# United States Patent

[11] 3,575,293


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[54] **METHOD AND APPARATUS FOR SEPARATING FINELY DIVIDED MATERIALS OF DIFFERENT SPECIFIC GRAVITIES**
**7 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **209/458,** 209/485, 209/492, 209/214, 209/215, 209/223, 209/232
[51] **Int. Cl.** ..... **B03b 3/04**
[50] **Field of Search** ..... 209/214, 215, 223, 232, 423, 428, 430, 451, 478, 479, 481, 485, 486, 225, 458, 492



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**ABSTRACT:** A method and apparatus for separating finely divided materials of different specific gravities, and involving the passage of a liquid pulp including the materials of interest over a bed of magnetic particles which are retained upon a support by magnetic attraction. The higher specific gravity particles of a particular particle size fall between and are retained by the magnetic particles. The magnetic particles and retained particles are then removed from the support and separated subsequently by conventional means such as screening, flotation and the like.

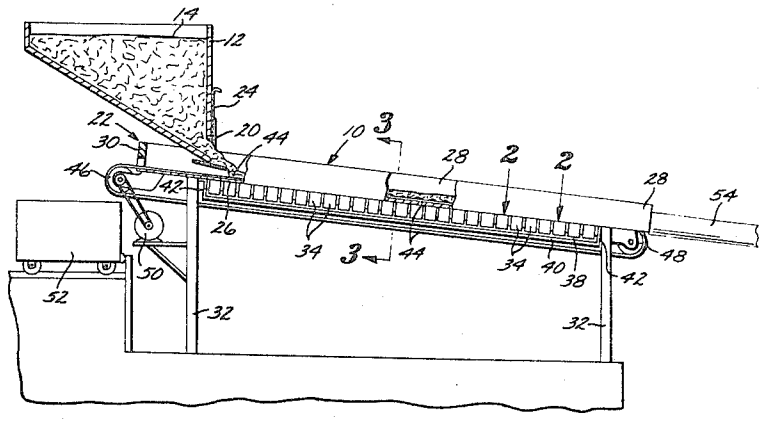



FIG.1

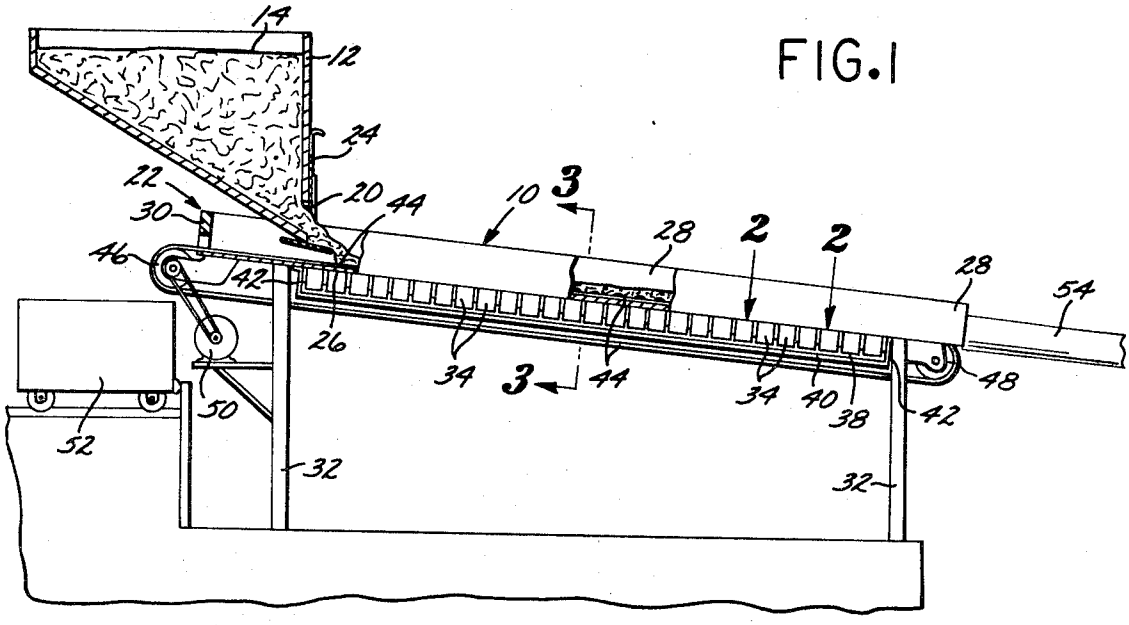



FIG.2

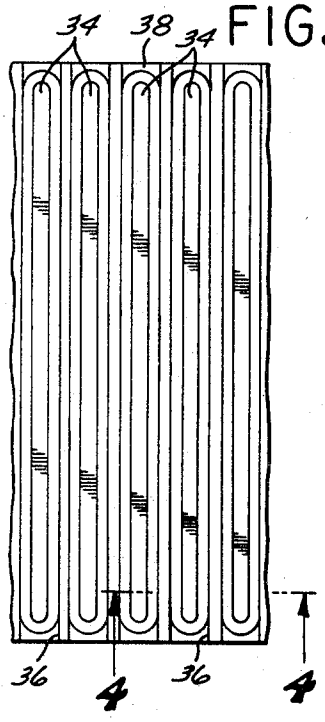
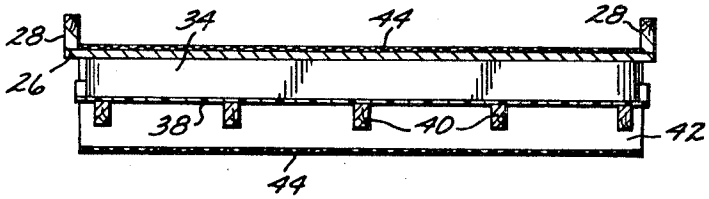



FIG.3



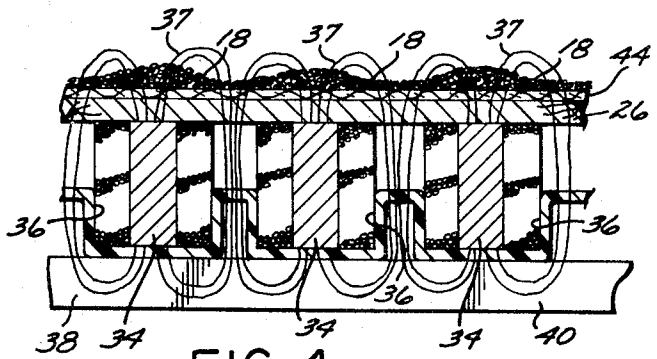
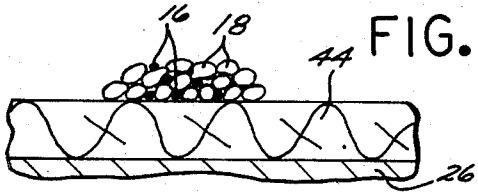




FIG.4

FIG.5




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# METHOD AND APPARATUS FOR SEPARATING FINELY DIVIDED MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

## BACKGROUND OF THE INVENTION

1. Field of the Invention

Separation of materials of fine particle size and of different specific gravities, and particularly through utilization of a rifflelike bed.

2. Description of the Prior Art

Valuable materials such as shceelite, galena, gold, and other minerals are usually found in combination with less desirable materials such as quartz, other silicates, and the like. These materials exist together in both placer and ore deposits.

Whether the materials to be recovered are part of the generally finely divided particles of placer deposits, or are found in ore which must be crushed and ground, the prior art processes for effecting recovery are expensive and time consuming. The particular prior art process of particular interest in the present application is that involving the flow of a pulp of water and the materials to be separated over riffles or rifflelike devices.

More particularly, and by way of example only, gold-bearing placer deposits heretofore have been sluiced or dredged from a riverbed or similar natural collection area and passed over usual riffles. However, the very fine gold particles tend to skip over the riffle bars and escape with the lighter sand particles and the like. The same is true where the pulp is constituted of finely divided particles of crushed and ground ore. Various alternative forms of rifflelike devices have done little to improve the percentage of gold particle recovery, or if the percentage of recovery is raised there is a prohibitive accompanying rise in the time required and in the costs involved, particularly in separating the gold particles from the riffle device. Thus, where a section of canvas or corduroy cloth constitute the riffle device, a tedious washing process is involved.

## SUMMARY

According to the present invention a pulp of a liquid carrier, such as water, and the finely divided materials to be separated is passed over a bed of magnetic particles. The bed is preferably slightly inclined, with the magnetic particles held in place by any suitably developed magnetic field. Permanent or electromagnets may be used.

The magnetic particles define small catch basins so that as the pulp passes over the bed, the higher specific gravity particles fall upon and become lodged between the magnetic particles. The lower specific gravity material is carried away by the flowing water.

The bed of magnetic particles with its concentrate of the higher specific gravity material is then gathered for separation of the concentrate from the magnetic particles. If the particle size of both are approximately the same, separation is accomplished by use of, for example, cyanide treatment to dissolve gold where that is the material being recovered, or by flotation processes if the material of interest is tungsten or the like. Preferably the size of the magnetic particles is made appreciably larger than the size of the particles to be recovered. This then permits easy separation by usual screening techniques.

Other objects and features of the invention will become apparent from consideration of the following description taken in connection with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of an apparatus utilizing electromagnets for separating finely divided materials of different specific gravities according to the present invention;

FIG. 2 is an enlarged view taken along the line 2–2 of FIG. 1;

FIG. 3 is an enlarged view taken along the line 3–3 of FIG. 1;



FIG. 4 is an enlarged view taken along the line 4–4 of FIG. 2; and

FIG. 5 is an enlarged detail view illustrating the entrapment of concentrate particles on the magnetic particles and within the interstices of the magnetic particles.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and particularly to FIG. 1, there is illustrated an apparatus 10 operative to separate finely divided materials of different specific gravities. The apparatus 10 comprises, generally, a tank 12 which holds a pulp 14 constituted of a liquid carrier such as water, and finely divided materials which include the materials to be separated.

Although the method and apparatus of the present invention is adapted to treat small particle size pulps of different types, the present description is directed by way of example to the treatment of pulp 14 made up of water, relatively high specific gravity gold flakes or particles 16, FIG. 5, and lower specific gravity particles of silicates and the like (not shown).

The pulp 14 may be obtained from a placer deposit, in which case the pulp 14 is introduced into the tank 12 by usual means such as a hydraulic dredge or pump (not shown). If the pulp 14 is derived from solid ore, the pulp 14 is introduced in similar fashion after the ore is crushed and sufficiently finely ground. particles; and

The bottom of the tank 12 is provided with an outlet or discharge opening 20 through which the pulp 14 drops toward an inclined, generally rectangular and elongated base or support 22. The rate of passage of the pulp 14 along the inclined support 22 is regulated by a transverse gate 24 which overlies the opening 20 and is vertically slideably mounted to the forward wall of the tank 12. In its down position the gate 24 completely blocks the flow of pulp 14 along the support 22, while raising the gate 24 allows a greater and greater flow of the pulp 14, and will be apparent.

As best seen in FIGS. 2—4, the support 22 is made of a nonmagnetic material such as wood, and includes a bottom wall 26, a pair of sidewalls 28, and an upstream end wall 30. The support 22 is held in position by suitable vertical stanchions 32, as best seen in FIG. 1.

A plurality of elongated, transversely disposed electromagnets 34 are arranged beneath the bottom wall 26 and are energizable to develop a substantially continuous magnetic field upon and immediately above the bottom wall 26, as indicated by the lines 37 in FIG. 4.

The electromagnets 34 may be secured in this position by any suitable means, being secured in position in the present embodiment by disposition within adjacent channels 36 in a mounting pan 38 arranged coextensive with the bottom wall 26. The pan 38 is supported by longitudinally disposed support elements 40 which are secured at their opposite ends to end supports 42 attached to the underside of the bottom wall 26.

An endless belt 44 made of a suitable nonmagnetic material such as canvas is arranged to travel in an upstream direction over the surface of the bottom wall 26, the belt being mounted upon drums 46 and 48 attached to the opposite extremities of the bottom wall 26, with the drum 46 being driven by an electric motor 50. The belt 44 passes through a transverse opening provided in the end wall 30.

A suitable collection device or wheeled container 52 is arranged adjacent the drum 46 for collection of materials carried to that point by the belt 44.

In practicing the invention, particles of magnetic material such as magnetite particles 18 are uniformly distributed by any suitable means (not shown) upon the portion of the belt 44 which overlies the support bottom wall 26. These magnetic particles 18 could be magnetite particles from the placer deposit itself, which would require preliminary separation of these particles from the placer deposit. Such separation could be accomplished by any of several known methods of

magnetic separation. Alternatively, a separate supply of iron or magnetite particles could be obtained elsewhere and used. In either event, the magnetic particles 28 preferably are characterized by a particle size of minus 35 mesh and plus 100 mesh. This size is preferred since the particle size of the gold particles or flakes in a gold separation operation are in the order of minus 150 mesh. Thus, the magnetic particles 18 would have a particle size appreciably larger than the gold particle size. Although the present method and apparatus is suited for use in conjunction with particle sizes larger than the minus 150 mesh just mentioned, it is most efficiently used in conjunction with the smaller particle sizes.

In operation, the pulp 14 flows from the tank 12 at a rate controlled by the gate 24, and controlled by the degree of inclination of the support 22. Energization of the electromagnets 34 maintains the magnetic particles 18 in position. At this time the belt 44 is not driven, but is stationary upon the support bottom wall 26.

The interstices defined by the magnetic particles 18 provide pockets into which the denser or higher specific gravity gold particles 16 fall and are entrained. The lighter particles of lesser specific gravity flow with the water or liquid carrier of the pulp 14 and pass out of the open downstream end of the support 22 and onto a suitable discharge trough 54 for transport to a waste area. The inclination of the support 22 is such that the denser gold particles 16 fall onto the magnetic particles 18 prior to reaching the end of the support 22.

After a period of time the interstices defined by the magnetic particles 18 become filled with the particles 16. The bed defined by the particles 16 and 18 must then be removed from the belt 44. This is accomplished closing the gate 24, deenergizing the electromagnets 34, and driving the belt 44 in an upstream direction. The bed of particles 16 and 18 are then scraped off or dumped into the container 52.

After the bed of particles 16 and 18 is collected in the container 52, a new supply of magnetic particles 18 is spread upon the belt 44, and the operation is repeated.

If the particle size of the magnetic particles 18 was selected to be relatively large, as previously indicated, the larger particles 18 are quickly and inexpensively separated from the gold particles 16 by any usual screening operation. In the event that the particle size of the particles 18 was selected such that the size is substantially the same as that of the particles 16, the separation of the gold from the particles 18 must be accomplished by some process such as cyanide treatment.

In summary, the method and apparatus of the present invention provides a relatively inexpensive and expeditious means for separating finely divided materials of different specific gravities. Magnetic particles are used to provide a rifflelike structure, and are relatively easily separated from the particles of interest, particularly if they are selected to be relatively larger than the entrapped particles.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention.

I claim:

1. Method for separating finely divided materials of different specific gravities, said method comprising the steps of:

distributing magnetic particles in a bed upon support means operative to create a magnetic field which normally maintains said magnetic particles in position;

flowing a liquid pulp including the materials to be separated over said bed whereby the higher specific gravity particles of said materials fall toward said bed and those of said higher specific gravity particles which are less than a predetermined particle size lodge between and are retained by said magnetic particles;

removing from the bed the particles not retained by said magnetic particles;

removing said magnetic particles and said particles less than said predetermined particle size from said support means.

2. The method according to claim 2 wherein said magnetic particles are larger than said predetermined particle size.

3. The method according to claim 1 wherein said magnetic particles are magnetite.

4. The method according to claim 2 wherein said magnetic particles are characterized by a particle size of minus 35 mesh plus 100 mesh and said predetermined particle size is minus 150 mesh.

5. The method according to claim 2 and including the additional step of separating said magnetic particles from the particles lodged therein by screening.

6. The method according to claim 1 wherein said support means is oriented to locate said bed in inclined relation to a horizontal plane.

7. The method according to claim 1 wherein the step of removing said magnetic particles includes the step of first eliminating said magnetic field.

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(5/69)

# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,575,293 Dated April 20, 1971

Inventor(s) Harold C. Nelson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 27, after "ground." delete "particles; and"
Column 4, line 33, delete "2" and insert --1--.

Signed and sealed this 10th day of August 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents