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MEANS FOR SEPARATING SOLID GRANULAR MATERIALS HAVING DIFFERENT SPECIFIC GRAVITIES

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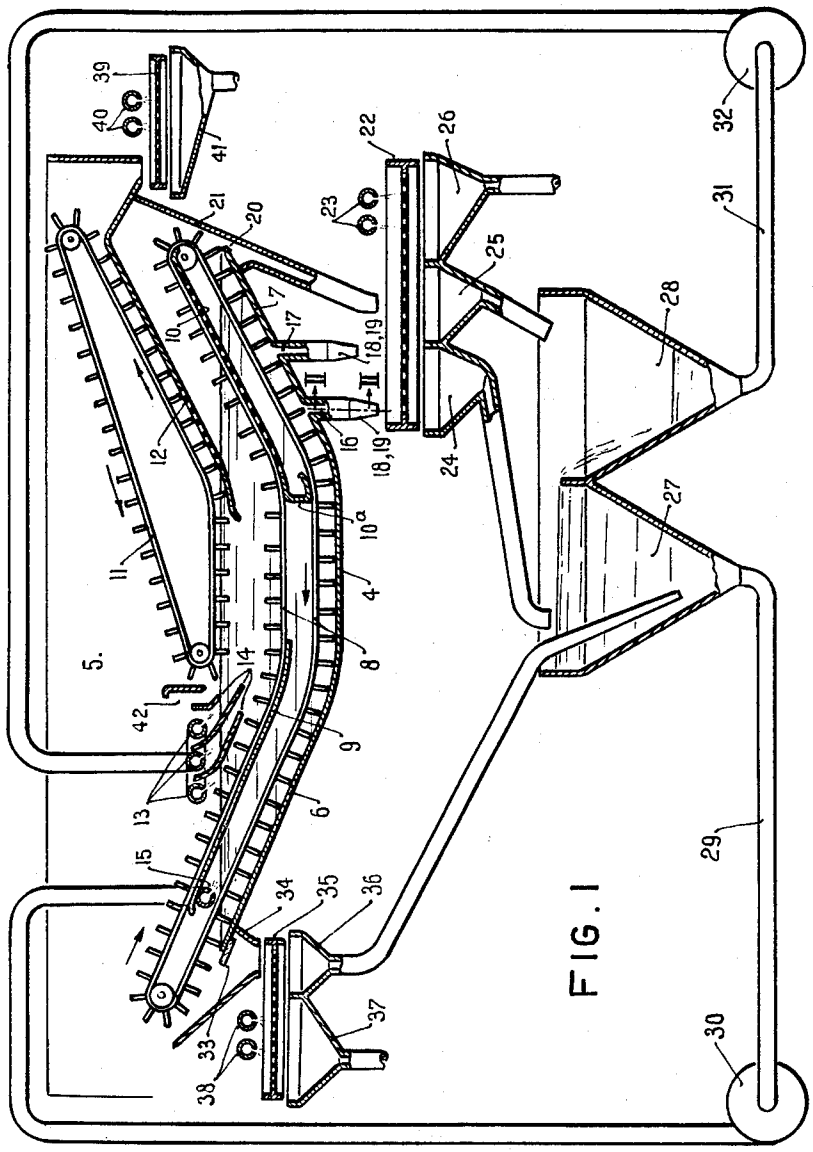


FIG. 1

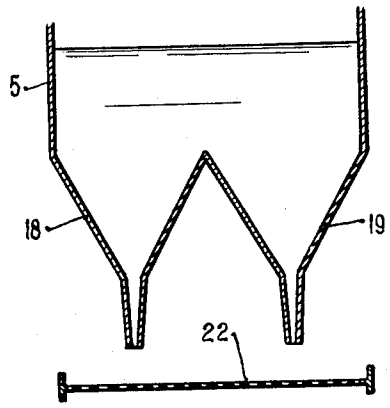


FIG. 2

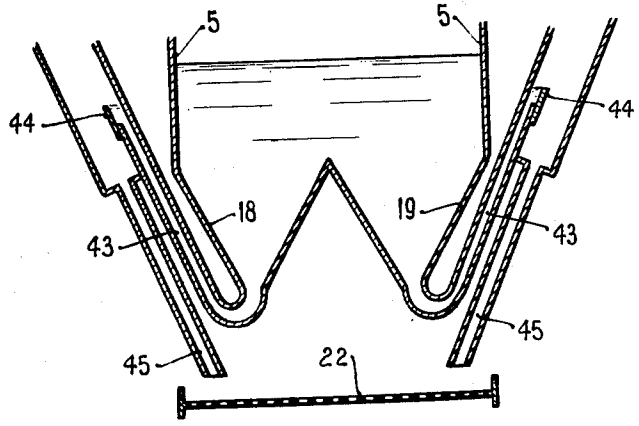


FIG. 3

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MEANS FOR SEPARATING SOLID GRANULAR MATERIALS HAVING DIFFERENT SPECIFIC GRAVITIES

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6 Claims. (Cl. 209—172.5)

This invention relates to methods and means for separating solid granular materials having different specific gravities by means of a suspension, especially, although not exclusively, for washing, cleaning or dressing raw coal, so as to separate the coal into three or more specific gravity fractions.

Hereinafter, reference will only be had to the washing of raw coal and the word "water" will be used to mean any liquid suitable for the purpose. The word "sand" will be used to mean any comminuted insoluble material specifically heavier than the liquid and adapted to be used as the solid constituent of the suspension.

My British specification 530,742 and my U. S. specification 2,139,047 disclose manners in which raw or run-of-mine-coal can be separated into a plurality of fractions in one washing tank. In apparatus of this type, the middlings or bony coals, which have specific gravities intermediate that of pure coal and that of the impurities such as rocks and pyrites, and which remain in suspension at different levels, in the fluidic mixture, are carried, by means of substantially horizontal currents, to individual discharge means, i. e. means independent of those for discharging the floats and the sinks.

It is well known that the discharge of the middlings from apparatus of said types may offer certain difficulties. In some instances, this discharge is performed exclusively by hydraulic means, i. e. by causing the substantially horizontal currents carrying the suspended products to deviate either in upward or in downward direction, as exemplified by my foresaid British specification 530,742 and by my pending U. S. patent application 371,105. In other known apparatus, the middlings are discharged by mechanical means only, see, inter alia, British specification 466,964, or by a combination of hydraulic and mechanical means, reference being had to British specification 593,455.

The fact that various means have been suggested for discharging the middlings indicates that none of the known apparatuses gives full satisfaction. The main disadvantage of said apparatuses is, in my opinion, that they are suitable only for handling coal having a particle size of a limited maximum value. This is due, inter alia, to the necessity of separating the pure coal at a relatively very low, and the rocks at a relatively very high specific gravity, if large coal is to be washed. This can be demonstrated as follows.

A ½" piece of bony coal, which accommodates a 1/16" lamina of slate having a specific gravity of 2.7, will have a specific gravity of 1.4, the specific gravity of pure coal being 1.3. The presence of pieces of this type in coal is readily accepted by the customers, but the presence of 8" pieces of bony coal each accommodating a lamina of rock of 1" although having the same specific gravity of 1.4, would not be accepted, or be accepted only at a reduced price.

The reverse is the case with the separation of middlings and sinks. An 8" piece of bony coal having a specific

gravity of 2.0 may be composed of a 2½" piece of pure coal (specific gravity 1.3) and a 5½" piece of rock having a specific gravity of 2.7. If such a piece is crushed, for instance to a top particle size of ½", the pure coal thus set free can well be recovered by washing. If, however, it is desired to recover an equivalent percentage of pure coal from a ½" piece of bony coal also having a specific gravity of 2.0, said piece would have to be crushed to a top particle size of only 1/32".

Now, it is well known that the cost of washing one ton of coal and also the losses suffered thereby, increase as the particle size decreases. Thus, the separation of the rocks in washing large coal can, and should be, carried out at a considerably higher specific gravity than would be justified in washing nuts and fines.

In apparatus provided with hydraulic means for discharging the middlings, the velocity of the ascending currents should be sufficient to raise the top size of the bony coal present in the raw coal to be handled. The required velocity of flow increases with the difference between the specific gravities at which the pure coal and the rocks, respectively, are to be separated. Indeed, a 4" piece of bony coal having a specific gravity of 1.8 suspended in a fluidic mixture having a specific gravity of 1.6 requires a velocity of flow of about 0.65 metres per second, and assuming the discharge opening to be sized 0.3 by 0.3 metres, this would require an amount of liquid of about 210 cubic metres per hour. An 8" piece having the same specific gravity suspended in the same fluidic mixture would require a velocity of flow of 0.91 m./sec., but since the said size of the discharge opening would have to be increased in view of the increased particle size, the required amount of liquid would be about 590 cubic metres per hour. If said 8" piece should have a specific gravity of 2.0, the said amount would even have to be increased to about 850 cubic metres per hour. In view of these enormous amounts of liquid, hydraulic discharge means for the middlings are not very suitable in the washing of large coal, and mechanical means are indicated.

However, the following difficulty still has to be faced. It is well known that the substantially horizontal currents for carrying the middlings towards the discharge openings should be effective through the full depth of the zone wherein the middlings are adapted to remain suspended. On the other hand it is desirable for the washing tank to have a limited depth with a view to reducing the initial cost and the amount of circulating suspension. But the washing of large coal requires a relatively great depth of the tank, and the same holds true when the difference between the specific gravities is considerable.

My invention, which has for its object to enable large coal to be effectively washed in a tank of reduced depth and which, consequently, meets the above seemingly conflicting requirements, consists herein that, at a level about centrally between the surface of the suspension and the bottom of the tank, the density of the suspension jumps up to a considerable increased value, and that the middlings accumulating at said level are carried towards and across an upwardly inclined screen, from which they are discharged.

In order that my invention may be readily understood by those skilled in the art, I shall now proceed to describe the same with reference to the annexed diagrammatic drawing, in which:

Fig. 1 is an elevation of a plan in accordance with my invention, various parts thereof being shown in vertical section,

Fig. 2 is a cross section along the line II—II in Fig. 1, and

Fig. 3 is a similar cross section of a modified construction.

The plant comprises a comparatively shallow washing tank having a horizontal bottom 4, parallel, vertical side walls 5 (see Figs. 2 and 3), a sloping front wall 6 and a sloping rear wall 7.

Mounted in the lower part of the tank is the horizontal portion of a drag conveyor 8 adapted to be driven, by means not shown, in clockwise direction as indicated by an arrow. The lower part of said conveyor sweeps the bottom 4 and the sloping front and rear walls 6, 7 of the tank, its upper part sweeping an imperforate false bottom 9 some distance vertically above the front wall 6 and also a perforate false bottom or screen 10 some distance vertically above the rear wall 7.

The lower part of a second drag conveyor 11 adapted to be driven, by means not shown, in counterclockwise direction, also indicated by an arrow, sweeps the surface of the suspension with which the tank is filled when in operation, and also an upwardly sloping sheet 12 mounted some distance vertically above the screen 10 and having its lower, perforate portion partly submerged in the bath.

Provided some distance above the false bottom 9 are a plurality of pipes 13 for supplying relatively low density suspension to the tank, said pipes being perforate so as to evenly distribute the suspension through the full width of the tank. By means of curved guide plates 14 said suspension is also evenly distributed through the full height of that portion of the bath, which is situated above the lower portion of the top part of the conveyor 8, and so that this suspension will flow in a substantially horizontal direction in the tank.

A horizontal, perforate pipe 15 for the supply of relatively high density suspension to the space confined between the parts of the conveyor 8 is located above the surface of the bath a small distance behind the upper edge of the front wall 6 of the tank.

The rear wall 7 of the tank has two transverse openings or slots 16, 17 extending through the full width of the bath. Each slot opens into two narrow hoppers 18, 19 (Fig. 2) mounted side by side, and each hopper has a relatively small outlet opening.

The front edge of the screen 10 has a downward bend 10*a*, through about 180°, the lower portion of which is substantially flush with the lower part of the conveyor 8.

Mounted vertically below the upper edge 20 of the sloping rear wall 7 is a funnel 21 having its outlet opening vertically above the central portion of a dewatering screen 22, whose front portion is located vertically below the outlet openings of the funnels 18, 19. Disposed vertically above the rear portion of the screen 22 there are sprayers 23.

Mounted vertically below the front, the central and the rear portion of the screen 22 are three funnels indicated by 24, 25 and 26, respectively, and disposed at a level below said funnels are two boots or thickeners 27, 28. The suspensions from funnels 24 and 25 are discharged into the boots 27 and 28, respectively. The outlet opening of the boot 27 communicates, through a pipe 29 and a pump 30, with the supply pipe 15 for high density suspension, and the outlet opening of the boot 28 communicates, through a pipe 31 and a pump 32, with the supply pipes 13 for low density suspension.

The vertically adjustable front edge or weir 33 of the sloping front wall 6 is located vertically above a funnel 34 having its outlet opening vertically above the rear portion of a screen 35, disposed below which portion is a funnel 36 discharging into the boot 27. Disposed below the front portion of screen 35 is another funnel 37 and mounted vertically above said front portion are sprayers 38.

The pure coal discharged across the sheet 12 falls onto a screen 39, which is provided with sprayers 40 and is located vertically above a funnel 41.

Disposed at the rear of the supply pipes 13 is a conduit 42, through which the coal to be washed can be supplied to the bath.

The modus operandi of the plant described so far is as follows.

Assuming the tank to be filled with suspension and run-of-mine or raw coal to be supplied thereto, the pure coal, i. e. the product of relatively low specific gravity, will float on the surface of the suspension, be carried by the lower part of the conveyor 11 across the perforate sheet 12 and discharged onto the screen 39. The sand still adhering to said pure coal will be removed therefrom by the jets of pure water from the sprayers 40.

The sinks, i. e. the rocks, will be received by the false bottom 9, whence they are removed by the upper part of the conveyor 8 so as to fall to the bottom 4 of the tank. Thereafter, they are carried by the lower part of the conveyor 8 across the sloping front wall 6 and discharged onto the rear portion of the screen 35, which allows the suspension accompanying the rocks to pass and be supplied, via the funnel 36, to the boot 27. Thereupon, the sand still adhering to the rocks is removed therefrom by pure water from the sprayers 38.

The relatively light middlings or bony coals are carried by the horizontal currents in the higher zone of the bath towards the screen 10. The heavier middlings float on the relatively high density suspension, whose level coincides approximately with the upper part of the conveyor 8. They are carried by the combined action of the said upper part and of the substantially horizontal currents in the bath towards the screen 10. These currents are compelled to flow through the openings of said screen, seeing that the bend 10*a* cooperates with the lower part of the conveyor 8 to prevent these currents from flowing directly into the space below said screen. Moreover, the lower part of the conveyor 8 tends to draw a certain amount of suspension from said space and to add it to the said currents. Owing thereto, the bony coals are positively drawn into contact with the screen 10, so that the upper part of the conveyor 8 is capable of raising these coals across said screen, whereby they are discharged onto the central portion of the screen 22, together with the suspension overflowing the weir 20. Said suspension passes the screen 22 and collects in the boot 28.

The suspension discharged by the openings 16, 17 and the funnels 18, 19 is supplied to the front portion of the screen 22 and collects in the boot 27. The amount of this suspension, added to that supplied by the funnel 36, exceeds the amount extracted from the boot 27 by the pump 30, so that light suspension from boot 27 will overflow into the boot 28, whence it is supplied, by pump 32, to the pipes 13.

It will be understood that it is essential for the openings in the screen 10 to be prevented from clogging, whereby the passage of the light suspension would be impaired and the conveyor 8 would fail to catch the bony coals, which, so to say, have no weight since they are suspended in the fluidic mixture. Therefore, said openings should be rather wide, and with a view thereto it is advisable for the screen 10 to be constituted as a bar screen comprising bars at about ½" spacing.

In this connection it is to be remarked that the described means for discharging high density suspension through each of the slots 16, 17 as illustrated in Fig. 2 and constituted as twin funnels 18, 19 directly discharging onto the screen 22, is suitable as long as the spacing of the bar screen 10 does not exceed a predetermined, comparatively low value. If the spacing exceeds said limit, it is preferred to discharge the heavy suspension from the twin funnels 18, 19 by syphonic action, reference being had to Fig. 3, according to which the outlet opening of each funnel is connected, through an elbow, to a riser 43 having its vertically adjustable weir 44 located some distance below the level of the liquid in the funnel. The liquid overflowing said weir is discharged, through a pipe 45, onto the screen 22.

As a matter of course, the bars of the screen 10 should not be spaced so widely that the top size of the middlings

passing the screen **10** are no longer adapted to be discharged hydraulically, either upward by the suspension overflowing the weir **20**, or downward by the funnels **18, 19.**

Obviously, the details of the construction described above and illustrated by the drawing may be varied within certain limits. For instance, it is not always necessary to provide for two suspension discharge openings **16, 17.** In many cases, opening **17** may be dispensed with. Furthermore, the floats, i. e. the pure coals, could be discharged, in known manner, laterally through chutes, instead of being removed from the bath across the sloping sheet **12.**

Attention may still be called to an interesting and advantageous application of my invention. If the raw coal is sized say from 6" to ¼", the separation of the middlings from the sinks is ordinarily performed at a given specific gravity of say 2.0, both for the coarser and for the finer particles. As explained above, if said specific gravity is economically justified for the 6" particle size, it will be too high for the ¼" particle size. However, if in my apparatus the suspension, which is discharged by the slot **16** and which carries small sized middlings having a relatively high specific gravity, is directed to the screen **35**, and if the spacing of the bar screen **10** is suitably selected, the finer fraction of the said coals can be separated from the rocks at a specific gravity appreciably lower than 2.0.

What I claim is:

1. Apparatus for separating granular materials having different specific gravities, comprising a tank for holding a body of suspension, said tank having a downwardly and rearwardly sloping front wall, an upwardly and rearwardly sloping rear wall and a substantially horizontal bottom; means for feeding materials to be separated into said tank intermediate the front and rear side thereof; means provided behind said feeding means for introducing relatively low density suspension to the zone of the bath above a level substantially centrally between the surface and the bottom of the bath, independent means behind said feeding means for introducing relatively high density suspension to the zone of the bath below said level; means for withdrawing suspension from the tank at the rear side thereof; means for removing floats from the surface of the bath; an upwardly and rearwardly inclined perforate partition extending from a region located substantially at the said level and intermediate the front and rear side of the tank to a region above the surface of the bath and at the rear side of the tank; and a drag conveyor whose lower part sweeps the rear wall, the bottom and the front wall of the tank in the direction from rear to front and whose upper part sweeps the said inclined perforate partition.

2. Apparatus in accordance with claim 1, wherein the upper part of the said drag conveyor also sweeps an imperforate partition located vertically above and in substantially parallel relation with the inclined front wall of the tank and extending downwardly substantially to the said level.

3. Apparatus in accordance with claim 2, wherein the means for supplying relatively high density suspension to the tank is located above the surface of the bath and intermediate the said imperforate partition and the lower part of the drag conveyor.

4. Apparatus in accordance with claim 1, wherein means are provided for substantially sealing the space between the front edge of the inclined perforate partition and the lower part of the drag conveyor.

5. Apparatus in accordance with claim 1, wherein an opening is provided in and extending through substantially the full width of the rear wall of the tank and located substantially at said level for discharging suspension from the tank through a funnel having a restricted outlet opening located vertically above a dewatering screen.

6. Apparatus in accordance with claim 5, wherein the outlet opening of said funnel is connected to the riser of a syphon whose downtake opens vertically above said dewatering screen.

References Cited in the file of this patent

UNITED STATES PATENTS

1,290,515	Conklin	Jan. 7, 1919
1,839,117	Nagelvoort	Dec. 29, 1931
2,150,917	Foulke et al.	Mar. 21, 1939
2,365,734	Tromp	Dec. 26, 1944
2,603,352	Tromp	July 15, 1952