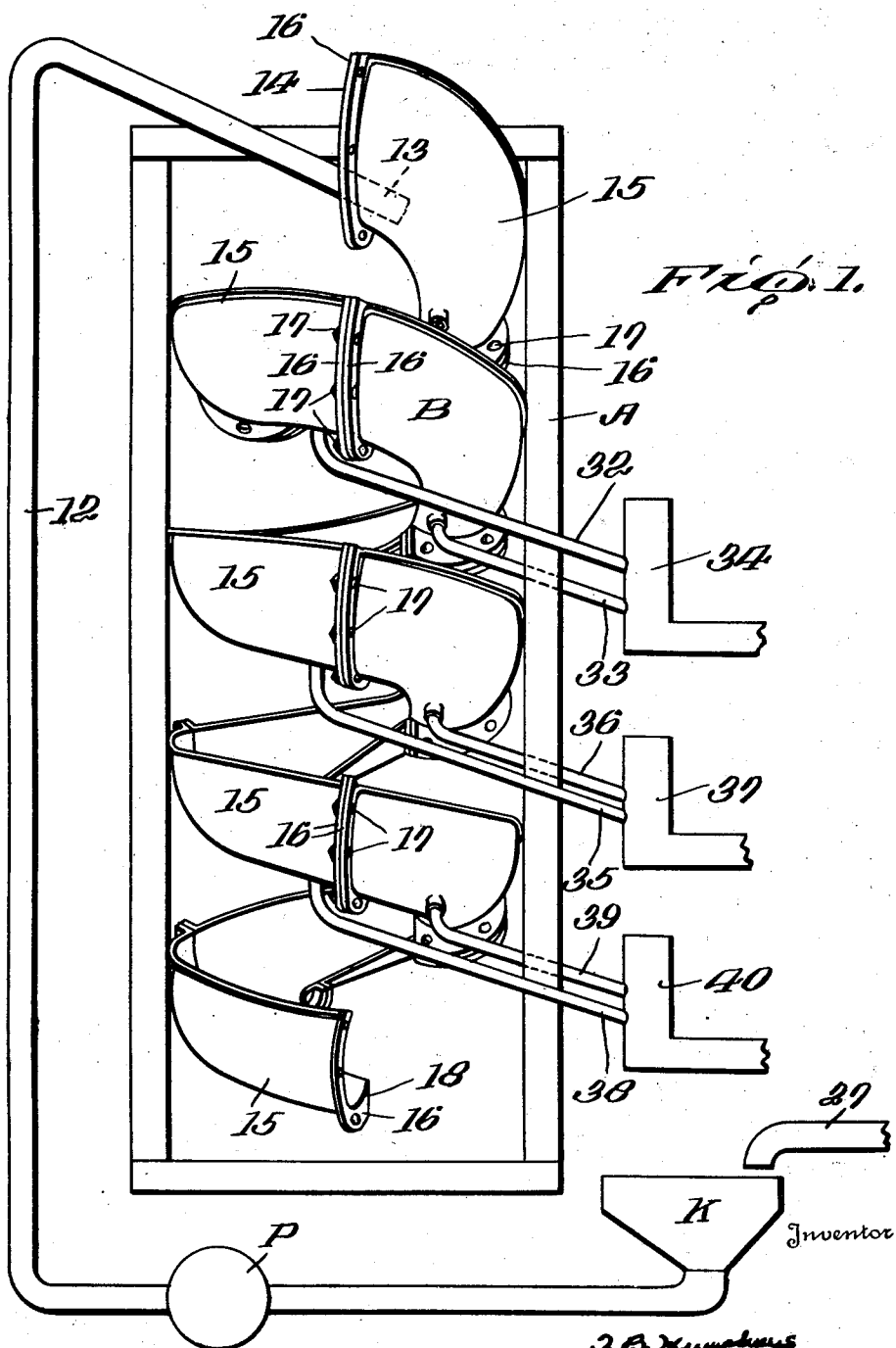


Nov. 25, 1947.

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HELICAL CHUTE CONCENTRATOR AND THE METHOD
OF CONCENTRATION PRACTICED THEREBY
Filed April 10, 1943

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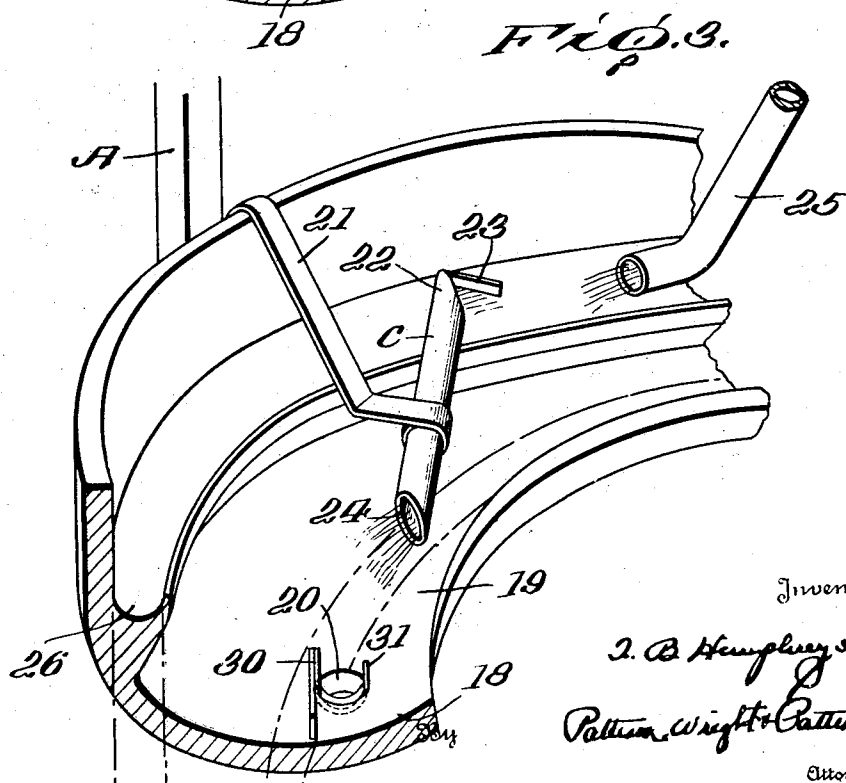
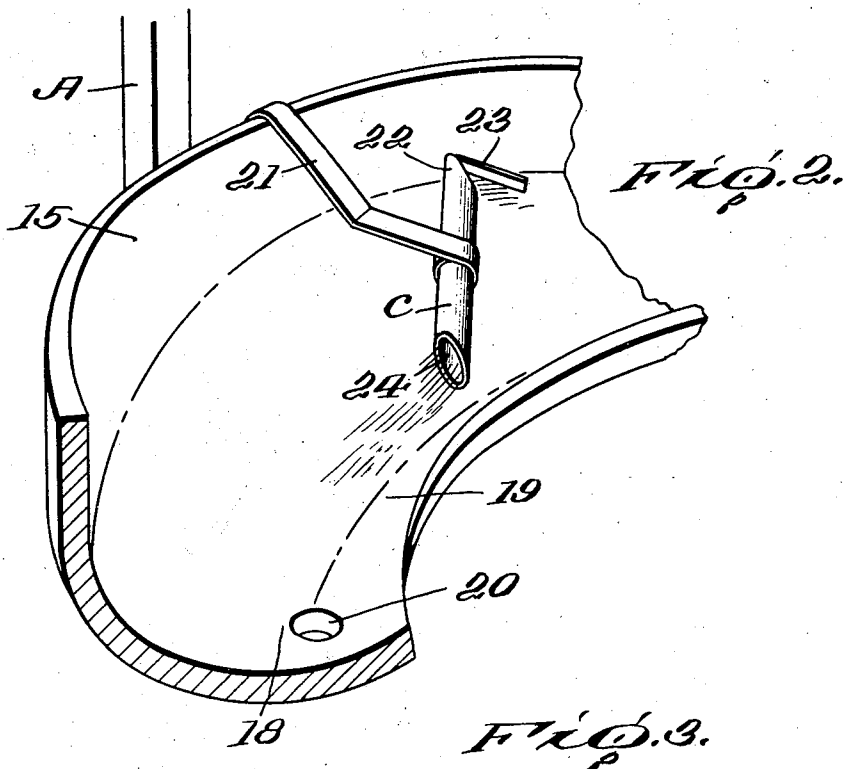
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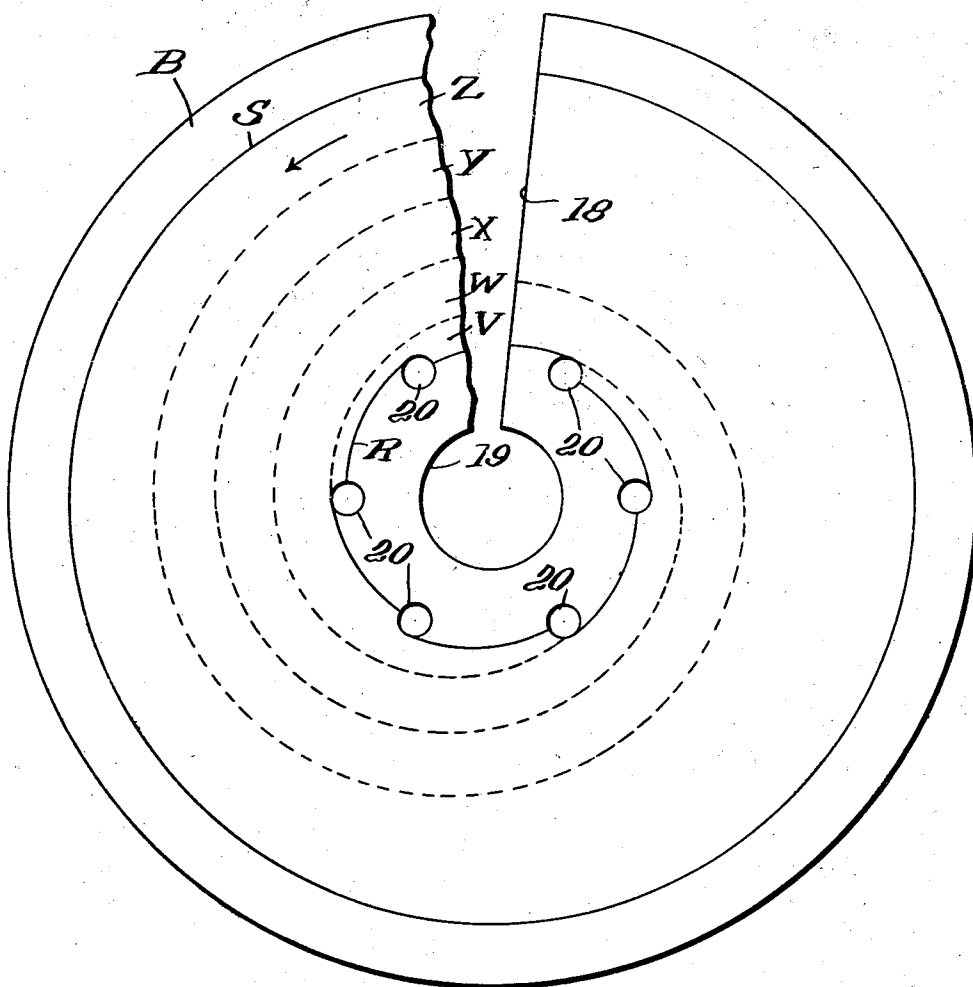
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UNITED STATES PATENT OFFICE

2,431,559

HELICAL CHUTE CONCENTRATOR AND THE
METHOD OF CONCENTRATION PRACTICED THEREBYIra B. Humphreys, Denver, Colo., assignor to The
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Application April 10, 1943, Serial No. 482,589

22 Claims. (Cl. 209-211)

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This invention pertains to a method and apparatus for concentrating ores or the like for the purpose of separating and separately collecting from a mass those particles or elements which have approximately the same specific gravity. The method and apparatus is not limited to making a separation between two different materials but will operate to separate and permit separate collection of a plurality of materials having different specific gravities and which compose and are intermingled within a comminuted mass.

The primary object of the invention is the provision of a method and apparatus which is highly efficient in concentrating and providing a separation and collection of material or particles of approximately like specific gravities from a comminuted mass composed of intermixed particles of different specific gravities.

A further object of the invention is the provision of a concentrating apparatus in the form of a helical chute or passageway through which travels a stream having therein the material to be concentrated.

A still further object of the invention is the provision of a helical chute or conduit type of concentrator in which concentration of the material is continuously performed throughout the length of the chute and in which the concentrated material is periodically removed from the chute at spaced points throughout the length thereof.

Another object accomplished by the invention is that of classifying the particles of the mass simultaneously with the concentration thereof; by classification I mean the separation of the concentrated material in accord with its size and the accomplishment of this classification I have found to be inherent in my concentrating method.

Other objects, novel features of construction and improved results of the invention will appear from the following description when read in the light of the accompanying drawings wherein an apparatus capable of practicing the novel method is illustrated.

Broadly the concentrating method is one wherein the separation of the particles comprising the mass being worked is accomplished by intermixing the mass with water or some other liquid and thereafter directing the liquid containing the particles through or over a path which will permit the particles within the stream of fluid to effect a stratification by gravitational

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fall of the particles in accord with the specific gravity of the particles.

Broadly an apparatus for carrying out the foregoing method comprises a spiral or helical conduit which may be either open at one side or completely closed at all of its sides and which causes the liquid carried particles to follow a curved path so that in accord with the laws of nature various portions of the stream of particle carrying liquid will assume different speeds of travel and will at all times continue these specific speeds and assume the same pattern throughout the travel of the stream. From different sections or parts of the flowing stream the particles carried by that portion of the stream are removed by suitable mechanical means.

In addition to the concentration or separation of the particles in accordance with their specific gravities the method also results in a classification of the particles, that is, a sizing, in each zone of concentration, of the particles which have been concentrated into the several zones within the moving stream. More specific description of this feature of the method will appear hereinafter.

As is the case in respect to all methods which require the use of an apparatus it is possible to utilize mechanical instrumentalities of varying constructions in the practice of the method. Accordingly the hereinafter described apparatus is to be considered only one of the forms of mechanical devices by which it is possible to practice the present method.

Having reference now to the accompanying drawings, which illustrate an apparatus which I have found highly efficient in the practice of my method:

Fig. 1 is side view of an apparatus suitable for practicing the new and improved method, a portion of the figure being diagrammatic in nature.

Fig. 2 is a vertical sectional view through the helical chute.

Fig. 3 is a vertical sectional view through a modified form of the helical chute and additionally illustrates the divider fingers.

Fig. 4 is a schematic view illustrating the zones occupied by the several minerals in the moving stream within the helical chute.

The method and apparatus is not limited to a concentration of any particular ores or in the working of a mass made up of any particular constituents, but is limited only to the concentration of materials having different specific gravities.

For the purpose only of a better understanding

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of the invention a description of the concentration of a particular sand containing minerals will be hereinafter given. The mineral-bearing sand selected for illustrative purposes is a beach sand found in the state of Oregon which contains particles of gold, chromite, garnets, and silica. The gold particles have the highest specific gravity; the chromite the next highest; the garnets the next highest; and the silica the lowest specific gravity. The chromite and garnet particles have specific gravities which are very close to one another and the most difficult part of the concentration will be between the chromite and garnet particles. As will appear hereinafter in the specific description of the operation of the invention, a 100% pure concentrate between chromite and garnet particles is not obtained but the take-off of chromite particles will consist of a concentrate which consists almost entirely of chromite and garnet particles and constitutes a concentrate which is sufficiently high in chromite particles as to make this concentrate a marketable product.

In operation there will be obtained a very high gold concentrate and both it and the chromite concentrate will be substantially entirely free of silica and tailings discharge at the lower discharge end of the chute will be practically free of gold and chromite.

More in detail relative to the foregoing and the manner of its accomplishment will be set forth in the hereinafter following description.

Describing the here illustrated apparatus in detail and using like reference numerals and characters to designate similar parts throughout the following description. A designates a frame or support for the spiral or helical concentrator channelway or conduit B.

The drawings illustrate the frame or support as carrying a single concentrator but it is to be understood that any number could be provided in accord with the capacity it is desired that the plant or installation have in the handling of the mineral bearing sands.

The sand or heads, that is the mass of comminuted particles containing the particles of chromite and other material, is suitably mixed, in any desired economical manner, with water or some other suitable liquid and then this liquid with the sand therein is forced by a pump P or otherwise suitably fed through a pipe 12 the discharge end 13 of which is disposed within the upper or receiving end 14 of the spiral or helical conduit or channelway B.

For convenience and economy both in manufacture and assembly the spiral or helical conduit is made up of a plurality of open-sided sections each of which is designated as an entirety by 15. Each section at its ends is provided with a flange 16 and by placing the flanges of the sections in abutment and bolting or otherwise suitably securing them together as at 17 a conduit of any desired length can be quickly assembled. No particular cross sectional configuration of the sections making up the chute or conduit need be employed as a chute of most any cross sectional configuration would result in the stratification and separation which is sought to be accomplished. In the drawings the chute sections are illustrated as having a cross sectional configuration which is a portion of a true circle but this form is illustrated and has been utilized because of its simplicity in production and because it has been found to work satisfactorily.

The number of chute sections employed will

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determine the length of the chute or conduit and the length of the conduit will be determined by the particular material being worked and resulting concentration obtained as it would of course obviously be unnecessary to elongate the chute beyond a point where any separation and collection of the particles sought to be recovered is being obtained.

In the drawings four convolutions of the chute are illustrated and the discharge end 18 of the chute carries one of the flanges 16 by which the chute can be readily elongated should it be found desirable.

At separated points along its inner and lower wall 19 the chute is provided with draw-off holes or openings 20 through which the concentrated particles having closely similar specific gravities are progressively discharged to a suitable point of collection, as will hereinafter more fully appear. These draw-off holes are illustrated as being circular in shape but they could be oblong or shaped otherwise without detrimentally affecting the practice of the method. The number of draw-off holes provided is optional but one in each of the chute sections 15 has been adopted for convenience in manufacture. The number of draw-off holes and the spacing of them in respect to one another is optional and would be varied if need for variation were found by reason of the particular material being operated upon; or the desire of separating and collecting a plurality of concentrates of different materials; or the desirability of the collection, for reworking, of a plurality of middlings.

The apparatus can be used with or without wash water and when used with wash water this can be provided in numerous ways two of which are illustrated in the drawings and will now be described. The part which the wash water plays in the operation of the method will appear in the hereinafter following description of the operation of the method and apparatus.

The wash water, when used, is utilized at the inner and lower side of the chute and one manner of accomplishing this would be the provision of clean water or fluid inlets at separated points along and through the inner and lower wall 19 of the chute. This manner of introducing wash water is not illustrated because word description of it is considered adequate. All that would be necessary would be a series of water or liquid supply pipes which would communicate with openings in spaced relationship along the length of the chute through the inner side wall thereof.

Another manner of supplying the wash water is illustrated in Fig. 2 of the drawings and comprises diverting some of the water or fluid flowing in the middle or along the upper and outer side of the chute to the lower and inner side of the chute. In this instance this is accomplished by the medium of a pipe C which is disposed within the chute and adjustably supported upon a bracket 21 or the like. This pipe has an inlet end 22 which faces the downwardly moving stream of liquid within the chute. Liquid is caused to enter the open pipe end 22 by an extending tongue 23 and transverse the chute toward the lower side thereof in the pipe and is discharged through the pipe open outlet end 24 into the inner and lower portion or side of the chute. This pipe is rotatable about its longitudinal axis so as to raise and lower its inlet end 22 and tongue 23 whereby the pipe can pick up a greater or lesser amount of fluid in accord with the extent to which the open inlet end of

the pipe or the tongue is submerged within the flowing stream of liquid.

The bracket 21 has a loose fit with the upper and outer edge of the chute B and is thereby adjustable along the length of the chute. The pipe is slidable longitudinally in the bracket which provides an adjustability enabling the wash water to be picked up at any point transverse the stream or to discharge the water into any desired or advantageous portion of the inner and lower side of the chute or stream.

An optional manner of supplying wash water is that of providing the interior of the chute adjacent its outer and upper side with an inwardly extending flange which extends throughout the length of the chute and forms at the outer and high side of the chute a groove 26 to which wash water can be suitably supplied as for instance by a pipe 25. The water traveling down the chute in the groove 26 would be utilized as wash water by diverting or conveying it over the inner lower side of the chute. This could be done by an arrangement such as already described and which comprises the pipe C and its parts 22, 23 and 24, or by any other suitable instrumentality.

The material to be concentrated and separated can be mixed in any convenient manner with the water or other liquid. In Fig. 1 of the drawings this is illustrated as being accomplished by supplying water from any convenient source through a pipe 27 to a hopper K. The material to be worked is dumped into the hopper and the intermixed water and material is drawn from the hopper through the pipe 12 by the pump P.

More take-off or discharge openings in the chute are illustrated than are actually used in the particular example of concentration which is herein described. It will be obvious that the take-off openings can be plugged or utilized as conditions require and dictate.

The concentrates which are withdrawn from the take-off or outlet openings 20 can be collected in any suitable and convenient manner. In Fig. 1 of the drawings the collected concentrates are illustrated as being conveyed from the first utilized two take-offs by pipes 32 and 33 to a main conduit 34 which serves to convey the concentrates to a point (not shown) for collection.

Similarly the next utilized two take-offs are connected by conduits 35 and 36 to a main conveyor discharge conduit 37 and the remaining last utilized two take-offs are connected by pipes 38 and 39 to a conveyor conduit 40.

The specific arrangement for conveying the concentrates to a point of collection could and probably would vary in accord with the particular material being sent through the concentrator. The arrangement illustrated is suitable for working the particular ore bearing sands hereinbefore referred to, as will be made clear from the following description of the operation of the method.

In Fig. 3 of the drawings a slight modification of the invention is illustrated. Although the concentrates will properly discharge through the take-off outlets 20 because said outlets lie in the path of travel of the concentrates down the chute it might be desirable to utilize cutting or dividing fingers in combination with said take-off outlets. In this figure of the drawings such fingers are designated at 30 and are retained in quickly detachable position by resilient fasteners 31, or the like, which extend downwardly into the take-off openings 20 and resiliently engage the sides thereof. The arrangement is such that the finger or divider fasteners 31 can be rotated within

the take-off openings 20 to permit the upper ends of the fingers or dividers to be adjustably positioned so as to divide and divert from the lower inner edge of the stream any desired portion thereof into the respective take-off outlets 20.

From the foregoing description and with the construction of the concentrator in mind an understanding of how a concentration or separation is effected will be readily understood.

The stream of water or other liquid bearing the comminuted material to be concentrated is introduced into the spiral or helical chute at the upper end 14 thereof.

The size or volume of the stream of particles carrying liquid in respect to the cross sectional area of the chute is such that the chute is not completely filled with the stream. The size of the stream is regulated so that at its inner and lower edge, where the stream is running over or on that portion of the chute adjacent its lower and inner side, it is comparatively shallow with the result that a thin or shallow zone or film of intermixed solid material and liquid is moving over the chute at its inner lower side. It is at this side of the chute and in this shallow part of the stream that the particles within the stream having the greater specific gravity concentrate to be periodically drawn off, as will hereinafter appear.

All parts of this stream or material carrying liquid do not acquire the same speed of movement in the passage of the stream down, along and through the helical or spiral chute. Neither do the comminuted particles carried by the stream of liquid all acquire the same speed of travel through and along the chute.

Promptly after the introduction of the solid material carrying liquid into the chute the particles making up the solid material will stratify according to specific gravity with the result that those particles having the greater specific gravity will move to the bottom of the stream of liquid and these particles also in response to the force of gravity will move to the inner and lower side of the chute, with the result that the stream, after traveling a short distance, is composed of several zones each of which contains those particles having substantially the same specific gravity. This condition is schematically illustrated in Fig. 4 of the drawings.

Those portions of the traveling stream of liquid which are on the bottom of the stream and in contact with the bottom of the chute and at the lower inner side will travel the slowest. The particles having the greater specific gravity will for the foregoing reasons sink to the bottom of the traveling stream of liquid and move to the lower and inner side of the chute.

It will be understood that the water or liquid, like the particles, responds in its movement to the force of gravity and that as a result the water on the bottom of the stream will have some tendency to move from the high to the low side of the stream and that this movement in response to gravity will set up in the stream a movement transverse the stream and transverse the forward and downward movement of the stream. This transverse movement of the water will assist in moving the particles of high specific gravity toward the inner lower side of the stream and to the inner lower side of the chute, all as explained above.

Those particles having the lesser specific gravity will be in the faster moving portions of the stream of liquid and will travel therewith and

away from the particles having the higher specific gravities.

As the stream of water with the solid material therein progresses downwardly through the spiral chute the lighter materials or particles having the lesser specific gravity will move along with the faster flowing portion of the stream and the remaining material will arrange itself within the stream in zones according to the specific gravities of the several particles making up this material.

Having reference to Fig. 4 of the drawings the stream carrying the intermixed materials is illustrated within the chute B and dotted lines are utilized to indicate the several zones into which the materials within the stream arrange themselves within a short time after the stream has started its descent within the helical chute. The inner and lower edge of the chute 19 is illustrated as being at the center of Fig. 4 and the concentrator take-offs or outlets 20 are illustrated in conformity with their positions as illustrated in the remaining figures of the drawings. The inner and lower edge of the stream is designated as appears at R and the upper and outer edge of the stream at S.

The several zones within the stream are identified as V, W, X, Y and Z. Describing now the zoning of the stream when operating upon the aforementioned Oregon beach sands, the gold particles because they have the highest specific gravity are at the inner lower edge of the stream in the zone V. This is the slowest moving zone of the stream and due to the weight of the gold concentrates it would probably be desirable to direct wash water to the inner lower edge of this zone to assist in progressing the gold concentrates downwardly to the discharge take-offs 20. To assure complete recovery of all of the gold particles the first two take-offs 20 are connected to the same conveyor pipe, namely pipe 34 illustrated in Fig. 1 of the drawings.

As the gold concentrates are removed from the stream through the take-offs the particles having the next highest specific gravity will move inwardly toward the inner lower edge of the stream. These particles will be the chromite and garnets and are traveling in zone W. This particular concentrate is removed from the stream through the next two take-offs 20 and are delivered to the delivery or conveyor pipe 37. This material being quite heavy the use of wash water with it is also desirable although not essential. The specific gravity of chromite and garnets is quite close but the chromite being the heavier the concentrate removed from this zone will be composed to a greater degree of chromite particles. This zone will be composed almost entirely of a concentrate of chromite and garnets as the lighter silica will be found in the remote zone Y of the stream which is a zone of water traveling with more rapidity than any of the other zones V, W or X.

The next zone X will be composed of a middlings product which is removed from this zone of the stream through the next and last remaining two take-off outlets 20. The degree that this middlings product is made up of chromite and garnet particles will dictate whether or not the middlings product should be returned to the upper end of the chute for reworking. In the majority of instances the reworking of the middlings would prove profitable and commercially feasible. As a matter of fact in some instances it might be desirable to provide two additional take-offs so

as to return for reworking an even greater amount of middlings product.

The next zone Y will be composed of tails and will discharge over the outlet end 18 of the chute adjacent the inner lower edge of the chute. In this zone will be found the silica.

The last remaining zone Z is composed of water and slimes.

From the foregoing it will be seen that as the several concentrates are removed the zones of material within the stream move inwardly towards the inner lower edge of the chute. As an example, due to the removal of concentrates, the zone Y of tails which is far removed from the inner lower edge of the chute at the upper end of the spiral constitutes the inner lower edge of the stream when the stream has reached the discharge end of the chute.

The use of the wash water is optional but has been found to be desirable because it will keep the stray silica and other light foreign matter washed off of the concentrates so that they will be clean when withdrawn from the take-offs or outlets and will also assist in moving the heavier concentrates to their points of discharge. The movement of the concentrates without wash water would be quite slow because they are in not only the slowest moving zone or portion of the stream but are in a very shallow portion or zone of the stream. In practice this wash water will flow for a limited time or distance at the inner and lower side of the stream and chute but will gradually move toward the center or upper side of the chute and stream and will carry with it any stray silica and other light material which might be present in the heavy concentrates.

The particles of different specific gravities will arrange themselves in the zones as described by reason of a natural stratification which causes those particles having the highest specific gravities to be positioned in the slowest moving stream or zone of the stream. These heavier particles will concentrate in these zones because they will as the stream moves through the chute gradually work to the inner and lower side of the chute by moving under the faster moving portion of the stream which is carrying with it the lighter materials. Actually the comminuted particles assume a position in the chute and stream which is determined by their velocity down the chute and this pattern of operation and concentration is not disrupted or disturbed by the admission of liquid and material to the upper end of the spiral and the pattern is altered only progressively by the removal of concentrates from or through the inner lower side of the chute. The concentrates are removed and collected progressively in accord with their specific gravities.

In addition to accomplishing a concentration of the comminuted particles a classification is also effected. In each of the zones there is not only concentrated those particles having the same or closely similar specific gravities but in each zone the particular particles thereof will arrange themselves in accord with their size. The smaller sized particles will be at the inner and lower side or edge of the zone and will graduate upwardly in size toward the outer edge of the zone. Consequently if any advantage can be obtained by collecting the concentrates in accord with their sizes it will be found that as each zone of concentrates is removed from the chute said concentrates first to be drawn off will be found to be the smaller in size. It will be obvious that were it desirable to do so any number of

take-off outlet openings could be provided for each zone so as to collect and separately convey away the concentrates in accord with size ranges.

The material being concentrated and the specific manner of practicing the process can and will control the degree of purity, that is the cleanness, of the concentrates collected. Where there is a wide demarkation in the specific gravity between the particles of different material making up the mass a clean or pure concentrate is very easily obtainable with the use of a minimum number of take-off outlets. Where there are particles of different materials having closely similar specific gravities obtaining a clean separation or concentration is more difficult. If the nature of the concentrates being recovered is such as to dictate or require clean concentration it could prove desirable to provide a greater number of outlet take-offs and possibly a reduction in size of said take-offs so that there would in effect be a very slight or thin cutting away at the inner lowermost edge of the stream at each take-off outlet. This same result could be obtained by the use of the adjustable cutting or divider fingers. To those skilled in this art it will be perfectly clear that the cleanness or purity of the collected concentrates can very readily be obtained by careful attention to the foregoing mentioned variables.

Additionally, those skilled in this art will recognize that the take-off outlets need not necessarily be positioned exactly as illustrated in the drawings. Under some conditions and upon working of certain kinds of ore bearing sands or dirt it might be found to be desirable to extend the take-off outlets in either a straight line across the spiral chute or in a diagonal line across the chute. If this were done concentrates could be removed from the several zones of the stream simultaneously or substantially simultaneously. Hereinbefore I have mentioned that the method is not limited to practice upon the exact apparatus illustrated. Furthermore, like all methods, there is more than one apparatus by which the method may be practiced.

Consequently, the present method and invention is not to be limited to the apparatus illustrated and described or by the example concentration described, but it is to be limited only by the scope of the hereinafter appended claims.

It would also be possible to let the stream traverse the entire length of the chute without removing any concentrates and remove all the concentrates at the discharge end of the chute by means of dividers or splitter fingers.

I claim:

1. The method of concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, mixing particles of said mass with a liquid and causing said liquid with said particles therein to flow as a stream in a downward helical course, confining said stream in a manner to give the stream a high and deep outer side and a low inner side which from a point within the stream is of decreasing depth outwardly toward the inner edge of the stream with a considerable portion of said inner stream side being shallow and terminating at its edge in a depth which is substantially of only film thickness, continuing said stream travel until the particles therein stratify in accordance with their specific gravities and assume by reason of their speed and direction of travel position such that particles of like specific gravities are in side by side zones ex-

tending longitudinally of the stream with those particles having the greatest specific gravities in a zone at the inner edge of the stream and with the remaining zones in a direction toward the high side of the stream being of progressively decreasing specific gravity, and thereafter separately removing and collecting from said stream the particles within each of said zones.

2. The method of concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, mixing particles of said mass with a liquid and causing said liquid with said particles therein to flow as a stream in a downward helical course, confining said stream in a manner to give the stream a high and deep outer side and a low inner side which from a point within the stream is of decreasing depth outwardly toward the inner edge of the stream with a considerable portion of said inner stream side being shallow and terminating at its edge in a depth which is substantially of only film thickness, continuing said stream travel until the particles therein stratify in accordance with their specific gravities and assume by reason of their speed and direction of travel positions such that particles of like specific gravities are in side by side zones extending longitudinally of the stream with those particles having the greatest specific gravities in a zone at the inner edge of the stream and with the remaining zones in a direction toward the high side of the stream being of progressively decreasing specific gravity, and thereafter separately removing and collecting the particles constituting each of said zones by continuously removing at spaced points spaced in the direction of flow of the stream those particles which are in and traveling with the shallow inner edge of said stream.

3. The method of concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, mixing particles of said mass with a liquid and causing said liquid with said particles therein to flow as a stream in a downward helical course, confining said stream in a manner to give the stream a high and deep outer side and a low inner side which from a point within the stream is of decreasing depth outwardly toward the inner edge of the stream with a considerable portion of said inner stream side being shallow and terminating at its edge in a depth which is substantially of only film thickness, continuing said stream travel until the particles therein stratify in accordance with their specific gravities and assume by reason of their speed and direction of travel positions such that particles of like specific gravities are in side by side zones extending longitudinally of the stream with those particles having the greatest specific gravities in a zone at the inner edge of the stream and with the remaining zones in a direction toward the high side of the stream being of progressively decreasing specific gravity, and thereafter separately removing and collecting the particles constituting each of said zones by continuously draining off at spaced points spaced in the direction of flow of the stream the innermost shallow inner edge of the stream and the particles therein.

4. An apparatus for concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, a stationary downwardly inclined helical chute, means

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for feeding an intermixture of liquid and particles of said mass as a stream to the upper end of said chute, said chute having a high and concave outer side wall and an inner low concave side wall terminating only a little beyond the lowermost point of the chute bottom, and the bottom of the chute in spaced relationship lengthwise thereof and in substantially the said lowest portion thereof being provided with outlet openings for the discharge of a portion of said stream and the particles therein.

5. An apparatus for concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, a stationary downwardly inclined helical chute, means for feeding an intermixture of liquid and particles of said mass as a stream to the upper end of said chute, said chute having a high outer side wall and lower inner side wall, means positioned in spaced relationship along the length of the bottom of said chute beneath the stream and adjacent but inward of the inner side edge of the stream for continuously drawing off at spaced points spaced in the direction of flow of the stream a portion of the inner edge of the stream and the particles therein, an open-ended conduit extending transverse the chute, means adjustably supporting said conduit to position one end to receive liquid from the stream at the high outer side of the chute and to position the other conduit end to discharge said liquid into the edge of the stream at the lower inner side of the chute.

6. A construction such as defined in claim 5 wherein, the means for adjustably supporting said conduit is freely adjustable along the length of the chute.

7. An apparatus for concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, a stationary downwardly inclined helical chute, means for feeding an intermixture of liquid and particles of said mass as a stream to the upper end of said chute, said chute having a high outer side wall and lower inner side wall, means positioned in spaced relationship along the length of the bottom of said chute beneath the stream and adjacent but inward of the inner side edge of the stream for continuously drawing off at spaced points spaced in the direction of flow of the stream a portion of the inner edge of the stream and the particles therein, the high outer wall of said chute being provided longitudinally with a wash water carrying channelway, means for delivering wash water to said channelway, an open ended conduit extending transverse the chute, means adjustably supporting said conduit to position one end to receive liquid from said wash water channelway and to position the other conduit end to discharge said liquid into the edge of the stream at the low inner side of the chute.

8. A construction as defined in claim 7 wherein, the adjustable supporting means for said conduit is freely adjustable lengthwise of the chute and of the wash water channelway.

9. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravities comprising, a vertically disposed helical passageway of an arcuate shape in cross-sectional configuration having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to provide a stream which is caused to

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travel through said passageway from the upper to the lower end thereof, said passageway being disposed so that the outer end is in a plane above its inner edge, the lowest portion transverse any given point in the length of said passageway being adjacent but in spaced relation to the inner lower edge of the passageway, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower edges thereof, means for removing from the lower inner edge of said stream as it moves through said passageway the particles of the comminuted mass which are in and moving with said stream portion, and means for automatically picking up water from the upper outer edge of the stream and delivering it as wash water to the lower inner side of the stream and of the passageway.

10. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravities comprising, a vertically disposed helical passageway of an arcuate shape in cross-sectional configuration having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to provide a stream which is caused to travel through said passageway from the upper to the lower end thereof, said passageway being disposed so that the outer edge is in a plane above its inner edge, the lowest portion transverse any given point in the length of said passageway being adjacent but in spaced relation to the inner lower edge of the passageway, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower edges thereof, means for removing from the lower inner edge of said stream as it moves through said passageway the particles of the comminuted mass which are in and moving with said stream portion, said passageway being provided interiorly with a secondary passageway beyond one side of the stream moving through the main passageway, means for delivering wash water to said secondary passageway, and means for conducting wash water from said secondary passageway and delivering said water to the lower inner side of the stream and of the main passageway at spaced points throughout the length of the same.

11. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravities comprising, a vertically disposed helical passageway of an arcuate shape in cross-sectional configuration having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to provide a stream which is caused to travel through said passageway from the upper to the lower end thereof, said passageway being disposed so that the outer edge is in a plane above its inner edge, the lowest portion transverse any given point in the length of said passageway being adjacent but in spaced relation to the inner lower edge of the passageway, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower edges thereof, means for removing from the lower inner edge of said stream as it moves through said passageway the particles of the comminuted mass which are in and moving with said stream portion, said last named means comprising openings arranged in spaced relationship along the length of the passageway at the lowest point transverse thereof and in the path of travel of the lower inner edge portion of said stream, and means adjust-

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ably mounted for selectively diverting into said openings a portion of the inner edge of said stream of a predetermined width.

12. The method of concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, mixing particles of said mass with a liquid and causing said liquid with said particles therein to flow as a stream in a downward spiral course, confining said stream in a manner to give the stream a high and deep outer side and a low inner side which from a point within the stream is of decreasing depth outwardly toward the inner edge of the stream with a considerable portion of said inner stream side being shallow and terminating at its edge in a depth which is substantially of only film thickness, continuing said stream travel until the particles therein stratify in accordance with their specific gravities and assume by reason of their speed and direction of travel positions such that particles of like specific gravities are in side by side zones extending longitudinally of the stream with those particles having the greatest specific gravities in a zone at the inner edge of the stream and with the remaining zones in a direction toward the high side of the stream being of progressively decreasing specific gravity, and thereafter separately removing and collecting the particles constituting each of said zones by continuously removing through the bottom of the means which confines said stream at spaced points spaced in the direction of flow of the stream those particles which are in and traveling with the shallow inner edge of said stream.

13. An apparatus for concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles having like specific gravity comprising, a stationary downwardly inclined spiral chute, means for feeding an intermixture of liquid and particles of said mass as a stream to the upper end of said chute, said chute having an interior which is of a concave shape in cross sectional configuration and has its lowest portion transverse any given point in the length of the chute adjacent but in spaced relation to the inner edge of the chute, and the bottom of said chute in substantially the said lowest portion thereof being provided with a plurality of outlet openings in spaced relation lengthwise of the chute for the discharge of a portion of the inner edge of said stream and the particles therein.

14. A construction as defined in claim 13 wherein, a water conveying means extends transverse the chute, means supporting said water conveying means to position one end thereof to receive liquid from the outer edge of the stream and to position the other end of the conveyor to discharge said liquid into the inner edge of the stream at the inner side of the chute.

15. A construction as defined in claim 13 wherein, a water conveying means extends transverse the chute, means adjustably supporting said water conveying means to position one end thereof to receive liquid from the outer edge of the stream and to position the other end of the conveyor to discharge said liquid into the inner edge of the stream at the inner side of the chute, and said means which adjustably supports said water conveying means being supported in optional adjustment along the length of the chute.

16. An apparatus for concentrating and separately collecting from a mass of intermixed particles of different specific gravities those particles

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having like specific gravity comprising, a stationary downwardly inclined helical chute, means for feeding an intermixture of liquid and particles of said mass as a stream to the upper end of said chute, said chute having an interior which is of a concave shape in cross sectional configuration, means positioned in spaced relationship along the length of the bottom of said chute adjacent but inward of the inner edge thereof and beneath the inner edge of the stream for continuously drawing off at spaced points spaced in the direction of flow of the stream a portion of the inner edge of the stream and the particles therein, the wall defining the outer edge of said chute being provided with a longitudinally extending wash water carrying channelway, a water conveying means extending transverse the chute, means supporting said water conveying means to position one end thereof to receive liquid from said wash water channelway and to position the other end of the conveyor to discharge said liquid into the inner edge of the stream at the inner edge of the chute.

17. A construction as defined in claim 16 wherein, the means which supports the water conveying means provides longitudinal adjustability of the water conveying means and rotation of the water conveying means upon its longitudinal axis, and said support for said water conveying means being freely adjustable for optional positioning lengthwise of the chute and the wash water channelway.

18. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravities comprising, a vertically disposed helical passageway of an arcuate shape in cross-sectional configuration having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to provide a stream which is caused to travel through said passageway from the upper to the lower end thereof, said passageway being disposed so that the outer edge is in a plane above its inner edge, the lowest portion transverse any given point in the length of said passageway being adjacent but in spaced relation to the inner lower edge of the passageway, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower edges thereof, means for removing from the lower inner edge of said stream as it moves through said passageway the particles of the comminuted mass which are in and moving with said stream portion, and means for automatically picking up water from the stream and delivering it as wash water to the lower inner side of the stream and of the passageway.

19. In a concentrating apparatus, an elongated passageway adapted to carry a stream of liquid having therein the material to be concentrated, a trough extending along the length of said passageway at one edge thereof and out of communication with the stream and adapted to carry a stream of wash liquid, an open ended conduit having means associated therewith for conveying water from the trough into the conduit, and said conduit and its said associated water pick up means being adjustable to cause the pick up means to pick up and convey varying amounts of water from the trough into the conduit.

20. In a concentrating apparatus, an elongated helical passageway adapted to carry a stream of liquid having therein the material to be concentrated, a trough extending along the length

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of the chute at one edge thereof and above and out of communication with the stream and adapted to carry a stream of wash liquid, an open ended conduit extending in a direction transverse the stream and trough and disposed above both, means depending from one end of the conduit and into the trough for conveying water from the trough into the conduit, and the opposite end of the conduit being positioned to discharge wash water into and at one side of the stream.

21. A construction as defined in claim 20 wherein, said conduit is adjustably supported to provide adjustability of the conduit longitudinally of the passageway and the trough and adjustability of the conduit in a direction transverse the passageway and the trough.

22. A construction as defined in claim 20 wherein, the conduit is supported by a bracket which has longitudinal sliding supporting en-

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gagement with one side of the passageway, said conduit being longitudinally movable in said bracket, and said conduit further being axially rotatable in the bracket.

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