Aug. 3, 1943. M. S. ROBERTSON 2,325,881

RECOVERY APPARATUS

Filed July 29, 1940

Fig. 1

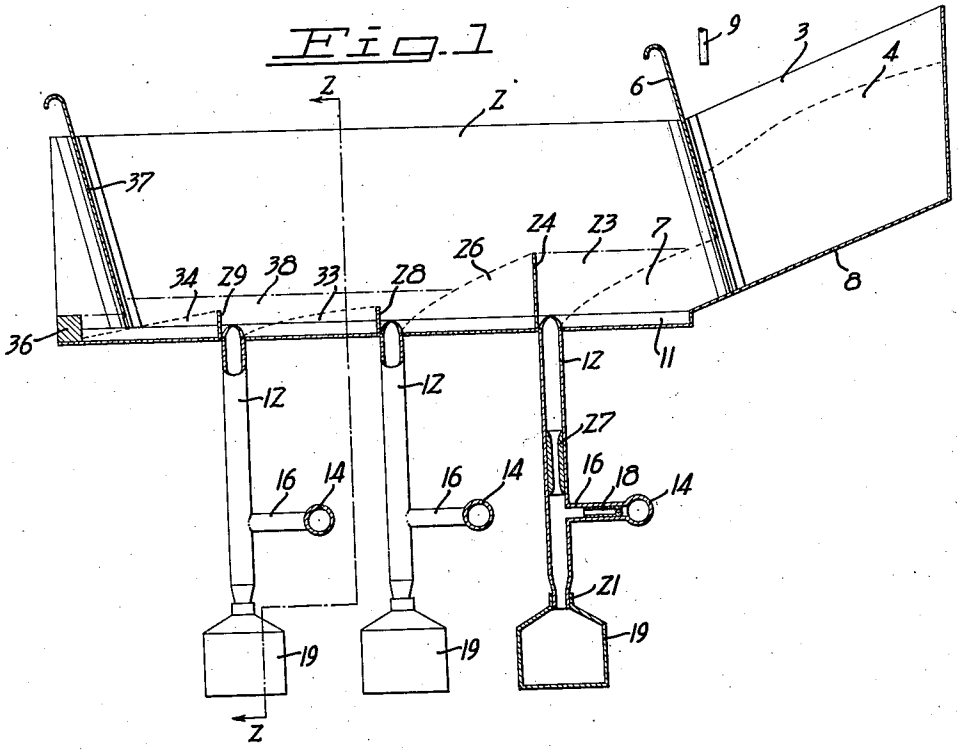
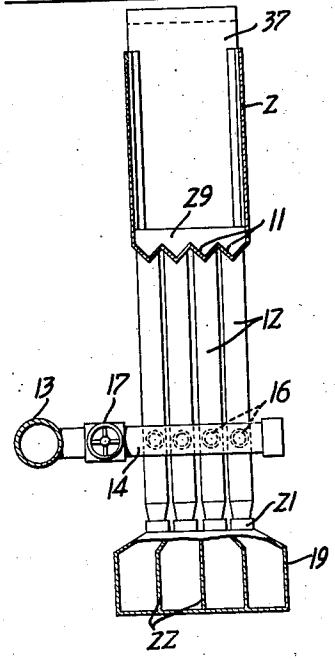


Fig. 2



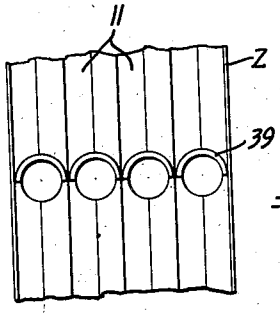


Fig. 3

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RECOVERY APPARATUS

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Application July 29, 1940, Serial No. 348,317

2 Claims. (Cl. 209—155)

My invention relates to apparatus for separating particles of material; and more particularly to a device for separating particles of different density.

It is among the objects of my invention to provide improved apparatus for separating small particles of finely divided material.

Another object is to provide apparatus for recovering fine gold from sand.

A further object is to provide a fluid counterflow apparatus embodying means for eliminating eddy currents so as to effectively separate finely divided material.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention, as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawing:

Figure 1 is a side view, partly in section and partly in elevation, showing a recovery apparatus embodying the improvements of my invention; and

Figure 2 is a transverse vertical sectional view of the same, taken in a plane indicated by line 2—2 of Figure 1.

Figure 3 is a fragmentary plan view showing a modified construction.

Many black sands, such as found on ocean beaches, contain fine gold in quantities justifying its recovery if suitable equipment is available for effecting its separation. This offers an almost unlimited opportunity for livelihood to persons not otherwise employed, providing an efficient recovery unit may be had which is portable and easily operated. While the apparatus of my invention is particularly well adapted for use in small units into which the sand is shoveled by an individual operating his own equipment, it may also be operated with auxiliary power equipment and used in banks of units for larger scale operations.

In terms of broad inclusion, my recovery apparatus comprises a separating station including a counterflow of fluid for separating dense from lighter particles of material, and means for preventing eddy currents in the counterflow to effect efficient separation between particles of finely divided material. A plurality of these separating stations are preferably provided; and means are provided for controlling the counterflow at the stations.

In greater detail, and referring to Figures 1 and 2 of the drawing, my apparatus as adapted for recovering fine gold from sand comprises a trough 2 having a hopper 3 formed at one end for receiving sand 4 containing the gold. The apparatus illustrated is a small capacity unit having a trough about four inches wide; the overall length of the trough and hopper being about thirty inches. For a unit in which a person shovels sand into the hopper, the trough is preferably about twelve inches wide. Of course it is understood that the apparatus may be made still larger and adapted for use with power equipment for feeding the sand into the trough; or the units may be used in banks in larger scale operations. While I have shown an open-top trough, a closed trough or pipe could be used, through which the sand or material passes.

A slidable gate 6 is preferably arranged at the head of the trough for controlling flow of sand from hopper 3; the position of this gate determining the slope of sand bar 7 extending into the trough. Hopper 3 has a sloping bottom 8, and a duct 9 is preferably provided for feeding a small stream of water into the hopper to keep the sand moving uniformly into the trough. The bottom of trough 2 is preferably corrugated to provide a series of longitudinally extending V-shaped channels 11 to facilitate cleaning up after a day's run. If desired however, a flat bottomed trough may be used.

A separating station is arranged in the trough ahead of sand bar 7, and counterflow means are provided at the station for separating the dense from lighter particles. For this purpose a group of upright ducts or tubes 12, preferably disposed in a transverse row, are ported into the bottom of the trough in registration with channels 11 at the foot of sand bar 7. While I have shown four tubes in a row, it is understood that a different number may be employed. Thus in a trough twelve inches wide, a group of twelve tubes is preferably used, the tubes being approximately one inch in diameter. Water is introduced into the tubes from a supply manifold 13 through a header 14 having branch ducts 16 opening into the sides of the tubes. The flow of water is regulated by a suitable valve 17 in header 14, and a uniform flow of fluid into the several tubes is insured by orificed inserts 18 in branch ducts 16. A tank 19 is provided at the lower ends of the tubes for receiving the dense particles of material and to provide a closure so that the water is directed upwardly through the tubes. The reduced ends of the tubes seat in necks 21 on the tank to provide

a tight joint, yet permit removal of the tank for taking out the collected values. In order to prevent recirculation through the lower ends of tubes 12, partitions 22 are arranged in the tank to divide it into separate compartments.

A portion of the fluid from tubes 12 is retained in a body or pool 23 above the tubes by a barrier or riffle plate 24 disposed transversely of the trough immediately behind the tube ports. Excess water from pool 23 discharges over riffle plate 24 and the lighter particles carried over the plate build up a second sand bar 26. As a matter of fact, this second sand bar will form by reason of sand deposited on the bottom of the trough without the presence of plate 24, and in such case the sand bar itself forms a riffle. The presence of a rigid riffle plate 24 however prevents surges of water from washing out the sand bar. By the term "riffle" as used throughout the specification and claims I mean any suitable barrier such as plate 24 or sand bar 26 without the plate.

As the incoming sand flows into the trough along bar 7 it falls into tubes 12 and is met by the counterflow of fluid. The denser gold particles fall against the counterflow and are deposited in tank 19, while the lighter sand particles are carried off with the fluid discharging over riffle plate 24. The turbulence of the water in pool 23 keeps the particles moving while the separation takes place; the lighter particles being urged upwardly over the riffle and the heavier particles gradually settling down along the tubes under the influence of gravity. This turbulence in pool 23 also aids in keeping the incoming sand moving down along bar 7 until it is entrained by the counterflow. Valve 17 is preferably adjusted so that only the larger gold particles are allowed to settle out at this first station; the force of the counterflow being such that some of the finer gold is carried over the riffle with the sand for recovery at other stations.

An important feature of my invention is the provision of the group of relatively small counterflow tubes at the separating station. If a single large counterflow tube were employed, through which a relatively large column of water flowed, there would be eddy currents set up in the tube that would destroy the uniformity of the counterflow and allow other material to fall through with the gold. This eddy current problem is one of the principal reasons why counterflow systems have not been successful for recovering fine gold. In my improved apparatus this is overcome by dividing the counterflow into a group of relatively small water columns, thus maintaining the capacity of the unit without the eddy current problem. While I have shown separate tubes 12, it is understood that they may be integrally connected in the group. Thus an elongated box-like structure could be employed, divided by partitions into a plurality of tubes or ducts. Such a cellular structure would serve equally well to divide the flow into a plurality of columns to retard the formation of eddy currents. Although I show a single row of tubes or ducts at each station it is understood that additional rows may be added in the groups.

In order to further improve the separating action a Venturi passage is perferably provided in each tube by a suitably shaped insert 27. The throat of this Venturi passage is preferably quite long, as shown in Figure 1, to dissipate surges in the water and insure a uniform counterflow against which the fine gold particles may settle out. The slope at the upper flaring end of the Venturi passage is preferably such as to prevent gold particles from collecting on the rim.

A series of say three separating stations are preferably arranged along the trough, each having a group of counterflow tubes 12 similar to those described for the first station. Riffle plates 28 and 29 for the second and third stations are preferably shorter than riffle plate 24; the latter having the greatest height to dissipate surges in the water originating at the intake end. The sand carried with the discharging water over the first riffle plate 24 and moving down along bar 26 intercepts the counterflow at the second station and is subjected again to the separating action. Counterflow at the second station is regulated so as to be less forceful than that at the first station, thereby allowing more of the finer gold particles to settle out.

The still finer gold particles are again discharged with the sand over riffle plate 28 and move along bar 33 to the last station. Here the force of the counterflow is still less and the very fine values are recovered. Another important feature of my invention therefore is the passage of the material through a series of separating stations, and regulating the counterflow to progressively decrease the force of the flow at successive stations to control the separation. Such procedure gives good recovery and faster action. It is understood of course that additional stations may be employed, although with a three-station unit I have recovered as high as ninety-eight percent of the free gold in black sand.

From riffle 29 of the last station the sand forms another bar 34 and the fluid and sand are finally discharged from the trough over an end riffle 36. Some values collect ahead of this end riffle and also behind the other riffles and are recovered when the clean-up is made after a day's run. A gate 37 serves to restrict the flow at the outlet end to control the water level 38 behind riffle plate 24.

Instead of flat riffle plates a modified form shown in Figure 3 may be used. This type comprises semi-circular sections 39 and is conveniently formed by cutting away the forward half of projecting ends of tubes 12. The concavities in this riffle plate lead to a somewhat different fluid motion and the separating action is good.

If desired, the apparatus may be used to recover the lighter particles, in which case the material discharging from the tail end of the trough would be collected.

I claim:

1. Recovery apparatus comprising a trough for receiving material to be separated and having a bottom with a plurality of longitudinally extending V-shaped channels, and a group of upright tubes extending from the bottom of the trough in registration with said channels and through which the dense particles may fall, and means for establishing a counterflow of fluid upwardly through said tubes.

2. Recovery apparatus comprising a trough, a group of counterflow tubes arranged in a row disposed transversely of the trough and opening into the bottom portions thereof, said tubes being sealed against communication at the lower ends to prevent recirculation through the tubes, a header for supplying fluid, ducts connected with the header and opening into the sides of said tubes, flow restricting means interposed in each of said ducts, and means in said header for controlling the fluid.

MILTON S. ROBERTSON.