Feb. 14, 1933. B. M. BIRD 1,897,545

PROCESS OF SEPARATING COAL AND OTHER MINERALS

Filed June 10, 1931

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Patented Feb. 14, 1933 1,897,545

UNITED STATES PATENT OFFICE

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PROCESS OF SEPARATING COAL AND OTHER MINERALS

Application filed June 10, 1931. Serial No. 543,287.

My invention relates to process of separating coal and other minerals. It has to do primarily with the provision of a novel process of such a nature that separation of the minerals may be effected with a minimum amount of apparatus and in a minimum length of time. It is particularly applicable to the treatment of minerals where the components of high density are relatively infrangible.

Wet processess for effecting separation according to differences in specific gravity may be roughly divided into several broad classes. One of these classes involves the use of horizontally flowing currents of water or other fluids serving as a vehicle for conducting the material and effecting separation thereof. Another class involves the use of vertical currents of water passing upwardly through the material to bring about separation of the products.

In those processes which use horizontally flowing currents of fluid to effect separation, the material arranges itself in superimposed layers. In the main, the lower and intermediate layers or strata contain a larger proportion of the material of higher specific gravity while the upper layers mainly contain the particles of lower specific gravity. In the extreme upper layer, this separation is ordinarily complete. In the intermediate and lower layers, however, the separation according to specific gravity is usually incomplete.

Normally, the bottom layers contain coarser particles of comparatively high specific gravity. Between these coarser particles are interstices or voids which, under the normal operation with the usual type of feed become filled with finer material with an undesirably large percentage of particles of low specific gravity. In other words, these finer particles of low specific gravity move downwardly into these voids and in a measure nullify the separation according to specific gravity. Thus, in the use of sloping launders, in an effort to complete the separation of the product of highest density, it has been customary to resort to re-treatment of the product several times.

For example, in the treatment of coal by this process, the feed is delivered into the upper end of a launder at approximately the same point as the fluid and stratifies while flowing down the launder, with the denser material such as slate et cetera near the bottom of the launder and the material of less specific gravity, such as coal in the upper layers for ultimate delivery over the end of the launder. The general tendency is toward separation but the coarser particles of high specific gravity which normally stratify close to the bottom of the launder have interstices or voids between them which become filled with finer material of low specific gravity such as fine coal. Because this percentage of coal that finds its way into the interstices in the lower strata of the bed of the launder is normally quite large, it is ordinarily necessary to re-treat these lower strata several times. This is usually accomplished by withdrawing the bottom strata from the primary launder and re-treating them in one or more separate launders and in the same launder. Even these retreatment steps are often found to be not fully effective.

One of the objects of this invention is to avoid this necessity for re-treatment of the product or, at least, to reduce to a minimum any re-treating action which must be effected.

Another object of this invention is, by avoiding or minimizing the necessity for this re-treatment, to reduce the length of the process and the amount of apparatus necessary in performing such process.

Another object of this invention is to effect a more complete separation of the components of low specific gravity from the components of high specific gravity.

My invention contemplates adding to the normal feed, which is supplied in the horizontally flowing current process, a charge of material which contains a higher percentage of finer particles of high specific gravity than is found in the feed being treated. This added charge of material supplies an increased proportion of fine particles of high specific gravity which will gravitate into the interstices or voids between the coarser particles of high specific gravity adjacent the

bottom of the bed and fill these voids so as to prevent the entrance thereinto of fine particles of low specific gravity which it is desirable to crowd into the upper layers of the bed. In other words, by the introduction of this increased proportion of fine particles of high specific gravity and the subsequent passage of these fine particles of high specific gravity into the voids, the fine materials of low specific gravity are crowded into the upper layers and thus are grouped with the coarser materials of low specific gravity.

One way in which I may use my process contemplates the taking of a middling from a horizontally flowing current apparatus and delivering it to a vertical current apparatus suitable for making three products. In this vertical current apparatus, the charge delivered thereto may be separated to produce a product consisting of small particles of low specific gravity, a product consisting of coarse particles of high specific gravity, and a product consisting mainly of fine particles of high specific gravity together with any coarse particles of low specific gravity, if any are present in the product that was received by the vertical current apparatus.

The last product, that is, the product consisting mainly of fine particles of high specific gravity is then fed back into the horizontally flowing current apparatus. The preponderating quantity of fine particles of high specific gravity which make up this product will fill up the interstices or voids in the lower and intermediate strata of the bed and thus crowd the fine particles of low specific gravity up into the upper layers, thereafter making the separation of the feed according to specific gravity more complete and either rendering re-treatment unnecessary or greatly reducing the amount of re-treatment required under prior art conditions.

One type of apparatus which I may use in the performance of my process is shown diagrammatically in the accompanying drawing wherein similar characters of reference designate corresponding parts and wherein:

The figure is a perspective view diagrammatically representing the combination of a sloping launder and a vertical current classifier together with the various separating pipes and conveying units complemental thereto.

In the drawing, which illustrates the separation of coal, a launder of the sloping type is shown at 1 and is adapted to be fed with water at its upper end through the medium of a valve-controlled pipe 2. In the separation of coal, the material to be treated may be fed into this launder by a screw conveyer 3.

The trough 1 is provided in its base with suitable devices 1*a* and 1*b* for withdrawing products therefrom. A pipe is connected to each one of these devices. One such pipe, designated 4, conveys the refuse downwardly into a boot 5 from which it is delivered by means of an elevator 6 to a refuse storage pile. Another such pipe, designated 7, conveys a middling down into a boot 8 from which it may be delivered by means of an elevator 9 to a vertical current classifier 10. A third pipe 11 located at the lower end of the launder conveys the washed coal into a boot 12 from which elevator 13 delivers it to a car or other location.

The water from the elevator boots 5, 8 and 12 as well as from the other elevator boot to be subsequently described can be returned to the launder and classifier by any means used in the industry.

The vertical current classifier 10 may be of any conventional form but it is preferably of such construction as to produce three products. As shown, it comprises three compartments designated 14, 15 and 16, each equipped with perforations 17 in the screen plate and pipes 18 for delivering water upwardly thereto.

In the treatment of the middling product in the classifier, I preferably use an uprising current of water sufficiently swift to barely keep the mass of particles, with the exception of the lowermost strata in a mobile condition which is generally referred to in ore dressing or coal preparation as a condition of "teeter". This results in a substantially complete separation with the coarsest particles of highest specific gravity in the lowermost layer and with the fine particles of lowest specific gravity in the uppermost layer. In the intermediate layer, the separation according to specific gravity is incomplete but this product of the classifier is composed mainly of fine particles of high specific gravity together with such coarser particles of low specific gravity as may have been contained in the middling product delivered to the classifier.

The fine product of low specific gravity from the classifier is delivered from the compartment 14 into a pipe 19 which in turn delivers it to the boot 12. The coarse product of high specific gravity as delivered from the compartment 16 into a pipe 20 which in turn delivers it into the boot 5.

The intermediate product of the classifier being mainly composed of smaller particles of high specific gravity with such coarser particles of low specific gravity as may have been delivered with the middling charge to the classifier is delivered into a pipe 21 which in turn delivers it into boot 22. This constitutes the prepared charge. It is conducted by means of an elevator 23 upwardly to a point above the trough 1 and delivered into this trough 1 adjacent the upper end thereof through the medium of a chute 24.

It will be seen from this description that

the intermediate strata or middling from trough 1 are conducted into the vertical current classifier and there separated. Then the intermediate strata from the vertical current classifier, being composed mainly of fine particles of high specific gravity together with some larger particles of low specific gravity are delivered back into the trough 1 with the result that the fine particles of high specific gravity shortly find their way into the interstices or voids in the lower and intermediate layers of the materials therein so that, in the subsequent treating operation, the fine particles of low specific gravity are crowded upwardly into the upper layers in the trough and delivered in greater proportion to the end of the trough. Any coarser particles of low specific gravity which have entered the launder as a part of this charge from the classifier will, of course, normally flow over the end of the primary launder.

In the operation of my process by the use of the apparatus shown in the drawing, the treating operation will be started by delivering the feed to the trough 1 by means of the conveyer 3 and at the same time delivering water or other fluid to this trough through the pipe 2. At the beginning of the operation withdrawing device 1*a* will usually be closed and the refuse and middlings will be drawn out through the withdrawing device 1*b* and delivered by pipe 7 and elevator 9 to the classifier. The washed coal will pass over the end of the trough and down pipe 11 into boot 12.

The material delivered to the classifier will be treated in the manner described and the intermediate product thereof will pass into the boot 22 and be delivered by elevator 23 and chute 24 to the upper end of the trough 1. This intermediate product is mainly composed of smaller particles of high specific gravity. These smaller particles of high specific gravity will thereupon find their way into the interstices or voids in the lower and intermediate layers of the bed of material in the trough so that treatment from then on will result in the crowding of the finer particles of low specific gravity up into the upper layers in the trough.

As a bed of material of high specific gravity and relatively free from fine particles of low specific gravity forms in the launder, withdrawing device 1*a* is gradually opened and the entire system is rendered operative. In this manner, the formation of the proper bed with the desired high percentage of fine particles of high specific gravity may be obtained in a minimum length of time and may be maintained throughout the continuous operation of the apparatus.

It will be readily understood that the process is substantially identical in application to minerals where the valuable material to be saved is of higher specific gravity than the one to be rejected. Such valuable material will be recovered from draw 1*a* and from pipe 20. The middling product of the classifier containing small particles of high specific gravity to fill the voids in the bottom of the launder will serve to crowd fine gangue particles up into the upper layers and so to keep the concentrates up to grade.

It will be apparent that my process is not limited to the particular methods and apparatus shown and described. For example, the stratification of the material by substantially horizontal flow may be effected by the use of air instead of liquid or by various other means. Various types of hindered-settling classifiers or jigs may be used to prepare the charge or it may be separately prepared. The charge may also be prepared by use of a two deck screen, the top screen which is of relatively coarse mesh removing the coarse material of high specific gravity and the bottom screen, which is of relatively finer mesh, removing the fine material of low specific gravity, while the oversize of the bottom screen returns to the feed of the launder. Likewise, other devices for effecting classification may be selected.

Having thus described my invention, what I claim is:

1. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, supplying to the stream of minerals a quantity of material whose particles are of specific gravity equaling that of the lower strata of the stream and are of a size smaller than the average particle size of the minerals sufficient to substantially fill the voids in the lower strata of the mineral stream, and separating the strata thereby formed.

2. The process of separating composite minerals comprising subjecting composite minerals whose constituents of high specific gravity are infrangible relatively to those constituents of lesser specific gravity to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, supplying to the stream of minerals a quantity of material whose particles are of specific gravity equaling that of the lower strata of the stream and are of a size smaller than the average particle size of the minerals to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

3. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, supplying to the stream of minerals a quantity of material whose particles are of specific gravity equaling that of the lower strata of the stream and

are of a size smaller than the average particle size of the minerals to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

4. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, supplying to the stream of minerals a quantity of material whose particles are mainly of specific gravity higher than that of the top strata of the stream and of specific gravity lower than that of the bottom strata of the stream and are of a size smaller than the average particle size of the minerals to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

5. The process of separating composite minerals comprising subjecting said minerals with fluid to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, supplying to the stream of minerals a quantity of material whose particles are of specific gravity equaling that of the lower strata of the stream and are of a size smaller than the average particle size of the minerals to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

6. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, separating from such stratified material a material whose particles are of specific gravity equaling that of the lower strata of the stream and are of a size smaller than the average particle size of the minerals, introducing such material to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

7. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, separating from such stratified material an intermediate product whose particles are of specific gravity higher than that of the top strata of the stream and are of a size smaller than the average particle size of the minerals, introducing such material to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

8. The process of separating composite minerals comprising subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, withdrawing an intermediate portion of the said stratified material, selecting from said portion a middling containing particles of a specific gravity higher than that of the top strata of the stream and of a size smaller than the average particle size of the minerals, supplying such middling to the mineral stream to fill voids in the lower strata of the mineral stream, and separating the strata thereby formed.

9. The process of separating composite minerals which comprises subjecting said minerals to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, separating from such stratified material a product whose particles are mainly of a higher density than those of the top strata of the stream, subjecting such product to upward currents of water sufficiently swift to create in the particles of such product substantially a condition of "teeter" and removing from such product a middling product whose particles are mainly of specific gravity higher than those of the top strata of the stream and are of a size smaller than the average particle size of the lower strata of the stream, returning such middling product to the horizontal flow and then effecting stratification thereof with the stream, and separating the strata thereby formed.

10. The process of separating composite minerals comprising, first, subjecting said mineral to a substantially horizontal flow and thereby stratifying the components of said minerals according to densities, second, separating from such stratified material a product of low specific gravity and a product of high and intermediate densities, removing from the latter a material whose particles of high specific gravity are of a size smaller than the average particle size of the minerals in the lower strata of the horizontal flow, also removing therefrom a portion composed mainly of small particles of low specific gravity, third, introducing the material containing small particles of high density into the horizontal flow and stratifying it therewith and adding the separated small particles of low specific gravity to the product of low specific gravity from the horizontal flow, thereafter separating from the horizontal flow a product of low specific gravity and a product of intermediate density, removing from the latter a middling whose particles of high specific gravity are of a size smaller than the average particle size of the minerals in the lower strata of the horizontal flow and also removing a portion composed mainly of small particles of low specific gravity, introducing the material containing small particles of high density into the horizontal flow and stratifying it therewith, and mixing the small particles of low specific gravity with the particle of low specific gravity from the horizontal flow.

In testimony whereof, I hereby affix my signature.

BYRON M. BIRD.