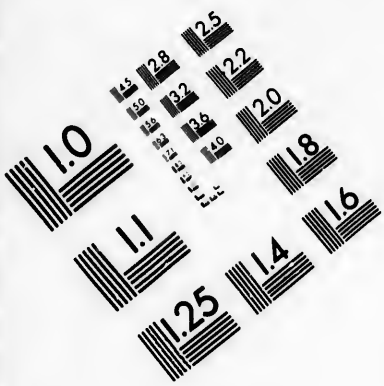

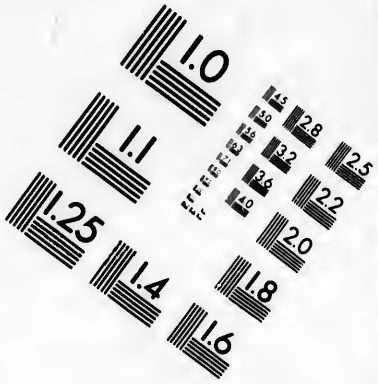

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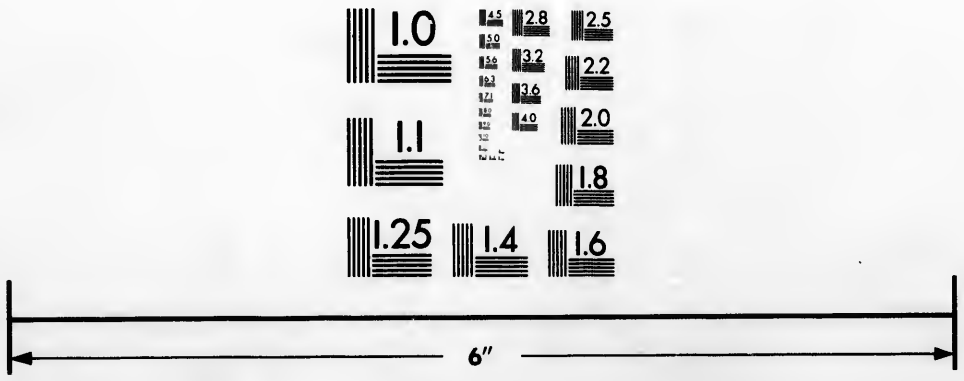

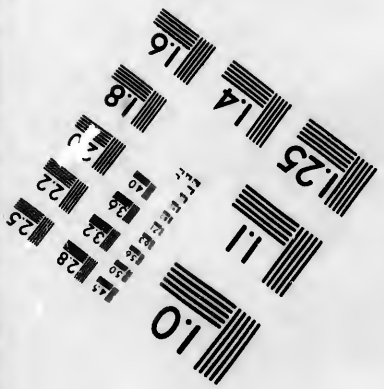

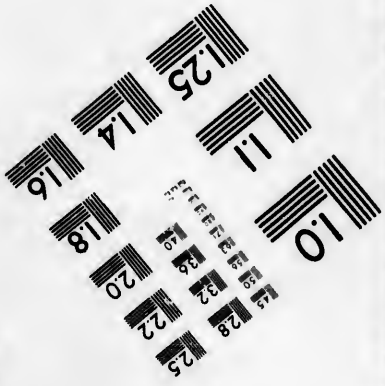

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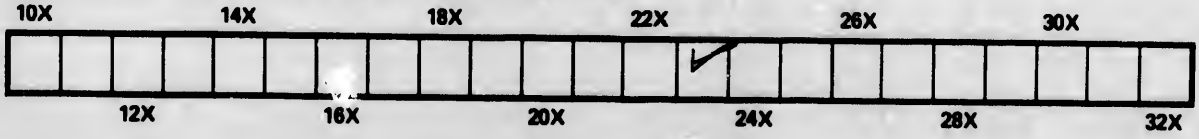

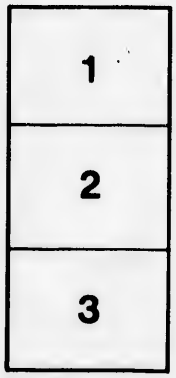

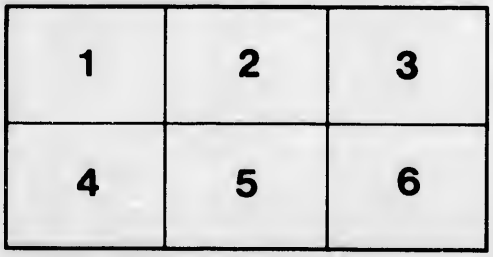

Dredging for Gold

By A. W. Robinson
M. Am. Soc. C. E., M. Am. Soc. M. E.

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DREDGING FOR GOLD

By A. W. Robinson, M. Am. Soc. C. E. and M. E.

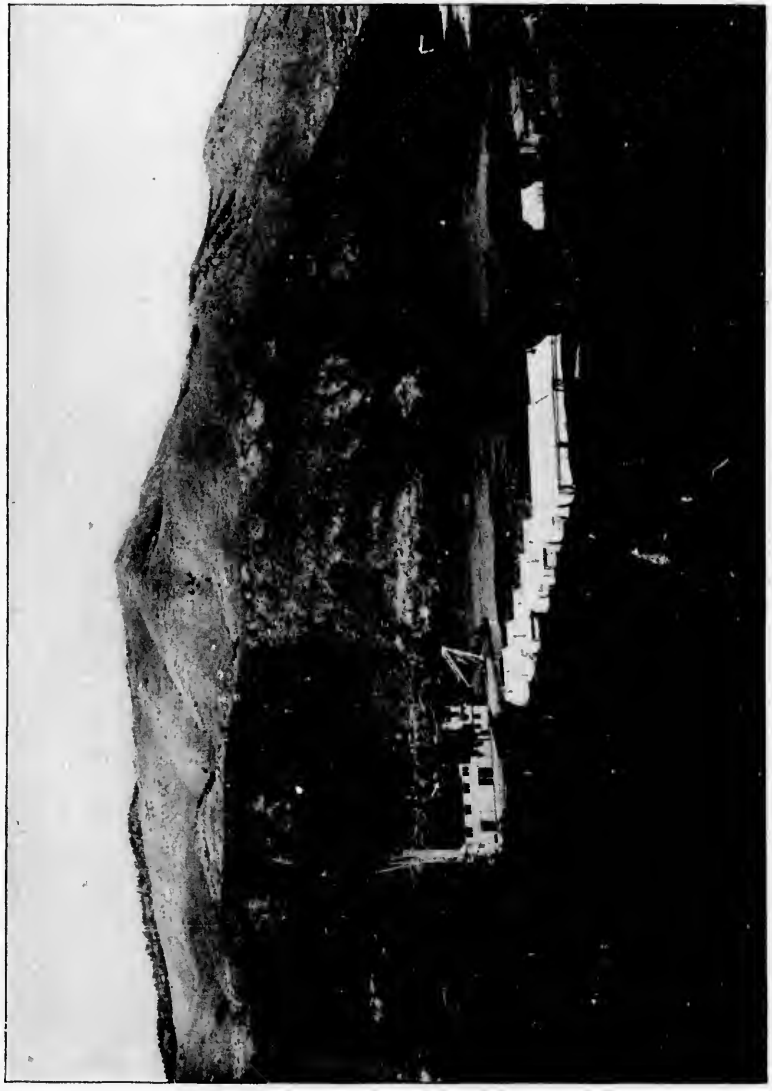
"PANNING OUT"

COINCIDENT with the decline of hydraulic mining for gold in the Great West of the United States, is the rise and velopment of a new process for recovering the precious metal from the alluvial bottoms and river beds which have heretofore been deemed inaccessible. It is the later and more perfect process succeeding the earlier and cruder one, and it makes available vast deposits of gold-bearing gravel which is beyond the reach of hydraulic mining.

Hydraulic mining is at once the simplest and most effective method of saving the bulk of the gold where the conditions exist for its use; but more or less loss occurs in the tailings. Hydraulic mining is the disintegration and washing down of a bank of auriferous gravel by means of a powerful jet of water, and the passing of the resultant water and *debris* off through a sluice-box containing riffles in which the gold is caught. Two essential conditions are necessary to successfully operate this system:—First, the water must be available in large quantity and under heavy pressure; and secondly, there must be a "dump," or natural grade, for the water to run off and deposit the tailings without interruption.

These conditions are found in many places along the banks of rivers and creeks and in the valley sides, situated so that the water can be laid on by a ditch or flume, which taps the stream near its head waters, and, following down the contour of the valley at a gentle grade, is soon far above the river bottom, which has descended more rapidly. A pipe line carries the water down to a "giant" nozzle, which, by the force of a stream, sometimes as much as 6 inches in diameter, from a pipe-line 18 inches in diameter, and with a pressure of several hundred pounds per square inch, does tremendous execution in washing down whole hillsides and spreading them out in the valley below. This harnessing of the forces of nature is so simple and efficacious, so free from complication, and so cheap as to operating expenses, that handsome returns are obtained, notwithstanding its wastefulness.

This simple and attractive system soon began to decline for the reason that the localities favored by nature became gradually exhausted and worked out. Furthermore, the vast volumes of *debris*, washed down into the rivers and fruitful valleys below, became a menace to agriculture and other occupations, so much so that the United States Government appointed the "California Débris Commission" to investigate and regulate the conflicting interests. The proceedings of this commission, and the record of the strife between the gold miners and the land and navigation interests, furnish an interesting chapter in the history of American gold mining, particularly in California.



A BIRD'S EYE VIEW OF THE VALLEY OF THE GRASSHOPPER AT BANNOCK, MONTANA, U. S. A.

The gold in these placer deposits is in the form of finely divided particles, scattered through the gravel. The value is very variable, 10 to 15 cents per cubic yard being accounted poor ground, while 50 cents to $1 would be rich pay. Occasionally pay streaks are found which will run $5 and even $20, or more, per cubic yard, but such streaks do not represent the general average of a deposit.

A cubic yard of gravel and sand will weigh about 2,800 pounds, or nearly a ton and a half. Fifty cents' worth of gold, scattered through this quantity, at $20 an ounce, will weigh only 12 grains. The proportion of gold to gravel by weight is, therefore, 1 to 1,630,000. Inasmuch as gold is eleven times as heavy as gravel, the proportion by volume would be 1 to 17,000,000.

This 50 cents' worth of gold is found usually in finely divided particles. If the particles weigh only a grain apiece, it is called "coarse" gold and can be readily saved in a sluice-box, although the particles are not larger than ordinary sand. Fine gold is of various degrees of fineness down to minute floating particles, scarcely visible to the naked eye, and of which it requires several hundred to make a cent's value.

The marvelous ease with which the apparently infinitesimal and elusive yellow grains, lost amid millions of tons of earth and stones, can be recovered is due to the great specific gravity of gold. Being eleven times heavier than sand and nineteen times heavier than water, it is only necessary to wash the two together, when the gold sinks to the bottom and the lighter sand and gravel are carried off by the rushing water.

The beautiful simplicity of the hydraulic sluicing process in all its forms causes it to be the most widely adopted of any method of gold saving. Its efficiency in fine gold is from 40 to 60 per cent., and in coarse gold, from 70 to 100 per cent. If the gold is wholly coarse, it will save it all.

This lack of efficiency has led many inventors to devise means to save that fraction of the fine gold that is lost in sluicing, but thus far with indifferent success. Several methods of amalgamation have been successfully used, but for thorough work their capacity is so limited that they do not pay.

The gradual erosion of the gold-bearing banks by the streams and rivers naturally causes a deposition of strata lower down, containing more or less gold. These alluvial bottoms, sedimentary bars and beds of streams have, until recently, been considered as beyond the reach of any ordinary method of working.

They were not capable of being washed or sluiced, because they were already at the lowest level. Various

THE ROCKER

attempts to dig the material up and elevate it into sluices, from which it could be worked, were made; but the constant presence of water in such workings and the great cost, or impossibility of drainage, rendered such efforts abortive. Miners were compelled to be content with scratching the surface or sinking shallow pits until overcome by the water, and speculating upon the unknown and untold riches that lay just beneath their feet.

The bottom of the alluvial deposit, or "bed rock," as it is termed, is generally where the richest pay is found,

due to the natural gravitation of the gold. Thus it comes about that attention has been turned to dredging as a method of reaching these deep and submerged deposits effectively. On the face of it a simple enough problem,

CLEANING UP A SLUICE BOX

yet what vast sums have been spent in the mistaken efforts of those who did not fully appreciate all the conditions involved, and how elusive the little yellow grains are when attacked under water! The seductiveness of the gold attracts many to engage in a mad and determined search for it, and it is not strange that, like moths around a candle, some should come to grief.

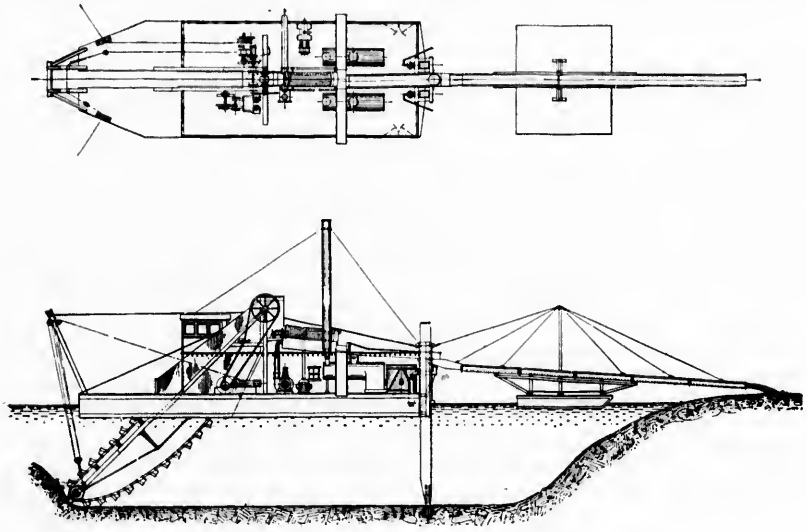
The truth is that gold mining is a business which must be learned, like any other business, and it is just as amenable to the natural laws which govern it as any other of the practical sciences. What would be said of a tailor who engages in watch making, or of a merchant who endeavours to design a bridge or a locomotive? Yet we see the merchant, the manufacturer, and the business man launch out into gold mining, and make simple calculations of the enormous wealth that can be taken out of their claims at so much per cubic yard, and assume all the responsibility of the practical and technical work. The primitive mode of hand washing is by the "pan,"—a shallow dish of sheet steel about 18 inches across and 3 inches deep, with a flat bottom and flaring sides. The little cut at the head of this article shows a miner panning out some samples with which he seems well satisfied. The much-used expression, "pan out" has its origin in the early gold-mining days, when, after careful washing down to the last fine particles, the results in the pan were eagerly looked for. Inasmuch as there are about a hundred pans to the cubic yard, it will be seen that a cent's worth of gold to the pan would be valuable ground when worked by modern wholesale methods.

"Panning" gold is a simple and rapid operation to an experienced miner, but to the novice it is slow and laborious. By a few gyratory movements with the lip of the pan under water the bulk of the gravel is quickly washed over the edge of the pan, while the gold settles to the bottom. The process is then continued, with repeated lappings of the water carrying off a little sand and gravel each time, until there remains only a small quantity of the heavy magnetic "black sand" always found in gold-bearing gravel. In this sand the occasional gleam of a "golden colour" is seen, and then comes the interesting and delicate part of the operation. Every grain of black sand must be carefully washed away, leaving the grains of gold perfectly clean.

The determination of values can be made only by weighing the results of a large number of pans, or from a definite volume of material, but the

number of "colours" to a pan is often used to indicate values. A "colour" is a particle of gold apparent to the eye, and as the visible particles vary in size from a pin's point upward, they can have no definite value.

Next following the "pan" is the "rocker." This is the panning operation performed continuously in a wooden box mounted on rockers, and fitted with a sieve and shelves below which serve as sluice-boxes for catching the gold. The miner, as shown on page 35, shovels the gravel into the rocker, then rocks it with one hand, and dips water into it with the other. Many wandering miners make a living by "rocking" out the surface gravel in selected spots along river bars and in favourite points in valley-bottoms.

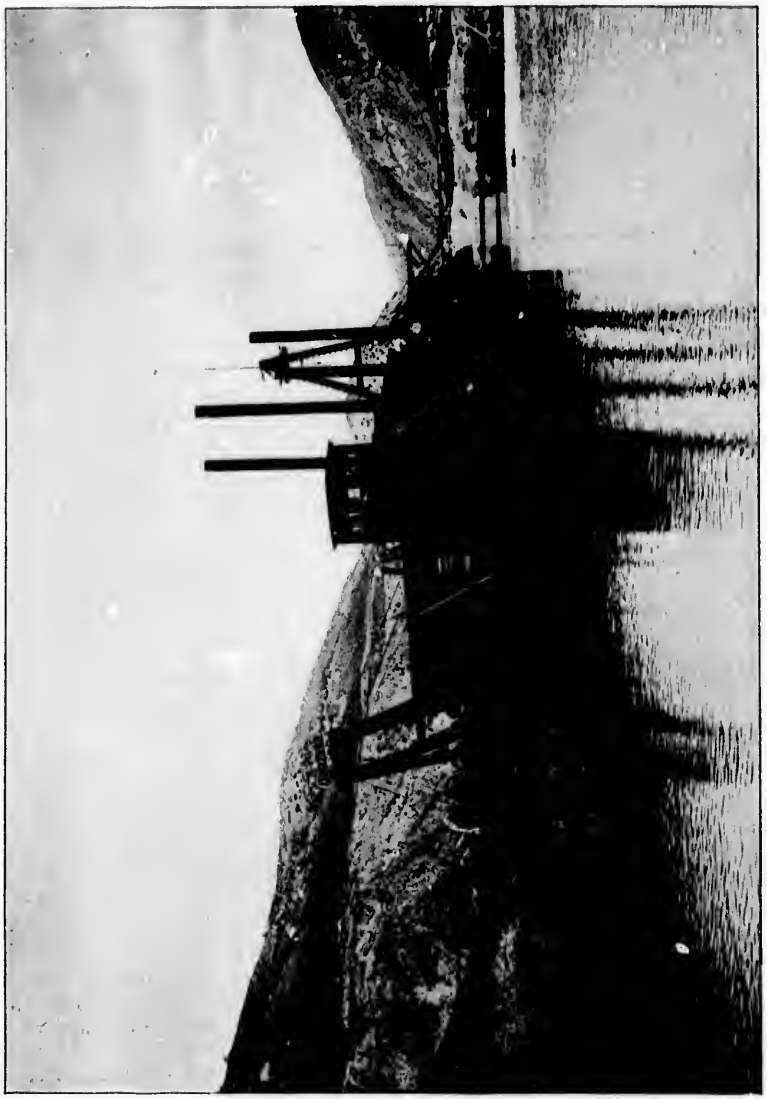


PLAN AND SECTION OF A GOLD DREDGER

From these primitive methods came the suggestion of the larger and more wholesale methods of dredging. It was only necessary to combine a dredging machine and a sluicing and washing apparatus in order to reach at once these precious deposits. The problem proved, however, much less simple than it seemed, and many experiments were tried before the final type of dredge was evolved and perfected.

Almost every known type of dredge has been tried for gold dredging. One of the most attractive types is the suction, or hydraulic dredge, which sucks up the sand and gravel with a large quantity of water. The water, thus pumped up, thereafter serves the purpose of sluicing, being practically one operation. There is a difference of opinion concerning the utility of using a centrifugal pump, or suction dredge, for handling gold-bearing gravel. It is claimed by some that grains of gold can be elevated and carried through the discharge pipe of the pump, because the velocity of flow is so much greater than the velocity at which grains of gold will fall through the water. This is true, and if the grains of gold could be introduced into the mouth of the suction pipe they would assuredly be elevated and passed through the pump into the riffles, and would there be caught.

But this is not the difficulty with this form of dredge. The difficulty is that the force of the suction, being intense close to the suction pipe and rapidly



A REPRESENTATIVE TYPE OF GOLD DREDGE

decreasing in intensity a short distance from the suction, causes all the sand and gravel to be picked up and leaves the gold behind, due to its greater specific gravity. Furthermore, the suction dredge cannot work in stones or bowlders. The use of a centrifugal pump, therefore, for cleaning up the bottom and picking up the gold is impracticable, especially if the gold be coarse and the bed rock uneven. A rotary cutter on the suction pipe does not remedy the difficulty, because it only agitates the gravel and further precipitates the gold.

The dipper dredge has also been used, but in most cases has been abandoned, although it is an admirable machine as a dredge and will handle any ordinary material. It is not adapted for placer-mining, because it disturbs the gravel in the act of digging, so that a considerable portion of the gold is lost. It is well known that agitation of gold-bearing gravel under water induces the precipitation of the gold; in fact, it is precisely this quality on which the whole operation of sluicing and gold washing depends.

It is, moreover, mechanically impossible to construct a dipper door which will be absolutely water-tight. Naturally, therefore, much of the fine gravel in the bottom of the dipper leaks out and carries gold with it. Various packings and devices for making the dipper door water-tight have been tried, but none are successful. A certain amount of looseness is necessary to its proper working. A bit of gravel would prevent a tightly fitted door from closing, and it would inevitably become loose by wear in any case.

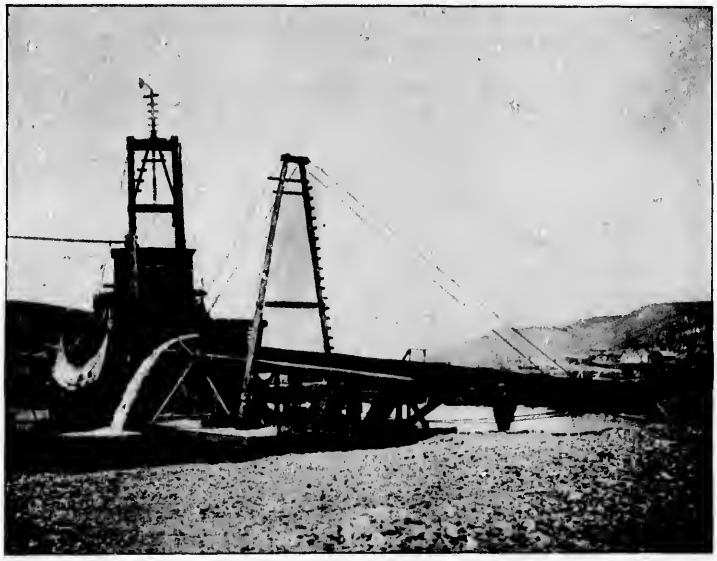
Another objection to the dipper dredge is that it deposits the material intermittently, several tons at a time, and at a long distance from the centre of the dredge, so that it is difficult to take care of the material delivered in this way. It is necessary to have a large hopper either on the bank or on an auxiliary scow, and to feed the gravel out of this hopper into sluice-boxes or other appliances.

The same objections apply to the clamshell form of dredge to an even greater degree, as it is by no means water-tight, and loses most of the gold in the act of bringing up the gravel.

In the elevator dredge none of the foregoing objections are found. The action of the endless chain of buckets is slow and quiet, and the material is picked up clean from the bottom with the smallest amount of agitation, and in a manner best calculated to retain the gold. The buckets are water-tight, and retain their entire contents until emptied by inversion at the top. The delivery of material is continuous and at the centre of the boat, instead of being intermittent and at a distance over the side of the boat, as in the dipper dredge. The elevator buckets also bring up a considerable proportion of water, which facilitates the washing operation, and the material is brought up in smaller masses than in the case of the dipper dredge, and, hence, is more easily broken and disintegrated in the screen. For all of these reasons it is the ideal type of dredge for river mining. This conclusion is confirmed by the fact that all the dredges in the Australian and New Zealand gold fields are of this type, and a large number of them are successfully in use there.

The elevator, or chain-bucket dredge, is not new; in fact, it is one of the earliest known types. Some very good dredges of this type were brought to America from the Clyde in 1832 for use on the river St. Lawrence. They had engines of the side-lever type, and did very effective work with 6 pounds of steam.

On the opposite page is shown a typical gold dredge. This machine consists of the following elements:—1st, the dredging apparatus proper, comprising the chain of buckets and means for driving them; 2d, a steel hopper into which the material is discharged; 3d, a revolving screen in which it is washed and by means of which the coarse stones are rejected; 4th, a sluice-box for carrying off the fine tailings and discharging them astern; and 5th, a centrifugal pump



AN ELECTRICALLY OPERATED DREDGE

for furnishing the necessary water for sluicing and washing purposes. All these details have been successfully combined so as to make a complete machine, capable of dredging and treating 3,000 cubic yards of material per day. The operations are simple and continuous, and under perfect control.

The vastness of the field thus opened up is incalculable. Thousands of miles of good gravel deposits, beyond the reach of all other known methods, can now be made available at a low working cost. One of these dredges can do the work of a thousand men working in the old way; and not only that, it can reach depths and clean up bed rock that would be totally inaccessible by the combined labour of any number of men. The work of gold dredges has already become a perceptible factor in the world's production of gold, and it is yet in its infancy and bound to increase.

Among the earliest successful dredges are those at Bannock, Montana, on Grasshopper Creek, in the United States, where three dredges are at work. The ground is not phenomenally rich, varying from 10 cents to 40 cents per cubic yard; but the dredges have maintained a steady average of work which has yielded "clean-ups" varying from $500 to $3000 per day.

On page 34 is shown a bird's-eye view of the valley of the Grasshopper with one of the dredges in the distance. The creek is quite small, averaging 20 feet wide by a foot deep; but the dredges work out the whole area of the valley bottom and work at different levels controlled by dams.

The whole field of dredging for gold is yet in its infancy, and it offers a promising field for investment under proper conditions. A large amount of placer-mining property yet remains to be opened up that can be worked only by dredging. The improvement of modern methods, by which large capacity can be maintained at low operating cost, renders the working of low-grade ground possible at a good profit. The proverbial uncertainty of mining is largely eliminated, and by taking proper precaution and proceeding on business principles, dredging for gold becomes simply a manufacturing proposition.

There are many good claims and river leases lying undeveloped for want of capital and for want of knowledge of how to produce certainty of results. If the results can be assured with reasonable certainty, capital will not be slow to embrace the opportunity. Many costly experiments have been made, some of which have been total failures, some partial failures and some successes. Capitalists, naturally and wisely, are reluctant to put money into schemes that may result in similar failure. An intelligent examination of these cases shows that in every instance failure has been due to some evident cause.

Some of these causes are the following:—

1st, the adoption of the wrong type of dredge, such as suction, clamshell, and other unsuitable types, which, for specific reasons, cannot be made a success for dredging gold; 2d, erroneous diagnosis of the conditions to be fulfilled as to the character of material and method of working, and the consequent lack of adaptability of the machine to those conditions; 3d, faulty design of the machinery, either in general arrangement or detail, so that it fails in point of insufficient capacity, frequent breakdowns, inability to dispose of tailings, inability to clean "bed rock," inability to save the gold, and excessive cost of operation in proportion to work done; 4th, poor management; 5th, not enough gold in ground to pay; 6th, organisation by a "promoter" for stock jobbing purposes; 7th, operation by an "inventor" who has a new machine, and can do what no one else has ever done; 8th, lack of capital to efficiently carry on the enterprise; 9th, ground not suitable for dredging; and, 10th, character of gold such that it cannot be commercially saved.

"Forewarned is forearmed," and to avoid these and other rocks and shoals it is necessary to have a knowledge of them. It is practically impossible for any one but an expert to determine all the points that must be covered from a mechanical, commercial and legal point of view; but enough has been said to indicate the general character of this new industry and the lines on which it can be successfully carried on.

HYDRAULIC SLUICING