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PATENTED JUNE 11, 1907.

H. E. WETHERBEE.

PROCESS OF SEPARATING OR CLASSIFYING ORES.

APPLICATION FILED OCT. 9, 1905.

2 SHEETS—SHEET 1.

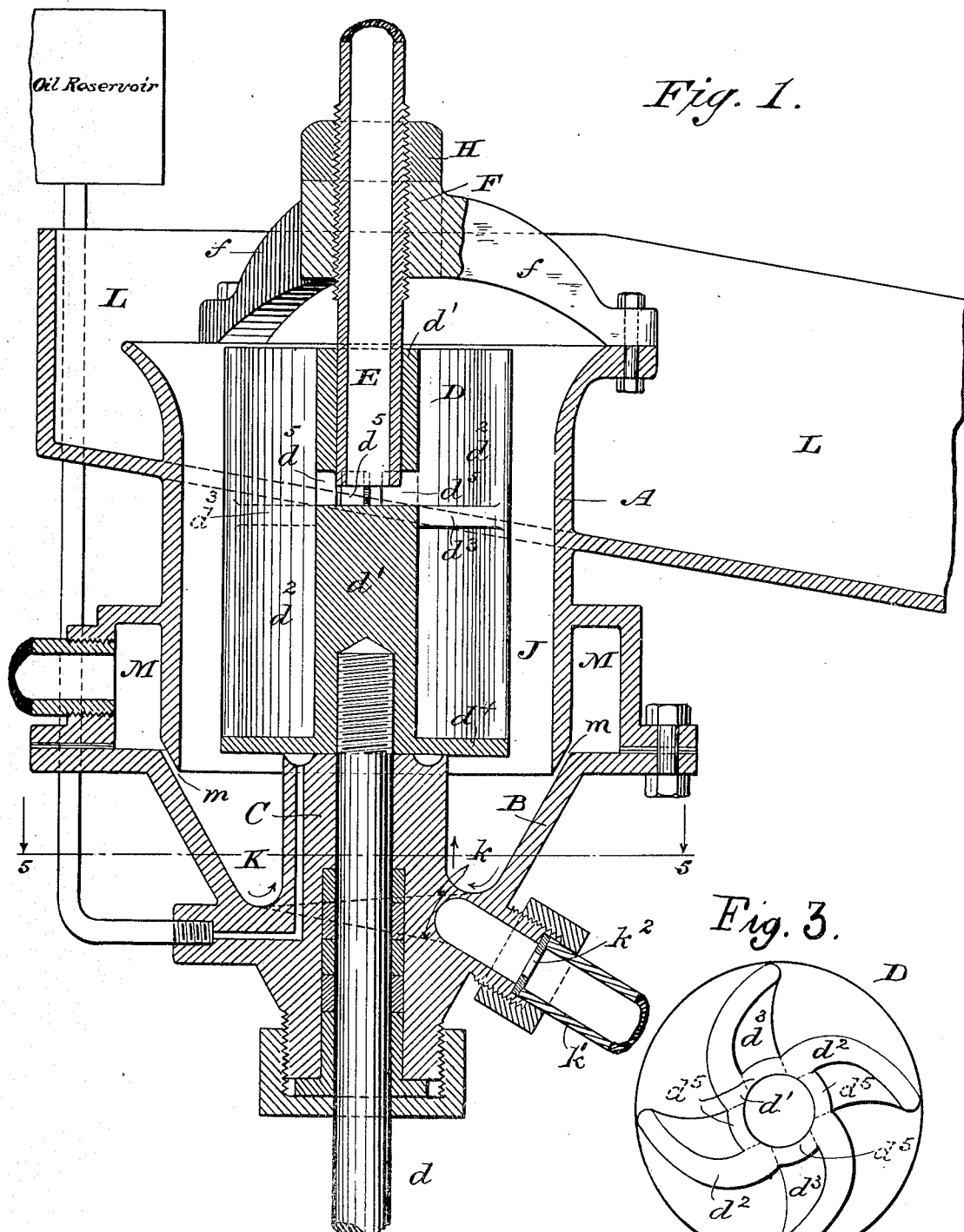


Fig. 1.

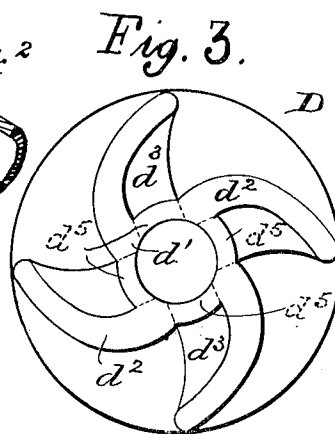


Fig. 3.

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2 SHEETS—SHEET 2.

Fig. 2.

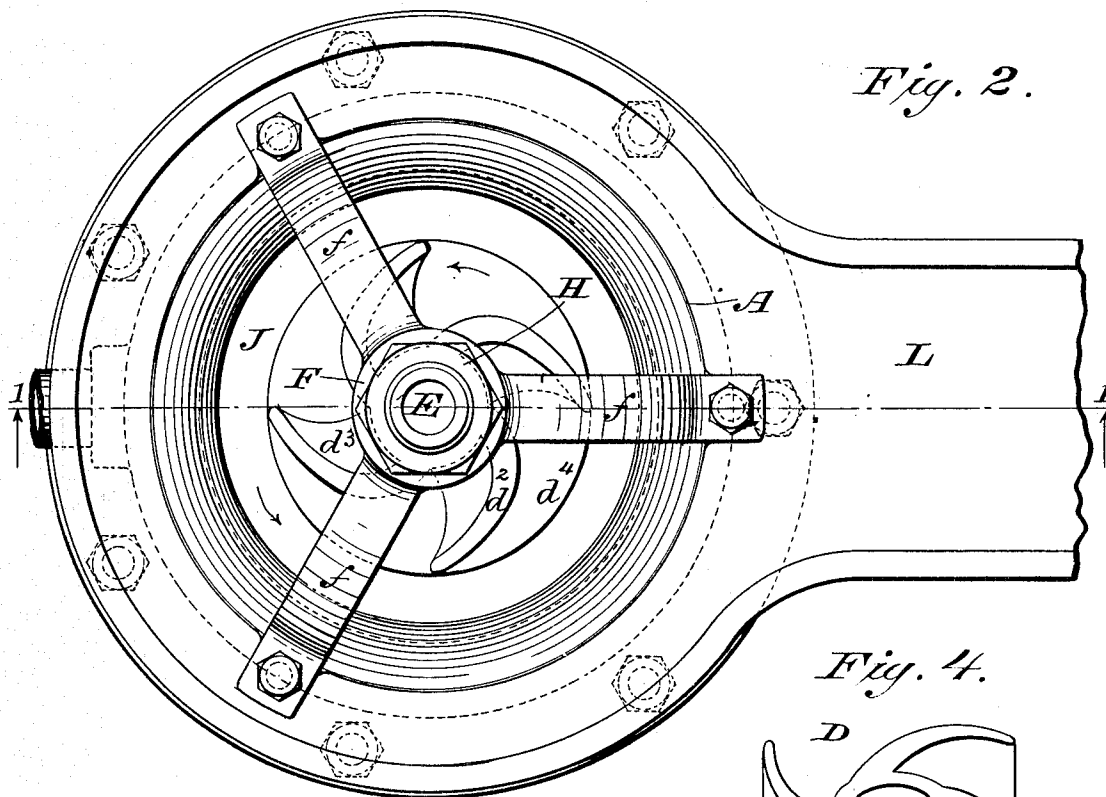


Fig. 4.

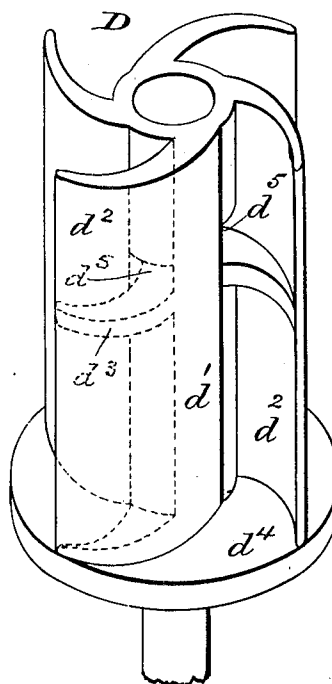
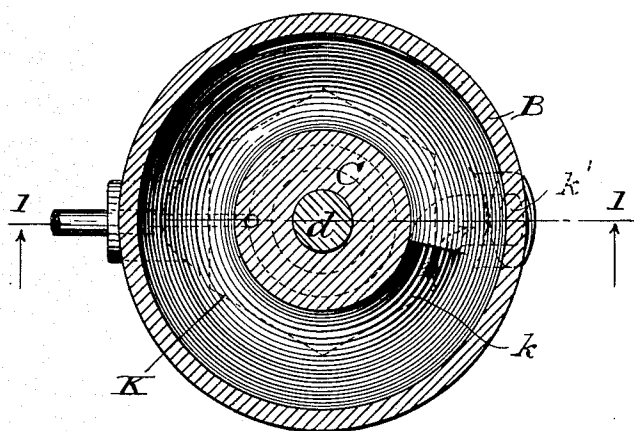


Fig. 5.



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PROCESS OF SEPARATING OR CLASSIFYING ORES.

No. 856,611.

Specification of Letters Patent.

Patented June 11, 1907.

Original application filed March 27, 1905, Serial No. 252,132. Divided and this application filed October 9, 1905. Serial No. 281,882.

To all whom it may concern:

Be it known that I, HERBERT E. WETHERBEE, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, State of Ohio, have invented a new and useful Improvement in Processes of Separating or Classifying Ores, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle so as to distinguish it from other inventions.

My invention relates to methods of separating or classifying ores, and particularly to methods of separating or classifying a mixture of ores of different specific gravities into the constituent ores.

My improved process has as its object the more thorough and economical separation of such ores.

Said invention consists of steps hereinafter fully described and specifically set forth in the claims.

The annexed drawings and the following description set forth in detail one mode of carrying out the invention, such disclosed mode constituting but one of various ways in which the principle of the invention may be used.

In said annexed drawings:—Figure 1 represents a central vertical section of one form of apparatus designed to carry out my improved process; Fig. 2 represents a plan view of the same; Fig. 3 represents a plan view of a central revoluble member; Fig. 4 represents a perspective view of the latter; and Fig. 5 represents a horizontal section taken upon the plane indicated by the lines 5—5, Fig. 1.

The subject-matter of this application has been divided out of my prior application for United States Letters Patent for an improvement in methods of separating or classifying ores and means for use in same, filed March 27, 1905, Serial No. 252,132 and continued in application filed March 25, 1907, Serial No. 364,283.

My improved method of separating a mixture of ores into constituent ores may be char-

acterized broadly as consisting in subjecting the mixed ore to the action of a rotary current of liquid of such a strength that the lighter ore particles are just kept in suspension thereby while the heavier particles are allowed to gradually settle through the liquid under the influence of the force of gravity. Simultaneously with the subjection of the ore to the action of such rotary current it is subjected to the action of an upwardly flowing current of a strength sufficient to wash out the lighter particles thus held in suspension, which upwardly flowing current, however, is not strong enough to prevent the settling of the heavier particles.

Having thus indicated in a general way the character of the operation I shall now proceed with a more detailed description of one approved way of carrying out the same. In such description reference will be had to the specific form of apparatus illustrated in the several figures of the drawings. Having regard, then, to such figures, A will be seen to designate an open-topped casing preferably of the cylindrical form shown, secured to the lower end of said casing is a bottom member B of inverted conical shape that is centrally provided with a large upwardly extending boss C. Upon the bearing surface furnished by this boss is revolubly mounted an inner revoluble member D. The revoluble member D and cylindrical boss C together form an annular space the upper portion J of which is elongated and intermediate of the casing A and said revoluble member. This portion J of said space I shall designate by the term "sorting column," the latter comprising the space in which the sorting of the ore is effected and, as will hereinafter appear, forms a conduit for upwardly flowing liquid. That portion of said space intermediate of the boss C and the conical bottom B I shall designate by the term "settling chamber." The latter comprises that portion of the annular space into which the sorted material settles and from which it is removed. The revoluble member D is connected to a suitable driving spindle *d* through which rotation is given to

it from any suitable driving mechanism, preferably a worm gear upon the spindle and a worm-wheel (not shown). The driving spindle d is journaled in the boss C and a suitable stuffing-box, gland and nut are provided, as indicated in Fig. 1.

The member D comprises a central cylindrical element d' , the upper part of which is hollow and the lower part solid, Fig. 1; a plurality of vertical curved wings or arms d^2 , four as shown, an equal number of horizontal curved distributing shelves d^3 , one of the latter being located between each two contiguous wings; and a lower bearing flange d^4 . The upper hollow portion of the central element d' receives a feed-pipe E which is held centered by means of a spider F having three arms f suitably secured to the casing A. The feed-pipe E is threaded into the spider F and is secured therein by means of a suitable jam-nut H, so that the pipe can be raised or lowered. The upper hollow part of the cylindrical element d' is provided with outlets d^5 , the lower extremities of which are flush with the top surfaces of the distributing shelves d^3 , as plainly shown in Fig. 1. The size of the open portions of such side outlets d^5 is controlled by the height at which the feed-pipe E is maintained. From a suitable source water is supplied to a pressure chamber M and is thence fed through an annular inlet m into a chamber K formed between the wall of the bottom-portion B and the boss C, and lying immediately below the chamber J.

As plainly shown in Fig. 5, the floor k of the chamber K is formed into a helical-shaped sluice-way around the boss C. A suitable discharge pipe from the chamber K is designated at k' and the rate of discharge therethrough is controlled by the insertion therein of a diaphragm k^2 of any desired size. The lower end of the sluice-way k terminates some distance short of the central vertical plane of the discharge pipe k' and the inner end of the latter is bent so as to connect with said sluice-way, as plainly shown in Fig. 5. A suitable oil-feed, Fig. 1, is provided for lubricating the bearing surface between the flange d^4 of the member D and the boss C. A receptacle or launder L is provided for receiving the lighter ore which is separated out from the mixture.

In the utilization of the apparatus just described, for the carrying out of my improved process, the inner revoluble member D is driven at the proper speed, which depends upon the character of the material being treated, as will hereinafter appear. While such member D is thus more or less rapidly rotated, the ores to be separated are fed into the central element d' of the member through the feed-pipe E, the height of which controls the size of the open portions of apertures d^5 ,

and simultaneously with such feeding of the material a stream of water is admitted into the lower portion of the casing A from pressure chamber M. This water initially follows the course indicated by the arrows in Fig. 1, being deflected, as it ascends, laterally of member D into the annular space formed between the latter and the wall of the casing, and finally escaping over the top of such casing into the launder L. To this ascending annular column of water the blades d^2 of rotating member D impart a corresponding motion of rotation so that the water does not flow in a direct but in a helical upward course. The rotation of member D, in addition to imparting the above described rotary motion to the stream of water, also serves at the same time to centrifugally discharge the material, as it emerges through apertures d^5 , horizontally into the ascending stream of water that fills the aforesaid annular space intermediate of said member and casing.

As was stated preliminarily in the general description of my process, the heavier ore particles upon which the force of gravity acts more strongly than the power of the rotating current to keep the same in suspension, gradually settle through the water to the bottom of the casing where they are removed through discharge pipe K. The rate of discharge through the outlet thus provided is of course regulated by the insertion of a diaphragm k^2 of proper size or by such other means as might suggest themselves as being suitable for this purpose. The water that is prevented from escaping through said outlet necessarily must travel the upward helical course around member D. Now the water that is admitted through annular inlet m from pressure chamber M is admitted at just such a pressure as is sufficient to enable that part thereof which flows through the annular space between said member D and the casing to wash out the lighter ore particles that are kept in suspension by the rotation imparted to the upwardly ascending stream. Such lighter particles, being swept by the water over the upper edge of the casing and into launder L, it will be seen are thus separated from the heavier particles. It will be noted that the rate of rotation of the member D, the rates of flow of water through inlet opening m and helical sluice-way k to discharge pipe k^2 , and the consequent rate of upward flow around member D, can all be kept under constant control and regulated as desired; so that, if upon examination of the resultant products being discharged at the bottom and top of the device, the separation is found to be unsatisfactory, the error can be continuously corrected until the ore of desired weight or kind is obtained. In this

manner a continuous flow of part of the water is allowed in an upward direction and simultaneously a continuous flow of another part in a second direction. By combining the effects of these two currents with the effect of the rotary member, a rapidly rotating annular column of water having a general upward flow is produced throughout substantially the whole length of casing A, while below such column is a relatively quiescent body of water in what may be termed the settling chamber. In view of the action of the annular column of water, the corresponding portion of the device may be termed a sorting column. Obviously the plane of demarcation between the settling chamber and sorting column will approximately coincide with that of the lower edge of rotating member D.

It need scarcely be remarked that the words separation and separator, as employed herein, are used in their ordinary or general significance. Technically speaking my invention may be used either as a "separator" or as a "classifier." In using, for example, that form of my invention just illustrated and described as a separator the material fed into the machine would have been previously sized by screens. The result of the operation in this case is the segregation of particles having different specific gravities as will be evident. In using the machine as a classifier, the material is fed thereto without being screened and the two segregated products will respectively comprise particles having equal settling capacities under free settling conditions. It is of course understood that if in the handling of any particular material such substitution should be found desirable, other liquids than water may be used in the machine.

The actual separation of the ore takes place in the column and, it would appear, upon the inner surface of the casing which serves momentarily to retard the material as it is centrifugally projected outward from the revoluble member, and thus to cause the rotating water to select and carry upward the lighter particles of such material. It is immaterial whether the movement of the particles thus retarded be regarded as a function of the rotation of the current or directly of revoluble member D. In conclusion the following distinction is to be noted between my method of separation and that illustrated under ordinary free settling conditions, such as are found, for example, in the several types of classifiers at present on the market, namely that the ratios of the settling powers, or capacities, of the respective classes of ore particles are widely different. Under ordinary free settling conditions, by way of illustration, two particles

of unlike specific gravities but of about the same size will in a given length of time each fall a given distance, such distance representing the velocity of a rising current that will just lift them. In order to separate these particles in an ordinary classifier the velocity of the rising current must be between the respective limits of fall assumed above to have been attained by such particles. By my method of separation the two particles can be subjected to a force, that of the rotary current, which can be so regulated as to practically retain the lighter of the two particles in suspension, while the heavier particle settles a certain assumed distance. In order now to separate these particles the slightest upward flow of current will suffice, since it will wash out the suspended particle while reducing only very slightly the rate of descent of the other particle. Regulation of the velocity of the rising current is consequently here to be had from zero to a very small current, whereas under the conditions first described such regulation must needs be between a fast and faster current. This result is a very important one when it is considered that the transporting power of the current, or the weight of the largest particle that it can carry, varies as the sixth power of the velocity. A much greater nicety of regulation is hence to be had by my method, and the economical separation of ores in this manner made possible that have never heretofore been successfully dressed in the manner contemplated.

Having thus described my invention, that which I particularly point out and distinctly claim is:

1. The process of separating or classifying ores which consists in forming a rapidly rotating annular column of water; subjecting the same to pressure from below, whereby an upward helical flow is produced; centrifugally projecting the ore into said column of water; and momentarily retarding the ore at the external surface of the column, thus causing the rotating water to select and carry upward the lighter ore particles.

2. The process of separating or classifying ores which consists in forming a rapidly rotating annular column of water; subjecting the same to hydrostatic pressure from below, whereby an upward helical flow is produced; centrifugally projecting the ore into said column of water intermediate of its length and at substantially the same speed of rotation; and momentarily retarding the ore at the external surface of the column, thus causing the rotating water to select and carry upward the lighter ore particles.

3. The process of separating or classifying ores which consists in forming a rapidly ro-

tating annular column of water; subjecting
the same to hydrostatic pressure from below,
whereby an upward helical flow is produced;
centrifugally projecting the ore into said
5 column of water intermediate of its length
and at substantially the same speed of ro-
tation; momentarily retarding the ore at the
external surface of the column, thus causing
the rotating water to select and carry up-

ward out of the ring the particles of the 10
lighter class; and removing the particles
which sink against the upward flow.

Signed by me, this 20th day of Sept., 1905.

HERBERT E. WETHERBEE.

Attested by—

D. T. DAVIES,

JNO. F. OBERLIN.