and dividing the product by the difference between the weight of the mercury recovered and the "button." This figure, multiplied by 1,000, gives the weight, in grains, of the free gold and silver per ton of ore, which, for all practical purposes, may be assumed to be all gold. Should, however, greater accuracy be desired, hammer the "button" flat and thin, and dissolve the silver from it with nitric acid, and weigh the gold. The difference in weight represents the silver.

Panning Assay.—Take 2 lbs. of ore, crush, and pass through a No. 40 sieve; any gold in the residue left on the sieve being set aside. The sample is then carefully panned, and the tailings re-panned, to make sure nothing is lost. This operation will show at once whether the ore is rich in sulphurets or not, and the nature of them. The visible gold should be panned as free as possible from all the sulphurets, taking care that none is lost. The pan and its contents, together with the residue left on the sieve, are dried by holding over a fire; the contents are brushed into a cone of lead-foil, rolled up, melted and cupelled. The "button" is weighed, and the free gold determined by multiplying its weight by 1,000.

The tailings produced in the panning operations should be panned over several times to collect all the sulphurets, which should then be dried, weighed, and their percentage in the ore determined.

Another method consists in not separating the free gold from the sulphurets, but in treating them both together by fire-assay, and determining the *total* value of the gold present in them. The operations, as far as described, are all that can be properly considered as coming under the term of battery amalgamation as practiced in California, if we except the use of the riffle and blanket sluices; these are placed below all the plates, and receive a very spasmodic attention in the majority of mills. Blankets are laid in strips, about 16 in. wide and about 6 ft. long, overlapping each other in double sets of sluices, set on a grade of about ¾ in. to the foot, washed in a separate water-box. The material thus obtained, with the contents of the riffles, is deprived of its valuable contents by the aid of arrastras, pans, or Chili mills. But few blanket-sluices are found to-day in California mills.

On the practical development of the Plattner chlorination process, by Mr. Deetken, in the "sixties," it was demonstrated that many of the low-grade quartz veins carried enough gold in their sulphurets to make their working profitable, causing attention to be directed to the concentration of these ores by mechanical contrivances. From the constant and successful use of the gold-pan the mechanical application of a similar motion was sought, resulting in the use of the Hendy and similar concentrating machines.

The Hendy concentrator consists briefly of a shallow iron pan with an annular groove on the outer edge and a waste discharge in the center. It is supported on a central upright shaft passing through the center of the pan, on which revolves, above the pan, a central bowl to receive the pulp, having two tubular arms extending close to the outer edge of the pan; these uniformly discharge the pulp at right angles from their axis. At a point on its circumference the pan is attached to a crank-shaft, making about 220 revolutions per minute. The sulphurets and small balls of amalgam gather in the groove at the outer edge, from whence they are drawn through a gate, which is regulated to be automatic in its discharge. This gate is not opened until the groove is pretty well filled with sulphurets. Two of these machines, driven by one shaft, are required for a five-stamp battery. The machine needs constant attention; one man can attend to twelve machines on a shift. They have been mostly displaced by the endless-belt machines which have developed from the endless blanket and shaking-table.

In 1867 the first patents for the revolving belt were issued.* This was the commencement of the belt concentrators, of which at present the Frue, Triumph, Woodbury, Tulloch, Embrey and Johnston are representatives. To produce the best results on these machines, all the stuff should be *sized*.

The Frue Vanner, which has the largest representation in California gold mills, has been frequently described.† It has a side shake of 1 in., with from 180 to 200 strokes per minute, the belt traveling upward on an incline from 3 to 12 ft. per minute. The belt is made in two sizes, 4 ft. and 6 ft. wide, and in the latest patterns as made at the Union Iron Works, San Francisco, has practical arrangements for easily changing the slope at the upper end. The frames of these modern styles are made of iron instead of wood. The pulp is discharged very evenly over the belt from a distributor near the upper end, just below the point where clear water is discharged in fine jets across the belt. In placing the machine, attention must be given to the solidity of the frame, and that a perfect level be obtained across the belt; further, the pulp and clear water must be distributed in an even depth of about ¼ in.; the grade and upper travel depend on the fineness of the pulp, and must be regulated accordingly.

The following guide for a proper condition of the work on the belt is given by Henry Louis, E.M., F.G.S., etc., in his very useful work, "A Handbook of Gold Milling," 1894, p. 324:—"The working conditions should be so adjusted that a small triangular patch of sand should show at each of the lower corners of the belt. These sand-corners should not be too large, but must be well marked, and the two should be of equal size. Should they be unequal the fault will be found to be either in that the belt is not accurately level across, that the distributor is not doing its work properly, or that some of the working parts have not been properly tightened up, so that there are other motions than normal ones communicated to the belt. Too large a corner of sand shows that the pulp is too thick, while absence of any corner indicates that it carries too much water."

Two of the 4 ft. belt vanners, or one of the 6 ft., handle the pulp from a five-stamp battery. The amount of clear water required to be added is about ⅛ cub. ft. per minute; the vanner requires ½ h.p.

The Triumph differs from the Frue, principally, in that it has an end shake of 1 in.. and slightly quicker stroke (230 per minute), the belt making a forward movement of 3 to 4 ft. per minute. It receives the pulp in a bowl containing quicksilver before reaching the distributor, which is all kept in agitation by revolving stirrers.

The Woodbury is similar to the Triumph in extent and number of motions, but divides the belt into seven longtitudinal partitions; an increased output being claimed for this construction.

The Tulloch gives a rocking motion from a fulcrum on the floor, making 140 shakes of 1⅜ in. per minute, using either canvas or rubber belt. This machine, it is claimed, saves a somewhat larger amount of the finer and richer grade of the sulphurets as compared with the former types.

The Embrey is similar to the Frue, but with end shake.

The Johnston, with improvements, and the latest of the belt concentrators placed on the market, claims many points of advantage. It is suspended from four non-parallel hangers capable of adjustment, by which the angle of oscillation can be changed as required, preventing the accumulation of sand at the edges, such as occurs with the horizontal side-shake machines, or the piling of the sands in the center of the belt, that occurs with the rocking motion. The motion imparted to this belt resembles more nearly that of the batea than that of any of the other concentrators. The belt is made of No 6 duck, oiled and painted, but a rubber belt can be used at one-third the cost of those with molded edges, which are short-lived. Small, hollow, brass, side-rollers on the shaking-frame, form the raised edges by curving the flat belt slightly upwards. The pulp is delivered from five slots running parallel with the belt frames, ¼ in. wide and 16 in. long, leaving 10 in. spaces, into which the pulp is thrown when it strikes the belt. Here the separation at once takes place; the sulphurets settling on the belt are carried by it up to the clear water, while the sands are carried down the belt. In neither case are the sands or sulphurets obstructed by the falling water and sands, as in other machines where the pulp is discharged across the belt. The clear water at the head of the table, instead of being discharged from a stationary box to the moving table, is discharged from a distributor, which is attached to and moves with the table, thus stripping the belt of the smallest possible portion of sulphurets. Two widths of belt, 54 in. and 72 in., are used, which are given a grade of ⅛ to ¼ in. to the foot, making about 118 side-shakes per minute. One machine handles the pulp from a five-stamp battery.

Another vanner, soon to be placed before the mining public, consists of the essential features of the vanner, but carries a rubber belt with depressions all over it, 2 in. in diameter and ⅛ in. deep, shaped after the batea, while the entire belt receives a motion corresponding to that given to a batea.

As the motion and grade given to any of these machines can only be correct for a certain size of grain in the pulp, it would be advisable to introduce some method of sizing the pulp previous to bringing it on the concentrators, and feeding the sized material to different machines. The finer the screen that has been used in the battery, however, the less does the lack of sizing affect the product from the concentrators. The concentrators should always, where possible, be attached to power independent from the stamps, and be placed on a floor below the aprons, and in a position to permit the attendant to pass all around and to conveniently transport the concentrated stuff to the covered drying floor, which should be made with a slight incline, preferably of concrete, and exposed to the sunlight.

Canvas Platforms or Tables—Investigation proving that the slimes passing off with the waste from the mill and concentrators still carried an appreciable amount of precious metal, millmen during the last few years have extended their operations, and re-treat the hitherto escaping slimes. This is done by conveying all the waste material from the mill, through sluices, to canvas platforms having the following general features.

A platform is built of clear, seasoned, and planed, 1¼ in. planking, on a solid, level foundation, and given a grade of about ¾ in. to the foot, over which No. 6 canvas is stretched smooth, longitudinally, though sometimes crosswise, with a 2 in. overlap. Particular attention must be paid that the canvas is stretched smoothly and evenly and that no crack opens between the planks constituting the platform. The length and width of the platform required, depends on the amount of pulp to be handled; overcrowding must be avoided. The platform is divided longitudinally into sections corresponding to the width of the canvas, which is 22 in.; the partition is made of wooden strips, 2 in. wide and ½ in. high, covering 1 in. on the edge of two adjoining pieces of canvas. Running along the head of the platform are two sluices, one placed above the other; one containing clear water, the other pulp from the mill, both furnished with ¾ in. to 1 in. plug-holes over each section. Below the lower edge of the platform are two sluices placed side by side, the inside one to convey the waste, the outer one for the concentrates (sweepings) from the platform. When ready for operation, the plugs are withdrawn, and both pulp and clear water commingled flow down in an even current and are discharged through the bottom waste sluice. After one hour or less, the plug is inserted in the pulp-box over the first section, and the clear water permitted to run for a few minutes longer, during which time quartz sand may be observed passing off the canvas, leaving a dark, partly metallic appearing sediment on the canvas. A tray or board is then placed over the waste sluice, connecting the lower edge of the section with the outside sluice, and the sediment is removed from the canvas, either by sweeping or with the aid of a hose with a flattened nozzle, to be worked later by chlorination or cyanide process.

The following is a description of an improved canvas plant erected and operated in Amador County, by the patentee, Mr. Gates. In this case, the pulp and waste water are conducted from the mill in a flume to the plant, and there divided into two equal streams by the insertion of an adjustable division plate in the flume. The divided pulp passes into boxes 4 ft. long and 1 ft. wide, and having steel screen bottoms with ⅛ and 1/16 in. perforations, set on a reversed grade of 6 in. to the box. The object of these screens is to prevent any chips, leaves, lint, or foreign substance from passing into the sizing-box beneath, which consists of a wooden V-shaped trough, 6 ft. long, 15 in. broad at the top and 2 in. in the bottom, constructed of 1½ in. boards. A piece of canvas is tacked on the bottom for packing; underneath is nailed a piece of scantling 4 x 6 in., at one end of which, reaching within 2 in. of the end of the box proper, a slot, 14 in. long and 2 in. broad, is cut; here a flattened, galvanized-iron funnel, ending in a 2 in. pipe, is attached. The pulp falls through the screen with some force and is considerably agitated in the separator-box. Naturally the coarser and heavier particles have a tendency to settle toward the bottom. Were the outlet there large enough, all the pulp would pass down and out. Its size of 2 in. causes the box to fill to the height of a sluice-box in the end, through which the finer pulp flows to the canvas-tables. To facilitate the separation, a device is placed in the lower end, consisting of an iron pipe, ½ in. inside diameter, connected with the main pipe above the screen, and divided into two sections, which are connected by rubber hose for ready detachment. The lower 6 in. of the iron pipe has small perforations, through which clear water is ejected, causing an agitation of the pulp. The end of the pipe is stopped with a wooden plug, easily removed. The agitation at the end of the pipe causes the fine material to be carried upward and into the sluice at the end of the separator-box. Only coarse sand passes through the bottom pipe, and on examining this with a magnifying glass, very few particles of sulphurets are discernible. This separator works well, and disposes of a lot of coarse, valueless material that would otherwise interfere with the subsequent working of the slimes on the canvas platforms. The fine pulp flowing from the top of the separator is conducted in a sluice to a broad, flat box, in which the stream is divided by partitions into ten separate currents, each terminating over a canvas-table, ten in a row. The pulp goes over a spreader made of strips of galvanized iron, ¾ in. in height, radiating from a common center to the farthest side of the table, which is 12 ft. wide. These strips are nailed to an inclined board extending across the canvas-table, having an iron strip, 1 in. high, fastened to the lower end, perforated or notched, with indentations 1/16 in. deep and 1 in. long, affording a perfect distribution. Twenty tables are arranged in two rows of ten each,

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*From the records of the United States Patent Office.

No. 61,426, January 22, 1867. T. D. & W. A. Hedger, Meadow Lake, California. "Revolving sluice for saving metals."

* * * "The endless apron is made of fabric sufficiently coarse to retain the heavier particles which it receives from the feed spout, beneath which issues a stream of water." * * *

Claim 3. * * * "Separating the ore by passing the valuable portion up the incline and the debris down to the foot, as waste matter, as described." * * *

No. 66,409, July 9, 1867. George Johnston and Edwin G. Smith, Auburn, California, "Amalgamator and Concentrator."

* * * "The pulverized ore or tailings passes to an endless traveling and shaking canvas belt, which ascends against a stream, carrying the heavier particles to be discharged into a box, while the lighter ones are carried off." * * *

Claim 1. The revolving belt or apron. with its raised edges, having a shaking or rocking motion from side to side, substantially as used for the purpose herein described.

No. 239,091, March 22, 1881. Judson J. Embrey, Fredericksburg, Va., "Ore Concentrator."

†See 6th Report of State Mineralogist, p. 92, article on Concentration, by J. N. Adams, E.M.; and 8th Report, p 718, "Milling of Gold Ores," by J. H. Hammond, E.M.