Jan. 11, 1938. H. E. T. HAULTAIN 2,104,926

CLASSIFIER

Filed April 4, 1935 2 Sheets-Sheet 1

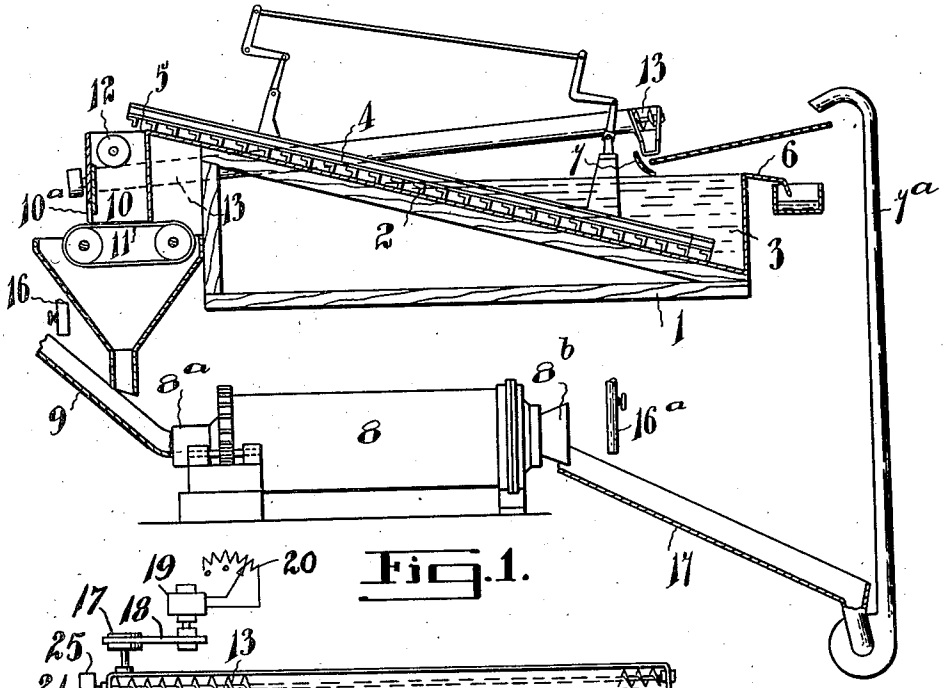


Fig. 1.

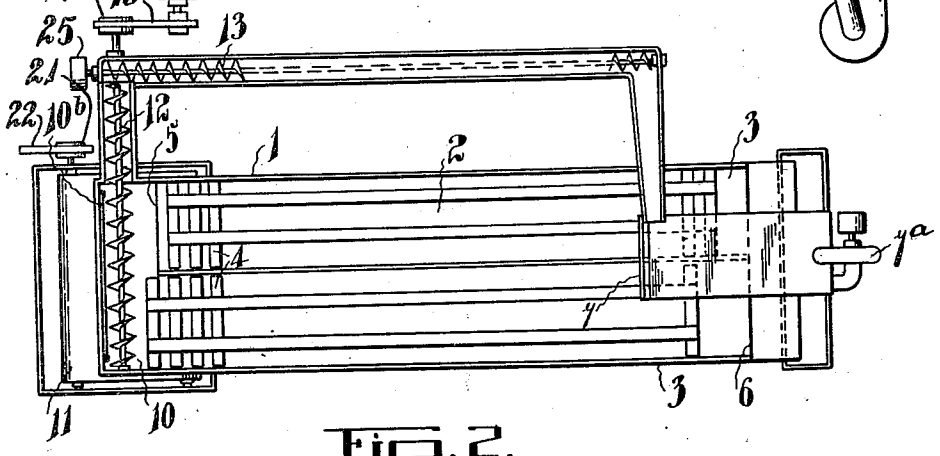


Fig. 2.

Inventor
H.E.T. Haultain
By J. Edw. Maybee

Jan. 11, 1938. H. E. T. HAULTAIN 2,104,926

CLASSIFIER

Filed April 4, 1935 2 Sheets-Sheet 2

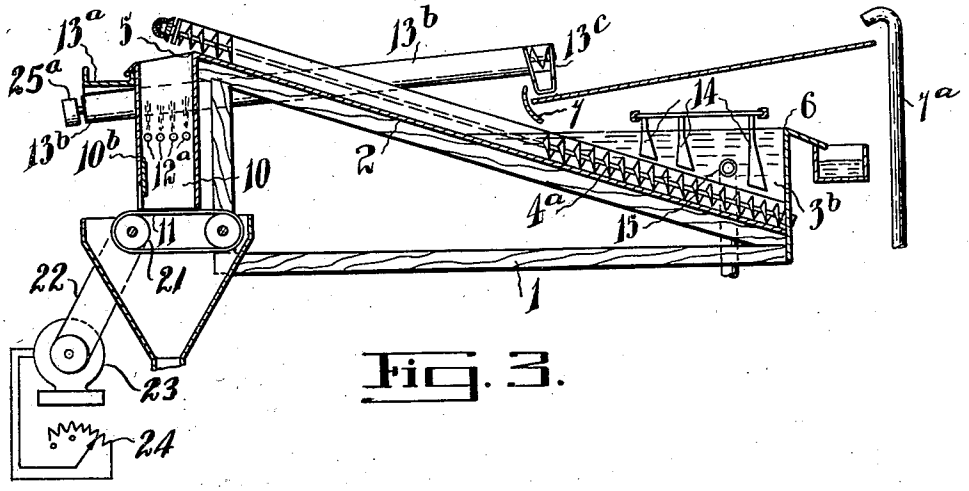


Fig. 3.

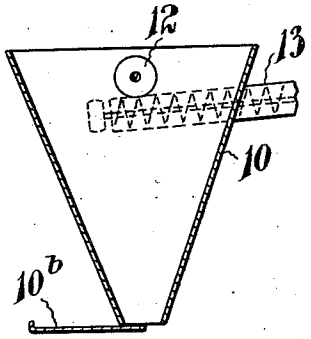


Fig. 4.

Inventor
H.E.T. Haultain
by J. Edw. Maybee ATTY.

Patented Jan. 11, 1938

2,104,926

UNITED STATES PATENT OFFICE

2,104,926

CLASSIFIER

Herbert E. T. Haultain, Toronto, Ontario, Canada

Application April 4, 1935, Serial No. 14,577

16 Claims. (Cl. 209—1)

This invention relates to classifiers for separating the coarse from the fine particles of crushed rock suspended in water and particularly to that type of classifier which is provided with a settling chamber and an incline up which the material that settles is conveyed by mechanical means and is returned to a grinding unit for retreatment thereby, and is subsequently returned to the settling chamber of the classifier, the latter and the grinding unit being in a closed circuit.

The main separation is effected in the settling chamber and on account of the unstable density conditions of the pulp within the chamber there are set up cycles of changes of density or surges which are objectionable in that they affect the uniformity of the separation, under some conditions more seriously than others, and with the classifiers now in use the skill of the operator is taxed in trying to keep the surges to a suitable minimum.

The manufacturers of classifiers have tried to overcome these surges by increasing the size of the settling chambers and the quantity of material in the circuit. While this tends to absorb the surges, the cost of the apparatus and the time required to check any changes made by the operator are also increased. The object of the present invention is to devise simple and inexpensive apparatus which will produce a uniform separation by minimizing or eliminating the above mentioned objectionable feature, which may be applied in part to classifiers now in use, and which will facilitate a more accurate study of the effect of any changes made in operating methods.

I attain my object by providing means for conveying a constant predetermined quantity of sands from the classifier to the grinding unit and for carrying the sands, which are carried up the incline by the mechanical conveyors, in excess of this predetermined quantity directly back to the settling chamber of the classifier.

The constructions are hereinafter more fully described and are illustrated in the accompanying drawings in which

Fig. 1 is a diagrammatic view in side elevation of a classifier circuit showing my apparatus applied thereto;

Fig. 2 a plan view of the classifier shown diagrammatically;

Fig. 3 a diagrammatic view of a modified form of my invention showing it built into a classifier; and

Fig. 4 a diagrammatic view of a modified form of receptacle.

In the drawings like numerals of reference indicate corresponding parts in the different figures.

1 is a classifier of ordinary construction which includes an incline 2, a settling tank or chamber 3, and a conveyor 4 which may be of the screw or "rake" type for carrying the settled product in the chamber up the incline 2 over the discharge end 5 thereof. The fine particles or slimes flow over a weir 6 and a feeder 7 is provided to direct the ore pulp into the chamber 3. This construction is well known and it has been the general practice to establish communication between the discharge 5 and the inlet 8^a of a grinding mill 8 and between the outlet 8^b of the mill 8 and the feeder 7 so that the classifier and the grinding mill are in a closed circuit. Of course the supply of material from the classifier to the mill is increased by a predetermined quantity of fresh material which may be directed into the inlet 8^a by means of a chute 9.

Instead of directing all the material or sands brought up the incline 2 from the chamber 3 to the grinding mill whether the quantity of sands be large or small, I convey only a predetermined quantity of such sands to the grinding mill. Any sands brought up the incline in excess of this predetermined quantity are returned directly to the settling chamber 3 without being passed through the grinding mill. This may be accomplished by any suitable means. In Figs. 1 and 2 is diagrammatically illustrated such apparatus which may be readily used with existing classifiers. Beneath the discharge 5 of the classifier is positioned a receptacle 10 for receiving all the sands from the classifier. The bottom of the receptacle is provided with an outlet 10^a beneath which a conveyor 11, which may be of the endless belt type, is located. Preferably the receptacle is rectangular having an open bottom and the conveyor 11 is located adjacent the lower edges of the sides and one end of the receptacle to form a bottom therefor.

The depth of material on the conveyor is controlled by a gate 10^b which is adjustably carried at the lower edge of the other end of the receptacle. By varying the height of the gate relative to the conveyor 11 and by varying the speed of the latter, any predetermined quantity of sands may be fed from the receptacle to the grinding mill 8.

In operation the quantity of sands carried by the conveyor 11 in a given period of time will be slightly less than that received in the same period of time by the receptacle from the classifier discharge 5. A screw conveyor 12 may be employed to remove any surplus sands from the receptacle. The conveyor 12 is located across the upper portion of the receptacle with its axis substantially parallel to the discharge end 5 of the classifier and discharges onto a conveyor 13. The latter directs the surplus sands into the settling chamber 3.

In the present classifiers, the conveyors 4 also serve as agitators in the chambers 3 and are driven at a constant rate of speed. As this speed

cannot be varied without varying the agitation of the pulp in the chamber 3, separate means are employed in my improved classifier for driving each of the conveyors 11 and 12, 13 so that the speed of the conveyor 11 may be varied relative to that of the conveyors 12, 13 or to that of the conveyor 4. The above mentioned separate means for driving each of the conveyors 11, 12 and 13 may include a pulley on each conveyor and a separate rheostat controlled electric motor for driving each pulley. The pulley 17 on the conveyor 12 is connected by a belt 18 with the pulley on a motor 19 which is provided with a rheostat 20 for varying the speed of the motor. The pulley 21 on the conveyor 11 is driven by a belt 22 from a motor 23 provided with a rheostat 24. The pulley 25 on the conveyor 13 may also be driven from the motor 19 or one similar thereto and controlled by the rheostat 20 so that the conveyors 12 and 13 will travel at substantially the same rate of speed. The drive for the conveyor 4 is well known in the art and is therefore not shown. The conveyor 12 is not used in Fig. 3 and therefore the pulley 25*a* on conveyor 13*b* will be driven by motor 19.

Referring to Fig. 3, it will be noted that separate agitators formed as paddles 14 are provided for agitating the ore pulp in the settling chamber. These paddles are actuated back and forth in the chamber by any suitable means which may be varied in speed relative to the speed of the conveyor 4^a which differs from the conveyor 4 in that it is not adapted to agitate the pulp in the chamber 3^b. Instead of using conveyors 12, 13 for returning the surplus sands from the receptacle 10, I show jets 12^a for introducing upwardly directed streams of water intermediate the top and bottom of the receptacle which agitates the upper stratum of sands so that they may overflow into a launder 13^a. The latter may convey the overflow directly to the chamber 3^b or to a conveyor 13^b which discharges on to a launder 13^c for directing the overflow to the chamber 3^b. Some of the fines or slimes in the excess material at the top of the receptacle which were withdrawn from the settling chamber with the sands will be separated therefrom by the action of the water and carried into the launder 13^a. Thus the agitation not only causes the excess material to be returned directly to the settling chamber but separates the finer particles of ore from the coarser particles and facilitates the return of these finer particles to the chamber from which they may pass over the weir 6.

Further, the separation of the sands and fines in the settling chamber 3^b is facilitated by withdrawing the "middlings" therefrom. The fines at the top of the chamber flow over the weir 6, the sands at the bottom of the chamber are withdrawn by the conveyor 4 or 4^a. Between the top layer of fines and the bottom layer of sands, an accumulation of what millmen term "critical size" material or "middlings" is being constantly built up. These "middlings" are about the size of the coarsest of the fines and have a tendency to remain intermediate the top and bottom of the chamber. A conduit 15 communicating with the chamber at a point intermediate its top and bottom is employed to remove the "middlings" which may be directed to the grinding mill or to a separate classifier.

From this description it is obvious that the quantity of the material returned from the classifier to the grinding mill may be maintained constant by the hereinbefore described means including the provisions for by-passing a portion of the sands discharged by the classifier to reclassify them in the settling chamber without passing them through the grinding unit. In other words, a direct circuit is established (between the receptacle 10 and the chamber 3) within the closed circuit including the classifier and the grinding mill 8, whereby a predetermined quantity of material in the said closed circuit will be fed to the grinding mill by using the direct circuit for directly returning to the settling chamber any material in excess of the said predetermined quantity.

It will be understood that the receptacle 10 might be frusto-conical as shown in Fig. 4 when certain types of coarse pulp are being separated. The gate 10^b, in this case, would be positioned to control the discharge from the outlet at the bottom of the receptacle and the conveyor 11 would not be necessary.

Pipes 16, 16^a may be employed for supplying water to the chute 9 and the launder 17 which forms part of the hereinbefore mentioned means for establishing communication between the outlet 8^b of the grinding mill 8 and the feeder 7 of the settling chamber 3. The launder 17 communicates with the inlet of a centrifugal pump having a pipe 7^a connected with its outlet. Any suitable means may be employed to direct the material discharged from the pipe 7^a to the feeder 7.

What I claim as my invention is:

1. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber having an overflow for the slimes or fine particles, the classifier also having a discharge end; means for drawing off settled sands from the settling chamber and discharging them over the said end; means for returning a predetermined quantity of the said discharged sands to the grinding mill so that they will be re-ground before re-entry to the classifier; and means for returning any surplus discharged sands directly to the settling chamber of the classifier so that such surplus sands will be re-classified before being re-ground.

2. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber and a discharge end for sands; means for drawing off settled sands from the settling chamber and discharging them over the said end; means for returning a quantity of the said discharged sands to the grinding mill so that they will be re-ground before re-entry to the chamber; means for varying the rate of return to the grinding mill; and means for returning any surplus discharged sands so withdrawn directly to the settling chamber of the classifier so that such surplus sands will be re-classified before being reground.

3. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber and a discharge end for sands; means for drawing off settled sands from the settling chamber and discharging them over the said end; means for returning a quantity of the said discharged sands to the grinding mill so that they will be re-ground before re-entry to the chamber; means for varying the rate of return to the grinding mill; means for returning surplus discharged sands so withdrawn directly to the settling chamber of the classifier; and means for varying the rate of return to the settling chamber of any sands in excess of said predetermined quantity.

4. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber and a discharge end for sands; means for drawing off settled sands from the settling chamber and discharging them over the said end; means for returning a predetermined quantity of the said discharged sands to the grinding mill so that they will be re-ground before re-entry to the chamber; means for returning any discharged surplus sands directly to the settling chamber of the classifier; an agitator located in the settling chamber separate from the withdrawal means; and means for varying the relative rate of action of the withdrawal means and the agitator.

5. In combination with a classifier having a settling chamber provided with an overflow for the slimes or fine particles, the classifier also having a discharge end for sands, and a grinding unit in communication with the discharge end and the chamber to form a closed circuit therebetween, of means for returning a constant quantity of the sands discharged over said end to the grinding unit; and means for bypassing a portion of the sands discharged by the classifier over said discharge end to reclassify them without passage through the grinding unit.

6. A classifier provided with a discharge end for sands, and a settling chamber having an overflow for slimes or fine particles; a receptacle for receiving sands discharged from the said end, the receptacle being provided with an outlet; means for controlling the quantity of sands discharged through the outlet of the receptacle; and means for returning any excess material from the receptacle to the chamber.

7. A classifier provided with a discharge end for sands, and a settling chamber having an overflow for slimes or fine particles; a receptacle for receiving sands discharged from the said end, the receptacle being provided with an open bottom; a conveyor located beneath the receptacle to form a bottom therefor; and means for returning any excess material from the top of the receptacle to the chamber.

8. A classifier provided with a discharge end for sands, and a settling chamber having an overflow for slime or fine particles; a receptacle for receiving sands discharged from the said end, the receptacle being provided with an open bottom; a conveyor located beneath the receptacle to form a bottom therefor; an adjustable gate carried by an end of the receptacle to control the depth of material on the conveyor; and means for returning any excess material from the top of the receptacle to the chamber.

9. A classifier provided with a discharge end for sands, and a settling chamber; a receptacle for receiving sands discharged from the said end, the receptacle being provided with an outlet; means for controlling the quantity of sands discharged through the outlet of the receptacle; and means including a screw conveyor for returning any excess material from the receptacle to the chamber.

10. A classifier provided with a discharge for sands and a settling chamber; a receptacle for receiving sands from the said discharge and provided with an open bottom; a conveyor located beneath the receptacle; means including a screw conveyor mounted in the receptacle to return the excess material from the latter to the chamber; and means for varying the speeds of the conveyors relative to one another.

11. A classifier provided with a settling chamber and an incline; a conveyor for conveying material from the chamber up the incline; a receptacle for receiving the material discharged from the incline; means for removing a predetermined quantity of material constantly from the receptacle; and means for returning any surplus material in the receptacle to the chamber.

12. A classifier provided with a settling chamber and an incline; a conveyor for conveying material from the chamber up the incline; a receptacle for receiving the material discharged from the incline; means for removing a lesser quantity of material constantly from the receptacle during a predetermined period of time than that discharged into the receptacle during the same time period; and means for returning any excess material from the receptacle to the chamber.

13. A classifier provided with a settling chamber and a discharge end; means for discharging material from the bottom of the chamber over the said end; a receptacle for receiving material discharged over said end; a grinding unit having an inlet; means for directing material from the receptacle to the inlet; means for controlling the quantity of material conveyed by the conveying means to the inlet of the grinding unit; and means for returning any excess material from the receptacle to the chamber.

14. A receptacle for receiving ore pulp; means for withdrawing pulp from the bottom of the receptacle; means for agitating the pulp with water intermediate the top and bottom of the pulp to separate the slimes therefrom, the receptacle having an open bottom and the first means including a conveyor located beneath the receptacle to form a bottom therefor; and means for carrying the said slimes and any excess pulp away from the top of the receptacle; and means for varying the rates of speed of the conveyor relative to the said carrying means.

15. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber and a discharge end; means for drawing off settled sands from the settling chamber and discharging them over said end; a receptacle for receiving said discharged sands; means for returning a predetermined quantity of the said discharged sands from the bottom of the receptacle to the grinding mill; means for agitating the sands with water intermediate the top and bottom of the receptacle to separate the slimes therefrom by flotation; and means for returning the said slimes and any surplus discharged sands directly to the said chamber.

16. In combination a classifier and a grinding mill in closed circuit, the classifier including a settling chamber and a discharge end for sands; means for drawing off settled sands from the settling chamber and discharging them over the said end; means for returning a quantity of the said discharged sands to the grinding mill so that they will be re-ground before re-entry to the classifier; means for returning any surplus discharged sands directly to the settling chamber of the classifier so that such surplus sands will be reclassified before being re-ground; and means for varying the rate of speed of the said second and third mentioned means relative to one another.

HERBERT E. T. HAULTAIN.