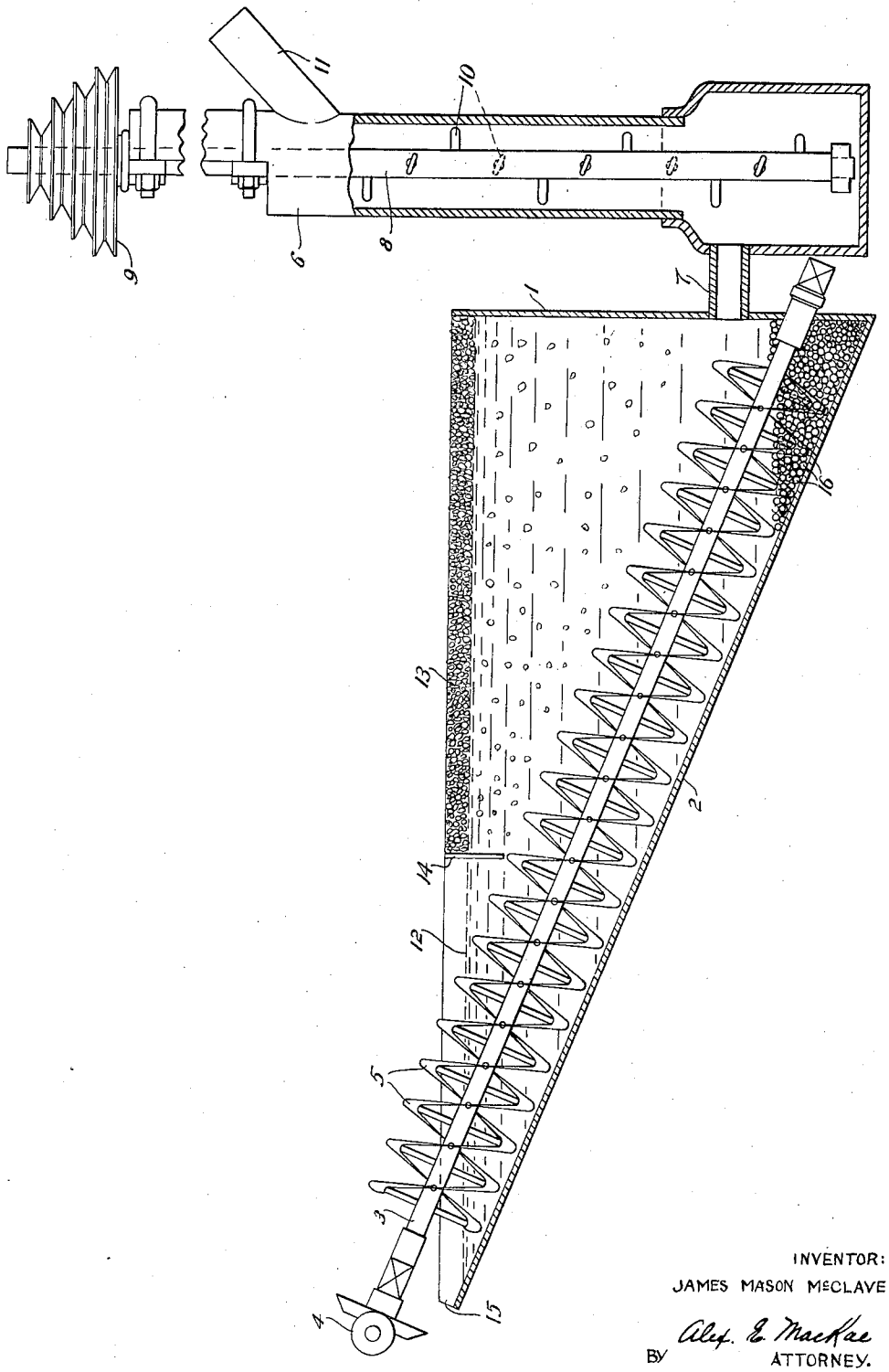
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PROCESS OF SEPARATING MINERALS, HYDROCARBONS, AND THE LIKE FROM ASSOCIATED MATERIALS

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## PROCESS OF SEPARATING MINERALS, HYDROCARBONS, AND THE LIKE FROM ASSOCIATED MATERIALS

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3 Claims. (Cl. 196—14)

This invention relates to the treatment of ores, materials containing hydrocarbons, and like materials for the recovery therefrom by flotation of the desired constituents.

The object of the invention is to provide an efficient, more economical and simpler flotation method, than those heretofore known, for separating minerals and mineral substances, including oils and other hydrocarbons, from the materials with which they are associated. A specific object of the invention is to avoid violent agitation of and turbulence in the water or pulp within the froth-forming zone and thus provide a quiet flotation zone within which a clean and efficient separation of the floatable and unfloatable constituents of the material is effective at a minimum of cost and without the inclusion in the froth of an undue amount of air, which must be later removed.

In flotation methods now in use a rotating impeller is used to stir and agitate the pulp to free the floatable from the unfloatable constituents, to incorporate air or other buoyant agent with the floatable material and to move the tailings through and from the cell. It has now been found that the agitation and turbulence thus produced interferes with a clean separation and, at the same time, produces a froth containing an unnecessary amount of air.

In accordance with the invention a quiet zone is provided wherein the froth, carrying the floatable material, is formed and separates from the pulp. The air or other buoyant agent is introduced into the ore pulp in such a way as not to interfere with this quiet froth-forming and separating zone. Direct mechanical means are provided for moving the solid matter through and removing part or all of it from the flotation zone and for freeing the floatable from the unfloatable material.

The invention will now be described with reference to the accompanying drawing which illustrates more or less diagrammatically apparatus which may be used in carrying out the invention.

In the drawing, 1 represents a flotation chamber having an inclined bottom 2 adjacent to which is arranged means for conveying solids through the chamber and for mildly agitating the same, illustrated by the rotatable shaft 3 with means 4 for rotating the same, and the blades or ribbons 5 spirally arranged thereon. A feeding device 6 discharges into the deep end of the chamber 1 through a pipe 7 adjacent the bottom of the chamber. A shaft 8 driven by a variable speed drive 9 and carrying angularly disposed agitating blades or arms 10 is arranged within the feed pipe 6, which is open at the top and is provided with means 11 for admitting ore pulp or the like thereto. 12 represents the water or pulp level in the chamber and 13 the froth bed formed on the surface of the water, while 14 is a baffle plate to prevent the froth being carried to the discharge end 15 of the chamber. Balls 16 may be placed in the lower end of the chamber, as shown, to increase the mild agitation and mixing of the pulp.

In the treatment, for example, of bituminous sands or other materials containing or impregnated with oil, asphalt or other hydrocarbons, the separation of the hydrocarbons from the sand or other materials and the flotation of the hydrocarbons are accelerated if heat is applied thereto. This may be accomplished by surrounding the lower part of the chamber 1 with a steam jacket or the like and steam may be substituted in part or wholly for air serving as the buoyant agent for floating the desired constituents. The application of too much may cause excessively rapid separation and flotation, bringing up too much mineral matter with the froth, which should be avoided.

In operation of the invention by the apparatus illustrated herein, the pulp to be treated and containing a required flotation agent is admitted through the pipe 11 to the feeder 6. The rapid rotation of the shaft 8 draws in air and mixes the same with the pulp, which is discharged into the flotation chamber 1 through the pipe 7. The conveyor mildly agitates the solids of the pulp, causing them to advance along the inclined bottom 2 and permitting the buoyant particles or laden air bubbles to rise to the substantially quiescent surface of the water in the quiet zone at the deep end of the chamber, while the tailings are ejected at the discharge end 15.

The amount of mild agitation of the pulp and the length of time to which it is subjected to treatment may be varied by varying the design of the conveyor or its speed or the angle at which it operates. As previously stated, balls 16 or the like of such size and specific gravity that they will not be unduly carried forward by the conveyor may be employed to increase the agitation and facilitate release of the buoyant particles. It will be apparent that other means than that specifically shown may be used for conveying the material through the unit, such as a drag, belt, or an electric or vibratory or other type of conveyor, or rotating rakes or rabbles or the like.

The unit may be divided into two or more compartments, if desired, by partitions reaching

deeply enough into the chamber to accomplish the desired results, solids passing from one compartment to the next below or through apertures in the partitions and liquids or liquids and solids passing from one compartment to another by overflow above or through the partitions. Air or other buoyant agent may be introduced into one or more or all of the compartments as desired. A single unit may thus serve the function of a battery of flotation cells.

As further illustrative of the detailed operation of the invention, specific examples of its application to two different types of material are given.

(1) Treatment of bituminous sand. The unit was set at an angle of 22½° so that at the feed end of the chamber 1 there was a depth of 14 inches of water above the top of the conveyor. The partition baffle 14 was placed 30 inches from the deep end of the chamber and extended about 3 inches below the water level 12. The shaft 8 was rotated at 12 to 20 R. P. M. A pulp formed by pugging oil sand with warm water, preferably containing a small proportion of sodium silicate, was fed through the pipe 11. Rotation of the shaft 8 with its agitating arms introduced air into the pulp and the mixture flowed into the chamber 1 through pipe 7. The lower end of the chamber was heated by a steam jacket, not shown, which surrounded the deep end of the chamber, to a point somewhat above the top of the conveyor ribbons 5. The oil quickly separated from the sand in the quiet flotation zone at the deep end of the chamber and rose to the surface in a relatively clean froth. The sand and silt were conveyed forward and discharged practically free from oil. The oily froth contained about 10% water and about as much mineral matter. The mineral content of the froth may be greatly reduced by re-running the froth through the unit. In this particular instance a second passage through the unit reduced the mineral matter to about 3%. As a comparative figure it may be stated that in heretofore known processes the mineral matter in the froth, even after re-running through a cleaner cell, amounts to 15 to 26%.

(2) Treatment of auriferous pyritic ore. The same apparatus as just described was used but the steam jacket was omitted and the speed of the shaft 8 was substantially increased to introduce into the pulp a larger amount of air to float the heavier pyrite. The increase in the speed of this agitator caused no disturbance in the flotation chamber. As before the ore was formed into a pulp to which a flotation agent was added before the pulp was fed through the pipe 11. The pyrite floated quickly and collected on the surface in the water in a fine clean froth. A small amount of the pyrite rose in the shallower part of the unit beyond the partition 14 and passed out with the tailings. This was overcome by inserting an additional partition as previously mentioned. Furthermore, the length of the zone may be increased. This gave a 90% recovery of the gold.

It appears that the substantially quiet zone in which the bubbles are permitted to rise carrying with them the floatable material is primarily responsible for the efficient separation and the formation of a clean froth.

I claim:

1. A method of separating mineral or other materials, including oil and other hydrocarbons from associated materials, which comprises forming with the materials an aqueous pulp containing a buoyant and a flotation agent, passing the pulp into a chamber, containing water at a constant level, with a bottom inclined upwardly to a discharge opening above the water level, mildly agitating the materials that remain on the bottom of the chamber while carrying them upwardly along the bottom to the discharge opening through a gradually diminishing depth of water, the depth of the water and the movement of the materials through the chamber being such that in the greater part of the chamber the water remains substantially undisturbed and removing from the surface of the water bubbles with adhering particles of floatable material.

2. A method as defined in claim 1 wherein the pulp is introduced into the quiescent body of water adjacent the bottom of the deep end of the chamber.

3. A method as defined in claim 1 wherein the bottom of the chamber is heated to facilitate release of floatable materials from the solids in contact with said bottom.

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