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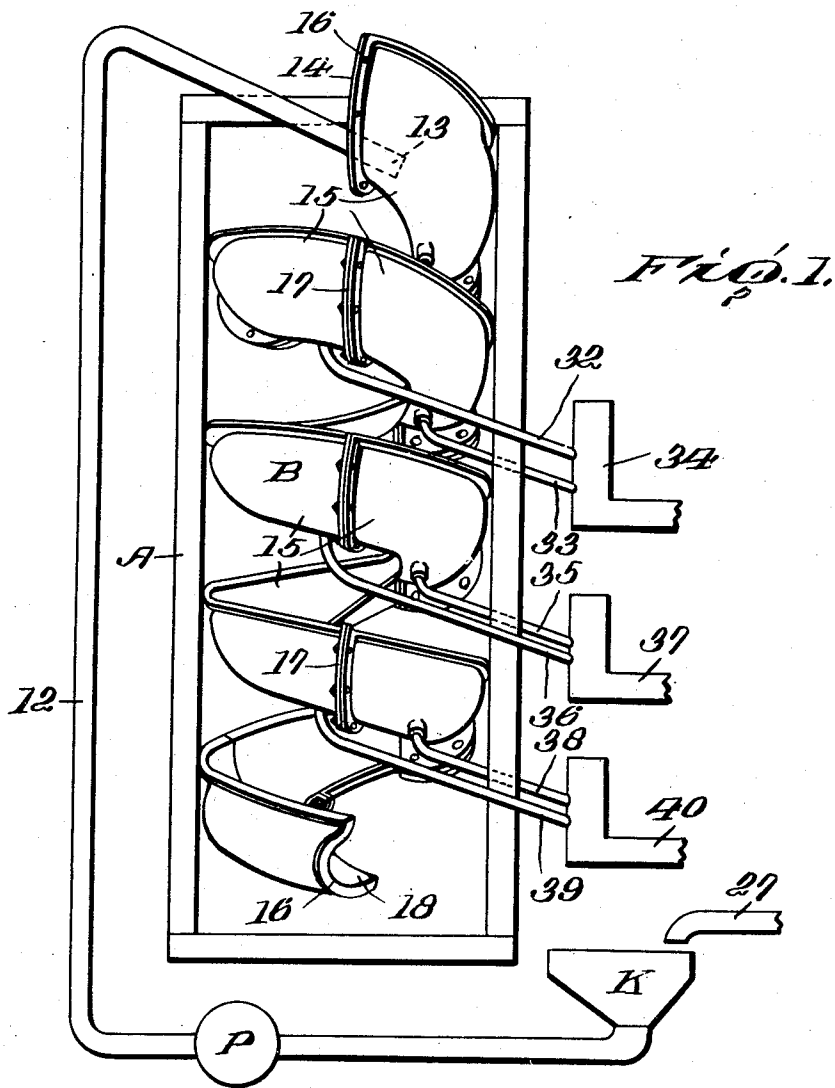
I. B. HUMPHREYS

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HELICAL CHUTE CONCENTRATOR

Filed Aug. 21, 1944

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Inventor

Lea B Humphreys

By Patterson Wright & Patterson
Attorneys

Attorney's

Nov. 25, 1947.

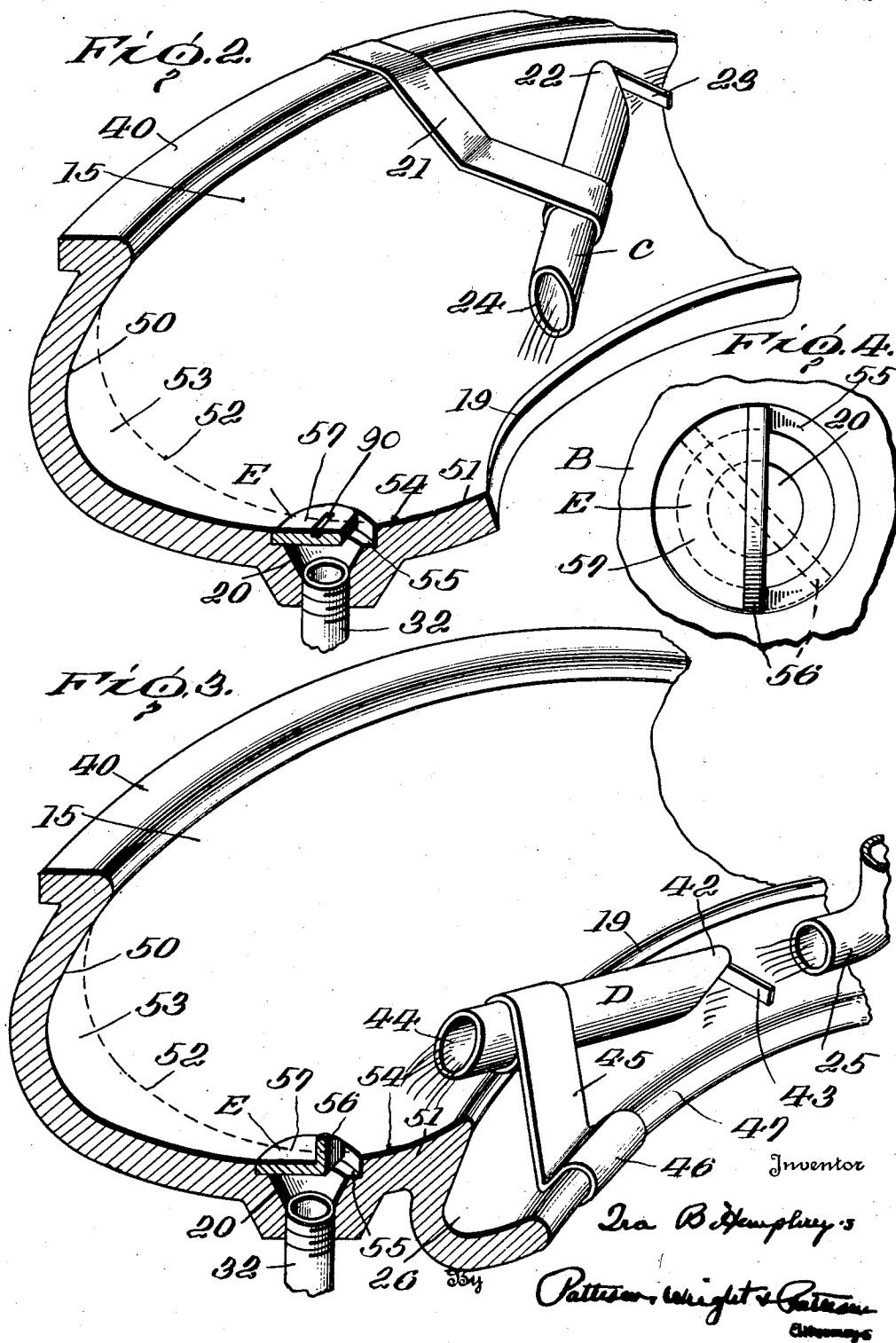
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Filed Aug. 21, 1944

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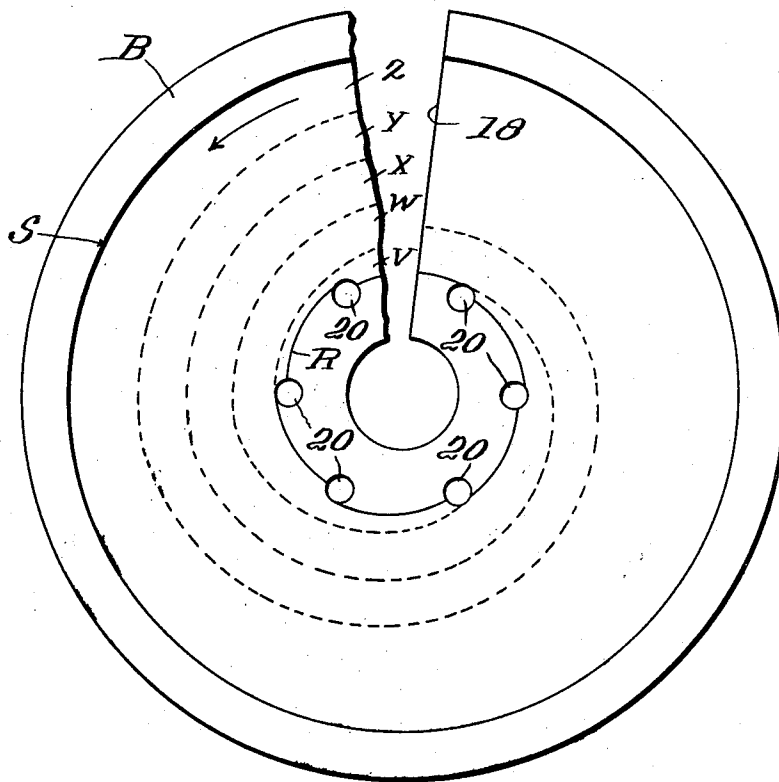
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HELICAL CHUTE CONCENTRATOR

Filed Aug. 21, 1944

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FIG. 5.



Inventor

Ira. B. Humphreys

By

Patterson, Wright & Patterson

Attorneys

Nov. 25, 1947.

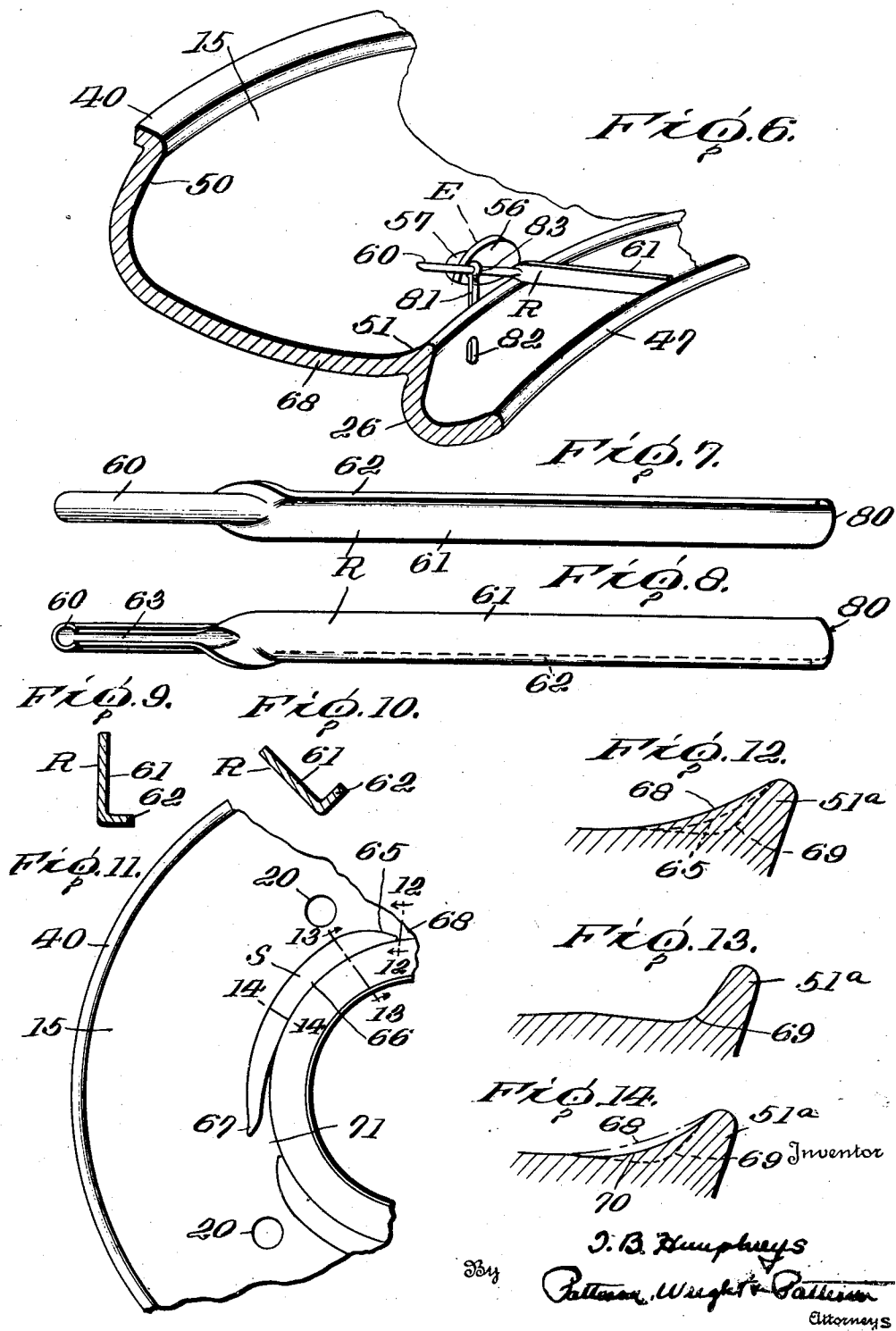
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HELICAL CHUTE CONCENTRATOR

Filed Aug. 21, 1944

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UNITED STATES PATENT OFFICE

2,431,560

HELICAL CHUTE CONCENTRATOR

Ira B. Humphreys, Denver, Colo., assignor to
The Humphreys Investment Company, Denver,
Colo., a corporation of Colorado

Application August 21, 1944, Serial No. 550,465

21 Claims. (Cl. 209—211)

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The present invention relates to apparatus for concentrating ores or the like and is a continuation in part of my copending patent application Serial No. 482,589 having like title.

The primary object of the invention is the provision of a highly efficient apparatus for separating and separately collecting particles of like specific gravities from a comminuted mass composed of intermixed particles of different specific gravities and the accomplishment of this even under wide fluctuations of operating conditions.

Another 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 and with which is associated a novel construction and arrangement for providing wash water for assisting in the removal of the concentrates for separate collection.

A still further object of the invention is the provision of a concentrating apparatus in the form of a helical chute which can be built and operated at a low cost and which has a negligible maintenance cost by reason of its simplicity of construction.

Another and further object is the accomplishment of not only the aforementioned concentration but in addition the accomplishment of a classification of the particles, by which is meant the concentration or separation of material or particles of like specific gravity in accordance with its size.

In the drawings:

Fig. 1 is a 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 the helical chute and illustrating a modified form of construction for providing wash water.

Fig. 4 is a detailed top plan view of one of the concentrate take-offs with the concentrate splitter or divider therein.

Fig. 5 is a schematic view illustrating the zones occupied by the several particles or minerals of different specific gravities in the moving stream within the helical chute.

Fig. 6 is a vertical sectional view through the helical chute illustrating a modified form of construction for providing wash water.

Fig. 7 is a top plan view of the wash water

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pick-up and conveying element appearing in Fig. 6.

Fig. 8 is a bottom plan view of the element illustrated in Fig. 7.

Fig. 9 is a vertical sectional view of the element illustrated in Figs. 7 and 8.

Fig. 10 is another vertical sectional view of the element illustrated in Figs. 7 and 8.

Fig. 11 is a fragmentary top plan view of a helical chute of modified construction.

Fig. 12 is a vertical sectional view on the line 12—12 of Fig. 11.

Fig. 13 is a vertical sectional view on the line 13—13 of Fig. 11.

Fig. 14 is a vertical sectional view on the line 14—14 of Fig. 11.

The concentration which is accomplished by the apparatus is not limited to one for any particular ore or ores or a mass made up of any particular constituents, and is limited only to the concentration of material having different specific gravities, and such a concentration is accomplished irrespective of how many different specific gravities are represented by the particles making up the mass. To enable an understanding of the invention some particular concentration must be selected, and for the purpose only of such an understanding a mineral-bearing sand found in the state of Oregon which contains particles of gold, chromite, garnets and silica has been selected. Respecting these particular minerals the gold has the highest specific gravity; and then in descending order of specific gravities, the chromite, the garnets and the silica. The specific gravities of the chromite and garnets is quite close and the most difficult part of the concentration as a consequence is between these particular particles. The method does not accomplish a 100% pure concentrate between the chromite and garnet particles but the concentrate take-off of chromite is sufficiently high in chromite particles as to provide a marketable product.

All of the concentrates will be substantially entirely free of silica and the tailings discharge from the apparatus will be substantially and for all practical purposes entirely free of gold and chromite.

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

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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.

The number of chute sections employed will 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.

The cross sectional configuration of the sections making up the chute or conduit is of considerable importance, but it is to be noted that it need not be identical to that illustrated in Figs. 2 and 3 of the drawings. The important point relative to the cross sectional configuration of the chute is that from its inner edge 19 for a considerable extent towards its outer side the chute be curved quite gradually while at its outer edge the chute is curved quite acutely, as indicated at 50. It is essential that the chute at its inner lower edge be upturned or upwardly curved and such a curve appears at 51. With a chute shaped substantially as described there is a considerable portion of the width of the chute which is of a gradual curve. The pitch of the spiral is also of considerable importance as the downwardly flowing stream must not travel at too great a speed. The contour of the stream within the chute is substantially that shown by the line 52 in Figs. 2 and 3 of the drawings, from which it will be seen that the stream is quite deep at the point 53 and climbs well up the outer side of the trough, whereas the stream at its inner lower edge feathers out to practically no depth as indicated at 54.

It is in this shallow portion or zone 54 of the stream that the concentrates collect. This zone or portion of the stream is comparatively slow moving and due to the fact that it is shallow there is not a great pressure exerted upon the particles in this portion of the stream to move them in a direction downwardly through the spiral chute. The pitch of the chute is important in respect to this shallow inner edge or zone of the stream because if the pitch were too great the speed of the stream at this point could be so great

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as to disrupt the proper collection and concentration of particles of like or substantially like specific gravity. Accordingly the pitch of the spiral is made such that in the majority of instances the delivery of wash water to this edge of the stream is essential to the movement of the concentrates downwardly through the spiral for discharge through the concentrate outlets. The wash water also performs another function, which will be hereinafter described.

At separated points throughout the length of the chute and at the lowest cross sectional point thereof, a plurality of draw-off holes 20 are provided. These draw-off holes are circular in shape and the lowest cross sectional point of the chute is approximately in the center of these holes. It is to these draw-off holes that the hereinafter described take-off pipes 32, 33, 35, 36, 38 and 39 are connected. The lowermost cross sectional point in the bottom of the chute is such that these draw-off holes are adjacent but in spaced relationship to the lower upturned inner edge 19 of the chute.

Each draw-off hole is provided internally with a circumferential shoulder 55 forming a seat for rotatably supporting a gate or valve E which is a flat disc the upper face of which is flush with the bottom of the inner face or bottom of the chute. The gate or valve comprises a portion of a circle and when rotated upon its seat will permit any desired portion of the inner edge of the stream and the material carried thereby to enter the take-off hole. Any suitable means for rotating the disc valve can be provided. A kerf 90 for the reception of a tool is illustrated in Fig. 2 of the drawings. A slight modification of the valve appears in Figs. 3 and 4 of the drawings wherein the disc is in the form of a complete circle but at a point off center is bent upwardly at right angles to provide a blade 56. This blade performs the double function of providing means by which the valve may be rotated and of a splitter which when the valve is rotated will direct any desired portion of the inner edge of the stream and the material carried thereby into the take-off hole. Either form of valve provides a simple and convenient device for removing an increased or decreased amount of concentrates which have collected in the inner edge shallow zone of the stream.

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 provision of wash water is important and one 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 dis-

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charged 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 40 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.

A modified construction for supplying wash water to the inner lower edge of the stream is illustrated in Fig. 3 of the drawings and comprises providing a wash water trough 26 adjacent and below the inner and lower side or edge 19 of the chute. This trough extends throughout the length of the chute and wash water can be supplied to it at any point throughout its length, or if desired at a plurality of points by any suitable means such as a pipe 25. This trough is illustrated as being formed integral with the main trough or chute, but it is to be understood that it could be separately formed and separately supported should such a construction prove desirable.

As the water travels down the trough 26 it is lifted and delivered to the lower inner side of the chute and to the shallow inner zone of the stream by an arrangement quite similar to that illustrated in Fig. 2 of the drawings. Specifically the construction comprises a pipe D which has an open end 42 which faces the downwardly moving stream of wash water within the trough 26. Liquid is caused to enter the open pipe end 42 by an extending tongue 43. The wash water entering the pipe is lifted over the inner lower edge 19 of the trough B by the pipe D and is discharged through the opposite open end 44 of the pipe. The pipe is supported upon a bracket 45 which is supported as at 46 upon the edge 47 of the chute 26. The bracket support 46 is such that it together with the pipe D is adjustable along the length of the trough 26. Like the pipe C the pipe D is also rotatable within its bracket to permit a greater or lesser amount of fluid to be picked up in accord with the extent to which the lower inlet end of the pipe or tongue is submerged within the flowing stream of liquid.

A modified construction for providing wash water appears in Figs. 6 to 10 of the drawings. In Fig. 6 there is a fragmentary illustration of the same chute or passageway 15 having at and below its inner edge the same wash water carrying trough 26. The trough is provided with the same concentrate take-off having therein the cutting or splitting finger E. The modification is of the precise construction utilized for taking off water from the wash trough and conveying it to the inner edge of the stream in the main chute. The wash water pick-up element or blade R is specifically illustrated in Figs. 7 to 10 inclusive from which it will be seen that the blade has a rounded shank 60 into which merges the main blade portion made up of a flat surface 61 which at one edge has an upstanding wall 62 which is disposed at right angles to the main flat blade portion 61. That end of the blade which is re-

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mote to the shank is rounded as at 80 and is intended to engage the bottom of the trough 26. By being rounded the end 80 conforms to some extent to the cross sectional configuration of the trough so as to facilitate rotation of the blade on its longitudinal axis.

The support for the shank end 60 of the blade is in the form of a cotter-key 81 which could sit in or, as shown, passes through a suitable opening in the inner lower edge 51 of the chute and has its lower end 82 in engagement with the curved inner wall of the trough 26. The shank 60 of the blade passes through the eye 83 of the cotter key. This construction makes it possible to move the blade longitudinally and also to rotate the blade on its longitudinal axis.

The amount of water picked up by the blade and conveyed to the main trough will be dependent upon the angle of inclination of the blade in respect to the downwardly flowing stream of wash water in the trough 26. When the blade is positioned as illustrated in Fig. 10 it will pick up and convey a greater amount of water than it will when the blade is in the position illustrated in Fig. 9 of the drawings. The blade can be rotated to assume the proper angle to pick up and convey the desired amount of wash water. This wash water will follow up the blade and along the shank 60. Some of the water will drop from the shank into the main trough whereas that water which has not fallen from the shank will travel down the cotter key 81. From the cotter key the wash water will be delivered to the inner lower edge of the stream in the main chute.

The construction provides an extremely simple yet effective wash water supply means. It has been found that the vertical wall or shoulder 62 is not absolutely essential. An absolutely flat blade or an element of other cross-sectional shape will convey water but the illustrated construction is preferable.

Figs. 11 to 14 illustrate a modified construction of spiral chute. The modification in the construction of the chute is in the cross sectional configuration of the chute and particularly of the lower inner edge of the chute.

Each chute section will be similarly constructed or shaped and a description of one section will therefore suffice to describe the construction of the whole length of the chute. The inner edge of the chute is modified, at a plurality of points throughout its length, as indicated generally at S. This modified shaping exists or extends from a point slightly in front of a concentrates take-off opening 20 and terminates short of the next succeeding concentrates take-off opening. The beginning of one of these modified chute shapes is indicated at 65 and its termination at 67. The exact configuration of an area or section S appears in Figs. 12 to 14 inclusive.

In these figures of the drawings it will be seen that 68 indicates the normal contour of the inner edge of the chute. Beginning at 65 the chute edge contour is slightly flattened which flattening is continued until the chute inner edge is substantially flat as indicated at 69 from a point approximately opposite the take-off 20 and continues to be flat for a considerable distance lengthwise of the chute. As the end 67 of the portion or section S is approached the contour of the chute begins to again approach normal. At the point where the section 14-14 is taken the contour is indicated at 70 which is approximately the same contour as that indicated at 65. By the time the point 67 is reached the

portion S has tapered off and at the point 71, Fig. 11 of the drawings, the chute again has its normal configuration 68.

This modified contour at the inner edge of the chute is to facilitate the function of the wash water in moving the concentrates at the inner edge of the stream to discharge into and through the several concentrates take-offs 20. It will be understood from the foregoing that the wash water is delivered to this section or portion S and by reason of the cross sectional configuration of this particular portion or area of the chute the wash water will be delivered in increasing amounts to the inner edge of the stream immediately in front of each concentrates take-off outlet 20.

Either of the wash water pick-up constructions can be used with the modified form of chute shape illustrated in Figs. 11 to 14 of the drawings. Should the constructions of Figs. 2 or 3 be used the delivery ends 24 or 44 respectively of these pipes would be positioned to deliver water onto the end 65 of a flattened chute section S. When the Fig. 6 construction is used the blade supporting pin or key 31 would pass through a section S adjacent its upper end 65 so that a portion of the wash water traveling up the blade 61 would be deposited or discharged to travel down the section S for ultimate discharge against and over the concentrates at the lower inner edge of the stream.

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.

From the foregoing description of 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 particle 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. 5 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. 5 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. 5 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 recovering 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 and being in the shallow edge of the stream the use of wash water with it is 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 the 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 to obtain the best results it 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 and their movement might be so sluggish as to disrupt the concentration 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.

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

I claim:

1. 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 shaped passageway 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 having an outer and high side and an inner and low side, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower sides 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, a trough extending along the inner and lower edge of said passageway, means for delivering wash water to said trough, and means for conducting wash water from said trough and selectively delivering the same to any desired point along the length of the lower inner side of the stream traveling in said passageway.

2. 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 shaped passageway 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 having an outer and high side and an inner and low side, said material bearing liquid traveling in

said passageway in the portion intermediate the upper and lower sides 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 at its inner edge carrying a trough which extends along the length of said passageway edge, means for delivering wash water to said trough, an open ended conduit having an extending scoop, means supporting the conduit so that the scoop picks up wash water from said trough and delivers it into said conduit, and the opposite end of said conduit delivering said wash water to the lower inner edge of the stream traveling in said passageway.

3. A construction as defined in claim 2 wherein, the support for said conduit is adjustable along the length of said trough so that wash water can be selectively delivered at any point throughout the length of the lower inner edge of the stream traveling in the passageway.

4. A construction as defined in claim 2 wherein, the conduit is adjustable within its support whereby that end of the conduit which receives water from the trough can be adjusted in respect to the stream of wash water within the trough to cause the scoop to deliver into the conduit greater or lesser amounts of wash water.

5. In a concentrating apparatus, an elongated spiral passageway adapted to carry a stream of liquid having therein the material to be concentrated, a trough extending throughout the length of said passageway at the inner edge thereof and adapted to carry a stream of wash liquid, an open ended conduit extending from said trough over the adjacent edge of said passageway and terminating at a point above and slightly within said passageway, means for supporting said pipe for movement longitudinally of the trough and passageway, and means associated with said conduit acting to pick up wash liquid from said trough and deliver it into said conduit for delivery to said passageway.

6. A construction as defined in claim 5 wherein, said conduit is adjustable within its support so as to cause said pick-up means to pick up wash liquid in varying amounts from said trough.

7. A construction such as defined in claim 5 wherein, said trough is disposed in a plane below that edge of the passageway along which the trough extends.

8. A construction such as defined in claim 5 wherein, the construction is such that rotation of the conduit about its longitudinal axis will cause the conduit wash water pick-up means to pick up from the trough wash water in varying amounts, and the conduit being longitudinally rotatable within its said support.

9. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravity comprising, a vertically disposed helical shaped passageway having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to form a stream and causing said stream to travel downwardly through said passageway, means for removing from the 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, a wash water conveying trough at and beyond and disposed in a plane below the inner edge of said passageway, a wash water pick-up and conveying

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blade, a support for said blade, one end of said blade being disposed within said trough and supported on the bottom thereof, the opposite end of said blade being supported by said support and being positioned to deliver wash water to said passageway between the inner edge of said passageway and the inner edge of said stream within said passageway.

10. A construction as defined in claim 9 wherein, said wash water pick-up blade support is provided with an eye, and the end of said blade being circular in cross section to fit within said eye for rotation therein and for longitudinal movement therethrough.

11. A construction as defined in claim 9 wherein, said blade throughout the greater portion of its length is of an L shape in cross sectional configuration.

12. A construction as defined in claim 9 wherein, the support for said blade is in the form of a cotter key which extends through the inner lower edge of the passageway and has its lower end in supporting engagement with the side wall of said wash water trough, and said blade has a cylindrical shank portion extending through the eye of said cotter key, whereby the blade is rotatable about its longitudinal axis and free from movement along its longitudinal axis while the blade is in supported relationship with said cotter key.

13. 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 the inner edge, said passageway having a plurality of concentrates outlet openings arranged in spaced relationship along the length of the passageway and positioned substantially in the path the inner edge of said stream, said passageway having a plurality of flattened portions positioned between its inner edge and the inner edge of said stream, each of said flattened portions being elongated lengthwise of the passageway and extending from a point between a pair of said concentrates outlet openings to terminate at a point short of the next following concentrates outlet opening.

14. A construction as defined in claim 13 wherein, the flattened portion beginning at its upper end becomes flatter and wider in the direction of its lower end and then becomes less flat and less wide to merge into the normal contour of the passageway when the lower end of said portion is reached.

15. A construction as defined in claim 13 wherein, said flattened portion is of graduated flatness and graduated width from its upper towards its lower end with its widest and flattened portion extending from a point slightly in front of and terminating at a point slightly beyond the particular concentrates outlet opening with which it is associated.

16. An apparatus for concentrating and separately collecting from a comminuted mass composed of particles having different specific gravities those particles having like specific gravity comprising, a vertically disposed helical shaped

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passageway having an upper inlet and a lower outlet end, means for intermixing said mass with a liquid to form a stream and causing said stream to travel downwardly through said passageway, said passageway having a plurality of circular shaped outlet openings arranged in spaced relationship along the length of the passageway, a splitter in each of said outlet openings, said splitter comprising a circular disc having a portion bent upwardly at right angles to provide a splitter which is substantially L-shape in cross-sectional configuration, said outlet openings provided internally with a circumferential shoulder, the horizontal leg of said splitter resting on said shoulder and being supported thereby so that the upper face of said leg is flush with the bottom of said passageway, and said splitters being freely rotatable in said outlet openings.

17. In a concentrating apparatus, an elongated passageway for carrying a stream of liquid having therein the material to be concentrated, said passageway at a plurality of separated points throughout its lengths provided with circular shaped outlet openings in its bottom, said openings at a point below their upper ends provided with a circumferential shoulder, a disc of the proper size and configuration to fit within each of said openings and partially close the same, said discs provided with a substantially vertically extending blade forming a cutting finger, and said discs being freely rotatable on their shoulder support to selectively position said cutting finger and the open portion of said outlet opening.

18. A construction such as defined in claim 17 wherein that portion of the disc which is within the opening is of a thickness so that its upper face is flush with the inner face of the bottom of said passageway.

19. In a concentrator, an elongated chute along which travels a stream of intermixed particles and a liquid, said chute being provided in its bottom with a circular shaped passageway, a combined valve and splitter supported in said passageway and being rotatable about the axis thereof, said splitter and valve comprising, a circular shaped disc having a portion bent upwardly at right angles to provide a splitter with the remaining unbent portion of the disc constituting a partial closure for the passageway, and the rotation of said disc variably positioning the splitter and the unbent portion of the disc, for the purpose described.

20. 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 shaped passageway 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 having an outer and high side and an inner and low side, said material bearing liquid traveling in said passageway in the portion intermediate the upper and lower sides 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, a trough extending along the inner and lower edge of said passageway, means for delivering wash water to said trough, and means for conducting wash water from said trough and delivering the same to any desired point along the length of the lower

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inner side of the stream traveling in said passageway.

21. 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 shaped passageway 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 having an outer and high side and an inner and low side, said material bearing liquid traveling in said pasageway in the portion intermediate the upper and lower sides 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, a trough disposed in a plane below and extending along the inner and lower edge of said passageway,

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means for delivering wash water to said trough, and means for conducting wash water from said trough and delivering the same to any desired point along the length of the lower inner side of the stream traveling in said passageway.

IRA B. HUMPHREYS.

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