METHOD AND APPARATUS FOR TREATING MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

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The invention relates to the separation of materials of different densities, such as coals, ores and the like, and especially concerns such a separation when obtained by means of pulsating apparatus, particularly by means of pulsating apparatus associated with washing troughs.

It has already been proposed to classify or to pre-classify materials of the kind referred to on screens or grids to which essentially horizontal movements are imparted, and with which are associated currents of water of constant intensity, while separating, at the end of said screens or grids, layers, in particular the lower layers, of the grouted bed. With such an arrangement however, it has been found that the grading of the materials takes place more or less slowly, so that, other things being equal, the output of low as compared with the size of the apparatus.

According to this invention, which, inter alia, has for its object to obviate this drawback, a classification or a pre-classification, and/or a separation of materials of different densities, is obtained by conveying said materials, if necessary, after passing them through a washing trough, to a screen or grid to which are imparted movements comprising alternating vertical and/or horizontal components, and subjecting simultaneously said materials to liquid impulses generated in timed relation with the movements of the screen or grid, particularly impulses entertained by a reciprocating piston, in association or not with liquid currents of constant or variable intensity.

According to another feature of the invention, the discharge of the graded products, or at least of certain categories of them, may be controlled in a similar manner, i.e., in timed relation with the movements of the screen or grid, or with those of the piston, preferably by means of a movable device the movements of which are made dependent from those of the screen or grid.

If necessary, the movements imparted to the discharge device may be such as to make the discharge to agree with a given law during the movements of the screen or grid, and said discharge may furthermore be influenced in accordance with the quantity and/or the quality of the treated material.

A classification-separation system according to this invention enables dense products to be extracted quickly from a mass of materials of different densities; therefore it is particularly well adapted for association with the treatment by washing of such materials in alluviation or grading troughs, thereby permitting a substantial reduction of the size of the washing plant. Especially in such a case, it is possible to improve the separation by making use of ascending liquid currents.

In order that the invention may be well understood, it will be described hereinafter in greater detail, but not limitatively, in its application to the treatment of coal, reference being made to certain preferred embodiments of classifying-separating apparatus illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a more or less diagrammatic elevational view of a classifying-separating apparatus in accordance with the invention;

Fig. 2 shows similarly the diagram of a plant comprising the association of apparatus according to Fig. 1 with washing troughs.

Referring first to Fig. 1, 1 designates a bin provided at 2 with an inlet for the materials to be graded and separated, which are conveyed to a movable grid or screen 4 pivoted at 5 to rods 6 secured to shafts 7 journaled in the walls of the bin 1, and at least one of which shafts may be oscillated.

In a compartment 8 of the bin 1 is mounted a piston 9 to which an eccentric drive, designated as a whole by 10, imparts reciprocating movements of suitable amplitude.

Said eccentric drive operates on the other hand, through the intermediary of an appropriate linkage, such as that designated as a whole by 11, the movable grid or screen 4, by acting, through the intermediary of a connecting rod 13 and a chain or equivalent member 14, on one of the shafts 7, the arrangement being such that the grid or screen 4 effects reciprocating movements in the vertical direction and in the horizontal direction, each time of the desired amplitude, in accordance with the movements of the piston 9. 15 is a counterweight for balancing the screen or grid 4.

Opposite the free end of the screen or grid 4 is mounted a device which enables the discharge of the products at said end to be controlled, and which comprises a system of planes 16 and 17 pivoted at their adjacent ends about a common pivot 18 and on the other hand about a shaft 19 rotating in the wall of the bin 1 and also about a pivot 20 connected, by connecting rods 21 pivoted together at 22, to a shaft 23 journaled in the walls of the bin 1.

On said shaft 23 may be keyed, externally of the bin 1, an operating lever which is adjustable as to its position, but with advantage, as illustrated, the pivotal connection 22 may be con-
connected, through a connecting rod 22a, to a mechanism generally indicated 22b and comprising a threaded rod, a hand wheel and a return spring in order to modify the position of said pivotal connection 22 and, consequently, the basic position of adjustment of the discharge control device 16—17.

Furthermore, said discharge control device may be connected, as shown, for example through a point of an external lever 26 keyed on the shaft 19, and by means of an appropriate linkage 27, to the eccentric drive 18 or a countershaft driven by the same, in order to impart if necessary, to the discharge control device, reciprocating movements in timed relation with the movements of the screen or grid 4 and of the piston 9.

Naturally, the various controls may be provided with adjusting means enabling the amplitude and the movements of the driven members to be adjusted, as shown for example at 28 and 29 for the controls 27 and 14 respectively, the arrangement enabling, if desired, the discharge slit or section to be caused to follow any desired law of periodic variation compatible with the desired discharge of a given category of products.

Preferably, as is moreover shown, the screen or grid 4 is located at a lower level than the inlet 2 for the materials, with the interposition of a wall 3 which may be inclined, and one of the functions of which is to act as an abutment for the lower layers of the materials on the screen or grid 4, as will more clearly appear from the following.

The arrangement is advantageously completed by a liquid inlet shown at 30, which is adapted to be adjusted in such a manner as to obtain either the compensation for the liquid losses accompanying the discharge at the bottom of the bin of the products separated in the apparatus, or eventually, in addition to the compensation of said losses, the formation of one or more desired ascending currents passing through the screen or grid and/or the discharge slit or section, and preventing the discharge of the particles the extraction of which is not desired, particularly where an apparatus of the kind described is associated with an alluviation or grading washing trough.

In such an association, upstream and downstream the classifying-separating apparatus proper, are connected sections 31 and 32 of a washing trough, whereas to the bottom of the bin 1 may be connected a continuous or intermittent discharge device of any known kind.

2 shows by way of example the combination, with the bottom of the bin 1, of a discharge system comprising a drum provided with cells or pockets 36, the plant including a washing trough 35 equipped with two classifying-separating apparatus, each of which is provided at its base with a discharge system comprising a drum with cells or pockets 36, these apparatus discharging the extracted products in a lower trough 31, itself fitted with a classifying-separating device of the same kind.

Naturally classifying-separating apparatus may be combined with washing troughs arranged in a very different manner, such as troughs which themselves include other apparatus for collecting and/or discharging materials having predetermined characteristics.

Whether the classifying-separating device is used as an individual element, or in association with an alluviation or grading trough, its operation is as follows:

Considering, by way of example, the case of the treatment of coal, the mixed materials or materials which have already been more or less formed into a graded bed, arrive at 2, and pass onto the grid or screen 4.

Owing to the reciprocating movement of the piston 9, these materials are subjected thereon to impulses, while they are simultaneously influenced by the movements imparted to the screen or grid 4, and also, where provided, by the ascending currents which may be produced by the liquid inlet 30.

The connections being made so that the piston 9 effects its downstroke while the screen or grid moves downwards and backwards—i.e., towards the left—the liquid impulse produced by this downward movement of the piston 9 determines the opening of the mass or bed of the materials, and throws upwards the particles or grains of lesser density, whereas the particles or grains of greater density, which are less affected, sink into or remain in the lower layers. At the same time, owing to the inertia of the particles or grains, in particular of the denser ones, when the screen or grid moves downwards, it shifts towards the left relatively to said particles or grains, so that the materials finally move towards the right-hand discharge end of the grid or screen.

This movement of the materials is assisted, or even caused, by the presence of a wall such as 3, forming an abutment for said materials, especially those of the lower layers, and preventing them from moving towards the left together with the screen or grid, should they have a tendency to follow the movement of said screen or grid in that direction.

It ensues that at the said right-hand end the materials are effectively discharged from the screen or grid 4, the denser ones passing above the bin 1, between the end of the grid and the element 16, and the lighter products passing above the element 17 of the discharge device.

If ascending currents are formed by the inlet 30, their separating action is enhanced by the impulse produced by the downward movement of the piston 9, so that the mass or bed of materials is more completely opened and the separation into categories more efficiently insured.

In the next phase of the operation, i.e., during the up-stroke of the piston 9, the grid or screen 4 is simultaneously moved upwards and towards the right, while the mass or bed of materials rests on said screen or grid. The suction produced by the up-stroke of the piston assists this movement, and at the same time reduces the action of the ascending currents produced by the liquid inlet 30 when provided.

Of course, it is within the scope of the invention to increase or to reduce the suction effect due to the up-stroke of the piston 9, by controlling same in an appropriate manner, for example by means of a cam of suitable shape replacing the eccentric shown.

In the next phase, the piston 9 and the screen or grid 4 move downwards again, and the already described operations are repeated.

In the foregoing description of the operation of the device it has been assumed that the position of the discharge device is not periodically modified during the movements of the piston 9 and of the screen or grid 4.

By connecting the drive 27—optionally adjusted at 28—to the linkage 11, the common piv-
A method of separating the materials of greater densities from a continuously, horizontally moving, wash water graded bed of granular materials of different densities, especially coals, ores, and the like, comprising supporting the moving bed of materials in the upper portion of a body of liquid, periodically oscillating the support for the bed of materials downwardly and horizontally in opposition to the normal direction of movement of the bed and upwardly and horizontally in the normal direction of movement of the bed, periodically subjecting the bed of materials to upwardly and downwardly directed liquid impulses which will alternately lift and loosen the bed and allow the bed to settle and compact, timing the oscillations of the support with the liquid impulses so that the bed support will move downwardly while the bed is lifting and will move upwardly when the bed is settling, advancing the bed of materials greater densities, by settling the same into the lower portion of said body of liquid, while the remainder of the bed continues its horizontal movement, and increasing the rate of separation of the materials of greater densities each time the bed is lifted and loosened by an upward liquid impulse.

Apparatus for separating from one another granular materials of different densities, especially coals, ores, and the like, comprising a bin adapted to be filled with liquid, having a side inlet for the admission of the granular materials to be separated and a side outlet for the discharge of the separated materials of lesser densities, a screen, having an unobstructed top surface, positioned in the upper portion of the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulses producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment adjacent the inlet end of the screen for opposing the tendency of the materials to follow the horizontal movements of the screen toward the side inlet, advance the materials along the screen, and means positioned in said discharge opening for controlling its effective area.

Apparatus for separating from one another granular materials of different densities, especially coals, ores, and the like, comprising a bin adapted to be filled with liquid, having a side inlet for the admission of the materials to be separated and a side outlet for the discharge of the separated granular materials of lesser densities, a screen, having an unobstructed top surface, positioned in the upper portion of the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally moving, wash water graded bed of granular materials of different densities, especially coals, ores, and the like, comprising supporting the moving bed of materials in the upper portion of a body of liquid, periodically oscillating the support for the bed of materials downwardly and horizontally in opposition to the normal direction of movement of the bed and upwardly and horizontally in the normal direction of movement of the bed, periodically subjecting the bed of materials to upwardly and downwardly directed liquid impulses which will alternately lift and loosen the bed and allow the bed to settle and compact, timing the oscillations of the support with the liquid impulses so that the bed support will move downwardly while the bed is lifting and will move upwardly when the bed is settling, advancing the bed of materials greater densities, by settling the same into the lower portion of said body of liquid, while the remainder of the bed continues its horizontal movement, and increasing the rate of separation of the materials of greater densities each time the bed is lifted and loosened by an upward liquid impulse.
zontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulse producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment against the inlet end of the screen for opposing the tendency of the materials to follow the movement of the screen horizontally toward the side inlet to advance the materials along the screen, and means positioned in operative relation to said discharge opening and to said side outlet for controlling their effective areas.

5. Apparatus for separating from one another granular materials of different densities, especially coals, ores, and the like, comprising a bin, adapted to be filled with liquid, having a side inlet for the admission of granular materials to be separated and a side outlet for the discharge of the separated granular materials of lesser densities, a screen, having an unobstructed top surface, positioned in the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulse producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment adjacent the inlet end of the screen for opposing the tendency of the materials to follow the movement of the screen horizontally toward the side inlet to advance the materials along the screen, a pair of hingedly connected plates, and means for pivotally supporting said plates in operative relation to the discharge opening to control the effective area of said opening and to the side outlet of the bin to form a weir for controlling the discharge of materials through the outlet.

6. Apparatus for separating from one another granular materials of different densities, especially coals, ores, and the like, comprising a bin, adapted to be filled with liquid, having a side inlet for the admission of granular materials to be separated and a side outlet for the discharge of the separated granular materials of lesser densities, a screen, having an unobstructed top surface, positioned in the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulse producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment adjacent the inlet end of the screen for opposing the tendency of the materials to follow the movement of the screen horizontally toward the side inlet to advance the materials along the screen, a pair of hingedly connected plates, and means for pivotally supporting said plates in operative relation to the discharge opening to control the effective area of said opening and to the side outlet of the bin to form a weir for controlling the discharge of materials through the outlet.

7. Apparatus for separating from one another granular materials of different densities, especially coals, ores, and the like, comprising a bin, adapted to be filled with liquid, having a side inlet for the admission of granular materials to be separated, and a side outlet for the discharge of the separated granular materials of lesser densities, a screen, having an unobstructed top surface, positioned in the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulse producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment adjacent the inlet end of the screen for opposing the tendency of the materials to follow the movement of the screen horizontally toward the side inlet to advance the materials along the screen, and means positioned in operative relation to said discharge opening and means for pivoting said plate in timed relation to the movements of said screen to increase the effective area of the discharge opening while the screen is moving downwardly and horizontally toward the side inlet and to decrease the effective area of said opening while the screen is moving upwardly and horizontally toward the side outlet.

8. Apparatus as defined in claim 7, further characterized by the provision of means for moving the location of the axis about which
one of said plates swings to adjust the range of movement of both of said plates.

9. Apparatus for separating from one another granular materials of different densities, especially coal, ores, and the like, comprising a bin, adapted to be filled with liquid, having a side inlet for the admission of granular materials to be separated and a side outlet for the discharge of the separated granular materials of lesser densities, a screen, having an unobstructed top surface, positioned in the upper portion of the bin to receive the granular materials admitted through the side inlet and spaced at its discharge end from the side outlet to provide an opening through which the materials of greater densities will be discharged into the portion of the bin below the screen, means for supporting the screen for oscillating movements downwardly and horizontally toward the side inlet and upwardly and horizontally toward the side outlet, means for imparting such movements to the screen, means for producing liquid impulses in the bin acting on the materials resting on the screen, means for actuating said liquid impulse producing means in timed relation to the movements of the screen to produce an upward impulse through the screen while the latter is moving downwardly and a downward impulse through the screen while the latter is moving upwardly, a stationary abutment adjacent the inlet end of the screen for opposing the tendency of the materials to follow the movements of the screen horizontally toward the side inlet to advance the materials along the screen, movable means positioned in operative relation to said discharge opening and to said side outlet for varying their effective areas, and means for actuating said movable means in timed relation to the movements of the screen to increase said area of the discharge opening and decrease said area of the side outlet as the screen moves downwardly and horizontally and to decrease said area of the discharge opening and increase the area of the side outlet as the screen moves upwardly and horizontally.

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