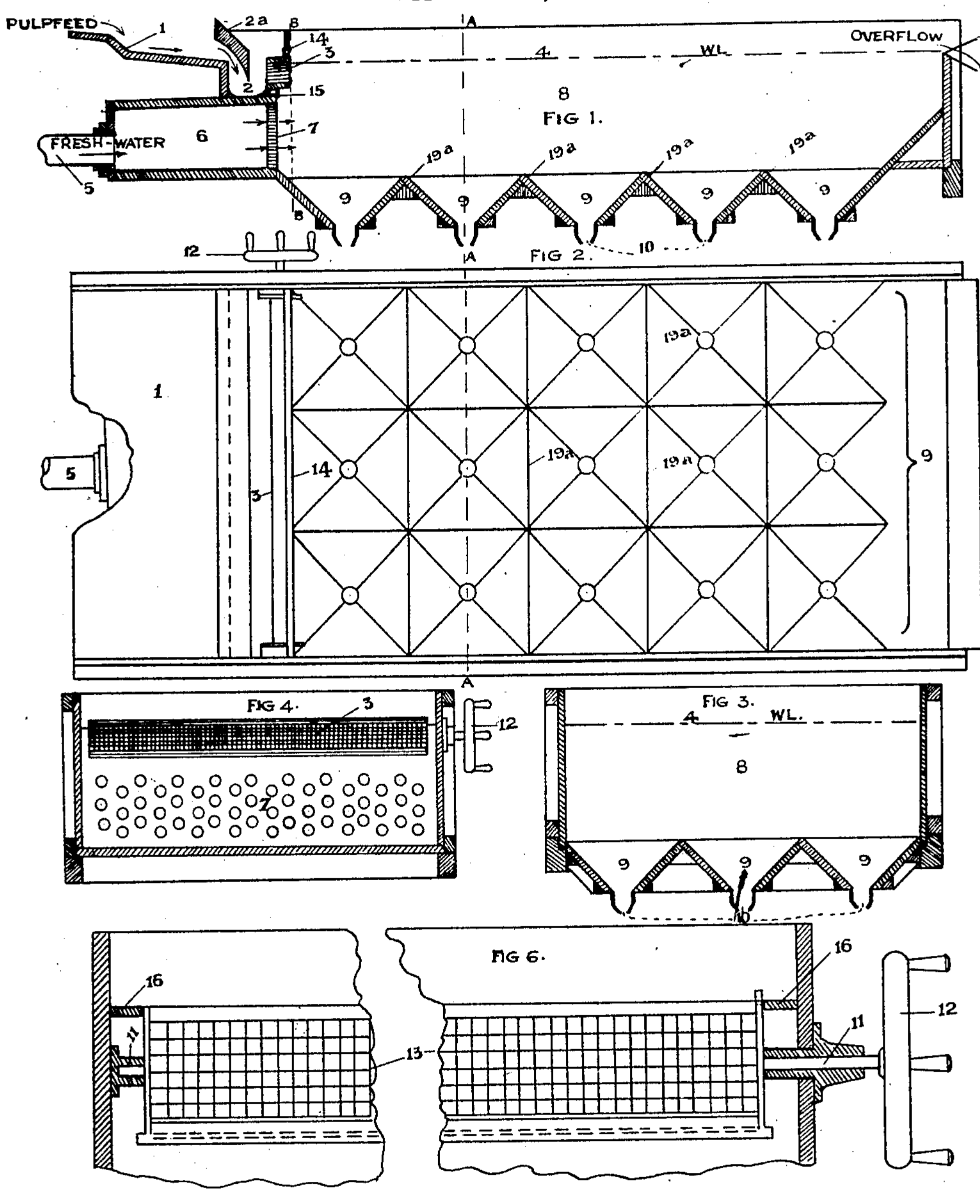
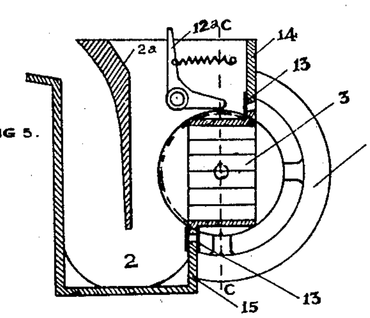
April 16, 1929. J. F. NEWSOM 1,709,365

PROCESS AND APPARATUS FOR CONCENTRATING ORES

Filed Feb. 7, 1923 2 Sheets-Sheet 1





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PROCESS AND APPARATUS FOR CONCENTRATING ORES

Filed Feb. 7, 1923 2 Sheets-Sheet 2

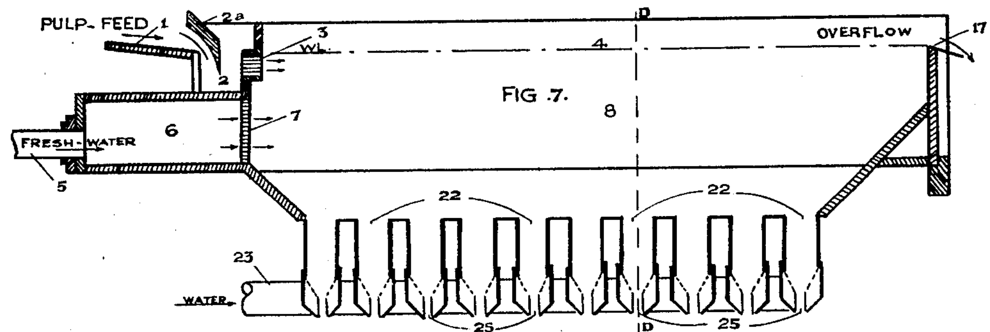

FIG. 7.

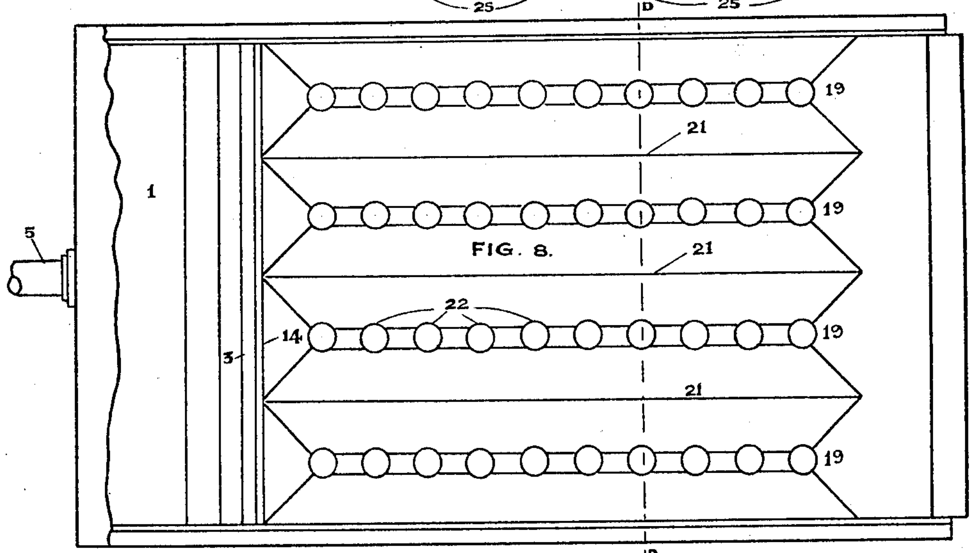

FIG. 8.

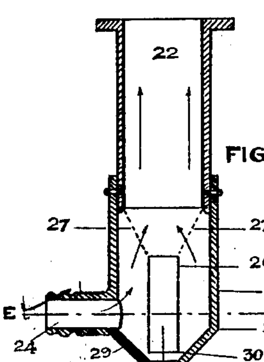

FIG. 10.

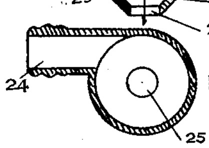

FIG. 11.

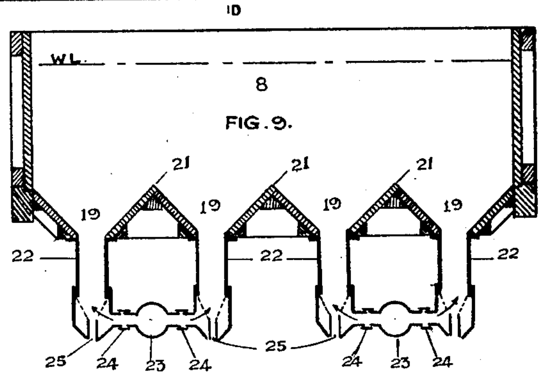

FIG. 9.

WITNESS
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UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR CONCENTRATING ORES.

Application filed February 7, 1923, Serial No. 617,524, and in Federated Malay States November 30, 1922.

My invention relates to a concentrating and classifying apparatus and process for ore bearing material and as a preliminary step to remove the finer barren sands and slimes from the material treated usually referred to as the "pulp" and to concentrate the ore into certain other coarser classes of sands which are to be treated in subsequent ore dressing appliances.

The employment of rectangular boxes, provided at the bottom with rows of hoppers of varying depths, for the purposes of settling out ore-bearing materials according to their specific gravity has, I am aware, been heretofore resorted to, but such boxes hitherto employed have been used with very slow currents and arranged for the settling out of slimes and the removal of the excess water from the pulp, preparatory to further treatment of the slimes. In my invention, however, the box is employed with a rapid current and is arranged for rejecting a large portion of the material passing to it, such rejected material being usually the finer sizes only of worthless sands combined with the very fine silts ordinarily spoken of as slimes.

I am aware that various types of shallow current classifiers commonly known as "spitzkasten" are employed for settling and classifying ore bearing materials into various sizes, but these classifiers employ a shallow surface current with varying sized pockets, in which the current is gradually slowed down and in order to get as perfect a separation as possible employment is usually resorted to of a vertical current of water passing upwards through a settling column, attached to the bottom of the hoppers. In the type of classifier which I am now describing, namely the spitz-kasten, the material caught by the hoppers settles to the bottom of those hoppers and into the settling columns and is there met by an ascending current and the materials that have a settling rate greater than the speed of the ascending current settle through the current and pass out through the spigot opening, but the materials which have a settling rate less than the speed of the ascending current are carried upwards, and must be caught by the currents sweeping onwards through the hoppers and carried over to the next compartment. These types of classifier have very limited tonnage capacities when close work is done.

One of the main objects of my invention is to provide a concentrating apparatus, which will have very high capacities and will be simple and positive in its action.

Another of such main objects is to provide a concentrating apparatus, in which large variation in the character and quantity of the feed, contingent upon the dredging operation and other alluvial mining operations, will not interfere with the satisfactory working of the device.

Other lesser and ancillary objects will appear from the description of the invention set out hereafter.

In order to accomplish these objects I employ a box, essentially rectangular in shape, the length, width and depth of which is made in accordance with the quantity of material to be handled.

At the bottom of this box, rows of hoppers are provided with outlets or spigots in the bottom, through which the heavier materials, as they pass through the box, are sorted out in accordance with their settling rates in water.

The ore bearing material, carried in a current of water, and usually known as the "pulp" is fed into one end of this box and that part of the pulp which is not caught by the hoppers escapes by an overflow outlet at the far end of the box. In passing through the box the various grades of coarser sands and ore settle through the water, in accordance with their free settling rates in water, the coarser and heavier grains settling near the head of the box, the lighter and finer sands settling into the hoppers nearer to the overflow end and the finest materials of all escaping by the overflow.

The process described above brings about the following result, namely, that the bulk of the valuable minerals, referred to herein as the "ore", will be caught by comparatively few rows of the hoppers and in these rows there will be also caught those portions of the barren material which have equal settling rates with the ore grains, but since the variation in size of the grains of the worthless material is usually much greater in alluvial deposits than that of the bulk of the ore, while the specific gravity of the ore is greater than that of the worthless material, it follows that the zone within which the bulk of the ore settles to the bottom is much narrower than that in which the worthless material settles.

By the use therefore of a long, deep box arranged with parallel transverse rows of hoppers, the material falling into certain of the hopper rows may be too low in grade to warrant subsequent treatment and may be discarded, and, as in most alluvial residual and other near surface ore deposits, the low grade material will consist of the finer grades of sands, the material discarded will be that which passes through the spigot rows nearest to the overflow.

The introduction of the large quantities of material and water necessary into a rectangular box in a shallow stream will give the stream such velocity as to cause eddy and return currents throughout the box and thus seriously interfere with the free settling rates of the material.

In order to break up the return and eddy currents I provide a perforated plate or screen below the cellular feed above described and extending across the box. Through this plate, or screen a current of fresh water, by which is meant a current essentially free from any ore-bearing material, enters the box from a pressure box and is regulated in quantity and speed at will and flows parallel to but below the pulp current.

This fresh water current passing into the box immediately below the pulp current, coalesces with the pulp current and forms one even current in the box and thus by preventing return and eddy currents permits the various materials brought into the box by the pulp current to settle to the bottom at their free settling rates and the entire surface area of the box is available for the continuous settling of the sands at their proper rates; furthermore the ore and coarser sands as they settle to the bottom of the box must settle through this fresh water current and thereby the cleanest possible separation is obtained.

While the ordinary type of feed sole may be used to convey the pulp into the box and a fairly even flow imparted to the pulp current I have found that in order to impart the evenest possible flow to the pulp as it enters the box it is best to provide a pocket at the intake end of the box (preferably with a deflecting vane) and a cellular feed distributor. The vane is so placed that the rush of the pulp current is checked as it enters the pocket and after passing the vane it enters the cellular feed, by means of which it is broken up into many separate individual currents flowing parallel to one another, and as these issue from the cells they coalesce and form one even current. It is obvious that the use or omission of the deflecting vane above described depends upon the relative elevation of the pulp feed and the cellular distributor, and I do not make it an essential feature of my apparatus.

In order to save headroom and floor space, to obtain the greatest possible elimination of barren material in one appliance and to equalize so far as possible the supply of ore bearing material going to the subsequent treatment devices, settling columns through which a vertical column of water passes may be attached to the bottom of the apparatus above described and thus combine in the one appliance two important steps of elimination:—(*i*) by free settling, followed by (*ii*) hindered settling, applied to the valuable portions only of the material resulting from the free settling process.

In order that the nature of my invention may be more readily understood I refer to the drawings accompanying this specification.

In these drawings:—

Fig. 1 is a longitudinal section through the classifier showing the longitudinal arrangement of the hoppers, of the fresh water supply, of the pulp feed, and of the cellular and pocket feed control.

Fig. 2 is a plan of Fig. 1.

Fig. 3 is a section on A A of Figs. 1 and 2 and shows a cross section through any particular spigot row.

Fig. 4 is a section on B B Fig. 1.

Fig. 5 is an enlarged section showing the arrangement of the feed pocket and the cellular feed apparatus.

Fig. 6 is a section on C C in Fig. 5.

Fig. 7 shows the arrangement with the hoppers removed from Figs. 1, 2 and 3 and with the settling column added for ascending water current, but with 4 longitudinal rows of settling spigots and troughs instead of 3 as in Figs. 1, 2 and 3.

Fig. 8 is a plan view of Fig. 7.

Fig. 9 is a cross section of Fig. 7 on the line D D.

Fig. 10 is a detail of one of the settling columns shown in Figs. 7 and 8.

Fig. 11 is a cross section of Fig. 10 on the line E E.

Referring now in detail to the drawings, in which the same number is always applied to the same part: Fig. 1, after the ore-bearing material has been sufficiently puddled, crushed and mixed with water to free the ore particles, the stream of water carrying the ore is led in by the feed sole (1) to the feed pocket (2) in which the plunging and rushing current contingent upon a rapidly moving surface current is broken up by the deflecting vane (2^a). From this feed pocket the pulp-bearing material is led through the cellular feed distributor (3) which extends across the width of the box. In the present instance the top of this cellular feed is shown approximately level with the surface of the water (4) in the box. In order to overcome any eddies and return currents that would be formed in the box by the feed current, a fresh water supply is brought through the pipe (5) into a pressure box (6) in which the rapid current of the water in the pipe (5) is equalized, and from which the water flows through the perforated plate (7) into the main body of the settling box (8). It is thus apparent that two currents of water will enter, coalesce and sweep through the box, that the speed and depth of the upper current carrying the ore may be controlled by the width and height of the cellular feed distributor (3), and in which the speed and depth of the fresh water current may be controlled by the amount brought in through the fresh water pipe (5) and the height and length of the perforated plate (7).

In order to produce an even steady current from the pulp feed to the box as that material enters the box, the cellular feed distributor (3) is so constructed that the length of the various cells through which the water must pass is made greater than the width of each compartment or cell, as is indicated at (3) Fig. 5. By this arrangement any boiling or plunging action given to the water in the pocket (2) is overcome, and the currents flowing through the cells issue from those cells with parallel axes, and coalesce into one solid even current in the box. As the current, carrying the ore and sands issues from (3) the solids carried by it will immediately begin to settle towards the bottom of the box in accordance with their specific gravity and the sizes of their particles, the heavier and coarser materials settling out first, and the successively finer and lighter materials settling last.

In order to remove both the settled out sands and ore, hoppers (9) are provided in the bottom of the box with spigot openings (10) at the bottom of the hoppers. These spigot openings are arranged in parallel rows both longitudinally and laterally and therefore classes of ore and worthless material of the same settling rates will be caught in the same lateral row of hoppers, that is to say, the hopper rows (9) with their spigots (10) which are successively further from the feed intake, will each carry slower and slower settling classes of material, but each row will carry material of approximately the same sorts both as regards sizes and as regards ore contained. In practically all cases in alluvial and other near surface deposits, the larger percentage of the ore will be caught in the spigot rows which lie nearest to the feed end of the box, and successively smaller portions of the valuable material, will be caught in the rows further removed from the intake end, this distribution being largely controllable by the quantity of the fresh water supplied to the box through (7) and by the height of the cellular feed distributor (3). It becomes possible, therefore, to so regulate these elements that the maximum portion of the valuable material may be caught in the narrowest possible zone lying across the box, to convey this high grade material to subsequent treatment appliances suitable for treating the sizes and classes of material coming from it, and to discard the material that passes through the remaining spigot rows without further treatment, and thus the largest possible discard of barren materials may be reached without overloading subsequent treatment devices.

In order to provide against the clogging of the cellular feed (3) by roots, twigs, and other extraneous materials, the feed distributor is made reversible and is pivotally mounted (11), so that it may be reversed from time to time by the hand wheel (12) or by any automatic device that might be made to operate at stated intervals.

In order to make water-tight joints at the top and bottom of the distributor, and not to interfere with turning it, pliable fins (13) are attached to the distributor, which will impinge on the vertical partition (14) at the top of the distributor and (15) at the bottom of the feed pocket (2) and a similar fin of pliable material is attached to the inner side of the partition (15) at the bottom of the feed pockets (2). By means of these fins, the feed distributor (3) can be reversed from time to time as desired and the joints between the feed distributor partitions (13 and 14) remain essentially water-tight. Any roots, twigs or other extraneous material which might have collected on the intake of the distributor will be immediately washed out by the current when the distributor is reversed, and this material will be carried through the box, and out by way of the overflow opening (17). In order to prevent currents passing into the box around its ends, short semi-circular vanes (16) extend out from each side of the box and practically contact with the ends of the feed distributor. The dog (12^a) with spring attached holds the feed distributor in correct working position when once set.

Wood fibre, grass and other materials which are so small, or whose specific gravity is so low that they will not settle and be caught by the hoppers within the time the water travels from the intake end to the outflow end of the box, will pass out at the overflow point (17). By this arrangement the fine sands, the woody fibre, vegetable matter and the bulk of the clayey material fed to the box are discarded at the same level at which they are brought to it.

Under certain conditions it is advisable to get a further elimination of worthless material in the preliminary settling and discarding step than can be obtained by the free settling action alone, and it is advantageous to accomplish this result in a single machine in order to save the head room and floor space that would be required in employing separate machines. The discard of additional barren material over that obtained by the free settling process may be obtained by employment of the hindered settling rate of material of different sizes and specific gravities settling in water.

Referring now to Figures 7, 8 and 9, Fig. 7 shows a longitudinal section of the double current classifier equipped with hindered settling columns. In this apparatus the construction is similar to that shown in Figs. 1 and 2, except that the dividing partitions of which a few are indicated by the number (19^a) which form the square hoppers in Figs. 1, 2 and 3 are omitted, thus making longitudinal troughs (19) through the box. These troughs are separated from each other by the angular partitions (21); at the bottom of these troughs, as close together as practicable, are settling columns of which a few are indicated by the number (22) with fresh water supplied to them through the water main (23), and individual pipes (24). At the bottom of these columns is an opening (25) through which the settled sand, ore and a portion of the water supply escape.

The fresh water supply through the main (23) is introduced under predetermined pressure and of requisite amount, and the quantity of water supplied to each settling column (22) is greater in amount than the quantity of water that escapes through the spigot openings (25). Thus an upward current of water is produced in the sorting columns (22) and through this upward current of water the sand and ore particles must fall. These particles whose settling velocity is less than the speed of the upward current through the column will be carried up by that current and carried on to the next settling column. By regulating the water supply to the succeeding columns (22) so that there are slower ascending currents in the succeeding rows of columns a close sorting action is obtained.

When the supply of sands to the settling column is small so that the grains falling through each column are widely separated from each other, the free settling rate will come into play in the columns and but little elimination of barren material will result in this arrangement beyond that already obtained by the double horizontal currents in the upper part of the box. But when the sand supply is larger so that the sand grains coming to each column are close together the hindered settling ratio of sorting will come into play, and the quantity of barren material eliminated will be great.

Fig. 10 shows an enlarged section of the lower end of the sorting column. Fig. 11 is a cross-section on F—F of Fig. 10 and shows the way in which the water supply, (24) is led into the column. At the lower end of the sorting column (22) there may be inserted a funnel shaped, perforated plate or screen (27) attached to the tube (26). The object of this screen is to cause the even distribution of water supply coming in at (24) as that supply passes into the settling column (22). For equalizing the flow of water through the screen (27) a water compartment (26) is provided into which the water from (24) is led; between the walls (29) of this compartment and tube (26) is an annular opening (30) through which sands and other extraneous material entering the compartment may escape, and by regulating the size of this opening, the downward flow of sand and water through (26) may be controlled.

No novelty is claimed for these settling columns as illustrated in Figures 10 and 11 as regards assembly or principles involved as these columns are well known and used appliances. The novelty of my apparatus lies in the combination of these settling columns with a box settler as described.

By means of this arrangement, I combine in one machine the following steps. (I) The classifying and eliminating capacities of the double current box classifier by means of which a large portion of barren material coming to the machine is at once discarded, thus relieving the succeeding appliance from treating this worthless material, and (II) A second treatment of the value bearing material, (which has been already greatly reduced in bulk) by means of ascending currents of water and these currents operating in combination with the double horizontal current classifier, to which they are attached, have the property of automatically becoming hindered settling columns, when the supply of sand is great and, therefore when the largest possible elimination of barren material is required, and of free settling columns when the supply of sand is small. It is obvious, therefore, that this combination of appliances will bring about an automatic adjustment and regulation of the materials passing through the appliance, and passing on to succeeding treatment machines. That is to say, when the proportion of coarse sands in the feed coming to the double current box settler (8) is large, so that the discard of fine material in that settler would be small, and the treatment machines following the settler would for that reason be overcrowded with material fed to them, then the hindered settling principles of sorting will come into play in the settling columns (22), there will be a correspondingly larger elimination of the barren sands in this part of the machine, and thereby the average quantity of feed going to the succeeding treatment machines will be equalized, while practically the total ore content will be caught in both cases.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

1. An ore classifier comprising a box adapted to be filled with liquid and means for feed-

ing a current of water carrying slimes and coarse material into the liquid in a horizontally moving unagitated stream, below the surface of the liquid, whereby the coarse material settles through the liquid solely by gravity.

2. An ore classifier comprising a box adapted to be filled with liquid, a pulp feed receptacle at one end of the box, a port connecting the receptacle with the box below the level of the liquid therein and means in the port for causing liquid from the pulp feed receptacle to enter the box in a substantially solid unagitated horizontal stream.

3. An ore classifier comprising a box adapted to be filled with liquid, means for introducing a deep horizontal stream of water into the box, a feed receptacle above said means adapted to receive water carrying slimes and coarse material and means for introducing said water carrying slimes and coarse material into the liquid in a smooth flowing horizontal stream above and in the same direction as the water stream and below the surface of the liquid in the tank, whereby the coarse material settles through the liquid solely by gravity.

4. An ore classifier comprising a box adapted to be filled with liquid, classifying chambers in the bottom of the box, means for introducing a horizontal stream of water into the box, and a cellular feed distributor arranged above said means and adapted to introduce an unagitated stream of water carrying slimes and coarse material horizontally into the liquid above the water stream.

5. An ore classifier comprising a box adapted to be filled with liquid, classifying chambers in the bottom of the box, means for introducing a horizontal stream of water into the box, a pulp feed chamber, a cellular feed distributor connecting the pulp feed chamber with the box and a baffle wall in said chamber to check the rush of the entering current.

6. An ore classifier comprising a box adapted to be filled with liquid and from which liquid overflows, a plurality of hoppers forming the bottom of the box, the hoppers being arranged in series in the direction of the length of the box, means for introducing a nether current of water into the box above said hoppers and means for introducing a current of water carrying slimes and coarse material into the liquid in a horizontally moving, unagitated stream below the surface of the liquid and above and in the same direction as the nether stream, whereby the coarse material settles through the liquid solely by gravity.

7. The process of classifying ore which comprises flowing a current of substantially clear water horizontally through a box filled with water, and bringing a horizontal current of water containing ore slimes and coarse ore-bearing material into the box below the level of the water therein, and above the clear water current, and in the same direction as the clear water current, so that the two currents merge and pass horizontally and quiescently through the box, and so that the coarser ore-bearing material in the upper current settles solely by gravity to the bottom of the box through the clear water current at different locations, due to the settling rates in water of the solid particles, and the slimes pass out over the overflow.

In testimony whereof I hereunto set my hand this 4th day of December, 1922.

JOHN FLESHER NEWSOM.