March 5, 1963 P. S. DREYFUS ET AL 3,080,056

DRY CONCENTRATOR

Filed Nov. 29, 1960 2 Sheets-Sheet 1

Fig. 1

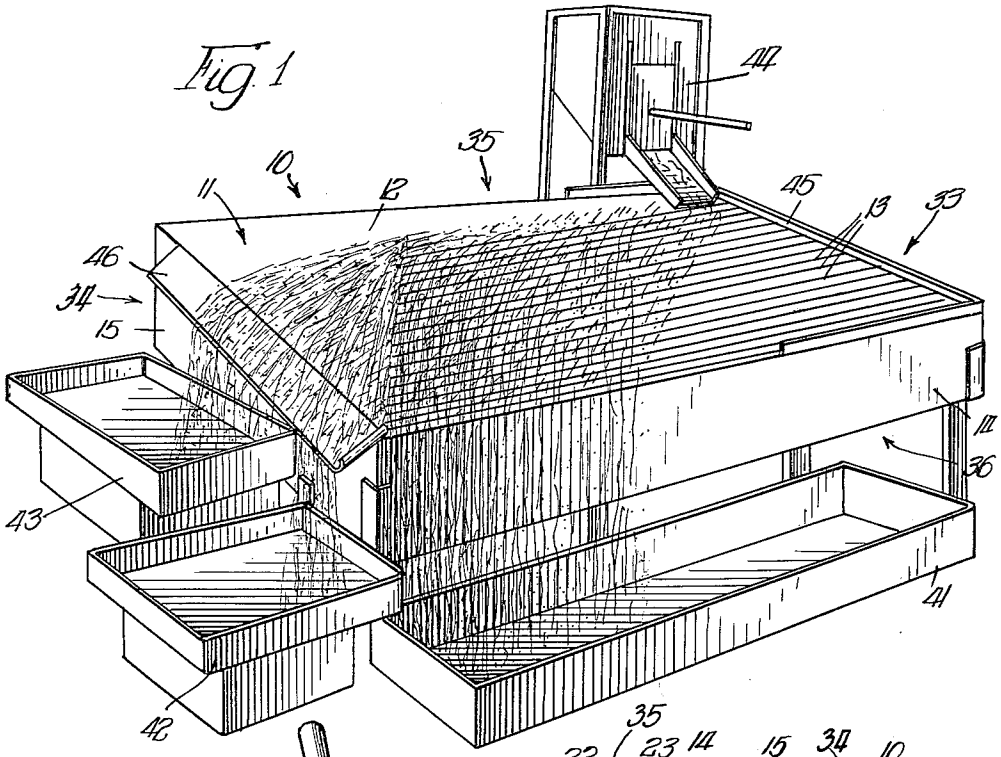
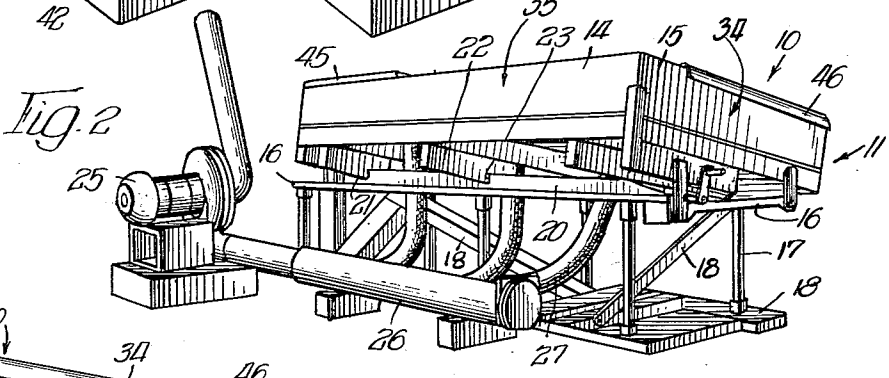


Fig. 2



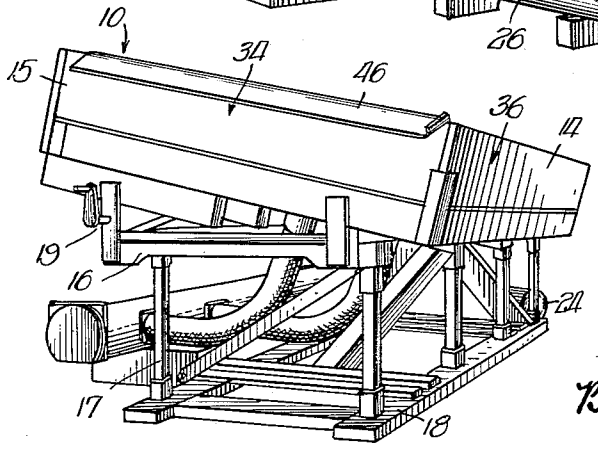


Fig. 3

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March 5, 1963 P. S. DREYFUS ET AL 3,080,056

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Filed Nov. 29, 1960 2 Sheets-Sheet 2

Fig. 7

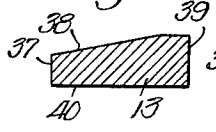


Fig. 8

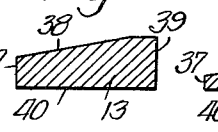


Fig. 8a

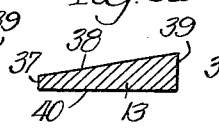


Fig. 8b

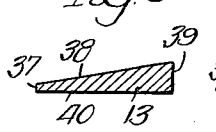


Fig. 8c

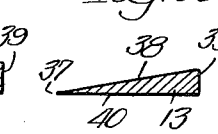


Fig. 4

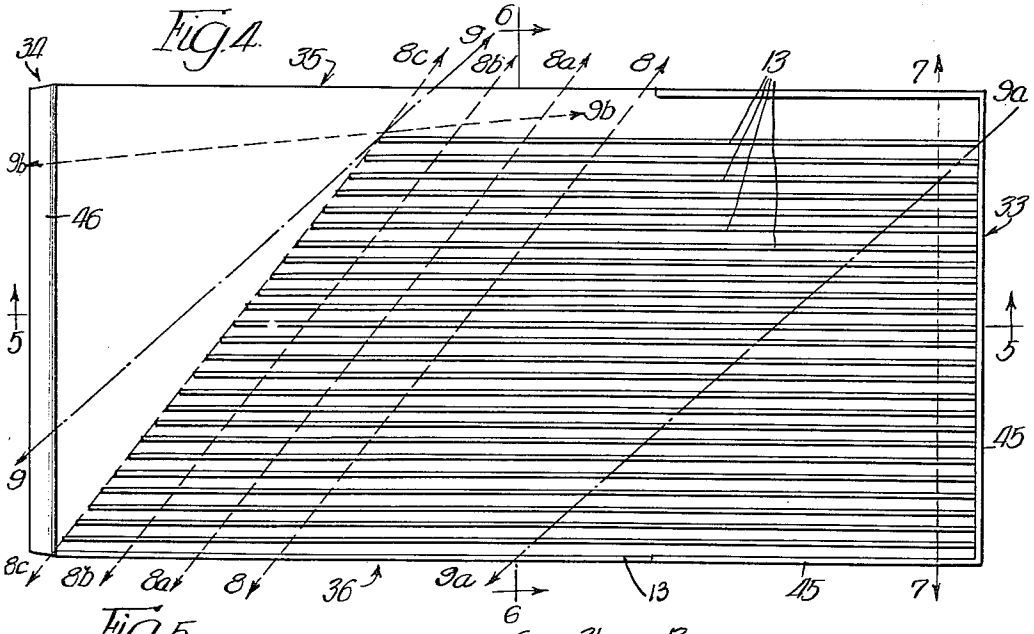


Fig. 5

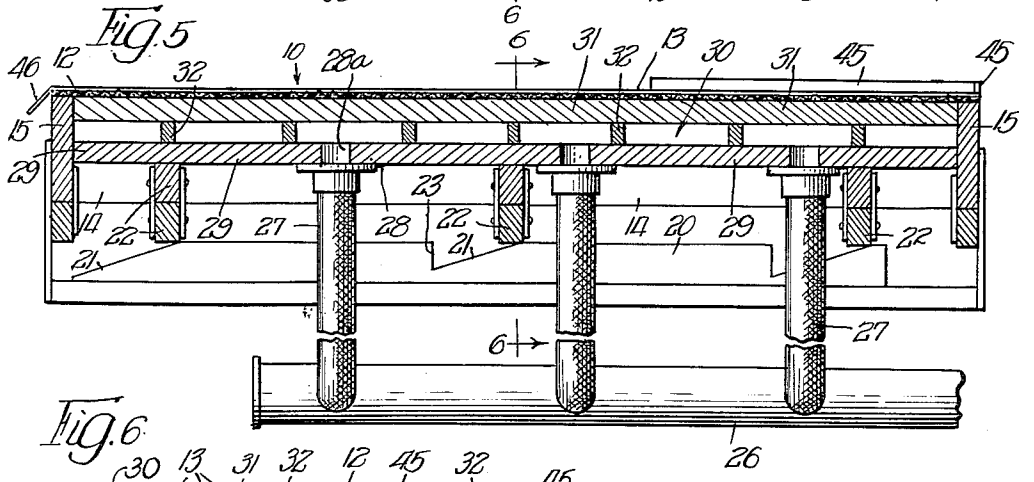
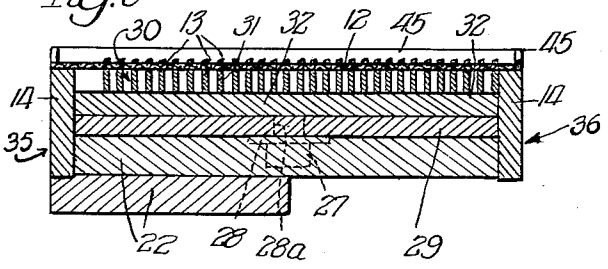


Fig. 6



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3,080,056
DRY CONCENTRATOR

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Filed Nov. 29, 1960, Ser. No. 72,462
4 Claims. (Cl. 209—466)

This invention relates to improvement in a dry concentrator and, more particularly, to a concentrating table having riffles of a novel construction for separating valuable material from waste material while in a dry state.

It is an object of the present invention to provide a table for the separation of a mass of material, composed of parts having different characteristics, such as the yield from mines and the like, in order to concentrate the valuable particles therein and to separate the same from the waste particles, without requiring the use of water.

It is another object of the present invention to provide a dry concentrator for the separation of mixed particles of sized and graded material according to the specific gravity of such particles.

It is a further object of the present invention to provide a dry concentrator for operation upon a continuously flowing stream of mixed material, commonly referred to as heads, so as to effect a separation of the valuable and waste particles from each other.

It is yet a further object of the present invention to provide a dry concentrator for the recovery of valuable particles from mixed materials by the use of an apparatus which minimizes the loss of valuable particles, thereby reducing the concentrating costs.

It is a still further object of the present invention to provide a dry concentrator comprising a separation table having means for uniform air floatation in combination with a plurality of spaced riffles of a novel construction, thereby producing a percentage recovery not possible with the type of dry concentrating table available prior to the present invention.

Other objects and features of novelty will be apparent from the following specification, when read in connection with the accompanying drawings, in which certain embodiments of the invention are illustrated by way of example.

In the drawings:

FIGURE 1 is a perspective view of one embodiment of a dry concentrating table embodying the principles of the present invention, and specifically illustrating the introduction of heads at the upper side and head end of the table, the discharge of gangue or tailings from the lower side of the table, and the capture of concentrate and middlings from the foot of the table;

FIGURE 2 is a reduced scale perspective view from the left rear of the dry concentrator shown in FIGURE 1, specifically illustrating the means for introducing uniform air pressure to the deck of the table;

FIGURE 3 is a reduced scale perspective view of the foot of the dry concentrator illustrated in FIGURE 1, specifically illustrating the means for regulating the angle of inclination of the table;

FIGURE 4 is an enlarged scale top plan view of the table deck of the dry concentrator shown in FIGURE 1, specifically illustrating the alignment of the riffles in this embodiment of the invention;

FIGURE 5 is a sectional view taken along the line 5—5 of FIGURE 4;

FIGURE 6 is a cross-sectional view along the line 6—6 of FIGURES 4 and 5;

FIGURE 7 is a greatly enlarged cross-sectional view of any one riffle along the line 7—7 of FIGURE 4;

FIGURE 8 is a greatly enlarged cross-sectional view of any one riffle roughly along the line 8—8 of FIGURE 4, it being understood that the section is normal to the riffle even though line 8—8 traverses the riffle at an angle;

FIGURE 8*a* is a greatly enlarged cross-sectional view, similar to that of FIGURE 8, along the line 8*a*—8*a* of FIGURE 4;

FIGURE 8*b* is a greatly enlarged cross-sectional view, similar to that of FIGURE 8, along the line 8*b*—8*b* of FIGURE 4; and

FIGURE 8*c* is a greatly enlarged cross-sectional view, similar to that of FIGURE 8, along the line 8*c*—8*c* of FIGURE 4.

Although this invention may find application for the separation of any dry materials having a difference in their specific gravities sufficient for the concentration of one or more of such materials, such as seeds, coal and metallic ores, the operation of this invention will be described in relation to the separation of metals, by way of example, and it is to be understood that the invention is not limited merely to the separation of metals.

Since nature usually creates metals in an impure state, it is necessary to separate the impurities from the ores before the valuable metals can be smelted. Depending upon the nature of the ore, the mineral in which the metal is contained, the other minerals that are associated with it, and the grain size and texture of the mineral aggregate, a wide variety of treatment processes may become applicable in order to determine what can be done with the material after it has been mined. The science of metallurgy has developed a specialized knowledge for the determination as to what method of treatment is best suited to the ore, what portion of the metal can be recovered, and how much its recovery will cost.

Recovering a metal from its ore involves two kinds of processes, one being purely physical, the separation of the metallic mineral from its gangue, and the other being chemical, breaking down the metallic mineral itself to recover the metal and get rid of the other elements that are combined with it. The metal that either of these processes yield is rarely completely free from undesirable impurities; therefore, it needs refining before it is ready for the market.

Physical concentration, reduction, and refining are therefore, the three standard steps in the treatment of a typical ore; but one or even two of these steps can be omitted in special cases. If the ore is to be reduced by smelting, it usually pays to concentrate it at the mine before shipping it to the smelter, unless the smelter is close at hand. It follows that the primary reasons for concentration are to avoid paying freight on valueless rock and to reduce the tonnage of material that is to be treated by the smelter. An additional reason is that metals in certain complex ores can be separated from each other more economically by milling than by smelting.

The ores that are fed to a mill are known as millheads or simply heads. The product from the mill is com-

monly referred to as concentrate and the material that is discarded is known as gangue, tails or tailings.

The effectiveness of mill operation is indicated by two factors: percentage recovery and ratio of concentration. The meaning of these terms will be evident from the following example. Suppose that during a day's run a mill treats 100 tons of lead ore assaying 4 percent lead and produces 6 tons of concentrate assaying 60 percent lead. The ratio of concentration is 100 to 6 or 16.67 to 1. The recovery is calculated as follows:

Ores	Tons	Percent Lead	Lead Contained, tons
Millheads	100	4	4.0
Concentrate	6	60	3.6
Tailings	94	0.42	0.4

The percentage recovery is 3.6 divided by 4.0, or 90 percent. The 0.4 ton of lead unaccounted for amounts to a 10 percent loss, presumably in the tailings, which should have a weight of 94 tons, excluding water, and therefore assay 0.42 percent lead.

In a well-managed mill the heads and concentrates are systematically weighed and sampled as a matter of routine. The tailings are sampled also; but, as they will have been diluted by a large volume of water, except where a dry concentrating process is used, their weight is difficult to determine directly; therefore, their weight is usually estimated by deducting the weight of concentrate from the weight of millheads. The results of these samples should check; that is, the weight of concentrates times the assay of concentrates plus the weight of tailings times the assay of tailings ought to equal the weight of millheads times the assay of millheads. If this equation does not balance, there is something wrong with the sampling or weighing, or with both. In small mines the discrepancy is likely to be found in the figures for millheads; where there is no automatic sampler, the millheads are often sampled casually; and where there is no mechanical weighing device, their weight is commonly estimated from the assumed weight of a carload or skipload of ore, a factor that may lead to cumulative error unless it is checked periodically.

One method of ore concentration is hand picking. Primitive as it is, hand sorting can be the most economical method of concentration when circumstances favor it. In its more modern form, hand picking is facilitated by mechanical aids. The ore, after coarse crushing, goes over a screen to separate the fines and under a spray to wash off dust and mud. Then a broad conveyor belt, or, less commonly, a revolving table, carries it in front of the pickers. Used alone, hand picking is likely to be wasteful; if the valuable material is picked out of the waste, there will be execessive loss in the residue. But, as a preliminary to mechanical concentration, hand sorting is often the cheapest method of separating ore from waste at coarse sizes. It may be employed either to get rid of part of the gangue and wall rock or to collect pieces of high grade ore for direct shipment. In either case, it reduces the bulk of the ore that has to be milled and so, in effect, increases the capacity of the existing treatment plant.

Another method of concentration is by the use of gravity. Gravity methods are mechanical refinements of the simple processes of washing and panning. Their effectiveness depends on the difference in specific gravity between different minerals; naturally, the greater the difference the better the separation. Since a liquid buoys up a body by the weight of the liquid displaced, a particle immersed in water has its apparent specific gravity reduced by 1. That is, if a specific gravity of a gangue mineral is 3 and that of a metallic mineral is 5, their relative weights in water are as 2 to 4.

But the size as well as the specific gravity of a particle affects its behavior in a liquid. Large particles of light minerals settle as fast as small particles of heavy minerals. For this reason separation is imperfect unless the particles all have the same size. Uniform sizing becomes especially important among fine particles. Among particles of very small size, gravity separation is not efficient. Therefore, brittle minerals that tend, on grinding, to yield a high prooprtion of slime give poor separation by gravity methods.

A great variety of machines has been used in gravity concentration, but much the commonest are jigs and vibrating tables. Auxiliary to these are boxes and cones of various forms designed to permit settling in an ascending current of water. Various types of gravity concentrators are used in combination with other treatment processes. Thus, ore in a relatively coarse state may pass thrdough jigs before floatation or cyanidation. The jigs take out large grains of heavy mineral and save the added expense and the possible tailing loss that would be incurred if this fraction of the material went through the complete process. Tailings from floatation or cyanidation are sometimes passed over slime tables to pick up valuable particles that have escaped recovery.

Another method of concentration is by heavy fluid separation. This is commonly referred to as the sink-and-float process. This process operates most successfully on coarse ore from 2 inches down to ¼ inch, but it has been used on some types of ore as fine as 48 mesh which is about the coarser limit for floatation. Thus, it competes with jigging, hand sorting, and the coarser ranges of tabling. The sink-and-float method is best adapted to ore that breaks in such a way that the valuable mineral or the gangue, or both, occur in chunks of fairly large size. For most ores it is a preliminary to further concentration by floatation or other methods. When used as a pre-concentration process, it may serve either to recover a coarse marketable product, leaving a tailing that can be further concentrated, or to reject coarse waste and recover a low grade concentrate for additional treatment.

Another method of ore concentration is the floatation process. A particle of sulfide, suitably treated, floats on the surface of water while a particle of quartz sinks. This is because the quartz, unlike the sulfide, is wetted by the water; the sulfide adheres to air and the quartz to water. This same preferential adherence applies not only to mineral particles at the top of the liquid but also to the particles that are submerged. Thus, sulfied particles adhere to bubbles of air and are buoyed upward as the bubbles rise to the surface. Although each mineral behaves in its own way with regard to adherence to air or water, the natural tendencies may be modified almost at will by introducing suitable chemicals into the pulp (mixture of water and finely ground ore). The practice is to mix the appropriate reagents into the pulp and cause air to bubble up through the mixture. The sulfide particles rise with the air bubbles to form a froth which overflows the tank and is filtered to recover the mineral-bearing concentrate.

Another method of concentration is by the amalgamation process. Mercury forms an amalgam with metallic gold and silver. This principle is utilized in the recovery of precious metals by passing a layer of pulp over a table consisting of a plate of silvered copper which has been coated with mercury. The mercury holds and partly absorbs the particles of precious metals, while gangue and sulfides pass onward. The mercury and gold are later separated from each other by distillation of the amalgam. Amalgamation is a cheap and simple process and yields a product in the form of directly marketable bullion. But it is suited only to ores in which the gold or silver occurs in native and fairly coarse particles, as is the case in placers and in many oxidized deposits. Gold that is locked up in grains of pyrite or other minerals escapes recovery. Hence, in modern lode mining, amalgamation is chiefly an auxiliary process used to recover coarse gold before cyaniding or floatation or to recover free gold

from floatation concentrates. It no longer has wide application in treating silver ores, since the proportion of silver occurring in native form is small.

Another method of ore concentration is by the magnetic separation process. Magnetic methods have long been used for concentrating magnetite or iron ores. The other iron oxides, hematite and goethite, as well as carbonate and ciderite, are virtually non-magnetic, but they may be converted into artificial magnetite by controlled roasting. Magnetic separation occupies a limited but useful field chiefly in the concentration or cleaning of ferrous ores and for separation of other magnetic materials that do not respond to floatation.

Mining, as most other businesses, is a matter of watching pennies. In the case of nearly all mines, two of the largest expenses are transportation and smelter costs. However, if the values in the native ore can be boiled down to a small part of its original bulk, the hauling and smeltering of useless mass can be eliminated, and these costs can be lowered to a point where they do not eat up most of the profits.

There is little problem where water is available; many different and varied water separators have been built to run with a fairly high degree of retention and selection. Unfortunately, where there is no water, a mining property, unless it has exceptionally high values, cannot profitably operate, since there is no dry machine available to do what water does in more fortunately located mines.

Throughout the world are vast areas where water is not available but which contain large and rich ore deposits. These certainly would have been developed were water near. Specifically, in our country large parts of the West and the Southwest fall in this category. Known properties which from a cost standpoint today would be considered losing or marginal operations could be transformed into profitable ventures with the advent of any efficient dry ore concentrator.

In the last century, in this country alone, from 800 to 1000 different machines have been commercially developed to solve the problem of dry concentration. Most of these were unsuccessful, but a few have had a fair degree of efficiency in percentage recovery, though not enough where volume was a factor.

By way of example, one of the earliest of the dry concentrators was a machine that depended upon gravity and an air current to separate the lighter material from the valuable metal desired to be recovered. The material was sized and sent to separators adjusted to the size; the sized material was fed onto a frame covered with a coarse heavy cloth, across which were riffles about four inches apart. The frame formed the upper side of a bellows that was turned by a crank having a fly wheel. The puffs of air through the cloth agitated the gravel; and, aided by the slope of the frame, the waste was discharged at the lower end, while the heavier valuable material was retained in the riffles. The gravel and valuable material retained by the riffles were brushed off into a tub, and, after a sufficient quantity of this concentrate had accumulated, it was put over the machine a second time. The concentrate from the second operation was then separated into its various components, such as black iron sands from gold, by means of a magnet.

The art has demonstrated many improvements over this early type of dry concentrating table. Nevertheless, the dry machines that have put to use such improvements as have been developed heretofore have notably failed to achieve a percentage recovery of much more than 75 to 85 percent. In fact, even wet tables have rarely recovered more than 85 percent of the valuable ores present in the mixed materials being concentrated, except by the exercise of extreme and careful control, where 90 percent has been recovered by water.

Routine runs on the dry table of the present invention have produced percentage recovery between 93 and 98 percent of the valuable ores.

It must be taken into consideration, however, that the dry table predominantly is not out to compete with the wet table, for the dry table is intended for use in areas where wet tables are geographically precluded. As a general rule, ores which are incompatible to a wet table are also incompatible to a dry table. However, the dry table does not slime as much as a wet one; it does not lose the values of water soluble ores; and ores which tend to float due to their characteristics of water surface tension are unaffected on the dry table.

A preferred embodiment of the improved machine of the present invention comprises a standard-size separation table, four feet wide and eight feet long, whose bed is constructed of a porous material, such as cloth, porous tile, or fine wire screen, which allows air forced from underneath to permeate evenly where its distribution is desired. This distribution is controlled by air valves underneath the table bed. Along the top of the table are riffles to hold the heavy materials. The table is vibrated longitudinally, and the vibrations are controlled as to speed and length of stroke. The whole table is angled laterally so that one side is higher than the other. Mixed material is fed at the upper side and head end of the table by a hopper. When this material hits the table deck, the air forced through the deck has a tendency to make the material buoyant, and the heavier particles are retained by the riffles and carried down to the foot of the table, while the lighter particles (gangue) cascade over the riffles and are discharged off of the lower side of the table. The overall effect is that the gangue is constantly eliminated over the lower side, and the concentrates ride the length of the table and are captured.

In order to agitate the table longitudinally, suitable means must be provided, such as an over-balanced pulley working against springs and a bumper, and affording a complete stop every time it makes one revolution. Such agitating means is common in this art and may be operated by any standard motor suitable to the geographic location of the operation.

In order to provide uniform air pressure through the perforated deck of the table, it is necessary to produce a back-pressure in the air chamber. Also, depending on the type of ores and the fineness of grind, there must be a suitable means for regulating the uniform air pressure so as to provide more air pressure when the millheads constitute a coarser grind and less air pressure for the more fine grind of ores. It is to be understood that any of the suitable constructions common and available for performing these functions of producing and regulating uniform air pressure may be utilized.

The improvement of the present invention lies primarily in the novel construction of the riffles in combination with certain preferred features in themselves old in the art of dry concentrators. These riffles may be constructed of any suitable material, such as metal, wood, or any of the plastic fibers, and may be suitably aligned along the deck in parallel spaced relationship longitudinally or at any angle to the dimensions of the table. It is preferable that the riffles be of graduated lengths, those at the upper side being shorter at the discharge end than those at the lower side, so as to permit any gangue retained by the riffle to flow laterally; however, it is to be understood that this aspect is only preferential and not a limitation. It is also preferable that gates or dams running normal to the aligned riffles be eliminated so as to avoid any damming up and re-mixing of the material after it has begun to concentrate.

Many of the riffles of the prior art are too high and sharp. Most ores are granular and have sharp edges like facets in crystals. In order to more efficiently hold the concentrate and let the lighter gangue flow over, the present invention embodies a riffle having a longitudinally

tapered construction in combination with a laterally bevelled construction.

In the preferred embodiment illustrated in the drawings, the tapered construction of the riffle is restricted to that portion of the riffle associated with the foot of the separating table. The art discloses, besides the non-tapered variety, riffles tapered on an inclination running the entire length of the riffle, and it is to be understood that this invention is not limited to such a restricted-tapered riffle, but embraces the fully-tapered riffles, nontapered riffles, and any other construction of partially-tapered riffles as well.

Thus, the present invention entails the construction of a dry concentrator for the separation of valuable material and gangue from millheads, comprising, in combination with a laterally-inclined separating table, a plurality of aligned, spaced riffles mounted on said table, each riffle being tapered toward its foot and having an upper leading edge that is bevelled so as to retard the action of air floatation in relation to such valuable material as would otherwise be dissipated and lost in the tailings.

Just as some gangue may be retained by the riffles and caused to transverse the table longitudinally, some of the concentrates are blown over the riffles as a result of the air floatation and are passed off into the tailings and lost. The percentage loss of valuable material has been found to be as high as from 10 to 25 percent with a riffle construction as in the prior art, but has been reduced to form 2 to 7 percent by machines utilizing the teaching of the present invention.

One explanation for this result may well be that such concentrate as is blown up by the air floatation process passes over the bevelled riffle, thereby is removed from the air stream and allowed to fall on the riffle, where a portion will be retained by the bevelled edge and passed longitudinally, being substantially unaffected by the air floatation process while so retained. It will thus be seen that some concentrate will be retained by each riffle base, some concentrate will be retained by the bevelled edge on the riffle, some concentrate will pass over the riffle for similar action in relation to the succeeding riffles, and ultimately some concentrate will be lost in the tailings.

Another explanation for this result, which is not entirely understood by the inventors, is that static electricity may well be set up as a result of the air passing through the deck under pressure and up through the ore carried thereon. This static electricity has a tendency to attract most ores that have a small degree of magnetic qualities in them, such as tungsten, magnetite iron, manganese, garnet, gold with iron, and others, and to hold these ores to the deck of the separating table. As illustrated in FIGURE 1 of the drawings, it has been found that the concentrates that have passed in a longitudinal direction beyond the bounds of the upper, shorter riffles stay at substantially the same lateral position high on the deck while continuing to move longitudinally, desipte the absence of riffles. The direction of movement of the concentrates is illustrated by the line *9b—9b* in FIGURE 4. It is believed that the static friction built up, as described, acts to hold the concentrates in relatively the same position on the table laterally, while the reciprocal motion of the table keeps the concentrates moving along the table longitudinally.

Referring now more particularly to the drawings, FIGURES 1–3 show one preferred embodiment of the present invention, in which the dry concentrator is denoted generally by the reference number **10**. The dry concentrator **10** comprises a separating table **11** having a deck **12** along which are aligned a plurality of spaced-apart riffles **13**. The deck **12** is supported by side members **14** and end members **15** suitably fastened together to form the table **11** in a structurally sturdy manner. The table **11** is suitably supported on a frame **16** mounted upon flexible legs **17** which are in turn mounted on a platform **18**. The table **11** is articulated with relation to the frame **16** and may be elevated on one side by means of a crank **19** controlling elevating mechanism (only partially shown) of any suitable design. In the illustrated embodiment the elevation of the table **11** is controlled by a guide member **20** mounted on the platform **18** and having suitable guide slots **21**, in combination with depending carriage members **22** mounted on the table **11** and cooperating with the guide slots **21**. The carriage members **22** ride upon the guide members **20**; and the extent of upper elevation is determined by the height of the guide member, while the extent of lower elevation is limited by a bumper **23** in each slot **21**.

The flexible legs **17** provide leeway for longitudinal movement of the table relative to the platform **18**. Any suitable means known in the art for agitating or vibrating the table, such as an electric or gasoline motor **24** and an over-balanced pulley (not shown) working against springs and a bumper (not shown), may be provided to reciprocate the table longitudinally. The table is brought abruptly to a complete stop every time the agitating means makes one revolution; it is operated at between 200 and 500, and preferably 300 cycles per minute.

Any suitable means may be provided for maintaining uniform air pressure beneath the deck **12**. In the preferred embodiment shown in the drawings, a motor driven compressor **25** draws air from the ambient atmosphere and impels it through a central tubular member **26** from which the air is circulated through supplementary hoses **27** and introduced through gaskets **28**, connected with openings **28***a* in a floor **29** of the table **11**, into an air chamber **30** below the deck **12**. The construction of the table **11** is such as to permit the air pressure within the air chamber **30** to build up to a desired value so that, when the air flows through the table deck **12**, it is released at a uniform total pressure over the surface of the deck **12**. However, since different types of ores require different degrees of air pressure depending upon the nature and size of the ore, any suitable regulating means may be provided in combination with the compressor **25** to produce the desired degree of pressure within the air chamber **30**.

The table deck **12** is air-permeable and may be of any suitable construction, although it has been found that a layer of glass fibers or other building insulation material, having a thickness of approximately 1 inch, upon which has been stretched a cloth of metal or fiber, having a mesh of minus 260, will operate in a manner to provide suitable back-pressure of the air within the chamber **30**. The deck **12** may be supported by ribs **31** of a thickness comparable with that of the riffles **13** and which are mounted in alignment with and directly beneath each riffle. These ribs **31** are in turn supported by cross rails **32** within the table **11**. Such a construction provides an open chamber **30** and avoids the appearance of blank spots, other than at the riffles, on the table deck **12**, which blank spots would otherwise produce undesirable whirlpools and tornados in the material being separated.

The riffles **13** may be constructed of any suitable material, such as metal, wood or fiber, and are aligned along the deck **12** of the table **11** in spaced, parallel relation, running from the head **33** toward the foot **34**. Those riffles nearer to the upper side **35** of the table **11** are shorter than those nearer to the lower side **36**. This is to permit such gangue as is retained by the upper riffles to flow laterally off the lower side **36** of the table **11**. Each riffle **13** may be tapered toward the foot of the table to further aid in the release of gangue. In the preferred embodiment shown in the drawings, the riffles begin tapering at a point approximately 2 feet from the end of each riffle. Thus, the taper begins generally along the line **8—8**, as shown in FIGURE 4, and is completed at the end of the riffle, on the line *8c—8c*. Cross-sections illustrating the taper in the riffles **13** have been taken at in-

termediate points along the lines 8*a*—8*a* and 8*b*—8*b* of FIGURE 4, and are illustrated in the corresponding figures. At the same time, the leading edge **37** of each riffle **13** is bevelled, extending throughout the length of the riffle. This bevelled surface **38** is shown more clearly in FIGURES 7–8*c*. A trailing or lower edge **39** of each riffle is normal to the base **40** of the riffle **13**. In the operation of the dry concentrator **10**, the table deck **12** is adjusted to the desired angle of inclination depending on the type of materials being concentrated. It will thus be seen that the bevelled surface **38** of the riffles **13** is substantially in a plane parallel to the ground although it may vary from this horizontal position depending upon the adjustment of the deck **12** of the separating table **11**.

Suitable means for catching the separated materials may be provided, such as a tray **41** at the lower side **36** of the table to catch the tailings, a tray **42** at the lower foot **34**, **36** of the table to catch the middlings, and a tray **43** at the upper foot **34**, **35** of the table to catch the concentrates. The mixed ores are introduced at the upper head end **33**, **35** of the table by means of a suitable hopper **44**; and a suitable railing **45** may be provided at the head end **33** and extending around the upper and lower sides **35**, **36** to prevent any discharge where there is no means provided for catching the same. An apron **46** may be provided at the foot **34** of the table to assist in discharging the concentrates and middlings.

Another embodiment of the present invention proposes a saving in energy input by the provision of suitable means to block off those portions of the deck **12** where the materials to be separated do not normally flow. As will be seen from the drawings, the material usually flows from the upper head end **33**, **35** of the table **11** toward the lower foot end **34**, **36** of the table, and little if any material comes in contact with the lower head end **33**, **36** or the extreme upper foot end of the table **11**. A substantial saving in energy will be entailed by either blocking the air-permeable deck in these pertinent areas or by providing a non air-permeable deck at such areas. It will also be seen that the riffles may be shortened at the lower head end **33**, **36** just as they are shortened at the upper foot end **34**, **35** as illustrated in the drawings. This modification may be made for the same reasons that the deck is non air-permeable in this area, that is to say, that the simplicity of construction will work a saving in the ultimate cost of operation of this machine.

Although the operation of this invention has been described in relation to the recovery of heavier valuable concentrates and the disposal of lighter weight materials, it is to be understood that some valuable ores have a lighter specific gravity than the gangue with which it is disposed. An as example, in order to recover mica, which has a relatively light weight, from its ore, such recovery would be instituted by capturing the lightest portion of the tailings coming off the lower or tail side **36** of the table. The tailings discharged from the middle of the lower side **36** along the line 9*a*—9*a* have a tendency to be lighter than the tailings coming off of the lower corner **34**, **36** of the table. By making a division of the tailings such light materials as mica may be readily recovered from the ores.

Another embodiment of the present invention entails the addition of a cut-off riffle (not shown) which might be mounted on the deck **12** along the line **9**—**9** of FIGURE 4. Such a cut-off riffle would be of a similar construction to the other riffles of the machine and would additionally aid in the division of concentrates and middlings.

As examples of the percentage recovery produced in machines utilizing the teaching of the present invention, the following results from actual test runs and laboratory analyses are given:

Example 1

400.5 pounds of gold placer sand having a size of minus 20 plus 60 mesh was introduced to the dry concentrator as millheads. Operation of the machine produced 10.75 pounds of concentrates or 2.7 percent of the original weight of the millheads; 74 pounds of middlings or 18.5 percent of the original weight; 305 pounds of tailings or 76.1 percent of the original weight; and 10.75 pounds or 2.7 percent by weight were lost. The test run lasted for 12 minutes at the rate of 1 ton of ore per hour. Assaying determined that 100 percent of the gold in the millheads was 0.01 ounce per ton of ore; the concentrates assayed at 0.33 ounce of gold per ton of ore or 88.5 percent of the total gold values represented; the middlings assayed at 0.0025 ounce per ton or 4.6 percent of the gold values represented; the tailings assayed at nil; and a gold loss of 6.9 percent was incurred. Since the middlings are passed through the concentrator a second time, the total percentage recovery of gold for this test run was 93.1 percent, being the sum of the recovery percentages for the concentrates and middlings.

Example 2

This test run was made on 292.75 pounds of tungsten ore, containing both scheelite and hubnerite minerals, ground to minus 20 plus 60 mesh. After seven minutes of operation at the rate of 1.25 tons of ore per hour, the concentrates were determined to weight 17.75 pounds or 6.1 percent of the original weight of the headings; the middlings weighed 44.25 pounds or 15.1 percent of the original weight; the tailings weighed 224.25 pounds or 76.6 percent of the original weight; and there was a loss of 6.5 pounds or 2.2 percent of the original weight. The heads assayed 3.85 percent tungsten (WO_3), being 100 percent of the values represented; the concentrates assayed 57.95 percent tungsten or 91.3 percent of the values represented; the middlings assayed 1.35 percent tungsten or 5.3 percent of the values represented; the tailings assayed 0.15 percent tungsten or 3.0 percent of the values represented; and the loss amounted to 0.4 percent of the values represented. Thus, the total percentage recovery (concentrates plus middlings) was 96.6 percent.

It will be apparent from the foregoing description and explanation that the invention provides a dry concentrator having numerous advantages over dry concentrators of this type previously available.

While the arrangement of the invention described herein is at present considered to be preferred, it is understood that variations and modifications may be made therein, and it is intended to cover in the appended claims all such variations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a dry concentrator, a generally horizontally disposed separating table adapted to be longitudinally reciprocated, said table having a head end and a foot end, means for inclining said table to the horizontal along a longitudinal axis so as to establish a lower side and an upper side thereof, an air permeable deck on said table, means to supply air under pressure beneath said deck, a plurality of riffles mounted on said deck and extending longitudinally of said table, said riffles being laterally spaced a predetermined distance apart on said deck, each of said riffles having an upper surface bevelled such that said surfaces lie in generally horizontal planes when said table is inclined.

2. In a dry concentrator, a generally horizontally disposed separating table adapted to be longitudinally reciprocated, said table having a head end and a foot end, means for inclining said table to the horizontal along a longitudinal axis so as to establish a lower side and an upper side thereof, an air permeable deck on said table, means to supply air under pressure beneath said deck, a plurality of riffles mounted on said deck and extending longitudinally of said table, said riffles being laterally spaced a predetermined distance apart on said

deck, a section of each of said riffles tapering toward said foot end, each of said riffles having an upper surface bevelled such that said surfaces lie in generally horizontal planes when said table is inclined.

3. The dry concentrator of claim 2 further characterized in that each tapering section comprises an end section of a corresponding riffle adjacent said foot end.

4. In a dry concentrator, a generally horizontally disposed separating table having a head end and a foot end and adapted to be longitudinally reciprocated, means for inclining said table to the horizontal about a longitudinal axis so as to establish a lower side and an upper side thereof, an air permeable deck on said table, means to supply air under pressure beneath said deck, a plurality of riffles mounted on said deck and extending longitudinally of said table in spaced relationship a predetermined distance from each other, the ends of said riffles

adjacent said foot end terminated progressively further from said foot end between said lower side and said upper side, a section of each of said riffles tapering toward said foot end, said tapered sections being of generally equal length, each of said riffles having an upper surface bevelled such that said surfaces lie in generally horizontal planes when said table is inclined.

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