precipitated and rotating in the annular section of said vortex below the point of tangential delivery of said mixture of water, gravel and trash, and uninterruptedly gravitating the washed gravel continuously collecting, and rotating with decreasing linear velocity within the lowest annular section of said vortex freely through the lower circular passage of said unobstructed cavity.

2. The method of separating gravel from trash of lesser density than said gravel, consisting in delivering a mixture of water, gravel and trash in a horizontal plane and tangentially into the lower outer portion of a substantially cylindrical body of confined water under an impetus sufficient to engender in the combined mass of said mixture and body of confined water centrifugal action to develop a horizontally whirling vortex having an unobstructed cavity of inverted frusto-conical shape within said vortex and having upper and lower circular passages in direct communication with the exterior of said vortex, and continuously elevating and withdrawing by said centrifugal action the annular rotating mixture of water and separated trash collected adjacent to and surrounding said upper circular passage, and simultaneously washing the gravel by agitating and frictionally engaging the gravel and water precipitated and rotating in the annular section of said vortex below the point of tangential delivery of said mixture of water, gravel and trash, and uninterruptedly gravitating the washed gravel continuously collecting, and rotating with decreasing lineal velocity within the lowest annular section of said vortex freely through the lower circular passage of said unobstructed cavity.

3. An apparatus for separating gravel from trash of lesser density than said gravel, comprising a vertical cylindrical receptacle having a central bottom gravel discharge opening, an upper trash discharge opening at the periphery of said receptacle, a casing of uniform semi-circular cross-sectional area protruding from, encircling and having its interior in circumferential communication with the interior of said receptacle and provided with a tangentially disposed inlet for a mixture of water and said gravel and trash and interposed in a horizontal plane between said central bottom gravel discharge opening and upper trash discharge opening and normal to the axis of said cylinder, and means for controlling the velocity of said mixture entering said inlet, whereby to engender into the mass of said mixture within the receptacle a whirling vortex of such disposition, velocity and contour as to form therein an unobstructed cavity of inverted frusto-conical shape having upper and lower

circular passages in direct communication with the exterior of said vortex and maintain the lower inlet limit of the vortex outside of the line of register with and free of said bottom gravel opening and the upper inner limit of said vortex or upper end of said cavity at the upper trash discharge opening, thereby permitting said gravel to be separated in unstable equilibrium, simultaneously horizontally rotated and frictionally agitated within and against the inner walls of said casing and move downwardly by action of gravity through the lowest annular section of said whirling vortex and freely discharged in turn through said lower cavity passage and said central bottom gravel discharge opening, and said water and trash being centrifugally elevated and removed through said upper discharge opening.

4. An apparatus for separating gravel from trash of lesser density than said gravel, comprising a vertical cylindrical receptacle having a central bottom gravel discharge opening, an upper trash discharge opening at the periphery of said receptacle, a casing protruding from, encircling and having its interior in circumferential communication with the interior of said receptacle and provided with a tangentially disposed inlet for a mixture of water and said gravel and trash and interposed in a horizontal plane between said central bottom gravel discharge opening and upper trash discharge opening and normal to the axis of said cylinder, said receptacle provided with an inverted conical bottom section extending and converging from said casing to said bottom gravel discharge opening, and means for controlling the velocity of said mixture entering said inlet, whereby to engender into the mass of said mixture within the receptacle a whirling vortex of such disposition, velocity and contour as to form therein an unobstructed cavity of inverted frusto-conical shape having upper and lower circular passages in direct communication with the exterior of said vortex and maintain the lower inner limit of the vortex outside of the line of register with and free of said bottom gravel opening and the upper inner limit of said vortex and upper end of said cavity at the upper trash discharge opening, thereby permitting said gravel to be separated in unstable equilibrium, simultaneously horizontally rotated and frictionally agitated within and against the inner walls of said casing and move downwardly with a rotating and decreasing lineal velocity on said conical bottom section by action of gravity through the lowest annular section of said whirling vortex and freely discharged in turn through said lower cavity passage and said central bottom gravel discharge opening, and said water and trash being centrifugally elevated and removed through said upper discharge opening.

5. An apparatus for separating gravel from trash of lesser density than said gravel, comprising a vertical cylindrical receptacle having a central bottom gravel discharge opening at the periphery of said receptacle, an upper trash discharge opening, a casing of uniform cross-sectional area protruding from, encircling and having its interior in circumferential communication with the interior of said receptacle and provided with a tangentially disposed inlet for a mixture of water and said gravel and trash and interposed in a horizontal plane between said central bottom gravel discharge opening and upper trash discharge opening and normal to the axis of said cylinder, said receptacle provided with an inverted frusto-conical bottom section extending

and converging from said casing to said bottom gravel discharge opening, and means for controlling the velocity of said mixture entering said inlet, whereby to engender into the mass of said mixture within the receptacle a whirling vortex of such disposition, velocity and contour as to form therein an unobstructed cavity of inverted frustro-conical shape having upper and lower circular passages in direct communication with the exterior of said vortex and maintain the lower inner limit of the vortex outside of the line of register with and free of said bottom gravel opening and the upper inner limit of said vortex or upper end of said cavity at the upper trash discharge opening, thereby permitting the gravel to be separated in unstable equilibrium, simultaneously horizontally rotated and frictionally agitated within and against the inner walls of said casing and move downwardly with a rotary and decreasing lineal velocity on said frustro-conical bottom section by action of gravity through the lowest annular section of said whirling vortex and freely discharged in turn through said lower cavity passage and said central bottom gravel discharge opening, and said water and trash being centrifugally elevated and removed through said upper discharge opening.

6. An apparatus for separating gravel from trash of lesser density than said gravel, comprising a vertical cylindrical receptacle having a central bottom gravel discharge opening, an upper trash discharge opening, a casing of semi-circular and uniform cross-sectional area protruding from the vertical side, encircling and having its interior in circumferential communication with the interior of said receptacle and provided with a

tangentially disposed inlet for a mixture of water and said gravel and trash and interposed in a horizontal plane between said central bottom gravel discharge opening and upper trash discharge opening and normal to the axis of said cylinder, said receptacle provided with an inverted conical bottom section extending and converging from said casing to said bottom gravel discharge opening, and means for controlling the velocity of said mixture entering said inlet, whereby to engender into the mass of said mixture within the receptacle a whirling vortex of such disposition, velocity and contour as to form therein an unobstructed cavity of inverted frustro-conical shape having upper and lower circular passages in direct communication with the exterior of said vortex and maintain the lower inner limit of the vortex outside of the line of register with and free of said bottom gravel opening and the upper inner limit of said vortex or upper end of said cavity at the upper trash discharge opening, thereby permitting said gravel to be separated in unstable equilibrium, simultaneously horizontally rotated and frictionally agitated within and against the inner walls of said casing and move downwardly with a rotary and decreasing lineal velocity on said conical bottom section by action of gravity through the lower annular section of said whirling vortex and discharged in turn through said lower cavity passage and said central bottom gravel discharge opening, and said water and trash being centrifugally elevated and removed through said upper discharge opening.

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