

May 20, 1958

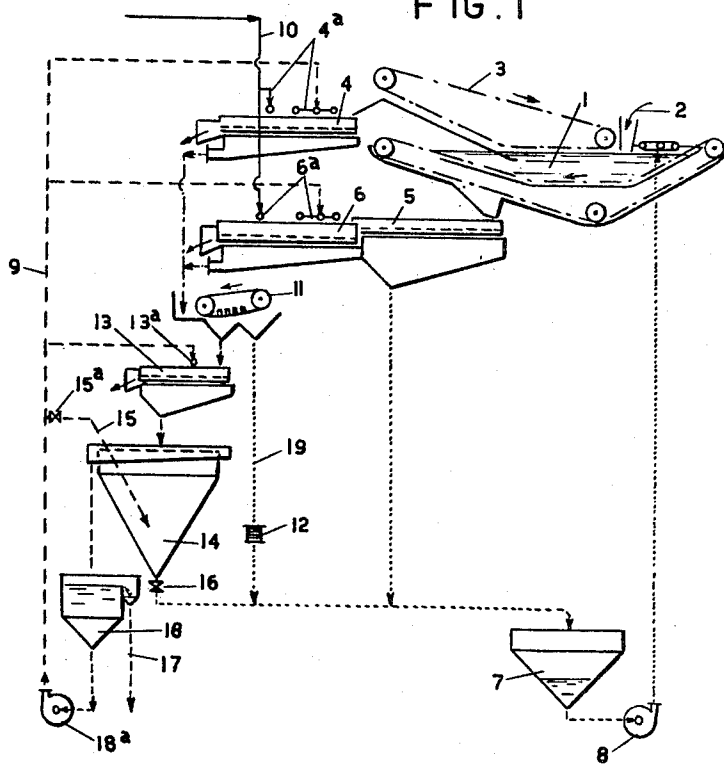
K. F. TROMP
PROCESS FOR RECOVERY AND PURIFYING OF
FINELY DIVIDED HEAVY MATERIALS

2,835,384

Filed May 11, 1954

2 Sheets-Sheet 1

FIG. 1



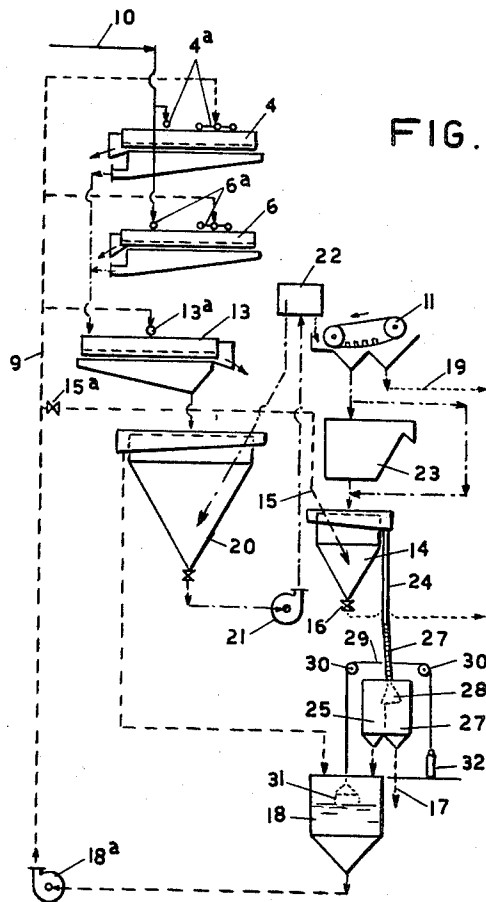
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PROCESS FOR RECOVERY AND PURIFYING OF
FINELY DIVIDED HEAVY MATERIALS

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2 Claims. (Cl. 209—12)

This invention relates to process for the recovery and purifying of finely divided heavy materials.

For the washing of coal and of minerals, suspensions of finely divided heavy materials are often used which may be magnetic or magnetisable such as for example magnetite or ferrosilicon. For the sake of convenience, these materials will be referred to hereinafter as "magnetite," and solely the washing of coal will be considered.

After having left the washing tank, the products washed by the aid of such a suspension are rinsed with water the magnetite being subsequently recuperated from this rinsing water either gravimetrically or magnetically (cf. U. S. A. Patent No. 2,139,047).

If the gravimetric recuperation of the magnetite consisted solely in thickening the rinsing water, the fine coal and rock particles having passed through the rinsing screen would return with the magnetite into the suspension of the washing tank where they would, by accumulating, produce an undesirable increase in viscosity of the said suspension. For this reason the gravimetric recuperation is effected by making the rinsing water first pass through a screen of a mesh size allowing the magnetite just to pass whereafter the suspension which has passed the screen is treated in a classifier or stream washer.

As compared with the magnetic recuperation, that one by gravimetry offers the advantage that the purification of the heavy material is effected according to the specific weight. The non-magnetisable particles of high specific weight (for example haemetite) finding themselves in the magnetite and, being suitable as a heavy material, are not lost when this process is applied. It is even more important that other heavy particles (pyrites, siderite and the like) deriving from the rocks which accompany the coal, remain in the magnetite and thus provide an economical supplement of the heavy material. On the other hand, this material recovered by gravimetry is in general less pure than that obtained by magnetic extraction. The reason is that in practice the screening should be carried out with a size of mesh larger than the maximum grain size of the ground magnetite; in the opposite case there would be losses in magnetite. Owing to this fact impurities of too large a grain size pass through the screen and are separated only imperfectly during the subsequent treatment in the classifier, and accordingly remain in the magnetite. This is illustrated by the results of analysis of the magnetite gravimetrically recuperated from coal washing plants.

Screened grain size	percent by weight	specific weight
0.15 millimetres or more	2.0	1.84
0.15 to 0.12 millimetres	4.0	1.98
0.12 to 0.088 millimetres	12.8	2.60
0.088 millimetres or less	81.2	4.06
	100.0	3.57

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When the magnetic recuperation is well conducted the magnetite recuperated has a higher specific weight. As the specific weight of the suspension recuperated increases, the viscosity of the latter in the washing tank can be reduced. In this respect it should be noted that the viscosity of a suspension of a definite specific weight is determined, admittedly, principally but not exclusively by the specific weight of the heavy material (properly stated by the mean specific weight of the mixture of heavy materials and of the impurities which have remained therein). The grain size here also plays an important part, for the finer the heavy material is, the more the viscosity of the suspension increases. The above table shows that in magnetite recuperated gravimetrically (pure magnetite being of a specific weight of 5.17) the impurities make themselves felt particularly in the largest grain sizes. Consequently the viscosity is not as high as the comparatively low specific weight of 3.57 would make expect.

Now these difficulties can be considerably reduced by means of the present invention, which consists in combining the magnetic recuperation with the gravimetric recuperation in such a manner that the magnetisable heavy material is firstly separated magnetically, the separation of the non-magnetisable materials from the remaining material being then effected in a stream washer.

The following description with reference to the accompanying drawings will help to a better understanding of the process according to the invention. In the drawings:

Figure 1 is a diagram of a plant according to the invention in which the rinsing water is directed directly towards the magnetic separator or separators,

Figure 2 is a diagram of a similar plant in which, however the rinsing water is concentrated before reaching the magnetic separator or separators.

In Figure 1 of these drawings 1 is a washing tank, built in the usual manner, in which the coal is separated into two products in a suspension of heavy materials, part of which is magnetic or magnetisable. The coal drops at 2 into the suspension. The floating product is discharged from the washing tank by the drag conveyor 3 and is rinsed with water on a screen 4. The rinsers are denoted 4a. The product which has gone to the bottom drops with the overflowing suspension onto a screen 5. The products which remain on the screen 5 arrive on a rinsing screen 6 the rinsers of which are denoted 6a. The suspension which passes through the screen 5 is collected in a reservoir 7 from where it is returned to the washing tank 1 by means of a pump 8.

The washed products are rinsed on the screens 4 and 6, firstly by means of clarified water coming from the pipe 9, and then by means of fresh water from the pipe 10, while the rinsing water traversing these screens moves towards a magnetic separator 11. When two or more separators are used the same may be mounted in parallel or in series. The heavy material recuperated by the separator or separators is directed by means of a pipe 19 into the reservoir 7, if desired after having been demagnetized by the coil 12, and the muddy water from which the magnetisable materials have been separated to the greater extent passes with the non-magnetisable fraction of the heavy materials onto a fine screen 13 provided with rinsers 13a. The suspension which passes through this screen is directed towards a classifier 14 the dimensions of which are such that solely the heavy materials of a specific weight sufficiently high are deposited there.

By opening a valve 15a in a branch pipe 15 of the pipe 9 more or less widely, the intensity of the hydraulical separation can be regulated at will. At the bottom of the classifier 14 the heavy material deposited is drawn off by a valve 16, and returned to the reservoir 7. It is advan-

tageous to drain in such a manner that the specific weight of the suspension discharged does not become lower than that of the coal. This can be done automatically, if desired, as described in the U. S. A. Patent No. 2,332,953.

The muddy water overflowing from the classifier 14 is passed to a reservoir 18 from where it is partly directed towards the screens 4, 6 and 13 by means of a pump 18a and of a pipe 9. That part of this water which overflows from the reservoir 18 is discharged by a pipe 17 in a quantity corresponding to that of the fresh water supplied by the pipe 10. The water discharged by the pipe 17 may moreover be directed into a magnetic separator if desired, in order to recuperate the traces of magnetite still present therein.

In the gravimetric recuperation of the magnetite, that is without foregoing magnetic recuperation, the intensity of the flow in the classifier should be regulated to suit the smallest grain size of the magnetite, in view of the fact that also the smallest grains should settle. Moreover, care must be taken to have a security margin on order to limit the losses in magnetite. This means that concessions in the purity i. e. in the specific weight of the heavy material have to be made. The present invention, however, affords a greater freedom of action, and allows the intensity of the flow in the classifier to be regulated completely according to the degree of purity desired for the non-magnetisable heavy materials.

In view of the fact that magnetic separators are expensive and that their collecting capacity diminishes as the volume of the liquid to be treated per unit time diminishes, it is advantageous in large plants first to increase the concentration in magnetite in the rinsing water by thickening in order to improve thus the collecting capacity of the magnetic separators. Figure 2 shows diagrammatically an embodiment of the invention allowing such thickening. For greater clarity the washing tank and the pipes through which the heavy materials returns to this tank are not indicated in this figure. The parts of the installation which correspond to those of the device according to Figure 1 are designated by the same reference numerals. Accordingly, 4 and 6 denote the screens for the rinsing of the washed product, and the rinsing water of these screens is directed onto the fine screen 13. The liquid which passes through the latter is then directed towards a thickener 20, the overflow liquid of which passes towards the reservoir 18 and is used for rinsing the products washed, as will be explained hereinafter.

The thickened heavy material is transported by a pump 21 towards the magnetic separator or separators 11, and passes on its way through a reservoir 22 arranged above the separator or separators, from where the overflow liquid returns to the bottom of the thickener 20; this allows to maintain constant the static pressure under which the liquid travels towards the separator or separators, which is desirable for a good functioning of the latter. The muddy water, from which the magnetisable heavy materials have been removed, is directed towards the classifier 14 either directly or via a flotation cell 23.

In the classifier 14 the hydraulic separation is effected between the usable (non-magnetisable) heavy materials of high specific weight (for example pyrites, siderite and the gangues) on the one hand, and the fine particles of coal and rock of low specific weight on the other hand. These heavy materials are drawn off at the bottom of the classifier 14 by means of a valve 16, and the particles of coal and rock of low specific weight are discharged with the overflow liquid in order to be partly transported towards the reservoir 18, and partly removed. This distribution of the overflow liquid can be effected in the following manner:

The overflow liquid flows off through a rigid pipe 24, a flexible hose 27 attached to this pipe, and a nozzle 28 fixed to the flexible hose. Thus, said nozzle can be swung horizontally above two boots 25 and 26 mounted side by side. The flexible hose 27 is connected to a cable 29

which passes over pulleys 30 and whose ends are fixed to a float 31 and to a counter-weight 32, respectively. The float 31 floats in the reservoir 18 on the surface of the rinsing water deriving from the thickener 20. The boot 25 opens into this reservoir and the boot 26 into the pipe 17, the liquid being thus discharged from the plant. The liquid level in the reservoir 18 should be kept constant. When it drops, the nozzle 28 which normally supplies principally the boot 26, is drawn towards the left above the boot 25, and the liquid then flows into the reservoir 18. Consequently, when the level rises again, the counter-weight 32 draws the nozzle 28 back towards the right.

It will be understood that the necessary removal of the fine particles of coal and gangue is thus effected by the muddy water, from which the valuable, magnetisable and non-magnetisable heavy materials have been separated. If the pipe 24 were allowed to dip directly into the reservoir 18 and the latter were in this case provided with a weir, the muddy water overflowing therefrom would be essentially constituted of overflow water from the thickener 20, and it would be necessary to use a very large thickener in order to prevent loss of non-magnetisable heavy materials such as magnetite, pyrites etc.

In comparison to the plant according to Figure 1 the one according to Figure 2 offers the advantage that the magnetic separator can be smaller. The saving thus attained compensates in a plant, which is not too small, for the additional expenses of the thickener 20 and of the pump 21, especially since the classifier 14 may be relatively small.

Another advantage of the plant according to Figure 2 consists in that the pipe 10 needs to supply less fresh water for maintaining the content in sludge of the rinsing water below a permissible value. This is due to the higher concentration of the muddy water drained by the pipe 17.

In certain cases the screen 13 will be placed between the magnetic separator 11 and the classifier 14. Since in that case the screen is much less heavily loaded, a smaller screen may suffice.

The present invention can also be usefully applied when it is desired to improve the efficiency of washing plants operating with suspensions of heavy materials of relatively low gravity such as limestone, sand or ground rocks from washing plants, by adding magnetite to these materials in order to increase the specific weight thereof. The rinsing water, if desired after being thickened, is then directed to a magnetic separator, whereafter it is purified by froth flotation and classification with a view to recuperating the non-magnetisable heavy material.

According to Figure 2, froth flotation in the flotation cell 23 precedes the hydraulic separation in the classifier 14. However, one could proceed in the inverse sequence.

For the plant according to Figure 1 as well as for the one according to Figure 2 the present invention offers the possibility of separating the recuperated magnetite supplied by the pipe 19, from the non-magnetisable heavy material drawn off through the valve 16. This is important when the coal is washed in two or more washing tanks, in which the separation should be carried out according to different specific weights. By mixing these materials in suitable proportions, it is possible to supply the washing tank wherein the suspension has the highest specific weight with heavy material of higher specific weight than the washing tank or tanks wherein the suspension is of lower density, so as to ensure that in none of these tanks the density is unduly increased.

What I claim is:

1. A process for recuperating and purifying high specific gravity solid particles present in the rinsing water of a washing plant for minerals such as raw coal, the washing plant operating by means of a suspension in which said high specific gravity solid particles form the dis-

continuous phase, the high specific gravity solid particles being constituted in part by magnetizable and in part by non-magnetizable materials, the process comprising the steps of magnetically separating the magnetizable high specific gravity solid particles from the rinsing water, removing particles having a size exceeding the maximum particle size of said high specific gravity solid particles from the remaining water with a fine screen, separating the non-magnetizable high specific gravity solid particles in the rinsing water hydraulically from low specific gravity solid particles still suspended therein, recycling only part of the rinsing water containing said low specific gravity solid particles, depositing the non-magnetizable high specific gravity solid particles, and returning the magnetizable and the non-magnetizable high specific gravity solid particles to the suspension of the washing plant.

2. A process as claimed in claim 1 wherein, after the magnetic recuperation the non-magnetisable high specific gravity solid particles, are purified by froth flotation.

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