discharged and iron strikes on iron. The battery water is then shut off, the self-feeder pushed back, the stamps hung up, the splash-board or canvas removed from in front of the screen, and the face of the latter washed off with the hose. The aprons and plates are then scraped, and the aprons, if fixed, covered with planks near the mortar, to protect them while working around the mortar. The keys that hold the screen in place are withdrawn and the screen-frame loosened and slightly raised, permitting the water that is still retained in the mortar to gradually run out; a too sudden raising of the screen-frame from the chock-block would cause the water to escape in a body and possibly wash amalgam from the plates. After raising the screen out of the grooves, the chock block and inside plates are removed and all of them carefully washed over the apron, scraped and set to one side or removed to the clean-up room for treatment. The sand mixed with ore on and around the dies is taken out by trowels and passed through some other mortar, or retained to place around the dies when returned to the mortar. The dies are broken out of their beds with the help of chisels and crowbars; when the centre or end die has been successfully worked loose, the remaining ones are easily taken out, washed, examined for any adhering amalgam (which is scraped off), and placed on the floor, *in the same order* they occupied in the battery, ready to be replaced. The remainder of the material in the mortar is then easily removed, and placed in the clean-up barrel; in small mills it is panned in a water-box provided for the purpose in the clean-up room. In the revolving clean-up barrel, pieces of quartz or old iron, with an additional amount of quicksilver, are added, and the barrel is half filled with water, where it is left revolving for a couple of hours. As all battery sands contain more or less nails and chips of iron and steel, these are removed by a magnet while panning out. The clean-up barrel is discharged through a manhole into a bucket placed over a riffled sluice. The bulk of the quicksilver and amalgam is retained in the bucket and the overflow passes into the sluice.

After all the sand, etc., has been removed from the battery, the inside is washed out, and any amalgam found adhering to the sides or linings is carefully scraped off with a case-knife and placed with the rest of the amalgam for further cleaning. A bed of dry tailings-sand is then spread over the bottom of the mortar, and the dies *replaced exactly* as they were before. The tappets are then set, plates and screens put in, the feeder replaced, water turned on and the battery once more started.

The operation of cleaning-up the batteries is performed usually once or twice a month, and in some mills once a week, at which time tappets are re-set and any necessary repairs made; also, any shoes that are too thin or broken are knocked from the boss and new ones substituted. As one new shoe in a battery of old ones causes irregular working, it is best to replace all the shoes at the same time, and if any of them are not worn down thin enough to discard, they may be set aside and used to replace a broken one at some future time. The same thing holds good with the dies, for if they are of uneven height they interfere with the regularity of "splash," and the higher die will be pounding iron, while the remainder have still a sufficient cushion of quartz.

The amalgam obtained from a clean-up is washed in small batches in the gold-pan, to free it from all sand, fine iron, or sulphurets, and then stirred up with an excess of mercury in a wedgewood mortar, bringing all impurities to the surface; this dross is skimmed off and collected for further cleaning. The superfluous quicksilver is squeezed through a straining cloth or closely-woven drilling, or through buckskin, and the resulting balls of amalgam retorted. This squeezing is best done by hand. After first thoroughly wetting the cloth or skin, it is laid loosely over a cup or bowl, and a convenient amount of amalgam poured in the centre, enough to make, when squeezed, a ball of 20 to 30 ozs. The ends of the cloth are then gathered tightly together, and commencing near the ends, it is twisted until the amalgam is compressed to a hard ball, the strained quicksilver dropping into a pan of water beneath. It is not good practice to squeeze the balls too dry, as the last quicksilver expressed is heavily saturated with gold.

In large mills the retorting is done in pans placed in an iron cylindrical retort built into a furnace, where the flame passes under and around it. But in the majority of cases in California they use the cup-shaped iron retort. These are made in different sizes, numbered from 1 to 7; No. 1 containing 150 ozs., and No. 7, 2,000 ozs. They are made of cast-iron, with flat or half-spherical lids, which are secured to the retort by clamps and wedges or thumb-screws, the flanges being ground together. From a vent-hole in the cover a curved condensing pipe, securely screwed in, extends several feet. The retort is placed in a ring standard, or suspended when retorting, and should always have a space of about 6 in. beneath it. In preparing to retort, the inside is well rubbed with chalk and the balls of amalgam broken up and dropped in loosely; not pressed down into a solid cake, as is sometimes the practice, as that retards the operation. The flanges of the retort and lid are then luted together with a thin paste of flour and water or sifted wood ashes and water (the former is preferable), and securely fastened. The extended end of the condensing pipe is placed in a vessel with water, and as this pipe must be kept cool, fresh water is kept passing over it during the entire operation. The retort should never be filled to its full capacity, to avoid danger of an explosion through the amalgam swelling and closing the vent. At first a light fire should be started at the top, and the heat gradually increased until drops of quicksilver issue from the end of the condensing pipe. The retort should then be kept at a red heat until no more quicksilver is seen to issue from the pipe, when the temperature should be raised to a bright "cherry heat" for a short time. The retort should be kept covered by the fire during the whole operation. If during the retorting the condensing pipe should suck water, it should be raised momentarily out of the water to permit of the latter flowing out. A better arrangement, and one that obviates this difficulty, is to attach firmly to the end of the pipe, a rubber or canvass bag in the water, which will distend itself as soon as the mercury commences to flow, and collapse when the distillation ceases. When the operation is completed, which usually occupies about two hours, if the amount be not very large, the quicksilver is removed and the retort taken from the fire and allowed to cool; the lid is removed and the retort turned over a *dry* gold pan. If the gold adheres to the retort, a few taps with the hammer on the bottom or the help of a long-handled chisel will release it. Well-cleaned and retorted amalgam should show a good yellow color. If black spots be seen it is proof that the cleaning was not thoroughly done, and a pale-whitish color shows that it still contains quicksilver. Care should be observed, when removing the lid of the retort, to avoid inhaling any fumes retained therein. All retorted amalgam should be melted and run into a bar, before shipping, as it saves losses incurred by abrasion where the distance is great to the shipping point. The melting is performed in a black-lead crucible, which, when new, must first be dried and annealed by placing the inverted crucible and lid in the furnace with a slow fire, which is gradually increased until the crucible is red hot. When ready to commence melting, the crucible is placed on a firebrick in the furnace, after introducing the retorted bullion, in not too large pieces, with borax, and covered with the lid, adding, if necessary, more of the bullion as the metal subsides. After all is melted down, the slag is skimmed off carefully from the top of the metal, which should show a bright surface. It is then ready for pouring. Should the surface not appear bright, but show a scum on top, some lumps of borax must be added, the crucible again covered and heated, when the scum will be slagged and skimmed as before, when it is ready to be poured into a mould. Should the second addition of borax fail to produce a bright surface, a very little nitre may be added with the borax. Before using the mould it should be warmed and smoked on the inside by holding over the flame of a lamp or over a dish with burning rosin. The metal in the pot should be stirred before pouring; the stirrer, an iron rod, must be heated before introducing it. The bar, when solid, is turned out of the mould, and any adhering slag is hammered off; it can then be dipped into water to thoroughly cool it, dried, and weighed. Two small chips should then be taken—one from an upper corner, the other from the diagonally opposite lower corner—to be assayed.

ASSAYING AND SAMPLING.

Although at present most California mills have their own assayers to test the ore and the tailings, the time was not so very remote when it was not considered requisite to do *any* assaying. The expert millman could tell (?) by horn-spoon test how much his ore would mill to the ton; and if a horn-spoon test of the tailings showed no amalgam, he confidently asserted that all was being saved. It was decidedly a case where "ignorance was bliss." No gold milling can be carried on understandingly without light being thrown on the different results achieved, and which can only be given by careful sampling and assaying. It is not sufficient to know that a certain loss has been sustained. It should be accompanied by a knowledge in what particular part of the operation the loss has been incurred, to enable the operator to remedy the evil; hence the necessity of constant sampling and assaying. In some cases the loss will be found entirely in the coarse sands, indicating that the screens are not fine enough; again, the loss may be entirely through sliming of the ore, or the missing percentages of gold will be found mostly in the sulphurets. The assay test alone, *with correct sampling*, furnishes the knowledge.

Sampling.—Samples should be taken regularly of the ore as it comes to the mill, as well as of the tailings *as they pass off*, for without the knowledge derived from these two operations there is no means of controlling the work.

Ore, as it arrives at the mill, is sampled by taking a stated amount (shovelful) from each ore-car or waggon, and throwing the samples together in a pile on a clean-swept floor or into a small bin. The pile should be shovelled over, after breaking the pieces to the size of macadam; or if the pile be too large, cut through it at right angles, throwing the rock from the trench thus made in a pile by itself. This should be crushed or broken to a nearly uniform size, mixed by shovelling, and made into a low truncated cone, which is divided into four equal parts by making a cross on the surface and throwing out two diagonal quarters, which are again reduced in size, made into a second similar cone, and treated as before. This quartering and crushing is continued until a half-pound sample is obtained for fire assay. Great care must be observed when removing the different quarters to see that all the fine dust is swept up and added to the pile each time, as otherwise very defective results will be obtained. The rest of the ore is returned to the main ore-bin. Samples taken in this way from the aprons of the self-feeders are likely to give a more correct average, having been crushed, and the coarse and fine duly mixed. Samples should be taken at regular intervals from the pulp *with the water* that has passed over all the plates, and also from the concentrators.

Tailings samples should be taken at stated intervals by passing a vessel across the entire width of the discharge, where they leave the mill, without permitting any to flow over, and gathering at each interval an even amount. This is allowed to settle in a bucket and the clear water then poured off carefully or drawn off with a siphon. The residue is dried and thoroughly mixed, and several packages of 5,000 to 10,000 grains each weighed out. In some mills tailings samples are obtained automatically, using their current as the motive power for the sampler, which works by intermittently deflecting a spout through the tailings where they finally drop from the sluices, obtaining the sample across the entire section of the current.

To ascertain the amount of slimes in the tailings sample, put one of the packages into a bucket, add water, and stir it. After settling two or three minutes, pour off the muddy water into a separate vessel; repeat this operation until the water comes off clear; add a little powdered alum in the vessel containing the muddy water, and when the mud has all settled, draw off the top water carefully and evaporate the remainder. Dry the washed sands of the sample, and pass through different sized screens, weighing the different amounts as they have passed, and assay each size; this will show where the greatest loss is sustained.

To ascertain where the loss in sulphurets occurs, it is sufficient to pass one of the 10,000 grains samples through a 60-mesh wire screen; weigh that which passes through and that which remains on the screen, and pan out each lot carefully by itself, from one pan into another, as long as sulphurets can be recovered; then weigh each batch of sulphurets separately.

The use of 10,000 grains is recommended, as every 100 grains is 1 per cent., and each grain is $\frac{1}{100}$ of 1 per cent.; it is also a convenient size for obtaining accurate results. By using pulp samples instead of tailings, the amount of sulphurets in the ore may be ascertained.

If the sulphurets assay $75 per ton, and the quantity per ton is 1.7 per cent., the value of the sulphurets in one ton of ore is found by multiplying $75 by 0.017, which would be $1.27 per ton. If the loss of sulphurets in the tailings is 11 grains out of the 10,000 grains sample, and the value of the sulphurets is $75 per ton, then multiply $75 by 0.0011, and the value of sulphurets in the tailings is found to be $0.0825 (8¼ cents) per ton of tailings.

MILL ASSAYS.

Amalgamation (Free-Gold) Assay.—Take two pounds (being exactly one thousandth part of a ton) of ore, crush in an iron mortar, and pass through a No. 60 sieve; remove the gold and other metallic substances left on the sieve, and place in a small porcelain dish containing a little dilute nitric acid, to remove any adhering crusts of oxide of iron, etc., which might prevent amalgamation; these residues are then carefully washed and thrown into the sifted ore, which is then placed in a wedgewood-ware mortar and mixed with enough warm water to make a stiff paste To an ounce Troy (480 grains) of new, clean mercury, *free from gold*, add a piece of clean sodium about the size of a pea. The mercury thus highly charged with sodium is then thrown into the mortar containing the sample, and the mass ground constantly for an hour, when amalgamation should be quite complete. The mass is then transferred to a gold-pan and *carefully* washed over another pan or tub, in which the tailings are caught, and re-washed to save anything that may have escaped. The mercury is collected and transferred to a small dish; if it be much floured and refuse to run into globules, stir it with a small piece of sodium held in the end of a glass tube, which will cause it to run together. The mercury is then washed carefully in clear water and dried with blotting paper It is then re-weighed, and if the loss exceeds 5 per cent. the assay must be rejected and a new one made. The mercury is next transferred to a small annealing-cup or crucible, which has been carefully black-leaded inside, covered with a porcelain or clay cover, and volatilized with a gentle heat. When all the mercury has been volatilized, about 50 grains of assay lead are thrown into the crucible and melted, giving it a rotary motion while in a molten state. It is then removed, cupelled, and the "button" weighed. It may be assumed without sensible error that the mercury lost in the operation carried the same proportion of gold as is contained in the mercury recovered; hence the gold contents of the ore will be found by multiplying the weight of the "button" obtained by the weight of the original quantity of mercury