Dec. 13, 1955 F. J. FONTEIN 2,726,764

HEAVY MEDIA SEPARATION PROCESS

Filed Sept. 9, 1952

2 Sheets-Sheet 1

FIG.1

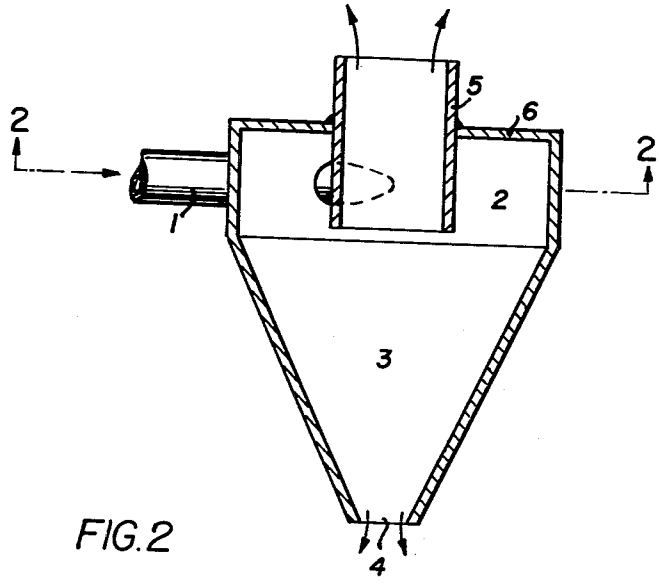
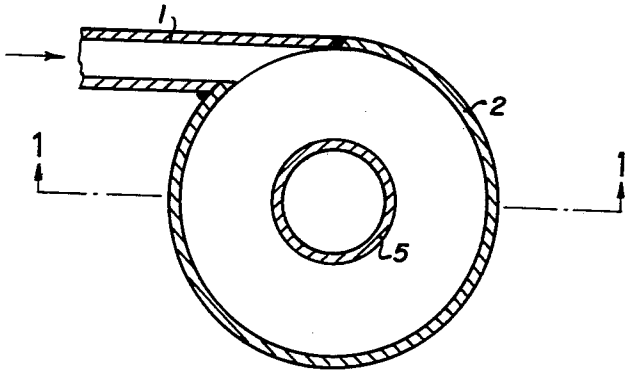


FIG.2



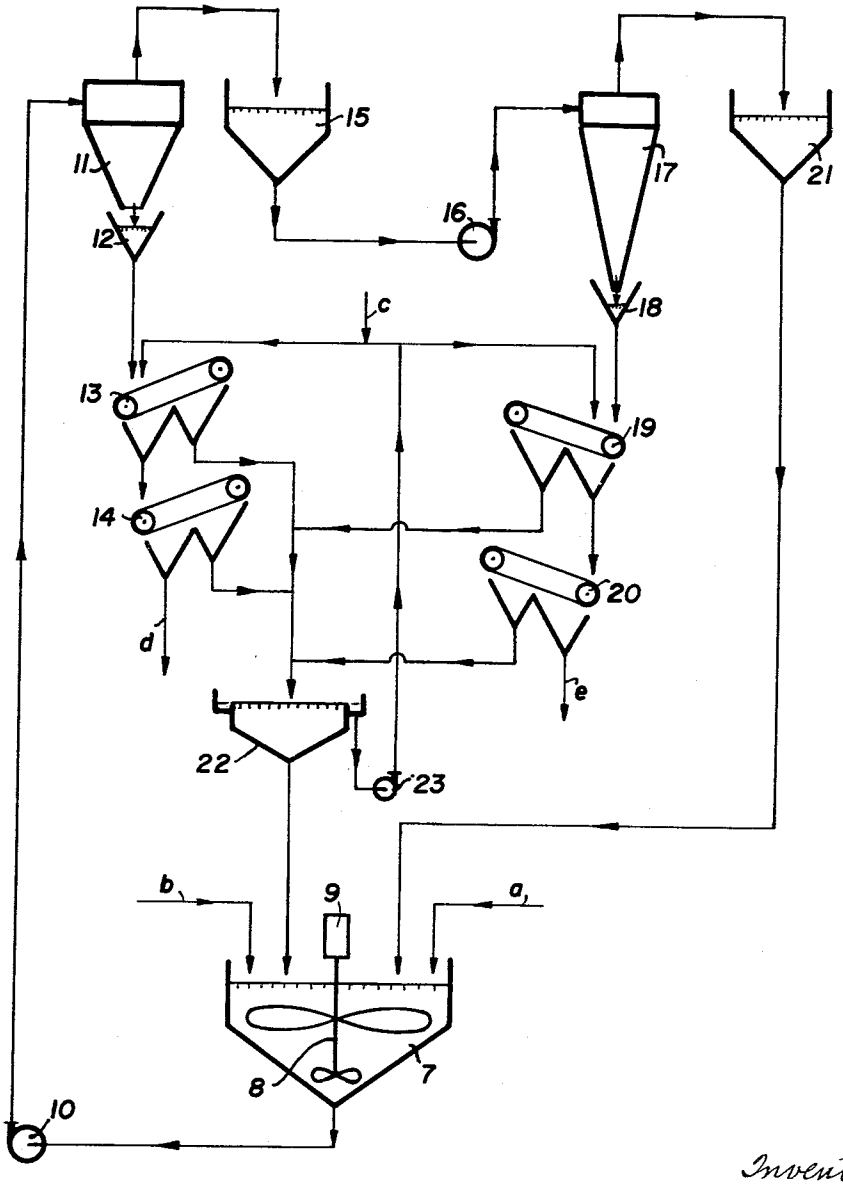
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FIG. 3



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HEAVY MEDIA SEPARATION PROCESS

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Application September 9, 1952, Serial No. 308,654

Claims priority, application Netherlands September 24, 1951

1 Claim. (Cl. 209—172.5)

This invention relates to the separation of heterogeneous mixtures of small solid particles having different specific gravities by means of a separating suspension of fine magnetic particles in a liquid. In such processes two fractions are obtained, one consisting of separating suspension—also called "heavy medium"—and the specifically light particles of the mixture and the other consisting of heavy medium and the specifically heavy particles of the mixture. In both fractions the particles of the mixtures are then separated from the heavy medium. Thus the heavy medium is recovered and can be used again.

If the particles of the mixture are larger than about 1 mm. the medium can easily be recovered by screening of the separated fractions. If the ore contains smaller particles, however, screening of those particles is not efficient since fine screening is an expensive operation. With fine solid particles therefore the magnetic particles of the medium are recovered by means of magnetic separators. That procedure also has disadvantages: magnetic separators are expensive and a small portion of the magnetic particles always gets lost therein.

Now it is the main object of this invention to provide a heavy media separation process for separating mixtures of solid particles wherein heavy medium is recovered from the separated fractions without the use of screens being necessary and wherein a substantial portion of at least one separated fraction is not passed through a magnetic separator. More in particular it is the object of this invention to provide such a process for separating ores which substantially only contain particles ranging in size down to 0.1 mm.

Since in general the best separating results are obtained when stable separating suspensions are employed it is a further object of this invention to provide a process of this kind in which use can be made of a stable suspension.

In summary, the above, and possibly other objects are attained in a process comprising the following steps. A liquid mass is formed consisting on the one hand of the mixture of solid particles to be separated, at least 95% by weight of which should be larger than 80 microns and on the other hand of a liquid separating suspension of magnetically susceptible particles, for instance magnetite or ferrosilicon particles, which for at least 85% by weight should be smaller than 60 microns and preferably fine enough to form a substantially stable suspension, said separating suspension having a significantly lower specific gravity than the particles of the mixture. This liquid mass is then separated into two fractions, one of which contains separating suspension and the bulk of the specifically heavier particles of the mixture, the other containing separating suspension and the bulk of the lighter particles of the mixture. Such a separation can for instance be effected in a jig or in a hydrocyclone of the kind described in the co-pending applcation Serial No. 228,834 filed on May 29, 1951 in the name of Fontein and Dijksman and now abandoned. The next step consists of classification of the fraction of specifically lighter particles and

separating suspension. For this purpose preferably use is made of a hydrocyclone classifier such as for instance has been described in British Patent Specification 651,094. The cut is made such that the bulk of the specifically lighter particles of 80 microns and more goes into the coarser classified fraction and that the bulk of the magnetically susceptible particles goes into the finer classified fraction. To this end the magnetically suscepticle particles are very small, and preferably the separating suspension should be substantially stable. As the separating suspension has a significantly lower specific gravity than the specifically lighter particles of the mixture these particles can settle in the suspension, which makes the classification step possible.

The finer classified fraction is returned to the process to be used for forming a liquid mass with further mixed solid particles to be separated. The coarser classified fraction is subjected to magnetic separation.

If the mixture to be separated contains particles which are smaller than 80 microns the finer classified fraction contains a large portion of those fine particles. As this fraction is recycled the fine particles tend to accumulate to a certain extent, but since the amount of fines in the mixture to be separated is only small, this accumulation substantially does not affect the process. In operation equilibrium will establish so that the amount of fines introduced into the system is the same as the amount of fines removed therefrom by the magnetic separators. Thus the measure of accumulation depends on the ratio of the volumes of the two classified fractions. If the coarser fraction has a relatively large volume there is little accumulation, but then also a relatively large portion of the separating suspension will go into the coarser classified fraction. Since it is desired to get the largest possible amount of separating suspension in the fine classified fraction a relatively high measure of accumulation of fines should be allowed, but of course the concentration of fines should not be allowed to increase too far, for instance not above 400 grams per liter. It thus will be clear that, to obtain the highest efficiency, supervision of the process may be necessary so as to attune it to possible changes of the composition of the feed.

In order that the invention may be the more readily understood, reference is hereinafter made to the accompanying diagrams, in which, by way of example, Fig. 1 represents a longitudinal section of a hydrocyclone specific gravity separator, suitable for use in the process, Fig. 2 being a section at right angles to the axis of the hydrocyclone shown in Fig. 1 and Fig. 3 is a diagram of an ore-dressing plant according to the invention.

Referring to Figs. 1 and 2 of the drawing, **1** is the feed conduit of the hydrocyclone, which conduit leads tangentially into a cylindrical part **2** of the cyclone chamber which has a smooth interior surface and comprises the said cylindrical part conjoined to a conical part **3**. The apex discharge aperture of the hydrocyclone is designated **4**, the cover-plate **6**, and **5** designates a pipe passing through the cover-plate, which pipe forms the vortex finder which extends axially into the hydrocyclone chamber and also defines the overflow aperture of the hydrocyclone.

Referring now to the plant diagrammatically represented in Fig. 3, the mixture to be separated *a*, a substantially stable magnetite suspension *b*, and recycled magnetite suspension are mixed in a vessel **7** with the help of an agitator **8** actuated by a motor **9**. The pump **10** supplies this mixture continuously from the tank **7** to a battery of hydrocyclone washers **11** connected for operation in parallel. Only one cyclone of the battery is shown. Said hydrocyclones **11** are of the type described in the aforesaid co-pending patent application 228,834 their dimensions being such as to ensure that the specific

gravity according to which the separations in these hydrocyclones are effected, will be considerably higher than the specific gravity of the stable separating suspension.

The fraction leaving the hydrocyclones **11** through the discharge apertures **4** (the apex fraction) comprises substantially all particles of the mixture to be separated with a specific gravity higher than the specific gravity of separation, and has a higher percentage content of solid matter, whereas the fraction leaving the hydrocyclones through the overflow apertures (the overflow fraction) consists mainly of particles specifically lighter than the said specific gravity of separation.

The apex fraction of the hydrocyclones **11** is collected in an open topped vessel **12**, and after being diluted with water *c* it is passed to the magnetic separators **13** and **14**, which have been so arranged in series, that the non-magnetic fraction from **13** is subjected to an after-treatment in **14**. The non-magnetic fraction *d* from the magnetic separator **14** comprises substantially all particles of the mixture to be separated having a specific gravity higher than the specific gravity of separation. Subsequently, the water may be recovered from this fraction and resupplied to the process.

The overflow fraction from the hydrocyclone **11** is collected in the open topped vessel **15** and is subsequently continuously and under pressure, by means of pump **16**, supplied to a battery of hydrocyclone classifiers **17**, connected to operate in parallel. (Only one of the hydrocyclones **17** is shown.) The dimensions of the hydrocyclone **17** are such, that the overflow fraction from the hydrocyclones **11** is separated into a concentrated apex fraction comprising substantially all the particles of the mixture to be separated which are fed into the hydrocyclones **17**, and an overflow fraction mainly consisting of separating suspension. This overflow fraction is collected in the open topped vessel **21** and is subsequently returned to vessel **7**.

The apex discharge from the hydrocyclones **17** is collected in the open topped vessel **18** and, after being diluted with water, is passed to the magnetic separators **19** and **20** which have been so arranged in series, that the non-magnetic fraction from **19** is subjected to an after-treatment in **20**. The non-magnetic fraction *e* from the magnetic separator **20** consists almost exclusively of particles of the mixture to be separated having a specific gravity lower than the specific gravity of separation. Subsequently, the water may be recovered from this fraction and resupplied to the process. The magnetic fractions from the magnetic separators **13**, **14**, **19** and **20** are thickened in a thickener **22**. The overflow fraction from the thickener **22** is returned to the magnetic separators **13** and **19** by the pump **23**, the thickened magnetite suspension being returned to the vessel **7**.

Any magnetite going to waste with the fractions *d* and *e* is made up for by supplying fresh magnetite to the vessel **7**. The concentration of the separating suspension is controlled in a known manner.

The system of Fig. 3 is particularly suited for separating mixtures of particles which substantially are larger than 80 microns and smaller than 4 mm. A washing circuit for coarser particles can of course be connected in parallel to the system of Fig. 3, and in that case it is of advantage to have a single circuit of the separating suspensions for the two washing circuits. Thus it is possible to feed diluted suspension from the washing circuit for coarser particles to thickener **22** and to use part of the clarified water from thickener **22** and separating suspension from vessel **7** in the circuit for coarser particles.

Example

An installation as shown in Fig. 3 is used for concentrating the 0.5–4 mm. fraction of a galenite ore. The specific gravity of the gangue was 2.6. The lead content was 4.02%.

For treating 26 tons per hour use was made of 15 hydrocyclone-washers **11** arranged in parallel and 12 hydrocyclone classifiers **17** likewise arranged in parallel, their dimensions being as follows:

	Hydrocyclone washers	Hydrocyclone classifiers
Internal diameter cyclindrical part 2	122 mm	122 mm.
Height cylindrical part 2	80 mm	50 mm.
Apex angle conical part 3	75°	10°.
Inside diameter feed pipe 1	24 mm	24 mm.
Inside diameter vortex finder 5	48 mm	48 mm.
Length of vortex finder 5 within the hydrocyclone	48 mm	48 mm.
Diameter apex aperture 4	24 mm	24 mm.
Feed pressure	1 at. gauge pressure.	1 at. gauge pressure.

The separating suspension consisted of magnetite (smaller than 60μ) in water. The amount and composition of the various products was approximately as follows:

	Quantity, m.³/h.	Concentration of ore, grams/liter	Lead content, percent	Specific gravity magnetite suspension
Feed to the hydrocyclone washers	134	202	3.85	2.1
Apex fraction from the hydrocyclone washers	4	1300	18.6	2.4
Overflow fraction from the hydrocyclone washers	130	167	0.17	2.095
Feed to the hydrocyclone classifiers	130	167	0.17	2.095
Apex fraction from the hydrocyclone classifiers	22	935	0.17	2.2
Overflow fraction from the hydrocyclone classifiers	108	10	0.15	2.08

Under these conditions, the feed to the hydrocyclone washers consequently contains about 169 tons of magnetite per hour, 144 tons per hour being immediately recycled together with the overflow fraction from the hydrocyclone classifiers, only 25 tons of magnetite per hour being recoverable by the magnetic separators. From this it is clear, that the invention makes it possible to reduce the quantity of magnetite requiring to be magnetically recovered and to considerably reduce the magnetite losses.

I claim:

In a process of separating according to specific gravity a mixture of solid particles which for at least 95% by weight are larger than 80 microns the combination of steps which comprises: forming a liquid mass of said mixture with a liquid separating suspension of magnetically susceptible particles which for at least 85% by weight are smaller than 60 microns, said suspension having a significantly lower specific gravity than the particles of the mixture; separating said liquid mass into two fractions one of which contains separating suspension and the bulk of the specifically heavier particles of the mixture, the other containing separating suspension and the bulk of the specifically lighter particles of the mixture; classifying the fraction of specifically lighter particles and separating suspension, making the cut such that the bulk of the magnetically susceptible particles goes into the finer classified fraction and that a major portion of the specifically lighter particles of the mixture goes into the coarser classified fraction; returning the finer classified fraction for forming a liquid mass with further mixed solid particles and subjecting the coarser classified fraction to magnetic separation.

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