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METHOD FOR CLEANING COAL

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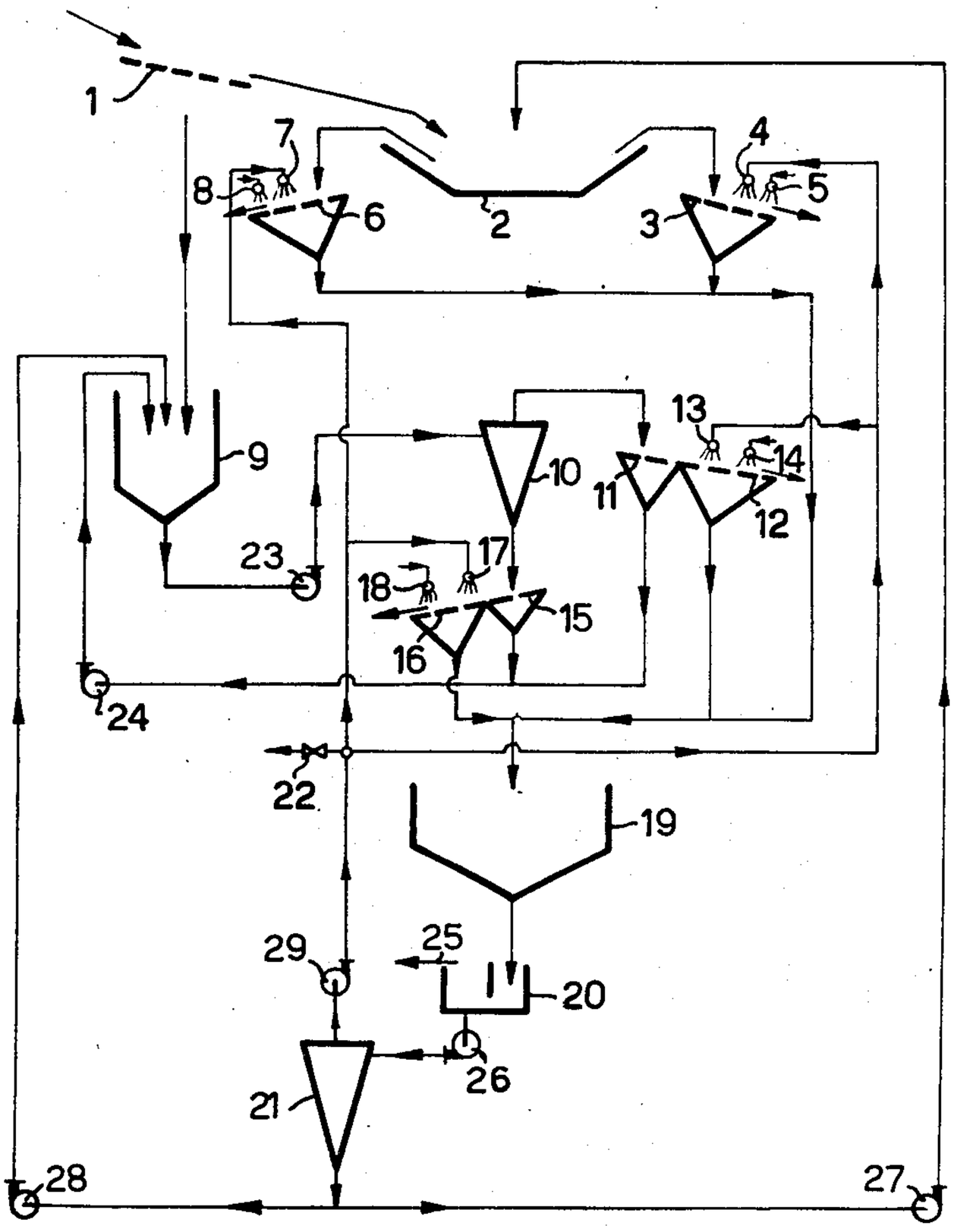

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METHOD FOR CLEANING COAL

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This invention relates to a method for cleaning raw coal with the aid of a separating suspension. In a known method the raw coal is cleaned by means of sink and float separation, in which the raw coal is fed into a separating tank containing a liquid separating medium composed of water and comminuted solids in suspension therein, the specific gravity of the medium being so adjusted that the coal particles float, while the heavier shale particles sink. The separated products are discharged and sprayed with water on a screen to wash the adhering separating medium therefrom. The diluted medium obtained from this washing action is cleaned in order to remove the impurities, after which it is thickened to the specific gravity desired in the separating tank. The water obtained from the thickening operation is used for spraying the separated products on the washing screens.

In another known method for cleaning raw coal, the material to be separated is introduced under pressure into a so-called hydrocyclone washer, together with a suspension of suitable specific gravity. The coal and shale fractions are separately discharged from the outlet openings of the hydrocyclone, and sprayed with water on washing screens to remove adhering suspension medium. The thus-obtained diluted suspension is thereafter cleaned and thickened to the desired specific gravity, and reintroduced into the hydrocyclone.

Because the separating suspension is thickened in the hydrocyclone washer, the specific gravity of separation therein is higher than the initial specific gravity of the suspension when introduced into the hydrocyclone. For this reason it is common practice to employ two separate separating suspension circuits in washeries where hydrocyclones and separating tanks of the sink and float type are used, one circuit for the separating tank and another for the hydrocyclone washer, the suspension in the hydrocyclone washer circuit being of a lower specific gravity than the suspension in the separating tank circuit.

This arrangement involves duplication of apparatus and piping in the suspension regenerating systems.

It is, therefore, an object of my invention to provide an efficient method for cleaning coal with the aid of separating suspension, in which both separating tanks of sink and float type and hydrocyclone washers are employed.

A further object of the invention is to provide an improved method for cleaning coal which has been subjected to breakers, due, for example, to the method of coal cutting and/or transport to the washery.

Another object of the invention is to provide a method for cleaning coal in which the regeneration equipment for recovering used suspension is of simplified design.

It has been discovered that if raw coal is preliminarily separated according to particle size into a coarse and a fine fraction, both separating tanks of the sink and float type and hydrocyclone washers may be employed to clean the coal, utilizing the same separating suspension in the separating tanks and the hydrocyclone washers. By treating the coarse fraction in separating tanks and treating the fine fraction in hydrocyclone washers, the separation in the hydrocyclones may be effected to produce a coal product having an ash content substantially as low as

that of the coal product from the separating tanks, notwithstanding the higher specific gravity of separation in the hydrocyclones.

This results from the circumstance that during the cutting of the coal from the coal face, and during transport of the raw coal from the coal face to the washery, the coal is subjected to considerable breakage. Since the relatively soft coal inevitably is more broken than are the harder shales, the percentage of free coal is considerably higher in the finer portion of the raw coal than in the coarse portion. Particularly when the coal is cut by machine, and where skips are employed to raise the coal to the surface, this phenomenon is clearly observed. Mechanical cutting breaks up the raw coal to a considerable extent, and further breakage also occurs in the filling and emptying of skips. For example, a quantity of raw coal to be washed, cut by coal plows and transported to the surface in skips, was found to have the following composition:

Table I

Spec. Grav.	Grain size			
	>30 mm.	18–30 mm.	12–18 mm.	<12 mm.
	Percent	*Percent*	*Percent*	*Percent*
<1.3	12.6	27.6	41.4	46.4
1.3–1.45	10.8	13.5	14.6	18.3
1.45–2.0	14.8	13.4	10.9	9.4
>2.0	61.8	45.5	33.1	25.9
	100	100	100	100

This table indicates the marked increase in the percentage of free coal in the finer fractions.

Separating tests with these fractions were carried out at specific gravities of 1.60, 1.76 and 1.90. The ash contents of the washed coal resulting from the separating tests are indicated in the table below:

Table II

Grain Size	Spec. Grav. of Separation		
	1.60	1.76	1.90
>30 mm.	17.6	12.8	15.6
18–30 mm.	7,5	11.0	11.2
12–18 mm.	6.7	8.2	8.8
<12 mm.	6.1	7.3	7.6

The results indicate that the ash content of the coal product obtained by washing the fraction smaller than 12 mm. at a specific gravity of 1.90 is no higher than that of the coal product obtained by washing the fraction coarser than 30 mm. at a specific gravity of 1.60.

The present invention provides a method for cleaning raw coal, wherein the raw coal mixture is first divided into coarse and fine fractions. The coarser fraction is fed to a suspension bath of such specific gravity that the coal particles float and the shale particles sink therein. The clean coal and shale particles are removed from the bath, and adhering suspension is washed therefrom. The finer fraction is introduced into a hydrocyclone washer, together with a suspension of the same specific gravity as that of the suspension bath. The cleaned fine coal and shale particles are discharged from the hydrocyclone washer, and adhering suspension is washed therefrom also. The diluted suspensions resulting from the washing of the particles discharged from both the suspension bath and the hydrocyclone washer are collected. Impurities may be removed from the diluted suspension so collected, and the suspension is then thickened to the specific gravity desired in the suspension bath. The common thickened suspension is then supplied partly

to the suspension bath and partly to the hydrocyclone washer.

In this way a simple regenerating system is attained, wherein notwithstanding the higher effective specific gravity of separation in the hydrocyclone washer, the coal product obtained from the hydrocyclone has the desired purity. This result is possible because the increase in ash content due to the higher specific gravity of separation in the hydrocyclone is balanced by the decrease in ash content resulting from the higher carbon content of the finer coal fraction.

The degree of purity of the coal product from the hydrocyclone washer, as will be readily understood, is influenced by the grain size according to which the separation of the initial raw material takes place, and it will in general be found readily possible to obtain a cleaned coal product from the hydrocyclone as low in ash content as the float fraction from the separating tank. For this purpose, it is in general found that normal run-of-mine coal may be divided according to a particle size within the range of from 10 to 18 mm.

The invention will be more readily understood in connection with the following description and the accompanying drawing, in which the figure represents a flow sheet of a coal washery arranged to practice the invention in preferred manner. It will be understood that various changes and modifications are possible without departing from the scope of the invention.

Run-of-mine coal, ranging in size up to 80 mm. and having a composition as shown in Table I, is supplied to a screen **1**, which has a mesh of 18 mm. The raw coal particles greater in size than 18 mm. are fed into a separating tank **2**, which is filled with a shale slurry suspension having a specific gravity of 1.5. The washed coal is discharged onto a screen **3**, where the adhering suspension is rinsed off by means of sprays **4** and **5**. The coal may subsequently be sorted into several commercial classes of different grain size, such as nuts-coal I, II and III. The mean ash content of the washed coal is 7%. The fraction whihc settles in separating tank **2** is discharged onto a screen **6**, where the adhering suspension is removed by sprays **7** and **8**. The settled fraction from the separating tank **2** may also be subjected to a further separation, carried out for instance in an upward current separator, to separate the middlings from the shale.

The undersize of screen **1** is fed into a mixing vessel **9**, into which a suspension of shale slurry having a specific gravity of 1.5 is also supplied. The fine particles to be cleaned, together with the suspension, are introduced at a gauge pressure of 0.7 atmosphere by means of a pump **23** into two hydrocyclone washers **10**. The hydrocyclones **10** have the following dimensions:

Outer diameter	350 mm.
Inlet aperture	70 mm.
Base aperture	150 mm.
Apex aperture	Variable between 40 and 125 mm.
Apex angle	20°.

In the hydrocyclone washers **10** a separation is effected at a specific gravity of 1.8. The cleaned fine coal particles are discharged, together with suspension, through the base apertures onto a screen **11**, where the suspension drains from the coal. The suspension still adhering to the coal is removed on washing screen **12** by sprays **13** and **14**. The cleaned fines may be further separated by classification into nuts-coal IV and V. The ash content of the cleaned fines approximates 7.5%. As will be evident, this is only very little higher than the ash content of the coarse cleaned coal, and satisfies the standard of a good fuel.

The fine heavy particles discharged by the hydrocyclone washers **10** are discharged onto a screen **15**, together with suspension, which drains off on the screen. The suspension particles still adhering to the heavy particles are rinsed off on a washing screen **16** by sprays **17** and **18**.

The undiluted suspension collected under the draining screens **11** and **15** is returned to mixing vessel **9** by means of a pump **24**. The diluted suspension collected under screens **3**, **6**, **12** and **16** flows to a collecting vessel **19**, from which the suspension is introduced into flotation apparatus **20**. In this apparatus impurities, such as fine coal particles, are removed from the suspension at **25**, and subsequently the suspension is forced at a gauge pressure of about two atmospheres, by pump **26**,

into a set of six hydrocyclone thickeners **21**, each having the following dimensions:

Outer diameter	350 mm.
Inlet aperture	50 mm.
Base aperture	50 mm.
Apex aperture	Variable between 20 and 40 mm.
Apex angle	20°

In the hydrocyclone thickeners **21**, the suspension is thickened to a specific gravity of 1.5. Part of the thickened suspension is returned to separating tank **2** by means of a pump **27**, and the remainder by means of pump **28** to the mixing vessel **9**. The overflow from the hydrocyclone thickeners **21** is led to sprays **4**, **7**, **13** and **17**, by means of a pump **29**. Clean water may be supplied to the sprays **5**, **8**, **14** and **18**. Excess liquid may be withdrawn from the liquid circuit through conduit **22**.

As is well known, the separating effect of a hydrocyclone washer is influenced by the shape of the hydrocyclone, the diameters of the feed and discharge apertures, and the pressure under which the mixture is introduced into the hydrocyclone. By appropriate adjustment of the feed pressure and/or of the outlet apertures, the specific gravity of separation may be altered within certain limits, for a separating suspension of given specific gravity. For instance, adjustment of the hydrocyclone feed pressure or the diameters of the outlet openings permits variation of the specific gravity of separation of the hydrocyclone washers **10** within a range of about 0.1, thus in the example, between 1.75 and 1.85. In this manner, any minor changes in the composition of the raw coal or in the required ash content of the finer coal fraction may be compensated for by adjustment of the feed pressure or the size of the outlet apertures, in such manner that the fine coal fraction will be of the desired quality. Such adjustment is adequate to compensate for normal variations in composition of a given initial raw coal mixture to be treated.

If a different raw coal mixture is to be treated, the composition of which differs considerably from that of the previous mixture, the adjustment of feed pressure and/or outlet aperture of the hydrocyclone washers may not be sufficient to compensate for this difference. In such case, the grain size of separation of the raw material may be adjusted. A suitable grain size of separation may be determined by a separating test of the new mixture of the nature of that illustrated in Table II. It is also possible to compensate for greater variations in the composition of the raw coal mixture by utilizing hydrocyclone washers of different shape. In general, a tapering hydrocyclone is preferred, as in this type of hydrocyclone the specific gravity of separation may be adjusted, by adjusting feed pressure or the outlet aperture, through the widest range. In cases where anthracite is being cleaned, the coarse coal product to be employed as a domestic fuel and the fine coal product to be employed as a boiler fuel, which boiler fuel has a higher permissible ash content than the domestic fuel, adjustment may obviously be made in such a way that the coal product from the hydrocyclone has an ash content substantially higher than that of the coal product from the separating tank.

The term "hydrocyclone," as used throughout the specification and claims, is to be understood as including a multiple hydrocyclone, that is, the well known apparatus comprising a plurality of individual hydrocyclones connected to operate in parallel.

I claim:

1. A method for cleaning raw coal comprising the steps of separating the coal according to particle size into coarse and fine fractions, feeding the coarse fraction to a suspension bath of specific gravity between that of coal and shale, separately removing coal and shale particles from said suspension bath, washing adhering suspension from the coal and shale separated from said suspension bath, feeding the fine fraction into a hydrocyclone washer together with a suspension corresponding in specific gravity to that of the suspension bath, separately discharging coal and shale particles from said hydrocyclone washer, washing adhering suspension from the coal and shale discharged from said hydrocyclone washer, collecting all the diluted suspension resulting from said washing operations, thickening the diluted suspension to the specific gravity of the suspension bath, and utilizing said common thickened suspension to replenish said suspension bath and to feed said hydrocyclone washer.

2. A method as defined in claim 1, including the step of removing impurities from the diluted suspension prior to the thickening operation.

3. A method as defined in claim 1, wherein the particle size of separation into coarse and fine fractions is within the range of from 10 to 18 mm.

4. A method as defined in claim 1, wherein the diluted suspension is thickened by a hydrocyclone thickener.

5. A method as defined in claim 1, including the step of recycling the water resulting from the thickening operation and utilizing said water in the washing operations.

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