2 Sheets—Sheet 1.

F. E. MILLS.

ORE-CONCENTRATORS.

No. 183,319. Patented Oct. 17, 1876.

Fig: 1.

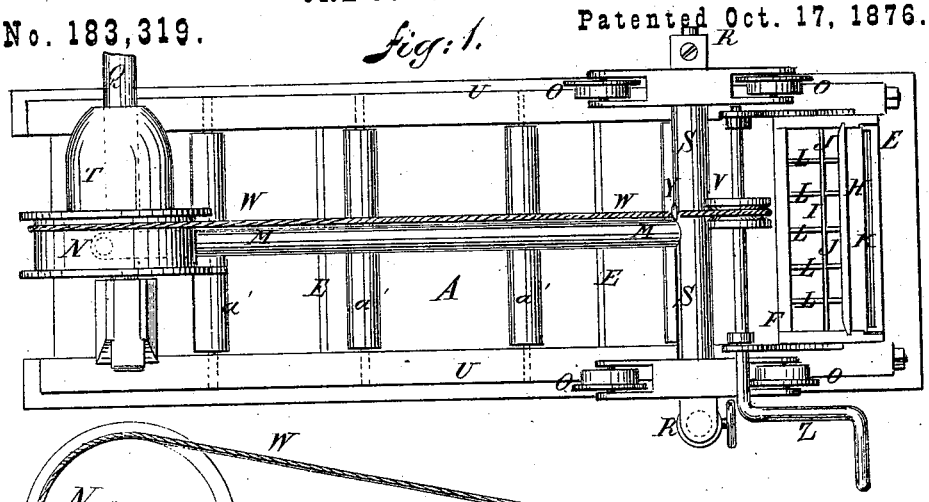

Fig: 2.

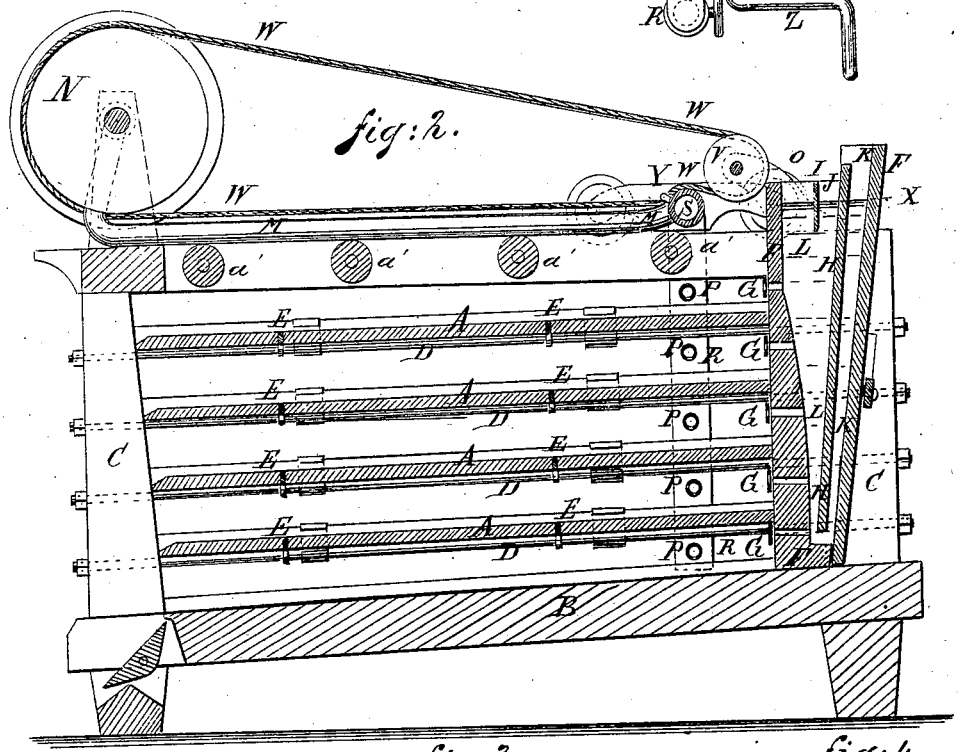

Fig: 3.

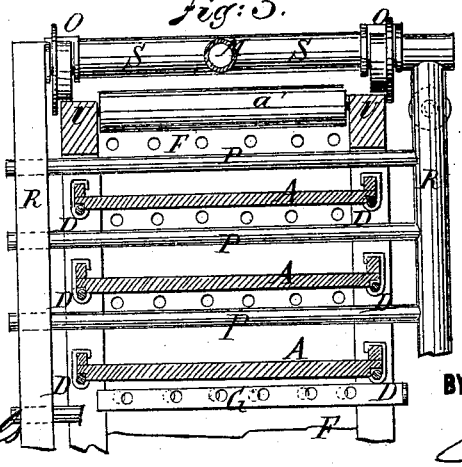

Fig: 4.

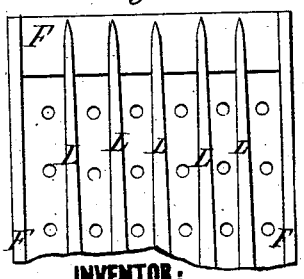

Fig: 5.

Fig: 6

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John Goedtel

INVENTOR:

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BY Munn & Co

ATTORNEYS.

2 Sheets—Sheet 2.

F. E. MILLS.

ORE-CONCENTRATORS.

No. 183,319. Patented Oct. 17, 1876.

Fig: 7.

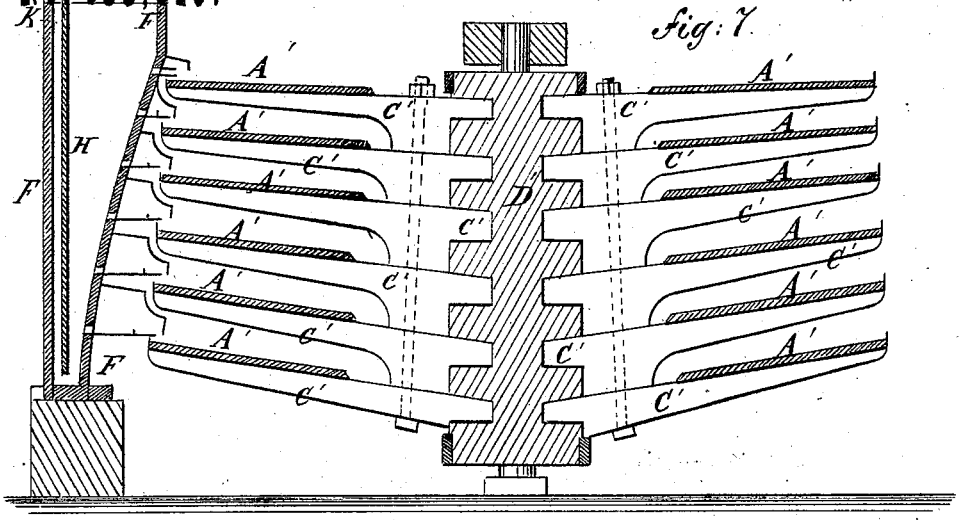

Fig: 8.

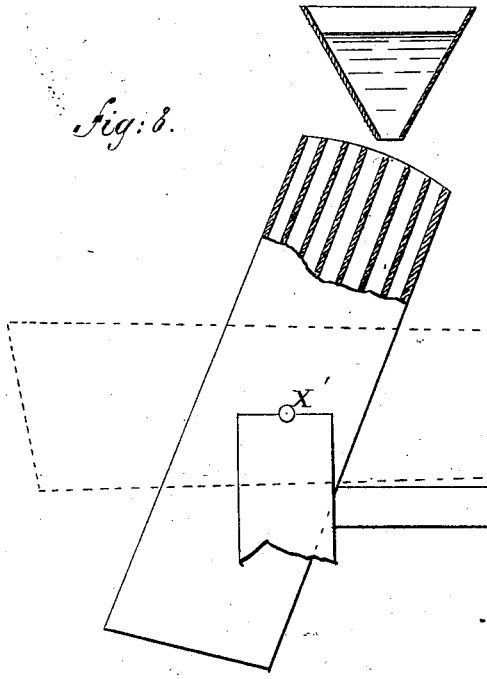

Fig: 9.

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UNITED STATES PATENT OFFICE.

FRANCIS E. MILLS, OF VIRGINIA CITY, NEVADA.

IMPROVEMENT IN ORE-CONCENTRATORS.

Specification forming part of Letters Patent No. **183,319**, dated October 17, 1876; application filed August 16, 1876.

To all whom it may concern:

Be it known that I, FRANCIS E. MILLS, of Virginia City, in the county of Storey and State of Nevada, have invented a new and Improved Ore-Concentrator, of which the following is a specification:

This improvement is designed especially to take the place of the long lines of blanket-tables now so generally employed on the Pacific coast in concentrating tailings from quartz-mills, but is also to be used as a substitute for all that class of inclined tables, whether blanketed or plain, stationary or rotating, where the metallic particles, after having been deposited upon the surface of the table from a thin sheet of ore-pulp flowing over it for a time, are washed by the admission of clear water, and then swept off either with brooms or jets of water.

In order to do much work, all concentrating-tables of the class referred to must have a large surface; and one objection to those in present use, (which my invention is designed to remedy) is, that when working on a large scale, this surface being spread out either on a single plane, covering sometimes many thousand square feet, or on several large planes, side by side, they occupy so much ground-room that it is impracticable, or very expensive, to house them or to operate them in severe weather.

The process of sweeping off the ore-deposit with ordinary brooms, which is employed on tables of any great length, besides being laborious and slow, is very destructive to the blanket or other fabric with which they are covered.

The objection to the stationary side jet-pipe or revolving sprinkler, which, instead of the ordinary broom, is advantageously used on some shorter tables, is that the reach of its effective sweep is too limited; and in order to sweep any considerable distance it must be placed so high above the table that the force of the jet is greatly abated by the resistance of the atmosphere, and much of it is converted into mere spray, necessitating a much larger expenditure of clear water than would be required if the jets could issue from their orifices close to the surfaces of the table.

Another objection to the present mode of using concentrators of this class, especially on the Pacific coast, is that in the absence of any convenient attachment for classifying the sands as they flow, the coarse and the fine are all commingled, and flow at the same time over the same table, occasioning a great loss of the finely-comminuted ores; for where the current is kept sufficiently strong, either by its volume or steepness, to carry off the coarsest sands, the lighter particles of metal cannot find a lodgment on the surface of the table or cloth.

The object of my invention is to remedy each and all of the objections referred to; and it consists, first, in arranging inclined plates, tables, or floors in a vertical series, like shelves, one over another, all held in one frame, and sloping in the same direction, but with varying degrees of inclination. The purposes of this arrangement are to enable a concentrator of large working capacity to be constructed at small cost, occupy small ground-space, be easily housed and operated in cold weather, and be quickly swept at one operation; also, to insure a proper and easy classification of the sands as they flow upon the respective tables, and thus secure a larger percentage of the ore; secondly, connecting with such vertical arrangement of tables a classifying head-box, F, by means of which the sands naturally grade themselves as they flow out upon the different tables, the coarsest and heaviest particles flowing over the bottom tables, the finest and lightest over the top table, and grains of intermediate grades of fineness over the intermediate tables, the inclination of each table, respectively, and the volume of current, being adapted to the grade of sand it carries; thirdly, in employing on all stationary tables a traveling water-broom, which, consisting of a perforated pipe or gang of perforated pipes, extending across the tables, and fed with clean water under pressure, is made to traverse the length of the table, close to the surface, (either on rollers or otherwise,) and sweep off the deposit in its progress by jets through the perforations.

I make the gang-tables stationary, as represented in Figures 1, 2, and 3, rotating, as shown in Fig. 7, tilting, as represented in Fig. 8, or in any other form desired; but as the station-

ary form would generally be most useful in the mining regions of this country where water is scarce, I now describe more particularly my usual mode of constructing them, reference being had to the accompanying drawings, making a part of this specification, and in which—

Fig. 1 is a top view of a gang of tables. Fig. 2 is a longitudinal section. Fig. 3 is a cross-section. Figs. 4, 5, and 6 are detail views. Fig. 7 is a vertical section of a rotary gang. Fig. 8 is a detail view of a tilting gang. Fig. 9 is a detail view of a water-broom.

Similar letters of reference indicate corresponding parts.

The general arrangement will be seen in Figs. 1, 2, and 3, in which A A A are the tables. In order to permit the sweeping of all the tables in the gang at one operation, it becomes necessary to leave a clear space between each, from end to end, for the water-broom to travel in. Any vertical supports between the tables would interfere with this movement. For this reason I generally construct them as follows: Supposing the gang is to consist of twelve (12) tables in superposition, each table to be four (4) feet wide by forty (40) feet long, I plant two heavy timbers, B B, about fifty feet long, side by side, parallel, and frame the ends together about four (4) feet apart, giving them an inclination longitudinally of about half an inch to the foot. Say five (5) feet from the ends of each I frame in strong upright posts C C, about (5½) five and a half feet high; or, in place of wood, I make these posts of iron, with a thick broad flange for a base, which I bolt firmly to the timber. Through these posts, longitudinally with the gang, I insert strong iron rods D D D, one inch in diameter, one over another, with a space of from three to four inches (vertically) between each, giving to each rod, respectively, the proper inclination for its table, as hereafter explained. They are then made taut by heavy nuts and washers on the ends. These tense rods support the table. I make the floor of boards, say, one and one-fourth inch thick, laid transversely on the rods, with grooves or rabbets cut in the under side of each to fit the rods. To prevent the rods from either spreading or approaching each other, and to guard against any sagging of the boards in the center, I connect the rods transversely by rigid metal bars E E E, a few feet apart, laying the upper surface flush with the surface of the boards. The narrow list on the sides of each table is held on with metal clamps, in order that it may be easily removed and replaced when renewing the cloth covering.

The tables may be made of any width and length desired. If more than four or five feet wide, they should have a third line of supporting-rods extending longitudinally through the center; but, for convenience of working, it is better to have each gang not to exceed four or five feet in width by thirty to fifty in length, and, when more surface is desired, increase the number of tables in the gang rather than their width.

For finely-pulverized ore or tailings, I give to the lower table an inclination of three-fourths of an inch to one and one-half inch to the foot, and to the upper one about one-eighth of an inch to the foot, those intermediate being graduated between those two extremes; but these grades may be varied to suit different characters of ore. The lower ends of the tables are not in a vertical line, but hang over a little, to prevent the contents of the upper falling upon the lower as they discharge.

The surface of the table is covered with cloth or used plain, as preferred; but for most pulverized ores and tailings from quartz-mills, heavy duck for the bottom table and fine cotton sheeting for the upper one make about the right kind of surface, with fabric of varying degrees of roughness for those intermediate. At the head of this gang of tables, with its face pressing against the upper end of each table, is the classifying-box F, into which the main stream of pulp is first fed, and from which it flows out upon the head of the tables through horizontal rows of apertures cut in its face just above each table, respectively. This box is made eight or ten inches higher than the gang of tables, to prevent the pulp spreading over as it falls into it from the main conduit.

The proper size of the apertures over each table will depend upon the coarseness of the ore, but may be varied to suit different conditions by the adjusting-slides G, Figs. 1 and 2, which can always be regulated to admit the right quantity of pulp to each table. This classifying-box is quite narrow at the bottom, (not exceeding an inch or two in width,) but is ten or twelve times wider at the top. The flare of the box is principally on the side next the tables, the other side being nearly vertical. This flare inside is not uniform from top to bottom, but increases rapidly toward the top, as represented in Fig. 2, detail view.

H, Fig. 2, is a sliding partition, extending through the box from top to bottom, which may be left up, say, from one to two inches from the bottom, to permit the passage of pulp or water underneath it, or may be pushed down upon the bottom, cutting off all communication between the two compartments of the box. I is simply a thin metal guard, extending down into the box eight or ten inches, to give initial direction to the entering grains of sand.

I use this classifying-box in either of three ways, specified as follows: First, in case the running pulp is very thick, and there is not clean water at command to dilute it, I close down the sliding partition H and feed the pulp in just forward of it at J, (the box being kept full up to the line X.) The drop from the main conduit into this box should be as small as possible, to avoid any detrimental disturbance below.

Fed in this manner, the operation of the box is this: The box being kept full, there is the vertical tendency of the grains by gravitation, and also a lateral tendency by the draft of the currents through the side apertures. Acted upon by these two forces, the coarsest grains of both sand and metal, being least diverted from their vertical course, will reach the lowest aperture and flow out upon the bottom table. The finest particles, in the nature of slime, having but little tendency to descend through the mass, remain at the top, and pass out upon the upper table or tables, while grains of intermediate degrees of gravitating power will mainly be drawn through apertures of corresponding distance from the bottom.

Second mode: If there is an abundance of clear water at command, I raise the sliding partition H about one inch, or less, from the bottom, and, while still admitting the thick pulp at J, let a stream of clear water flow into the compartment K, being careful so to adjust the open space under the partition that the head of clear water standing in that compartment shall preponderate sufficiently over that of the pulp to produce a slight upward current of the latter in the lower portion of the box.

Third mode: If the pulp, as it comes from the main conduit, should be already greatly diluted with water, I raise the partition-slide somewhat higher, and feed it all in at K. In that case all the sands reach the discharging-apertures with an upward current, diminishing in velocity with the increasing width of the box as it ascends.

In either of these described modes of using the box the classification of the sands on the respective tables will be sufficiently thorough for practical working, provided proper attention be given to secure uniformity of standing head in the box and the proper volume of flow over each table.

Inside the box, forward of the partition, the box is partially filled with wedge-shaped blocks L L L, extending transversely through it from top to bottom, to narrow the channel downward, and prevent any dead water in the lower portion of the box, in which sand would be liable to settle. Outside the box, in front of each row of discharging-apertures, is fixed a thin metal dash-board, which checks the spouting pulp and spreads it evenly upon the head of the table.

Although it is most convenient to place the classifying-box against the head of the gang, with the apertures discharging directly upon the tables, yet, if the gang be wide, it is sometimes better to place this box a few feet back, make it quite narrow transversely of the gang, with a single large aperture for each table, instead of a row of apertures, and attach a fan-shaped trough to each aperture leading to its corresponding table. In that case I place the dash-board designed to break the spouting force of the pulp inside this trough, which spreads and drops it quietly upon the head of the table.

The traveling water-broom: This, when employed on the gang of stationary tables hereinbefore described, consists of a vertical gang of small horizontal perforated pipes, P P P, set rigidly in a frame resting on the wheels O O. These pipes are supplied with clear water through the hose M, which is coiled on the reel or drum N. This hose connects, by means of a bent pipe inside the drum and a turning joint at Q, with another pipe, (not represented,) which furnishes the clear water under pressure of eight or ten feet head. The perforated pipes reach entirely across the gang of tables, one over each table, as seen in Fig. 1. The frame which holds the pipes, and which rests upon the wheels O, lies horizontally across the top of the gang of tables, with arms R R hanging down vertically on each side nearly to the bottom table. The horizontal part S of this frame, also one of the hanging arms R, is hollow, constituting a receiver of the water from the hose, and into which both the hose and the perforated pipes open. The opposite hanging arm R is simply to support the closed ends of the pipes extending through between the tables.

A globe-valve at T lets on or shuts off the water to and from the gang of pipes. I also attach similar valves or stop-cocks to each of the perforated pipes near their junction with the receiver, to regulate the amount of clear water to be supplied to each table, respectively.

The wheels on which the entire weight of this traveling water-broom rests are provided with flanges and run upon two rails, U U, placed longitudinally over the gang of tables. The hose-drum should be made as light as consistent with the requisite strength, but should have large circumference. I place this hose-drum over the lower end of the gang of tables, the under side being five or six inches higher than the top of the rails. Over the upper end of the gang, just forward of the classifying-box, I fix a grooved pulley, V, about one foot in diameter, its lower edge being the same distance above the rails as that of the hose-drum. Passing over this pulley and drum is an endless chain, W, which is also attached, by a hook or otherwise, to the frame of the water-broom at Y, near the point where the hose enters the receiver. This pulley is turned by hand by means of the crank Z.

In practice, both the drum and pulley may be suspended from the timbers of the building, and not attached to the frame-work of the tables.

Fixed transversely between the rails, and, say, three or four feet apart, are placed rollers a' a' a', to support any slack of the hose as it travels back and forth. The size of the pipes P P will depend upon the width of the tables, and the size of the hose and receiver upon the width and number of tables in the gang. If

the tables are only four or five feet wide, ten or twelve in a gang, I make the diameter of the pipes about one inch (or less) inside, that of the hose and receiver being from three to three and one-half inches. The perforations in the pipe may be in the form of one row of small round holes, say one-sixteenth of an inch in diameter, (those for the lower tables being somewhat larger,) or very fine horizontal slits, half an inch long, placed in two rows, the slits slightly overlapping each other. These perforations are a little forward of the bottom of each pipe, in such a position that the jets of water issuing therefrom shall strike the plane of the table at an angle of about forty-five degrees.

The operation of this water-broom is as follows: The position of the broom while the pulp is flowing over the tables is at the head of the gang, the hose being uncoiled and resting upon the line of rollers, and each pipe reposing across its respective table, just under the row of discharging-apertures in the head-box. When the washed deposit on the tables is ready for the sweeping, the valve T is opened. The water jets through the perforations, and the crank being turned appropriately, the hose is slowly coiled upon the drum, causing the broom to travel with the same motion down the length of the gang, each pipe sweeping off the deposit on its own table as it moves along. The valve of the receiver is then closed, the motion reversed, and the broom run back to its former position at the head of the tables. If preferred, the gang may be made much narrower and shorter, say only two feet wide by twenty feet long, and the inclined floor made of thin sheets of metal laid not more than one inch apart, the sweeping-pipes being proportionately small. This, if the gang were four and one-half feet high, would give a working-surface of nearly two thousand square feet, and occupy but forty square feet of ground-floor.

Having thus particularly described the construction and operation of my invention in its best form when applied to stationary rectangular tables, I will briefly point out some modifications of the same as applied to other forms and conditions.

In all cases where there is an abundance of clear running water to be had convenient to the works, instead of the stationary rectangular tables just described, I construct the gang in the form of a circle, and give to it a slow rotating movement. In this case the inclined tables are framed one over another, on one vertical shaft, all sloping toward the center, but with varying degrees of inclination, as represented in Fig. 7 in the accompanying drawing, in which A^1 A^1 A^1 are the tables. Each table is supported by a set of strong arms, C′ C′ C′, framed into the large vertical shaft D′. In the central portions of the wheel these arms are strong and deep, rest upon each other, and are firmly bolted together, to make the entire frame as rigid and unyielding as possible; but that portion of each arm immediately under the table is considerably smaller, and tapers to the end, leaving a clear space between each table over the whole surface.

In constructing a rotating gang, consisting of ten or twelve tables, I give to the upper one, which receives the slimes, an inclination of about one-eighth of an inch to the foot; to the next, three-sixteenths, and so on, increasing the inclination more rapidly toward the lowest, which may fall as much as one and one-half inch to the foot, if some of the material to be concentrated is coarse. In a gang of that number of tables, it is not essential that they all vary in inclination. Two or more tables carrying the same class of sands may be parallel. The pulp is fed onto this rotating gang from the outside or periphery, at several points in the circle, there being a classifying-box, F, at each feeding-point, (substantially like that described for the stationary gang,) through which the sands classify themselves in flowing out upon their respective tables. For sweeping off the deposit from this rotating gang-table, I use vertical gangs of perforated pipes under pressure, placed at the proper distances around the wheel, one pipe in every gang reaching diagonally across each table. Other appliances connected with the working, being similar to those employed in operating rotating tables now in use, it is unnecessary to describe in this specification.

There is another mode in which I contemplate using the gang-table and head-box in localities where clear water is too scarce to run the traveling water-broom. It is represented in Fig. 8. In this form I place the shelf-like inclined plates closer together than in any heretofore described, with the sides inclosed, and the entire gang (which is only eight or ten feet long) so nearly balanced on the horizontal pivot or bearings X′ that, on washing down, the head end of the gang may be tilted up clear of the head-box F, and the deposit swept off all the plates at once by a douche from a vessel of water, *w*, overhanging the tilted end of the gang.

Fig. 8 represents in dotted lines the position of this gang and box while working, and in full lines its position when tilted to receive the douche. The entire end of the gang is only about one and one-half to two feet square by nine feet long, and the thin plates about half an inch apart. The head-box stands on small wheels like casters, so that it may be readily drawn back a little, then pushed up against the head of the gang at each tilting operation.

Another form of the traveling broom: I do not confine the use of the traveling broom to gang-tables, but apply it also to all forms of single stationary tables, whether rectangular or circular.

When applied to a broad rectangular table, spread out on a single plane, I generally construct the broom in the manner represented in Fig. 9. In this form the broom does not

move on rollers or wheels, but, being suspended by the arms e^2 e^2 to a horizontal shaft, f^2, placed high above the table, it swings forward and back over the plane of the table, sweeping off the deposit in its forward movement by jets through the perforations. This form being quite desirable on some tables already constructed, I will describe it more particularly.

Fig. 9 is a vertical elevation of this single table and broom, in which A^2 is the table, and P^2 is an end view of the water-broom, which consists of a triangular-shaped pipe, perforated at its lower acute angle, extending transversely over the table, suspended by the arms e^2 e^2 to the horizontal shaft f^2, this shaft being placed on bearings about twelve feet (more or less) above the table.

S is a hollow receiver or pipe, attached rigidly to the arm e, its lower end connecting with the broom P, and its upper end connecting, by means of a turning joint at Q, with a stationary pipe, in line with the axis of the shaft. This latter pipe communicates with a reservoir of clear water.

The pipe S^2 is furnished with a globe-valve near its junction with the broom. If the table is very wide, the shaft (which is small) should have two or more bearings toward the center in addition to those at the ends, and at each bearing an additional arm should extend down and embrace the broom, in order to stiffen and support it through its entire length.

The weight of the arms, broom, and pipe S^2, filled with water, is counterpoised by the balancing-weight K, placed on the opposite side of the shaft, to insure its equilibrium at all points while working. If the arm be twelve feet long, the broom will sweep thirty feet in length of tables at one movement. The line over which the shaft lies should be one-third the length of the table from its head.

When constructed in this form, the traveling broom may be moved over the table by the operator taking hold of a sliding knob inserted in the arm at l^2, and walking along with it forward and back; or light segment-gearing may be attached to the arm e^2, and the broom operated with a crank. The dotted lines in Fig. 9 show the position of the broom at the extremes of its movement.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. An ore, tailings, or slime concentrator, consisting essentially of a vertical series of inclined tables, plates, or floors, framed one over another, and sloping in the same direction, provided with feeding-apertures of different heights, and combined with a water-spouting device for sweeping the whole series simultaneously, substantially as and for the purpose hereinbefore described.

2. The stationary gang-table A A A, Figs. 1 and 2, combined with the traveling water-broom P P P P, Figs. 1 and 2, constructed and operating substantially as described.

3. In combination with a series of inclined plates or tables, framed one over another, the classifying head-box F, either with or without the partition H, constructed and operating substantially as and for the purpose hereinbefore set forth.

FRANCIS E. MILLS.

Witnesses:
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IRA S. PARKE.