PRACTICAL MINING AND ASSAYING

FREDERIC MILTON JOHNSON

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BY

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PREFACE.

This work is the result of fifteen years of practical experience in the mountains, the mines, the mills and the assay office, and is published for the benefit of the prospector, the miner and those who may desire to obtain a general knowledge of practical mining and assaying.

I have endeavored to make it as brief and plain as possible for those who have not had the opportunity to acquire the desired information on this subject, and this alone has prompted the publication of this pocket edition of PRACTICAL MINING AND ASSAYING.

FREDERIC MILTON JOHNSON.

ERRATA

PAGE 29:— Fourth line, use Sulphuric acid instead of Muriatic acid.

PAGE 50:— Third line, after the word "with" add the word "water".

CONTENTS.

INTRODUCTION.

Carbon is the base of the vegetable and organized world, and quartz or silica is the chief or principal of the mineral world. A particle of any one substance is a unit or simple. There are 64 simple substances known. Those that are unknown are termed elements, which have a tendency to combine with know substances or other elements, forming compounds with the different substances under various conditions of temperature, pressure, electricity, etc. All may assume either a liquid, solid or gaseous state. These elements may be mixed in any proportion, but they combine only in fixed proportions. Chemistry gives us the knowledge of the proportions in which the different substances combine. A general idea only of such knowledge necessary for this work is given. The mixture of all metals by fusion forms alloys, hydrogen, oxygen, chlorine, bromine, sulphur, arsenic, phosphorus, silicon, etc., with the different metals enter into the various compositions of ores and fluxes, which to a certain extent the assayer must understand.

A test of ore is made with acids or heat, usually with a blow pipe, with an indefinite amount of ore, simply to determine whether the ore contains gold or silver or the metals sought for. Testing may precede assaying to enable one to know what fluxes are best adapted for a correct assay.

Assays are made by wet or dry processes, i. e., acids and chemicals or heat with the proper fluxes and with a definite quantity of ore to determine the exact amount of metals it contains per ton of ore. Lead combined with oxygen in the exact proportion of 103½ parts of lead by weight to 8 parts by weight of oxygen to form litharge, this being a flux for most classes of ores carrying precious metals. The melted lead gathers up the precious metals and is thrown down by carbon which is a reducer, forming a lead button in the bottom of the crucible. Under heat the affinity of carbon for oxygen is greater than that of lead for oxygen. Therefore if litharge and carbon are heated together the carbon takes the oxygen from the litharge and the lead is set free and goes to the bottom as stated above. One grain of charcoal reduces 30 grains of lead from litharge. Flour contains carbon and hydrogen, also oxygen and nitrogen and consequently is a reducer, but one grain of flour will only throw down 14 grains of lead. Hence double the amount of flour must be used in an assay. I prefer the flour for assaying because it is more convenient to procure and is cleaner and in a finer powder.

Nitre consists of nitrogen, oxygen and potassium, and when heated gives off its oxygen. When sulphur is present, the oxygen combines with it, and the sulphur is carried off, because the affinity is stronger for the sulphur, so that nitre is used in the assay of sulphurets to carry off the sulphur, melted lead having a strong affinity for oxygen which it takes from the air, when the door or opening to the muffle is open to admit it and the lead is oxydized and part of it goes off in fumes and part is absorbed by the bone-ash of which the cupel is composed. Gold and silver do not combine with oxygen, hence when the lead button is cupelled, the gold and silver remain.

FORMATION.

This question is of the utmost importance and requires considerable study, but a general idea may be given to help the miner or prospector in his search for gold, and requires a technical knowledge of mineralogy. By technical mineralogy I mean only that amount of mineralogical knowledge which will enable the prospector to recognize the valuable minerals and metals and to trace them by the formation in which they are most likely to be found. This forms but a small part of the whole subject of mineralogy as a science. It is therefore important that the prospector should be able to distinguish many kinds of rocks, to guide him or to check him in his exploration.

The formations forming the gold belts are entirely different in different countries or districts, hence the knowledge of the formation in Oregon or Arizona will not assist the prospector in California or any other territory except in a very general way. A man may be an expert on the Mother Lode in California and know nothing of the formation in Colorado. One thing, however, may be settled for any country or district, and that is where veins, lodes, or vein matter is found in a contact or fissure, i. e., a vein between adjacent bodies of dissimilar rock, where gold is found in these formations it is the very best evidence of the existence of a permanent ledge, and the prospector can begin his development with a certain degree of certainty.

ROCKS.

Rocks may be classed in four great groups, described as follows: Superficial rocks, Sedimentary rocks, Igneous rocks and Metamorphic rocks.

FIRST—THE SUPERFICIAL ROCKS. These are composed chiefly of clay, sand and gravel and lie in irregular beds and unconsolidated.

SECOND—SEDIMENTARY ROCKS. These are conglomorate sandstone, shale and limestone which have been deposited by the water and have usually become hard.

THIRD—IGNEOUS ROCKS. These are rocks which have been thrown up from a molten condition through crevices and fissures and cooled where they have formed dikes and veins. Sometimes they pour out of cracks and volcanoes and flow over the surface as lava and afterwards become scattered and broken up by water and streams. The most abundant of these are granitic, grano-diorite, granite-porphyry, diabase, basalt, augite-porphyrite, augite-andesites and hornblende.

FOURTH—METAMORPHIC ROCKS. These are altered rocks of crystalline texture and have been so changed by pressure and chemical action that the mineral particles in many cases re-crystallize and are understood as metamorphic, crystalline formations.

We will now give the names and a brief description of some of these rocks.

ALLYBYDENUM is a sulphide in masses. Has a strong metallic lustre. Color, dead grey. Shows a greenish black streak on a common piece of broken plate or china. Easily scratched with a nail. Occurs in granite, syenite and chlorite schists. Sometimes mistaken for graphite. Its chief use is for the manufacture of blue colors. Value, $12 per pound.

ANDESITE.—An effusive, porphyritic rock. The constituents are lime, spar, magnesia and silica.

ANTIMONY.—Resembles galena in color but is crystalline in form and when pure looks like a mass of needle points melted together. Very often galena and antimony are combined, especially in gold and silver ores. This metal mixed or combined with galena often destroys the value of a lead mine, and vice versa.

AUGITE.—A dark green or blackish, composed of iron, schists, and magnesia; lustre vitreous; found chiefly in volcanic rock.

BASALT.— 40 to 50 % of silica, 15 to 30 % of alumina, and oxide of iron, manganese, lime, and magnesia. Color is black, bluish or greenish shades when broken, usually drab or greyish brown on the surface.

BIRD'S EYE PORPHYRY is composed of feldspar and specks of hornblende and mica through the rock in such a manner as to form little specks resembling birds' eyes.

CASSETERITE OR TIN ORE.—Tin ore is usually an oxide and contains small quantities of iron, copper, manganese, arsenic and silica and rarely any lime. The ore is nearly as hard as quartz and will scratch glass. It is of a dark brown color, sometimes almost black; when scratched with a file or knife, the mark turns brown or light brown. Zinc does the same when found in other ores. These are the only metals that the fine powder made with a file turns brown. It is usually found in granite, quartzite, metamorphic sandstone and slaty rock; often traced with black tourmaline. It is sometimes found with other ores as the sulphide of tin with iron and copper. Looks like bell metal or black oxide of tin. It is found in granite only when the granite contains chiefly mica and quartz or mica and soda feldspar.

COPPER GLANCE.—Similar to the above in character but carries a much larger per cent. of copper. The fine glance carries about one-third metal. Found in copper ores.

DIABASE.—An intrusive or effusive granular rock composed of augite, partly or wholly converted into fibrous hornblende, soda, lime and feldspar.

DIORITE.—A granular intrusive rock composed principally of soda-lime, feldspar and hornblende.

FELDSPAR is silicate of potash and alumina; silica and lime.

GABBRO.—A granular intrusive rock consisting principally of dialage, pyroxene, together with soda, lime and feldspar.

GABBRO-DIORITE.—This term has been used where the gabbro areas contain primary and secondary hornblende.

GALENA.—Bright lead color having a metallic lustre and when not mixed with antimony, breaks in cubes; carries silver and gold; very often found in gold ores.

GRANITE.—A term descriptive of rocks composed of silica, feldspar and mica. There are different classes of granite, nor are they alike in color. Some granites contain no mica as in graphic granite. Others contain black mica stained with iron, and hornblende.

GRANO-DIORITE.—This is also an intrusive rock carrying feldspar, quartz, biatite, hornblende and mica.

GRAPHITE or PLUMBAGO or BLACK LEAD.—Soft and soils the fingers; marks on paper; color, gray to dark blue, nearly black. Found chiefly in crystalline limestone and mica schists or graphite schists.

GYPSUM.—Composed of sulphuric acid, lime and water. When it is pure white it is called alabaster; when transparent, selenite; when fibrous, satin spar; and when burnt, forms plaster of Paris.

HORNBLENDE.—Contains dark or black crystalline specks or crystals consisting essentially of silica, magnesia, lime and iron.

ITACOLUMITE.—A quartzose rock that is more or less cemented by mica; takes its name from a mountain in Brazil. Diamonds and other precious stones are found in this and other similar rocks.

KAOLIN.—A peculiar clay, composed of silica, alumina, pyroxide of iron and water. It is used in the manufacture of porcelain and china; found in granitic formations.

LIMONITE.—A brown ironstone. It is composed of iron, alumina and silex, and sometimes manganese. Belongs to the iron ores.

MANGANESE.—It occurs as a black or red oxide, often with red or brown hematite; very easily pulverized. When dissolved with muriatic acid, it throws off chlorine gas which can be easily detected by the smell.

MICA SCHIST.—This term is given to those laminated rocks composed of mica and quartz, manganese, often black, colored with iron, easily broken up.

MISPICKLE.—Often mistaken for brittle silver. It occurs usually in ores that are regarded as rebellious with zinc and other bases. It is simply composed of arsenide of iron and iron pyrites and is very brittle.

MICACEOUS QUARTZ ROCKS.—These are not very common. Generally found in a granite formation; sometimes carry gold.

PORPHYRY is feldspar, quartzite, talc, mica, iron, and clay; chiefly feldspar and quartzite.

PORPHYRITIC GRANITE.—A granite with a large proportion of porphyritic potash-feldspars. Color, dark green.

PORPHYRITIC QUARTZ.—A rock consisting of quartz, lime, feldspar, and a small amount of hornblende. Often found in contact or connected with grano-diorite.

PYROXENE.—Lustre vitreous inclining to resinous, some pearly. Color green of various shades verging from white and grayish white to brown and black. A bi-silicate of lime, magnesia, protoxide of iron, protoxide of manganese, and sometimes potash, soda and oxide of zinc. Usually two of these bases are present. The first three are the most common but lime is always present and in a large percentage.

QUARTZ or SILICA is combined with nearly every other kind of rock. The miner must study it carefully, as nearly all the gold is found connected with it in some way. A few general ideas may be given to assist the prospector.

When found in ledges or loads in granite walls, it is flinty and white when pure, but it is nearly always stained with iron and often carries iron pyrites. It breaks in chunks like sand and granite rocks, and when gold bearing, the gold is found in pockets or bunches and not evenly distributed through the rock as it is found in other formations. Sometimes laminated or stringer quartz is found in granite that carries the gold principally in the seams. When found in a contact vein or "true fissure" it is of a more even texture, carries lime and spar and is much the better class of ore. When gold or pay ore is found, it is more evenly distributed through the quartz when found in contact of slate and porphyry. It carries enough oxide of manganese or slate to give a bluish cast, and is more stratified. Often carries iron pyrites and galena, and when galena or copper stain is found in the quartz, it is the best evidence of a permanent ledge of "pay ore." This class of ore when found in Mexico, Arizona, Nevada and Southern California, carries silver and often leads into a silver mine below the water line.

RHYOLITE.—It is of the tertiary age. The essential composition is alkali, quartzose, and hornblende.

RED OXIDE OF MANGANESE.—Looks like red ironstone. At first sight might be taken for cinnabar.

SERPENTINE.—A hydrous silicate of magnesia combined with talc, syenite, and hornblende, forming rock known in mining regions as "serpentine."

SIDERITE.—An iron carbonate; about 62 per cent. of protoxide of iron or nearly 45 per cent. of pure iron and from 15 to 20 per cent. of manganese. Looks like black ironstone with small streaks or specks of white. Color, gray to black.

SILVER occurs native in various forms usually branching or leaf-like or in small particles that resemble leaf lead. It is never found pure; often carries copper, lead and gold; it is always malleable and can easily be distinguished from mispickle by the fact that it can be cut with a knife and is not brittle. Before the blowpipe it melts without leaving any oxide or whiteness around it as does zinc, antimony, bismuth and tin.

SILVER GLANCE.—A metallic silver combined with iron and copper. Has the appearance of leaf lead nearly black. Often occurs pure enough in the ore to be cut with a knife. This is often connected with copper glance found in rich copper ores with hematite. Usually carries from 20 to 33 per cent. of silver.

SLATES.—There are several kinds of these slates which should be carefully studied. All of these slates are sedimentary or water washed disintegration and are found as mica slate, hornblende slate, clay slate or argillaceous shale and bituminous shale, plumbago schists and talcose slate. Sometimes trap rock and trap and blue limestone are mistaken for slate, but all slates have cleavage lines and break in planes while the trap rock breaks irregularly and rough and rings to the hammer.

TALC.—Composed chiefly of silica and magnesia, with alumina and iron; color varies from a greenish, to a yellowish white with a pearly lustre, and is smooth and greasy to the touch, or soapy if moistened.

ZINC BLENDE.—Streaks white to reddish brown. Color, resin yellow to dark brown or black. Occurs in rocks of all ages and is often associated with ores of lead and sometimes those of iron, copper, tin and silver.

VEINS OR LODES.

The rocks in the Auriferous Belt occur in very complex associations, but we have to deal principally with the granites, slates and schists, and it is chiefly in these schists that the gold or quartz veins are found. These "gold belts" consist principally of quartzite, mica-schists, clay, slate and limestone lentils. The trend of these lodes or belts is generally North-west and South-east, but the great mass of granite and igneous rocks have been intruded among these schists, forming irregular bodies which interrupt the regular schistose structure, These are of the group that forms the famous "Mother Lode" of California.

Converging or wedge veins are numerous and lie between the divisions of stratified rock, as granite, clay, slate, etc. They are never very long and sometimes show a large blowout or cropping, but are nearly always unreliable, as the wedge-like space between the walls must necessarily diminish in depth.

GASH VEINS.

These are found in all sedimentary deposits.

They are caused by shrinkage of the particular stratum in which they exist by the underlying igneous conditions. Ledge matter or mineral deposits may be found in these veins which sometimes "go down" to quite a depth and may be rich, but they are not very long and thin or pinch out at the ends. Sometimes they are lapped with another similar vein which may continue further. A number of these veins may lap each other and form a number of ledges in one claim only a few feet apart, but they seldom, if ever, go down to any great depth or make a large or permanent mine.

FISSURE VEIN.—True fissure vein quartz invariably shows ribbon-like stringers parallel to the walls. The most lasting and permanent paying mines are found in true fissures as well as in the contact.

CONTACT VEINS.—A quartz ledge or other vein matter lying between two walls of dissimilar rock, as slate and porphyry, or granite and diorite, etc.

CROSS VEINS are transversely fractured fissures of more recent origin. They are often paying feeders for the mineral deposits of regular veins.

BLANKET LEDGES are those that lie nearly horizontal and are often a break from some permanet vein that may be found in slides which have moved them from their fracture. They are seldom very large.

DIKES are not veins and are generally larger and are chiefly composed of yellow or blue colored feldspathic, finely crystallized, igneous rock, or porphyry, often carrying gold, but very fine.

DEPOSITS.—Sometimes quite extensive and must have been concentrated by alluvial water-washing, or precipitation of quantities of minerals in large cavities or depressions in the bed-rock. Those of the volatile and condensable minerals found in these deposits are cinnabar and sublimations of lead and antimony.

ALLUVIAL DEPOSITS are of placer and gravel, sometimes rich in gold and platinum.

QUARTZ LODES and vein matter often well defined, and cropping boldly in veins and spurs, cross-courses and small dikes, with a variety of heave, shift or slide that are very misleading and must be carefully studied and examined in order to determine what relation they bear, if any, to a contact or "true fissure."

TESTS.

TEST FOR SILVER.

Powder and boil a small quantity of the ore in nitric acid; allow to settle and put in a few drops of muriatic acid when it will immediately form a white curdle if silver is present. When exposed to sunlight for a short time, this white curdle will turn dark. Sometimes the whole solution is colored with iron; if so, allow it to stand in the test tube until the whitish curdle will settle in the bottom as a precipitate.

TEST FOR SILVER IN COPPER ORES.

Boil in nitric acid as above; allow it to settle. Put into the soluton a polished piece of copper. If silver is present, it will show on the copper.

WET ASSAY FOR COPPER.

Pulverize an ounce of ore finely; place in a pint dish (agate or porcelain lined) and boil in four ounces of muriatic acid until the acid has nearly all evaporated, leaving the mass in a pasty condition. Add one-half as much sulphuric acid and boil and stir for a few minutes. Then add five times the quantity of water. Stir until it nearly boils, then filter the whole. The copper is now all dissolved and held in solution. To this solution put in about four square inches of sheet zinc and allow it to stand until the zinc has entirely dissolved. All the copper will be precipitated in the form of a brown or nearly black powder. Filter and dry when the powder may be weighed and melted into a button.

TEST FOR NICKEL.

First pulverize one ounce of ore. Boil in 3 ounces of muriatic acid until nearly dry. Add 8 or 10 ounces of water; stir and boil. Filter and add to the solution caustic potash until it stops effervescing. Filter and put the filtrate in a crucible with three parts of soda and one of borax, and melt. Allow it to cool in the crucible and find the button in the bottom.

TEST FOR IRON.

Powder and dissolve in muriatic acid in test tube over the lamp. Allow it to cool and settle. Add a few drops of ferro-cyanide, when, if iron is present, it will immediately turn blue.

TESTS FOR GOLD.

MILLING TEST.—This may be satisfactorily made in the following manner. Break up and powder the ore to pass through 10 mesh, not less than one-fourth of a pound: one or two pound lots are better if your muller or mortar is large enough. For this purpose a Buck's patent muller is the best. Now dissolve one ounce of cyanide and 3 ounces of caustic soda in five gallons of water: then add one-half teacup full; no more, of this solution into the water or muller with the ore, and half a thimble-full of mercury, then add one pint of water; grind for half an hour; fill the mortar nearly full of water, turning slowly for fifteen minutes. Empty the whole in a pan and collect the mercury. Be careful to save every particle. Sometimes it is very hard to collect all of the mercury. In such cases pour off all the water and add a little sodium amalgam; shake for a few minutes, when it will all collect nicely. In the absence of sodium amalgam use one handful of dry sand, stirring it thoroughly for a few minutes, then pan it as usual, when the mercury will collect. Now dry the mercury with blotting paper, put it in an evaporating dish or any small dish that will stand heat; cover with two ounces of nitric acid and boil until all agitation ceases. The gold, if any, will be found in a bead-like form at the bottom. Pour off the acid carefully, rinse with rain or distilled water; dry over a lamp and weigh. Calculate the weight of gold at four cents per grain. If one pound of ore has been used, multiply by 2,000. If one-half pound of ore, multiply by 4,000, and so on. This gives the value per ton. Follow these directions carefully and the result will give the exact quantity of free gold.

CHEMICAL ASSAY FOR GOLD.

Take a carefully prepared sample of one ounce of ore, ground to 60 mesh; put into an enameled or porcelain dish with a half teacup-full of nitric acid; stir and boil until the fumes are steam white. Now fill the dish with clear water, stir and then filter, or carefully pour off the water; add a little lime or lye with more water to entirely destroy the acid. Be sure to save all the pulp, filter or pour off the water again; rinse all the pulp into an earthen bowl; now add a few drops of mercury and grind with a pestle or the bottom of a long bottle for half an hour, save the mercury and retort with acid as in the mill test. Weigh and multiply by 32,000; the result will be the value of a ton of ore. The gold from this test must be weighed on the bead scales. One bead point on the scale with one-tenth of a grain rider is equal to $12.56 per ton of ore.

A TEST FOR GOLD.

A simple test for gold may be made by first pounding the rock to a fine pulp and mixing with it twice the quantity of common gunpowder and water into the constituency of thick mortar. Press it into the form of a brick or ball and let it dry. When thoroughly dry place it on a shovel or flat rock, cover with a few chips and set fire to it. When the fire goes out, rake through the ashes or pan them, and you will find a gold button if there is any in the ore. This test will not succeed if the ore carries much iron pyrites or other base metals.

TEST FOR MANGANESE.

A very interesting test for manganese is made as follows. Take the ore supposed to contain manganese and powder a little very fine and dissolve it in ~~muriatic~~ sulphuric acid over a gentle heat; then let it cool and settle. This solution will be colored brown. Now dissolve a little sal soda, (common washing soda), in pure water; then put a little of the brown solution into a test tube or saucer, add soda solution, when it will instantly become clear and nearly water-white, if manganese is present. If curdled and dark or cloudy, it is iron, and not manganese.

TEST FOR RED COPPER.

Very brittle; does not froth with acid, but is dissolved in ammonia and turns blue in a few minutes. Also the carbonates of copper will turn blue when dissolved in ammonia.

TEST FOR ZINC.

Powder the ore and throw on live coals. Shows a brilliant white flame. Moisten a piece of charcoal with a solution of cobalt nitrate. Put some of the powdered ore on the moistened charcoal and heat with a blow pipe or over the forge, when it will turn to a deep green.

BLACK ZINC BLENDE.

Is sometimes found so pure that it is mistaken for galena. The infallible test is that when scratched with a knife the powder of galena turns black whilst that of the blende turns brown.

TEST FOR FLUORSPAR.

Is composed of fluoric acid and lime. Throw a piece in a hot fire on a forge, when it will fly and crack in pieces. The pieces of the pure fluorspar after a strong heat will show a phosphorescent light some little time after being taken from the fire. Once seen will always be remembered.

TEST FOR LIME AND THE CARBONATES.

After heating to nearly a white heat, will slack in water and when powdered produces a somewhat violent effervescence in acids.

TEST FOR MERCURY.—(CINNABAR.)

Powder the ore, mix one or two grains with equal parts of soda, and place in the bottom of the test tube. Take a small thin piece of copper or brass about two inches long or a little gold-leaf; (the gold leaf must be wrapped around a thin piece of wire.) Place the copper inside the test tube using a cork to hold it in place—one inch of the copper extending below the cork. Gently heat over a lamp until nearly red and allow it to cool. If mercury is present it will show on the copper, brass or gold, whichever may be used.

TEST FOR TELLURIUM.

Powder and moisten; heat with blow pipe on a piece of white porcelain; now moisten the hot porcelain with sulphuric acid. Leaves a red or scarlet color.

TEST FOR ARSENIC.

Powder the ore and throw on to coals or heat on charcoal with a blow pipe. Gives off the smell of garlic.

TEST FOR LIME, MAGNESIA AND BARITA.

It cuts or scratches with a knife. Foams or effervesces with nitric acid. It dissolves with effervescence in muriatic acid, and if pure, that is, not mixed with other matter, the solution will be colorless.

TEST FOR GYPSUM.—(HEAVY SPAR.)

Is scratched with quartz or a knife. Does not dissolve with acids and has no smell when heated. When ground finely, it feels like starch.

TEST FOR NITRATES.—(CHILLY NITRE, ETC.)

Flashes when thrown on live coals. It will dissolve in water, and when four parts of this solution and one part of sulphuric acid and one part of salt are mixed together it will dissolve gold.

PANNING FOR GOLD.

The prospector and even the practical miner is almost invariably deceived in the value of gold he gets from a few pieces of ore in the pan or horn. In the first place, he will always think that the piece or pieces of ore he took to sample or pulverize is not nearly as much as it really is. He will think he has pounded up about an ounce when it is nearer three ounces, and should always weigh the sample before crushing, and then he may form some reasonable estimate of the value of ore per ton by the amount of gold in the pan, if he has been careful to have even ounces, as two or four. Now after he has saved a few colors they always look to be more than there really is. Especially if the gold is fine, one may really think there is $10 per ton when there is not $5. It takes very many fine particles of gold to make one cent. To illustrate how very fine it can be, one grain of gold is worth four cents, and this one grain can be hammered into a leaf of gold containing 75 square inches.

One 50,700th part of one grain can be seen by the eye, and gold is found in talcose slate so very fine that it would take enough of these particles to cover four inches square to make one cent, so unless the gold is coarse, one may easily be deceived as to the amount or value of gold in a ton of ore, if you will carefully pan the gold from ¼ pound of ore and then collect it with mercury, as in the mill test given on page 26; then the gold can be weighed and calculated with some degree of certainty.

ASSAYING.

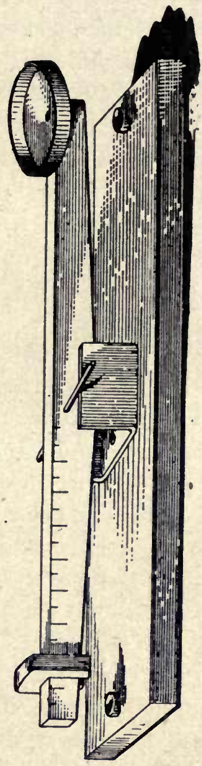
This work is not intended for those who wish to fit up an assay office for a permanent business, in which case they would require a full and complete laboratory. I will endeavor to describe and explain how to make satisfactory assays and practical tests on the ground, at the mine, or over the forge. An outfit for the assayer may be very elaborate and expensive but for the purpose of this work only the few implements actually necessary are mentioned. First, a small portable carbon or coke furnace. It can be bought for $12 or $15. In a coal furnace the muffle will be included. With the carbon furnace it will be necessary to have a muffle furnace separate. This muffle furnace will cost about $23, but for the many who may not possess either of these, satisfactory assays may be made with an ordinary blacksmith's forge. Nearly everything required for practical tests and assays may be had at almost every small town, or may be carried in a gripsack. The only expensive things required are the scales for weighing the prills or beads. There are small pocket scales that will answer every purpose, and can be bought for $12, but if one has no scales, the prills or beads from the assay and the gold from the mill test must be saved in small bottles, and numbered, to be weighed when convenient.

For assaying one must have crucibles to hold 8 ounces. I use No. 9 Denver; they cost 8 cents each. (Following is given a list of the more important things.)

The cupels should be one and one-half inches, and cost 30 cents a dozen. One-half inch test tubes 5 inches long. For a drying cup a broken saucer will answer. Evaporating dishes 3 and 4 inches. These cost 35 cents, and will stand heat. A muffle costs one dollar.

A substitute for a muffle.—Take a piece of 4 or 5 inch iron pipe or an old mercury flask or a crucible; any one of these will answer the purpose. A mortar.—A good substitute for a mortar is a piece of 2 or 3 inch gas pipe 8 inches long. For a pestle any old steel drill. Sieves 60 mesh and 10 mesh. One pair of small pulp scales to weigh the ore; any scales that will weigh a half-ounce or more, will answer.

On page 36 is a cut of a pulp scale that any one can make in an hour, that will answer for weighing from one-sixteenth of an ounce to two ounces or more of ore for assaying. A glance at the cut will show how it is made. A scale bar is made out of a thin strip of board ½ inch wide, narrowed down at the ends a little, and a needle put through the middle just above the center line; piece of tin, 3 inches long and 1 inch wide, more or less, with the ends bent up square, as shown, for the needle to rest on; and the cover of a small tin can be fastened to one end to hold the ore, and a small bar of lead weighing just two ounces, bent so as to straddle the bar. Place the lead weight close to the needle, just so it will balance the pan at the other end. Mark the bar at the lead, and divide or rule it from the balance to the end into 32 lines or divisions, to the end. Now when the lead weight is at the end it should balance with 2 ounces of ore in the pan.



PULP SCALES. (See page 35.)

A common earthen bowl will do for mixing the assay, or it may be mixed on a piece of strong paper with a spatula or ordinay table knife. One pair of crucible tongs and one pair of cupel tongs. — These may be made with a piece of quarter-inch wire three feet long. Flatten the ends, bending them together. Some of the smaller blacksmith's tongs will answer. An iron mould is necessary for pouring the assay into, if you desire to save the crucible for another assay; but if you have no mould, remove the crucible from the fire, jar it lightly to settle the lead and stand it where it will cool and then break and find the lead button at the bottom which must be cleaned of all the slag, when it is ready for the cupel.

If working with a coke or charcoal furnace or forge, first get a good bed of glowing coals. Set in the crucibles, hold them in place until the coal is placed firmly around them. The crucibles must always be covered with the crucible covers in order to keep everything out. Open the blast and heat until nearly white. Remove the cover, and if the slag has quit boiling, looks smooth and settled, it is ready to pour into the mould. When nails are used, they must be taken hold of with the tongs, tapped lightly against crucible side and removed; then pour.

CUPELLATION.

Cupels may be made of bone ash together with the proper moulds, but when a few are wanted it is preferable to buy them. The proper size is one and one-half inches for the ordinary assay. If you have a regular furnace the muffles will be provided and the work is simple. The cupels are placed inside the muffle as many as may be required, and then brought to a red heat when you take out the tongs and place the lead button inside the cupel, carefully noting the position in order to identify each assay. Close the muffle and increase the heat to a bright red or until the lead is well melted, when it is opened a little to admit air. The lead now appears luminous; rainbow colors are circling over it. Air should be admitted at this point to increase the oxidization.

When the fumes are seen rising from the lead it must be kept in that condition until the lead has enterely disappeared, when the cupel is removed and cooled. The prill is then ready to be weighed and parted.

PARTING.

Silver is soluble in nitric acid. Gold is not, but the bead to be parted must contain at least twice as much silver as gold, and should be flattened to a thin sheet and put in test tube and boiled in nitric acid until the red fumes cease, and the acid clears; and the particles of gold, if any is seen at the bottom, as brown powder. Now pour off the acid and fill the tube with pure or distilled water, and rinse once; then fill with water, and place the dry cup or saucer over the tube to hold the water, and invert the whole, still holding it firm, allowing the gold to settle in the cup, and let the water off gradually. Now dry and weigh the gold. Having first weighed the bead from the assay subtract the weight of gold from the weight of the whole bead and you have the amount of silver and gold in the assay, unless it is known that the ore contains two or more parts of silver, to one of gold, a weighed amount of pure silver should be added to the assay in the crucible, and deducted from the bead weight.

BEAD SCALE.

A cheap and convenient bead scale is shown on page 41. Take a hard, dry piece of wood 6 inches long and $\frac{1}{8}$ of an inch thick and $\frac{3}{8}$ of an inch wide in the center and $\frac{1}{4}$ of an inch wide at each end. Bend a small piece of tin, or thin brass V-shaped, and fasten to the right end as shown in the cut to hold the weights, and fasten to the other end, a piece of tin ½ inch square, made a little cupping to hold the beads. Now take a piece of 1¼ inch wide and 6 inches long for a base. Fasten onto each side of this base a piece 3 inches long and ¼ inch square, on top of these (see cut.) Fasten a piece of glass tubing filled nearly full of alcohol corked and sealed, on top of these pieces with small wire staples, as shown. These show when the scale is level, and serve as rests for the ends of the needle, passing through the scale beam as seen in the cut. This needle must be put exactly in the middle of scale bar, and just ⅛ of an inch below the top. Use the regular Troy weights from 10 grain to one-tenth of a grain, with a one-tenth rider weight to use on the scale bar which must have the division lines from the center to right end. Divided into 20 parts with the figures, 1, 2, 3, 4, 5, 6, 7, 8, 9, on the tenth divisions, the same as the regular scales, the pan making the tenth.

WEIGHING.

The bead is taken from the cupel, placed in left hand pan of the scales, as it will be more convenient to use the weights in the right hand pan, if you have the proper bead scale, with riders. The beam is divided into 20 parts, numbering the tenths, 1, 2, 3, 4, 5, 6, 7, 8, 9,

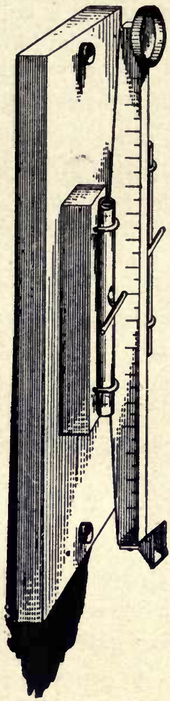


Fig. 1.

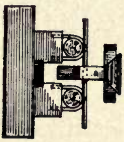


Fig. 2.

BEAD SCALE. (See page 39.)

the pan making 10. Now if you have taken 240 grains for the assay, and have the Troy weights, every number, or tenth, is one one-hundredth part of a grain and is called a "bead point," and is 1.21 ounces to the ton of 2,000 pounds of ore, and if gold, $25.12. (See table.)

If you take 291.66 grains of ore for the assay, every bead point will represent one ounce to the ton of ore, and if gold, $20.67.

FLUXES.

LITHARGE.—A lead oxide, 8 to 10 cents per pound. It is an oxidizer or desulphurizer; that is, it oxidizes the iron and destroys the sulphur and is a source of lead which takes up the gold and silver in the ores. It is a flux because refractory substances are melted with litharge at a moderate heat. It fluxes most rocks, earth and metal oxides. A desulphurizer, because it burns the sulphur.

SODA.—Common baking soda, 4 cents a pound. It fluxes quartz and some metal oxides, desulphurizes galena, antimony and bismuth.

BORAX.—8 cents per pound. Fluxes clay, lime, magnesia, slate.

BORAX GLASS.—65 cents per pound. Fluxes the same as borax but does not swell. To prepare it, melt it, allow it to cool in thin pieces and grind to powder. One part by weight is equal to two of undried borax.

GLASS.—Common bottle or window glass. Pulverize and grind finely. Used in assays containing much lime, clay, etc., but not quartz. Useful in an assay where much litharge or nitre is used to protect the crucible.

NITRE.—15 cents per pound. A powerful oxidizer; destroys the sulphur; will oxidize all metals excepting gold and some of the platinum group.

SULPHUR.—Used in certain kinds of assays, as copper, to prevent the copper entering the lead button. The copper will be converted into sulphurets.

IRON.—(Nails or wire.) A desulphurizer for galena and silver ores with sulphur, not for sulphurets of iron, copper and zinc.

SALT.—Used because it becomes very fluid. Serves as a cover to exclude air, also to wash the sides of the crucible.

SHEET LEAD.—25 cents a pound. Tea lead will answer.

FLOUR.—A reducer; reduces the litharge into lead. One part by weight of flour reduces fifteen parts of lead.

CHARCOAL.—A still better reducer than the above, as it throws down 30 parts of lead by weight to one part of charcoal.

ACIDS.—Nitric 40 cents per pound, muriatic and sulphuric.

DISTILLED WATER.—Filtered rain water will answer.

BLACK FLUX.—A mixture of charcoal, potassium carbonate; one ounce of powdered charcoal and 8 ounces pulverized potassiu mcarbonate, thoroughly mixed and kept dry.

DRESSING FOR DIFFERENT ORES.

It must be remembered that soda is a flux for quartz and galena, borax for earths and metal oxides generally, litharge for all. I give a few samples of dressings for general use. Charcoal and flour are reducers. Charcoal has double the strength of flour; either can be used.

Quartz:

Ore . . . . One part.
Litharge. . . . . Three parts.
Soda . . . . One and one-half parts.
Borax. . . . . One-half part.
Flour . . . . One-eighth part.
or Charcoal. . . . One-twelfth part.
Cover with salt.

Mix the litharge with the ore first, then mix all together thoroughly, and after placing in the crucible cover with the salt. The crucible should not be more than two-thirds full.

Quartz carrying not more than three per cent. of sulphurets:

Ore ....One part.
Litharge...........Three parts.
Soda.............One-half part.
Borax ....One part.
Charcoal.......One-eighth part.
Cover with borax and salt.

Rock carrying iron pyrites and galena from two to ten per cent.:

Ore ....One part.
Litharge ....Three parts.
Soda ....One part.
Pearl ash.........One-half part.
Borax ....One part.
Charcoal.......One-eighth part.

Cover with salt with two or three twelvepenny nails, according to the amount of sulphurets contained in the ore. The nails are stuck down through the dressing, heads up. They serve to throw down the lead and silver and take up the sulphur.

Ore carrying galena, copper, zinc and other bases:

Ore.................. One part.
Litharge............ Five parts.
Soda............... Three parts.
Pearl ash............ One part.
Charcoal .... One-sixteenth part.

Cover thickly with salt and add three or four twelvepenny nails.

Silver ores carrying galena:

Ore.................. One part.
Soda............... Two parts.
Pearl ash............ One part.
Charcoal .... One-sixteenth part.
Cover with borax.

Quartz rock carrying five to ten per cent. sulphurets:

Ore.................. One part.
Litharge .... Four parts.
Soda .... One part.
Pearl ash......... One-half part.
Borax .... One part.
Charcoal........ One-tenth part.
Cover with salt and borax mixed.

Ore containing arsenical pyrites or arsenide of iron, five to twenty per cent.:

Ore.................. One part.
Soda .... Two parts.

Litharge . . . . Four parts.
Pearl ash . . . . One part.
Charcoal . . . . One-twlfth part.

Cover with borax; stick one twelvepenny nail in the center.

Antimony:

Ore. . . . . One part.
Soda . . . . Four parts.
Cyanide of potassium Two parts.

After charging the crucible, add a few grains of charcoal.

Galena:

Ore. . . . . One part.
Soda . . . . Four parts.
Pearl ash. . . . . One part.
Charcoal . . . . One-sixteenth part.

Ordinary ores carrying quartz, clay, lime, iron, etc.:

Ore. . . . . One part.
Litharge . . . . Three parts.
Soda . . . . One-half part.
Pearl ash. . . . . One-half part.
Borax . . . . One part.
Charcoal. . . . . . One-twelfth part.

A little salt to cover, and one-third part of borax on top.

For the most refractory ore:

Ore.................. One part.
Litharge .... Sixteen parts.
Soda .... Two parts.
Borax-glass........... One part.
Charcoal........ One-sixth part.
Salt to cover.

Concentrated pyrites:

Ore.................. One part.
Litharge........... Eight parts.
Soda .... Eight parts.
Glass............... Four parts.

Lead:

Ore.................. One part.
Soda............... Four parts.
Borax .... One part.
Flour, by weight, One-sixth part.

Bismuth:

Ore.................. One part.
Soda............... Four parts.
Borax-glass ...... One-half part.
Flour......... One-twelfth part.
Salt to cover.

Tin:

Ore.................. One part.
Soda............. Three parts.
Cyanide of potassium Two parts.

Assay for pure concentrates or ore, any very heavily sulphurated ore or nearly any of the very base ores:

Take 240 grains of ore or the assay ton of 291.66 grains of ore; pulverize to 60 mesh; mix thoroughly with double the quantity of nitre, (salt peter). Put into a crucible so large as not to more than half fill it. Place in a moderately hot fire and after complete fusion stir it in the crucible with a hot iron rod or wire three or four minutes, then add quickly with a long scoop or ladle, the flux, it having been prepared beforehand, as follows: ½ ounce of litharge, one ounce of soda and six grains of finely pulverized charcoal; and cover the crucible and incease the heat, when it should melt in fifteen or twenty minutes. When melted take the crucible and tap lightly to settle the lead, and let it remain in the crucible until cool; then break the crucible, extract and clean the button, cupel and weigh.

METALS THAT ARE DISSOLVED IN ACID.

Nitric acid disssolves silver, copper, iron, bismuth, zinc and mercury.

Sulphuric acid dissolves silver, copper, bismuth, zinc, tin and antimony.

Hydrochloric or muriatic acid dissolves iron, zinc, bismuth, and antimony if powdered.

One part of nitric acid and two parts muriatic acid dissolves gold, platinum, copper, iron, silver, zinc and bismuth; and if diluted with, will dissolve lead. Lead is not dissolved in nitric acid, but will be converted into a white powder.

A solution of caustic potash dissolves zinc, tin, and aluminum.

A solution of cyanide of potassium dissolves the following metals out of finely pulverized ore: gold, silver, zinc, copper, lead and aluminum. It will act more rapidly when combined with peroxide of soda.

TESTING ORES WITH ACIDS.

Many very satisfactory tests can be made with acids with very little trouble, the outfit costing only a few dollars, and can be carried in a small chest or even a grip sack, the material actually necessary consists of the following:

1 lb. C. P. nitric acid.
1 lb. C. P. muriatic acid.
1 lb. sulphuric acid.
½ lb. cyanide of potassium (dry).
1 bottle caustic soda, in sticks (pure).
1 small porcelain-lined dish.
2 small evaporating cups.
½ dozen test tubes.

1 funnel, some filter paper and some blotting paper.

1 lb. mercury and ¼ lb. sodium amalgam.

1 small bottle of ammonia.

½ lb. ferrocyanide; a few thin strips of copper and zinc.

1 lb. sal soda (common washing soda).

The above outfit will enable one to make the milling test for free gold, the copper assay and the chemical tests given in this work, as well as many qualitative tests for gold, silver, copper, lead, mercury, iron, bismuth, manganese, antimony and nickel. If the ore contains iron pyrites, sulphate of copper, arsenic or zinc, it is well to powder and roast the ore before the acid is added, but if one ounce or less is taken for the test, and this powdered to 90 or 100 fine, then nitric acid will do the work.

Put a little of the powdered ore into a test tube, or one of the evaporating dishes; if a test tube is used, take as much ore as will lay on a ten cent piece. If a dish is used, ½ ounce of the powdered ore may be used. The acid used in test tube should fill the tube not more than 1½ inches above the ore; if a dish is used 1 ounce of nitric acid with a very little water may be added to the ore and heated gently over a lamp 10 or 15 minutes, or until any violent action ceases, then let it stand until cool and settled. Now pour a little of this solution into a test tube, and add and as much muriatic acid. Now if the ore carries silver, it will be seen as a whitish curdle or white precipitate of chloride of silver. If lead is present it will be thrown down as a white precipitate, or powder; mercury will show the same as silver, but mercury and silver are not found in the same ore. Now if a precipitate is found and settled at the bottom, carefully pour off the clear solution and add a little ammonia to this precipitate and shake it a little in the tube and note the result.

If the white precipitate is dissolved, it is silver. If blackened, it is chloride of mercury. If it still remains unchanged, it is lead. A test for antimony is made the same way, dissolving first in nitric acid, and adding muriatic; let it settle clear as before and introducing a piece of zinc, if it is antimony a black precipitate will be seen. If the ore to be tested carries iron, copper, and other metals, first thoroughly dissolve the powdered ore in nitric acid by heating; let cool and settle. Now try a little of this solution in a test tube, by adding as much dilute sulphuric acid, white precipitate, shows lead. Add an excess of ammonia to some of the original solution, and a blue color shows copper, or nickel.

Red color shows peroxide of iron. By adding muriatic acid to this solution, and introducing the point of a knife, a coating of copper will form on the blade if copper is present. Again add an excess of potash to the first solution and note the reaction. Blue shows the presence of colbalt; light green of nickel, brown of iron; white of zinc; yellow of mercury.

CONCENTRATOR.

My improved carpet concentrator (see cut, page 54), is one of the most effective and least expensive used, and does not require power. "A" is tank 6 feet wide and 16 feet long. In it is placed a box 29 inches square and 15 feet 5 inches long, hung on gudgeons at each end, to run in boxes on the outside of, and at the end of tank "A," as shown in the end view (fig. 2), allowing it to revolve. This inside box is made by cutting end pieces out of 2-inch plank exactly 27 inches square. Now nail on one-inch boards 16 feet long to form the box. Let the inch board project over the two sides two or three inches to form a trough or sluice, and nail strips one by three on the other two sides for the sluice; now cover these sides, which will be just 27 inches inside the sluice, with Brussels carpet;

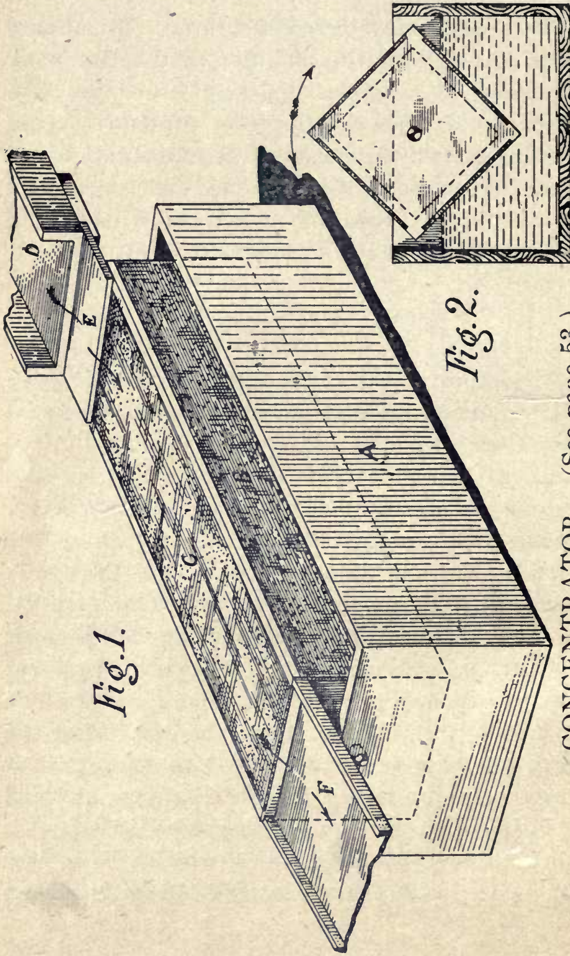


Fig. 1. Fig. 2.

CONCENTRATOR. (See page 53.)

the whole is placed below the plates "D" as any other concentrator, with the same pitch or incline as the copper plates. Now the pulp is carried from the plates to the carpet with a short moveable apron. Then the pulp flows over the carpet, and the sulphurets, and heaviest particles settle in carpet, and are washed off into tank "A" as the box revolves, in the water in the tank. Now as the carpet becomes filled with concentrates a clean side must be turned up. This may be done every hour or two. The idea is to keep the carpet free from the gangue, or nearly so, as nothing catches concentrates better than clean Brussels carpet, With very little experience and attention this will do the work. An apron is placed at the lower end to carry off the gangue.

AMALGAMATION.

The first and most important point is to thoroughly understand the cleaning of the mercury.

First—Retorting of foul mercury. The retort should not be more than half full, and covered with a layer of quick-lime or powdered charcoal. Lute and wedge the cap on the retort. Cover the pipe with wet rags and allow it to extend to, but not in the water. Keep water running on the rags, and commence the heating very gradually and slowly until the retort is nearly red. Stop heating before it is fully red and allow it to cool. The mercury will be found in the water.

Second—To clean mercury without retorting: Put the mercury in a fruit jar or large bottle, say five pounds. To this add one teacup full of nitric acid, three teacups full of distilled water. Allow it to stand for twenty-four hours, shaking it occasionally.

HOW TO KEEP MERCURY.

It should be kept in a large jar, mug or bottle, preferably a bowl or large mouthed bottle. Put into the bottle 5 pounds of mercury, one pound of sal-ammoniac, 2 pounds of quick-lime, with just enough water to dissolve. Shake it well. Use the mercury from this jar.

DRESSING THE PLATES.

Rinse them off with a hose, using clean water. If they are fouled or dark, go over them with a brush or flannel-mop, washing them with the following solutions as may be best suited to the conditions which will be given below.

The best for general purposes is solution

No. 1.—	Cyanide of potassium,	2 ozs.
	Caustic soda,	5 ozs.

Dissolved in five gallons of water.

When the plates are fouled or blackened with black sulphurets, use eithel of the following:

No, 2.—To five gallons of strong brine add one-half pint of sulphuric acid.

No. 3.—Sal-ammoniac,	1 lb.
Lime,	3 lbs.
Carbonate of soda,	½ lb.

Go over the plates thoroughly with one of these solutions. When the plates are fouled with zinc, black oxide of manganese, sulphate of copper, use

No. 4.—Muriatic acid,	1 lb.
Water,	5 gallons.

After having cleaned the plates and used one of the above solutions, take from the bottle one pound of mercury, put it in a small bottle and add one-half ounce of sodium amalgam.

Stretch a piece of muslin over the mouth of the bottle and sprinkle the plate with the mercury; rub them smooth with a flannel mop in clean water. They are then ready to receive the pulp from the mill. The mercury now is fed into the battery every half hour. The quantity must be governed by the amount of gold in the ore. Two and one-half ounces of mercury is sufficient to amalgamate and hold in proper condition on the plates one ounce of gold. The millman must keep the plates in good condition, that is, the mercury should be kept soft on the plates but not to run, so that it may be rubbed up with the finger, feeling like soft putty, and as the amalgam accumulates, it should be kept in like condition, but must be spread on the plates, and not be allowed to remain in bunches as it will. This may be done with a brush, going over the plates from side to side, the brush in this manner forming very fine ridges. When the ore carries black oxide of manganese or black sulphurets the plates become foul so often that it is a very hard matter to keep them clean, and the following may be found very useful not only in keeping the plates clean but in saving the fine gold.

Take some light tent cloth or heavy cotton drilling; cut a piece six feet long and the width of the plates; tack or sew a narrow, thin lath across each end and in the middle to keep the cloth stretched like a window shade. Place this right over the plates thirty inches from the battery and just below the first copper, raise the upper end so that all the pulp and water flows under. Allow the whole piece to float on the pulp. You may add a little more water below the battery. This arrangement serves to force the fine gold on to the plate and at the same time serves to force the foul matter off.

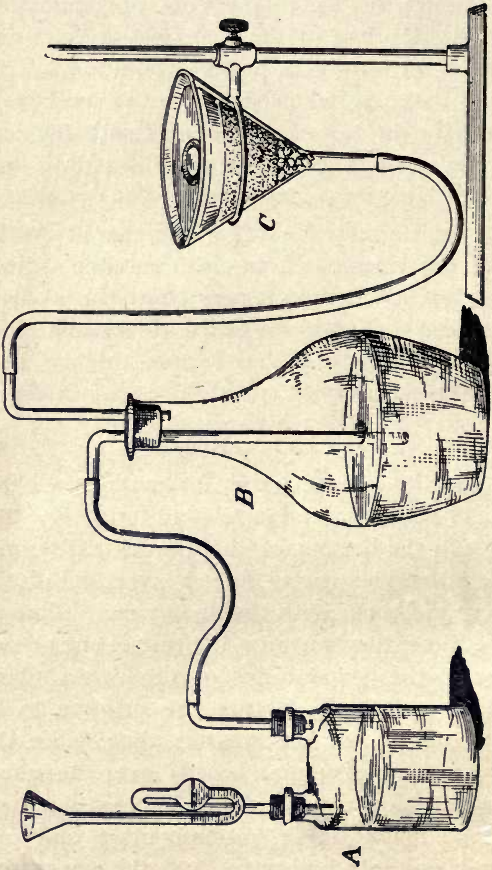
Sometimes the water prevents amalgamation and causes the loss of the fine gold, even when the plates seem to be in perfect condition. This is often the case when the water is used from the mine in the batteries. When this is the case the water should be kept in a tank, adding one bushel of lime for every 1,000 gallons of water.

SODIUM AMALGAM.— This is prepared by dissolving dry chips cut from clean metallic sodium in dry mercury. Heat it very gently in a flask or porcelain dish; add the chips of sodium piece by piece until the mass has become thick. This must always be kept perfectly dry and air tight.

CHLORINATION.

On page 60 see apparatus for making a chlorine test, which can be purchased for $1.50.

Place in the bottom of the funnel "C" some quartz pulverized pretty fine, a layer first of the coarser, and cover with the fine quartz. This is for the filter; then put into the funnel one or two ounces of the concentrates or sulphurets which must be roasted to destroy the sulphur, to be treated, on top of the quartz; then place the cover (cut out of a pine board) over the whole and lute it down with dough. Now mix one ounce of black oxide of manganese and one ounce of fine salt, and put it into the generator,

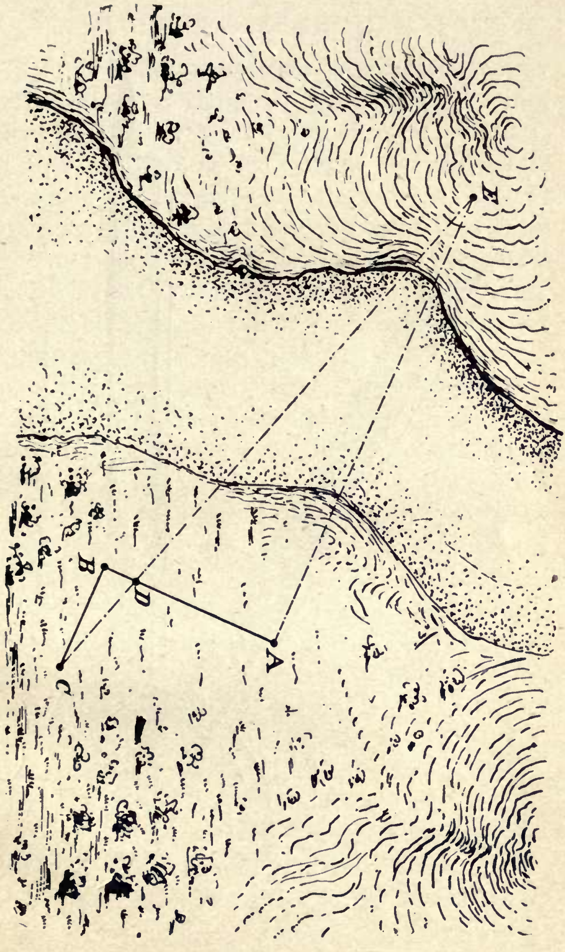


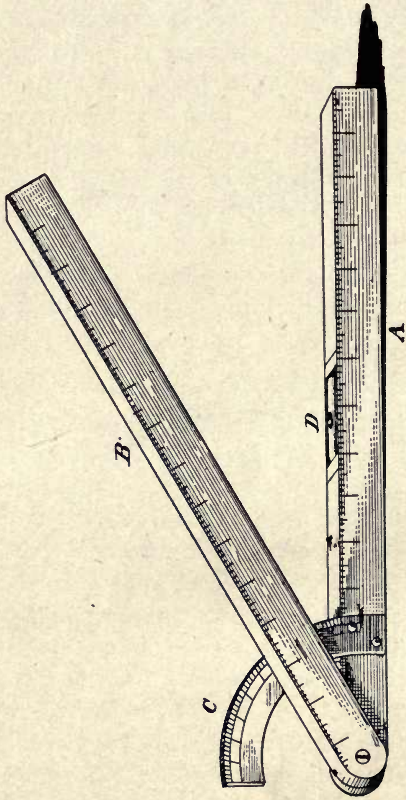
CHLORINATION APPARATUS.

"A;" then connect the generator, as shown. To wash bottle or any clear bottle filled with water as shown, above the end of the glass tube, connect this bottle wi'h rubber tube to the bottom of the funnel as shown. Now pour into the small funnel top of glass tube in the generator, "A;" water to cover the manganese and salt, and then add 2 ounces of sulphuric acid, a little at a time, and in a minute or two you will see the chlorine gas begin to bubble up through the water in the bottle, and this gas will pass through the rubber tube in the ore in the funnel and will dissolve the gold. If there is a leak you will detect it at once by the smell, and you can readily discover it by dipping a stick or a sliver into ammonia and holding it all around the different connections, as you would do with a lighted match, to discover a gas. The moment the stick wet with ammonia is touched with the gas, a whitish fume will rise from the stick. The leak when found can be checked at once with dough. When the bubbles cease in the bottle, add a little more acid; let it work for six or eight hours, then take the cover from the ore, and remove the rubber tube from the bottom of the funnel and place a bowl under the funnel and begin to pour hot water on the ore, which will leach down through the ore and carry the chloride of gold with it in solution, after it has been thoroughly leached out. You precipitate the gold from the solution with sulphate of iron and a few drops of muriatic acid, which you can make by dissolving any hoop iron or thin sheets of iron in sulphuric acid. The whole is filtered and the brown precipitate is then dried and mixed with litharge and borax, and melted. The lead button is then cupelled as in an assay. The better way is to thoroughly rinse the ore with hot water, to leach out all the gold, and assay for the pulp to determine the per cent. of gold extracted.

TO MEASURE INACCESIBLE DISTANCES.

A very simple and convenient method of measuring inaccessible distances, as across a canyon or river is shown on page 63. Suppose it is desired to know the distance from a given point as "A" across a stream to "E" (see cut.) Step off or measure with a line, 100 feet, yards, or rods, at right angles from the starting point "A" to "B," and set a stake on the same line at 80, one-fifth of the 100 at "D." Now measure or step off at right angles from "B" to a point "C," where a line to "E" will cut the stake at "D" as shown by the dotted line from "C" to "E." Now the distance from "B" to "C" multiplied by four gives the correct distance from "A" to "E."


A
B
C
D
E



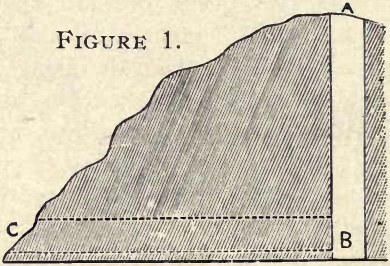
LEVELING INSTRUMENT.

LEVELING INSTRUMENT.

There are very many times and places where it is necessary to know the depth of shaft to tap a drift or the length of a tunnel to cut a shaft, and it is very seldom convenient to have a surveyor or even a compass. On page 64 I have shown a cut of an instrument I have made and used, that is very simple, satisfactory, and easily made. Take two pieces of hard, sound, clear board, ½ inch thick, 1 inch wide and two feet long, dressed, and rule them the same as an ordinary two foot rule. Fasten them together at one end with a common wood screw; now cut a quadrant, and ½ inch or more out of a piece of thin brass or tin and mark the degrees on it from 0 to 90, as shown at "C;" the ½ inch is to fasten to the base "A;" let "0" begin at the top edge of "A." Let this in flush with the face of the piece "A" and fasten with small screws; now take a piece of glass tubing, cork one end and fill it with alcohol; cork and seal both ends; countersink a place in the middle of base "A" and fasten this in it as shown at "D." This makes a good spirit level of the base. Stick a piece of a pin in each end of the leg "B," for sights; now the instrument is ready for use. For grading a ditch or flume, or tunnel, push the leg "B" below the base, the number of inches required for the grade, if end of the leg "B" is pushed below the end of the level — 2 inches. This would make the grade one inch to the foot, etc., holding the base level; the leg "B" forms the pitch, or incline, or base required.

For measuring distances, running tunnels, etc., when it is desired to know the length of a tunnel to cut a lode or shaft: Let "A," fig. 1,

FIGURE 1.



be the top of the lode or shaft, and "C" be the point where the tunnel is to start. Now place the instrument level at "C;" let the leg "B" point to "A," and note the angle, and then measure the distance carefully up to the shaft at "A," and take the pitch, or angle, of the incline or pitch of the shaft. Now from the table of sines, get the sine of the angle at "c" and the sine of the angle at "a;" then the

Length of tunnel "B - C" = "AC" $\times$ sine "a".

Depth of shaft "A - B" = "AC" $\times$ sine "c".

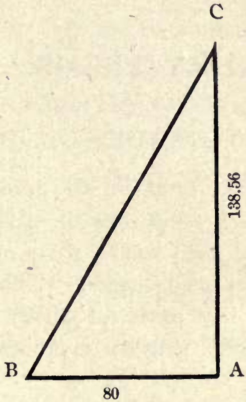


FIGURE 2.

Suppose it is desired to get the distance to a certain point, with the instrument, accurately, set a stake at the starting point, "A;" then measure off any distance at right angles from the line "AC" to point "B," set the base or level at "B" and sight back to "A;" then point the leg of the instrument to "C" and note the angle, which in this example, figure 2, is 60°, then the angle at "C" must be 30° and the distance from "A" to "B" is 80 (feet, yards or rods). The distance from

$$\text{"A" to "C"} = \frac{\text{"AB"} \times \text{sine "b"}}{\text{sine "c"}}$$

Example: Angle at "B" is 60°, sine 8660. (See table of sines.) Angle at "C" is 30°, sine 5000. Now the line "AB" is $80 \times 8660 = 6928 \div 5000 = 138.56$.

SUNDRY ITEMS.

DIFFERENT GRADES OF GOLD.

Twenty-four-carat gold is all gold; 22-carat gold has 22 parts of gold, one of silver and one of copper; 18-carat gold has 18 parts of gold and three each of silver and copper; 12-carat gold is half gold and has 3½ parts of silver and 8½ of copper. Its specific gravity is about 15; pure gold is 19.

LOCATION NOTICE.

There are many forms; the shortest and most concise is as good as any, besides being the easiest. Take a soft pine board and a hard lead pencil, and the writing will sometimes outlast your claim. I have written notices that have remained legible for six years.

"Notice is hereby given that I, Samuel Burbank, claim by right of discovery and to locate under the mining laws of the state of California, 1,500 feet in length and 600 feet in width along this vein or lode to be known as the "Gold Bug" beginning at center of this shaft (cut or mound) and running 700 feet in a northerly direction and 800 feet in a southerly direction, together with 300 feet on either side of this vein or lode.

Located January 1, 1897.

SAMUEL BURBANK, Locator."

Now have a copy of this recorded.

MINER'S INCH.

An outlet of two inches width, four inches of water above the outlet, one inch wide, is two miner's inches, and a flume ten inches with six inches of water, would give twenty miner's inches.

SOLUTION NO. 3 FOR WORKING BLACK SAND.

Dissolve one pound of cyanide potassium and two pounds of caustic soda in 40 gallons of water. Use one gallon of this solution mixed with six gallons of water. This will free the gold so that it will amalgate when it comes in contact with the mercury.

209 feet square is one acre.

A gallon of fresh water weighs 8⅓ pounds, and contains 231 cubic inches.

A cubic foot of water weighs 62½ pounds, and contains 1,728 cubic inches or 7½ gallons. A cubic inch of water weighs .0361 pounds.

The friction of water in pipes increases as the square of its velocity.

The capacity of pipes increases as the square of the diameters, thus doubling the diameter increases the capacity four times.

To find the area of a piston, square the diameeter and multiply by .7854.

In calculating horse power of tubular boilers, 15 square feet of heating surface is equivalent to one nominal horse power.

Each nominal horse power of boilers will require about one cubic foot of water per hour.

The mean pressure of the atmosphere is usually estimated at 14.7 pounds per square inch, so that, with a perfect vacuum, it will sustain a column of mercury 29.9 inches, or a column of water 33.9 feet high.

To find the capacity of a cylinder in gallons: Multiplying the area in inches by the stroke in inches will give the total number of cubic inches: divide this amount by 231 (which is the cubical contents of a gallon in inches), and the product is the capacity in gallons.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. Approximately each foot elevation is called equal to one-half pound pressure per square inch.

To find the diameter of a pump cylinder to move a given quantity of water per minute at a piston travel of 100 feet per minute, divide the number of gallons by 4, then extract the square root, and the product will be the diameter of the pump cylinder in inches.

To find the horse power required to elevate water to a given height, multiply the amount of water, in gallons, to be raised per minute by 8.35, the weight of a gallon of water, and this product by the height (in feet) of the discharge from the point of suction; divide the result by 33,000, and you have the theoretical horse power required to raise the amount of water a certain distance. Owing to the friction of water in pipes, the friction of machinery and the pump itself, a liberal allowance must be made for friction.

The area of the steam piston, multiplied by the steam pressure, give the total amount of pressure exerted. The area of the water piston, multiplied by the pressure of water per square inch, gives the resistance. A margin of from 30 to 50 per cent. must be added to move the piston at the required speed.

To find the velocity in feet per minute necessary to discharge a given body of water in a given time, multiply the number of cubic feet of water by 144, and divide the product by the area of the pipe in square inches.

Amount of water to mill one ton of ore is from 1,200 to 2,400 gallons, the average being about 1,800 gallon to the ton of ore.

Small particles of anything may be picked up with the moistened point of a pin or needle.

ASSAY TABLE

Showing the amount of Gold and Silver, in ounces and fractions, contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of (half an ounce) two hundred and forty grains of ore.

If 240 grains of Ore give of Fine Metal — Thousands of the unit of 10 grains.	One ton of Ore will yield of Fine Metal —Ounces.	Intrinsic value per ton— Silver	Intrinsic value per ton— Gold ......
.001	1.21	$ 1.56	$ 25.01
2	2.43	3.14	50.23
3	3.64	4.71	75.24
4	4.86	6.28	100.46
5	6.08	7.86	125.68
6	7.29	9.42	150.70
7	8.51	10.99	175.92
8	9.72	12.57	200.93
9	10.94	14.14	226.15
.010	12.15	15.69	251.16
1	13.37	17.29	276.38
2	14.58	18.85	301.29
3	15.80	20.43	326.61
4	17.01	21.99	351.63
5	18.23	23.57	376.85
6	19.44	25.13	401.86
7	20.66	26.71	427.08
8	21.87	28.27	452.09
9	23.09	29.85	477.31
.020	24.30	31.42	502.32
1	25.51	32.99	527.54
2	26.74	34.57	552.76
3	27.95	36.14	577.78
4	29.17	37.71	603.00
5	30.38	39.28	628.01
6	31.60	40.86	653.23
7	32.81	42.42	678.24
8	34.03	44.00	703.46
9	35.24	45.56	728.47
.030	36.46	47.14	753.69
1	37.67	48.70	778.71
2	38.89	50.28	803.93
3	40.10	51.85	838.94
4	41.32	53.42	854.16
5	42.53	54.99	879.17
6	43.75	56.56	904.39
7	44.96	58.13	929.40
8	46.18	59.71	954.62
9	47.39	61.27	979.64

ASSAY TABLE — Continued.

Showing the amount of Gold and Silver, in ounces and fractions, contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of (half an ounce) two hundred and forty grains of ore.

If 240 grains of Ore give of Fine Metal — Thousands of the unit of 10 grains.	One ton of Ore will yield of Fine Metal —Ounces.	Intrinsic value per ton—Silver	Intrinsic value per ton—Gold ....
.040	48.61	$ 62.85	$ 1004.86
1	49.83	64.43	1030.07
2	51.04	65.99	1055.09
3	52.26	67.57	1080.31
4	53.47	69.13	1105.32
5	54.69	70.71	1130.54
6	55.90	72.27	1155.55
7	57.12	73.85	1180.77
8	58.33	75.42	1205.79
9	59.55	76.99	1231.00
.050	60.76	78.56	1256.02
1	61.98	80.13	1281.24
2	63.19	81.70	1306.25
3	64.41	83.28	1331.47
4	65.62	84.84	1356.48
5	66.84	86.42	1381.70
6	68.05	87.98	1406.72
7	69.27	89.56	1431.93
8	70.48	91.12	1456.95
9	71.70	92.70	1482.17
.060	72.92	94.28	1507.39
1	74.13	95.84	1532.40
2	75.35	97.42	1557.62
3	76.56	98.99	1582.63
4	77.78	100.56	1607.85
5	78.99	102.13	1632.86
6	80.21	103.70	1658.08
7	81.42	105.27	1683.10
8	82.64	106.85	1708.32
9	83.85	108.41	1733.33
.070	85.07	109.99	1758.55
1	86.28	111.55	1783.56
2	87.50	113.13	1808.78
3	88.71	114.69	1833.79
4	89.93	116.27	1859.01
5	91.14	117.84	1884.03
6	92.36	119.41	1909.25
7	93.58	120.99	1934.47
8	94.79	122.56	1959.48
9	96.01	124.13	1984.70

ASSAY TABLE — Continued.

Showing the amount of Gold and Silver, in ounces and fractions, contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of (half an ounce) two hundred and forty grains of ore.

If 240 grains of Ore give of Fine Metal — Thousands of the unit of 10 grains.	One ton of Ore will yield of Fine Metal —Ounces.	Intrinsic value per ton—Silver	Intrinsic value per ton—Gold ....
.080	97.22	$ 125.70	$ 2009.71
1	98.44	127.27	2034.93
2	99.65	128.84	2059.94
3	100.87	130.42	2085.16
4	102.08	131.98	2110.18
5	103.30	133.56	2135.40
6	104.51	135.12	2160.41
7	105.73	136.70	2185.63
8	106.94	138.26	2210.64
9	108.16	139.84	2235.86
.090	109.37	141.41	2260.87
1	110.59	142.98	2286.09
2	111.80	144.55	2311.11
3	113.02	146.13	2336.33
4	114.23	147.69	2361.34
5	115.45	149.27	2386.56
6	116.67	150.84	2411.78
7	117.88	152.41	2436.79
8	119.10	153.99	2462.01
9	120.31	155.55	2487.02
.100	121.53	157.13	2512.24
.200	243.05	314.26	5024.48
.300	364.58	471.39	7536.72
.400	486.11	628.52	10048.96
.500	607.64	785.65	12561.21
.600	729.16	942.78	15073.45
.700	850.69	1099.91	17585.70
.800	972.22	1257.04	20097.93
.900	1093.75	1414.17	22610.17
1.000	1215.27	1571.30	25121.41

ASSAY TABLE

Showing the amount of Gold and Silver, in ounces and fractions, contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of 20 Grammes of ore.

If 20 grams of Ore give of Fine Metal — Thousands of the unit of 1 Gram.	One ton of Ore will yield of Fine Metal — Ounces....	Intrinsic value per ton— Silver.......	Intrinsic value per ton— Gold ....
.001	1.458	$ 1.88 5	$ 30.14 6
2	2.916	3.77.1	60 29.2
3	4.374	5.65.7	90.43.8
4	5 833	7.54.2	120 58.5
5	7.291	9.42.8	150.73.1
6	8 749	11.31 3	180.87.7
7	10.208	13.19.8	211.02.4
8	11.666	15.08.4	241.17 0
9	13.124	16.95.9	271.31.6
.010	14.583	18.85.4	301.46.3
1	16.041	20.73.9	331 60.9
2	17.499	22.62.5	361.75.5
3	18.958	24.51.0	391.90.1
4	20.416	26.39.5	422.04.8
5	21.874	28.28.1	452.19.4
6	23.333	30.16.6	482.34.0
7	24.791	32.05.2	512.48.7
8	26.249	33.93 7	542.63.3
9	27.708	35.82.4	572.77.9
.020	29.166	37.70.8	602.92.6
1	30.624	39.59.4	633.07 2
2	32.083	41.47.9	663.21.8
3	33 541	43.36.4	693.36.5
4	34.999	45.25.0	723.51.1
5	36.458	47.13.5	753.65.7
6	37.916	49.02.1	783.80.3
7	39.374	50.90.6	813.95.0
8	40.833	52 79.2	844.09.6
9	42.291	54 67.7	874.24.2
.030	43.749	56 56.2	904.38.9
1	45.208	58.44.8	934.53.5
2	46.666	60.33.3	964 68.1
3	48.124	62.21.9	994.82 8
4	49.583	64.10.4	1024.97.4
5	51.041	65.99.0	1055.12.0
6	52.499	67.87.5	1085 26.7
7	53.958	69.76.0	1115.41.3
8	55.416	71.64.6	1145.55.9
9	56.874	73.53.1	1175.70.5
.040	58.333	75.41.9	1205.85.0
1	59.791	77.30.4	1235.99.8
2	61.249	79.18.9	1266.11.4
3	62.708	81.07.5	1296.29.1

ASSAY TABLE — Continued.

Showing the amount of Gold and Silver, in ounces and fractions, contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of 20 Grammes of ore.

If 20 grams of Ore give of Fine Metal — Thousands of the unit of 1 Gram.	One ton of Ore will yield of Fine Metal — Ounces....	Intrinsic value per ton—Silver.......	Intrinsic value per ton—Gold ....
.044	64.166	$ 82.96.0	$ 1326.43.7
5	65.624	84.84.6	1356.58.3
6	67.083	86.73.1	1386.73.0
7	68.541	88.61.7	1416.87.6
8	69.999	90.50.2	1447.02.2
9	71.458	92.38.7	1477.16.8
.050	72.916	94.27.3	1507.31.5
1	74.374	96.15.9	1537.46.1
2	75.833	98.04.4	1567.60.7
3	77.291	99.93.0	1597 75.4
4	78.749	101.81.5	1627.90.0
5	80.208	103.70.1	1658.04.6
6	81.666	105.58.6	1688.19.3
7	83.124	107.47.1	1718.33.9
8	84.583	109.35.7	1748.48.5
9	86.041	111.24.2	1778.63.2
.060	87.499	113.12.8	1808.77.8
1	88.958	115.01.3	1838.92.4
2	90.416	116.89.9	1869.07.0
3	91.874	118.78.4	1899.21.7
4	93 333	120.67.0	1929.36.3
5	94.791	122.55.5	1959.50.9
6	96.249	124.44.0	1989.65.6
7	97.708	126.32.6	2019.80.2
8	99.166	128.21.1	2049.94.8
9	100.644	130.09.7	2080.09.5
.070	102.083	131.98.3	2110.24.1
1	103.541	133.86.8	2140.38.7
2	104.999	135.75.4	2170.53.4
3	106.458	137.63.4	2200.68.0
4	107.916	139.52.4	2230.82.6
5	109.374	141.41.0	2260.97.2
6	110.833	143.29.5	2291.11.9
7	112.291	145.18.1	2321.26.5
8	113.749	147.06.6	2351.41.1
9	115.208	148.95.2	2381.55.8
.080	116.666	150.83.7	2411.70.4
1	118.124	152.72.2	2441.85 0
2	119.583	154 60.7	2471 99 7
3	121.041	156 49.4	2502.14.3
4	122.499	158.37.9	2532.28 9
5	123 957	160.26 5	2562.43.6
6	125.416	162.15.0	2592.58.2

ASSAY TABLE — Continued.

Showing the amount of Gold and Silver, in ounces and fractions contained in one ton of ore, of two thousand pounds, from the weight of fine metal obtained in an assay of 20 Grammes of ore.

If 20 grams of Ore give of Fine Metal — Thousands of the unit of 1 gram.	One ton of Ore will yield of Fine Metal —Ounces.	Intrinsic value per ton—Silver	Intrinsic value per ton—Gold ....
.087	126.874	$ 164.03.5	$ 2622.72.8
8	128.332	165 92.5	2652.87 4
9	129.791	167.80.6	2683.02.1
.090	131 249	169.69.2	2713.16.7
1	132.708	171.57.7	2743.31.3
2	134.166	173.46.3	2773.46.0
3	135.624	175.34.8	2803.60.6
4	137.083	177.23.3	2833.75.2
5	138.541	179.11.9	2863 89.9
6	139.999	181.00.4	2894.04.5
7	141.458	182.89.0	2924.19.1
8	142.916	184.77.5	2954.33.7
9	144.374	186.66.1	2984.48.4
.100	145.833	188 54.7	3014.63.0
.200	291.666	377.09	6029.26
.300	437.499	565.64	9043.91
.400	583.333	754.19	12058.55
.500	729.166	942.73	15073 18
.600	874.999	1131.29	18087.82
.700	1020.833	1319.83	21102.46
.800	1166.666	1508.38	24117 09
.900	1312.499	1696.93	27131 73
1.000 Or 1 Gram	1458 333	1885 47	30146.37
2 ..	2916.666	3770.95	60292.74
3 ..	4374.999	5656.42	90439.10
4 ..	5833.333	7541.90	120585.47
5 ..	7291.666	9427.37	150731.84
6 ..	8749.999	11312.85	180878.21
7 ..	10208.333	13198.32	211024.58
8 ..	11666.666	15083.80	241170.94
9 ..	13124.999	16964.27	271317.31
10 ..	14583.333	18854.75	301463 68
11 ..	16041.664	20740.22	331610.05
12 ..	17499 999	22625.70	361756.42
13 ..	18958.333	24511 17	391902.78
14 ..	20416.666	26396.65	422049.15
15 ..	21874.999	28282.12	452195.52
16 ..	23333.333	30167.60	482341.89
17 .	24791.666	32053.07	512488.25
18 ..	26249.999	33938.55	542634.62
19 ..	27708.333	35824.02	572780.99
20 ..	29166.666	37709.50	602927.36

The foregoing table is computed from an assay of 20 grammes, which is a convenient amount for a crucible assay. When a scorification assay is made, two scorifiers are used with 10 grammes in each, and the two buttons (which should weigh exactly alike, if the assay is correct) are weighed together and treated as one assay. It is then only necessary to compare the tables with the number of milligrammes obtained, in the first column; in the next will be found the number of ounces to the ton, and the value of gold and silver in the other columns. A single example will fully illustrate it.

20 grammes of ore yield a metallic button of gold and silver weighing 830 milligrammes.

Boiled in nitric acid.—Gold weighing 32 milligrammes remains.

380—32 gold=348 silver.

In the first column find 32 milligrammes and you have 46.666 ozs. Troy and its value in gold column, $964.68. In the first column find 348 milligrammes. To do this you must add 48 and 300, and you have 69.999+437.499=507.49 ozs. Troy, and its value in silver column 90.50+565.54=$656.14. The result will be,

Gold	46.666	ozs. Troy	=$964.68.
Silver	507.49	" "	= 656.14.
Value per ton of 2,000 lbs.			$1,620.82.

TABLE OF SPECIFIC GRAVITY, WEIGHT IN CUBIC INCHES AND CUBIC FEET, AND MELTING POINT.

METALS.	Specific Gravity.	Weight of cu. in. in lbs.	Weight of cu. ft. in lbs.	Melting point Fahrenheit.
Antimony	6.712	.244	411.67	1150°
Bismuth	9.823	.355	616.44	506°
Brass	7.820	.282	487.29	1712°
Copper	8.788	.317	547.77	1990°
Gold	19.258	.697	1204.41	2100°
Iron	7.780	.272	466.56	2780°
Lead	11.352	.410	708.48	612°
Mercury	13.592	.492	850.17	....
Platinum	22.069	.798	1378.94	3688°
Silver	10.474	.379	554.62	1800°
Tin	7.291	.263	454.46	526°
Zinc	6.861	.248	428.54	773°

RELATIVE VALUE OF AVOIRDUPOIS AND TROY WEIGHTS.

AVOIRDUPOIS OUNCES REDUCED TO TROY WEIGHTS AND GRAINS.					TROY OUNCES REDUCED TO AVOIRDUPOIS WEIGHTS AND GRAINS.			
Avoirdupois Ozs.	TROY.			GRAINS.	Troy Ounces.	AVOIRDUPOIS.		GRAINS.
	Ozs.	Dwts.	Grs.			Ozs.	Drachms.	
1	----	18	5½	437½	1	1	2	480
2	1	16	11	875	2	2	3	960
3	2	14	16½	1312½	3	3	5	1440
4	3	12	27	1750	4	4	6	1920
5	4	11	3½	2187½	5	5	8	2400
6	5	9	9	2625	6	6	9	2880
7	6	7	14½	3062½	7	7	11	3360
8	7	5	20	3500	8	8	12	3840
9	8	4	1½	3937½	9	9	14	4320
10	9	2	7	4375	10	11	0	4800
11	10	0	12½	4812½	11	12	1	5280
12	10	18	18	5250	12	13	3	5760
13	11	16	23½	5687½	----	----	----	----
14	12	15	5	6125	----	----	----	----
15	13	13	10½	6562½	----	----	----	----
16	14	11	16	7000	----	----	----	----

WROUGHT IRON WELDED PIPE.

Dimensions, Weight, etc., of standard sizes for Steam, Gas, Water, etc. 1 inch and below are butt welded and proved to 300 lbs. per square inch hydraulic pressure. 1¼ inch and above are lap welded and proved to 500 lbs. per square inch hydraulic pressure.

Inside Diameter.	Outside Diameter.	External Circumference.	Length Pipe pr. Sq. Ft. Outside Surface.	Internal Area.	External Area.	Length of Pipe Containing One Cubic Ft.	Weight per Ft. of Length.	No. of Threads per Inch of Screw.	Contents in Gals. per foot. *	Weight of Water per foot of Length.
Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Feet	Lbs.			Lbs.
1/3	.40	1.272	9.44	.012	.129	2500.	.24	27	.0006	.005
1/4	.54	1.696	7.075	.049	.229	1385.	.42	18	.0026	.021
3/8	.67	2.121	5.657	.110	.358	751.50	.56	14	.0057	.047
1/2	.84	2.652	4.501	.196	.554	472.40	.84	14	.0102	.085
3/4	1.05	3.299	3.637	.441	.866	270.00	1.12	11½	.0230	.190
1	1.31	4.134	2.903	.785	1.357	166.90	1.67	11½	.0408	.349
1¼	1.66	5.215	2.301	1.227	2.164	96.25	2.25	11½	.0638	.527
1½	1.90	5.969	2.010	1.767	2.835	70.65	2.69	11½	.0918	.760
2	2.37	7.461	1.611	3.141	4.430	42.36	3.66	8	.1632	1.356
2½	2.87	9.032	1.328	4.908	6.491	30.11	5.77	8	.2550	2.116
3	3.50	10.996	1.091	7.068	9.621	19.49	7.54	8	.3673	3.049
3½	4.00	12.566	.955	9.621	12.566	14.56	9.05	8	.4998	4.155
4	4.50	14.137	.849	12.566	15.904	11.31	10.72	8	.6528	5.405
4½	5.00	15.708	.765	15.904	19.635	9.03	12.49	8	.8263	6.851
5	5.56	17.475	.629	19.635	24.299	7.20	14.56	8	1.0200	8.500
6	6.62	20.813	.577	28.274	34.471	4.98	18.76	8	1.4690	12.312
7	7.62	23.954	.505	38.484	45.663	3.72	23.41	8	1.9990	16.662
8	8.62	27.096	.444	50.265	58.426	2.88	28.34	8	2.6110	21.750
9	9.68	30.433	.394	63.617	73.715	2.26	34.67	8	3.3000	27.500
10	10.75	33.772	.355	78.540	90.792	1.80	40.64	8	4.0810	34.000

*The U. S. standard gallon, 231 cubic inches.

CAST IRON PIPE.

Safe Thickness of Metal and Weight per length, including bells for different sizes and under various heads of water.

Size Inside Diameter.	25 Ft. Head or 10.82 lbs. pressure.		50 ft. Head or 21.65 lbs. pressure.		100 ft. Head or 43.30 lbs. pressure.		150 ft. Head or 64.85 lbs. pressure.		200 ft. Head or 86.60 lbs. pressure.		250 ft. Head or 108.25 lbs. pressure.		300 ft. Head or 129.90 lbs. pressure.		Contents in galons for 1 ft. in Length.
	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	Thick's of Metal.	Weight per Length.	
2	.255	54	.294	63	.312	67½	.330	72	.348	76½	.366	81	.384	86	.163
3	.320	132	.344	144	.353	149	.362	153	.371	157	.380	161	.390	166	.367
4	.335	180	.361	197	.373	204	.385	211	.397	218	.409	226	.421	235	.652
6	.375	300	.393	315	.411	330	.429	345	.447	361	.465	377	.483	393	1.469
8	.433	456	.422	445	.450	475	.474	502	.498	529	.522	557	.546	584	2.611
10	.442	576	.459	600	.489	641	.519	682	.549	723	.579	766	.609	808	4.081
12	.446	720	.491	768	.527	826	.563	885	.599	944	.635	1004	.671	1064	5.876
14	------	------	.524	952	.566	1031	.608	1111	.650	1191	.692	1272	.731	1352	7.997
16	------	------	.580	1215	.604	1253	.652	1360	.700	1463	.748	1568	.796	1673	10.440
18	------	------	.589	1370	.643	1500	.697	1630	.751	1761	.805	1894	.859	2026	13.220
20	------	------	.622	1603	.682	1763	.742	1924	.802	2086	.862	2248	.922	2412	16.320
24	------	------	.687	2120	.759	2349	.831	2580	.903	2811	.975	3045	1.047	3279	23.500
30	------	------	.785	3020	.875	3376	.965	3735	1.055	4095	1.145	4458	1.235	4822	36.720
36	------	------	.882	4070	.990	4581	1.098	5096	1.206	5613	1.314	6133	1.422	6656	52.880
48	------	------	1.078	6616	1.222	7521	1.366	8431	1.510	9340	1.654	10269	1.798	11195	94.020

All pipe cast in lengths of 12 feet, except the 2 inch, which is cast 9 feet long.
Pipes with flanges weigh about 15 per cent. more than the above.
Packing of rubber for flanged pipe is usually ⅛ in. thick, and weighs about 10 lbs. to the sq. yd.

TABLE OF NATURAL SINES.

Degree.	0′	10′	20′	30′	40′	50′
0	.0000	.0029	.0058	.0087	.0116	.0145
1	.0175	.0204	.0233	.0262	.0291	.0320
2	.0349	.0378	.0407	.0436	.0465	.0494
3	.0523	.0552	.0581	.0610	.0640	.0669
4	.0698	.0727	.0756	.0785	.0814	.0843
5	.0872	.0901	.0929	.0958	.0987	.1016
6	.1045	.1074	.1103	.1132	.1161	.1190
7	.1219	.1248	.1276	.1305	.1334	.1363
8	.1392	.1421	.1449	.1478	.1507	.1536
9	.1564	.1593	.1622	.1650	.1679	.1708
10	.1736	.1765	.1794	.1822	.1851	.1880
11	.1908	.1937	.1965	.1994	.2022	.2051
12	.2079	.2108	.2136	.2164	.2193	.2221
13	.2250	.2278	.2306	.2334	.2363	.2391
14	.2419	.2447	.2476	.2504	.2532	.2560
15	.2588	.2616	.2644	.2672	.2700	.2728
16	.2756	.2784	.2812	.2840	.2868	.2896
17	.2924	.2952	.2979	.3007	.3035	.3062
18	.3090	.3118	.3145	.3173	.3201	.3228
19	.3256	.3283	.3311	.3338	.3365	.3393
20	.3420	.3448	.3475	.3502	.3529	.3557
21	.3584	.3611	.3638	.3665	.3692	.3719
22	.3746	.3773	.3800	.3827	.3854	.3881
23	.3907	.3934	.3961	.3987	.4014	.4041
24	.4067	.4094	.4120	.4147	.4173	.4200
25	.4226	.4253	.4279	.4305	.4331	.4358
26	.4384	.4410	.4436	.4462	.4488	.4514
27	.4540	.4566	.4592	.4617	.4643	.4669
28	.4695	.4720	.4746	.4772	.4797	.4823
29	.4848	.4874	.4899	.4924	.4950	.4975
30	.5000	.5025	.5050	.5075	.5100	.5125
31	.5150	.5175	.5200	5225	.5250	.5275
32	.5199	.5324	.5348	.5373	.5398	.5422
33	.5446	.5471	.5495	.5519	.5544	.5568
34	.5592	.5616	.5640	.5664	.5688	.5712
35	.5736	.5760	.5783	.5807	.5831	.5854
36	.5878	.5901	.5925	.5948	.5972	.5995
37	.6018	.6041	.6065	.6088	.6111	.6134
38	.6157	.6180	.6202	.6225	.6248	.6271
39	.6293	.6316	.6338	.6361	.6383	.6406
40	.6428	.6450	.6472	.6494	.6517	.6539
41	.6561	.6583	.6604	.6626	.6648	.6670
42	.6691	.6713	.6734	.6756	.6777	.6799
43	.6820	.6841	.6862	.6884	.6905	.6926
44	.6947	.6967	.6988	.7009	.7030	.7050

TABLE OF NATURAL SINES.

Degree.	0′	10′	20′	30′	40′	50′
45	.7071	.7092	.7112	.7133	.7153	.7173
46	.7193	.7214	.7234	.7254	.7274	.7294
47	.7314	.7333	.7353	.7373	.7392	.7412
48	.7431	.7451	.7470	.7490	.7509	.7528
49	.7547	.7566	.7585	.7604	.7623	.7642
50	.7660	.7679	.7698	.7716	.7735	.7753
51	.7771	.7790	.7808	.7826	.7844	.7862
52	.7880	.7898	.7916	.7934	.7951	.7969
53	.7986	.8004	.8021	.8039	.8056	.8073
54	.8090	.8107	.8124	.8141	.8158	.8175
55	.8192	.8208	.8225	.8241	.8258	.8274
56	.8290	.8307	.8323	.8339	.8355	.8371
57	.8387	.8403	.8418	.8434	.8450	.8465
58	.8480	.8496	.8511	.8526	.8542	.8557
59	.8572	.8587	.8601	.8616	.8631	.8646
60	.8660	.8675	.8689	.8704	.8718	.8732
61	.8746	.8760	.8774	.8788	.8802	.8816
62	.8829	.8843	.8857	.8870	.8884	.8897
63	.8910	.8923	.8936	.8949	.8962	.8975
64	.8988	.9001	.9013	.9026	.9038	.9051
65	.9063	.9075	.9088	.9100	.9112	.9124
66	.9135	.9147	.9159	.9171	.9182	.9194
67	.9205	.9216	.9228	.9239	.9250	.9262
68	.9272	.9283	.9293	.9304	.9315	.0325
69	.9336	.9346	.9356	.9367	.9377	.9387
70	.9397	.9407	.9417	.9426	.9436	.9446
71	.9455	.9465	.9474	.9483	.9492	.9502
72	.9511	.9520	.9528	.9537	.9546	.9555
73	.9563	.9572	.9580	.9588	.9596	.9605
74	.9613	.9621	.9628	.9636	.9644	.9652
75	.9659	.9667	.9674	.9681	.9689	.9696
76	.9703	.9710	.9717	.9724	.9730	.9737
77	.9744	.9750	.9757	.9763	.9769	.9775
78	.9781	.9787	.9793	.9799	.9805	.9811
79	.9816	.9822	.9827	9833	9838	.9843
80	.9848	.9853	.9858	.9863	.9868	.9872
81	.9877	.9881	.9886	.9890	.9894	.9899
82	9903	.9907	.9911	9914	.9918	.9922
83	.9925	.9929	.9932	.9936	.9939	.9942
84	.9945	.9948	.9951	.9954	.9957	.9959
85	.9962	.9964	.9967	.9969	.9971	.9974
86	.9976	.9978	.9980	.9981	.9983	.9985
87	.9986	.9988	.9989	.9990	.9992	.9993
88	.9994	.9995	9996	.9997	.9997	.9998
89	.9998	.9999	.9999	.9999	1.0000	1.0000

PELTON WATER WHEEL TABLES.

The calculations for power in these tables are based upon the application of one stream to the wheel, as also upon an 85 per cent. efficiency and effective heads, no allowance being made for loss of head by friction in pipe. The smaller figures under those denoting the various heads give the spouting velocity of the water in feet per minute. The cubic feet measurement is also based on the flow per minute.

Head in Feet.	Size of Wheels.	No. 1. 6 in.	No. 2. 12 in.	No. 3. 18 in.	No. 4. 18 in.	No. 5. 24 in.	3 Foot.	4 Foot.	5 Foot.	6 Foot.
80	Horse Power	.43	1.00	1.70	3.01	5.36	12.04	21.44	33.54	48.16
	Cubic Feet	3.35	7.82	13.25	23.46	41.66	93.84	166.64	260.73	375.36
4303.99	Miner's Inches	2.09	4.88	8.28	15.64	27.77	62.56	111.08	173.82	250.24
	Revolutions	1368	684	456	456	342	228	171	137	114
90	Horse Power	.51	1.20	2.03	3.60	6.39	14.40	25.59	40.04	57.60
	Cubic Feet	3.55	8.29	14.05	24.88	44.19	99.52	176.75	276.55	398.08
4565.04	Miner's Inches	2.22	5.18	8.78	16.58	29.46	66.32	117.83	184.36	265.28
	Revolutions	1452	726	484	484	363	242	181	145	121
100	Horse Power	.60	1.40	2.32	4.21	7.49	16.84	29.93	46.85	67.36
	Cubic Feet	3.74	8.74	14.81	26.22	46.58	104.88	186.32	291.51	419.52
4812.00	Miner's Inches	2.33	5.46	9.25	17.48	31.05	69.93	124.21	194.34	279.72
	Revolutions	1530	765	510	510	382	255	191	152	127
110	Horse Power	.69	1.62	2.74	4.86	8.64	19.44	34.58	54.11	77.76
	Cubic Feet	3.92	9.16	15.53	27.50	48.85	110.00	195.41	305.73	440.00
5046.87	Miner's Inches	2.45	5.72	9.70	18.33	32.56	73.33	130.27	203.82	293.32
	Revolutions	1605	802	535	535	401	267	200	160	133
120	Horse Power	.79	1.84	3.12	5.54	9.85	22.18	39.41	61.66	88.75
	Cubic Feet	4.10	9.57	16.21	28.72	51.02	114.91	204.10	319.33	459.64
5271.30	Miner's Inches	2.56	5.98	10.13	19.15	34.01	76.60	136.06	212.89	306.43
	Revolutions	1677	838	559	559	419	279	209	167	139

PELTON WATER WHEEL TABLES.

(CONTINUED.)

Head in Feet.	Size of Wheels.	No. 1. 6 in.	No. 2. 12 in.	No. 3. 18 in.	No. 4. 18 in.	No. 5. 24 in.	3 Foot.	4 Foot.	5 Foot.	6 Foot.
250	Horse Power	2.38	5.56	9.42	16.68	29 63	66.74	118.54	185.47	266.96
	Cubic Feet	5.92	13.82	23.42	41.46	73.64	165.86	294.59	460.91	663.45
7608.44	Miner's Inches	3.70	8.63	14.63	27.64	49.09	110.57	196.39	307.27	442.30
	Revolutions	2418	1209	806	806	605	403	302	241	202
260	Horse Power	2.52	5.89	10.05	17.69	31.43	70.78	125.72	196.71	283.15
	Cubic Feet	6.04	14.09	23.88	42.28	75.10	169.14	300.43	470.04	676.59
7759.10	Miner's Inches	3.77	8 80	14.92	28.19	50.06	112.76	200.28	313.36	451.05
	Revolutions	2466	1233	822	822	617	411	308	247	206
270	Horse Power	2.67	6.24	10.67	18.72	33.26	74.90	133.05	208.17	299.63
	Cubic Feet	6.15	14.36	24.34	43.09	76.53	172.36	306.15	479.00	689.46
7906.93	Miner's Inches	3.84	8.97	15.21	28.72	51.02	114.91	204.10	319.33	459.64
	Revolutions	2514	1257	838	838	628	419	314	251	209
280	Horse Power	2.82	6.59	11.16	19.77	35.12	79.11	140.51	219.84	316.44
	Cubic Feet	6.26	14.62	24.79	43.88	77.94	175.53	311.77	487.79	702.12
8052.01	Miner's Inches	3.91	9.13	15.49	29.25	51.29	117.02	205.18	325.19	468.06
	Revolutions	2562	1281	854	854	639	427	319	255	213
290	Horse Power	2.97	6.94	11.77	20 84	37.02	83.38	148.10	231.73	333.55
	Cubic Feet	6.38	14.88	25.23	44.66	79.32	178.64	317.29	496.42	714.56
8194.54	Miner's Inches	3.98	9.30	15.76	29.77	52.88	119.09	211.52	330.94	476.36
	Revolutions	2607	1303	869	869	651	434	325	260	217
300	Horse Power	3.13	7.31	12.38	21.93	38.95	87.73	155.83	243.82	350 94
	Cubic Feet	6.48	15.13	25.66	45.42	80.67	181.69	322.71	504.91	726.76
8334.62	Miner's Inches	4.05	9.45	16.03	30.28	53 78	121.12	215.14	336.60	484.51
	Revolutions	2652	1326	884	884	663	442	331	265	221

PELTON WATER WHEEL TABLES.

(CONTINUED.)

Head in Feet.	SIZE OF WHEELS.	No. 1. 6 in.	No. 2. 12 in.	No. 3. 18 in.	No. 4. 18 in.	No. 5. 24 in.	3 Foot.	4 Foot.	5 Foot.	6 Foot.
130	Horse Power	.89	2.08	3.53	6.25	11.11	25.02	44.46	69.53	100.08
	Cubic Feet	4.27	9.96	16.89	29.90	53.10	119.60	212.43	332.37	478.41
5486.54	Miner's Inches	2.66	6.22	10.55	19.93	35.40	79.73	141.62	221.58	318.94
	Revolutions	1746	873	582	582	436	291	218	174	145
140	Horse Power	.99	2.33	3.94	6.99	12.41	27.96	49.64	77.71	111.85
	Cubic Feet	4.43	10.34	17.53	31.03	55.11	124.12	220.44	344.92	496.48
5693.65	Miner's Inches	2.76	6.46	10.95	20.68	36.74	82.72	146.96	229.94	330.88
	Revolutions	1812	906	604	604	453	302	226	181	151
150	Horse Power	1.10	2.58	4.37	7.75	13.77	31.01	55.08	86.22	124.04
	Cubic Feet	4.55	10.70	18.14	32.11	57.04	128.47	228.19	357.02	513.90
5893.44	Miner's Inches	2.84	6.68	11.33	21.41	38.03	85.64	152.12	238.05	342.59
	Revolutions	1875	937	625	625	468	312	234	187	156
160	Horse Power	1.22	2.84	4.82	8.54	15.17	34.16	60.68	94.94	136.65
	Cubic Feet	4.73	11.05	18.74	33.17	58.92	132.68	235.68	368.73	530.75
6086.74	Miner's Inches	2.95	6.90	11.71	22.11	39.28	88.46	157.12	245.82	353.84
	Revolutions	1938	969	646	646	434	323	242	193	161
170	Horse Power	1.33	3.11	5.28	9.35	16.61	37.42	66.46	103.99	149.68
	Cubic Feet	4.88	11.39	19.31	34.19	60.73	136.77	242.93	380.08	547.08
6274.07	Miner's Inches	3.05	7.11	12.06	22.79	40.48	91.18	161.95	253.38	364.72
	Revolutions	1995	997	665	665	498	332	249	199	166
180	Horse Power	1.45	3.39	5.75	10.19	18.10	40 77	72.41	113.30	163.08
	Cubic Feet	5.02	11.72	19.87	35.18	62.49	140.74	249.97	391.10	562.96
6455.97	Miner's Inches	3.13	7.32	12.41	23.45	41 66	93.82	166.64	260 73	375.29
	Revolutions	2049	1024	683	683	513	342	256	206	171

PELTON WATER WHEEL TABLES.

(CONTINUED.)

Head in Feet.	SIZE OF WHEELS.	No. 1. 6 in.	No. 2. 12 in.	No. 3. 18 in.	No. 4. 18 in.	No. 5. 24 in.	3 Foot.	4 Foot.	5 Foot.	6 Foot.
	Horse Power	1.57	3.68	6.24	11.05	9.63	44.21	78.53	122.87	176.86
190	Cubic Feet	5.16	12.04	20.41	36.14	64.20	144.59	256.82	401.81	578.38
6632.86	Miner's Inches	3.22	7.52	12.75	24.09	42.80	96.39	171.21	267.87	385.58
	Revolutions	2106	1053	702	702	527	351	263	211	176
	Horse Power	1.70	3.97	6.74	11.93	21.20	47.75	84.81	132.70	191.00
200	Cubic Feet	5.29	12.36	20.94	37.08	65.87	148.35	263.49	412.25	593.40
6805.17	Miner's Inches	3.30	7.72	13.08	24.72	43.91	98.90	175.66	274.83	395.60
	Revolutions	2160	1080	720	720	540	360	270	216	180
	Horse Power	1.83	4.28	7.25	12.84	22.81	51.38	91.26	142.78	205.52
210	Cubic Feet	5.42	12.66	21.46	38.00	67.50	152.01	270.00	422.44	608.06
6973.26	Miner's Inches	3.38	7.91	13.41	25.33	45.00	101.34	180.00	281.62	405.37
	Revolutions	2214	1107	738	738	553	369	277	222	184
	Horse Power	1.96	4.59	7.77	13.77	24.46	55.09	97.85	153.10	220.36
220	Cubic Feet	5.55	12.96	21.96	38.89	69.08	155.59	276.35	432.38	622.36
7137.35	Miner's Inches	3.46	8.10	13 72	25.93	46.05	103.72	184.23	288.25	414.91
	Revolutions	2268	1134		756	567	378	283	226	189
	Horse Power	2.10	4.90	8.31	14.72	26.15	58.89	104.60	163.66	235.56
230	Cubic Feet	5.68	13.25	22.46	39.77	70.64	159.08	282.56	442.09	636 35
7297.78	Miner's Inches	3.55	8.28	14.03	26.51	47.09	106.06	188.38	294.73	424.24
	Revolutions	2319	1159	773	773	580	386	290	232	193
	Horse Power	2.24	5.23	8.86	15.69	27.87	62.77	111.50	174.45	251.10
240	Cubic Feet	5.80	13.54	22.93	40.62	72.16	162.50	288.64	451.60	650.03
7454.70	Miner's Inches	3.62	8.46	14.33	27.08	48.10	108.34	192.42	301.07	433.36
	Revolutions	2370	1185	790	790	592	395	296	237	197

MINING LAWS.

The Legislature of 1897 enacted more mining laws than any previous legislative body in the State.

Through the exertions of the Legislative Committee of the Miner's Association, of which Tirey L. Ford is chairman, and also the good work done by Joseph H. Neff, President; Samuel Thornton, Vice President, and Julian Sonntag, Secretary of the Association, backed by Assemblyman Howard of Sierra, who held the proud position of Chairman of the Assembly Committee on Mines and Mining, and who was the principal factor in obtaining favorable mining legislation, Senators Presk of Nevada, Boyce of Santa Barbara, Chapman of El Dorado, Gleaves of Shasta, Shine of Tuolumne, Smith of Kern and Voorhies of Amador counties, and Assemblymen Caminetti of Amador, Power of Placer, Robinson of Nevada, Burnham of El Dorado and Fontana of Calaveras counties, more legislative enactments of a practical character were pushed through to the Governor, who signed them willingly, than at any other period in the history of the State.

Among the many measures which were introduced and finally passed were the following:

First; All legal impediments were removed from the appropriation of $250,000, which was allowed by the State for the impounding of debris, thus making available for that object $500,000, as the General Government had already appropriated a like amount pending the action of the State Legislature.

Second; An act providing for the manner of locating and recording mining claims.

And it is a remarkable fact that though California was the first State to make large and wonderful discoveries of gold, it was the last to enact laws regulating, locating and recording of mineral claims. Every other mining State and Territory passed laws to cover these important points as soon as the conditions presented themselves; but the Golden State—the State replete with the history of Argonauts and mushroom millionaires—the mecca of prospectors for the past quarter of a century; neglected to protect her miners by wholesome laws until this late day. The follow-is a copy of Assembly Bill, No. 551.

SECTION 1. The location of mining claims upon the public domain of the United States shall be made and perfected as provided in this Act.

SEC. 2. The discoverer of any vein or lode shall immediately, upon making discovery, erect at the point of discovery a substantial monument, or mound of rocks, and post thereon a preliminary notice which shall contain:

First—The name of the lode or claim;

Second—The name of the locator or locators;

Third—The date of the discovery;

Fourth—The number of linear feet claimed in length along the course of the vein each way from the point of discovery;

Fifth—The width claimed on each side of the center of the vein;

Sixth—The general course of the vein or lode, as near as may be;

Seventh— That such notice is a first or preliminary notice.

Such notice shall be recorded in the office of the County Recorder of the county in which the same is posted within twenty days after the posting thereof. Upon the erection of said monument and posting such notice, the discoverer shall be allowed the period of time specified in section three of this Act to enable him to perfect his location as hereinafter provided.

SEC. 3. Within sixty days from the date of the discovery of the vein or lode, the discoverer must perform fifty dollars' worth of labor in developing his discovery, and distinctly mark his location on the ground so that its boundaries can be readily traced, and must file in the office of the County Recorder of the county in which the claim is situated, a certificate of location, which said certificate shall state:

1. The name of the lode or claim;

2. The name of the locator or locators;

3. The date of discovery and posting of the notice, provided for in section two of this Act, which shall be considered as the date of the location.

4. A description of the claim, defining the exterior boundaries as they are marked upon the ground, and such additional description by reference to some natural objects, or permanent monument, as will identify the claim.

5. A statement that such certificate is the final or completed notice of location, and that he has performed the aforesaid fifty dollars' worth of labor in development work thereon within the aforesaid sixty day period, stating generally the nature thereof. Said certificate shall be dated and signed by or on behalf of the locator or locators, and verified by them or by some one in their behalf, and when filed for record shall be deemed and considered as prima facie evidence of the facts therein recited. A copy of such certificiate of location, certified by the County Recorder, shall be admitted in evidence in all

actions or proceedings with the same effect as the original. The performance of such labor shall be deemed a necessary act in completing such location and a part thereof, and no part thereof shall inure to the benefit of any subsequent location.

SEC. 4. The discoverer of placers or other forms of deposit, subject to location and appropriation, under mining laws applicable to placers, shall locate his claim in the following manner:

First—He must immediately post in a conspicuous place at the point of discovery thereon a notice or certificate of location thereof containing:

(a) The name of the claim.

(b) The name of the locator or locators.

(c) The date of the discovery and posting of the notice, hereinbefore provided for, which shall be considered as the date of the location.

(d) A description of the claim by reference to legal subdivisions of sections, if the location is made in conformity with the public surveys; otherwise, a description with reference to some natural object or permanent monument as will identify the claim, and where such claim is located by legal subdivisions of the public surveys, such location shall, notwithstanding that fact, be marked by the locator upon the ground, the same as other locations.

Second—Within thirty days from the date of such discovery he must record such notice or certificate of location in the office of the County Recorder of the county in which such discovery is made, and so distinctly mark his location on the ground that its boundaries can be readily traced.

Third—Within sixty days from the date of the discovery the discoverer shall perform labor upon such location or claim in developing thereto an amount which shall be equivalent in the aggregate to at least ten dollars' ($10) worth of such labor for each twenty acres, or fractional part thereof, contained in such location or claim.

A failure to perform such labor within said time, shall cause all rights under such location to be forfeited and the land discovered thereby shall at once be open to location by qualified locators other than the proceeding locators, but shall not in any event be open to location by such proceeding locators, and any labor performed by them thereon shall not inure to the benefit of any subsequent locator thereof.

Fifth—Such locator shall, upon the performance of such labor, file with the Recorder of the county an affidavit, showing such performance, and generally the nature and kind of work so done.

SEC. 5. The affidavit provided for in the last section, and the aforesaid placer notice or certificate of location when filed for record, shall be deemed and considered as prima facie evidence of the facts therein recited. A copy of such certificate, notice or affidavit, certified by the County Recorder, shall be admitted in evidence in all actions or proceedings with the same effect as the original.

SEC. 6. All locations of quartz or placer formations of deposits, hereafter made, which do not conform to the requirements of this Act, in so far as the same are respectively applicable thereto, shall be void.

SEC. 7. No record of a mining claim or mill site, made after the passage of this Act, in the records of any mining district, shall be valid. All notices of location of mining claims, mill sites, and other notices, heretofore recorded in such district records, if such notices conform to the local rules and regulations in force in such district, are hereby declared valid. Within thirty days after the passage of this Act the district recorder or custodian of the records of the several mining districts in this State, shall transmit to the County Recorders of the respective counties, wherein the respective districts are situated, all the records of said respective districts, and thenceforward such County Recorder shall be deemed and considered the legal custodian of such records. Thereafter copies of such records, certified by the County Recorder, may be received in evidence with the same effect as the originals.

SEC. 8. This Act shall take effect and be in force sixty days after its passage.

Third; The act of 1880, which provided a penalty of $1,000 for failure of any mining company to post monthly accounts in its office, was amended so as to allow any stockholder to sue for any ACTUAL damage sustained by a neglect to post such notice. The old law worked a hardship on the small companies, located perhaps miles from any town, in mountainous districts, where it would be sometimes difficult to post such monthly statements. With the exception of the right to sue for actual damages instead of the $1,000 specified in the old statute, the law is still in force.

Fourth; By a law enacted by the recent Legislature it requires the consent of the majority of the stock, instead of two thirds of the stock as heretofore, before any transfer of real estate can be made by any mining company, and a record of such consent must be filed in the County Recorder's office.

Fifth; Where titles are given to town site locators through the Superior Judge of the district, preferance will in all cases be given to mining locators.

All these are good measures, and the Miners' Association may well be proud of its work.

GLOSSARY.

AIR FURNACE, A fireplace at the surface for drawing out foul air from shafts or levels by its natural draught from combustion.

ALUMINA, Oxidized aluminum extracted from clays, creolite, kaolin, bauxite, and what is generally known as chalk rock, or aluminite.

ANGLES, DIPS and SPURS, The side extent which can be claimed upon a mineral vein is expressed by these phrases.

ANHYDROUS, Waterless, as salts or minerals.

ANTIMONY, A mineral, symbol Sb. Atomic weight, 129.

AQUEOUS, A water solution.

ARBORESCENT, A tree-like formation of minerals.

ARGOL, Crude tartar. An acid salt deposited from wine.

ARSENATE, Arsenic acid united with a base.

ARSENIRET or ARSENIDE, Arsenic in chemical combination with some base, as arsenide of iron, sulphur or bismuth.

BASALT, An effusive rock composed mostly of pyroxene, olivine and silica.

BISMUTH, A metal. Symbol Bi. Atomic weight 213.

BLACK JACK, Sulphuret of zinc.

BOYER, The name of a common rock drill.

BREAST or BREASTING, The standing end of rock, vein or cliff of gravel immediately before taking down and blasting is called breasting.

BRECCIA, Cemented rock composed of angular fragments of one or more minerals which generally exhibit different colors.

CALCINE, To burn off and volatize.

CALCIUM, The metalic base of lime.

CALC SPAR, A pure crystalized or borate of soda and carbonate of lime, sometimes combined with the matrix in vein matter.

CAP ROCK, The uncertain upper rock which covers the older bedrock.

CARBONATE, Carbonic acid combined with a base as carbonate of lead.

CARBONATE OF SODA, Carbonic acid and oxide of sodium chemically combined.

CARBONIFEROUS, As carboniferous slate or shale, containing a little carbon, indicative of underlying coal seams.

COUNTER LODE, A vein obliquely crossing the regular veins of the district.

CELLULAR, When a stone or mineral has many small cavities, sponge-like.

CHLORIDE, Chlorine chemically united with some base, as chloride of sodium (common salt), especially found in manganese which when dissolved in muriatic acid gives off the fumes of chlorine gas.

CLAY, Chiefly composed of alumina in a moist and putty-like or dry, pulverized condition, often found between the vein matter and the footwall rock as gouge.

CLAY COURSE, Mostly applied to a common clay seam or gouge on the side of a vein.

CLEAVAGE, The planes at which cleavable stones break.

COBALT, A magnetic metal, Atomic weight, 29.5.

COHERENT, Firmly held together, not friable.

COMPACT, When a stone is all alike, not cleavable.

CONCHOIDAL, Fracturing to an irregular shaped surface like flint; brick or sand rock without any sign of plane or cleavage.

CONGLOMORATE, A pudding stone or cementation of rocks, pebbles and sand.

CUPEL, A moulded cup of bone ash for cupelling lead from the assay, leaving the gold and silver in the form of a bead.

CUPRIFEROUS, Containing copper, as copper ores.

DECOMPOSED, That which has undergone artificial or natural change, as the desulphurization and oxidation of the sulphurets and other metals.

DENDRITIC or ARBORESCENT, Shaped or crystalized like trees.

DETRITUS, Finely powdered deposits worn from hard substances.

DIKE, A large zone or vein-like formation but composed of bed rock or country rock instead of quartz.

FAULT, A cut-off or shift of a vein or seam.

FERRUGINOUS, Iron, iron oxide, containing iron.

FISSURE, An extensive crack or chasm in a somewhat regular plane of fracture, as a true fissure vein.

FLOAT STONES, Sometimes called shoal rock, mineralized rock lying upon the surface or near vein deposits. It sometimes directs the prospector to the vein or lode from which it came.

FLUX, Any substance that is favorable to combustion, oxidixation or reduction by fire.

FOLIATED, Lamillar or leaf-like in form, which can be cleaved.

FOX WEDGE, Wedged at two points. We find gash veins fox wedged.

FRACTURE, Applied to qualify the broken surfaces of minerals, as even or uneven fracture.

FRANGIBLE, Not tough, easily broken. brittle.

GANGUE, Waste, all kinds of enclosing waste rock, the matrix of quartz, etc., but gangues may not all be matrixes.

GLANCE, Sometimes applied to glancing or shining mineral, as copper glance, lead glance, silver glance.

GLOBULAR CONCRETIONS, Minerals occurring in small, rounded forms.

GOSSAN, Very rusty and finely powdered quartz. It is thought to be one of the best indications for minerals in deep sections of the vein.

GOUGE, Soft clay seam between the vein matter and the walls.

GRAMME, Equal to 15,433 grains Troy.

GRANULAR, Minerals exhibiting small grains across the plane of the fracture.

GRAPHITE, A mineral carbon.

GREENSTONE, A green colored, granular stone, a kind of trap, composed of hornblende and feldspar.

HORN SILVER, The common name for chloride silver because it has a horn-like surface.

HORSE, A long, convex-sided portion of a foreign rock completely inclosed in the quartz or vein matter.

HYDRAULIC CEMENT, A mixture of lime, magnesia, alum and silica so that it solidifies under water.

INCRUSTED, When a surface is covered with some other deposit.

INTERLACING, When the threads or ribbons of one mineral cross those of another.

INTERSTRATIFIED, Lying between other stratifications, as a layer of greenstone between other layers of slate.

LAVA, Igneous rock that has been melted, forced up or thrown out from volcanoes.

MATTE, The product of the first incomplete reduction of an ore, as copper matte.

MICA, A thin, scale-like mineral of the true granite.

OXIDE, A chemical combination of oxygen with a base.

OXYGEN, A gas we extract from the air in breathing; it also forms with many acids; one-half the weight of solid bedrock. When united with hydrogen it is water.

PALEOZOIC, Applied to the first rocks with fossil animals and to the older divisions of geologic time. It includes the silurian, devonian and carboniferous ages.

PLATINUM, A grayish-white metal infusible by ordinary means, insoluble in any single acid. It dissolves in a mixture of nitric acid one part, hydrochloric acid three parts.

SCHIST or SCHISTOSE, A crystaline or metamorphic rock having a slaty structure, as mica schist, argillaceous schist, etc.

SECTILE, Minerals which are sufficiently tough to cut smoothly without crumbling.

SERPENTINE, Composed of the mineral serpentine, feldspar, and pyroxene.