feature adverse to efficient gold saving on flume dredges is the excessive amount of water generally required to carry heavy material through the flume. The resulting high velocity or deep flow of material does not permit the lighter gold to sink and be caught in the riffles.

RIFFLES

The flumes of these dredges are paved with rail riffles, usually set lengthwise. It would be better practice if some of the rails could be set transversely, particularly in the upper part of the flume, especially if clay is present or the gravel is flat. Material will roll over transverse riffles and be better disintegrated than when it passes over longitudinal riffles, where it tends to slide more than roll. On screen-flume dredges this practice is generally followed, and manganese or cast-iron grate riffles may be used alone or with rails. On the table-stacker dredges standard steel-shod wooden riffles and angle-iron riffles are mostly used. The grades of the main tables average 1 to 1½ inches to the foot.

UNDERCURRENTS

Some flume dredges are provided with undercurrents, and a closely spaced bar or plate grizzly with small openings is installed in the bottom of the flume near its lower end. The material passing through this grizzly is conducted over short tables or sluices paved with screen, expanded metal, or punched plate laid over cocoa matting or burlap; small special transverse riffles and sometimes an amalgamation plate may be used in conjunction. The practical use of these undercurrents is governed by their construction and operation, the character of the deposit, and the character and size of the gold.

One flume dredge, formerly operated in the Council district, reported that 20 per cent of the gold was recovered by the undercurrent. The saving is usually less, and in some dredges the undercurrents have been discarded because of the low recovery. On the Northern Light flume dredge a test made during one clean-up showed that 82.54 per cent of the gold recovered was saved in the upper 25 feet of the flume, 10.93 per cent in the next 30 feet, 3.73 per cent by the undercurrent, and 2.8 per cent in the tail sluice beyond the undercurrent grizzly. This tail sluice was paved with punched screen, ⅝-inch holes, laid over burlap.

SCREENS

Dredges provided with screens not only have the advantage of better washing and disintegration of the material, but by shutting out the heavier stones improve conditions for saving gold. Stiff, sticky clay is always a bugbear to efficient gold saving because of its difficult disintegration and its sluice-robbing propensities. The best means of treating such material is to retain it in the revolving screen until thoroughly disintegrated. The material is rolled over and retarded by bars and rings fitted to the screen and is further retarded and broken up by high-pressure jets from nozzles set at the lower end of the screen. Additional jets may play downward on the material from nozzles projecting from a pipe extending lengthwise through the screen. The action is somewhat similar to that of wet grinding in a ball mill, as the clay is worked over by the gravel until it will pass through the perforations.

If nugget gold is present, the holes in the lower part of the screen are enlarged, and the material passing through them goes to a separate sluice. The nugget sluice on some dredges yields 5 to 25 per cent of the total gold recovered.

SAVE-ALLS AND OTHER APPLIANCES

Save-alls have in virtually every instance more than repaid for their installation and care. All dredges spill more or less material from the buckets, and the gold therein is lost unless a save-all is provided. Many dredges report a saving of $2,500 to $5,000 by the save-all during a working season.

A number of the table-stacker dredges were originally equipped with jigs or other special appliances for recovering fine gold and concentrate, particularly where such gold was coated with iron oxide or other compounds and could not be amalgamated. All of these, except the undercurrents mentioned, have been discarded.

MERCURY

Mercury is not required for saving coarse gold, and rusty or coated gold will not amalgamate. Where fine clean gold is present, the use of mercury in the riffles and undercurrent is essential. It has a strong affinity for clean gold, and the amalgam formed is more readily retained by the riffles and is easier to handle in cleaning up the sluices. Virtually all of the dredges (except small flume dredges where gold is coarse) and many of the larger properties mined by other methods practice amalgamation. There are many other mines, particularly in the interior, where it should be used, as there is generally some fine clean gold present that could be saved by mercury. Many miners, however, want their gold in dust, or wish to avoid the small additional trouble of retorting the amalgam and handling the product.

After a sluice has been used long enough to stop leaks and fill depressions with material the flow is shut off. Then the upper boxes

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is properly handled and the
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ut down to the proper volume,

Most of the gold recovered by Alaska dredges is recovered in the upper 25 feet of flume, or directly under the screens, or before it reaches the lower half of the tables.

The time of clean-up on dredges varies with the condition of the riffles. Some dredges clean up once a week and others once a month, when usually only the upper half of the flume or the main parts of the tables are cleaned up. The lower sluices are seldom cleaned up until the end of the season. Many dredge operators state that only a few dollars' worth of gold are recovered from the last 5 feet of flume or riffled sluice and feel satisfied that very little gold is being lost. No figures as to the amount of gold lost in tailing are available, but numerous colors of fine gold can often be panned from the washed tailing and both coarse and fine gold from the unwashed clayey material. The regular clean-up takes from a few hours to a shift; advantage is taken of the shutdown to adjust the engines and make minor repairs. One dredge is so arranged that all of the feed can be diverted to one set of tables while the opposite set is being cleaned. However, the possibility of overloading the tables and the difficulty of attending to repairs might outweigh the saving in time.

RECOVERY OF GOLD AND PREPARATION FOR MARKET

CLEANING GOLD DUST OR AMALGAM

The gold dust or amalgam is mixed with more or less sand, scrap iron, and other materials. The larger pieces of foreign material

CLEANING HEAVY SANDS

The heavy material from the sluices and from cleaning the gold dust and the amalgam may contain other metals or minerals besides gold and amalgam, including native copper, silver, platinum, iridosmine, monazite, pyrite, marcasite, hematite, chromite, galena, cinnabar, cassiterite, wolframite, scheelite, barite, and stibnite. In addition, magnetite, ilmenite, rutile, garnet, zircon, tourmaline, and other rock-forming minerals may be present. The specific gravity of some of these minerals is almost as high as that of gold, so that separation by water with ordinary methods is difficult. Where any valuable mineral is present in commercial quantities, the larger bits are usually picked out by hand or roughly concentrated by water. Some of these minerals have been a valuable by-product of gold placer mining; cassiterite has been the main product of several dredges.

Platinum will not amalgamate and when present will be closely mixed with the gold. Although it is as heavy as gold, thin flakes float easily on running water and may not settle with the gold. The black sands from the sluices and from the cleaning of the amalgam should, therefore, be carefully panned. Any platinum spilling over settles to the bottom of the tub and can be panned out later. The gold and the platinum particles are dried; then the platinum can be separated by the blowing process.

At some California gold dredges the platinum is recovered from the tables with the amalgam and the black sands. When the amalgam is cleaned, the platinum separates and sinks to the bottom of the soft amalgam, which is then cleaned by careful panning or blowing, and the sands are passed repeatedly over special pocket or auger-hole riffles and carpet or cocoa matting surfaces.

At some Alaska mines all the heavy sands are panned, rocked, or put over special small sluices. Some fine rusty or coated gold or amalgam ordinarily remains in the sands. It is customary to stir the sands in a tub or vat with cyanide or to put them in a clean-up barrel, add cyanide, lye, or wood ashes, rotate the barrel to brighten the gold, and amalgamate the gold in the barrel. This treatment takes 20 minutes to several hours, after which the sands are panned or passed over special riffles or amalgamated plates. Even then the sands may still contain gold.

All placer concentrates should be analyzed and assayed, for they very often contain large quantities of gold or other valuable minerals or metals that can not be recovered by ordinary methods but may justify their shipment to a smelter.

USE OF CYANIDE

Cyanide is often very carelessly used and when used in solutions of certain strengths will dissolve much gold.

Maclaurin[a] states that the solubility of gold in potassium cyanide is maximum at 0.25 per cent strength, is very slight in solutions containing less than 0.005 per cent, and at 0.01 per cent is 10 times as great as in the 0.005 per cent solution and about one-half as great as in the 0.25 per cent solution. A safe means of using it is to make up a stock solution of 1 ounce of 98 per cent potassium cyanide to ½ gallon of water and then use 4 ounces or about one-half teacup of this solution to 10 gallons of water.

One operator in the interior puts his sands, which are mainly garnet and magnetite, into a tub or box, adds cyanide and mercury, and stirs the mixture for one hour. Then about 80 per cent of the gold is recovered on amalgamation plates; next the sands are heated, dilute sulphuric acid (about 10 per cent strength) is added, and the sands are further heated. They are then treated as before, and virtually all the gold is recovered.

RETORTING AMALGAM

The cleaned amalgam is broken and packed loosely into a pot retort coated inside with clay, chalk, or paper. The retort should not be more than three-quarters full. The cover is provided with an asbestos gasket or luted with clay to assure a tight fit and keyed down. The retort is then placed on its stand and heated by wood, coal, or gasoline. The heat should be raised very gradually, as volatilization of the mercury should not start for about one hour. The mercury fumes are condensed in an iron pipe leading from the top of the retort and fitted with a condenser through which water runs continuously. The mercury is recovered in a vessel containing water. If no condenser is provided, the pipe should be covered with gunny sacking kept thoroughly wet. The retort should be kept at dark-red heat until nearly the end, when the heat is raised to cherry red. This heat is maintained for 15 minutes or so after the last of the mercury has been driven off. The pipe is usually tapped with a hammer to determine whether volatilization is complete.

PRECAUTIONS

The retort is allowed to cool gradually and should not be opened until cold. Care must be taken to do all retorting in a well-ventilated place, with the outlet of the retort kept outdoors, for mercury fumes

[a] Maclaurin, J., "The dissolution of gold in a solution of potassium cyanide"; Jour. Chem. Soc. (London), vol. 63, 1893, pp. 724–738; vol. 67, 1895, p. 199.

are very poisonous. The lower end of the retort pipe should not be under water, for a fall in the temperature might create a vacuum, thus drawing water into the retort and causing an explosion. It is safer to hang a piece of sacking over the end and keep it soaking wet.

The small balls of amalgam obtained by the lone miner are often placed on a shovel and held over a fire to drive off the mercury. This should only be done outdoors, and the miner should keep from the fumes.

MELTING RETORT SPONGE INTO BULLION

The retort gold from clean amalgam should be spongy, readily broken up, and a clean golden color. Incompletely retorted amalgam will be light to dark gray, due to the mercury still present. Too high a heat will cause formation of a tough dense mass. Sulphur, arsenic, and other compounds will blacken or otherwise discolor the sponge.

Retort sponge is often shipped to the banks for melting. The larger producers, particularly those in isolated districts, melt it into bullion for safe and easy shipment. A gasoline bullion-furnace is usually used for melting the gold. A graphite crucible is gradually heated and tested, and borax glass is added for flux and melted down. The gold is then added, and as it melts more may be added; the crucible should, however, not be too heavily loaded. The borax glass unites with any iron present and goes into the slag. If much iron pyrite is present, some metallic iron may be added to unite with the sulphur, forming iron sulphide, which comes off with the slag. If much silica is present, soda is added, usually in the proportion of one part of soda to two parts of borax glass. Toward the end of the melt the slag is skimmed off with an iron rod and more borax glass may be added.

When the melt is completed, the crucible is lifted from the furnace and the gold is stirred with a graphite rod and poured into heated bullion molds which have been previously coated by holding them over oil smoke or rubbing with lard oil. The molds should not be too hot but should be hot enough to ignite oil when it is applied to them. The bullion bricks are then plunged into cold water to loosen the slag, or into a pickling bath of one part of nitric acid to three parts of water, which will remove any stain. The bricks are then cleaned with a hammer and a steel slag brush, stamped, weighed, and made ready for shipment.

ASSAYING AND SHIPMENT OF PLACER GOLD

The fineness of Alaska placer gold normally ranges from about $14 to $19 per ounce. While several "runs" of gold on the same creek may differ in fineness and other characteristics, the gold from any

particular creek or deposit can usually be easily identified by an expert. The difference in fineness is due mainly to silver alloyed with the gold. Some copper, lead, or other metals may be present. The copper and silver content may be further increased where native copper and silver are present and are not removed in cleaning the dust, as both will amalgamate. Where base material is present, closer assay checks and better settlements will be obtained if the product is divided into clean gold and base bullion.

Some of the highest-grade placer gold has come from the Koyukuk district (fig. 1, *13* and *14*), where gold of 978.5 fineness, or $20.23 per ounce, was found on Fay Creek, and gold of 973.4 fineness, or $20.12 per ounce, on Swift Creek. Some nuggets found on Little Minook Creek in the Rampart district (fig. 1, *31*) were said to assay $20.42 per ounce. Gold dust from Little Moose Creek in the Kantishna district (fig. 1, *27*) assayed only 550 fineness, or $11.37 per ounce, on account of native silver present. On Tenderfoot Creek in the Richardson district (fig. 1, *36*) the gold has a fineness of 640 at the upper end, while at the lower end the fineness is 720. This wide difference may be due to the gold coming from different sources. Fine gold that has been transported relatively long distances from its source is usually purer than coarser gold mined nearer the same source.

The custom of using gold dust in place of money has now passed, except among some of the prospectors, mostly in the Fortymile (fig. 1, *41*) and Koyukuk districts. Gold dust is however purchased by all merchants near the mining camps at a reduction of $1 to $1.50 from its actual value per ounce. Most of the gold dust, retort sponge, and bullion is sent direct to the banks at Nome, Iditarod, Fairbanks, or Anchorage.

The banks conduct their own assay offices, melting all gold received, and settle on the basis of the assay minus a certain deduction for melting, assaying, insurance, express, refining, and marketing. This charge is 2.5 per cent of the gross on amounts under $25,000 and 2 per cent if the amount is $25,000 or more. One bank in an isolated district charges 3 per cent.

The banks ship by express to their representatives in the United States, and the operators not dealing with the local banks ship direct by express or mail. Virtually all of the gold eventually reaches the United States Assay Office at Seattle or the United States Mint at San Francisco. A little goes to the smelters, as does the base bullion. Express rates from virtually any of the camps to Seattle, San Francisco, and other Pacific coast cities normally range from $3.75 to $5 per $1,000 in amounts of $25,000 or more, $4.50 to $5 in amounts less than $25,000, including marine insurance, and in amounts of $1,000 or less are slightly higher. Winter express ship-

ments requiring dog or horse team transportation are practically double the summer rates. Shipments sent by registered first or fourth class mail are limited in weight to 11 pounds. First-class registered mail costs 2 cents per ounce or fraction thereof, in addition to the 10 cents per package for registration fee, with indemnity for loss up to $50. The packages can contain only 3 ounces of gold to be fully covered. Fourth-class mail can be insured up to $100 upon payment of 25 cents in addition to the regular postage.

To allow shipments by registered mail in packages up to 11 pounds in weight, the operator carries a special open insurance policy, which he fills in to cover the shipment, and notifies the insurance company of the details.

ALASKA PLACER-MINING LAW AND TAXATION

An act to supplement the mining laws of the United States in the Territory of Alaska and to repeal an act entitled, "An Act to supplement the mining laws of the United States in their application to the Territory of Alaska; providing for the location and possession of mining claims in Alaska and repealing all acts and parts of acts in conflict herewith to the extent of such conflicts," approved April 30, 1913, was enacted by the Alaska Legislature and approved on April 20, 1915. House Bill No. 48, in chapter 10 of the Session Laws of Alaska, 1915, deals with placer mining, as follows:

PLACER-MINING LAW

SECTION 1. Any person qualified under the laws of the United States who discovers upon the public domain within the Territory of Alaska a placer deposit of gold or other mineral which is subject to entry and patent under the mining laws of the United States may locate a mining claim thereon in the following manner, to wit:

1. He shall post, or write upon the initial post, stake, or monument on the claim, a notice of location containing: (*a*) The name or number of the claim; (*b*) the name of the locator or locators; (*c*) the date of discovery and of posting notice on the claim; and (*d*) the number of feet in length and width of the claim. This notice shall be known as the location notice.

2. He shall distinctly mark the location on the ground so that its boundaries can be readily traced, by placing at each corner or angle thereof substantial stakes, or posts, not less than 3 feet high above the ground and 3 inches in diameter, hewed on 4 sides; or by placing at each corner or angle thereof mounds of earth or rock not less than 3 feet high and 3 feet in diameter and the stakes, posts, or monuments so used must be marked with the name or number of the claim and the designation, by number, of the corner or angle. The initial stake or monument shall be one of the corner stakes, posts, or monuments of the claim located.

If the claim is located on ground that is covered wholly or in part with brush or trees, such brush or trees shall be cut or blazed along the lines of such claim, as to be readily traced.

If located in an open country, the boundary lines shall be located by placing line stakes or line monuments so as to be readily traced from corner to corner of said claim.

SEC. 2. Within 90 days after the discovery and posting of the notice aforesaid, the locator shall record with the recorder of the district wherein such claim is situated, a certificate of location. Such certificate shall contain: (*a*) The name or number of the claim; (*b*) the name of the locator or locators; (*c*) the date of discovery and of posting of the location notice; (*d*) the number of feet in length and width of claim; and (*e*) it shall set forth the description with reference to some natural object, permanent monument, or well-known mining claim, together with a description of the boundaries thereof so far as applied to the numbering of stakes or monuments.

A failure to record a certificate of location of claim as herein provided shall operate as and be deemed abandonment thereof, and the ground so located shall be open to relocation: *Provided*, That if a full compliance with the preceding provisions of this act shall have been made before any location by another, such compliance shall operate to prevent the abandonment or forfeiture of such claim and save the rights of the original locator.

SEC. 3. No association placer-mining claim shall hereafter be located in Alaska in excess of 40 acres, and on every individual or association placer-mining claim located in Alaska after August 1, 1912, and until patent has been issued therefor, not less than $100 worth of labor shall be performed or improvements made during each calendar year, including the year of location for each and every 20 acres or fraction thereof, and where the title of two or more contiguous placer claims has become vested in the same person or persons, or corporation, the said annual assessment work or improvements may be done or made at any place or places on said contiguous placer claims, provided that such work or improvement inures to, and is for the benefit of, the entire area of such placer claims. In computing the value of assessment work or improvements the rate of wages paid in the vicinity for similar work shall be allowed.

SEC. 4. And it is further provided that a survey of the claim or claims by a United States mineral surveyor may be credited to annual assessment work, but in no case shall the credit for such survey and its attendant expense exceed the required assessment for one year on the claim or claims surveyed. When credit is sought for such work or improvement, the claimant must file in the recorder's office in the district in which the claim is situated the field notes of the survey, together with a voucher showing the cost of such survey, properly attested by the surveyor, incorporated into the proof of annual labor as in case of other class of labor or improvements, as provided for in section 7 of this act.

SEC. 5. That no individual placer-mining location hereafter made shall be more than 1,320 feet in its greatest length; and no association placer-mining claim hereafter located shall be more than 2,640 feet in its greatest length.

Any location made containing an excess of ground beyond the limits prescribed in this act, either in area or length, may be relocated as to such excess, but such relocation shall be upon that end of the claim farthest from the initial stake, post, or monument.

SEC. 6. That no power of attorney for the location of placer-mining claims in Alaska shall be valid or have any force or effect whatsoever, nor shall any locations made thereunder be valid or have any force or effect unless such power of attorney be duly executed and acknowledged before an officer authorized to administer oaths and recorded in the office of the recorder for the district in which such claim is located prior to the date of the filing for record

By "net income" is meant the cash value of the output of the mine less operating expenses, repairs and betterments actually made, and royalties actually paid, and all taxes paid under section 2569 of the Compiled Laws of Alaska: *Provided*, That the lessor of any mine operated under a lease shall be deemed to be engaged in mining within the provisions of this act, and the royalties, less the cost of collecting the same, received by him shall be deemed to be the net income within the provisions of this act; but where he receives royalties from more than one mining property he shall pay the tax on the aggregate income over $5,000. No deduction shall be made on account of depreciation of machinery, interest on bonds or money borrowed, or other taxes paid.

* * * * * * *

SEC. 2. Every person, firm, or corporation desiring to engage in any of the lines of business * * * as specified in section 1 shall first apply for and obtain from the Territorial treasurer a license so to do. * * *. If the amount of the tax is not a fixed sum (as in placer mining), the applicant shall state in his application that he agrees to pay the license tax and will make a true return and will pay to the treasurer such tax on or before the 15th of the next ensuing January.

Incomes from placer-mining operations, the sale of placer-mining property, etc., are taxable under the Federal income tax law, the provisions of which are so widely known as to require no further mention here.

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