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Bartelt

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[54] **METHOD FOR CLEANING COAL**

[75] Inventor: **Dietrich Bartelt,** Essen, Germany

[73] Assignee: **Ruhrkohle Aktiengesellschaft,** Essen, Germany

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[58] **Field of Search** 209/44, 13, 19, 454, 209/457, 486

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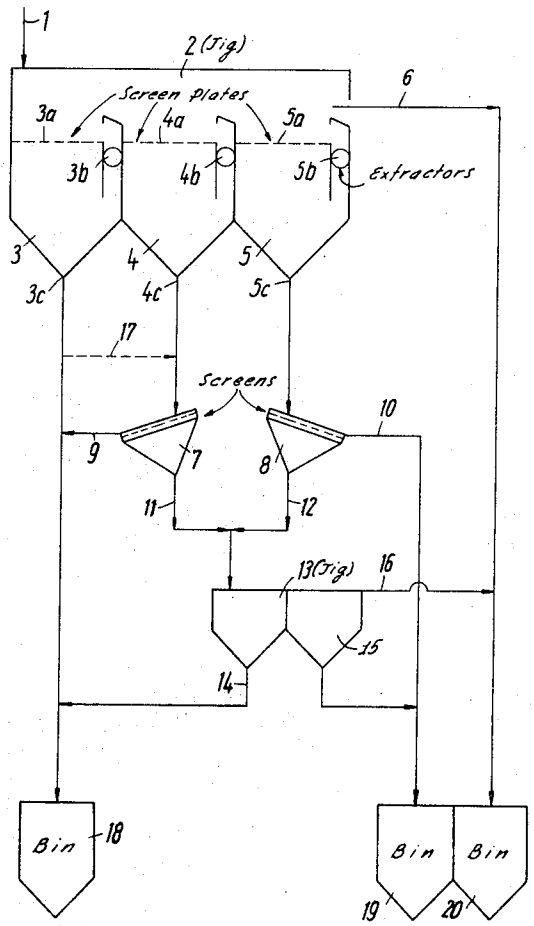
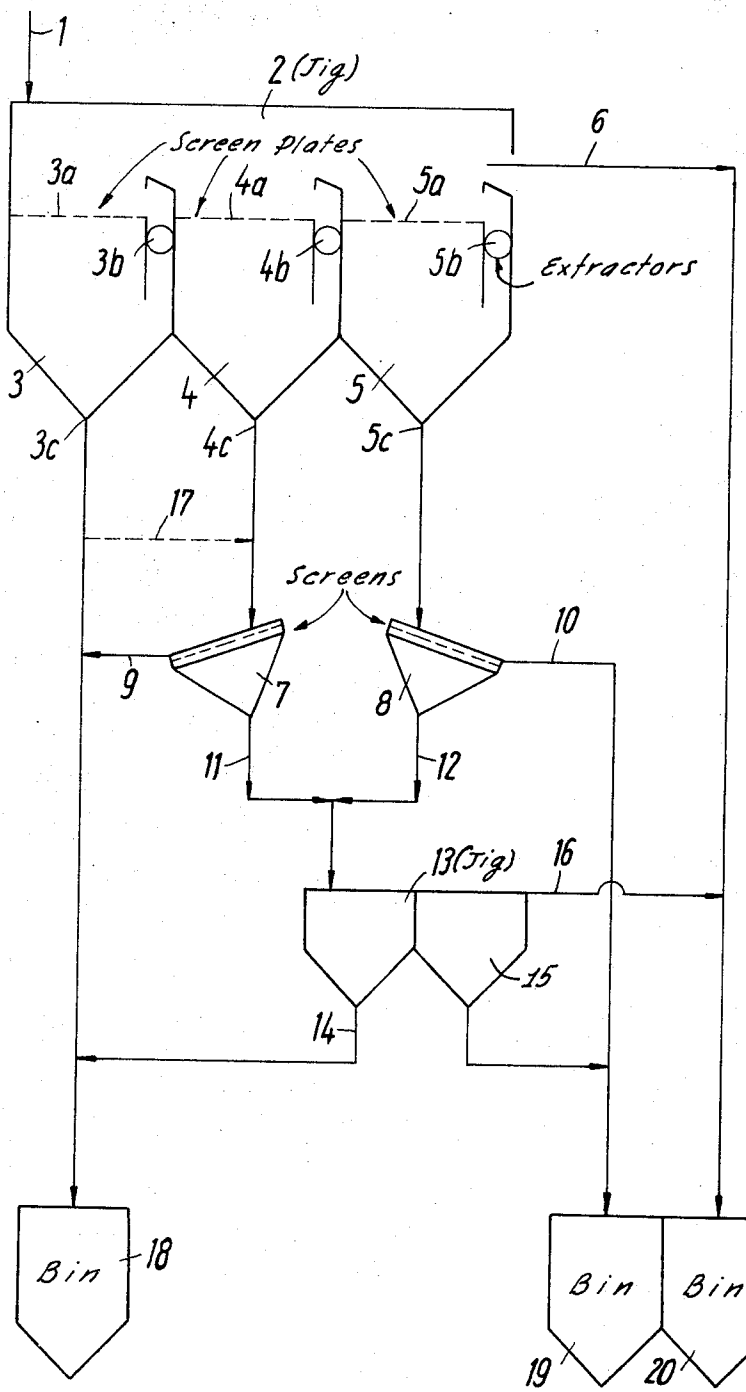
Primary Examiner—Frank W. Lutter
Assistant Examiner—Ralph J. Hill
Attorney—Smyth, Roston & Pavitt and Ralf H. Siegemund

[57] **ABSTRACT**

A cascaded washing process for coal in which after first stage jigging coarse shale is separated and the fine waste is re-washed for further fine coal-fine shale separation.

6 Claims, 1 Drawing Figure





Inventor:
Dietrich Bartelt
By Smyth, Roston & Pavitt
Alex K. Siegemund
ATTORNEYS

METHOD FOR CLEANING COAL

The present invention relates to a method for cleaning coal that is still comingled with shale etc. and is to be washed.

It is known to separate un-screened coal from shale in a jig. The grain or particle size of the raw material may cover a range of 0 (dust) to 80 mm, 0 to 150 or even up to 0 to 250 mm. Thus, coarse and fine coal as intermingled is processed together by this method, which is also known as "Baum's" jigging method. The separation process involved in this (or any other relevant) method refers to separation of the coal from the shale, resulting in at least two products accordingly. First, there is the washed coal having relatively low (specific) weight and which is being extracted from the jig through overflow. Second, there is the relatively heavy waste (shale), essentially comprised of rocks etc. and being extracted separately from the jig.

The jig includes a screen having quite small size apertures or gaps, and by adding water from below the screen, only small quantities of fine grain and dust components (coal and shale) is caused to pass the screen plate and added to the coarse, heavy weight waste. For practicing the "Baum" method alluded to above and involving combined processing of coarse and fine (unwashed) coal, the jig has to be adjusted in accordance with average grain size of all of the raw material as charged, so that jigging is not optimized for different sub-ranges of grain and particle size within the total range of particle sizes involved. As a consequence, this method has two significant disadvantages which heretofore have been deemed inevitable and, therefore, unavoidable. These disadvantages are:

a. The effective separation density increases progressively for lower grain size sub-ranges. The separation density for products within a sub-range grain size of 150 to 80 mm may be about 1.45 grams per cm^3, for a sub-range of 3 to 0.5 mm the separation density is about 1.9 grams per cm^3, due to compacting.

b. The degree of separation, i.e., the quality of the separation process for separating coal from shale is quite poor for particle sizes of the small value subranges because jigging is adapted to all (i.e., the average) grain sizes and not just to the fine grain components.

As a consequence of these disadvantages, fine, washed coal is still mixed to a considerable extent with fine grain shale.

In order to obviate the aforedescribed disadvantages, it was found more suitable to pre-screen the untreated coal so as to separate larger from smaller particles. For example, intermingled coal and shale of overall particle or grain size ranging from 0.5 to 10 mm was separated from material having particle size within the range from 10 to 150 mm. The thus separated material was processed in separate jigs. Now, as coarse and fine untreated coal is jigged separately, the separation density within each process varies over a smaller range, and degree and quality of separation is improved accordingly. The latter method, however, produces disadvantages of its own. First of all, the pre-screening and separation of the material by grain size ranges is a rather involved process. Moreover, such separation is hard on the material so that soft coal pieces of considerable size (so-called nut coal) are broken up in this process, which side effect is neither intended nor desired but more or less inevitable. Additionally, the coarse shale is still mixed to a considerable extent with fine grain material that includes coal dust too and is, therefor, to some extent combustible which renders discharge more difficult.

It is an object of the present invention to clean raw coal in a manner obviating the deficiencies outlined above, so as to increase quality of output and to improve processing capacity, whereby particularly the washed coal has a high ratio of high quality nut coal.

In accordance with the method of the present invention, it is suggested to proceed as follows: The unscreened raw coal of all particle sizes and which is still mixed with relatively heavy shale, e.g., rocks, is fed to a jig for jigging and clean coal extraction; coarse, relatively heavy waste particles are extracted separately from fine grain heavy components as the latter pass predominantly through screens. This way, an overall increase in separation density is avoided. At this point, however, the extracted waste contains in parts still significant quantities of fine coal.

Next, coarse and fine heavy waste, as discharged from the jig, is screened to remove coarse waste and the remaining fine grain material as passing through the screen is retreated, i.e., washed again, for example, in a second stage jig, for separation of fine coal from fine shale, to be extracted and used separately.

The invention avoids the disadvantages of the known methods as outlined above. As a consequence, coal and waste (rocks) as separated from each other, have respectively higher purity, i.e., the degree of separation is enhenced, and the resulting middlings are at least equivalent in quality to those resulting from the known processes. The large, size coal pieces are treated rather carefully, as throughout the separation and cleaning process they are embedded in fine grain material.

In accordance with a further refinement of the inventive method, plural product production and multi stage jigging may be used in the first washing step. Substantial portions of fine grain heavy waste are preferably extracted by some of the cascaded and staggeredly arranged screens only. Water is not to be charged into the jig from below the screens, because of the second stage washing, accommodating particularly small particles sizes. This, in turn, facilitates extraction of fine waste. Also, the total water consumption is considerably reduced. Moreover, at least one of the screens in the jig is to have relative large size apertures so that some control is exercised upon the passage rate of fine grain heavy waste, the size selection being made in dependence upon the composition of the raw product.

Even though the raw material does not have to be pre-screened through elaborate equipment, it is of considerable advantage to remove dust from the raw material by dedusting and/or de-sliming. In case the coal is sufficiently dry, dedusting suffices, if however, the raw material is too moist, de-sliming is preferred or even necessary. In either case dust and slurry is removed as either is detrimental in the jigging operation. Dust removal is not equivalent to or included in conventional separation of the coal-shale mixture by or included in conventional particle size as outlined above.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages

thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

The FIGURE shows somewhat schematically a diagram for equipment used for practicing the preferred embodiment of the inventive method.

Proceeding to the detailed description of the drawing, the un-screened coal to be washed is fed along charge path 1 to a jig 2 for jigging therein. The jig 2 has three essentially serially operating, shale discharge and extraction units for respectively providing three different output products. Jigging units which can be used here are known per se and described, for example, by Taggert in "Handbook of Mineral Dressing," pages 11–32 and 11–33 (John Wilex & Sons, Inc., New York). Furthermore, see also Steinkohlenbergbauverein Essen, second International Coal Preparation Congress, September 1954, AII8, "A Contribution toward the Improvement of the Air pulsated Jig" by Takakuwa and Matsumura. Each unit includes a hutch 3, 4 and 5 respectively. Clean coal is taken from a fourth output of jig 2 as defined by an overflow outlet 6.

A hutch 3 of the wash box is positioned closest to the inlet of the jig and collects some of the clean waste. Coarse shale enters hutch 3 via a discharge and coarse shale extractor 3*b*. Still closer to jig inlet, is a screen plate 3*a*. However, the aperture dimensions of screen plate 3*a* are relatively small, so that only small quantities of fine grain material is accumulated in hutch 3. Clean waste accumulates in hutch 3 and is extracted therefrom through a discharge 3*c* to be accumulated in storage bin 18.

The second and third waste extraction stages include hutches 4 and 5 respectively, and fine heavy waste components are extracted from jig 2 predominantly through screens plates 4*a* and 5*a*. Screens 4*a* and 5*a* have relative wide apertures so that the passage rate of the fine, heavy waste is relatively large. As water is not flushed into the hutches from below, considerable quantities of fine coal still pass screens 4*a* and 5*a*. Coarse waste is extracted by large particle extractor devices 4*b* and 5*b* for collection in hutches 4 and 5.

Fine and coarse heavy waste as extracted from the initial charge and as collected in hutches 4 and 5, are discharged therefrom via outlets 4*c* and 5*c*, respectively. As stated, clean coal is withdrawn from the jig 2 via overflow 6 path and charges a clean coal bin 20.

The shale extraction devices 3*b*, 4*b* and 5*b* are shown schematically as bucket wheel sluiceways. However, one could use other known large particle extractors, such as slide extractors or swing bed extractors. It is of particular advantage to select settling (jigging) conditions so that the layers on top of screens 4*a* and 5*a* remain relatively thin. This way, fine particles are indeed brought into close proximity to the screens proper and the fine shale will pass through the jigging screens and will not be extracted along overflow 6. A low level height of the heavy shale products on top of the screens is subject to control using isotope sensing techniques.

Now, I turn to the second principle step of this cascaded process, bearing in mind that considerable quantities of coarse shale has been removed already (bin 18) by means of jig 2. The proportional content of fine shale is thus relatively higher in hutches 4 and 5. The product as discharged from hutch 4 via outlet 4*c* is applied to a classifying screen 7. Coarse waste is separated by operation of an overflow path 9 leading also to bin 18.

The finer grain waste is permitted to pass screen 7 and is fed via path 11 to a relatively small jig 13, adapted particularly for jigging of products having small average grain size. Also, for a given total capacity of the system, the processing capacity of jig 13 can be kept considerably smaller than the corresponding capacity of jig 2. As indicated by dotted line 17, it may be of advantage to pass the output of hutch 3 also through screen 7, so that the fine waste from the first extraction stage of jig 2, and which may include some fine coal particles, is separated in jig 13 before the waste is passed to clean waste bin 18.

Jig 13 is additionally charged via path 12 with a product permitted to pass a classifying screen 8 that separates coarse waste from fine waste as jointly discharged from hutch 5 via outlet 5*c*. The coarse product is extracted from screen 8 via an overflow path 10 leading to a bin 19 for middings.

The smaller jig 13 re-sorts and washes the fine heavy product as extracted from units 4 and 5 via screens 7 and 8. A first settling hutch 14 collects fine shale to be fed also to clean shale bin 18. From the second hutch 15 medium grade products are extracted and fed to bin 19. Fine coal is extracted from jig 13 via overflow path 16 and fed to clean coal bin 20.

The re-washing or second stage jigging may be carried out in a relatively small jig 13. However, it can also be carried out in heavy liquid. Selection of separation size and grading depends upon further utilization of the final product. The bins 18, 19 and 20 represent merely final destinations of the products after their separation in accordance with the invention. All of such storage may not be needed; instead, these respective products may be passed immediately and directly into further processing equipment. This is particularly true for the washed and clean coal.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

I claim:

1. Method of cleaning coal comprising the steps of:

jigging an unscreened coal-shale mixture in a multistage jig for extraction of coal through overflow therefrom by means of cascaded jigging, including

a first jigging step wherein said shale and coal are stratified on a screen having relatively small apertures to thereby allow fine particles to pass through, and wherein coarse shale is separately extracted from the stratified coal and shale and combined with the fine particles that passed through the screen;

the cascaded jigging further including a second jigging step wherein shale and coal as overflowing during and pursuant to the first jigging step is also stratified on a screen having wider apertures than the screen used in the first jigging step, and wherein coarse shale is also separately extracted from the stratified coal and shale and combined with the fine particles that passed through the screen used in the second jigging step;

feeding the overflow from the second jigging step as containing coarse coal to a discharge path;

additionally screening at least the particles and the coarse shale as combined pursuant to the second jigging step for separation of coarse shale and middlings from fine particles to be re-washed; and

re-washing the fine particles after said additional screening to remove therefrom essentially fine coal that remained with the fine shale after the cascaded jigging.

2. Method as in claim 1, the first one of the cascaded jigging steps carried out in vicinity of the charge point of said multi-stage jig used for jigging and including relatively little fine shale screening during jigging.

3. Method as in claim 1, said cascaded jigging step preceded by a step for removal of dust from the coal to be washed.

4. Method as in claim 1, the re-washing carried out by using a jig of relatively small size as compared with the jig used for the cascaded jigging and adapted for small particle size operation.

5. Method as in claim 1, jigging and extracting including permitting unimpeded sinking of the fine shale in the jig used for the cascaded jigging.

6. Method as in claim 1, wherein the re-washing step is carried out as cascaded jigging and includes separation of middlings from fine coal and fine waste.

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