

March 6, 1962

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PROCESS FOR SEPARATING PARTICLES OF SOLID
MATERIAL ACCORDING TO SPECIFIC GRAVITY

3,023,893

Filed Aug. 26, 1959

2 Sheets-Sheet 2

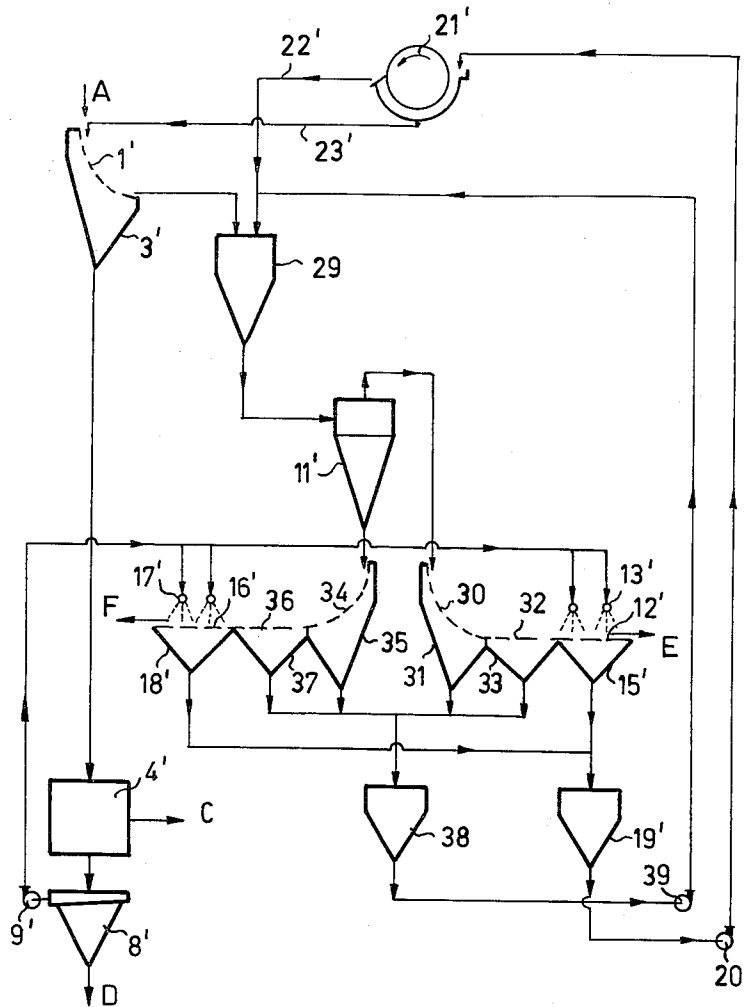


FIG. 2

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PROCESS FOR SEPARATING PARTICLES OF SOLID MATERIAL ACCORDING TO SPECIFIC GRAVITY

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Filed Aug. 26, 1959, Ser. No. 836,292

Claims priority, application Great Britain Sept. 2, 1958

3 Claims. (Cl. 209-18)

This invention relates to a process for separating particles of solid material into fractions according to specific gravity in which the coarser particles are separated by means of a separating suspension of magnetisable particles whereas the finer particles are separated by means of a liquid of lower specific gravity, such as water.

In such a system the coarser particles may be separated in a washbox by means of the float-and-sink method or in cyclone washers. For recovering and regenerating the separating medium used in this separating step it has been proposed to rinse the separated fractions on screens to remove adhering magnetisable suspension particles and to feed the thus obtained diluted suspension to a magnetic separator to separate the magnetisable particles from the non-magnetisable particles and the bulk of the water. The magnetisable particles are returned for re-use in the separator, whereas the non-magnetic fraction, after being freed from the solid non-magnetisable particles, is used as rinsing water on the rinsing screens.

The finer particles are separated by means of jigs, launders, froth flotation or similar devices. The water leaving the separated fractions is separated therefrom and after being clarified in settling cones returned for re-use in these devices.

It is the object of the present invention to provide an improved process in which both separating steps are combined in such a way that the costs of treatment and apparatus are reduced.

Accordingly, the present invention provides a process for separating particles of solid materials into fractions according to specific gravity, which comprises screening the particles to be separated into a coarse fraction and a fine fraction, separating the coarse fraction by means of a separating suspension of magnetisable particles and separating the finer fraction by means of a liquid of lower specific gravity, rinsing the separated coarse particles on rinsing screens to remove adhering magnetisable particles, supplying the diluted fraction obtained as a result of such rinsing to a magnetic separator, returning the magnetic fraction obtained from said magnetic separator to the separating means for the coarse material, supplying the non-magnetic fraction obtained from said magnetic separator to the separating means for the finer fraction, dewatering the separated finer fractions, and feeding water obtained from said dewatering step and clarified partly or as a whole to the sprayers above the rinsing screens for the separated coarser fractions.

In this way no separate rinsing water circuit for rinsing the coarser separated products is necessary. The rinsing water is now obtained from the separating step for the fines, passed through the rinsing screens and after removal of the magnetisable particles returned to the separating step for the fines. In known methods thickeners or similar devices have been applied to remove from the rinsing circuit the fine non-magnetic particles which are present in this circuit due to breakage of the separated material and defects of the initial screening of the raw material. As the non-magnetic fraction is now returned to the separation step for the fines this removal of fine particles may be dispensed with. The losses of magnetisable material are very low because of the high efficiency of the magnetic separators used for cleaning suspensions of magnetisable material. These losses may

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be kept down to a minimum by arranging a second magnetic separator in series to remove from the non-magnetic fraction of the first magnetic separator the magnetisable particles which may be still present therein.

In known processes the initial screening of the raw material into a coarse fraction and a fine fraction is effected by wet-screening. For this purpose a certain amount of water is sprayed on the classifying screen. It is now a further object of the invention to eliminate this additional amount of water. To this end according to the invention the non-magnetic fraction obtained from the magnetic separator may be supplied to the classifying step in which the raw material is separated into a coarse and a fine fraction. The diluted non-magnetic fraction from the magnetic separator now first serves for classifying the raw material and subsequently as separating medium in the separation step for the fines.

The invention will be further explained with reference to the accompanying drawings in which embodiments of the invention are illustrated by way of example.

FIG. 1 represents a flow-sheet of a coal washery treating coal up to a particle size of 7" and FIG. 2 represents a flow-sheet for a coal washery treating coal up to a particle size of 1/2".

Referring now to FIG. 1 raw coal having a particle size from 0 to 7" is supplied at A to a screen 1 having a size of mesh of 7/8", where it is wet-screened by supplying a liquid medium through sprayers 2. The throughput of the screen is collected in a tank 3 from where it is supplied to a jig washer 4. The shale particles separated in the jig washer may be removed by means of for example bucket elevators 5, which both remove the shale and dewater it. The washed fine shales are discharged at B. The washed fine coal is dewatered on screen 6 and discharged at C. The underflow of screen 6, which consists of water and fine coal of e.g. from 0-1/2 mm., is collected in a tank 7 from which it is supplied to a settling cone 8.

At the bottom of the settling cone 8 a thickened sludge is discharged at D. The clarified overflow of the cone is partly returned by means of a pump 9 through a conduit 10 to the jig washer.

The overflow fraction from screen 1, comprising the raw coal particles from 7/8" to 7", is introduced into a float and sink separator 11, which is filled with a magnetite suspension of the required specific gravity. The coal which floats in the separator is discharged onto a screen 12, where it is rinsed with clarified water supplied through sprayers 13 to wash off the adhering suspension particles. This clarified spraying water is obtained from the overflow of the settling cone 8 and is supplied to the sprayers by means of pump 9 through conduit 14. The separated coal is discharged at E, whereas the diluted suspension is collected in a tank 15 disposed beneath the screen 12.

The separated shale is discharged onto a screen 16 and rinsed off by clarified water supplied through sprayers 17. The washed shale leaves the system at F, whereas the diluted suspension is collected in a tank 18 disposed underneath the screen 16. The diluted suspension from the tanks 15 and 18 is fed to a receiver 19 from where it is pumped by means of a pump 20 to a magnetic separator 21.

From the magnetic separator a concentrated magnetic fraction is obtained which is returned to the float and sink separator through a conduit 22. The non-magnetisable fraction obtained from the magnetic separator, comprising the fine non-magnetisable particles and the bulk of the water is supplied to the sprayers 2 above the classifying screen 1 through a conduit 23.

In the case the raw material is classified on a dry screen the non-magnetisable fraction is supplied directly to the fine washing system, as indicated by the dotted line 24 in FIG. 1.

The specific gravity of the suspension in the float and sink separator is controlled by means of a control device 25 of known design. If the density in the separator falls below a preset value, it is automatically adjusted by opening a valve 26, so that a higher proportion of the suspension in the separator 11 is circulated through the magnetic separator 21. If the density in the separator is too high, a valve 27 is adjusted to supply clarified water through conduit 28 into the separator.

In the flow-sheet according to FIG. 2, raw coal having a particle size of from 0 to $\frac{1}{2}$ " is fed with water at A onto a curved screening deck 1' where it is deslimed by the method described and claimed in U.S. Patent No. 2,916,142, issued December 8, 1959. The slots between the bars of this screen may have a width of e.g. 0.5 mm., so that the throughput of these screens, which is collected in a tank 3', comprises the particles up to a size of 0.25 mm. These slimes are supplied to a froth flotation plant 4'. Clean fine coal particles are discharged at C, whereas the tailings of the froth flotation machines are supplied to a flocculating tank 8', where the fine shale particles settle. These particles are discharged at D.

The overflow of the screening deck 1' is fed into a vessel 29 from where it is introduced together with a magnetite suspension of the desired specific gravity into a cyclone washer 11'.

In this hydrocyclone the mixture is separated into a fraction of washed coal, which together with some of the magnetite suspension leaves the hydrocyclone through the outlet opening in its wider end (the "overflow outlet"), and a fraction of washed shales, which issues from the hydrocyclone, likewise together with some of the magnetite suspension, through the opening in its apex.

The washed coal is wet screened on a curved bar screen 30. The undiluted underflow of this screen is received in a tank 31 and the overflow is passed across a vibrating screen 32. The undiluted underflow of this screen is received in a tank 33 and the overflow is passed across a vibrating screen 12' on which the washed coal is rinsed with the clarified overflow of the flocculation tank 8' supplied by pump 9' through sprayer 13', in order to remove adhering suspension particles. The diluted suspension from the rinsing screen 12' is collected in a tank 15'. The washed coal is discharged at E.

The washed shales are wet screened on a curved bar screen 34. The undiluted underflow of this screen enters a tank 35, whereas the overflow is passed across a vibrating screen 36. The undiluted underflow of this screen is received in a tank 37 and the overflow is passed across a vibrating screen 16' on which the washed shales are rinsed with the clarified overflow of the flocculation tank 8' through sprayers 17'. The diluted suspension from the rinsing screen 16' is collected in a tank 18'. The washed shales are discharged at F.

The undiluted suspension collected in the tanks 31, 33, 35 and 37 is led to a tank 38 from which it is pumped by means of a pump 39 to the vessel 29 in which the mixture to be separated is introduced.

The diluted suspension collected in tanks 15' and 18' is led to a tank 19' from which it is pumped by means of a pump 20' to a magnetic separator 21'.

The magnetite fraction separated by the magnetic separator is returned through a conduit 22' to the mixing vessel 29, suitable amounts of water being added thereto to adjust the specific gravity to the required value. The non-magnetic fraction is supplied through a conduit 23' to the feed of the curved bar screen 1'.

It will be understood that the invention is not restricted to the systems described above because other modifications may be adopted without departing from the scope of the invention. According to one such modification the coarse shale fraction may be crushed and rewashed in the washing system for the fine fraction or the coarse fraction may be separated into three fractions, of which the middling fraction after being crushed is retreated in the washing system for the fines.

Instead of a froth flotation plant as described with reference to FIG. 2 other devices may be used for separating the fines, such as launders. As a further alternative the slimes obtained from the desliming step may be thickened in cyclones, Spitzkasten, or the like before being subjected to further treatment and the water obtained from this thickening operation may be supplied to the rinsing screens for the coarse fractions.

Though the invention is of particular advantage in the cleaning of coal, it may also be applied in other connections such as the dressing of ores.

What is claimed is:

1. A process for separating particles of solid materials into fractions according to specific gravity, which comprises screening the particles to be separated into a coarse fraction and a fine fraction, separating the coarse fraction by means of a separating suspension of magnetisable particles and separating the finer fraction by means of a liquid of lower specific gravity than the specific gravity of said separating suspension, rinsing the separated coarse particles on rinsing screens to remove adhering magnetisable particles, supplying the diluted fraction obtained as a result of such rinsing to a magnetic separator, returning the magnetic fraction obtained from said magnetic separator to the separating means for the coarse material, supplying the non-magnetic fraction obtained from said magnetic separator to the separating means for the finer fraction, dewatering the separated finer fractions, and feeding water obtained from said dewatering step at least in part to the sprayers above the rinsing screens for the coarser separated fraction.

2. A process according to claim 1, in which the non-magnetic fraction obtained from the magnetic separator is supplied to the classifying step in which the raw material is separated into a coarse and a fine fraction.

3. A process according to claim 1 wherein the feeding water obtained from said dewatering step is also fed to the separating means for the finer separated fraction.

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