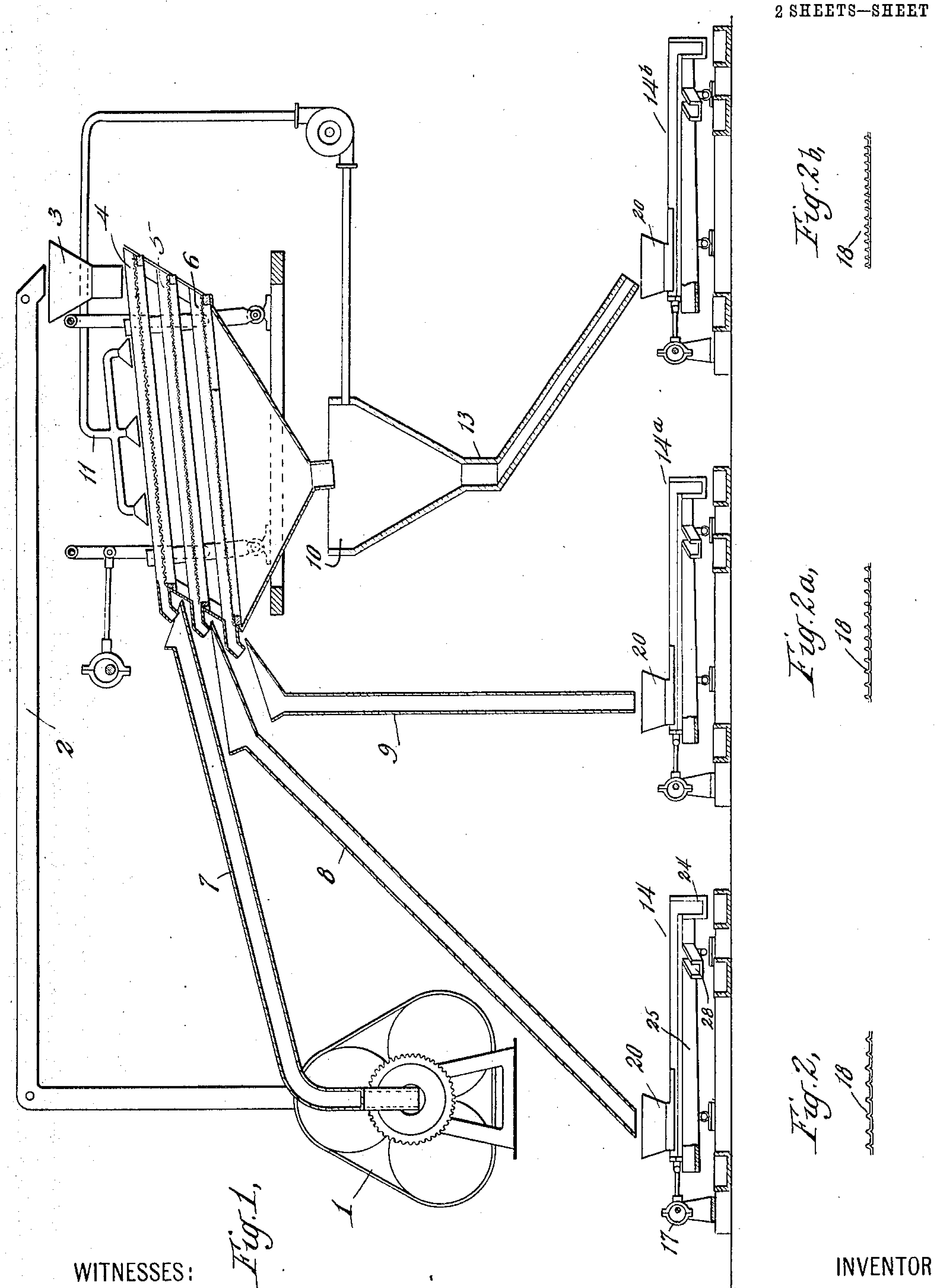
No. 871,368. PATENTED NOV. 19, 1907.

A. SCHWARZ.

METHOD OF CONCENTRATING ORES.

APPLICATION FILED OCT. 27, 1906.

2 SHEETS—SHEET 1.



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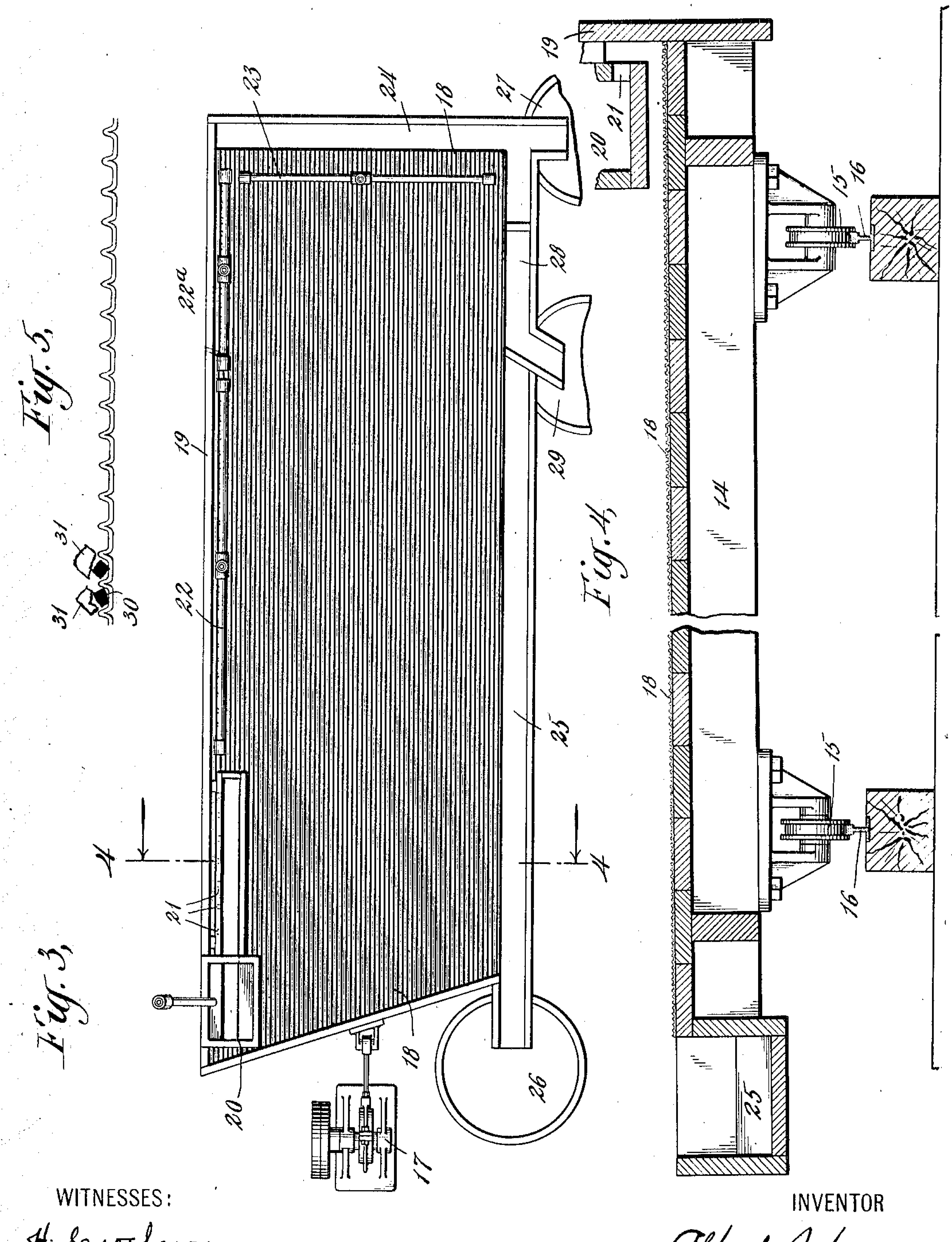

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METHOD OF CONCENTRATING ORES.

No. 871,368. Specification of Letters Patent. Patented Nov. 19, 1907.

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To all whom it may concern:

Be it known that I, ALFRED SCHWARZ, a subject of the Emperor of Germany, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Method of Concentrating Ores, of which the following is a specification.

My invention relates to a method of concentrating ores all as fully described hereinafter.

In the previous practice of concentrating ores the surface of the concentrating tables is divided by longitudinal wooden strips, sometimes of equal, sometimes of unequal length, the length in the latter construction increasing from the upper to the lower side of the table. These strips or "riffles" have been made substantially rectangular in section. The tables are inclined transversely, and in operation the ore in the form of pulp is introduced at the higher side near one end, and under the action of the wash water and the reciprocations of the table the ore is carried transversely downward and longitudinally forward, the purpose being that the gangue shall be discharged at the lower edge of the table, while the values or concentrates are discharged at the foot of the table. The lighter portion of the gangue passes over each riffle in succession while the values and the heavier gangue are caught by the riffles and carried toward the foot of the table. The function of the riffles is to catch and retain the values and confine their movement to one longitudinal of the table; but, owing to the comparatively great width of the riffles and their depth as compared with the particles of ore, masses of the latter become banked against the sides of the riffles, causing back eddies which prevent the proper settling of the values and afford an opportunity for the escape of the finer metallic particles.

The presence of obstructions in the form of riffles to check the travel of the ore pulp has heretofore been considered essential to the successful operation of a gravity concentrating table. I have found, however, that it is necessary to have a substantially continuous and unobstructed flow of water over a surface that offers no opportunity for the piling up or even stoppage of either gangue or values and to guide the heavy mineral particles in the direction of movement of the table (which is substantially at right angles to the flow of water) in such a manner as not either to disturb substantially the even flow of water or to offer obstruction to the particles of gangue carried thereby.

A further advantage of my method of treatment is dependent upon these facts: In pulverizing the ores preparatory to subjecting them to concentrating operations it is found that the values are ground finer than the gangues, which are, on the average, of harder composition. Hence, when the mass is ground to "30 mesh", or "40 mesh", it is, in general, the gangues—*e. g.* silica—that compose the bulk of the particles that are of about the caliber of the screen, while the values are mostly among the finer particles. These large particles, on account of their size, will act as heavier material in gravity processes; and tend to find lodgment at any obstruction, whereby they retard all the finer particles and prevent their separation. I have found that if the surface upon which the operations are taking place be provided with a series of fine indentations sufficient to act as guides for the mineral particles, but of such size and shape that the particles of large average caliber cannot lodge in them, the values will all follow the direction of the indentations, while the gangue will be carried by the water in the direction of its flow.

In the accompanying drawings, I have represented, largely in a diagrammatic and conventional way, grinding and separating machinery by which my methods of treatment may be carried out, and which are susceptible of wide modification in many particulars.

Figure 1 is a diagrammatic view, illustrating an ore grinding and screening mechanism and a plurality of ore concentrating tables fed therefrom, the mechanism being represented as reducing the ore to various meshes, and delivering ores of different meshes to different tables. Figs. 2, 2[a], 2[b] represent the corrugated surfaces of the three different tables illustrated in Fig. 1. Fig. 3 is a top plan view of one of the tables. Fig. 4 is an enlarged sectional view, on the plane of the line 4—4 of Fig. 3. Fig. 5 is a detail, greatly enlarged, illustrating the corrugated surface of the table.

Similar letters of reference indicate corresponding parts in the several figures of the drawings.

1 represents an ore crushing or grinding machine from which the crushed ore is delivered, through a pipe 2, to a hopper 3,

through which it falls upon the highest of a series of screens 4, 5, 6, which are kept in agitation by any suitable means, as will be readily understood. Water may be fed to these screens through the pipes 11, operatively connected with a pump 12. Particles too large to go through the upper, and coarsest, screen 4, may be washed or shaken back into a pipe 7, and carried back to the grinder.

In the normal operation of the machine, the finest particles will pass in succession through all three screens, and fall from the lowest into a hopper 10, whence they are carried to a pipe 13 that leads to a concentrating table 14^b. In like manner the screenings from 5 and 4 are carried through pipes 9 and 8 to other tables 14^a and 14. The meshes of the screen 5 are less than those of screen 4, and screen 6 is of still finer mesh than 5. The tables 14, 14^a, and 14^b, have their operating surfaces corrugated, as will be more fully described, the corrugations being proportioned to the mesh of the screens from which they are fed. Thus, assuming screens 4, 5 and 6 to be of 30, 40 and 60 mesh, respectively, the surfaces of tables 14, 14^a and 14^b will have 8, 12 and 15 corrugations per inch respectively, these differences being illustrated in Figs. 2, 2^a and 2^b.

Figs. 3 and 4 illustrate more fully the construction and arrangement of the tables 14, it being understood, however, that the corrugations indicated at 18 in Fig. 3 are proportionately far larger than are used on such a table as is there represented, which is in the neighborhood of 6 feet in width. The table is suitably mounted as on rollers 15 running upon track 16 so that it may be given a longitudinal reciprocating movement which may be imparted to it by any suitable means, such as that illustrated at 17. A head motion to impart a differential reciprocating movement, well understood in this art, will be employed. The table is preferably inclined slightly transversely of its length, as is illustrated in Fig. 4, and in describing it I shall refer to the right hand side of Fig. 4 as the "higher" or "upper" side of the table; and in like manner I shall refer to the left hand end of the table as shown in Fig. 3 as the "head" and the right hand end "foot".

The upper side of the table is provided with a vertical wall 19, extending above its surface, and secured by brackets to 19 is a trough 20 located near the head of the table, having openings 21 in the bottom thereof for the discharge of the ore pulp upon the corrugated surface 18. Extending along a part of the higher side of the table 14 is a perforated water supply pipe 22, which is so disposed as to discharge the wash water issuing from the perforations thereof against the vertical wall 19 extending around the higher side of the table, so as not to splash the water over the corrugated surface which would create an undesirable disturbance of the masses of ore and concentrates thereon. A short distance back of the foot of the table, and extending transversely thereof, is a water discharge pipe 23, the perforations of which direct the flow of water toward the foot of the table so as to tend to wash it clear and carry the values into the trough 24.

Secured to the lower side of the table is a trough 25 adapted to receive gangue or tailings, said trough being inclined downwardly toward the head of the table and discharging into a settling tank 26. The trough 24 at the foot of the table extends transversely across it and connects with the settling tank 27, into which it discharges the values or concentrates. Between the troughs 24 and 25 is a short trough 28, which receives the middlings and discharges them into a settling tank 29. The lengths of the troughs 25 and 28 may be varied to suit conditions met with in the treatment of different ores.

The pipes 22, 23 may be connected with a pump or other suitable source of water supply, and the trough or hopper 20 is similarly supplied. As will be readily understood, a complete water circulating system may be used whereby the water running into the settling tanks 26, 27 and 29 may be drawn off and run back into the pipes 22, 23 and the trough 20. Instead of having a single pipe 22 extending along the upper side of the table I may provide separate discharge pipes 22, 22^a so as to have separate regulation of the water supply at different points of the table.

As has been stated before, the surface of the table is provided with indentations or corrugations 18 which extend preferably in the direction of the reciprocating movement imparted to the table as above described. These corrugations may be mere lines or scorings cut into or raised upon the surface of the table, which will be sufficient to act as guides for the heavier particles of ore, or values; but I have obtained the best results when these indentations or corrugations have an appreciable depth and width that bears a certain relation to the mesh of the ore, (*i. e.* the size of the larger particles of gangue). Practical experience suggests that, for 30 mesh ore there should be 8 corrugations per inch; for 40 mesh ore, 12 corrugations per inch; for 60 mesh ore, 15 corrugations; and for 80 mesh, 20 corrugations.

In Figs. 1 and 2, 2^a, 2^b, I have illustrated proper means for separating, handling and concentrating 30, 40 and 60 mesh ores. The proportions stated are not absolute, but it is of the greatest importance that the width and depth of the corrugations shall be so proportioned to the mesh of the ore that the larger particles of the latter do not form obstructions or dams upon the table, the avoidance of eddies in the flow of water being of great importance. So far as my experience has shown, the maximum permissible width of the indentations is about 4 or 5 times the mesh of the ore, and in no case should the width exceed a quarter of an inch. The best results I have attained by making the indentations from 1/25 to 1/40 of an inch deep; and as a general rule the width of the indentations is about three times the diameter of the larger particles, and the depth less than the width.

It is not necessary that the corrugations shall be in the direction of agitation alone, or even that they shall be exactly in that direction. For example, there may be several series of intersecting corrugations, or a single series running at an angle of less than 90 degrees to the direction of flow of water.

In the practice of my method upon the apparatus I have described and illustrated, the ore is pulverized in the crusher 1, and after being screened upon the screens 4, 5 and 6, or some of them, is fed to the tables 14, &c., falling into the hopper 20 at the upper side of the table near the head. From this hopper the ore, which is in the form of "pulp", being mixed with water during or after the operations of grinding and screening, falls upon the corrugated surface of the table which is being agitated or moved backward and forward longitudinally. At the same time water is supplied to the table through the pipes 22, 22^a and the trough 20 in such quantity and at such a rate as to make an even and uninterrupted current down the table from the upper to the lower side. The mass of ore pulp begins to work in a general diagonal direction across the surface of the table, this direction being varied to some extent by regulating the flow of water from the rear section of pipe 22^a. The current of water at once washes out of the mass of ore a large part of the gangue and carries it over to the trough 25, whence it flows into the tank 26. The concentrates, on the other hand, by the reciprocations of the table and guided by the corrugations 18, move down toward the foot of the table. If the guides 18 are in the form of corrugations the small particles of values fall into them and progress toward the foot of the table until they are caught by the wash of water from the pipe 23 and swept into the trough 24, thence into the tank 27. If the guides 18 are mere scorings or lines upon the surface of the table, the travel of the concentrates is in less definite paths, there being some lateral shift of the lines of values in their progress toward the foot of the table. There is a certain residue not entirely separated, but composed of a large proportion of gangue with a small percentage of values, that continues on the diagonal path until it reaches the middlings trough 28; the values in these middlings, however, are practically all unliberated from particles of silica, thus forming a medium gravity material. One of the advantages of my process is that by a single operation a plurality of metals of different specific gravities will be separated from a single composite ore, and may be taken off at different points of the field.

In the construction shown in the drawing, the values, by reason of their greater specific gravity, tend to settle in the corrugations near the upper side of the table and over a well defined area; and as they are then free from any disturbing influence except that which tends to move them toward the foot of the table, they will be carried off to the concentrate tank without loss such as has been occasioned in former treatments by the formation of dams and eddies due to the lodgment of large particles of gangue. The body that continues to move diagonally across the table tends to spread out in a fan-like mass, the characteristic of which is that the values are held or tend to fall into the corrugations toward its higher side, while the gangue is being constantly carried off by the current of water down toward the trough 25. In this operation there is a substantially uniform flow of water carrying particles of gangue from the upper to the lower side of the table, and a substantially uninterrupted progression of the values down the guides or corrugations 18 to the foot of the table.

The observed behavior of the corrugated surface above described is substantially different from that of a table having riffles in that the corrugations tend toward the maintenance of bodies or zones of water which are substantially quiescent in planes transverse to the corrugations and in which the separated metallic values are protected from, while the gangue is exposed to the currents of wash water, the values being free to move in these protected zones longitudinally of the corrugations.

Another factor incident to the present invention and which adds to its utility, is that the corrugations are so proportioned that the values have a proportionately larger area of contact with the walls of the corrugations than the particles of gangue.

While I have described certain instrumentalities for grinding and otherwise preparing the ore, it is obvious that any means whereby the ore is reduced to a certain maximum mesh will be sufficient for this step in my process. While I have described a "table" for carrying out the further operation, it will be understood that any suitable field will answer the purpose, provided it be supplied with a uniform flow of water in one direction and be agitated in another, there being guides to direct the movement of the heavier particles in substantially the direction of agitation. For the surface of the table or other field I have used lead, since, being soft, it is easily corrugated by being passed between suitable rolls. I may, however, use materials such as glass, which may be molded in one piece, or aluminium, or even vulcanized rubber. I prefer, however, an electro-deposited covering of copper formed upon a suitable matrix; this covering may be made in one piece, thus dispensing with the necessity of joints or seams which create undesirable local disturbances in the current of water. The electro-deposited covering of copper is particularly advantageous when it is desired to have corrugations such as are shown in Fig. 4 or Fig. 5. In Fig. 5 it will be understood the parts are indicated on a greatly enlarged scale for the purpose of showing how the values 30 settle in the hollows, while the current of water carries the large particles of gangue 31 over the tops of the corrugations.

What I claim and desire to secure by Letters Patent of the United States is:

The process of concentrating ores consisting in sizing the ore and flowing each size in a pulp current over bodies of liquid restrained from movement in planes in the direction of gravital flow, inclosing the values in the quiescent liquid, and differentially agitating the whole to promote settling and to convey the settled values in directions other than that of gravital flow, and gravitally washing away the gangue.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALFRED SCHWARZ.

Witnesses:
M. LAWSON DYER,
CHARLES S. JONES.