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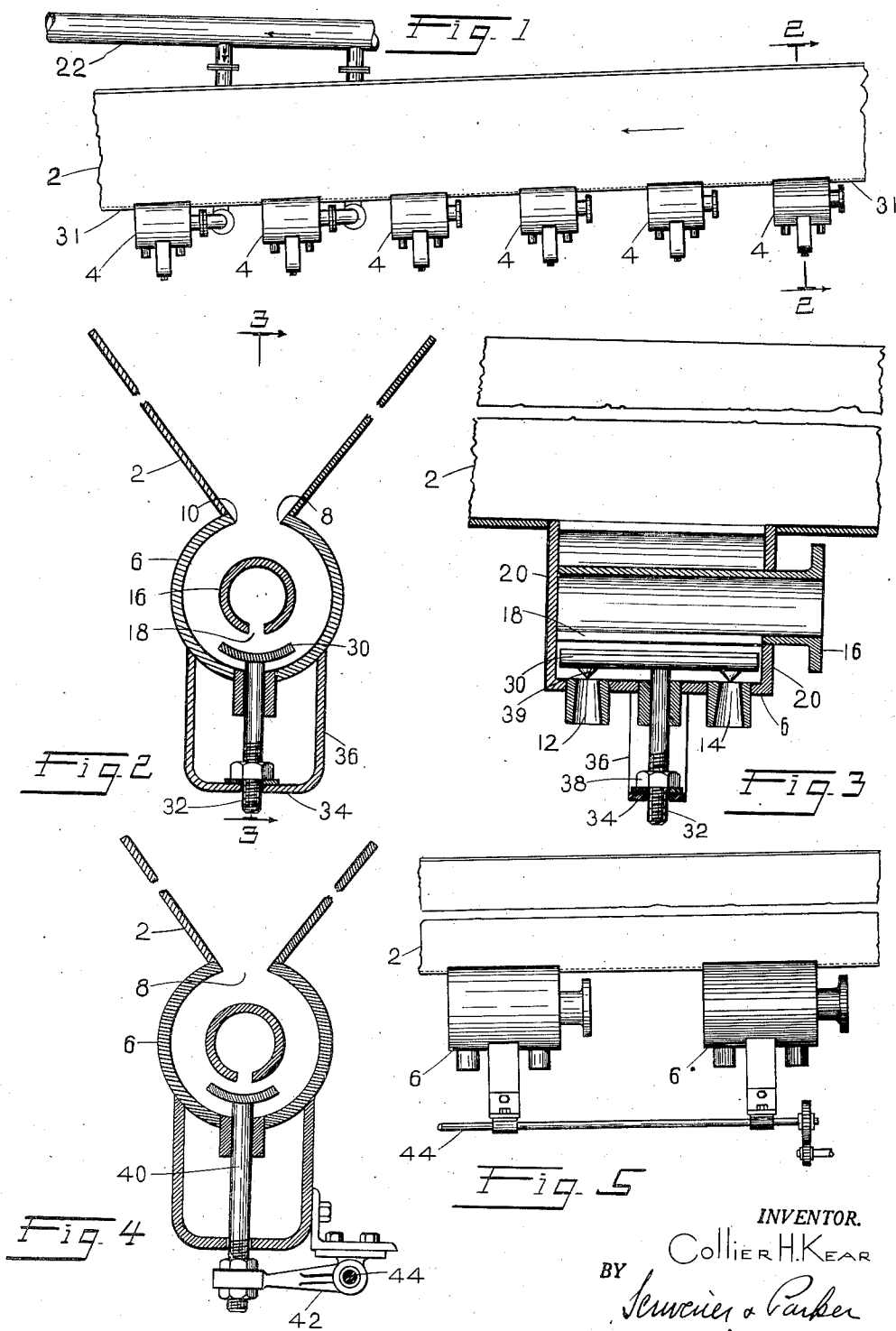
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2,440,097

TROUGH SEPARATOR WITH VERTICAL CLASSIFYING CURRENT

Filed May 9, 1945

3 Sheets-Sheet 1



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TROUGH SEPARATOR WITH VERTICAL CLASSIFYING CURRENT

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3 Sheets-Sheet 2

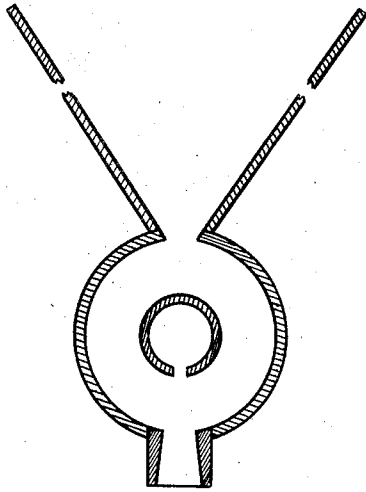


Fig. 6

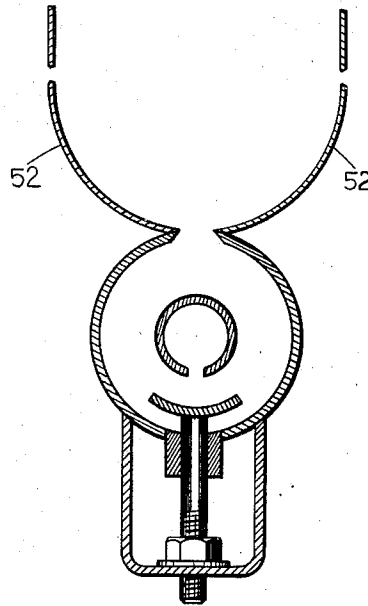


Fig. 7

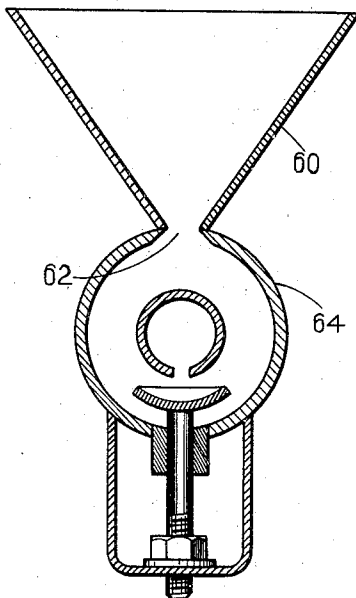


Fig. 8

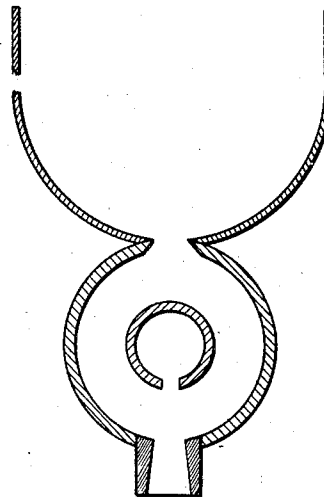


Fig. 9

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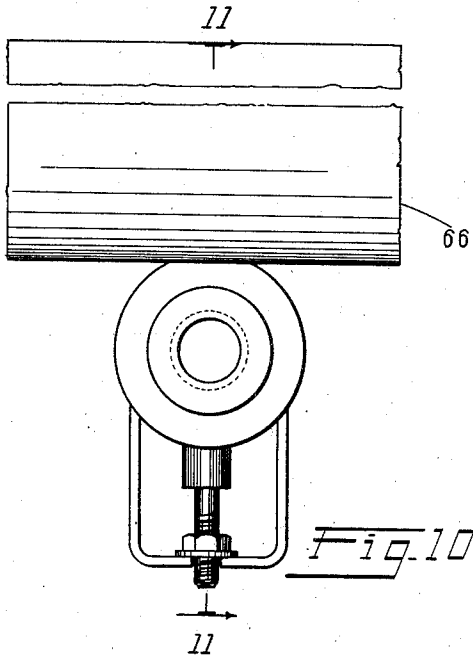
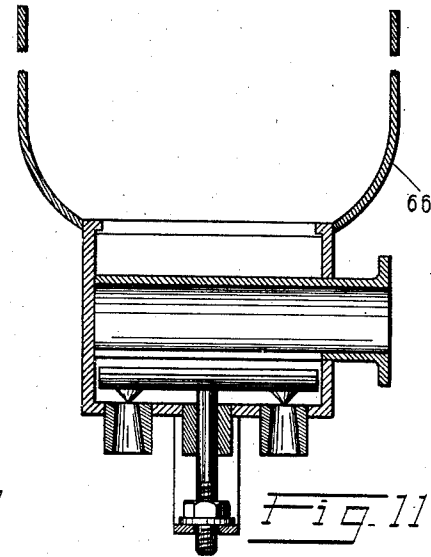
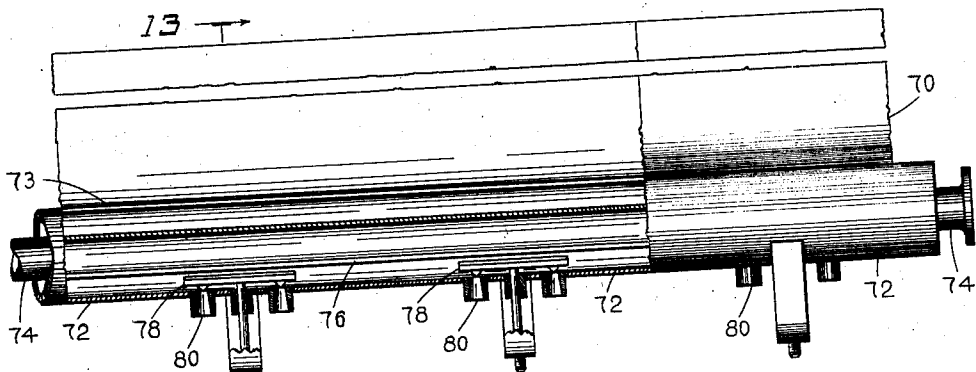
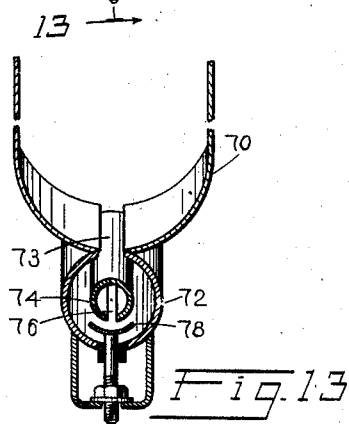
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TROUGH SEPARATOR WITH VERTICAL CLASSIFYING CURRENT

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3 Sheets-Sheet 3



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2,440,097

TROUGH SEPARATOR WITH VERTICAL
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Application May 9, 1945, Serial No. 592,792

6 Claims. (Cl. 209—155)

1

This invention relates to the separation of discrete mineral particles or pieces from each other by means relying principally on the different specific gravities of such particles or pieces. An example of such mineral separation is the washing of coal in order to separate the coal from the schist, rock, bone, ash and other impurities. In this application the invention will be described as applied to such washing of coal although it will be understood to be of general utility in the field of the separation of minerals or other materials.

In mineral separation systems of the type to which my invention relates, a stream of water and mixed minerals is moved along a trough, forming a moving mass which tends to become stratified with the heavier pieces at the bottom. At spaced intervals along the trough ascending streams of water are directed into the trough, the upward forces of which are so adjusted that only the heavier materials sink therethrough while the lighter material, for example the coal, is passed along and out of the trough. The units which direct these ascending streams into the chute and receive the sinking materials are known as pressure boxes or chambers.

It is the principal object of the invention to provide a new and improved pressure chamber for use with such mineral separation systems, which will provide advantages not provided by known pressure boxes, for example, more even upward flow over the area of the orifice into the trough and more fine and accurate adjustment of the force of the ascending stream.

It is a further and most important object to provide means whereby the pressure of the ascending stream produced by each pressure chamber may be set and adjusted with great precision to permit a sharp separation effecting a desired withdrawal. As a corollary to this, it is an object of the invention to provide separating apparatus comprising a series of pressure chamber which may be adjusted to produce ascending streams of very accurately controlled and differentiated pressures whereby a highly selective separation is made as the material being treated moves from one ascending stream to the next.

It is a further object of the invention to provide, as a new combination not known to the art, a new combination of trough and pressure chamber producing new results not produced by known devices.

It is a still further object of the invention to provide, as a new combination not known to

2

the art, a combination of hopper and pressure chamber producing new results not produced by known combinations of such elements.

A still further object of the invention is to provide an entirely new and improved mineral separating apparatus of the described type having an upwardly-directed stream extending continuously throughout a substantial length thereof, whereby the minerals being processed are subjected to a continuous separation rather than an intermittent separation as in known systems.

Other objects and features of novelty of the invention will be made apparent by the following description and the annexed drawings which, it will be understood, are only illustrative of the invention and impose no limitation thereon not imposed by the appended claims.

Referring to the drawings, in which similar reference numerals refer to like parts,

Fig. 1 is a side view of a coal washing apparatus according to the invention;

Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a view which is similar to Fig. 2 but which shows a modified form of the invention embodying different means for operating the baffle plate;

Fig. 5 is a view which is similar to Fig. 1 but which shows the baffle-operating means of Fig. 5 connected to operate a plurality of baffles at once;

Fig. 6 is a view which is similar to Fig. 2 but which shows a modified form of the invention;

Fig. 7 is a view which shows the pressure chamber of Fig. 2 in combination with a different, but broadly similar, form of trough;

Fig. 8 is a view which shows the modified form of pressure chamber of Fig. 5 in combination with a different, but broadly similar, form of chute;

Fig. 9 shows the combination of a pressure chamber according to the invention and a conical hopper;

Fig. 10 is a side view of a chute having the pressure chamber extending transversely to the length of the chute;

Fig. 11 is a cross-sectional view taken on the line 11—11 of Fig. 10;

Fig. 12 discloses a modified form of the invention in which a continuous and elongated upwardly-directed stream is provided within the chute, and

Fig. 13 is a cross-sectional view taken on line 13—13 of Fig. 12.

In Fig. 1 of the drawings there is disclosed a coal washing apparatus according to my invention comprising an inclined trough 2 down which is passed a stream consisting of water and an aggregate of coal, schist, slate, rock, sulfur and other impurities, all of which impurities must be separated from the coal. Means, indicated at 4 in Fig. 1, are provided along the length of the trough for producing ascending streams of water within the moving stream of water and aggregate within the trough. Each of such means, as more clearly disclosed in Figs. 2 and 3, comprises a cylindrical casing 6 which is axially parallel to the trough and abuts the lowest part of the lower edge or surface thereof, and the interior of which communicates with the interior of the trough through registering openings 8, 10 in the two. At the lowest part of the chamber 6, diametrically opposite to the opening thereof into the trough are axially spaced discharge openings 12, 14. Arranged within the chamber 6 and extending axially and concentrically thereof is a supply pipe 16 having an orifice 18 in the lowest part thereof which is elongated and extends substantially the length of the chamber. The ends of the chamber are enclosed by walls 20, one of which is apertured to admit and sealingly surround the supply pipe 16. The supply pipe 16 is connected through pipe 22 (which is shown diagrammatically in Fig. 1) to a source of water under substantially constant pressure, which is not shown in the drawings.

The supply pipe 16 is preferably of such diameter and the orifice 18 therein is of such size, all with respect to the total areas of the exit orifice 8, 10, 12, 14 that water will flow from the supply pipe through orifice 18 and thence upwardly about the exterior of the supply pipe through the elongated orifices 8, 10, thus producing an ascending stream within the trough through which stream the heavier pieces of the aggregate within the trough sink into the pressure chamber 6 and pass therefrom through the lower exit openings 12, 14.

Means are provided by the invention for adjusting the upward flow of water through the exit orifice 8, 10 and into the trough. Such means comprise an elongated plate 30 which underlies the exit orifice 18 from the supply pipe and extends substantially throughout the length of the pressure chamber, which is downwardly convex (or part-cylindrical) in cross-section and is vertically adjustable with respect to the supply pipe. The plate is supported at the midpoint of its lower face on a vertical rod 32 the lower end of which is passed freely through the horizontal member 34 of a U-shaped frame, the upper ends of the side members 36 of which are rigidly connected to the outside of the pressure chamber. A nut 38 is threaded to the rod 32 and is connected to the horizontal frame member whereby rotation thereof will cause vertical movement of the rod and plate. It will be seen that by moving the plate toward or away from the supply pipe 16 without reducing the flow through the orifice 18 the pressure or force of the ascending stream may be increased or decreased, thus regulating the weight of pieces of aggregate which sink through the ascending stream. A very fine adjustment of the force of the ascending stream is made possible by proper positioning of the baffle plate 30. In addition the baffle plates of different pressure chambers may be differently positioned, thus causing a differential settling as the aggregate

stream proceeds from one pressure chamber area to another.

In order to provide an additional control of the size of the exit orifices 12, 14 closure members 39, which are preferably of inverted conical shape, are attached to or formed on the lower surface of the baffle plate and overlie the said exit orifices. Movement of the baffle toward and away from the lower wall of the pressure chamber will vary the position of these closure members with respect to the exit orifices and therefore vary the effective areas of such orifices.

It will be obvious that the movement of the baffle plates may be accomplished in other ways than that disclosed in Figs. 2 and 3. For example, in Figs. 4 and 5 the baffle-supporting rod 40 is connected at its lower end to the outer end of a bell crank 42 which is connected at its other end to a shaft 44 which may be rotated by small increments to effect vertical adjustment of the plate. The shaft 44 may be operatively connected to the plates of a plurality of pressure chambers in order to operate the same simultaneously.

In the operation of a minerals separation system embodying my described invention the stream of material proceeding along the trough encounters successive ascending streams of water produced by my improved pressure chambers. The water producing these ascending streams originates in a constant pressure source (not shown) and flows therefrom through the supply pipes 22 and 16 and into the pressure chambers 6 which it enters through the elongated orifices 18. In each pressure chamber the downwardly-directed stream of water discharged through orifice 18 impinges on the baffle 30 which directs it upwardly about the exterior of the supply pipe and through the orifices 8, 10 from whence it emerges as an ascending stream within the trough. This ascending stream will have a material length along the chute and adjacent streams may be spaced as closely as desired. The force of each ascending stream may be varied by adjustment of the baffle with respect to the supply pipe, such force being increased by movement of the baffle toward the supply pipe.

Those pieces of the moving stream within the trough which are of sufficient specific gravity will sink through the ascending stream, passing through the orifices 8, 10, into the pressure chamber 6 and passing therefrom by the exit passages 12, 14. In the usual separation of coal from rock, slate, etc., the material discharged from orifices 12, 14 is a mixture of coal and refuse. The pieces of less specific gravity in the moving stream in the chute will not sink through the ascending streams and will therefore pass along the trough. In the usual washing of coal such low gravity material will include the coal. Means are provided by the invention for producing new and improved results in the operation of mineral separation apparatus of the ascending current type which are in addition to the new and improved results due to the new pressure chamber provided by the invention. Such new results are achieved by the combination with the new pressure chamber of a trough having downwardly converging side walls at or adjacent the lowest parts of which is the orifice through which the trough and pressure chamber communicate. In the preferred form of the invention the side walls of the trough form a V, as shown in Fig. 2, and the lower edges of the side walls are flush with the side edges of the orifice 8 in the pressure chambers and elsewhere form a pointed edge, as at 31 in Fig. 1. In another

5

er form of the invention, which is illustrated in Fig. 7, the side walls 52 are shaped to provide a trough which is U-shaped in cross-section. It will be understood that my invention is not limited to use of my improved pressure chamber with troughs having downwardly converging side walls, and that this combination produces new and unexpected results in the art.

My invention also contemplates that the pressure chamber may not have a baffle plate below the orifice in the supply pipe, and in Figs. 6 and 8 there is disclosed such a pressure chamber in combination with a V-shaped trough and a U-shaped trough respectively. In all other respects the pressure chambers of Figs. 6 and 8 are exactly like that disclosed in Figs. 2 and 3.

The pressure chamber provided by this invention may also be utilized in combination with a conical hopper or receptacle 60, as illustrated in Fig. 9, being connected to the lower end, or apex, thereof and communicating with the interior thereof through an aperture 62. In such an embodiment the pressure chamber 64 is preferably spherical and the baffle plate preferably circular in shape.

While it is preferred that the axis of the pressure chamber be parallel to the longitudinal dimension of the trough, this arrangement is not required, and in Figs. 10 and 11 I disclose an embodiment of the invention in which the pressure chamber extends transversely of the chute 66. In such an embodiment the bottom of the trough is preferably made wider than in other cases in order to accommodate the length of the pressure chamber but, as in other embodiments, the walls of the trough are downwardly converged.

Means are provided by the invention for producing, in an elongated trough of the type and for the purpose to which this invention relates, an elongated, continuous, ascending stream having the function hereinbefore described. Such means are disclosed in Figs. 12 and 13 in which there is disclosed a trough 70 having an elongated pressure chamber 72 connected to the lowest part thereof and communicating with the interior thereof through an elongated common aperture 73 which extends substantially the length of the pressure chamber. A supply pipe 74 is mounted concentrically within the pressure chamber and extends throughout the length thereof and has a discharge opening 76 at its lowest part. Spaced along the length of the pressure chamber are baffle plates 78, which are constructed, mounted, and operative in the same manner as those heretofore described in this application. Outlet openings 80 are also spaced along the length of the pressure chamber 72 adjacent the baffle plates and are controlled, as to size of opening, by conical members on the lower sides of the baffles.

It will be apparent that in the form of invention disclosed in Figs. 12 and 13 an elongated, continuous ascending stream will be produced in the chute 70 throughout the entire length of the common aperture between the pressure chamber and trough. This ascending stream is of substantial length, whereby a continuous, elongated ascending stream is produced within the material in the trough. The ascending stream may be given the same force throughout its length by adjusting the baffles equivalently with respect to the supply pipe or, alternatively, different parts of the ascending stream may be given greater or less force than other parts by differential adjustment of the baffles.

Air and other liquids than water are sometimes

6

used in processes and apparatus of the type to which the invention relates and it will be understood that the term "water" as used herein includes any gas or liquid or any mixture of gas and liquid.

It is believed that the operation of the apparatus, devices and combinations provided by my invention will be apparent and no further description thereof is believed to be necessary. While I have described and illustrated certain embodiments of my invention, it will be apparent to those skilled in the art that other embodiments, as well as modifications of those disclosed, may be made without departing from the spirit or scope of the invention, for the limits of which reference must be had to the appended claims.

I claim:

1. Apparatus for connection to the apertured lower part of a receptacle which is adapted to receive an aggregate of pieces having different specific gravities and for producing in such receptacle an ascending stream of water, comprising a closed chamber having an aperture in the upper part thereof adapted to register with the aperture in the lower part of the receptacle and having at least one exit orifice in the lower part thereof, water supply means extending into the closed chamber and having an aperture in the lower part thereof below the aperture in the upper part of the chamber, a plate positioned within the chamber below the aperture in the water supply means whereby a stream of water discharged downwardly from the aperture in the water supply means will impinge against the plate and rise about the water supply means and ascend through the aperture in the upper part of the chamber, and means for moving the plate toward and away from the water supply means to vary the force and volume of a stream of water discharged from the aperture therein.

2. Apparatus for connection to the apertured lower part of a receptacle which is adapted to receive an aggregate of pieces having different specific gravities and for producing in such receptacle an ascending stream of water, comprising a closed chamber having an aperture in the upper part thereof adapted to register with the aperture in the lower part of the receptacle and having at least one exit orifice in the lower part thereof, water supply means extending into the closed chamber and having an aperture in the lower part thereof below the aperture in the upper part of the chamber, a plate positioned below the aperture in the water supply means whereby a stream of water discharged downwardly from the aperture in the water supply means will impinge against the plate and rise about the water supply means and ascend through the aperture in the upper part of the chamber, means for moving the plate toward and away from the water supply means to vary the force and volume of a stream of water discharged from the aperture therein, and means carried by the plate and cooperating with the exit orifice in the lower part of the chamber to vary the effective size of said orifice as the plate is moved.

3. Apparatus adapted to be connected to the apertured lower part of a trough which is adapted to receive an aggregate of pieces having different specific gravities and for producing in such trough an ascending stream of water, comprising a closed cylindrical chamber having an aperture in the upper part thereof which is adapted to register with the aperture in the lower part of the trough and having at least one exit orifice in

7

the lower part thereof substantially diametrically opposite the elongated aperture, a water supply pipe mounted within the chamber and extending longitudinally thereof and having an orifice in the lower wall thereof below the aperture in the upper part of the chamber, means disposed below the orifice in the supply pipe for upwardly directing a stream discharged from the orifice therein, and means for moving said stream-directing means toward and away from the supply pipe to vary the force and volume of a stream of water discharged from the orifice therein.

4. Apparatus for the wet sorting of pieces of material which have different specific gravities, comprising a trough along which a stream of such pieces is adapted to be passed having an elongated narrow aperture in the bottom thereof extending throughout a substantial part of the length of the trough, a closed chamber attached to the bottom of the trough and communicating with the interior thereof through said aperture and being co-extensive in length with said aperture, means within said chamber for producing therein a downwardly-directed stream of water of substantially the same length as said aperture and parallel thereto, a plurality of separate means within said chamber below said stream producing means and spaced along the length thereof for receiving said downwardly-directed stream and directing it upwardly through said aperture into the trough, and separately operable means for selectively adjusting said separate stream directing means toward and away from the stream producing means to thereby differentially vary the force of the ascending stream at different points along the length of the trough.

5. Apparatus for connection to the apertured lower part of a trough which is adapted to receive an aggregate of pieces having different specific gravities and for producing in such trough an ascending stream of water, comprising a closed

8

cylindrical chamber attached to the lower part of the trough and having an aperture in the upper part thereof adapted to register with the aperture in the lower part of the trough and having at least one discharge opening in the lower part thereof, a cylindrical conduit extending into the chamber and being concentric with and smaller in diameter than the chamber, said conduit having an orifice in the lowest part thereof substantially vertically below said aperture, and means below the orifice in the conduit for receiving a downwardly-directed stream from said orifice and directing it upwardly about both sides of said conduit and through said aperture into the trough.

6. Apparatus according to claim 5, in which the means for receiving the downwardly-directed stream and directing it upwardly is the inner surface of the lower part of the cylindrical chamber.

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