June 1, 1954 I. S. THYLE 2,679,982

ATTRITION MACHINE

Filed Jan. 31, 1952

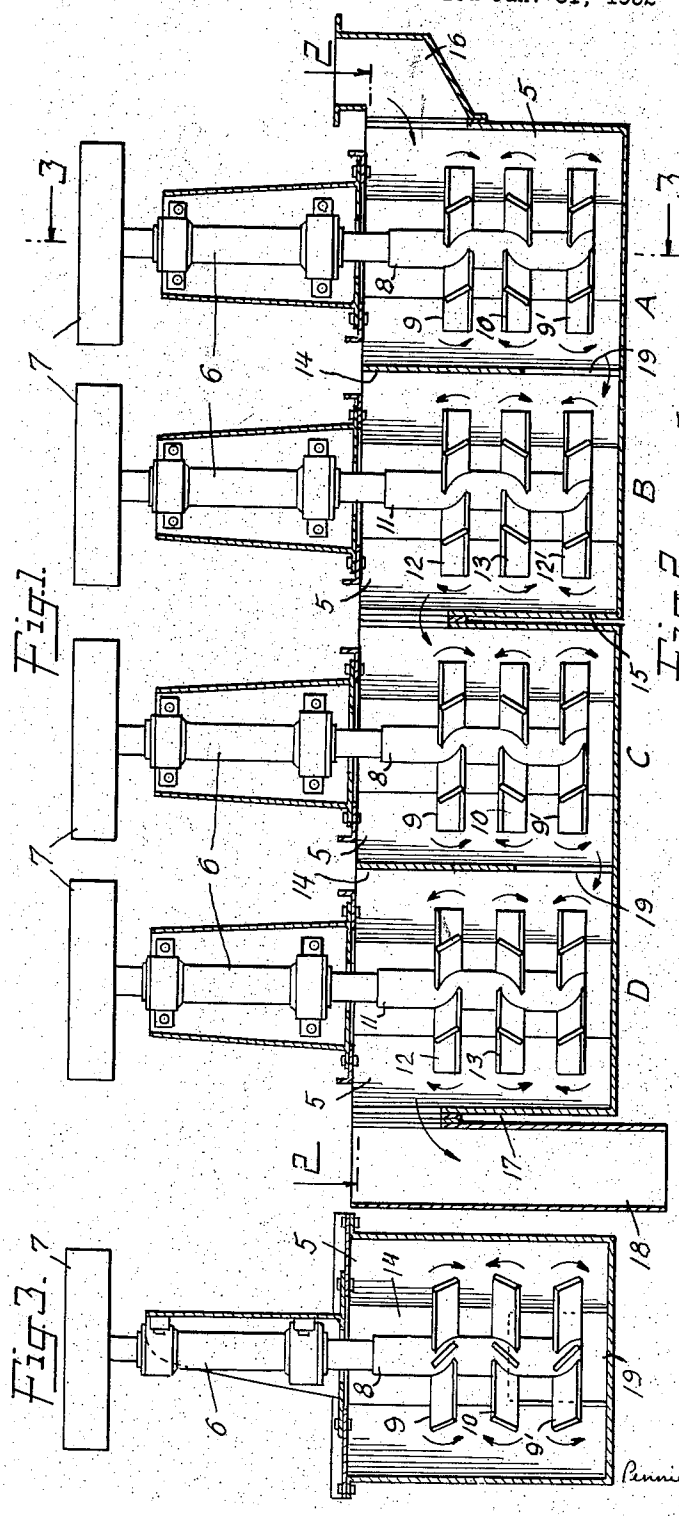


Fig. 1.

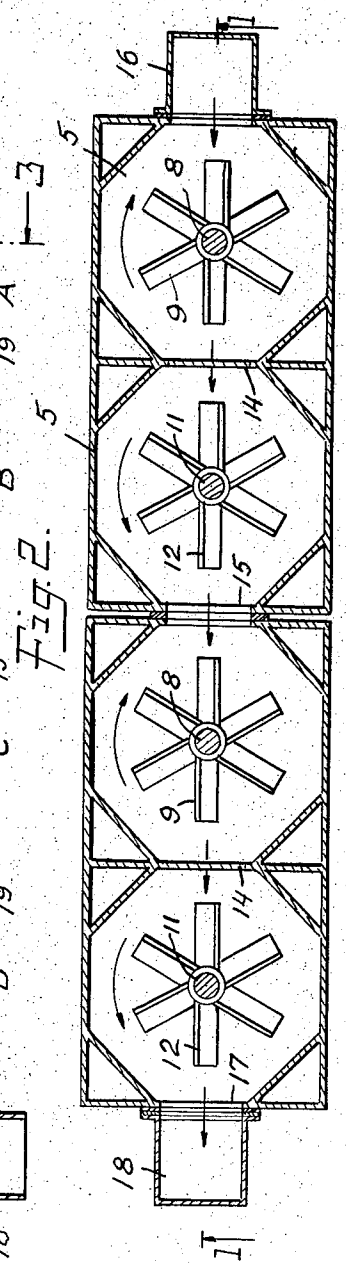


Fig. 2.

Fig. 3.

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Patented June 1, 1954

2,679,982

UNITED STATES PATENT OFFICE

2,679,982

ATTRITION MACHINE

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Application January 31, 1952, Serial No. 269,243

3 Claims. (Cl. 241—46)

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This invention relates to attrition or mineral-scouring machines, and has for its object the provision of an improved machine of that character.

The general purpose of the attrition machine is to scour, clean or polish mineral particles by means of the attrition of one mineral particle upon another in a mass action of the mineral particles at high density. The effect of the attrition action is generally to present a fresh surface or to remove detrimental stains or coatings that might interfere with the contemplated use or subsequent treatment of the minerals in industry. Heretofore, where the beneficial effects of attrition have been recognized, it has been customary to scour or clean the mineral particles in such conventional equipment as log washers, cylindrical scrubbers, tumbling barrels, roller type mulling machines and simple propellers mounted in a tank. Such equipment, however, being primarily intended for other purposes, is neither efficient nor economical for the scouring or cleaning of mineral particles.

The attrition machine of the invention is highly efficient and commercially economical for the scouring or cleaning of a wide variety of mineral particles preparatory to industrial use. For example, in the glass-making industry, very minute amounts of iron stain on the sand used in the industry are highly detrimental, and the attrition machine of the invention is particularly useful in removing such iron stains. The machine is also useful for removing clay from sand that is to be used in making concrete, and to break up and slime small amounts of soft shale that otherwise would decompose within the concrete when incorporated therein. Another wide field of use for the attrition machine is in preparing fresh surfaces on mineral particles preparatory to subsequent treatment, such for example as in the froth flotation process and in other ore dressing treatments. The minerals may be finely ground ores of iron, lead, zinc, copper, manganese and other metals, potash and phosphate ores, ilmenite sands, coal slush or fines, and any other mineral matter where freshly prepared surfaces are beneficial in subsequent ore dressing or other treatment.

In its preferred form, the attrition machine of the invention comprises a two-compartment or two-unit tank separated by a partition terminating short of the bottoms of the compartments, and providing communication between the compartments below the lower edge of the partition. Feed to be treated is introduced near

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the top of the first compartment, and treated feed is discharged near the top of the second compartment. A rotatable shaft is operatively positioned within each compartment, and means are provided for rotating the shafts in opposite directions. At least three sets of impeller blades are secured to each shaft in vertically spaced relation with the correspondingly positioned impeller blades in the two compartments arranged to impel liquid flow within the compartments in relatively opposite directions. Thus, with three sets of vertically spaced impeller blades secured to each shaft, the impeller blades of the top and bottom sets in the first compartment are preferably arranged to impel liquid flow downwardly and the impeller blades of the top and bottom sets in the second compartment are arranged to impel liquid flow upwardly, and the middle set of impeller blades in each compartment is arranged to impel liquid flow in the direction opposite to that of the adjacent sets of impeller blades.

A characteristic feature of the invention is the cross-sectional configuration of the compartments, which is polygonal and preferably octagonal. Throughout this specification and the appended claims polygonal is to be understood as a closed figure bounded by more than four straight lines. The combination of the polygonal shaped compartment and the multiplicity of opposed impellers produces a characteristic pattern of turbulence that induces and sets up a most effective attrition action between the contacting mineral particles. While the optimum advantages of the invention are attained with the preferred two-compartment machine, a single compartment machine is satisfactory for many purposes where a short detention period will effect the desired degree of attrition. On the other hand, for many purposes, where a longer detention period is required, two or more of the two-compartment machines may be operatively connected in series.

The foregoing and other novel features of the invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 is a longitudinal sectional elevation of the attrition machine of the invention having four compartments or units.

Fig. 2 is a horizontal section of the machine on the section line 2—2 of Fig. 1, and

Fig. 3 is a transverse section of the machine on the section line 3—3 of Fig. 1.

The machine illustrated in the drawings is

made up of four individual compartments or units operatively connected in series. While it is possible to attain many of the machine's advantageous operating features in a single unit, it is generally preferable to combine two units in a cooperative pair, and as many such pairs of units as desired may be incorporated in the complete machine. The drawings illustrate a machine having two pairs of units. In the first unit of each pair the mineral pulp flow is downward and the circulation within the compartment is clockwise, while in the second unit of each pair the pulp flow is upward and the circulation within the compartment is counter-clockwise.

Each compartment or unit of the machine illustrated comprises a tank or container 5 of octagonal cross section, and a rotating impeller. The several units of the machine may conveniently be built into a unitary structure of wood, metal or the like. The impellers are carried by bearing stands 6, rigidly secured to the tank structure 5, and are rotated by any suitable means such as belt-driven pulleys 7.

Each impeller comprises a depending shaft and a plurality of sets of oppositely directed blades. Thus, the shaft 8 of the first unit A is provided with three sets of blades 9, 10 and 9'. The top and bottom sets of blades 9 and 9' are arranged to impart a downward impulse to the mineral pulp in the unit, while the middle blades 10 impart an upward impulse to the pulp. The shaft 11 of the second unit B is provided with three sets of blades 12, 13 and 12'. The top and bottom sets of blades 12 and 12' are arranged to impart an upward impulse to the pulp in this unit, while the middle blades 13 impart a downward impulse to the pulp. The shafts 8 and 11 rotate in opposite directions. The second pair of units C and D is similarly constructed and corresponding parts are designated by the same reference characters.

A depending baffle or partition 14, terminating at about the level of the middle blades, separates the two units of each pair. The two pairs of units are separated by a dividing wall or partition 15, extending from the bottom of the tank to approximate the top of the upper blades. Feed is admitted to the machine through a feed box 16 near the top of the end wall of the first unit A. The scoured or cleaned feed overflows a baffle 17, extending from the bottom of the last unit D to approximate the top of the upper blades, and is discharged into a box or chute 18.

The direction of rotation of the shaft 8 (e. g. clockwise) coincides with the arrangement of the top blades 9 and the incoming feed (from box 16) is initially directed downward. The downwardly directed feed is met by upwardly directed pulp from the middle blades 10. The bottom blades 9' direct the pulp downwardly, and the pulp flows beneath the partition 14 into unit B. The shaft 11 of unit B rotates counter-clockwise, and the bottom and top blades 12' and 12 impart a lifting action to the pulp, while the middle blades 13 impel the pulp downward. The initially scoured pulp overflows the partition 15 into the top of unit C of the second pair, where the scouring action is continued. From unit D, the finally scoured pulp overflows the baffle 17 into the discharge chute 18. As many pairs of units as desired may be thus operatively connected in series.

There are continuous opposing liquid flow currents within each compartment. From compartment to compartment the pulp flow is alternately upward and downward, so that any short-circuiting is avoided. The combination of the opposing directional impellers within each compartment and the opposing directional rotation in subsequent, i. e. adjacent, compartments provides an extremely high degree of attrition or scouring of one particle upon another at a high density of solids. The percentage of solids in the mineral pulp should be at least 70% for effective operation, and preferably is between 75 and 85%. As attrition proceeds, particularly in the cleaning of mineral particles, fines and slime particles accumulate in the pulp, and this tends to slow down the rate of flow of the pulp through the machine. Where this tendency objectionably lowers the rate of pulp flow, the addition of water will increase the rate of pulp flow.

As a result of the octagonal shape of the compartment's vertical walls and the reversed circulation within the compartment, a characteristic swirling turbulence is imparted to the pulp in the compartment. The pattern of this swirling turbulence throws the mineral particles into attrition contact with one another so effectively and so often that the surface of each particle is very efficiently and economically cleaned and scoured. The machine is adapted to treat mineral particles of a wide range of size, for example from coarse particles of about ¼ inch in size to fine particles of around 325 mesh standard Tyler screen. One of the novel features of the machine is its ability to keep in continuous motion and in active attrition coarse mineral particle of a size of around ¼ inch. A further novel feature of the machine is its ability to maintain effective attrition action at a high density or percentage of solids. This feature is conducive to the greatest economy of space, since the water or other liquid of the mineral pulp then occupies the minimum volume within the machine.

The high intensity of attrition results from the polygonal configuration of the compartments, the counter-flow of the mineral pulp within each compartment, and the continuity of reversed counter-flow in subsequent compartments connected in continuous flow relation. The mineral particles at high pulp density are fed continuously to and discharged continuously from the machine. The detention period within the machine is determined by the time required to accomplish the degree of cleaning, scouring or polishing necessary to meet the specifications of the treatment following attrition. The detention period for a given flow rate or tonnage of mineral particles is determined by the pulp volume capacity of the individual compartments and the number of compartments in the series.

The polygonal, and especially the octagonal, shape of the compartment assures continuous circulation and turbulence of the mineral pulp with no dead pockets or localized quiescent areas. Moreover, such configuration is conducive to a swirling turbulence of the entire mass of pulp within the compartment with the result that the individual particles are continuously in repeated contact with one another. The octagonal shape also inherently results in a restriction in width of the communicating opening 19 between the two compartments of each pair that further inhibits short circuiting in the region of the pulp discharge from the first to the second compartment of the pair.

The operating advantages of the attrition machine of the invention are illustrated in the following examples:

1. A glass-making sand, contaminated with iron oxide (Fe_2O_3) and other heavy minerals, was treated by froth flotation using conventional agitating and conditioning equipment ahead of flotation for cleaning and scouring the mineral particles, with the following results:

Recovery of glass-making sand, 80.0%
Percent of Fe_2O_3 in the recovered sand, 0.06%

2. The same glass-making sand was cleaned and scoured in the attrition machine of the invention. The machine had six compartments. Each compartment was of octagonal cross-section, 2 feet square and 2½ feet deep. The feed density was 75–80% solids, and the rate of feed was 8 tons per hour. Following attrition, the scoured sand was given the same froth flotation treatment as in the first example, with the following results:

Recovery of glass-making sand, 95.0%
Percent of Fe_2O_3 in the recovered sand, 0.055%

A much higher recovery of glass-making sand was thus obtained, with a lower iron oxide content and hence of superior grade. Additionally, the iron oxide and heavy minerals removed from the sand were in a higher concentration, making a more economical product for the separation of the heavy minerals such as monazite, zircon and uranium.

3. A tungsten tailing, exposed to weather for a long period of time, was subjected to froth flotation without preliminary treatment. 22% of the tungsten mineral was recovered, and the grade of the concentrate was 18% WO_3.

4. The same tungsten tailing was treated in the attrition machine of the invention, and was then subjected to the same froth flotation treatment as in the preceding example. 68% of the tungsten mineral was recovered, and the grade of the concentrate was 27% WO_3.

5. A gold-silver tailing when subjected to froth flotation, without preliminary treatment, showed a recovery of 20% of the gold-silver values. This same tailing when treated in the attrition machine of the invention, and then subjected to the same froth flotation treatment showed a recovery of 65% of the gold-silver values.

I claim:

1. A machine of the character described comprising a two-compartment tank, each of said compartments being polygonal in cross section and the two compartments being separated by a partition terminating short of the bottoms thereof, means for introducing feed to be treated near the top of the first compartment, means for discharging treated feed near the top of the second compartment, a rotatable shaft operatively positioned within each compartment, means for rotating said shafts in opposite directions, and at least three sets of impeller blades secured to each shaft in vertically spaced relation with the bottom impeller in the first compartment and the top impeller in the second compartment arranged to impel liquid flow through the compartments from said feed introducing means towards said treated feed discharging means and with adjacent sets of impeller blades on each shaft arranged to impel liquid flow within the compartment in opposite directions.

2. A machine according to claim 1 in which the impeller blades of the top and bottom sets in the first compartment are arranged to impel liquid flow downwardly and the impeller blades of the top and bottom sets in the second compartment are arranged to impel liquid flow upwardly.

3. A machine of the character described comprising a two-compartment tank, each of said compartments being octagonal in cross section and the two compartments being separated by a partition terminating short of the bottoms thereof, means for introducing feed to be treated near the top of the first compartment, means for discharging treated feed near the top of the second compartment, a rotatable shaft operatively positioned within each compartment, means for rotating said shafts in opposite directions, and at least three sets of impeller blades secured to each shaft in vertically spaced relation, the blades of the top and bottom sets in the first compartment being arranged to impel liquid flow downwardly and the blades of an intermediate set being arranged to impel liquid flow upwardly, and the blades of the top and bottom sets in the second compartment being arranged to impel liquid flow upwardly and the blades of an intermediate set being arranged to impel liquid flow downwardly.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,611,944	Rapp	Dec. 28, 1926
1,745,291	Bleil	Jan. 28, 1930
2,152,108	Tice	Mar. 28, 1939
2,493,049	Weinig	Jan. 3, 1950

FOREIGN PATENTS

Number	Country	Date
677,496	France	Mar. 11, 1930