W. N. DIMMICK.

METHOD AND APPARATUS FOR SORTING PARTICLES OF SOLID DIVIDED MATERIAL BY A CINEMATIC PROCESS.

APPLICATION FILED MAR. 6, 1920.

**1,435,382.** **Patented Nov. 14, 1922.**

2 SHEETS—SHEET 1.

*Fig. 1.*

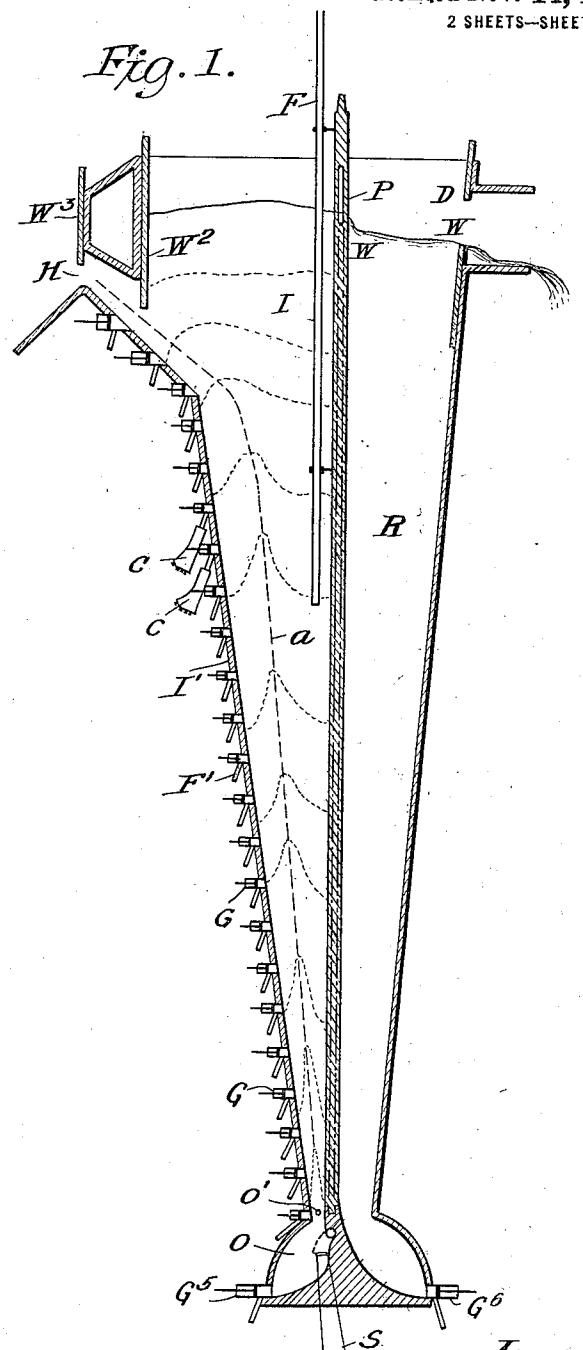
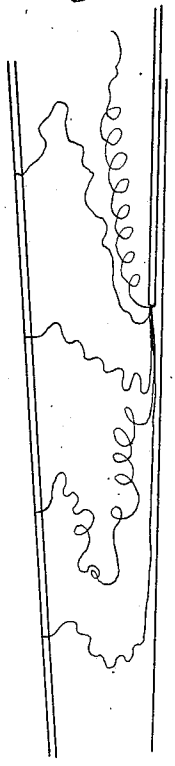



*Fig. 3.*



*Inventor*
*Walter N. Dimmick*
*by his Attorneys*
*Townsend & Decker.*

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2 SHEETS—SHEET 2.

Fig. 2.

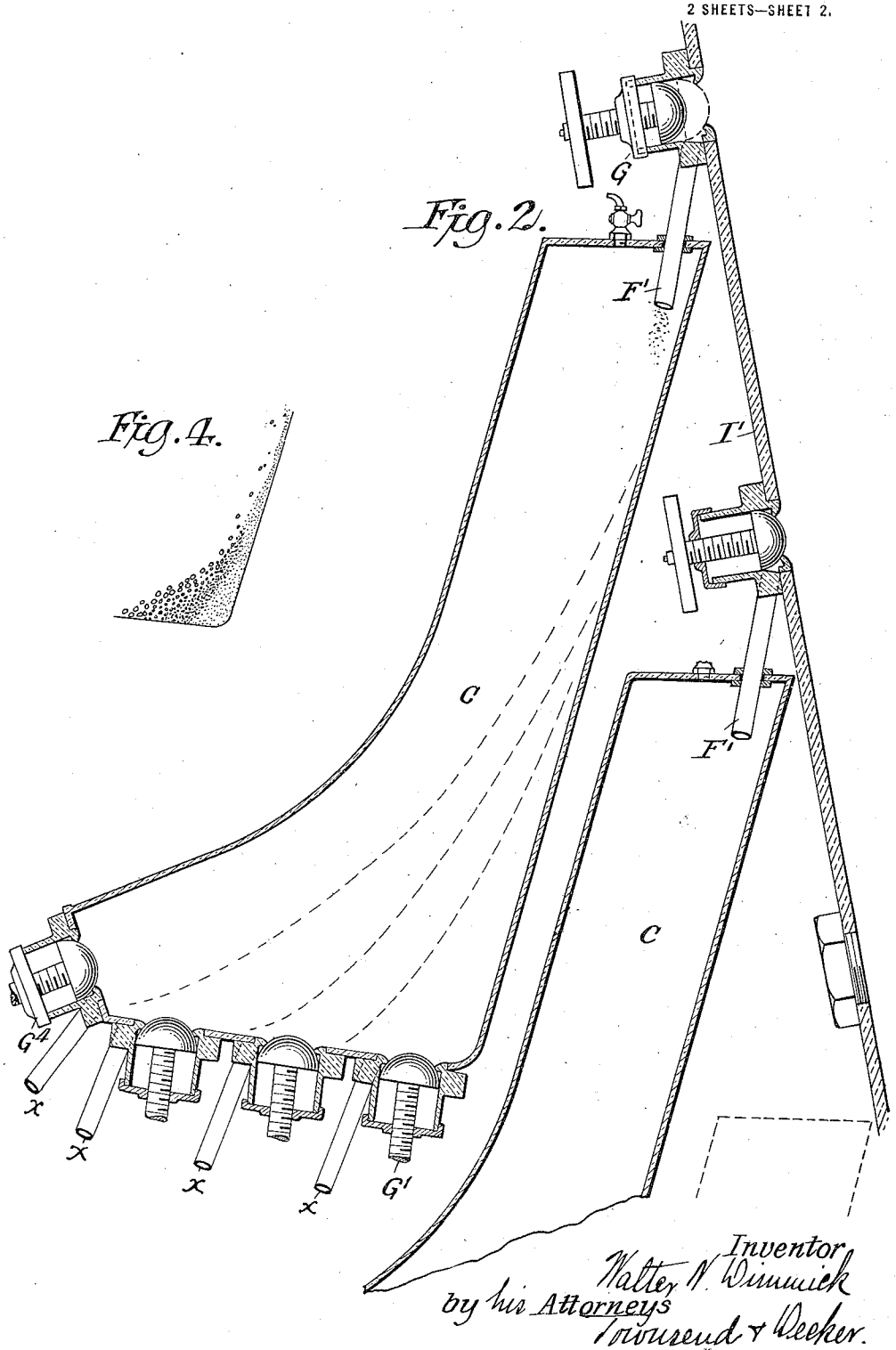



Fig. 4.



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# UNITED STATES PATENT OFFICE.

WALTER N. DIMMICK, OF BERKELEY, CALIFORNIA.

## METHOD AND APPARATUS FOR SORTING PARTICLES OF SOLID DIVIDED MATERIAL BY A CINEMATIC PROCESS.

Application filed March 6, 1920. Serial No. 363,724.

*To all whom it may concern:*

Be it known that I, WALTER N. DIMMICK, a citizen of the United States, and a resident of Berkeley, in the county of Alameda and State of California, have invented certain new and useful Improvements in Methods and Apparatus for Sorting Particles of Solid Divided Material by a Cinematic Process, of which the following is a specification.

My invention relates to the method of and apparatus for sorting or separating the units or particles of solid divided material into aggregates in which the particles or units approximate one another in weight or specific gravity and preferably also in volume or bulk.

The process as hereinafter described and claimed I term "The Cinematic Process."

The invention is especially useful in concentrating ores by removing the mineral constituent from the gangue or non-metallic contents and in such application may be practiced either upon metal-bearing sand or gravels as found in a natural state of division, or may be used or practiced for metal-bearing ores which, for the best results, are crushed or comminuted.

In carrying out my invention I resort to an ascending stream of fluid such for instance as water, air or steam having a graduated velocity or velocity differing or diminishing as the stream rises, and the divided solid material of whatever nature is fed into said stream and a sorting or separating effect of the different weights or particles is effected by the differences of velocity and buoying effect of the stream at different levels, the separated material being removed therefrom in its buoyed or sustained position through a side outlet or outlets, thus effecting the separation by weights rather than by volumes or bulks; the further separation and completion of the process by a sorting into particles of approximately the same bulk being effected through the agency of a body of fluid or liquid into which the collected particles or solids at the different levels are introduced in a manner to fall therein and at the same time be subjected to a sidewise displacing effect, by any suitable means, so that in certain sections and at the bottom of the body of water the particles approximating in weight will be disposed in different horizontal positions respectively, from which they may be removed by any suitable means. By this process I attain a complete and perfect specific gravity separation of the particles by weights as well as size, although as will be readily understood, the second step of separation into bulks or sizes might be omitted in cases where a rougher or less complete separation into grades of different weights is desired.

The invention consists in the method or process and in the apparatus for carrying out the same as more particularly hereinafter described and claimed.

For the separation of the solid particles or units by weight or specific gravity any steady fluid pressure for producing the ascending stream may be employed and in the case of water or other liquid is most readily obtained from a reservoir stand or head, but as will be readily understood, other means may be utilized for obtaining steady pressure and for preferably regulating the pressure to vary the volume and velocity of the flow of the liquid or fluid through kinetic energy utilized in zones of differing effect by the use of suitable means for producing a diminishing velocity of flow as the stream of liquid or fluid ascends. Obviously any required pressure or velocity of flow demanded by the nature and size of the particles or units in the divided material may be employed, but I have successfully practiced the process by using a water supply under about fifty foot head or about 21.67 pounds to the square inch with apparatus of the particular form shown in the drawings.

A pre-requisite to a successful and complete separation by my process is that the material to be operated upon be in such a state of division as will permit of the particles being graded into practically uniform sizes; this requirement is necessary in order that the proper energy may be applied without waste and with the greatest efficiency. The principles of the process are adaptable to the handling of particles of any reasonable size that may be within the scope of

apparatus constructed for the purpose. Ordinary gravel, the particles of which will pass through screens of one-quarter inch mesh, may be successfully handled for roughly selecting out the larger particles of the common minerals and such particles as may be of the more valuable and heavier minerals and metals. The process works efficiently and economically on fine placer gravel deposits. But, as only a very small proportion of the minerals composing any placer deposits are in such state of division and purity as will permit of precise separation, it is evident that the over-large pieces, especially of composite ores, must be reduced and so divided that a more intimate separation may be effected; and to that end a certain amount of crushing or grinding of the coarse material becomes necessary.

While the practical application of the principles involved is especially useful for the separation of minerals, the process is equally efficient for the separation of solids other than those popularly known as "minerals"; and when operated by one of several energies and with appropriately constructed apparatus, will effect a specific gravity separation of any solids.

In the best manner of employing my invention particularly when applied to the concentration of ores, the process requires as a preliminary or first operation the grading of the material into sizes. The second and an essentially distinctive operation is the separation of said different grades of sizes into groups of particles having the same or approximately the same weights. As the closeness of group separation necessarily depends upon the accurate weighing of the particles the apparatus is so designed that, by simple adjustment of parts, the weighing may be effected to any required degree of accuracy.

In the third operation the particles when grouped by their several relative weights are then separated into aggregations of particles having practically uniform bulks or volumes.

As to the preliminary operation in the case of ores, of mechanically dividing the ores into reasonably small particles of nearly uniform size, the product of such a division as may come from an ordinary mill may be handled with remarkably good results, but if a close concentration be required the particles should be separated into grades or ranges of sizes which, for descriptive purposes may be conveniently designated as "medium", "fine", "very fine", etc. If the product of the mill is handled as a whole without preliminary grading into sizes by screening or otherwise, care must be taken that the particles composing the pulp do not have any dimensions greater than a suitably established maximum of, say 1.5 millimeters,—or such dimensional maximum as will best serve to effect the requirements of particular cases.

The milled ore when of particles having dimensions less than the fixed maximum, may for descriptive comment be designated "standard grade". If the material to be operated upon be of standard grade very satisfactory results will be obtained, sufficient to meet all requirements for ordinary separation of the common minerals. But a treatment of a standard grade of pulp by operation number one becomes of special importance, in that it effects the separation of the particles into more definite and required grades. Any or all such sub-grades may then, if desired, be separately subjected to the next or more characteristic separation which is fully described hereinafter.

In practice it is found well worth while for the recovery of very minute particles of the more valuable minerals, to make three or more subgrades which loosely defined may be "medium" comprising those particles whose dimensions may range from say, 1.5 mm. down to .86 mm.; "fine" comprising those particles whose dimensions may range from 1. mm. down to .70 mm.; and "very fine" comprising particles whose dimensions may range from .70 mm. down to the very least occurring. A preliminary sub-division of the particles into grades having an approximate range of sizes is important when the entire principles that make up this process are to be applied for close or accurate results in the recovery of all values.

In respect to classification by bulks it should be observed that when there is sufficient variance in sizes to permit, fairly adequate separations may be accomplished in several ways, the commonest of which is screening. Screening, however, has decided limitations and becomes practicable only when a separation of certain definite bulks is required; it is not adequate to effect a separation of many very slightly differing bulks, such as this process undertakes to accurately handle. Screening or preliminary separation into grades is therefore not an essential feature of my process although it may be used to advantage in certain instances, such as, a preliminary grading of particles for the second or important operation, or when only a rough sorting is to be done.

In the accompanying drawings:

Fig. 1 is a vertical section of an apparatus by which the subsequent operations of separation by weights and then by sizes according to the principles of my invention may be carried on.

Fig. 2 is a vertical section of one of the size or bulk separators shown in Fig. 1 enlarged to full working size.

Fig. 3 is a diagram illustrating the move-

ment of particles in the weight separator part of the apparatus as they may sometimes be observed through transparent sides of the same.

Fig. 4 shows the way in which the particles dispose themselves in the size sorting compartments after the operation therein.

Referring first to the parts by which the weight separation is effected:

I is a space, vessel or duct through which is directed an ascending volume of energy,—(in the case herein described the energy is water) supplied by pipe S into receptacle O which is the point where the volume is controlled. From receptacle O the volume of water passes up through a graduated orifice O′ where the requisite maximum stream velocity is determined and applied. The water ascending in I, being of uniform volume of flow, takes a decreasing velocity as the recess enlarges upward and therefore at each horizontal line or section or zone of the interior of the recess there is a velocity which exerts a definite and a measurable energy, which when employed as a buoyant force is proportionate to the velocity at that point. The insoluble solids when fed into this ascending stream of water, by their weight submerge or emerge to, and are poised at, the point of equilibrant buoyant force.

It will be found of advantage to have the axis *a* of the flow inclined to the vertical and also to give an inclination to the outer wall I′ in which gate valves G or other means for withdrawal of the accumulation or aggregate of particles of approximating gravities are located. The vessel as shown, may be described as being a vertical plane or narrow section of an inverted cone; that is to say, it is a vessel the side walls of which are triangular and perpendicular of limited but exact distance apart; and the end walls diverging upward from the base after the manner of, and closely resembling an elongated letter V. The interior space may be likened to a narrow crevice, in which is affixed an adjustable partition dividing the interior space into two recesses I and R to be presently described. These recesses may, by a shifting of the partition, be reciprocally enlarged or diminished as may be required for accurate adjustment to different energy supply and nature and amount of work to be performed.

In the ascending stream of water or other fluid in I the divided material to be separated according to weight of its particles is fed preferably as a pulp in any suitable manner, the particles being of different weights and bulks to an extent depending upon the preliminary classification or natural state of the material operated upon.

The feeding is efficiently accomplished by a simple contrivance whereby the pulp, by gravity superimposed by a small jet of water, air or steam, is directed downward through feed pipe F into the space I at a point where it is intended the incoming pulp shall meet a buoyant force nearly equal to an average of the specific gravities of the particles that are to be recovered; such point of feed may be more particularly located as being near the center of mass of the column of ascending water. The point of proper feed will vary, of course, as the recess may be enlarged or diminished by a shifting of the partition in the adjustment of apparatus to meet different conditions or change in volume of work, but the feed pipe is made adjustable to requirements of all proper adaptation. The feed is preferably so directed that the pulp will in its downward travel have a tendency to approach on a slight tangent the curving center line of the upward stream as indicated.

The selection of particles by their respective weights is accomplished by this process in the weight separator in the following manner. The particles composing the prepared pulp, of all bulks and of varying weights, are fed into the separator at the proper point as determined. By the action of the ascending stream the particles begin the act of separation, whereby the lighter ascend and the heavier descend until each particle finds its equilibrant supporting force. The point of equilibration is first found somewhat to the side of the upward stream, but by the composition and opposition of the attending forces the particles are inclined toward the center of the stream where is a slightly less diminished velocity (hence a slightly greater buoyancy) which raises the load gradually to the highest point or apex of the equilibrium. From thence the particles gradually descend in a line of equipoise which here inclines downward conformably with the decreasing velocity and they remain at the other edge of the stream at or on the opposite side of the recess, in a nearly stationary position except for a gently vibrating motion which becomes of advantage as will appear in the description of the gate-valves G. (See diagram Fig. 3.)

The removal of each accumulating weight group is accomplished at and through the gate-valves G provided for the purpose in the foot wall I′. The number of gates required, together with their locations relative to each other, depends on the nature of the material that is under treatment as well as the size and kinds of the particles that are to be separated for recovery or removal: that is, if it be desired to effect with one operation a separation into many weight groups, a corresponding number of gates is employed.

The apparatus is constructed so that gates are installed at all the points of probable

need; and yet, in the event of certain gate-valves being unnecessary for the work in hand or infrequently required, they may remain closed or may be removed and a blank or plug substituted.

These gate-valves are preferably especially designed and constructed to facilitate the peculiar and very important conveying of the weighted particles out from the weighing apparatus and into any properly arranged receptacle, without disturbance of the groupings and without interference or hindrance of the weighing activities that may be in progress. Each gate-valve G in the wall I, as shown, is preferably provided with a concaved front whereby and with the aid given by the gently vibrating motions referred to, the particles are induced by least resistance into the concaved front of the particular open gate-valve opposite which they are assembled and the accumulations of particles of approximately the same weight fall across the abrupt valve rim, pass out through the outlet pipe F′ of the valve and are recovered or subjected to the further sorting or separation by bulk or size.

Since specific gravity is the ratio between the weights of equal volumes of substances and the standard, and since this operation makes the separations by particle weights only, it is evident that substances that are of the same specific gravity will be assembled at several of the sections of the weight separator in accordance with and as the particle bulks may be in ratio to the standard.

The accumulations then at any level or point on the lower side (or foot-wall) I′ are of particles having like weights but probably with some unlike bulks; that is, bulks will differ in proportion as the specific gravities of the material present may differ.

From this fact it is evident that if the particles have been reasonably well graded in the first instance, that is in operation number one, and the material treated be of homogeneous particles, there will be comparatively few bulk variations in any of the accumulations; but when there are variations it is noticeable that the bulks differ conspicuously. It is these marked and significant differences that enable a close bulk separation to be effected in the next or succeeding operation.

Separation by bulks or sizes:

The process of the more precise separation by slightly different bulks may be accomplished in receptacles such as indicated at C into which the material may be fed by pipes F′ which, in the apparatus shown, are connected each to its own gate-valve G in the foot-wall I′ of the weight separator. When the accumulation is separated as already described by weights and withdrawn through the gate-valves G supplemented by the action to be now described, a nearly perfect separation of varying bulks may be effected. Each chamber or compartment C receives grouped particles of approximately like weights and sorts the same into separate aggregations of particles having common bulks. As will be seen, the side wall of the compartment above which the inlet pipe F′ delivers the divided material to be sorted is inclined to the vertical. The other enclosing walls are tightly joined to the side walls, and give the vessel the shape of a boot resting on its heel with the leg and foot at certain prescribed angles to each other. The vessel C is tightly enclosed in order that there may be no escape of water or air except, that when it becomes desirable or necessary to draw off either air, water or any of the accumulations, certain valves provided for the purpose may be opened to facilitate such removal.

The compartments when working enclose a volume of still water or air; that is to say, a volume having the same compression as the adjoining section of I, but being unaffected by the passing stream velocity is in a state of comparative quiesence.

The conducting pipe F′ delivers the divided material into the compartment at a slight angle so that a slanting direction will be given to the particles as they enter the still water below. And as all particles that enter a particular compartment are of very nearly the same weight, the smallest particles will settle out of the slanting line more directly, and with greater speed than will the larger; because of the fact that small particles have less resisting surface, and in settling cause less displacement of the water or other fluid, as for instance air, than do the larger particles.

Now, as very nearly the same gravity pull is in effect on each particle, it is obvious that the water resistance and displacement determines the speed of descent; and on the other hand, the smallest particles settle out more directly than do the larger, because having less exposure of surface they have less inclination to glide in the slanting direction that is imparted by the sloping induction tube. The smallest particles are therefore foremost in reaching the sloping side (or foot-wall) of the compartment which they follow downward with accelerating speed as they accumulate in mass weight; while the larger particles, travelling downward more slowly and floating farther out into the still water, air or other fluid, tend to land further down and on the forming stratum of finer particles riding on the foot-wall. In the same manner will lodge each and all of the several sizes that may arrive,—the smallest on the lower sloping side or foot-wall and the differing sizes will be deposited and arranged in respective strata graduating upward and outward, with the

very largest of the particles in conspicuous layers on the extreme outward margin of the heap. In these positions will ride the mass without disturbance until the bottom of the compartment is reached, where the different layers of graded sizes spread out in aggregations without perceptible disturbance, except that in the spreading out movement the applied new principle exerts a further and a very decided corrective separation by the sizes.

In this connection attention should also be called to the fact that the smallest particles, be they few or many, actually do work down behind or through any amount of larger particles that may have preceded, and they find their proper assemblage in the lower section of the compartment.

As the particles that enter any single compartment C are all of very near the same weight, regardless of any variances in size and being of nearly the same weights the gravity pull is the same (very nearly) on each particle; therefore in the perpendicular direction, downward, the force that applies on each particle is equal. These perpendicular and equal forces, as such,—that is, forces of equal stress exerted in a downward direction,—are lacking in the particular characteristics that make for sorting in still water, and as these are the only forces present or available, it therefore becomes necessary to convert these forces into such as will answer the need and perform the service.

The necessary conversion of force-effect is made by changing the perpendicular stress in part, into a partial sidewise movement or stress. This is done by changing the direction in which gravity must exert its forces; and is accomplished and controlled by the rigid foot-wall being fixed at the proper angle to give a sheering movement that will apply a portion of each gravity force in an inclined direction.

It is a well established fact that bodies of matter require less force to move them horizontally than to raise vertically, and this fact is more conspicuously true of matter that is submerged in water or other liquid; therefore it does not require the full weight-force to move a particle sidewise in the compartments. The adaptation and the utilization of the conditions resulting under and by reason of these facts, together with the manner of application, is claimed as another of the fundamental principles of this process.

In the practical application of these principles the proceedings are:

The smallest particles, by the law of falling bodies, are the first to reach the sloping foot-wall where their weight-force is deflected on the incline and made to crowd with a sidewise push against their next nearest neighbor which with its weight-force combines for joint attack upon the next particle, and so on throughout the accumulations.

It follows, therefore, that the amount of force exerted sidewise against any particular particle is in proportion to the number of any smaller particles that may impinge upon it; which is to say, that if two particles should impinge on one particle of double the size (all being of equal weights) we shall have two weight-forces directed on and against one weight-force, resulting in evident displacement in the line of least resistance; or if three particles should impinge upon two particles, movement of the two take place. Therefore, any group or mass of particles will move any other group or mass that may have a lesser mass weight-force; any overbalancing force will prevail and cause movement to the extent of displacement.

This principle is the important factor that effects and controls the separations that are made within the compartments. This principle is in operative effect throughout the entire length of the compartment because of the fact that it is the mass weight of each overtopping stratum that determines the force of the sidewise push against any adjacent particle or group or stratum of particles. The effects of the principle are more conspicuously evident when the several mass accumulations reach the lowest unoccupied section of the compartment, where, in consequence of the restraining rigid bottom, the accumulations can move only in a horizontal direction and are spread out to a greater distance in the line of least resistance.

It is here that the so-called "corrective separation" referred to in the text, is most apparent and probably most effective; for it is observed that such particles as may have strayed into or been submerged in a wrong size-class are here, seemingly, singled out for special common attack and they are jammed about and displaced by dominating impinging forces, and made to lodge in the class of their equal size, where the sidewise stress is balanced. This action may be viewed through the glass sides of the compartments, when equipped for this purpose.

By equipping the weight separator with glass sides the actions and movements described in connection with the weight separation and assembling of the particles of various weights at particular zones or levels may be also observed. Particles of matter having the same specific gravity may be and usually are assembled in more than one compartment C; the number of compartments in which distribution is made depends upon the nature of the material operated upon and the extent to which separations may be necessary or desirable. In all compartments, however, the particles always ar-

range themselves in accumulated masses in the order of their respective gravities; that is to say, the finer particles (having the higher specific gravity) will be found nearest to the foot-wall in each compartment; and such accumulations may for descriptive purposes be designated "Order No. 1," and the accumulations of the next slightly larger sized particles (having the next lower gravity) in each compartment may be designated "Order No. 2," and so on, for as many orders of separation as it may be deemed advisable to make in any compartment. Each size separator is accordingly provided with separate gate-valves $G^1$—$G^4$, or other means, of any corresponding number to permit the separate removal of the accumulation of different bulks without disturbance of the aggregations or the order of their assembly.

By these valves any of the mass accumulations may be separately removed in whole or in part, and as frequently as may be necessary, without any perceptible disturbance of the remaining accumulations, except that the masses may shift position somewhat as a vacated space may be re-occupied.

The several collected orders of separation that are made by the apparatus are gathered into masses of kind by attaching a water-filled flask to a gate-valve stem or outlet $x$, and, by opening the gate the overlaying accumulation readily passes down into the flask; the gate is then closed, the flask is removed and contents added to the other extractions of like specific gravity.

In apparatuses working on large volumes of material it is proposed, to facilitate the gathering, to have suitably enclosed water filled tanks provided, each of which may be connected with all those certain compartment-gates that may control like specific gravity separations; and in this phase of action the apparatus may thus be made nearly self-acting.

The process of separating or concentrating ores in the manner above described by a preliminary separation of the crushed or comminuted ore into grades that pass respectively screens 8, 20, 40, 60 and 80 mesh to the inch will produce excellent results in the case of all grades but remarkably so in the case of the smallest grade; but a reduction of the minerals to smaller dimensions will give more accurate results,—in fact the finer the division, the more accurately and effectively does the process work.

The fact is recognized that no matter how small the particle may be, or to what extent the laws of crystallization and fracture may control the results of a mechanical division, theoretically a particle may still be of complex ore; that is to say, the particle may consist of mineral substances having different specific gravities and in widely differing proportions. Attention is called to the fact that when such instances present themselves, this process will select out such particles by their mean specific gravity, and will deposit them accordingly with those concentrates that have similar gravities and which may be intended for a smelter treatment.

The mechanical operation of the apparatus, when once it is set up and properly adjusted to the particular requirements, is comparatively a simple matter, requiring only ordinary care in directing the feed and the extractions; for beyond this the apparatus may be said to take care of itself.

The "cleaning up" is a very simple proposition and may be accomplished in a few minutes; it consists of allowing the apparatus to run without feed until the water in recess I becomes perfectly clear when all accumulations in the several compartments are drawn off, and the compartments flushed by the clear water coming over from recess I through the gates opened wide; and when all accumulations are removed a hose stream may be turned in at the top of recesses I and R and any remaining stray or adhering substances are washed down and into the catch-basins and out through gates $G^5$ and $G^6$.

When the energy flow is stopped in I either by "shutting down" or by any cutting off of the supply, the particles in suspension in I will settle to the bottom. These settlings pass the regular gate-valves without entering and will be received in the catch-basin O, where they are removable at and through gate $G^5$, and if desired may be reintroduced into the apparatus when started up. The catch-basin O is of double importance and use in that it is very necessary for and facilitates a "cleaning up," and also, it serves to catch and retain all particles of metal and minerals whose specific gravities are higher than the limit at which the apparatus may be set for ordinary recoveries. The ball-valve in the catch-basin working over the nozzle of the supply pipe S is held open by the stream force and closes on the stoppage, thereby preventing any of the settlings from getting in the supply pipe S.

Recess R: In respect to recess R it may be mentioned that this is to be kept full of water by the overflow from I through the graduated opening or weir $P^w$ in the top of the partition. The keeping of this recess full of water serves two important purposes: first, the stand of water therein is utilized to counter-balance the pressure on the opposite side of the partition in I so as to assist in keeping the partition in its proper adjusted place and to safeguard against any loss of energy in I which might be caused by leakage of water or of any extremely fine particles of the heavier minerals or metals from the other side; and second, the water

in R being slack, except for the overflow at weirs $P^w$ and $D^w$, serves admirably for the settling and retention of slimes or any exceedingly fine and light materials that may go over from the other recess. If it be desired to save such accumulations the mass may be drawn from the lower catch-basin R, through the gate $G^6$ provided for this purpose; and also, the catch-basin and gate are of great convenience in cleaning up.

The apparatus may be so arranged and constructed that, by the proper and exact adjustment of its parts, any one or a number of desired different specific gravity minerals or metals may be isolated in precise separations, while those minerals of lower specific gravity, not desired, may be rejected and allowed to escape as tailings. This feature of the process is accomplished by a proper setting and adjustment of the two weirs $W^2$ and $W^3$ at the uppermost section of recess I, so that the outgoing stream at H will have the exact volume and velocity necessary to carry off the particles of the undesirable or rejected minerals that are of normal size and weights.

The capacity of this process, in a broad sense, may be said to be unlimited; for the extent to which it may be applied is restricted only by the ratio of the energy supply to the material to be treated.

What I claim as my invention is:—

1. The method of separating divided solid material into aggregates of particles of approximately the same weight and approximately the same size, consisting in feeding the divided material into an upwardly directed stream of fluid of velocity diminishing upwardly to locate or sustain particles of different specific gravity in different vertical positions according to zones of velocity, removing the segregated particles of approximately the same specific gravity or weight from said zones and separating each segregated aggregation so removed into particles of approximately the same size by allowing the same to settle by gravity in a body of fluid wherein the particles are given a partial sidewise movement during their fall.

2. The method of concentrating ores consisting in crushing the ore, dividing the crushed material into grades, subjecting each grade to the separating effect of an ascending stream of liquid having velocity diminishing upwardly to separate the particles by gravity or weight, removing each aggregation or assemblage of particles of approximately the same weight from the side of the stream and subjecting each separate aggregation to a further sorting action into aggregations of approximately the same volume or bulk by allowing it to drop in a body of liquid while being affected by a sidewise displacing action.

3. The method of separating particles or units of solid divided material into units of approximately the same size, consisting in feeding the material to a quiescent body of fluid wherein the particles are allowed to settle by gravity and at the same time are subjected to a deflecting or displacing action causing them to be moved laterally or sidewise from the vertical and to settle in zones occupying different horizontal positions containing units of different size respectively.

4. The method of separating divided solid material into aggregates of particles or units of approximately the same size or bulk, consisting in feeding the material into a quiescent body of liquid wherein it is allowed to settle by gravity while being subjected to a displacing action tending to move the particles during their fall sidewise from the vertical and collecting them in aggregates of different sizes occupying respectively different horizontal positions.

5. Means for separating solid particles of divided material according to bulk, comprising a vessel holding a body of liquid in quiescent condition means for delivering the material into the body of liquid at an angle to the vertical and means for removing from the bottom of said tank the aggregates of particles of different sizes respectively collecting in different horizontal positions.

6. Means for separating solid divided material into aggregates of different specific gravity, comprising a chamber of size increasing upwardly and means for introducing fluid under pressure at the bottom of the column or chamber, an outlet near the top of the column having means for graduating the flow, means in the side of the column for removing the aggregate suspended in the stream, a chamber connected with the first chamber by a weir for receiving the slimes and lighter materials carried to the upper level of the stream and a catch basin at the bottom of the latter column.

7. Means for grading or separating particles or units of solid divided material according to bulk, comprising a vessel or receptacle adapted to contain liquid and having an inclined side wall and means for feeding the material into said receptacle at a point such that the particles or units in their fall to the bottom may engage the inclined side wall and means in the bottom of said vessel for removing the aggregates of particles of different bulk collecting respectively at the bottom of the vessel in different horizontal positions.

8. Means for separating particles or units of solid divided material according to size or bulk, comprising a tank or compartment adapted to hold a body of fluid in quiescent condition and having an inclined side wall, means for feeding the divided material into the tank at an angle and above said side

wall in such position that the particles in their fall to the bottom may engage the side wall and means for removing from the bottom of the tank the aggregates of particles of different bulk collecting thereon in different horizontal positions respectively.

9. Means for separating or classifying the particles or units of solid divided material according to size or bulk, comprising a tank or receptacle adapted to hold a body of fluid in quiescent condition and having an inclined side wall and a bottom provided with outlets arranged at different distances from said side wall and means for feeding the divided material into the tank in position such that in its fall it may engage the inclined side wall.

10. Means for separating or classifying the particles or units of solid divided material according to size or bulk, comprising a tank or reecptacle adapted to hold a body of fluid in quiescent condition and having an inclined side wall and a bottom provided with outlets arranged at different distances from said side wall, and means for feeding the material into the tank or receptacle at an angle to the vertical but in such position that in its fall through the contained fluid it may engage the inclined side wall.

11. Means for separating or sorting particles or units of solid divided material into aggregates of approximately the same weight and size, comprising a vessel or receptacle through which an ascending volume of fluid of diminishing velocity diminishing upwardly may be directed and one or more fluid containing compartments connected to the side of said vessel intermediate the inlet and outlet thereof, each said compartment having an inclined side wall and bottom provided with outlets at different distances from said side wall, the inlet to said compartment being arranged to deliver the outflow from the first-named vessel at a point above the inclined side wall.

12. Means for separating or sorting particles or units of solid divided material into aggregates of approximately the same weight and size, comprising a vessel or receptacle through which an ascending volume of fluid of diminishing velocity diminishing upwardly may be directed and one or more fluid containing compartments connected to the side of said vessel intermediate the inlet and outlet thereof, each said compartment having an inclined side wall and bottom provided with outlets at different distances from said side wall, the inlet to said compartment being arranged to deliver the outflow from the first-named vessel into the liquid at an angle to the vertical.

Signed at San Francisco in the county of San Francisco and State of California, this 28th day of February, A. D. 1920.

WALTER N. DIMMICK.

Witnesses:
F. B. TOWNSEND,
IRENE LEFKOWITZ.